RC1xxx-xSM-DK
Sensor module Development Kit User Manual

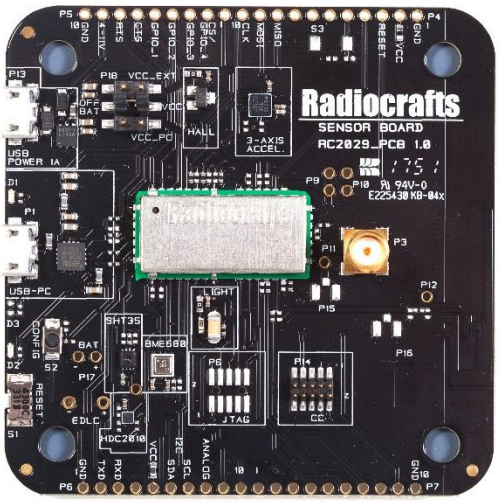


Table of contents

Development Kit Introduction

The Development Kit (DK) is designed to make it easy for the user to evaluate the onboard sensor module, tune the application and build prototypes very quickly.

This document covers the following kits.

KIT	Technology
RC1180-MSM-DK	Wireless M-Bus, 868 MHz
RC1701HP-MSM-DK	Wireless M-Bus, 169 MHz
RC1682-SSM-DK	Sigfox (RZ1), 868 MHz
RC1692HP-SSM-DK	Sigfox (RZ2/RZ4) 915 MHz

Your Development Kit contains the following items:

Kit contents (Sigfox kit)	
Item	*Number of articles*
Sensor board w/radio module	1
Antenna, 50Ω quarter-wave monopole, SMA male connector	1
USB cable (micro)	2
USB power supply	1

Kit contents (MBUS kit)	
Item	*Number of articles*
Sensor board w/radio module	1
MBUS development board	1
Antenna, 50Ω quarter-wave monopole, SMA male connector	2
USB cable (micro)	2
USB cable (Type A)	1
USB power supply	1
AC/DC adapter	1 (RC1701HP only)

The sensor board contains the selected module with embedded protocol and associated support circuits.

This User Manual describes how to use the Development Kit and provides detailed documentation for the Sensor board.

Sigfox Kit

The Sigfox sensor board is delivered with pre-coded ID, PAC and encryption key and with a 12 month subscription.

It you have an active Sigfox network in your region you can register the device at Sigfox and actively see data from the sensor module on the Sigfox cloud.

If you want to test the Sensor board, but do not have Sigfox coverage, a Sigfox SDR dongle is needed to receive packets. This is available from Sigfox : https://build.sigfox.com/sdr-dongle.

For details about the PC-tool, Sigfox registration and activation process, the RC16xxxx-SIG-DK_Quick_Start[1] is mandatory reading, The information there is also relevant for the sensor board, except downlink and the way Sigfox messages are generated.
For detailed information on using the RC16xx-SSM modules see [2],[3] and [4].

MBUS Kit

For MBUS kit a sensor board is delivered together with a standard MBUS development board. The development board can be used a concentrator/gateway/receiver for the sensor board.

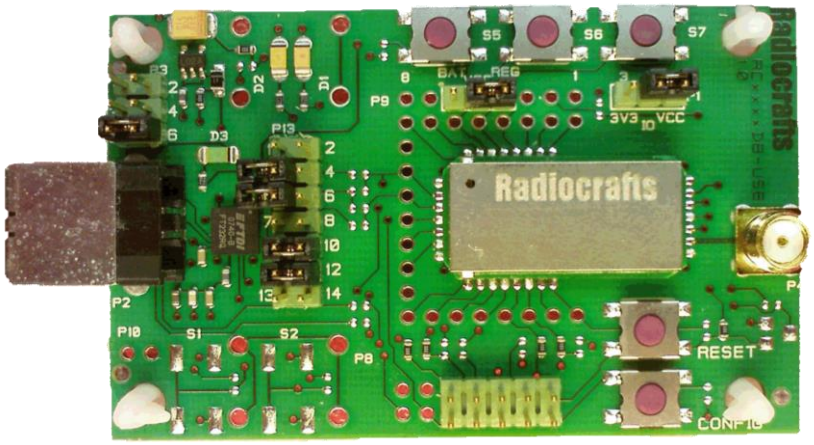


Figure 1. RC1180-MBUS3 development board

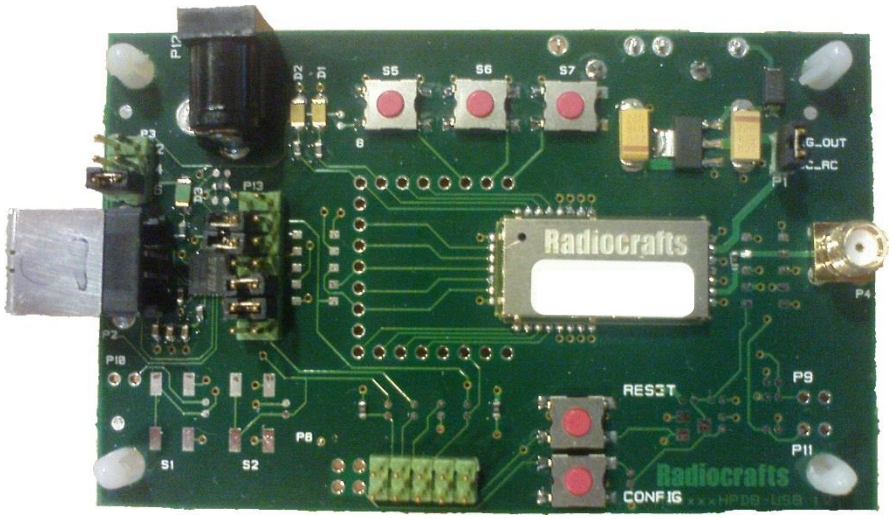


Figure 2 RC1701HP-MBUS4 development board

MSM Quick Start

The MSM Demonstration Kit is designed to make it easy for the user to evaluate the module, do prototyping and develop an application.

The demonstration Kit consists of two boards: The Sensor Board and the MBUS development board. To have a demo up and running in minutes, follow this guideline:

1. If you are using a **RC1701HP-MSM-SB**:
    a. Connect the USB power adapter to P13
    b. Ensure the jumper described in “Powering the Sensor Board” (later in this document) is set to “USB power 1A”
2. If you are using a **RC1180-MSM-SB**:
    a. Ensure the jumper described in “Powering the Sensor Board” (later in this document) is set to “USB PC”
3. Connect the SB to a PC using the USB cable on P1
4. Connect the MBUS development board to a PC using USB
5. Open the MBUS-Demo tool (Free download at www.radiocrafts.com)
6. The boards are already set up to use all the supported sensors on the board and transfer data every minute. Therefore, all that is needed is to start the packet sniffer in the MBUS-Demo tool:
    a. Connect to the COM-port of the MBUS development board (not the SB)
    b. Press “Read module setting” arrow in the “Module Quick Setup” tab
    c. Select MBUS Packet Sniffer tab
    d. Press start
7. Packets should now start appearing in the list

To understand the data received, refer to the RCxxxxxx-MSM User Manual

Default key configuration parameters:

Parameter	**Setting**
RF Power	Maximum
MBUS Mode	T1
M-field A-field VER DEV	0x4824 (Radiocrafts) 0x12345678 0x01 0x00
Transmission interval	1 minute
Encryption	Not used
Sensors used	**GPIO** : GPIO1 : out (LED), GPIO2-4 : inputs **ADC** : AIN (via light transistor), Temp, VDD **HDC2010** : Temperature + Humidity **SHT35** : Temperature + Humidity **LIS3DE** : X,Y,Z-axis

Detailed parameter list

Parameter	**RC1180-MSM**	**RC1701HP-MSM**
RF_Power	0x05	0x05
MBUS_MODE	0x01	0x01
MAN_ID1	0x48	0x48
MAN_ID2	0x24	0x24
MBUS A-Field ID1	0x12	0x12
MBUS A-Field ID2	0x34	0x34
MBUS A-Field ID3	0x56	0x56
MBUS A-Field ID4	0x78	0x78
MBUS A-Field VER	0x01	0x01

MBUS A-Field DEV	0x00	0x00
CI_FIELD	0x7A	0x7A
TX INTERVAL_H	0x00	0x00
TX INTERVAL_L	0x01	0x01
BATTERY_THRESHOLD	0x66	0x66
ENCRYPT_FLAG	0x00	0x00

SSM Quick Start

The SSM Demonstration Kit is designed to make it easy for the user to evaluate the module, do prototyping and develop an application.

The demonstration Kit consists of one board. To have a demo up and running in minutes, follow this guideline:

1. If you are using a **RC1692HP-SSM-SB**:
    a. Connect the USB power adapter to P13
    b. Ensure the jumper described in “Powering the Sensor Board” (later in this document) is set to “USB power 1A”
2. If you are using a **RC1682-SSM-SB**:
    a. Ensure the jumper described in “Powering the Sensor Board” (later in this document) is set to “USB PC”
3. Connect the SB to a PC using the USB cable on P1
4. The boards are already set up to use all the supported sensors on the board and transfer data every 10 minutes. You have two options to receive packets:
    a. Using the Sigfox network. See https://www.sigfox.com/en
    b. Using the Sigfox Network Emulator (SNE) together with an SDR Dongle. See https://build.sigfox.com/sdr-dongle
5. Default setup is to use public key and address, which enables you to use the SDR. This can be changed by changing the parameter “Public Key and Address” (configuration address 0x28)
6. You will now see packets arriving either at the SNE or Sigfox backend, depending on your setting.

To understand the data received, refer to the RC16xxxx-SSM User Manual

Default key configuration parameters:

Parameter	**Setting**
RF Frequency domain	ETSI (RC1682-SSM) FCC (RC1692HP-SSM)
Transmission interval	15 minutes
Public Key and Address	1 (Yes)
Sensors used	**GPIO** : GPIO1 : out (LED), GPIO2-4 : inputs **ADC** : AIN (via light transistor), Temp, VDD **HDC2010** : Temperature + Humidity **SHT35** : Temperature + Humidity **LIS3DE** : X,Y,Z-axis

Sensor Board Introduction

The Sensor Board includes the module to be evaluated. In addition it contains other circuitry needed for powering and communication to the module. All I/O signals are routed to holes at the edge suitable for 2.54 mm pitch pin headers for easy monitoring and control externally.

The board includes 6 different sensors and a controllable LED to demonstrate GPIO control options.

Sensor	Manufacturer	Sensor Type
SHT35	Sensirion	Precision Temperature and Humidity Sensor
HDC2010	Texas Instruments	Low Power Temperature and Humidity Sensor
BME680	Bosch Sensortech	Environmental sensor (**Not supported in MSM v1.0 / SSM v2.0**)
ALS-PT-315C	Everlight	Analogue Light Sensor
SL353LT	Honeywell	Hall detector
LIS3DE	ST	Accelerometer

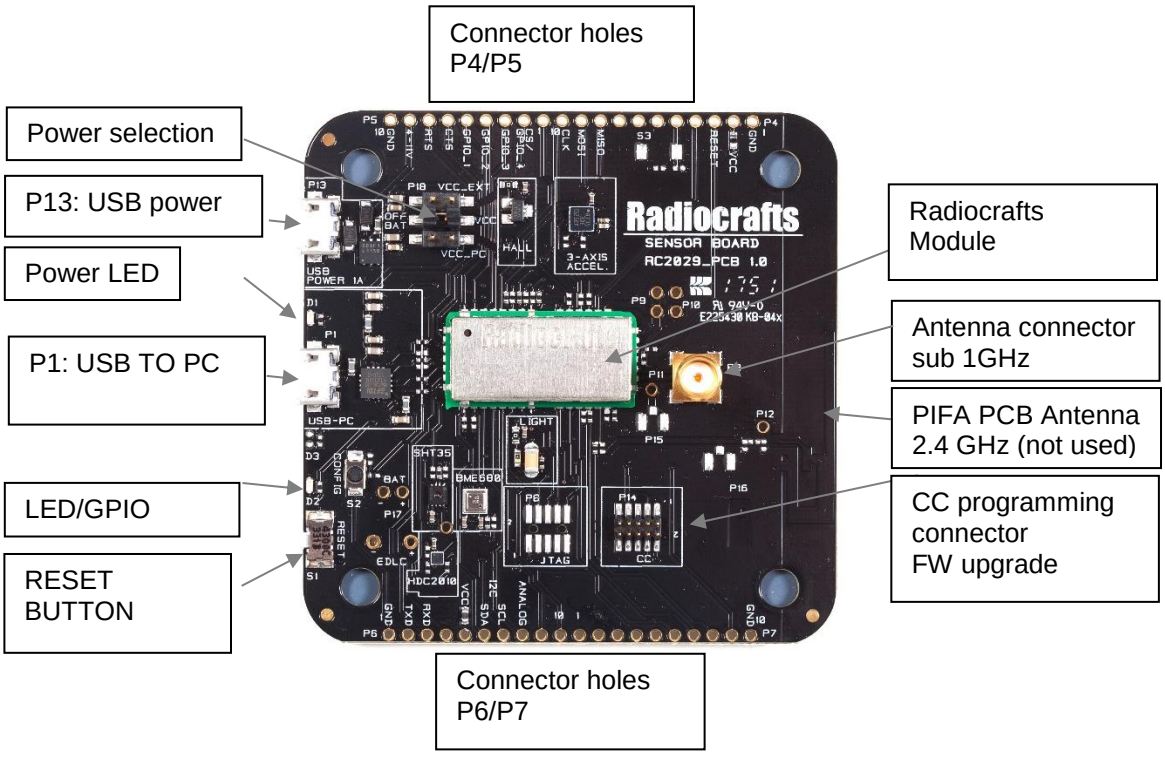


Figure 3: Sensor Board

Block Diagram Sensor Board

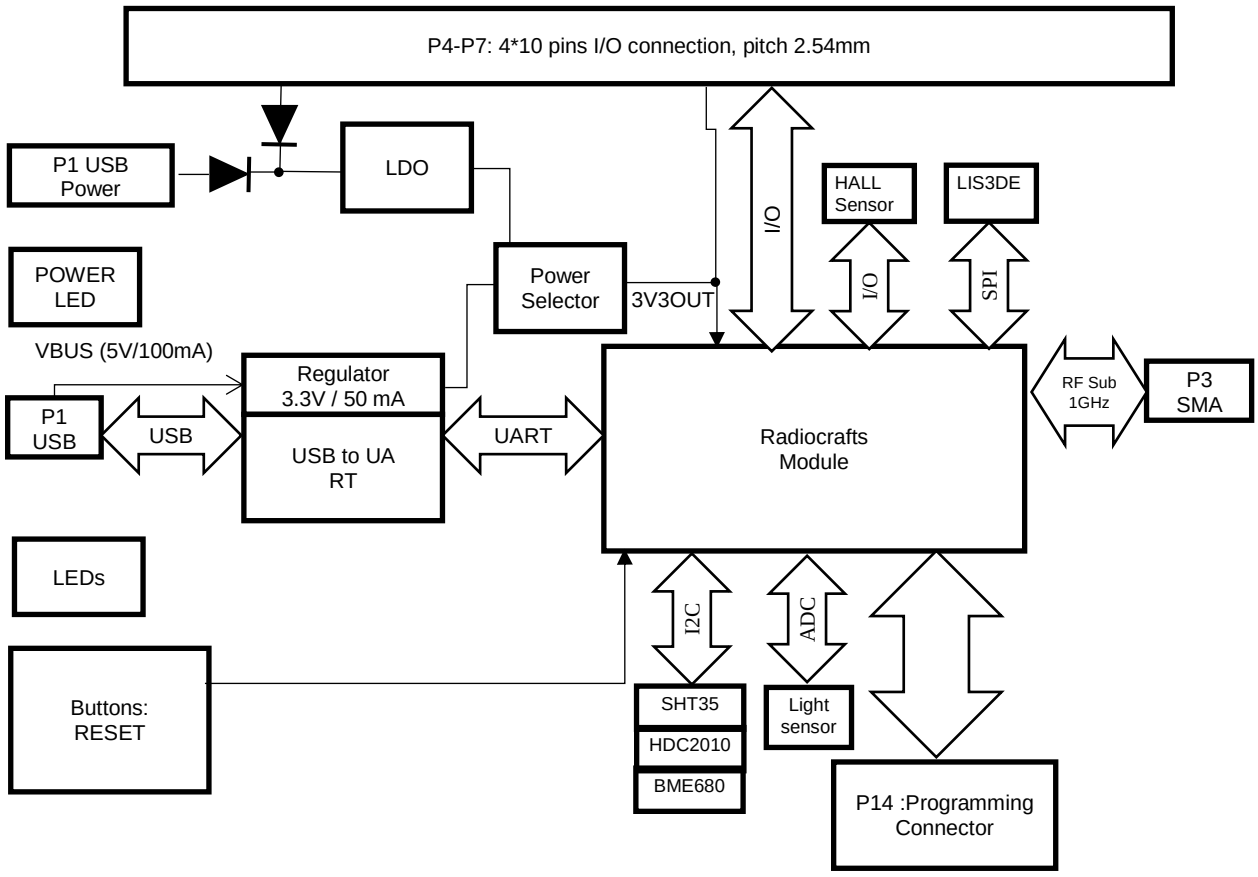
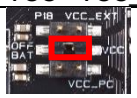
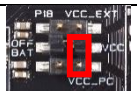


Figure 4. Block schematic Sensor board

Powering the Sensor Board

The sensor board can be power in several different ways, thus giving flexibility and ease of use.

Power source	Jumper position/RED	Comment
USB power 1A	 VCC - VCC_EXT	Make sure to use a USB power source capable of 1 A. A PC does normally not offer that high current
Extern Volt 4-11 V /9V battery	 VCC - VCC_EXT	Connect through pin holes at edge. Here a 9V battery can also be connected. NB: Using VCC > 6V, continuous transmission test mode cannot be used.
Battery 3.0/3.6V	 VCC - OFF/BAT	Battery can be connected
USB PC	 VCC – VCC_PC	Only for RC1180MSM. The others draw too high current

The sensor board is setup with a green power on LED, D1. This draws 2 mA and is always on. In case of using the sensor board for battery operated proof of concept, this LED need to be removed to ensure low power consumption

Controlling and Configuring Sensor Board

The sensor module can be controlled and configured through UART. For ease of use the UART is connected through a UART-to-USB bridge from FTDI and to a micro USB contact. By connecting a computer to this USB connector on the sensor board, a terminal emulator program can be used to communication with the module. There is also a config button on the board to easily put the module in configuration mode. See datasheets [3][4][6][7] and user manual [2][5] for details on communication via UART.

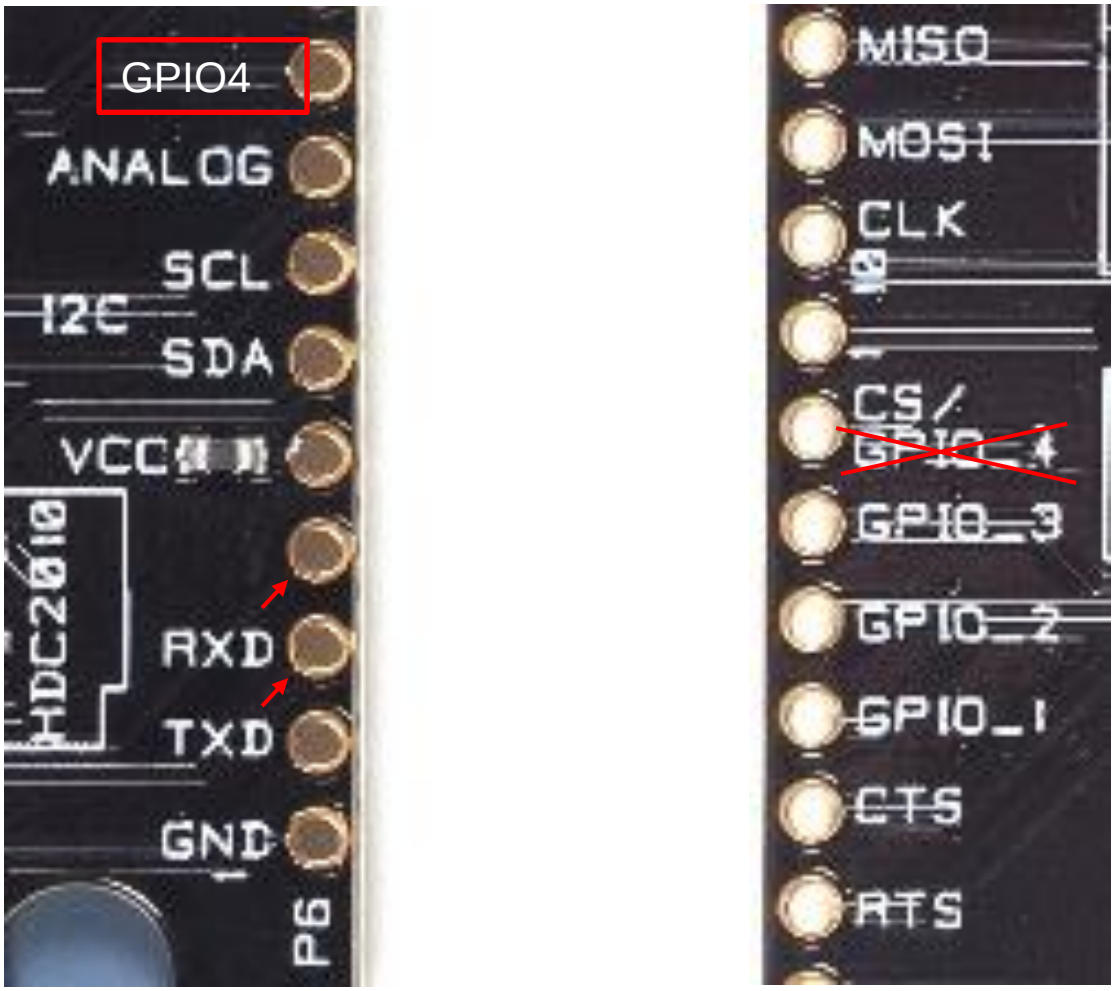
I/O Connection

All pins to the module are available through standard pin rows using a pitch distance of 100 mils (2.54 mm). These pins are connected to 4 x 10 pins holes named P4 to P7. The table below gives an overview of the edge connectors and their logical signals. Details on the pinning can be found in module datasheet.

I/O connection				
Connector	**PIN**	**Signal**	**Module PIN**	**Note**
P4	1	GND		
	2	VCC		Not used
	3	RESET		
	4	Not used		Reserved for future use
	5	Not used		
	6	Not used	32	
	7	Not used	33	
	8	Not used	34	
	9	SPI_MISO	35	
	10	SPI_MOSI	36	
P5	1	SPI_CLK	37	
	2	Not used	38	Internally used. DO not connect!
	3	SPI_CS	39	
	4	HALL_OUT	40 (GPIO3)	
	5	DRDY	41 (GPIO2)	
	6	LED_1	42 (GPIO1)	
	7	CTS	2	
	8	RTS	3	
	9	VCC_4_11V	4	
	10	GND		
P6	1	GND		
	2	CONFIG	5	
	3	TXD	6	TXD output (Connected to USB FTDI chip)
	4	RXD	27	RXD input (Connected to USB FTDI chip)
	5	VCC	8	Via EMI bead to module
	6	SDA	9	
	7	SCL	10	
	8	LIGHT_OUT_ ANALOG	11	
	9	DIO_24	12 (GPIO4)	
	10	TMSC	13	
P7	1	TCKC	14	
	2	DIO_16/TDO	15	
	3	DIO_17/TDI	16	
	4	DIO_26	17	
	5	DIO_27	18	
	6	DIO_28	19	
	7	DIO_29	20	
	8	DIO_30	21	
	9			Not connected
	10	GND		

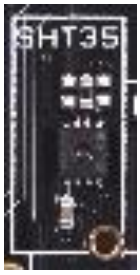
I/O Silkscreen

On revision 1.0 of the sensor board there are some inaccuracies in the silkscreen print.
GPIO4 is marked the wrong position and marking of RXD/TXD is offset.
See below



SHT35 Temperature and Humidity Sensor

SHT35 is the next generation of Sensirion's temperature and humidity sensors. It has a typical accuracy of ± 1.5 %RH and ± 0.1 °C. It connected to sensor module by I2C and is setup with I2C address 0x44.



HDC2010 Low Power Temperature and Humidity Sensor

The HDC2010 is an integrated humidity and temperature sensor from Texas Instruments, with very low power consumption and in an ultra-compact package. I has an accuracy of ± 2 %RH and ± 0.2 °C. It connected to sensor module by I2C and is setup with I2C address 0x40.

The data ready pin is connected to the GPIO-2 of the sensor module.

BME680 Environmental sensor

BME680 is an integrated environmental sensor developed specifically for mobile applications and wearables where size and low power consumption are key requirements. The sensor reads is a 4-in-1 sensor that measure gas, humidity, pressure and temperature. It connected to sensor module by I2C and is setup with I2C address 0x76.

ALS-PT-315C, Analogue Light Sensor

The ALS-PT-315C is light sensor that gives an analogue output based on the illuminance (Lux). The output is connected to the analogue input of the sensor module. On the sensor board this sensor is always on.

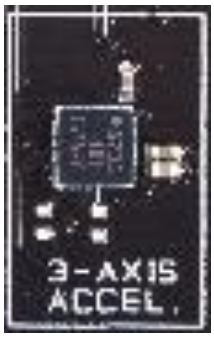
SL353LT Hall Detector

The SL353LT is a state-of-the art hall detector that enable magnetic detection. It has a very low power consumption of 1.8 uA in average for 2.8V operation. The output of the hall detector is connected to GPIO-3 on the sensor module.

LIS3DE Accelerometer

The LIS3DE is an ultra-low-power high-performance 3-axis linear accelerometer belonging to the "nano" family, with digital I²C/SPI serial interface standard output. The device features ultra-low-power operational modes that allow advanced power saving and smart embedded functions.

It is connected to the sensor module via the SPI and GPIO-4 is the chip select pin.



Blue LED

There is a blue LED on the board (D2) that is connected to GPIO-1 of the sensor module. This is used to demonstrate the GPIO output control capabilities of the sensor module.

Prototyping with the Sensor Board

The sensor board is well suited for prototyping/bread boarding. With all I/O pins easily accessible at the edge, connection to external boards can be made through board stacking with standard pin headers or cabled with standard 2.54 mm pitch cable.

With angled header mounted on I/O connector, the sensor board can also be mounted vertically to other boards with 2.54mm pitch connectors.

The idea is that an external application specific circuitry/sensors etc. easily can be connected to the sensor board as a proof of concept for the final product.

The sensor board is built to fit a commercially off the shelf enclosure named *Router Cube* from New Age Enclosure. Available at Mouser. The sensor board is not delivered with enclosure. Machining for connectors/antenna is required.

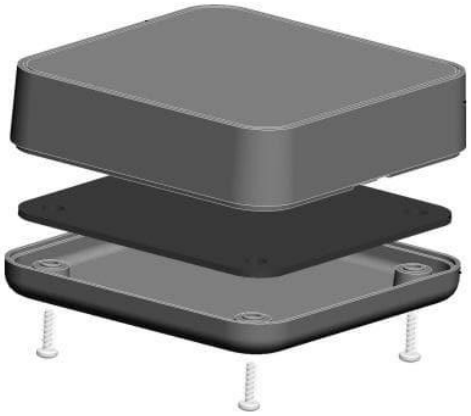


Figure 5 Optional enclosure from New Age Enclosures

Sensor Board PCB and Assembly Layout

The PCB is a simple 4-layer board where Layer 2 is used as ground plane. The laminate used is standard FR-4 board material. The PCB is 1.6mm thick. Full resolution layout and assembly drawing are found in [8]

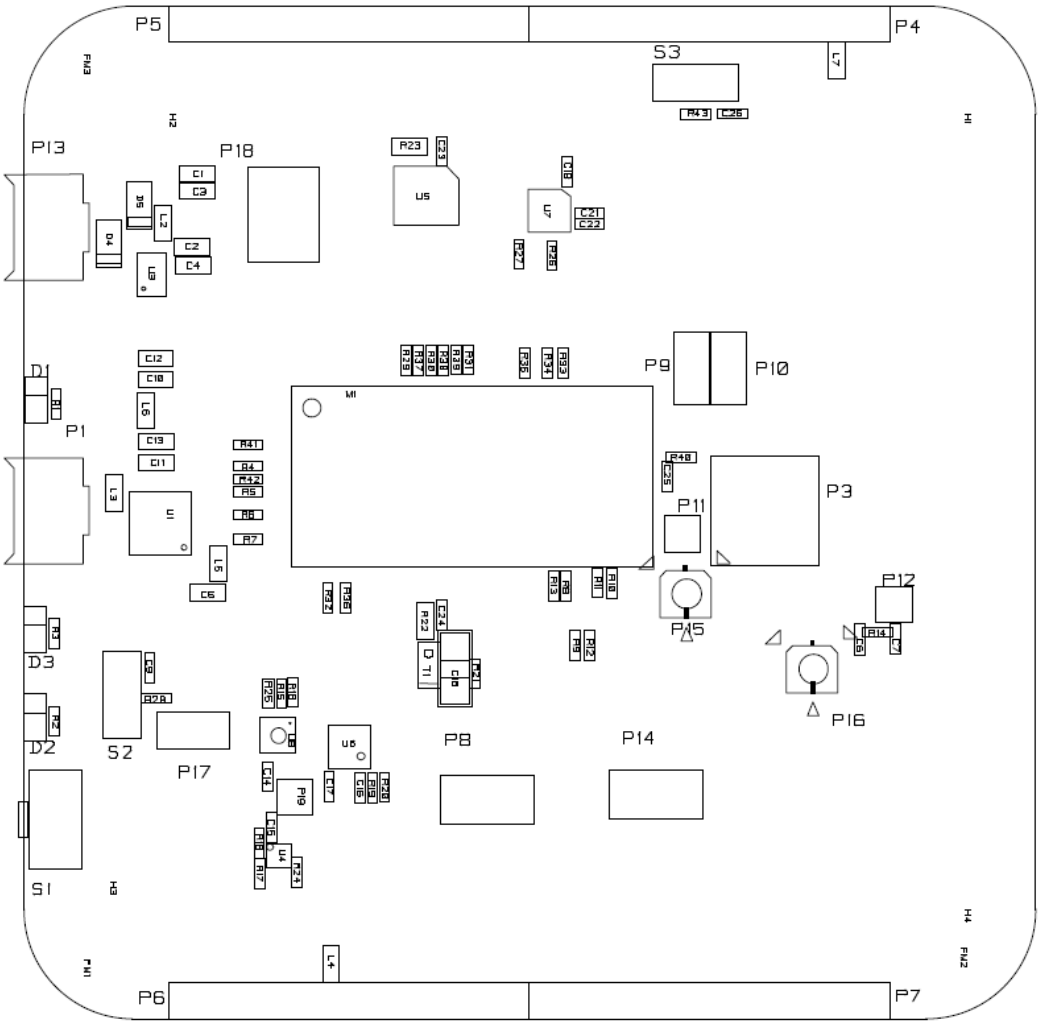


Figure 6. Sensor Board PCB component placement, top side

Programming/debug connector

Programming debug connector (P14) is connector with 1.27mm pitch. This can be used for firmware upgrade. A CC-debugger programming device is needed to upgrading.

Sensor Board Circuit Diagram

The circuit diagram of RC1xxx-xSM-SB is in figure 6. For better quality please see PDF in [8]

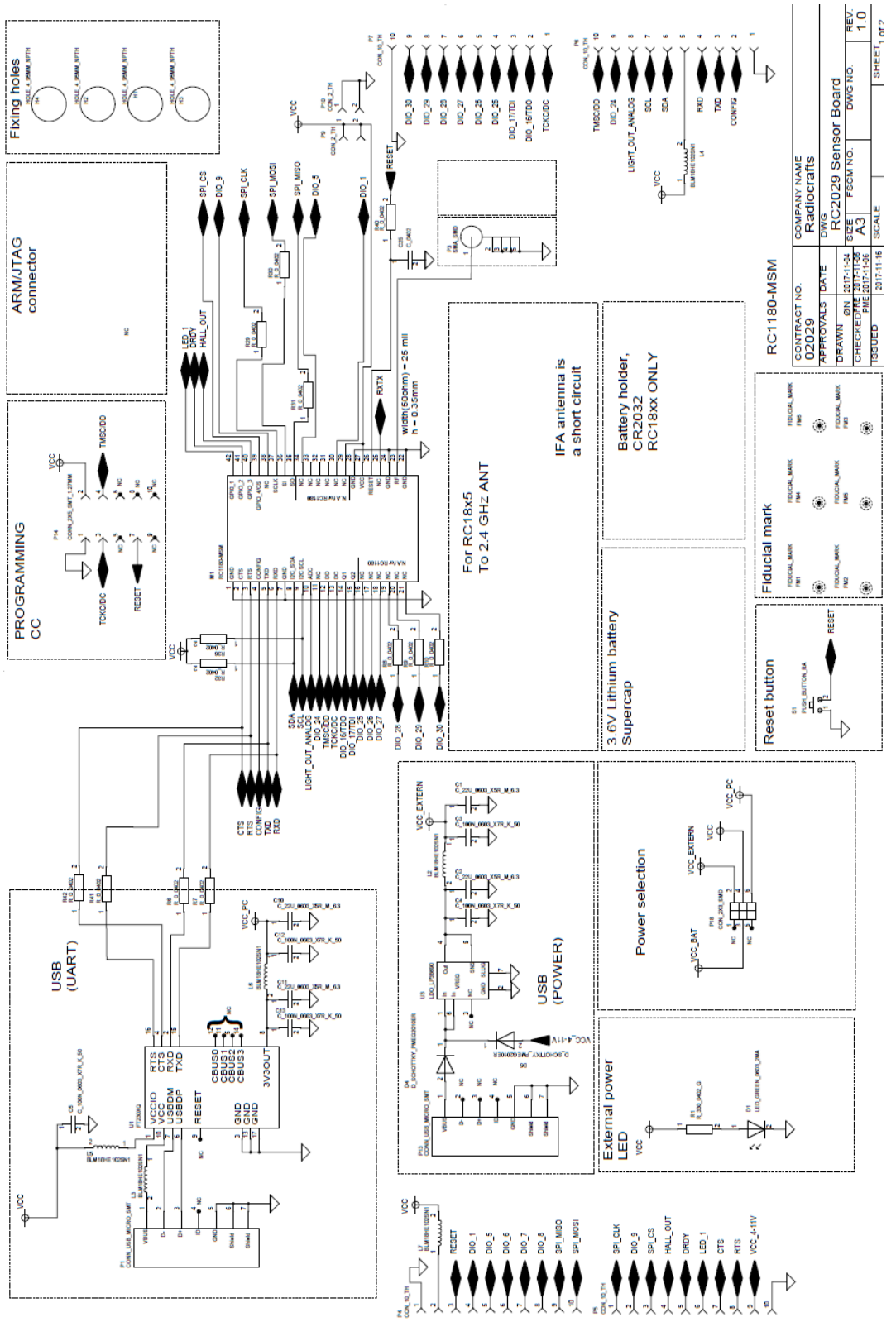


Figure 7: RC1xxx-xSM-SB Circuit diagram, page 1

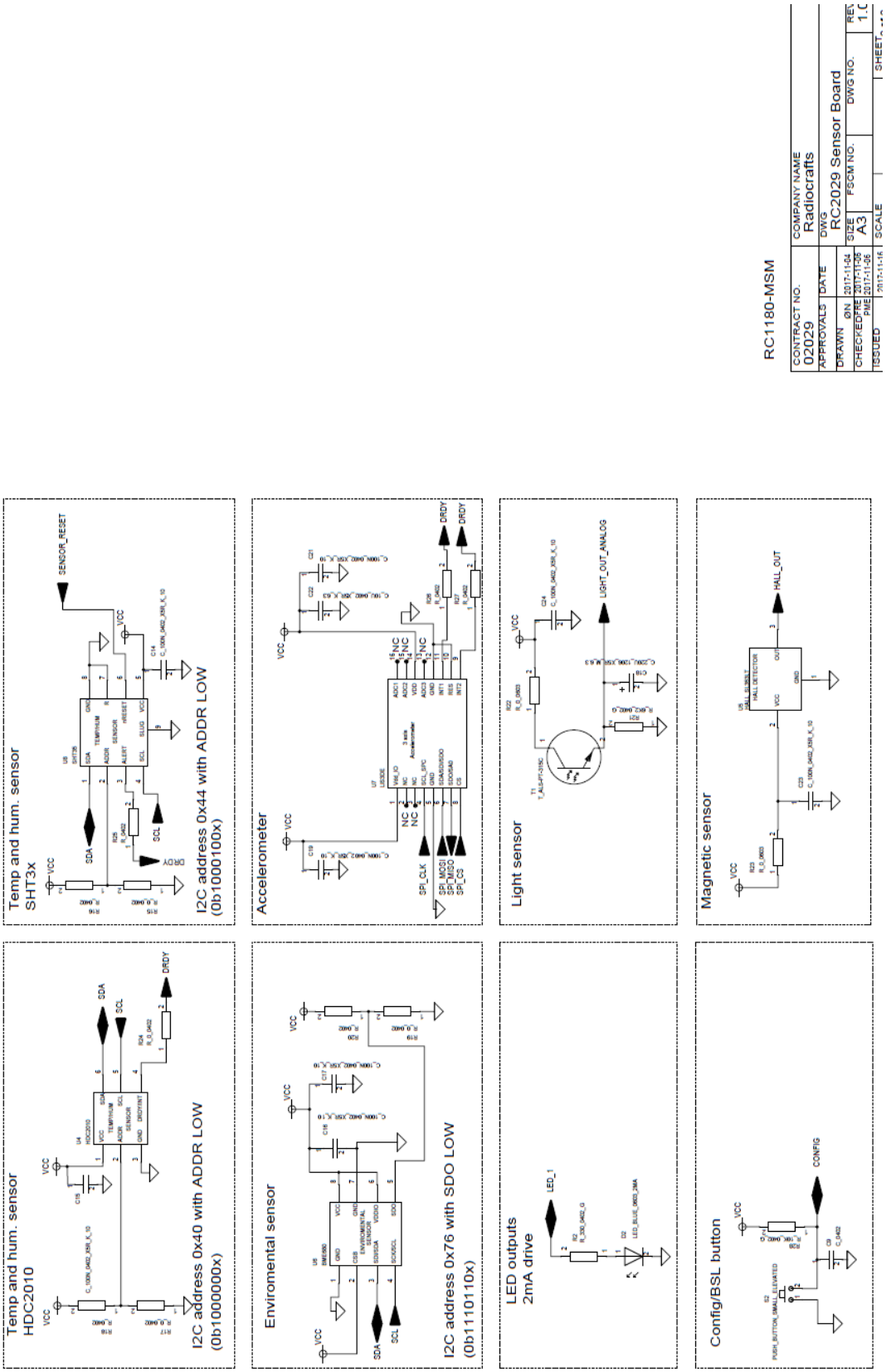


Figure 8: RC1xxx-xSM-SB Circuit diagram, page 2

Sensor Board Bill of Materials

The circuit diagram includes all components of RC1xxx-xSM-SB, but the Bill of Material describes which components are mounted. Details are listed in the following table. Components not mounted are marked *DNM (Do Not Mount)* in the 'Quantity/# column.

Bill of materials for Sensor board			
Reference	*Quantity*	*Part number*	*Description*
L2-7	6	BLM18HE102SN1	EMI filter bead, 1000ohm@1GHz
U6	1	BME680	Environmental sensor
P14	1	CONN_2X5_SMT_1.27MM	Connector 2x5 SMT with 1.27 mm spacing
P8	*DNM*	CONN_2X5_SMT_1.27MM	Connector 2x5 SMT with 1.27 mm spacing
P1;P13	2	CONN_USB_MICRO_SMT	USB micro connector SMT
P4-7	*DNM*	CON_10_TH	Connector, 0.9mm pin
P11-12;P19	*DNM*	CON_1_TH	Connector, 0.9 mm pin
P18	1	CON_2X3_SMD	Connector, 2x3 pins, SMD, pitch 2.54mm
P9-10;P17	*DNM*	CON_2_TH	Connector, 0.9 mm pin
P2	*DNM*	CR2032_HOLDER	HOLDER for coin cell
C6-7; C9;C25;C26	*DNM*	C_0402	Capacitor, 0402, general
C14-17;C19; C21;C23-24	8	C_100N_0402_X5R_K_10	Capacitor, 0402
C3-5;C12-13	5	C_100N_0603_X7R_K_50	Capacitor, 0603
C22	1	C_10U_0402_X5R_K_6.3	Capacitor, 0402
C18	1	C_220U_1206_X5R_M_6.3	Capacitor, 1206
C8	*DNM*	C_1206	Capacitor, 1206
C1-2;C10-11	4	C_22U_0603_X5R_M_6.3	Capacitor, 0603
C20	*DNM*	C_VSCM_005R4_155A	EDLC capacitor, 1.5F, 5,4V
D4-5	2	D_SCHOTTKY_PMEG2010ER	Schottky diode, low Vf =.24V @ 200mA
U1	1	FT230XQ	FTDI USB to UART
U5	1	HALL_SL353LT	Hall sensor, low duty cycle, SOT23
U4	1	HDC2010	Temp and humidity sensor
U3	1	LDO_LP38690	Low drop regulator, 3.3V, 1 A, 3x3mm WSON
D2	1	LED_BLUE_0603_2MA	LED 0603 Blue 2mA If
D1	1	LED_GREEN_0603_2MA	LED 0603 Green 2mA If
D3	*DNM*	LED_YELLOW_0603_2MA	LED 0603 Yellow 2mA If
U7	1	LIS3DE	3 axis accelerometer
S1	1	PUSH_BUTTON_RA	Push button, SMD, Right angled
S2	1	PUSH_BUTTON_SMALL_ELEVATED	Push button, SMD
S3	*DNM*	PUSH_BUTTON_SMALL_ELEVATED	Push button, SMD
M1	1	RF module, depend on variant of board RC1682-SSM RC1692HP-SSM RC1180-MSM RC1701HP-MSM	Sensor module
R3-5 ;R11-14 ;R16;R18;R20; R25-27; R32;	22	R_0402	Resistor, 0402, general

R33-35;R36; R37-39;R43			
R6-10; R15; R17; R19; R24;R29-31; R40-42	15	R_0_0402	Resistor, 0402
R22-23	2	R_0_0603	Resistor, 0603
R28	1	R_10K_0402_G	Resistor, 0402
R1-2	2	R_330_0402_G	Resistor, 0402
R21	1	R_6K2_0402_G	Resistor, 0402
U8	1	SHT35	Temp and humidity sensor
P3	1	SMA_SMD	Surface-mount SMA, straight
T1	1	T_ALS-PT-315C	Phototransistor, ambient light, SMT
P15-16	2	UFL_CONNECTOR	U.FL compatible connector

References

[1] RC16xxxx-SIG-DK_Quick_Start
[2] RC16xxxx-SSM_User_Manual
[3] RC1682-SSM_Datasheet
[4] RC1692HP-SSM_Datasheet
[5] RC1xxx-MSM_User Manual
[6] RC1180-MSM_Datasheet
[7] RC1701HPHP_MSM_Datasheet
[8] RC1xxx-xSM-SB_web (zip)

Document Revision History

Document Revision	Changes
1.00	First release
1.10	Added MSM Quick Start
1.20	Added SSM Quick Start

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