METAWEARR

PRODUCT

SPECIFICATION v0.8

V0.8 © Mbientlab Inc.

MetaWear R

Wearable and connected devices product solution

Product Specification v0.8

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
  - 8/9/10 bit ADC
- Freescale™ MMA8452Q 3-Axis Accelerometer
  - ±2g/±4g/±8g selectable scale
  - 12-bit/8-bit resolution
  - Data rates from 1.56 Hz to 800 Hz
  - Embedded event detection processor
- Lithium Ion/Polymer battery charger
  - CC/CV charging to 4.2V
  - Automatic pre-conditioning trickle charge
  - 90mA charge current for ultra portable batteries
- Ultra-Bright RGB LED with 20mA driver
- Miniature push-button switch
- High current driver for external vibration motor
- Micro-USB rechargeable
- Battery charge monitor
- I/O Expansion
  - Digital I^2C Bus
  - 4 Analog/Digital Pins
  - 4 Digital Pins
- Tiny 26mm x 17mm x 2.5mm form factor
- Pending FCC, CE, IC C-Tick certification

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1 Introduction

MetaWear is a complete development and production platform for wearable and connected device applications. It features the ultra-low power nRF51822 SoC, providing energy efficient smartphone communication and central processing. MetaWear integrates this radio with high value sensors and a rechargeable 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

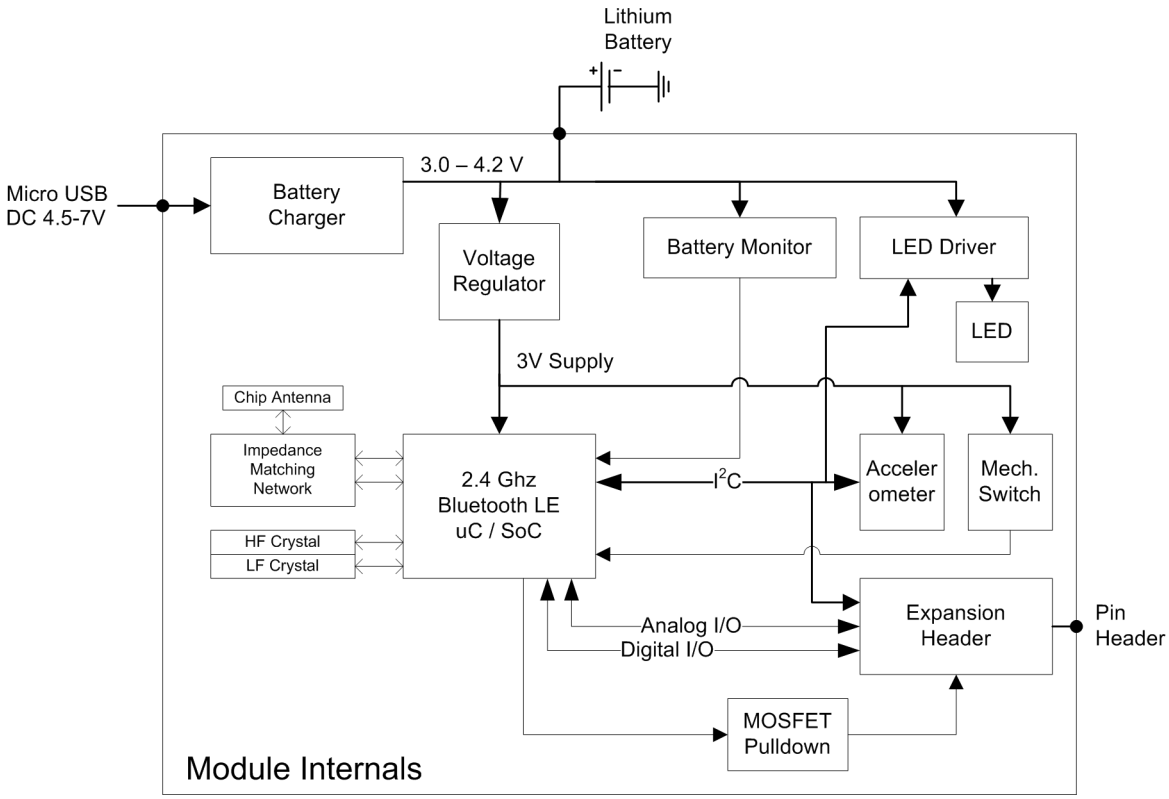


Figure 1 *Block Diagram*

2.2 Pin Assignments

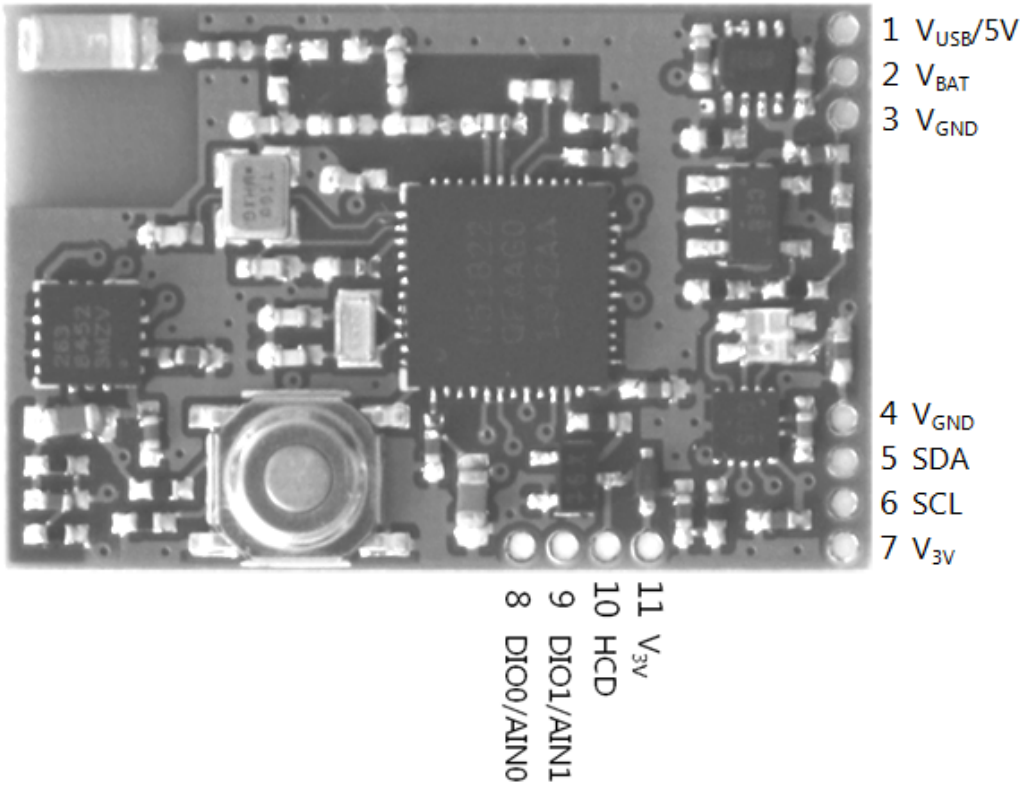
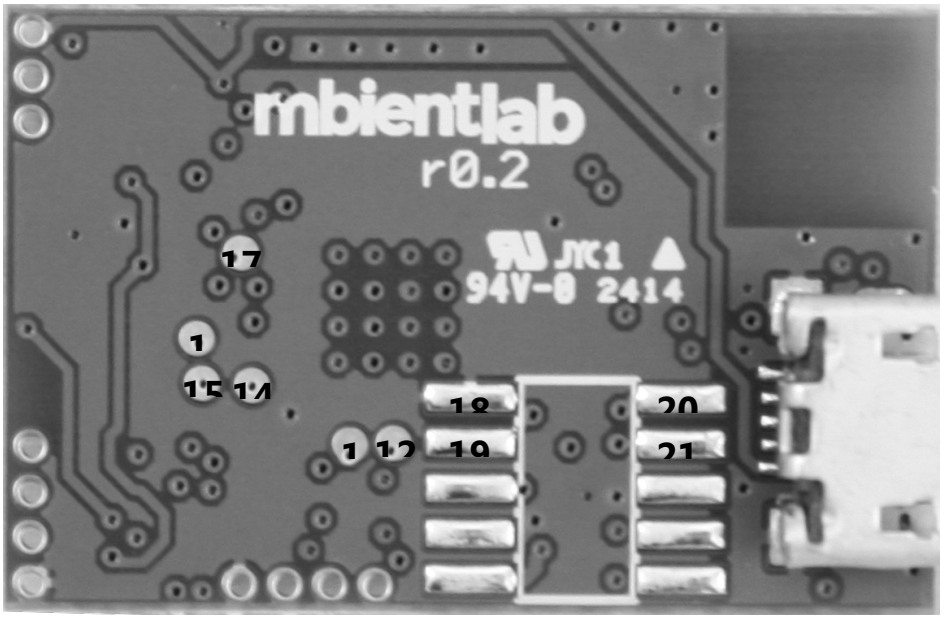


Figure 2 *Front Pin Assignments*



12 DIO2/AIN2
13 DIO3/AIN3
14 DIO4
15 DIO5
16 DIO6
17 DIO7

18 V
19 V
20 SWDIO
21 SWDCLK

Figure 3 *Back Pin Assignments*

2.3 Pin Functions

Pin	Pin Name	Function	Description
Power Supply			
1	V_{USB}	Power	Positive supply alternative to micro USB port.
2	V_{BAT}	Power	Positive battery connection.
3	V_{GND}	Power	Ground connection intended for battery.
Digital Peripheral Bus			
4	V_{GND}	Power	Supplementary ground for peripheral expansion.
5	SDA	Digital I/O	I^2C serial data.
6	SCL	Digital I/O	I^2C serial clock.
7	V_{3V}	Power	Regulated 3V output for peripheral expansion.
Analog / High Current Driver Bus			
8	DIO0 AIN0	Digital I/O Analog I/O	General purpose I/O and analog input.
9	DIO1 AIN1	Digital I/O Analog I/O	General purpose I/O and analog input.
10	HCD	High Current Driver	Switch for sinking high current peripherals.
11	V_{3V}	Power	Regulated 3V output for high current peripheral.
Surface Mount Extra Breakout			
12	DIO2 AIN2	Digital I/O Analog I/O	General purpose I/O and analog input.
13	DIO3 AIN3	Digital I/O Analog I/O	General purpose I/O and analog input.
14	DIO4	Digital I/O	General purpose I/O.
15	DIO5	Digital I/O	General purpose I/O.
16	DIO6	Digital I/O	General purpose I/O.
17	DIO7	Digital I/O	General purpose I/O.
SWD Debug Header			
18	V_{3V}	Power	System supply for debugger.
19	V_{GND}	Power	System ground for debugger.
20	SWDIO/nRESET	Debug	SWD debugger I/O line and system reset.
21	SWDCLK	Debug	SWD debugger clock line.

Table 1 *Pin Functions*

2.4 Module to SoC Pin Mapping

Module Pin	nF51822 Pin	Function	Description
GPIO			
DIO0/AIN0	P0.01	GPIO	General purpose I/O and analog input.
DIO1/AIN1	P0.02	GPIO	General purpose I/O and analog input.
DIO2/AIN2	P0.03	GPIO	General purpose I/O and analog input.
DIO3/AIN3	P0.05	GPIO	General purpose I/O and analog input.
DIO4/AIN4	P0.08	GPIO	General purpose I/O.
DIO5/AIN5	P0.09	GPIO	General purpose I/O.
DIO6/AIN6	P0.10	GPIO	General purpose I/O.
DIO7/AIN7	P0.16	GPIO	General purpose I/O.
High Current/Haptic Driver			
HCD	P0.07	Haptic	Open Drain MOSFET Pull-down.
I2C			
SDA	P0.14	Serial Bus	I^2C serial data.
SCL	P0.12	Serial Bus	I^2C serial clock.
Internal Module Pins			
	P0.29	Switch	Micro Push Button. Active Low.
	P0.04	Battery Voltage Monitor	Analog voltage at V_{BAT} / 2.
	P0.06	Accelerometer Interrupt	INT2 Pin of MMA8452Q.

Table 2 *Module Pin Mapping*

2.5 High Current/Haptic Drive Circuit

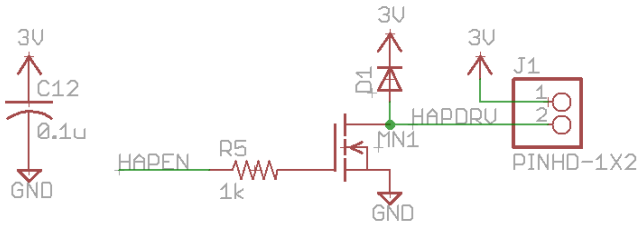


Figure 4 *Haptic Driver Circuit*

The haptic drive circuit features a logic level gate drive N-Channel MOSFET, and a flyback diode to 3V for switching inductive loads.

2.6 Battery Charging and Voltage Monitor

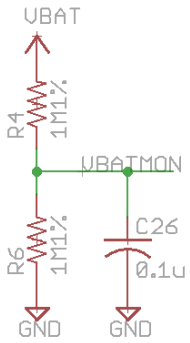


Figure 5 *Battery Voltage Monitor*

The MetaWear battery charge level is monitored via a voltage divider on the battery. Charging is managed entirely by a dedicated CC/CV charge controller chip, requiring no direct action from the main system controller.

2.7 Accelerometer Sensor

The Accelerometer Sensor MMA8452Q is attached to the shared I^2C bus at slave address 0x1C. The interrupt pin connection is detailed in the Module Pin to SoC Mapping.

2.8 LED Driver Circuit

The LED Driver NCP5623B is attached to the shared I^2C bus at slave address 0x38. The green diode is mapped to driver pin LED1, the red diode to pin LED2, and the blue diode to pin LED3. Due to limited component availability, the alternate LED Driver NCP5623C has been substituted in some production units. The only difference between these two components is the I^2C slave address of 0x38 or 0x39. An auto detection scheme should be used at boot time to identify which version of the chip is present. This can be achieved by attempting an I^2C read to each address and receiving an ACK from the device that is present.

4 Absolute Maximum Ratings

Spec	Description	Min.	Typ.	Max.	Units
V_{USB}	USB charging voltage.	-0.3		+8.0	V
V_{BAT}	Lithium battery voltage.	-0.3		+6.0	V
V_{GND}	Ground voltage			0	V
V_{IO}	I/O Pin Voltage	-0.3		+3.3	V
T_{MAX}	Storage Temperature	-40		125	°C

Table 3 *Absolute Maximum Ratings*

5 Operating Conditions

Spec	Description	Min.	Typ.	Max.	Units
V_{USB}	USB charging voltage.	4.0	5.0	7.5	V
V_{BAT}	Lithium battery voltage.	3.0	3.7	4.2	V
T_A	Operating temperature.	-25	25	75	°C
I_{IDLE}	Idle current consumption.		5	8	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

Spec	Description	Min.	Typ.	Max.	Units
$f_{HF,NOM}$	High frequency crystal frequency		16		MHz
$f_{HF,TOL}$	High frequency crystal tolerance		±40		ppm
$f_{LF,NOM}$	Low frequency crystal frequency		32.768		kHz
$f_{HF,TOL}$	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

Table 8 *Temperature Sensor (TEMP) Specifications*

6.5 Battery Charger (BC) Specifications

Spec	Description	Min.	Typ.	Max.	Units
$I_{BC,OP}$	Operating current (V_{USB} powered).		0.5	1	mA
$I_{BC,LEAKAGE}$	Reverse leakage (V_{USB} disconnected).		0.4	2	µA
$V_{BC,EOC}$	End of charge voltage.	4.158	4.20	4.242	V
$V_{BC,PRECON}$	Preconditioning voltage threshold.	2.85	3.0	3.15	V
$V_{BC,RCH}$	Recharge voltage threshold.		$V_{BC,EOC}$ – 0.1		V
$I_{BC,CHNOM}$	Nominal charge current.	81	90	99	mA
$I_{BC,PCH}$	Preconditioning charge current.		9		mA
$I_{BC,TERM}$	Charge termination threshold current.		9		mA

Table 9 *Battery Charger (BC) Specifications*

6.6 High Current Driver (HCD) Specifications

Spec	Description	Min.	Typ.	Max.	Units
$I_{ON,SS25}$	Steady state on current at 25°C.			310	mA
$I_{ON,SS85}$	Steady state on current at 85°C.			220	mA
$P_{ON,SS}$	Steady state power dissipation.			280	mW
$I_{ON,PULSE}$	Pulsed current for 10 µs.			1.4	A
R_{ON}	On state resistance.		2	5	Ω
$I_{OFF,LEAK}$	Off state leakage.			1	nA
V_{CLAMP}	Clamping diode voltage threshold.		3.3		V

Table 10 *High Current Driver (HCD) Specifications*

6.7 System Voltage Regulator (VREG) Specifications

Spec	Description	Min.	Typ.	Max.	Units
V_{OUT}	Regulated output voltage.	2.93	3	3.07	V
	Line regulation.	-1		+1	%
	Load regulation.	-2		+2	%
V_{DO}	Dropout voltage.			250	mV
I_{CL}	Output current limit.	150	230	400	mA
$I_{GND,IDLE}$	System idle ground current.		1	1.3	uA

Table 11 *System Voltage Regulator (VREG) Specifications*

6.8 Accelerometer (ACCEL) Specifications

Spec	Description	Min.	Typ.	Max.	Units
	Measurement range.	±2		±8	g
	Resolution.	256		1024	counts/g
f_{DATA}	Data sample frequency.	1.56		800	Hz
$I_{12.5}$	Low data rate current (12.5 Hz).		6		uA
I_{100}	Mid data rate current (100 Hz).		24		uA
I_{100}	High data rate current (800 Hz).		165		uA
$I_{STANDBY}$	Standby current.		1.8	5	uA

Table 12 *Accelerometer (ACCEL) Specifications*

6.9 LED + Driver (LED) Specifications

Spec	Description	Min.	Typ.	Max.	Units
I_{RGB}	Drive current per channel.	21.5	22.2	22.9	mA
λ_{RPEAK}	Red peak wavelength.		630		nm
λ_{GPEAK}	Green peak wavelength.		515		nm
λ_{BPEAK}	Blue peak wavelength.		460		nm
I_{vR}	Red luminous intensity.	60	120		mcd
I_{vG}	Green luminous intensity.	130	305		mcd
I_{vB}	Blue luminous intensity.	45	75		mcd
	Viewing Angle		120		°

Table 13 *LED + Driver (LED) Specifications*

7 Mechanical Specifications

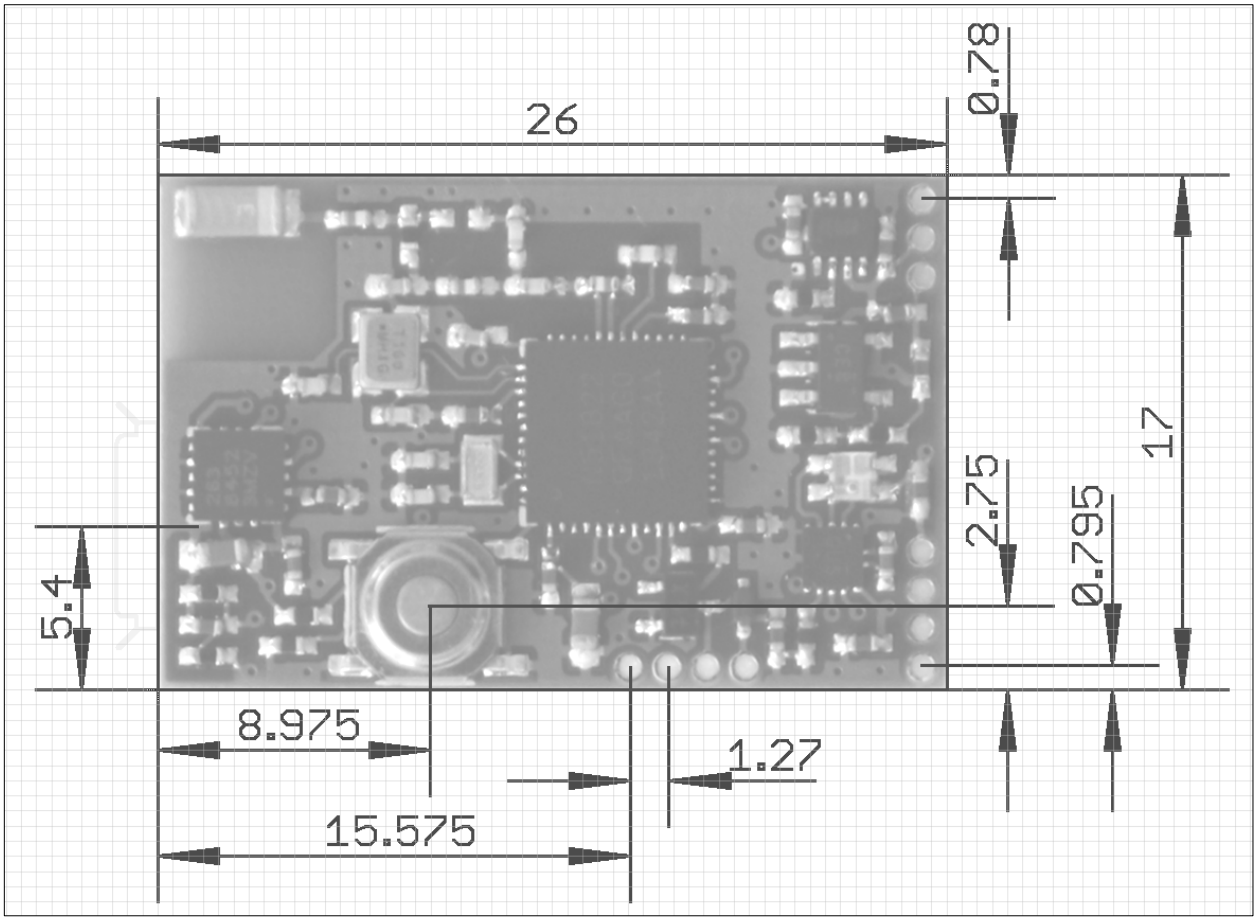


Figure 6 *Module dimensions in mm*

8 Typical Application Circuit

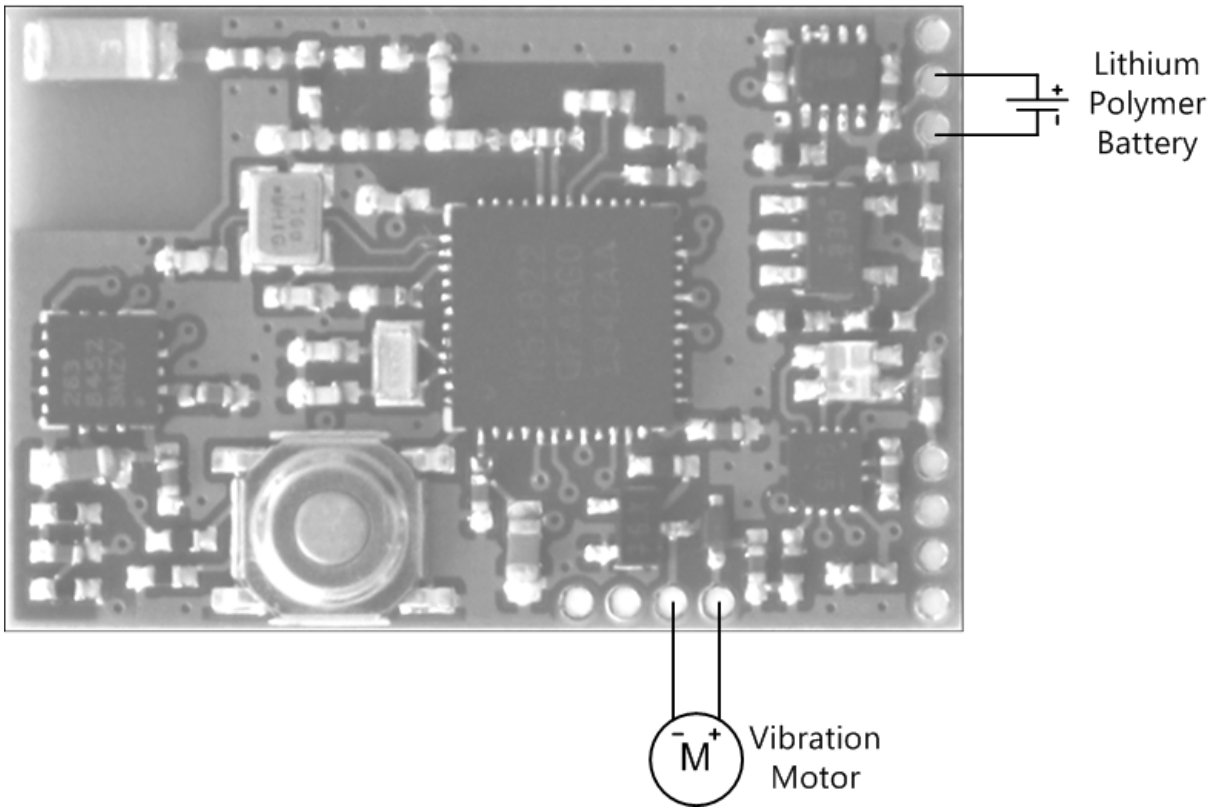


Figure 7 *Typical Application Circuit*

9 Revision History

Date	Version	Change Description
August 17, 2015	0.8	Added Information on LED driver for native developers.
November 11, 2014	0.7	Added MetaWear Module to SoC Pin Mapping. Added description of circuits necessary for firmware development.
July 21, 2014	0.6	Added Regulatory Statements Section Added Block Diagram. Added Back Side Pin Assignment Diagram.
June 2, 2014	0.5	Initial Draft

Table 14 *Revision History*

10 Regulatory Statements

10.1 FCC Statements

The MetaWear module was approved for 'Limited Modular' use and complies with part 15 of the FCC Rules.

Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation.

MetaWear may be used in devices without any further agency testing for intentional radiation compliance (FCC Part 15 Subparts C & E and IC RSS-210).

10.1.1 OEM Integration Requirements

- This module has a limited modular approval. Approval with any other antenna configuration or layout other than that approved will necessitate additional radiated emission testing to be performed.

- To inherit the modular approval, the antenna for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.

- This module is authorized for use in mobile and portable applications.

  Refer to FCC document KDB 447498 for more information on RF exposure procedures and equipment authorization policies for mobile and portable devices.

- This module was approved with the following antenna:
  Walsin Technology Corporation: RFANT3216120A5T 2 dBi

  If you use a similar type antenna, it must have a gain that is less than or equal to the gain of these antennas. If you do not satisfy this criterion, the Limited Modular Approval no longer applies and you must recertify your product for compliance with intentional radiation regulatory requirements. Operation of this module with any other antenna might require additional testing to be performed.

- Co-location with other radio transmitting devices operating concurrently in the same band will require additional testing and certification.

10.2 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: 2ACEB-METAR1” or “Contains FCC ID: 2ACEB-METAR1”. Any similar wording that expresses the same meaning may be used.

10.3 FCC Part 15.21

Change or Modifications that are not expressly approved by the manufacturer could void the user's authority to operate the equipment.

10.4 IC Statements

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions:

1. This device may not cause interference, and
2. This device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes:

1. L'appareil ne doit pas produire de brouillage, et
2. L'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

IMPORTANT! Tous les changements ou modifications pas expressément approuvés par la partie responsable de la conformité ont pu vider l'autorité de l'utilisateur pour actioner cet équipment.

10.5 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: 12118A-METAR1".

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: 12118A-METAR1".