Wireless Measurement
STAMP Radio Module User Guide

Contents

Rev	Date	Description of last three revisions	Authorised
1	2016-12-06	New Document	
2	2017-02-13	Updated block diagram and added ISED labelling requirement	
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Introduction

This manual is intended for users of the Wireless Measurement Ltd STAMP radio module. It describes the two modules and how they should be built-in to equipment. One of the modules has an integrated antenna, part WML-MOD-00003. This is intended for sensor equipment with no external antenna. The other part, WML-MOD-00004, fitted with a U.FL coaxial connector, is intended for use with an external antenna. Other than this the two modules are identical.

The modules have been designed to provide an easy integration path for the Wireless Measurement radio network system called Mercury. This is not described in this manual, but facilitates the deployment of networked, large scale wirelessly connected measurement sensors.

Module Description

The hardware block diagram in fig1 below, shows the system blocks of the module. Each module will be equipped with either a U.FL antenna connector or on board chip antenna.

As illustrated, the STM32W108 Integrated circuit device integrates the 2.4Ghz IEEE.802.15.4 radio transceiver and 32 bit ARM Cortex®- M3 microprocessor. It also incorporates system memory along with digital I/O, serial communication, analogue to digital conversion peripherals and voltage regulators.

The voltage regulators supply both the radio and digital sections of the IC. These supplies are monitored internally by brown-out detection and reset control circuitry. Frequency control for transmission and reception is provided by a phased locked loop frequency synthesiser; an external 24Mhz quartz crystal provides its reference.

RF connection between the transceiver output and antenna is conditioned by a balun, low pass pass filter and matching network.

A metal can is fitted over the module to provide RF screening.

Further details of the STM32W108 may be found on the ST Microelectronics data.
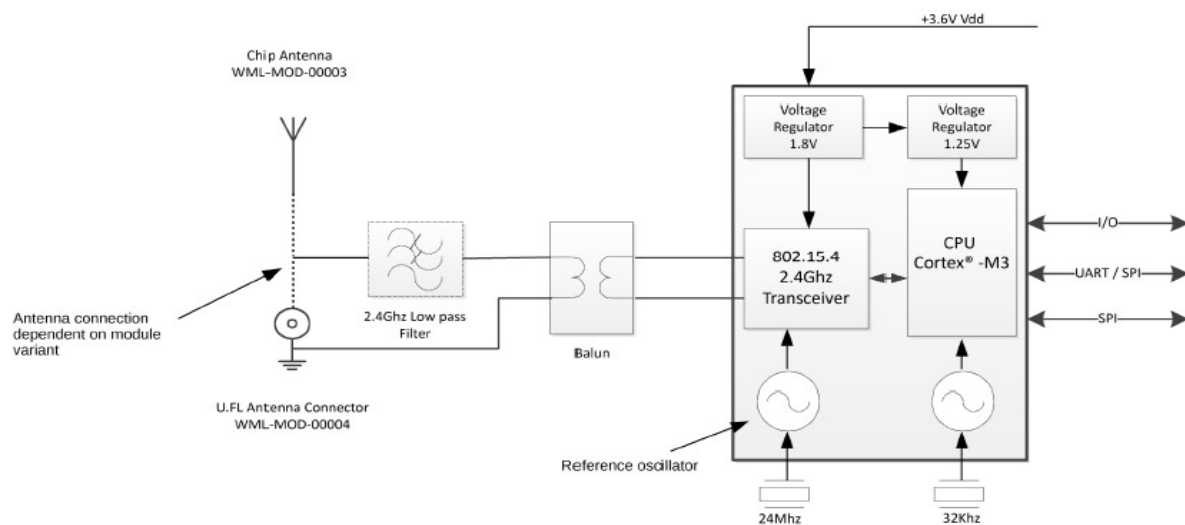
Module block digram fig.1

Transceiver Specification

The radio transceiver operates according to the specification defined by IEEE 802.15.4. This operates in the ISM global licence free band of 2.4 GHz. The characteristics are listed below:

1. 2.4Ghz ISM Band operation
2. 250Kbits/s transmission data rate
3. 15 Channels (IEEE802.15.4 Channel 11 to 25)
4. +8dBm maximum RF output
5. -100dBm receive sensitivity

Description of Modulation Used

The digital signal modulates the RF carrier using direct sequence spread spectrum (DSSS) and offset quadrature phase shift keying modulation (O-QPSK).

Operating Frequencies

Below is a list of the system operating frequencies and channels which may be used by the module. The IEEE standard 802.15.4 specifies that the channels be on 5 MHz spacing as follows:-

Channel	Frequency	Channel	Frequency
11	2.405Ghz	19	2.445Ghz
12	2.410Ghz	20	2.450Ghz
13	2.415Ghz	21	2.455Ghz
14	2.420Ghz	22	2.460Ghz
15	2.425Ghz	23	2.465Ghz
16	2.430Ghz	24	2.470Ghz
17	2.435Ghz	25	2.475Ghz
18	2.440Ghz		

Table 1 – Operating channels

Antennas

Module WML-MOD-00003 is fitted with an integral ceramic chip antenna with a gain of -0.5dBi.

Module WML-MOD-00004 has a U.FL connector for operation with external antennas similar to those listed below. Antennas having a gain greater than 6dBi are strictly prohibited for use with this device. The required antenna impedance is 50 ohms.

	WML Part Number	Manufacturer	Part Number	Gain	Type
1	ELC-ANT-00000	Pulse Antennas	W1038	4.9dBi	¼ W Dipole
2	ELC-ANT-00006	Pulse Antennas	W1027	3.2dBi	¼ W Dipole

Table 2 – Approved antennas

Product Approvals

The STAMP radio modules, WML-MOD-00003 and WML-MOD-00004 have been designed to meet the regulatory requirements for use world-wide operating on the licence exempt 2.4Ghz band and have the following certifications.

FCC Approvals

The WML-MOD-00003 with internal antenna and WML-MOD-00004 with an external antenna of gain less than 6 dBi as listed in table 2 have been tested to comply with FCC CFR 47 part 15. The devices comply with the requirements for modular transmitter approval as detailed in the modular certification FCC CFR 47 part 15.212. The radio modules are labelled with the allocated FCC ID Number. If the FCC ID is not visible when installed inside another device, then the outside of the device in which the product is installed must also display a label referring to the enclosed radio module. The exterior label must use the wording as follows:

For the WML-MOD-00003: - "Contains FCC ID: 2AKX6-MØ3"and for WML-MOD-00004:- "Contains FCC ID: 2AKX6-MØ4".

The end product must contain the following statement, this may be placed on an external label or contained in the operating instructions:

IMPORTANT: This equipment complies with part 15 of the FCC Rules. Operation is subject to the two following conditions: (1) this device may cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation (FCC 15.19).

The integrator is responsible for the end product compliance with FCC CFR 47 Part 15 Sub B. - Unintentional radiators.

FCC RF Exposure

The radio modules have been evaluated against the FCC specification CFR 47 Part 2.1093 as a portable device and found to be compliant with the FCC adopted limits for RF exposure. The radio module and antenna assembly must be installed at location to provide a separation of at least 20cm from all persons. Co-locating the radio module with any other transmitter will void this certification and the FCC will require the system be re-evaluated and certified.

ISED Approvals (Formally IC Industry Canada)

The Wireless measurement Ltd WML-MOD-00003 with integrated antenna and WML-MOD-00004 modules have been approved by ISED , Innovation, Science and Economic Development Canada to operate with the follow exclusions:-

The device complies with ISED licence-exempt RSS standards. 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.

Under ISED regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by ISED. To reduce potential radio interference to other users, the antenna type and its gain should also be so chosen that the equivalent isotropic radiated power (e.i.r.p) is not more than that permitted for successful communication.

The radio transmitter WML-MOD-00004 has been approved by ISED to operate with the antenna types listed in Table 2. Antennas having a gain greater than 6dBi are strictly prohibited.

The integrator is responsible for the end product compliance with ICES-003.

ISED product labelling

All Radio modules for use in Canada shall be identified as per the following requirements:

- The HVIN and ISED certification are to be placed on a permanently affixed product label.
- The ISED certification number shall be preceded by "IC:"
- The HVIN is permitted to be listed or placed with or without any prefix (HVIN:, Model#, M/N, P/N etc)
- The HVIN and ISED certification number are not required to be adjacent to each other.

Because the radio module is located inside the host product, the host product must be labelled such that the ISED certification number is preceded by the word "Contains" ie:
For the WML-MOD-00003 - "Contains IC: 22384-MØ3" and for WML-MOD-00004 - "Contains IC: 22384-MØ4" where: 22384-XXX is the WML radio module certification number.

ISED RF Exposure

The radio modules have been evaluated against ISED specification RSS-102 – "Radio Frequency (RF) Exposure Compliance of Radio communication Apparatus" as a portable device and found to be compliant with the ISED adopted limits for RF exposure. The radio module and antenna assembly must be installed at location to provide a separation of at least 20cm from all persons. Co-locating the radio module with any other transmitter will void this certification and the FCC will require the system be re-evaluated and certified.

Module Specification

1. SMT with side castellations for soldering and inspection
2. Two antenna options, U.FL antenna connector and with integral chip antenna.
3. Based around the ST Microelectronics STM32W108 integrated circuit
4. Operating supply of 2.1 to 3.6V DC
5. Integrated 32KHz crystal for real time control
6. 24 General purpose I/O lines, including analogue and serial data inputs and outputs.
7. Operating temperature range -40C to +85degC

Module Pinout

The table below gives the pinout detail of the module.

Module Pad	Pin Name	STM32W108 Pin	Normal use	Alternate Function	Comments
1	GND				
2	PC5	11	I/O	TX Active – use for RX/TX SW	Drives high when transmitting
3	PC6	13	OSC 32 in		Connected to internal crystal
4	PC7	14	OSC 32 out		Connected to internal crystal
5	PA7	18	I/O	TM1 CH4	Digital I/O or timer 1 CH4 output
6	PB3	19	I/O	TM2 CH3 / SC1SCLK	Digital I/O or timer 2 CH3 SPI master CLK or controller 1
7	nRST	12	Reset (active low)		
8	PB4	20	I/O	TM2 CH4 / UART RTS	
9	PA0	21	I/O	SPI2 MOSI	SPI port 2
10	PA1	22	I/O	SPI2 MISO / SC2SDA	SPI port 2
11	PA2	24	I/O	SPI2 SCLK / SC2SCL	SPI port 2
12	PA3	25	I/O	SPI2 nSEL	SPI port 2
13	GND				
14	PA4	26	I/O	ADC4	
15	PA5	27	I/O	ADC5	
16	PA6	29	I/O	TM1 CH3	High current I/O
17	PB1	30	I/O	SPI1 MOSI / SDA/TXD	Serial port 1
18	PB2	31	I/O	SPI1 MISO/SCL/RXD	Serial port 1
19	GND				
20	GND				
21	JTCK	32	I/O	SWCLK	Debug port
22	PC2	33	I/O	SWO	Debug port
23	PC3	34	I/O	JTDI	Debug port
24	PC4	35	I/O	SWDIO	Debug port
25	PB0	36	I/O	VREF / IRQA	
26	PC1	38	I/O		
27	PC0	40	I/O	IRQD	
28	PB7	41	I/O	IRQC	
29	PB6	42	I/O	ADC1/IRQB	

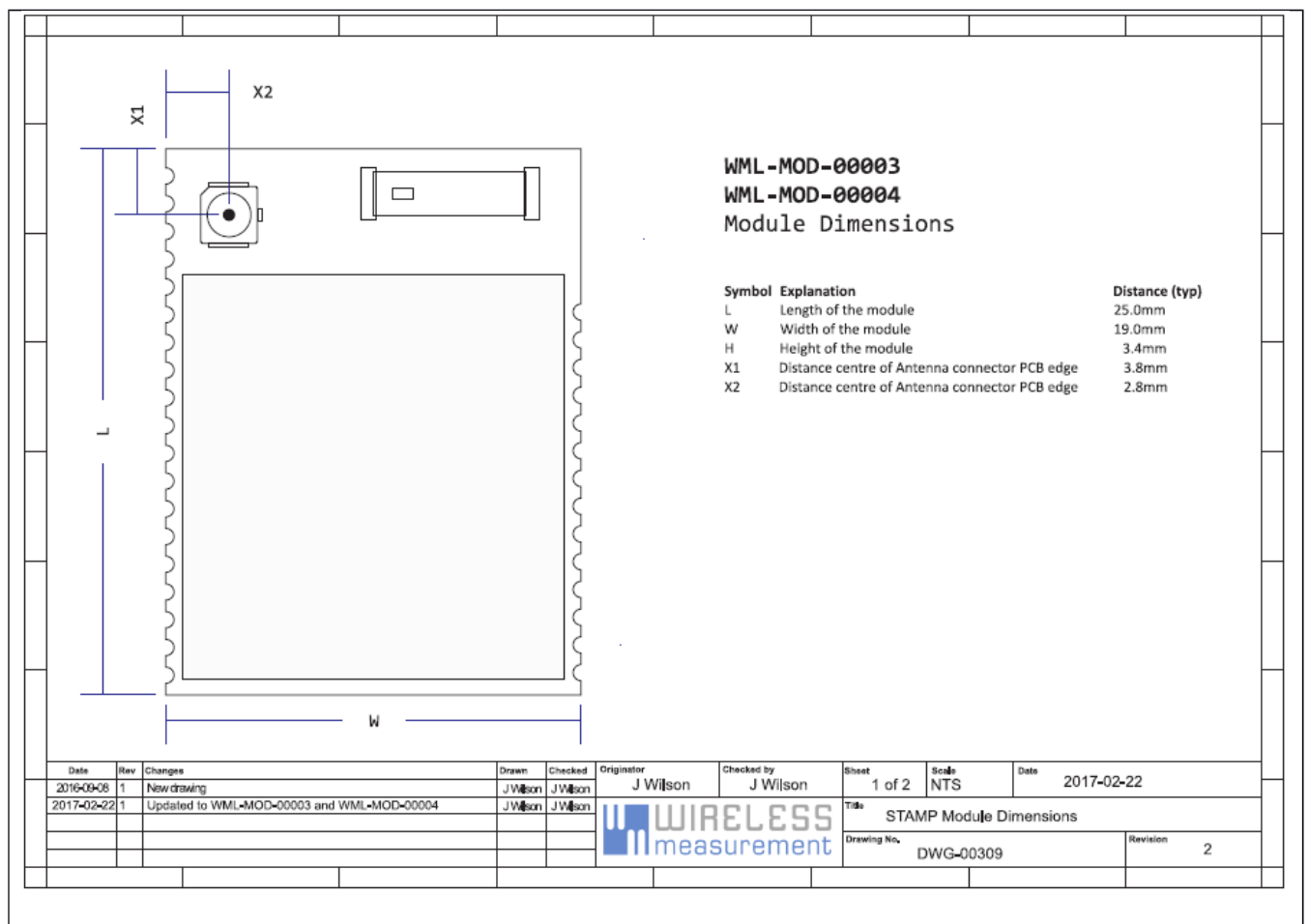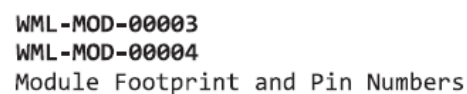| 30	PB5	43	I/O	ADC0	
31	GND				
32	VCC				
33	GND				

Table 3 – Module pinout

Location of Module within a host device.

The radio module should be placed at the edge or corner of the host PCB assembly. Copper tracks and ground planes should be kept away from the chip antenna as illustrated below. Care should be taken not to locate objects in close proximity of the antenna. These will effect the performance and operating range of the module.

Mechanical

The drawings below detail the module dimensions and pin numbers.

WML-MOD-00003
WML-MOD-00004
Module Dimensions

Symbol	Explanation	Distance (typ)
L	Length of the module	25.0mm
W	Width of the module	19.0mm
H	Height of the module	3.4mm
X1	Distance centre of Antenna connector PCB edge	3.8mm
X2	Distance centre of Antenna connector PCB edge	2.8mm

Date	Rev	Changes	Drawn	Checked	Originator	Checked by	Sheet	Scale	Date
2016-09-08	1	New drawing	J Wilson	J Wilson	J Wilson	J Wilson	1 of 2	NTS	2017-02-22
2017-02-22	1	Updated to WML-MOD-00003 and WML-MOD-00004	J Wilson	J Wilson					

Title: STAMP Module Dimensions
Drawing No. DWG-00309 Revision 2

WML-MOD-00003
WML-MOD-00004
Module Footprint and Pin Numbers

Symbol	Explanation	Distance (mm)
D	Width overall	19.0
E	Length overall	25.0
E2	Outer-edge to outer-edge	22.86
D2	Outer-edge to outer-edge	20.0
L	Pad Width	1.2
b	Pad Height	1.0
e	Pad Pitch	1.27
k	Width where copper permitted	13.6

Module KEEP OUT areas

For correct operation keep PCB ground planes and metal objects away from antenna area

The pads on the module extend inboard beyond the recommended footprint (shown black).

'k' is the distance between exposed copper on the module (shown gold) where exposed copper on the motherboard should be avoided

Date	Rev	Changes	Drawn	Checked	Originator	Checked by	Sheet	Scale	Date
2016-09-08	1	New drawing	J Wilson	J Wilson	J Wilson	J Wilson	2 of 2	NTS	2017-02-22
2017-02-22	1	Updated to WML-MOD-00003 and WML-MOD-00004	J Wilson	J Wilson					

WIRELESS measurement

Title: STAMP Module Dimensions

Drawing No. DWG-00309

Revision 2

Maximum Ratings

The tables below provide the absolute maximum ratings of the module.

Item	Description	Maximum Rating	Unit
1	Supply Voltage – Vcc	-0.2 to +3.6	Vdc
2	Voltage to module pins	-0.2 to Vcc + 0.3	Vdc
3	Module Storage temperature	-40 to +110	℃
4	Operating temperature range	-40 to +85	℃
5	RF input level to antenna connection	15	dBm

Table 4 – Maximum ratings

Electrostatic Discharge (ESD)

Symbol	Parameter	Conditions	Class	Maximum Value	Unit
$V_{ESD(HBM)}$	Electrostatic discharge voltage (human body model)	Ta = +25 ℃ Compliant with JESD22-A114	2	±2000V	V
	Electrostatic discharge voltage (human body model) RF pins			±1100	
$V_{ESD(CDM)}$	Electrostatic discharge voltage (charge device model) for all pins	Ta = +25 ℃ Compliant with JESD22-A114	II	±500	V
MSL	Moisture sensitive level	-	-	MSL3	-

Table 5 – ESD Absolute maximum ratings

Caution: The maximum ratings above must not be exceeded; operating the module above these ratings will result in permanent damage. The module is static sensitive follow the static handling precautions detailed below.

Recommended Operating Conditions

Item	Description	Maximum Rating	Unit
1	Supply Voltage – Vcc	2.1 to +3.6	Vdc
2	Operating temperature range	-40 to +85	ºC
3	RF input power	8	dBm
4	Operating frequency	2405 to 2480	Mhz

Warranty

This product carries a manufacturing defects warranty of 12 months from the date of purchase. Units returned under warranty will be repaired or replaced at the manufacturer's discretion. This warranty does not cover mishandling or modification or exceeding the maximum specified limits and is subject to the standard Terms and Conditions of Sale, a copy of which is available upon request. The equipment/goods are sold "as is" and with "all faults". Claims under warranty should be referred to the point of sale.

Disposal

This product may contain substances that can be hazardous to the environment if not disposed of properly. Electronic equipment should never be disposed of with general waste but must be separately collected for their proper treatment and recovery.

The crossed-out bin symbol, placed on the end product, reminds you of the need to dispose of the product correctly at the end of its life.

In this way you will assist in the recovery, recycling and reuse of many of the materials used in this product. At the end of life of your product please contact Wireless Measurement Ltd for information on collection arrangements.

Where possible recycle your packaging.

With your help it is possible to reduce the amount of electronic waste ending up in landfill and to improve quality of life by preventing the release of potentially hazardous substances into the environment.

Static Handling Precautions

All Wireless Measurement electronic devices are static sensitive and should be handled in a static preventative manner. Special care should be taken while handling electronic sub-assemblies.

Guarding against Electrostatic Damage

Three important steps are required to guard against electrostatic damage, these are:

- Prepare a static safe working area
- Handle sensitive components correctly
- Wear a wrist strap which provides a safe ground when handling sensitive parts

WARNING: To avoid shock or personal injury from accidental contact with line voltage, the ground lead of the wrist strap must provide a high resistance, a minimum of 1MΩ path to ground.

Creating a static safe working area

- Cover the work bench with a conductive surface and ground to earth through a 1Mohm resistor
- Remove surrounding plastics such as nylon, Styrofoam, cellophane
- Grounding yourself by touching a conductive surface before handling static-sensitive components

Take care with loose parts of clothing such as sleeves, ties, and scarfs, these can easily carry a static charge

Try not to touch connector pins or components of the electronic circuitry

Handling Sensitive Components Correctly

It is important to guard against electrostatic damage 'ESD' by always storing and carrying components and modules in static-shielding containers that protect against the effect of electric fields. Remove components and modules from static shielding packages only at a static-safe work area. Remember modules are only protected when they are completely in a static-shielding bag. Using the bag to hold the module does not protect the module. You should use correct handling procedures even with modules that are being returned for repair. This protects the good components for rework.

Hidden Dangers of ESD

In only 10% of cases does ESD permanently destroy components or modules with in the assembly, the remaining 90% are degraded in performance and may even pass all normal diagnostic tests. It is likely However to cause intermittent failure when subjected to temperature, vibration or load. Ultimately, the device will likely fail prematurely, in days, weeks, or even months after the ESD incident.

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