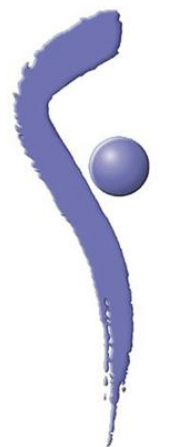


MMRW User Manual

| | |
|----------------|------------------------------------------|
| Product Name | MM Chip Reader / Writer module [2.45GHz] |
| Product Number | MMRW-MD-S01 |



FEC International (M) SDN BHD
2nd Nov. 2011

Contents

| | | |
|------|--------------------------------------------------------------|----|
| 1 | Introduction..... | 3 |
| 2 | Usage Important Points | 3 |
| 3 | Key features | 3 |
| 4 | Reader/writer module package content..... | 4 |
| 5 | Connections..... | 5 |
| 6 | Function and use..... | 5 |
| 7 | Hardware | 6 |
| 7.1 | Transmission circuit..... | 6 |
| 7.2 | Receiving circuit / Comparator circuit..... | 7 |
| 7.3 | Microprocessor..... | 8 |
| 7.4 | Microprocessor's pin assignment | 9 |
| 7.5 | RF antenna..... | 9 |
| 8 | Firmware..... | 10 |
| 9 | Firmware Writing Procedures..... | 11 |
| 9.1 | Firmware writing application start-up and installation | 11 |
| 9.2 | Firmware writing..... | 11 |
| 10 | Product general specification..... | 15 |
| 11 | Annexes | 16 |
| 11.1 | Schematics..... | 16 |
| 11.2 | List of components | 17 |
| 11.3 | Antenna layout | 18 |
| 12 | FCC STATEMENT..... | 19 |

1 Introduction

This MMRW-MD-S01 is a reader/writer module complied with multiband RFID chip dubbed as “MM Chip”. This document contains the instructions to use and evaluate the functions and the performance of this device. For external interface connection, either USB or UART serial connection can be applied, which is applicable to almost all of the controller systems.

For more details on the product specifications, please refer to “MMRW-S01 Product Specification Document”.

2 Usage Important Points

[Regulation/Standards]

This product follows the guidance for reading/writing communication equipment. It is important to check the regulation/standard and the seller or user of the intended country.

[Points to take notes before using the product]

- 1) This product is designed for general use and should not be utilized with application such as medical appliances related to human life or in space satellite environment which requires high reliability. Our company will not be responsible for any accidents caused from the said events, such as personal accident, fire accident or any public related accident.
- 2) This product is emitting radio wave which can affect medical appliances such as the pacemaker device.
- 3) Do not place this product near any radio device since it can cause interference.
- 4) Do not touch the connector terminal as it can result in electrical shock and will eventually destroy the product.

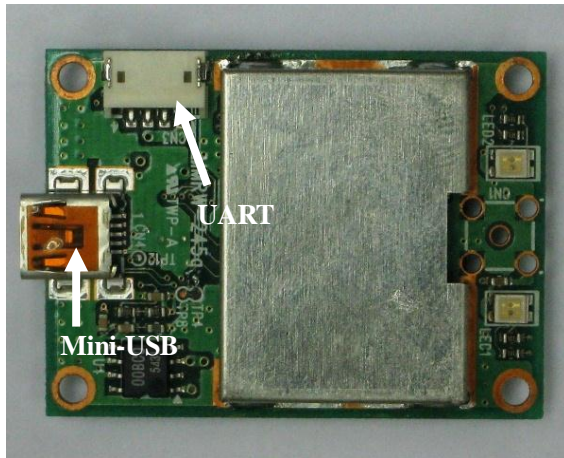
3 Key features

- Support MM2 chip air interface protocol and commands
- Light weight, compact size module
- UART serial and USB communication available
- RF output: 150mW
- Operation voltage: 5VDC

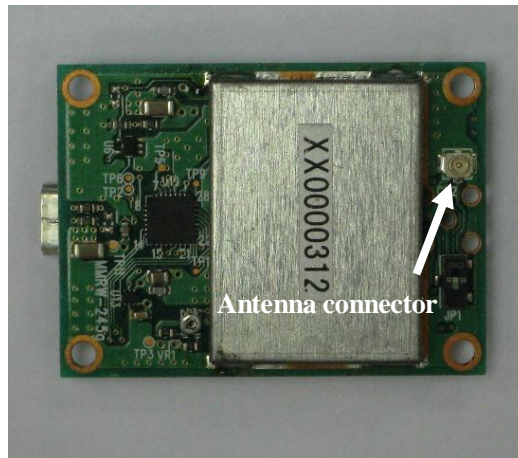
4 Reader/writer module package content

[RFID reader / writer board: MMRW-MD-S01]

Top side



Back side



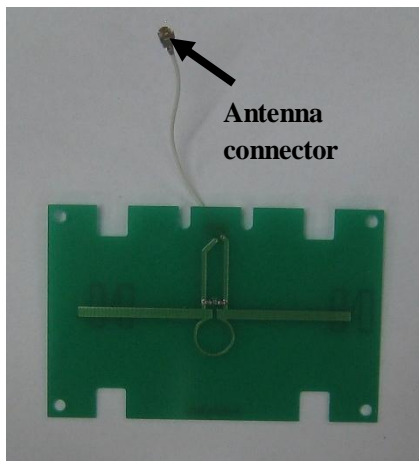
USB (Mini B)

Packet communication complies with USB2.0/1.1

UART serial

- Communication speed
Variable according to a command (default : 9,600bps)
(1,200/2,400/4,800/9,600/19,200/38,400/57,600bps)
- Data bit: 8bit
- Stop bit: 1bit
- Parity bit: N/A
- Flow control: N/A

[Board antenna: MMATS-4570]



[CD with SDK and documentation]

Included in the CD are SDK and related documents, product specifications and various manuals. For more details, please see “readme.txt” included in the CD.

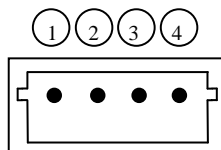
5 Connections

The first step is to connect the components. Connect antenna board to the RFID reader / writer board using the connector. Terminal and reader/writer can be connected by USB or UART serial port.

Pin assignment for UART serial is stated in the table below. Please prepare a harness cable for the connection to device terminal.

| No. | Signal name | I/O | Content |
|-----|-------------|-----|------------------------------------|
| 1 | VCC | - | Provide DC 5V (+/-0.25V) |
| 2 | GND | - | GND |
| 3 | TXD | OUT | UART serial signal output (LV-TTL) |
| 4 | RXD | IN | UART serial signal input (LV-TTL) |

[Pin assignment]



6 Function and use

The equipment is ready to be operated once all connections are completed.

Next, equipment operating with SDK package will be explained. SDK Package is prepared for application development of MMRW series. SDK Package contains demo software, USB driver, USB communication library, and sample source code. For further details, please refer to “Demo Software Manual” before using MMRW demo software.

Please refer to “MMRW Command Library Function Specification” to develop application.

7 Hardware

7.1 Transmission circuit

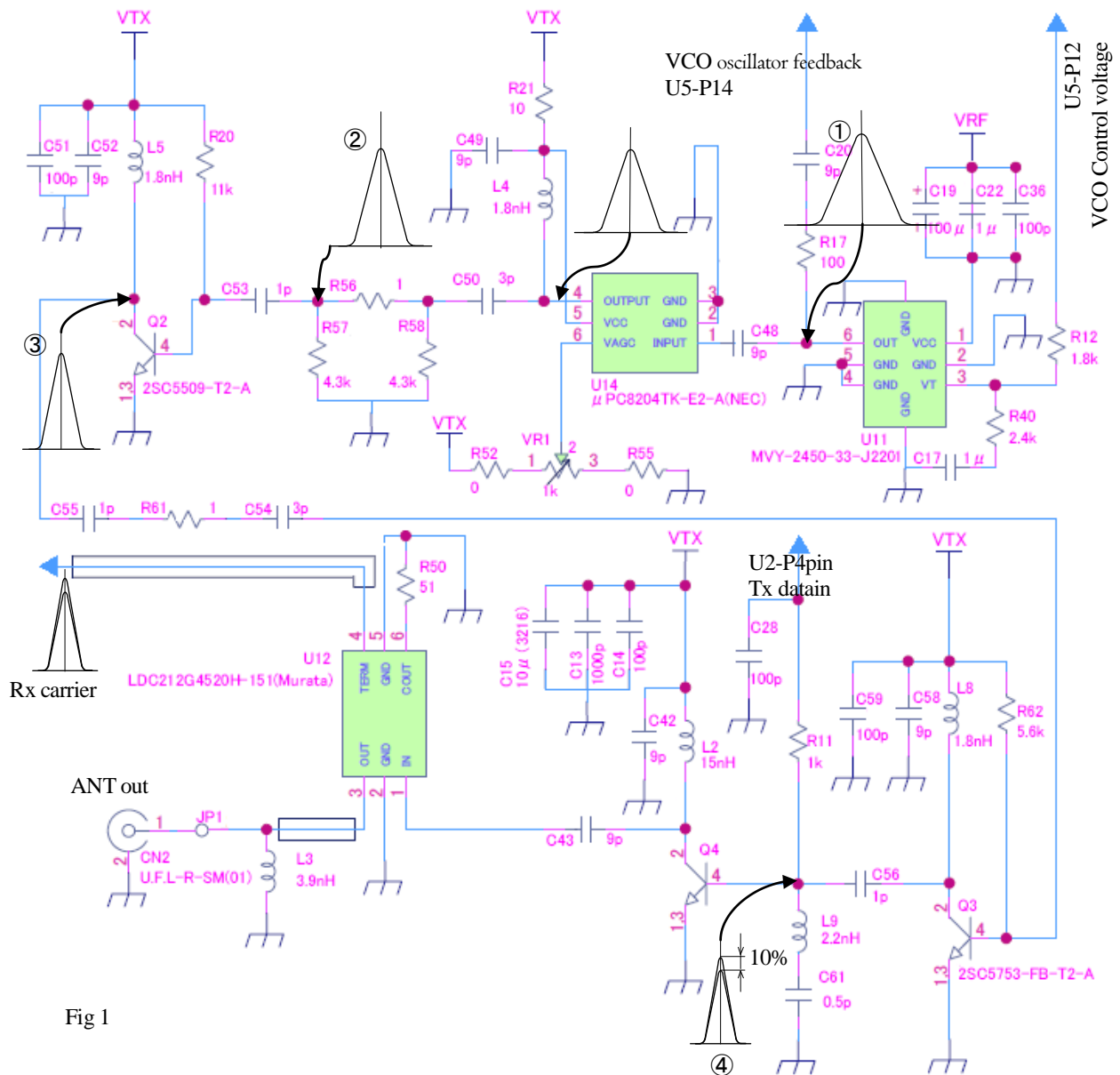


Fig 1

Fig 1 is a transmitting circuit. When VCO Control voltage from U5 PLL Synthesizer LMX 2434 12pin is input, VCO MVY-2450 of U11 oscillate the 2.427GHz - 2.47075GHz (waveform①). C2 output is an oscillator feedback out for U6. Oscillating out can control Gain with Gain Control Amplifier of U14 μ PC8204 and VR1. It does input to Q2 high frequency amplifier transistor base and outputs waveform ③. Q2 base's R56, R57 and R58 are -0.2dB π type attenuator. Q3 and Q4 is a frequency amplifier circuit. It becomes ASK modulation (waveform④) by Tx data Signal from U6 TC7S14 4pin. And, it is adjusted to 10% modulation with R11. Q4's out outputs Tx carrier (waveform⑤) from ANT out by passing Directional coupler. Tx carrier level is adjusted to 150mW with VR1.

7.2 Receiving circuit / Comparator circuit.

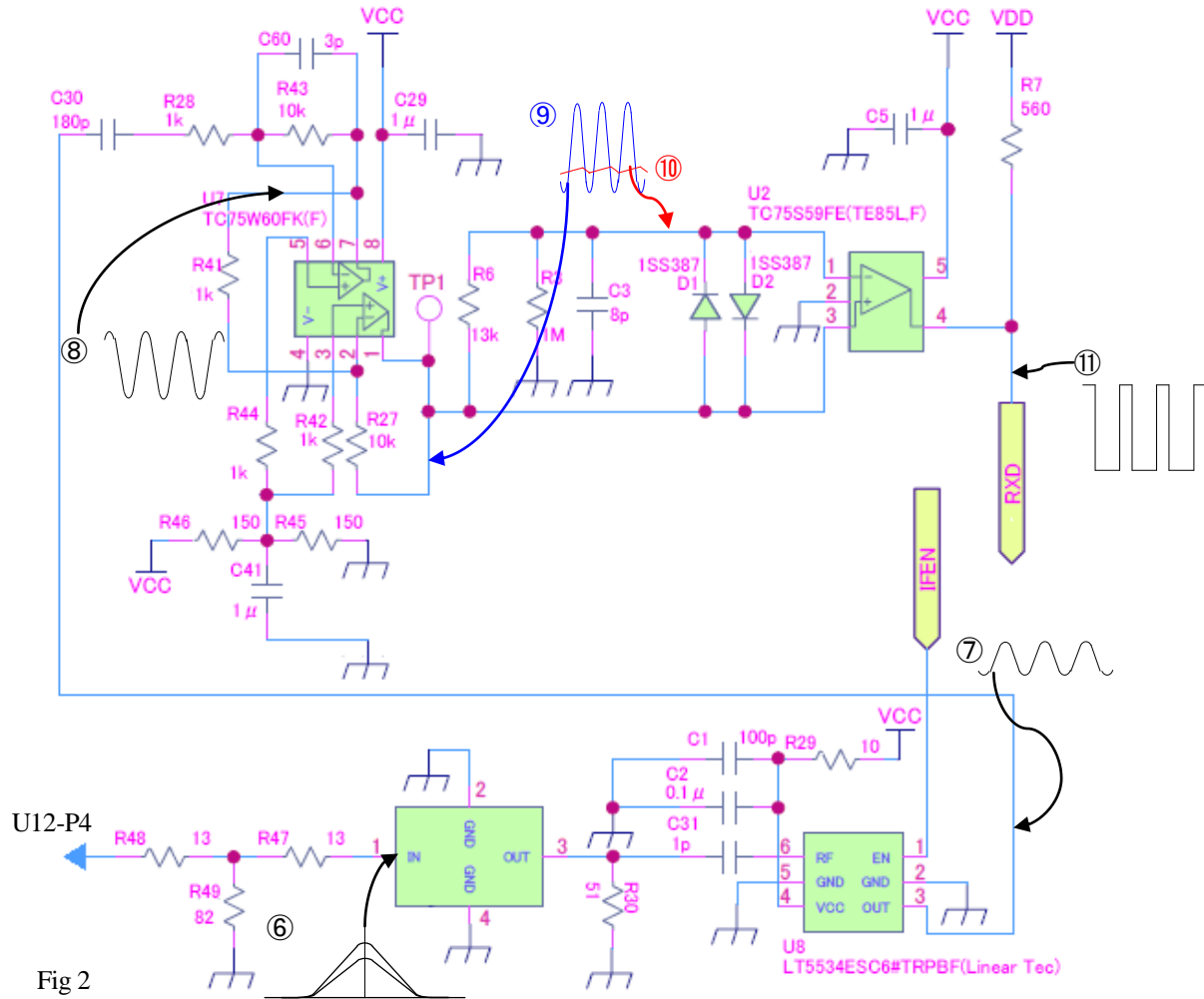


Fig 2

Fig 2 is receiving circuit / comparator circuit. Career Signal input from U12-4pin is attenuated (waveform ⑥) by R47, R48, and R49 -5dB T type attenuator. It outputs career wave (waveform ⑦) with U8 high frequency amplifier/detect IC LT5534 by passing U9 band pass filter. Career wave is amplified by U7 operational amplifier TC75W60 and outputs waveform ⑧, ⑨. Waveform ⑨ is input to U2 Comparator TC75S59 non inverting input. Other waveform ⑨ becomes threshold Signal ⑩ by R6 and C3.integrating circuit. It inputs to inverting input and outputs Rx data out (waveform ⑩a) to U8-1pin and 2pin.

7.3 Microprocessor

Fig 3

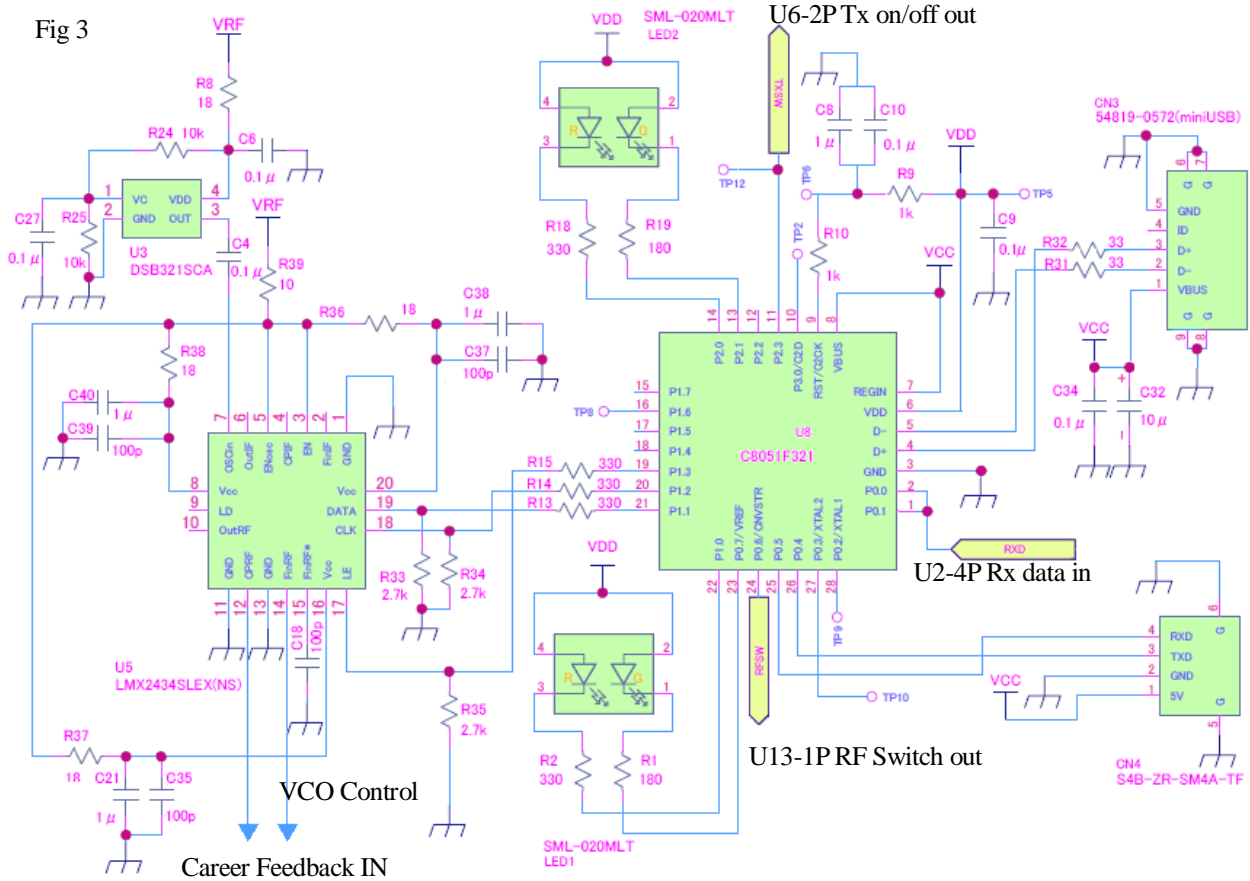


Fig3 is circuit that centers on U8 C8051F321 microprocessor. It is composed of LED drive, USB interface, serial data interface, U3 career oscillator, U5 PLL Synthesizer, and power reset circuit. The crystal oscillator is unnecessary, because clock generator is built into U10. Moreover, 3.3V voltage regulator and USB driver are built into it. 3.3V constant voltage is output from 6Pin. This Vdd is used so as not to change brightness of LED by the Vcc change. R9, R10, C8, and C10 are for set time constant. CN3 is USB interface connector, and C4 is a connector for the serial interface. CN4-1Pin must use 5V when you use the serial interface connector.

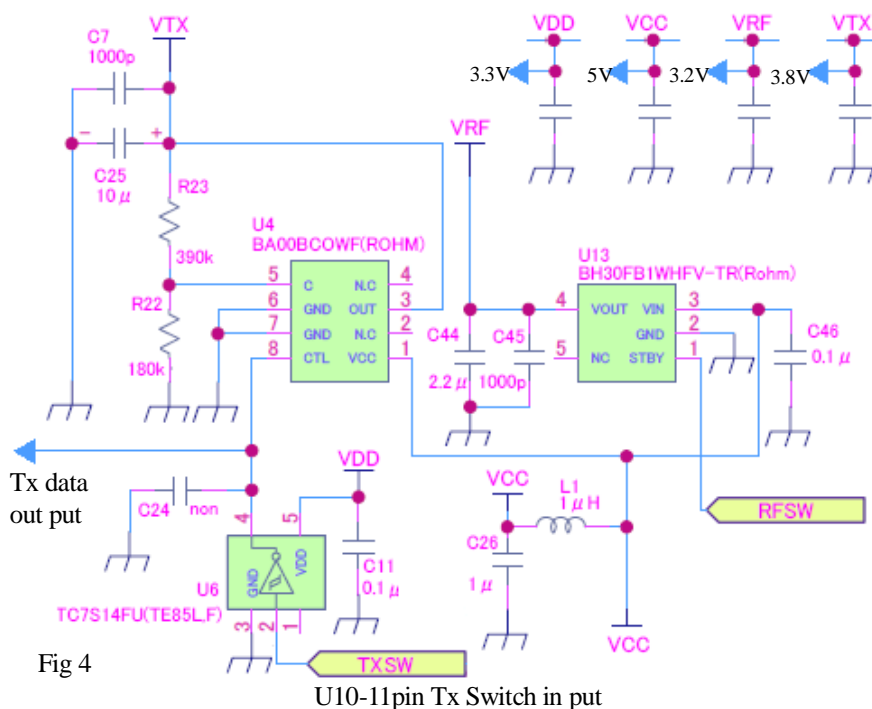


Fig 4

MMRW-MD-S01 uses four power supplies.

Vdd 3.3V=U10 CPU internal, U2 Comparator output interface, LED1-2 power voltage.

Vcc 5V= Receiving circuit, CPU farm wear write power voltage.

VRF 3.2V=U3 career oscillator, U5 PLL Synthesizer.

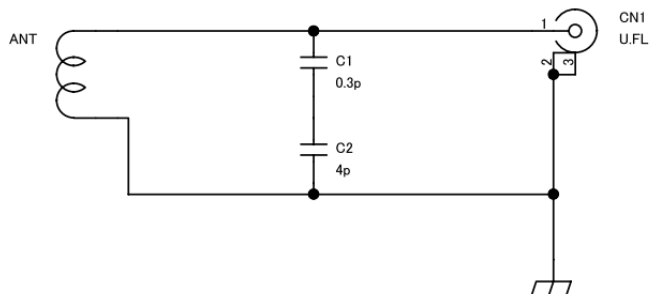
VTX 3.8V= Transmitting circuit U14, Q2, Q3, Q4 power voltage.

7.4 Microprocessor's pin assignment

| Pin# | Name | Signal Name | I/O | Type | ACTIVE | RESET | Description |
|------|-------------|----------------|-----|------------|--------|-------|-------------------------------|
| 1 | P0.1 | RXD | I | open-drain | ? | ? | RF Rx |
| 2 | P0.0 | RXD | I | open-drain | ? | ? | RF Rx |
| 3 | GND | GND | - | - | - | - | GND |
| 4 | D+ | D+ | I/O | - | - | - | USB D+ |
| 5 | D- | D- | I/O | - | - | - | USB D- |
| 6 | VDD | VDD | - | - | - | - | VDD(3.3V) |
| 7 | REGN | POWER(VCC) | - | - | - | - | VCC(5V) |
| 8 | VBUS | USB/POWER(VCC) | I | - | - | - | VCC(5V) |
| 9 | RST/C2CK | RESET | O | - | - | - | Device Reset/C2CK |
| 10 | P3.0/C2D | P3.0 | O | push-pull | - | H | C2D |
| 11 | P2.3 | TXSW | I | open-drain | L | H | RF Tx |
| 12 | P2.2 | | | | | | |
| 13 | P2.1 | LED2_G | O | open-drain | L | L | LED |
| 14 | P2.0 | LED2_R | I | open-drain | L | H | LED |
| 15 | P1.7 | | | | | | |
| 16 | P1.6 | DEBUG0 | O | push-pull | - | - | Debug port |
| 17 | P1.5 | | | | | | |
| 18 | P1.4 | | | | | | |
| 19 | P1.3 | PLL_LE | O | push-pull | H | L | Synthesizer control |
| 20 | P1.2 | PLL_CLK | O | push-pull | H | L | Synthesizer control |
| 21 | P1.1 | PLL_DAT | O | push-pull | H | H | Synthesizer control |
| 22 | P1.0 | LED1_R | O | open-drain | L | H | LED |
| 23 | P0.7/VREF | LED1_G | O | open-drain | L | H | LED |
| 24 | P0.6/CNVSTR | RFSW | O | push-pull | H(Fix) | H | RF regulator control(2.45Ghz) |
| 25 | P0.5 | UART_RXD | I | open-drain | L | H | UART Rx |
| 26 | P0.4 | UART_TXD | O | push-pull | L | H | UART Tx |

7.5 RF antenna

MMATS-4570 is 50Ω antenna connected with MMRW-MD-S01. The antenna is a dipole antenna, and resonates by 2.45GHz. Antenna size is 45 x 70mm.



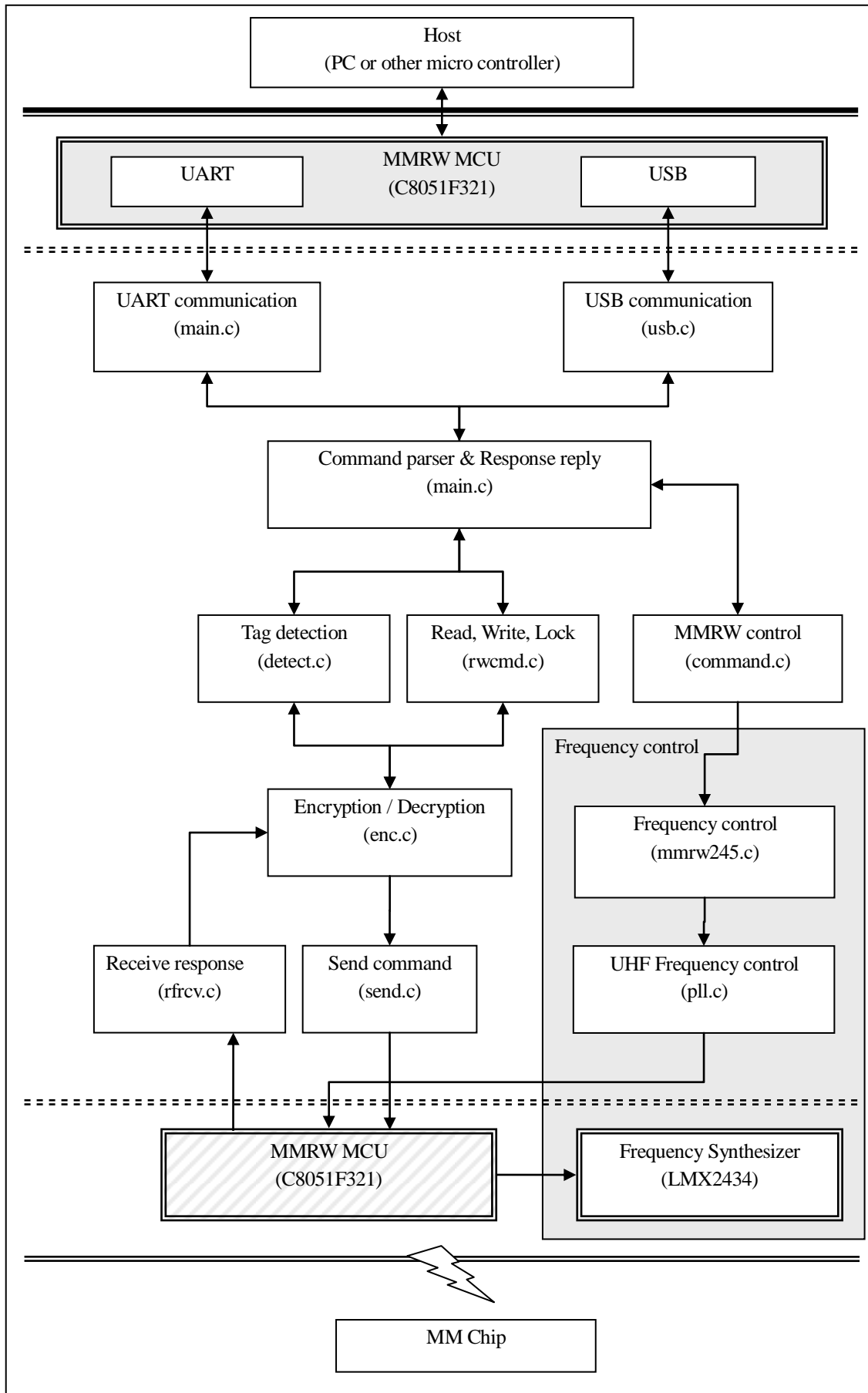
C1 = 0.3pF

C2 = 4pF

Antenna connector = U.FL receptacle

C1 and C2 are used to adjust VSWR of the antenna.

8 Firmware



The firmware was developed using “Keil C51 compiler” under Silicon Labs IDE. The firmware can be loaded into the microcontroller using the “on-chip Silicon Labs 2-Wire (C2) debug interface” connected to a USB debug

adapter, driven by Silicon Labs IDE.

C8051F320.h contains the firmware specific C51 code. (Input, output pins, etc.).

The file “mmrw245r.wsp” is Silicon Labs IDE project file.

9 Firmware Writing Procedures

9.1 Firmware writing application start-up and installation

For firmware writing (OS: Windows XP SP2 or higher is recommended), double click 「mcu_ide.exe」 and follow instructions on the screen accordingly.

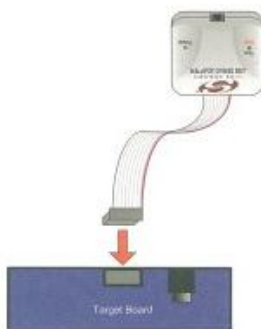
<http://www.silabs.com/products/mcu/Pages/SoftwareDownloads.aspx>

“Start” → “Silicon Laboratories” → Select and start “Silicon Laboratories IDE”.

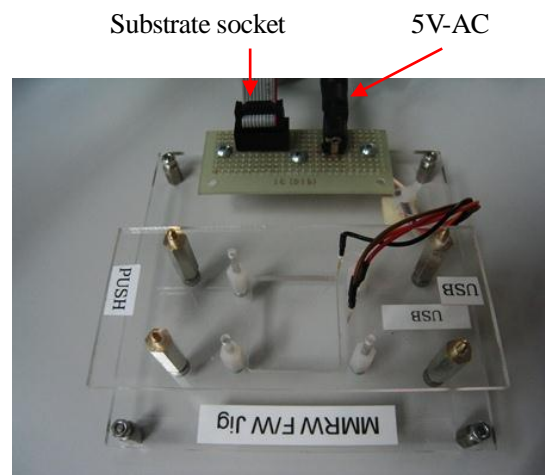
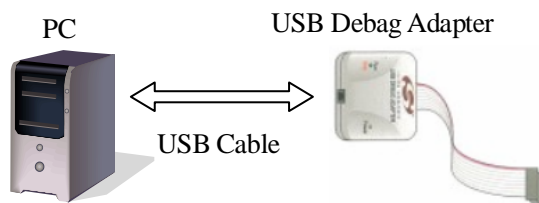
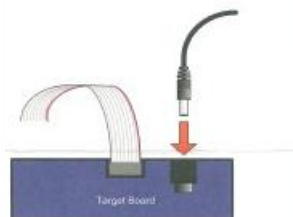
9.2 Firmware writing

- (1) Firmware file (MMRW-245ver01.00.OMF) is saved in any folder in the PC used for firmware writing.
- (2) “USB Debug Adaptor” and “5V-AC Adaptor” are connected to the “MMRW F/W JIG”, and this debug adaptor is connected to PC via USB cable.

Connect USB Debug Adapter to Target Board with JTAG/DEBUG cable



Connect power supply to Target Board

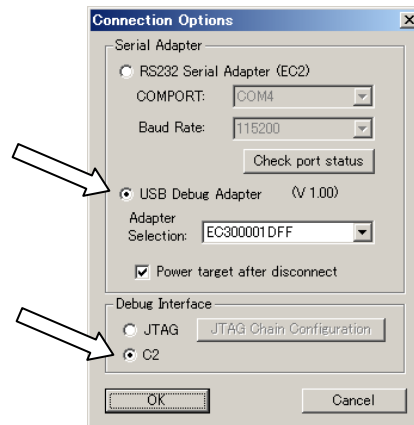
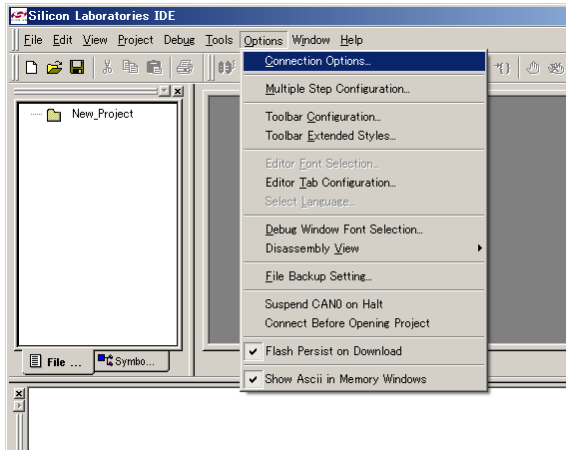


Completed Installation

- (3) Silicon Laboratories IDE starts.

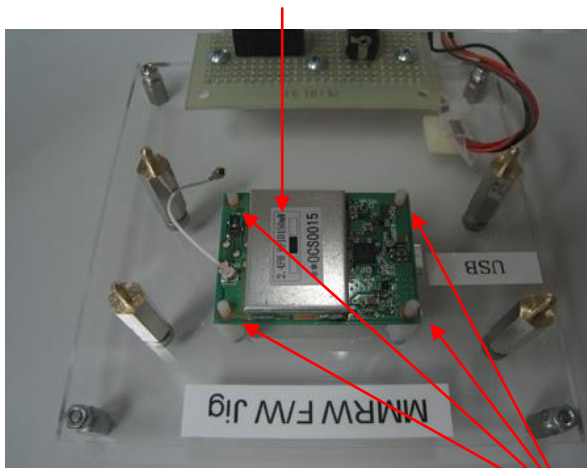
- (4) Set connection method for PC and connection substrate.

From the toolbar, select “Options” → “Connection Options”, then set USB debug adaptor to connector.

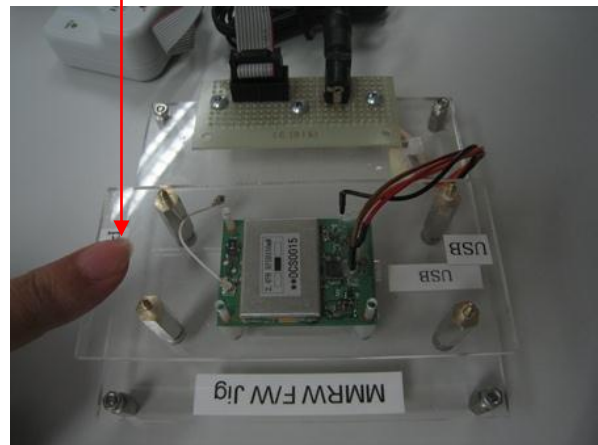


- (5) MMRW Module is put onto “MMRW F/W JIG”.

Set the MMRW module



Fix the upper board, push it with finger



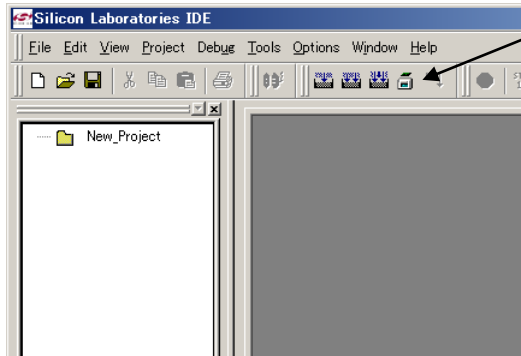
Note module's direction

Fix the 4 pins on module's hole



Please touch F/W jig pin to TP3, TP11, TP2, and TP6 of RW.

(6) PC and module connect electronically.



Click

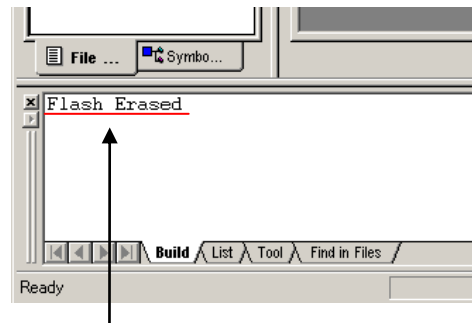
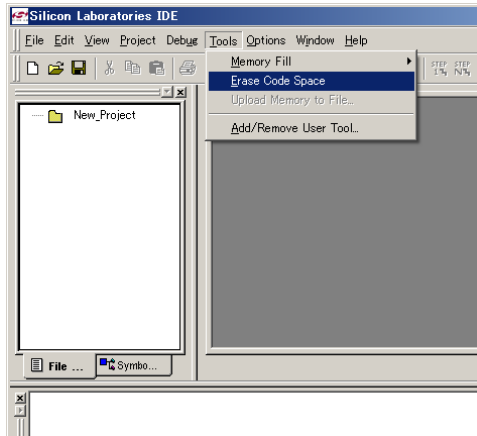
Connected correctly



Icon will be displayed

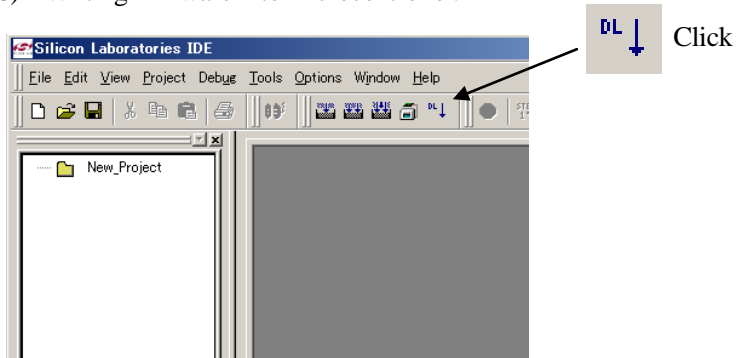
(7) In case where firmware has already been written, it is necessary to delete the firmware. If firmware is newly written, delete procedure is unnecessary.

Select "Tools" → "Erase Code Space" from Toolbar, and erase firmware.

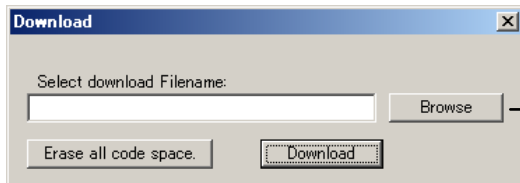


"Flash Erased" is displayed when deleting succeed

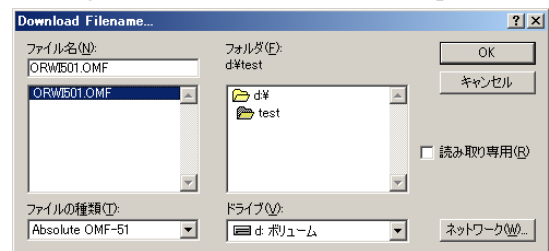
(8) Writing firmware into microcontroller.



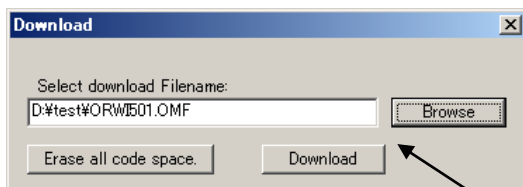
Get started with below shown window, select the folder where firmware file (MMRW-245ver01.00 OMF) is saved, click “Download” button and thereby firmware writing starts.



Clicking “Browse” button then select is possible too

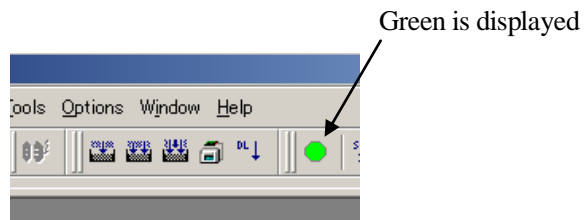
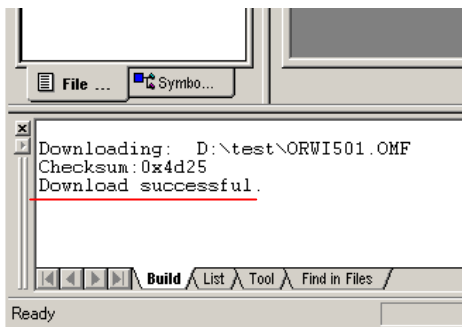


(Eg. Screen shows ORWI501.OMF saved in D:\test)



Click “Download” button

Once writing is succeed, below shown window will be displayed.



(9) PC and module electronically disconnected.



(10) MMRW module will detach from “MMRW F/W JIG”.

Before module is detached, PC and module MUST follow procedure (9) for release.

Repeat (5) - (10) for the next firmware writing.

To end firmware writing, close the application.

10 Product general specification

| Items | Specification |
|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Product number | MMRW-MD-S01 |
| Appearance diagram | 45(D) x 33(W) x 9.4 (H) mm (Excluding surface bump's presence) |
| Operation frequency | 2,427MHz~2,470.75MHz Hopping method (15channel) |
| Communication standard | MM Chip original protocol communication |
| IC card/tag | IC card/tag with MM chip (Excluding on-chip antenna) |
| Modulation | Receive: ASK10% Transmit: 90% |
| Communication speed | Receive: 25Kbps Transmit: 40Kbps |
| Input power supply | DC5V (Power supply voltage variation: $\pm 0.25V$) (USB bus power supply / external supply) |
| Current consumption | RF carrier ON: Approximately 430mA (Standard) RF carrier OFF: Approximately 80mA (Standard) |
| RF output | Approximately 150mW |
| Antenna output impedance | 50 Ω |
| Temperature environment | Storage temperature range: -30°C~+80°C Operation temperature range: -10°C~+60°C Storage / operation humidity range: Below 90% RH (Non-condensation situation) |
| Anti-collision | Unsupported |
| RF output I/F | U.FL-R-SMT(01) |

11.2 List of components

MMRW-MD-S01

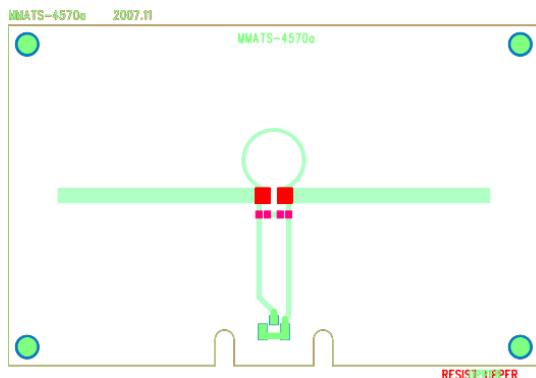
| Part Name | Specification | Qty | Part No. |
|--------------------------------|-------------------|-----|---------------------------------|
| Comparator | | 1 | U2 |
| TCXO | | 1 | U3 |
| Regulator IC | | 1 | U4 |
| " | | 1 | U13 |
| Dual PLL IC | | 1 | U5 |
| L-MOS | | 1 | U6 |
| Dual Operatinal Amplifier | | 1 | U7 |
| RF Power Detector | | 1 | U8 |
| LC Filter | | 1 | U9 |
| MCU | 16KB | 1 | U10 |
| Voltage-Controlled- Oscillator | | 1 | U11 |
| Hybrid Coupler | | 1 | U12 |
| Variable Gain AMP | | 1 | U14 |
| Chip Resistor | 1608 0Ω | 3 | R4,52,55 |
| " | 1608 1Ω | 2 | R56,61 |
| " | 1608 10Ω | 3 | R21,29,39 |
| " | 1608 13Ω | 2 | R47,48 |
| " | 1608 18Ω | 5 | R8,16,36,37,38 |
| " | 1608 33Ω | 2 | R31,32 |
| " | 1608 51Ω | 2 | R30,50 |
| " | 1608 82Ω | 1 | R49 |
| " | 1608 100Ω | 1 | R17 |
| " | 1608 150Ω | 2 | R45,46 |
| " | 1608 180Ω | 2 | R1,19 |
| " | 1608 330Ω | 5 | R2,13,14,15,18 |
| " | 1608 560Ω | 1 | R7 |
| " | 1608 1KΩ | 7 | R9,10,11,28,41,42,44 |
| " | 1608 1.8KΩ | 1 | R12 |
| " | 1608 2.4KΩ | 1 | R40 |
| " | 1608 2.7KΩ | 3 | R33,34,35 |
| " | 1608 4.3KΩ | 4 | R57,58,59,60 |
| " | 1608 5.6KΩ | 1 | R62 |
| " | 1608 13KΩ | 1 | R6 |
| " | 1608 10KΩ | 4 | R24,25,27,43 |
| " | 1608 11KΩ | 1 | R20 |
| " | 1608 180KΩ | 1 | R22 |
| " | 1608 390KΩ | 1 | R23 |
| " | 1608 1MΩ | 1 | R3 |
| Variable Resistance | Surface Mount 1KΩ | 1 | VR1 |
| Chip Capacitor | 1608 0.5pF | 1 | C61 |
| " | 1608 1pF | 4 | C31,53,55,56 |
| " | 1608 3pF | 3 | C50,54,60 |
| " | 1608 8pF | 1 | C3 |
| " | 1609 9pF | 7 | C20,42,43,48,49,52,58 |
| " | 1608 100pF | 10 | C1,14,18,21,28,36,37,39, C51,59 |
| Chip Capacitor | 1608 180pF | 1 | C30 |
| " | 1608 1000pF | 5 | C7,13,23,45,47 |

| | | | | |
|-------------------------------|-----------------------------|-------|----|---------------------------------|
| " | 1608 | 0.1μF | 11 | C2,4,6,9,10,11,12,16,27,34, C46 |
| " | 1608 | 1μF | 10 | C5,8,17,22,26,29,35,38,40, C41 |
| " | 2125 | 2.2μF | 1 | C44 |
| " | 3216 | 10μF | 3 | C15,25,32 |
| " | 4532 | 100μF | 1 | C19 |
| Chip Coil | 1608 | 1.8nH | 3 | L4,5,8 |
| " | 1608 | 2.2nH | 1 | L9 |
| " | 1608 | 3.9nH | 1 | L3 |
| " | 1608 | 15nH | 1 | L2 |
| " | 1608 | 1μH | 1 | L1 |
| Transistor | Surface Mount | | 1 | Q2 |
| " | Surface Mount | | 1 | Q3 |
| " | Surface Mount | | 1 | Q4 |
| Diode | Surface Mount | | 2 | D1,2 |
| LED | Surface Mount | | 2 | LED1,2 |
| Chip Jumper | Surface Mount | | 1 | JP1 |
| Coaxial Connector | Surface Mount | | 1 | CN2 |
| Connector | Surface Mount | | 1 | CN3 |
| Mini USB Connector | Surface Mount | | 1 | CN4 |
| Shield Case A | Component Side, Solder Side | | 2 | |
| R/F Substrate (Four- Layered) | 45×33×1mm | | 1 | |
| S/No. Sticker | 2.45GHz displayed | | 1 | |

MMATS-4570

| Part Name | Specification | Qty | Part No. |
|----------------------------------|-------------------|-----|------------------|
| Antenna substrate | 45x70x1.0mm | 1 | |
| Reflector (Fe/Sn plating) | 45x70x0.5mm | 1 | |
| Capacitor | 0.3pF (1005) | 1 | C1 |
| Capacitor | 4pF (1005) | 1 | C2 |
| Connector | U.FL receptacle | 1 | CN1(RS:426-5469) |
| Spacer (Resin type) | Hexagonal M2 16mm | 4 | |
| Stainless pan-head machine screw | Hexagonal M2x4 | 8 | (RS418-7404) |
| Serial No. sticker | 4mmx19mm | 1 | Number only |

11.3 Antenna layout



12 FCC STATEMENT

THIS DEVICE 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 UNDESIRE OPERATION.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.