
METATRACKER
PRODUCT
SPECIFICATION v1.0



MetaTracker

Environmental sensing and cargo tracking product solution

Product Specification v1.0

Key Features

- Nordic Semiconductor nRF51822 BLE SoC
 - 2.4 GHz transceiver
 - ARM[®] Cortex™-M0 32 bit processor
 - 256 kB flash program memory
 - 16 kB RAM
- Numonyx™ M25PX16 16Mbit NOR Flash Extended Log Memory
 - 100,000 write cycles
 - 20 year data retention
- Bosch[®] BMI160 6-Axis Accelerometer/Gyroscope
 - ±2g/±4g/±8g/±16g selectable scale
 - 125/250/500/1000/2000 degrees/sec
 - Industry leading 900uA active current gyro
- Bosch[®] BME280 Digital Humidity / Pressure Sensor
 - 30 to 110 kPa range
 - 0.16 Pa resolution
- Lite-On[®] LTR-329ALS-01 Ambient Light Sensor
- Bright RGB LED
- Miniature push-button switch
- Accurate Thermistor Temperature Sensor
- I/O Expansion
 - Digital I²C Bus
 - 4 Analog/Digital Pins
 - 2 Digital Pins
- Industrial 52mm x 35mm x 15mm Flanged ABS Casing
 - IP54 capable when forgoing humidity/pressure sensor port hole
- 29mm x 29mm x 10mm Electronic Assembly Including Battery
- Powered by high capacity CR2450 Lithium Coin Cell
 - Subject to fewer shipping restrictions than rechargeable Lithium Polymer
- FCC, IC, CE, Telec certification

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1 Introduction

MetaTracker is a complete development and production platform for Environmental sensing and cargo tracking. It features the ultra-low power nRF51822 SoC, providing energy efficient smartphone communication and central processing. MetaTracker integrates this radio with high value sensors and a coin cell battery architecture into a miniature form factor. All circuits have been designed from the ground up with energy efficiency in mind.

2 Product Overview

2.1 Block Diagram

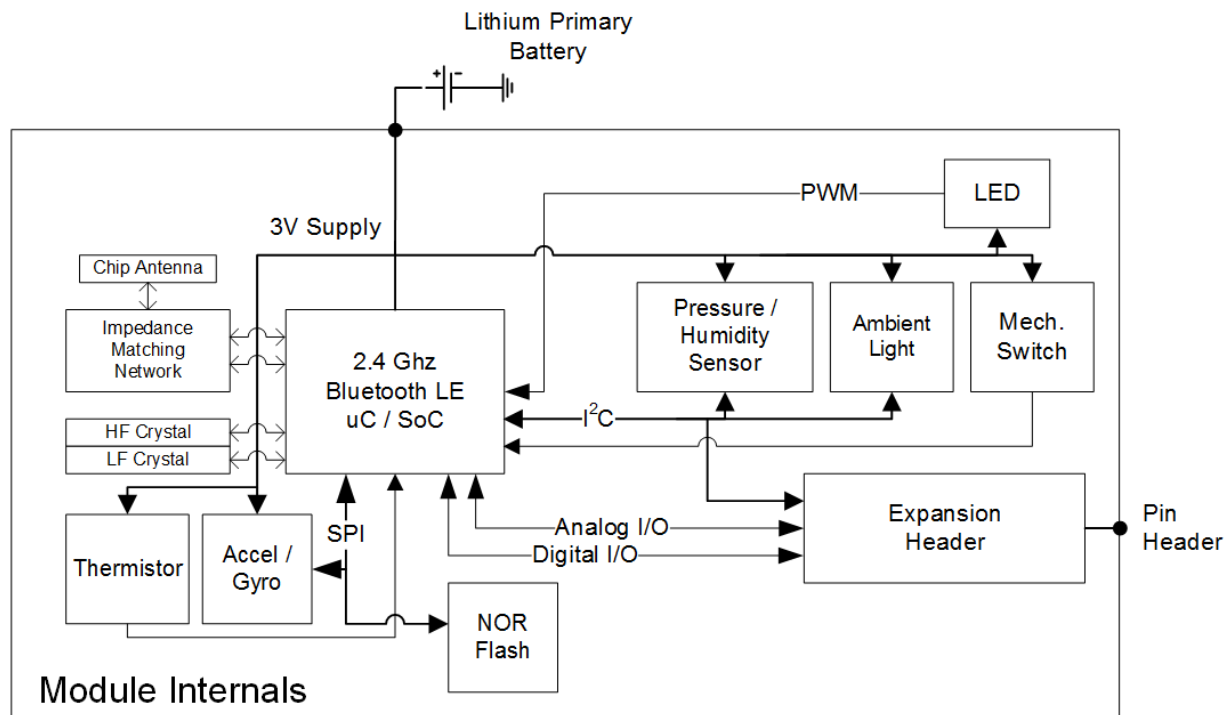


Figure 1 Block Diagram

2.2 Back Side Pin Assignments

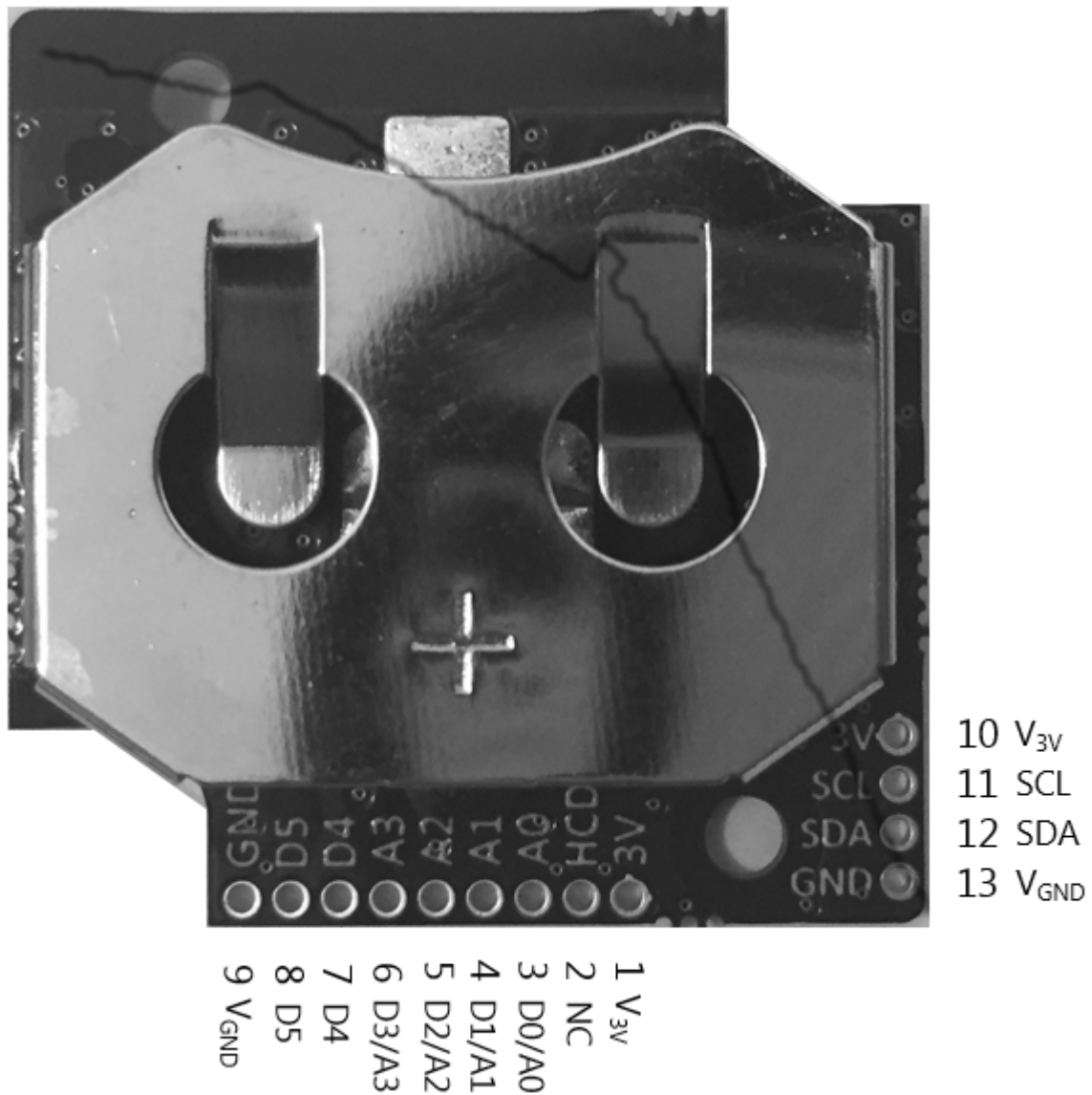


Figure 2 Back side Pin Assignments

2.3 Front Side Pin Assignments

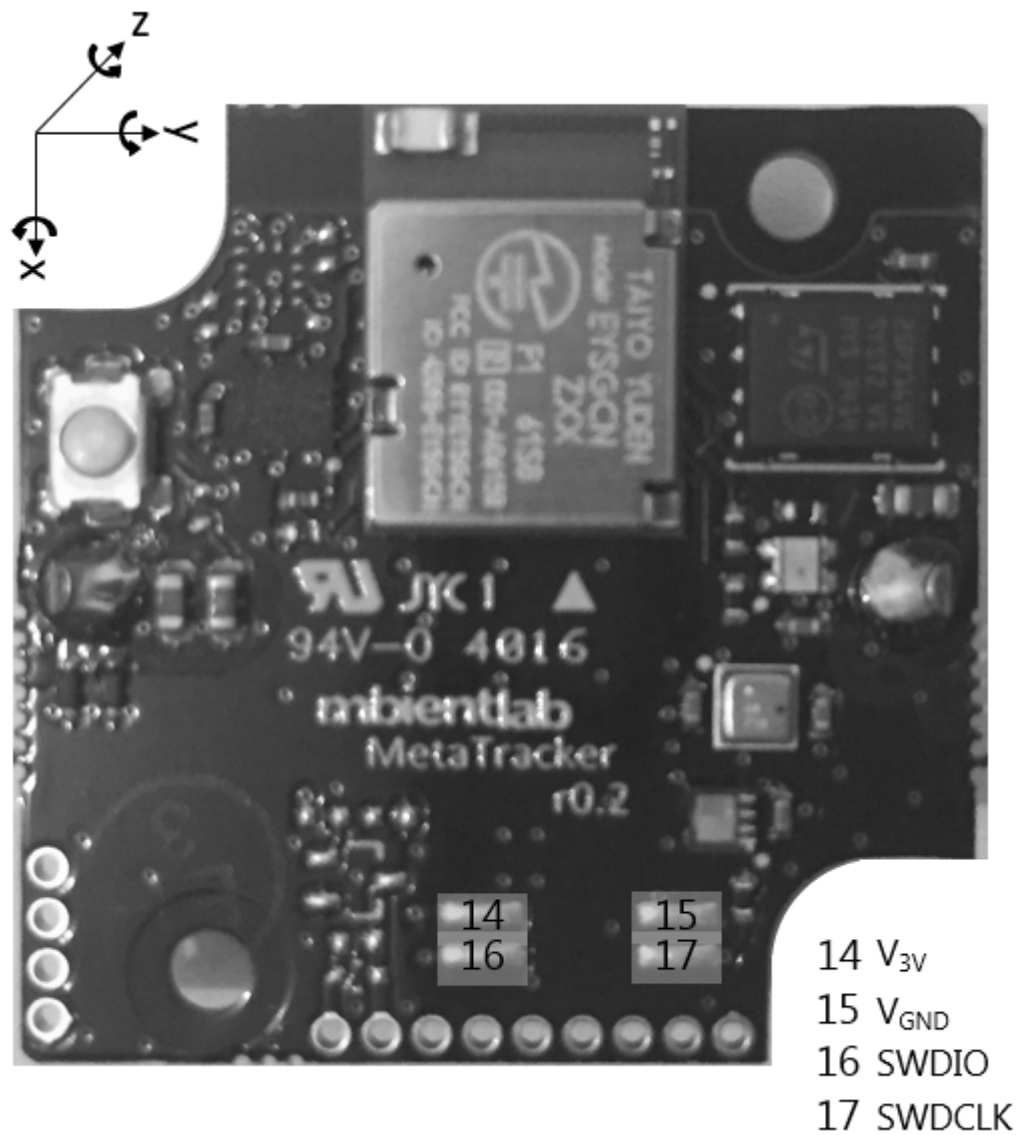


Figure 3 Front side Pin Assignments

2.4 Pin Functions

Pin	Pin Name	Function	Description
Power Supply			
1, 10	V _{3V}	Power	+3V battery connection.
9, 13	V _{GND}	Power	Ground connection.
Peripherals			
2	NC	No Connect	Not connected.
3	D0/A0	Digital I/O Analog I/O	General purpose I/O and analog input.
4	D1/A1	Digital I/O Analog I/O	General purpose I/O and analog input.
5	D2/A2	Digital I/O Analog I/O	General purpose I/O and analog input.
6	D3/A3	Digital I/O Analog I/O	General purpose I/O and analog input.
7	D4	Digital I/O	General purpose I/O.
8	D5	Digital I/O	General purpose I/O.
11	SCL	I2C Clock	I2C clock line.
12	SDA	I2C Data	I2C data line.
SWD Debug Header			
14	V _{3V}	Power	System supply for debugger.
15	V _{GND}	Power	System ground for debugger.
16	SWDIO/nRESET	Debug	SWD debugger I/O line and system reset.
17	SWDCLK	Debug	SWD debugger clock line.

Table 1 Pin Functions

2.5 Module to SoC Pin Mapping

Module Pin	nRF51822 Pin	Function	Description
GPIO			
D0/A0	P0.06	GPIO	General purpose I/O and analog input.
D1/A1	P0.05	GPIO	General purpose I/O and analog input.
D2/A2	P0.04	GPIO	General purpose I/O and analog input.
D3/A3	P0.03	GPIO	General purpose I/O and analog input.
D4	P0.13	GPIO	General purpose I/O.
D5	P0.15	GPIO	General purpose I/O.
I2C			
SDA	P0.16	Serial Bus	I ² C serial data.
SCL	P0.18	Serial Bus	I ² C serial clock.
Internal Module Pins			
	P0.10	Switch	Micro Push Button. Active Low.
	P0.01	Thermistor En	Active High Enable for Thermistor.
	P0.02	Thermistor Voltage	Voltage output from Thermistor Voltage Divider.
	P0.29	Acc/Gyro Interrupt	INT1 Pin of BMI160.
	P0.28	Acc/Gyro Interrupt	INT2 Pin of BMI160.
	P0.30	Acc/Gyro SCK	SCK Pin of BMI160/M25PX16.
	P0.00	Acc/Gyro MISO	MISO Pin of BMI160/M25PX16.
	P0.07	Acc/Gyro MOSI	MOSI Pin of BMI160/M25PX16.
	P0.11	Acc/Gyro nCS	nCS Pin of BMI160.
	P0.25	NOR Flash nCS	nCS Pin of M25PX16.
	P0.23	NOR Flash nWP	nWrite Protect Pin of M25PX16.
	P0.17	LED Red nEn	Current Sink for Red LED Channel.
	P0.19	LED Green nEn	Current Sink for Green LED Channel.
	P0.21	LED Blue nEn	Current Sink for Blue LED Channel.

Table 2 Module Pin Mapping

3 Circuit and Sensor Details

3.1 NOR Flash

The NOR Flash M25PX16 is attached to the shared SPI bus, with dedicated nCS and nWP pins as detailed in the SoC mapping table.

3.2 Humidity / Barometric Pressure Sensor

The Humidity and Barometric Pressure Sensor BME280 is attached to the shared I²C bus at slave address 0x77.

3.3 Accelerometer / Gyroscope

The 6-axis accelerometer and gyroscope sensor BMI160 with pin numbers detailed in the module to SoC mapping table.

3.4 Ambient Light Sensor

The Ambient Light Sensor LTR-329ALS-01 is attached to the shared I²C bus at slave address 0x29.

3.5 Mechanical Switch

The GPIO internal pullup resistor should be used with the mechanical switch, which is active low.

3.6 Thermistor Temperature Circuit

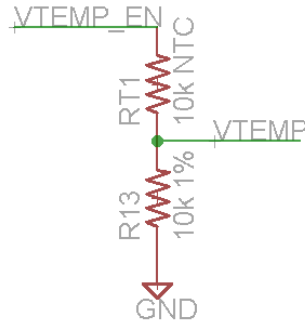


Figure 3 Thermistor Temperature Circuit

The thermistor circuit features a voltage divider and active high enable for power saving. Details on the sensor characteristics can be found in the data sheet for part number NCP15XH103F03RC.

3.7 RGB LED Circuit

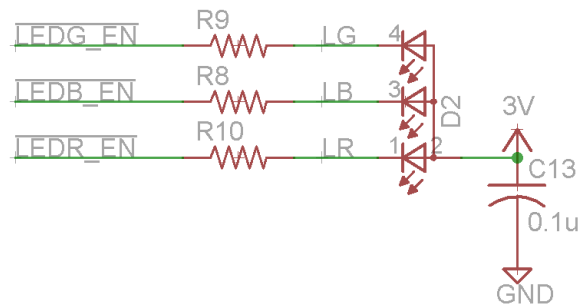


Figure 4 RGB LED Circuit

The RGB LED channels are driven by an active low PWM signal from the SoC. The resistance values have been chosen to approximately match intensity at 100 percent duty cycle. The high current bit should be set on the GPIOs to sink up to 5mA.

3.8 32Mhz High Frequency Crystal

If the MetaWear firmware is erased for native development, the SoC needs to be configured for use with the on board 32 MHz crystal. To do this you must write the value 0xFFFFFFFF to the UICR (User Information Configuration Register) at address 0x10001008. Please note that the UICR is erased whenever you download a SoftDevice.

The UICR can be written by using the debug tools:

```
nrfjprog.exe --snr <your_jlink_debugger_serial_number> --memwr 0x10001008 --val 0xFFFFFFFF
```

Or the following code can be added to the SystemInit function in the system_nRF51.c file, right before launching the TASK_HFCLKSTART task:

```
if (*(uint32_t *)0x10001008 == 0xFFFFFFFF)
{
    NRF_NVMC->CONFIG = NVMC_CONFIG_WEN_Wen << NVMC_CONFIG_WEN_Pos;
    while (NRF_NVMC->READY == NVMC_READY_READY_Busy){}
    *(uint32_t *)0x10001008 = 0xFFFFFFFF;
    NRF_NVMC->CONFIG = NVMC_CONFIG_WEN_Ren << NVMC_CONFIG_WEN_Pos;
    while (NRF_NVMC->READY == NVMC_READY_READY_Busy){}
    NVIC_SystemReset();
    while (true){}
}
```

4 Absolute Maximum Ratings

Spec	Description	Min.	Typ.	Max.	Units
V _{3V}	3V supply voltage.	-0.3		+3.6	V
V _{GND}	Ground voltage.			0	V
V _{IO}	I/O Pin Voltage.	-0.3		+3.6	V
T _{MAX}	Storage Temperature.	-40		125	°C

Table 3 Absolute Maximum Ratings

5 Operating Conditions

Spec	Description	Min.	Typ.	Max.	Units
V _{3V}	3V supply voltage.	2.7	3.0	3.6	V
T _A	Operating temperature.	-25	25	75	°C
I _{IDLE}	Idle current consumption.		15	50	uA

Table 4 Operating Conditions

6 Electrical Specifications

6.1 General Purpose I/O (GPIO) Specifications

Spec	Description	Min.	Typ.	Max.	Units
V _{IH}	Input high voltage.	2.1		3.0	V
V _{IL}	Input low voltage.	0		0.9	V
V _{OH}	Output high voltage.	2.7		3.0	V
V _{OL}	Output low voltage.	0		0.3	V
R _{PU}	Pull-up resistance.	11	13	16	kΩ
R _{PD}	Pull-down resistance.	11	13	16	kΩ

Table 5 General Purpose I/O (GPIO) Specifications

6.2 Crystal Oscillator Specifications (OSC)

Spec	Description	Min.	Typ.	Max.	Units
f _{HF,NOM}	High frequency crystal frequency		32		MHz
f _{HF,TOL}	High frequency crystal tolerance		±40		ppm
f _{LF,NOM}	Low frequency crystal frequency		32.768		kHz
f _{LF,TOL}	Low frequency crystal tolerance		±50		ppm

Table 6 Crystal Oscillator Specifications

6.3 ADC (ADC) Specifications

Spec	Description	Min.	Typ.	Max.	Units
DNL _{10b}	Differential non-linearity (10 bit mode).		<1		LSB
INL _{10b}	Integral non-linearity (10 bit mode).		2		LSB
V _{OS}	Offset error.	-2		+2	%
V _{REF_INT}	Internal reference voltage.	-1.5	1.20 V	+1.5	%
TC _{REF_INT}	Internal reference voltage drift.	-200		+200	ppm/°C
t _{ADC10b}	Sample conversion time (10 bit mode).		68		μs
t _{ADC9b}	Sample conversion time (9 bit mode).		36		μs
t _{ADC8b}	Sample conversion time (8 bit mode).		20		μs

Table 7 ADC Specifications

6.4 Temperature Sensor (TEMP) Specifications

Spec	Description	Min.	Typ.	Max.	Units
T _{RANGE}	Temperature sensor range.	-25		75	°C
T _{ACC}	Temperature sensor accuracy.	-4		+4	°C
T _{RES}	Temperature sensor resolution.		0.25		°C
T _{THM_RANGE}	Thermistor sensor range.	-25		75	°C
T _{THM_ACC}	Thermistor sensor accuracy.	-1		+1	°C
T _{THM_RES}	Thermistor sensor resolution.		0.125		°C

Table 8 Temperature Sensor (TEMP) Specifications

6.5 Accelerometer (ACCEL) Specifications

Spec	Description	Min.	Typ.	Max.	Units
	Measurement range.	±2		±16	g
	Resolution.	2048		16384	counts/g
f _{DATA}	Data sample frequency.	0.78		1600	Hz
I _{12.5}	Low data rate current (3.125 Hz).		5		μA
I ₁₀₀	Mid data rate current (100 Hz).		24		μA
I ₁₀₀	High data rate current (1600 Hz).		180	300	μA
I _{STANDBY}	Standby current.		3	10	μA

Table 9 Accelerometer (ACCEL) Specifications

6.6 Gyro (GYRO) Specifications

Spec	Description	Min.	Typ.	Max.	Units
	Measurement range.	±125		±2000	°/s
	Resolution.	16		262	counts/°
f _{DATA}	Data sample frequency.	25		3200	Hz
I _{GYRO}	Gyro active current. All Data Rates.		850	900	uA
I _{STANDBY}	Standby current. Included in Accel Standby Current.				

Table 10 Gyro (GYRO) Specifications

6.7 Pressure (BAROMETER) Specifications

Spec	Description	Min.	Typ.	Max.	Units
	Measurement range.	30		110	kPa
	Resolution in ultra high resolution mode.		0.16		Pa
f _{DATA}	Data sample frequency at max data rate.			157	Hz
I _{ACTIVE}	Active current. Data rate and oversampling sensitive.	0.14		650	uA
I _{STANDBY}	Standby current.		0.1	0.3	uA
I _{PEAK}	Peak current during measurement.		720	1120	uA

Table 11 Pressure (BAROMETER) Specifications

6.8 Humidity (HYGROMETER) Specifications

Spec	Description	Min.	Typ.	Max.	Units
	Measurement range.	0		100	% RH
	Resolution.		0.008		% RH
A _H	Absolute accuracy tolerance.		±3		% RH
I _{AVG}	Average current at 1Hz.		1.8	2.8	uA
I _{STANDBY}	Standby current.		0.2	0.5	uA
I _{PEAK}	Peak current during measurement.		340		uA

Table 12 Humidity (HYGROMETER) Specifications

6.9 LED (LED) Specifications

Spec	Description	Min.	Typ.	Max.	Units
I_{RGB}	Drive current per channel.	2	4	5	mA
λ_{RPEAK}	Red peak wavelength.		624		nm
λ_{GPEAK}	Green peak wavelength.		525		nm
λ_{BPEAK}	Blue peak wavelength.		470		nm
I_{VR}	Red luminous intensity.	12	60		mcd
I_{VG}	Green luminous intensity.	15	60		mcd
I_{VB}	Blue luminous intensity.	10	60		mcd
	Viewing Angle		120		°

Table 13 LED (LED) Specifications

6.10 Ambient Light (ALS) Specifications

Spec	Description	Min.	Typ.	Max.	Units
	Measurement range.	0.01		64k	lux
	Resolution.		16		bit
f_{DATA}	Data sample frequency.	0.5		20	Hz
I_{PEAK}	Peak active current.			220	uA
$I_{STANDBY}$	Standby current.			5	uA

Table 14 Ambient Light (ALS) Specifications

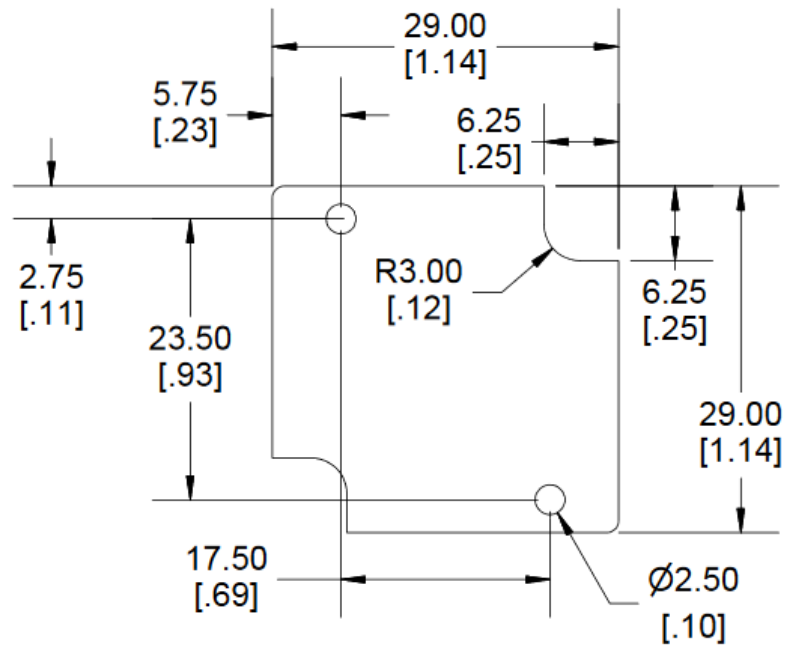
6.11 NOR Flash (NOR) Specifications

Spec	Description	Min.	Typ.	Max.	Units
	Powerdown current.			10	uA
	Write cycles per sector.	100,000			cycles
	Data retention	20			years
I_{READ}	Read current.			1	mA
$I_{PROGRAM}$	Program current.			15	mA
I_{ERASE}	Erase current.			15	mA
t_{SSE}	Subsector Erase time.		70	150	ms
t_{CE}	Chip Erase time.		15	80	s

Table 15 NOR Flash (NOR) Specifications

7 Mechanical Specifications

7.1 Module Dimensions



Dimensions:
mm
[inches]

Figure 5 Board dimensions

7.2 Case Dimensions

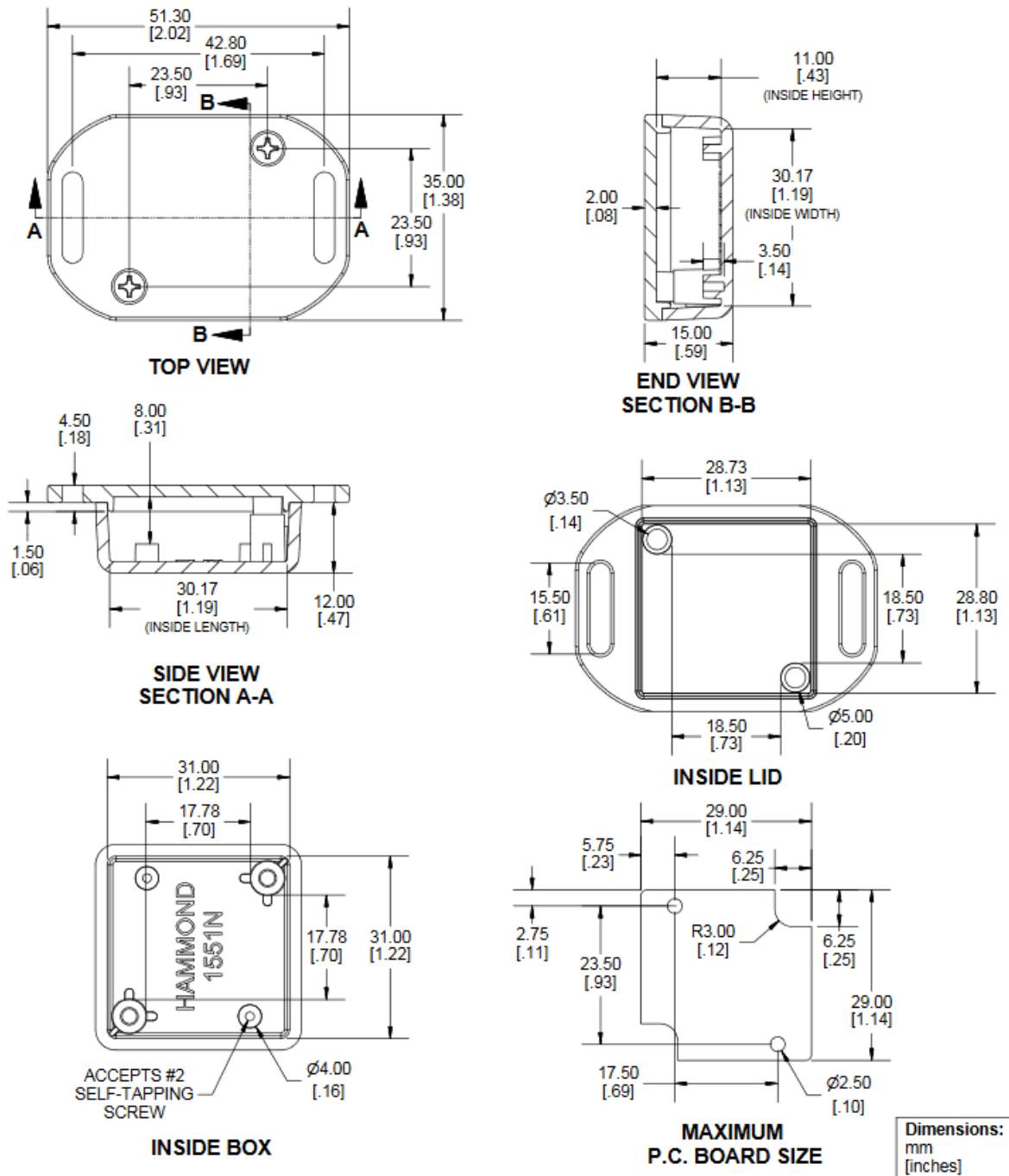


Figure 6 Case dimensions

8 Revision History

Date	Version	Change Description
November 18, 2016	0.5	Initial Draft
January 3, 2018	1.0	Layout Changes

Table 16 *Revision History*

9 Regulatory Information for MetaTracker

9.1 Taiyo Yuden Radio Module Approval

The MetaTracker uses the Taiyo Yuden module, part number EYSGCNZXX. The module is Bluetooth qualified, Telec (Japan), FCC, and IC (Canada) certified.

- Datasheet: http://www.yuden.co.jp/wireless_module/document/overview/TY_BLE_Overview_V1_3_20160809.pdf
- Bluetooth Listing: https://www.bluetooth.org/tpg/QLI_viewQDL.cfm?qid=27966
- IC: <https://industrycanada.co/number.php?ic=4389B-EYSFCN&id=171601>
- FCC: <https://fccid.io/RYYEYSGCN>

9.2 CE Conformance

The MetaTracker is conformant to relevant CE specifications.

- Details: <https://mbientlab.com/docs/MetaWearDeclarationOfConformity.pdf>

9.3 FCC Labeling Requirements

If the FCC ID is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording such as the following: “Contains Transmitter Module FCC ID: RYY-EYSGCN” or “Contains FCC ID: RYY-EYSGCN”. Any similar wording that expresses the same meaning may be used.

9.4 IC Labeling Requirements

Labeling requirements for Industry Canada are similar to those required by the FCC. A clearly visible label on the outside of a non-removable part of the final product must include the following text: "Contains IC: 4389B-EYSGCN".

Les exigences d'étiquetage pour l'Industrie Canada sont semblables à ceux exigés par la FCC. Une étiquette bien visible à l'extérieur d'une partie non amovible du produit doit inclure le texte suivant: "Contains IC: 4389B-EYSGCN".