

# WRF01-M24A Module Datasheet



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## 2 Revision history

Date	Description	Author
2016.10	0.9	TF

### 3 Introduction

This document introduces the user to the specification of WRF01-M24A hardware, including the following topics:

Chapter	Title	Subject
Chapter 4	Overview	Provides overview introduction to WRF01-M24A, including dimensions and specifications.
Chapter 5	Pin description	Provides introduction to pin layout and the relevant description.
Chapter 6	Functional description	Describes major functional modules and protocols applied on WRF01-M24A, including CPU, flash and memory, and interfaces.
Chapter 7	Electrical characteristics	Lists the electrical data of WRF01-M24A.
Chapter 8	Schematics	Provides WRF01-M24A schematics.
Chapter 9	Module Placement	
Chapter 10	GND plane	
Appendix	Notices	FCC/CE compliance statements.

## 4 Overview

DeviceDrive provides the SMD module - WRF01-M24A in which WRF01-QFP32 is embedded, see figure 1-0. It's a WiFi – 802.11 b/g/n module with UART interface (115200baud) and the MCU is for internal use only. It's recommended to use WRF01-M24A for test or further development. The module size is 18mm x 20mm x 3mm. The type of flash used on this module is an SPI flash with a package size of SOP 8-150mil. The gain of the on-board PCB antenna is 2 dBi.

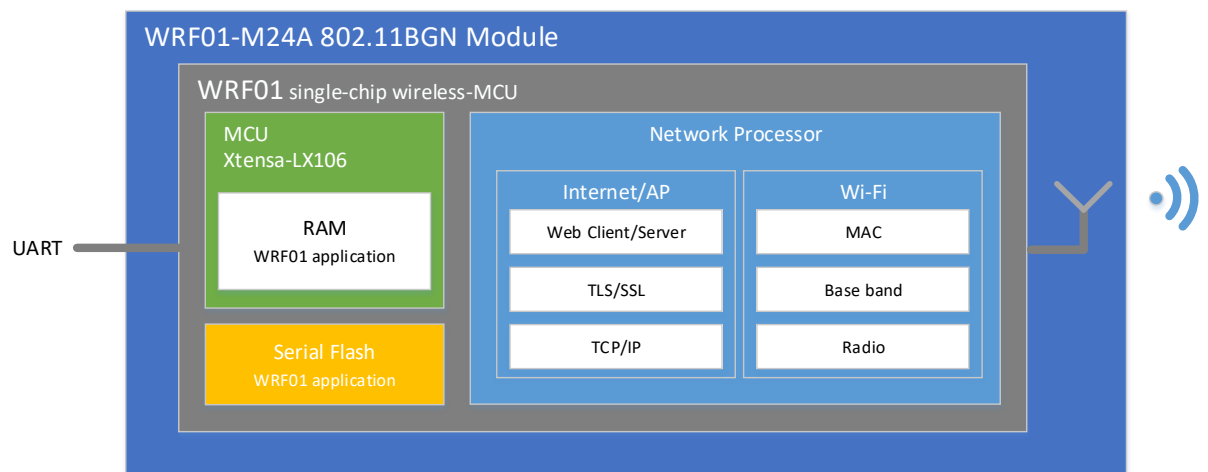


Figure 1-0. WRF01-M24A module

Table 1-1. WRF01-M24A specifications

Categories	Items	Specifications
WiFi	Standards	FCC/CE
	WiFi protocols	802.11 b/g/n
	Frequency range	2.4 GHz ~ 2.5 GHz (2400M ~ 2483.5M)
Hardware	Peripheral interface	UART, JSON format
		Power Control
	Operating voltage	3.0V ~ 3.6V
	Operating current	Average: 80mA
	Operating temperature range	-40°C ~ 85°C
	Ambient temperature range	-40°C ~ 85°C
	Package size	18mm x 20mm x 3mm
	External interface	UART
	WiFi mode	IEEE802.11.BGN
	Security	Secret device token +HTTPS
Software	Encryption	2048-bit SSL
	Firmware upgrade	DD Cloud (OTA)
	Software	Preloaded Firmware
	Network protocols	IPv4, HTTP/S

## 5 Pin description

The pin distribution of the SMD Module is illustrated in Figure 2-1.

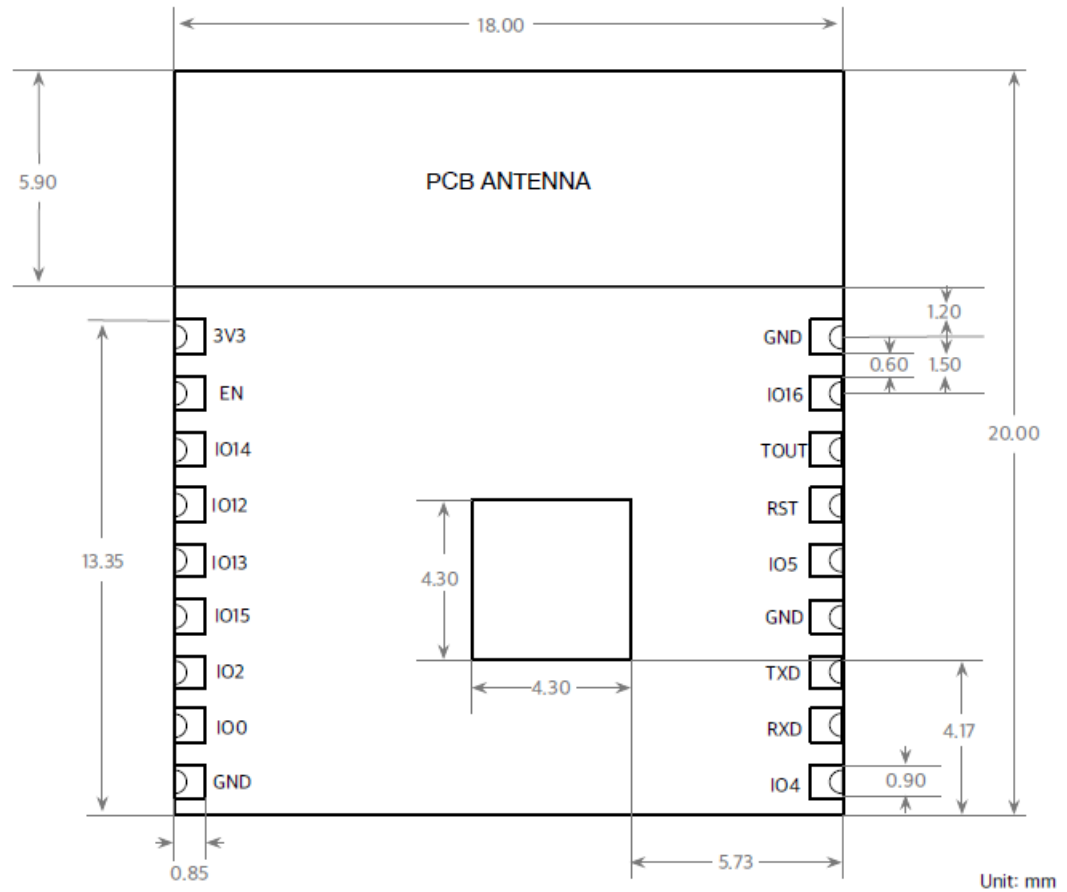


Figure 2-1. Top view of WRF01-M24A

Table 2-1. WRF01-M24A dimensions

Length	Width	Height	PAD size (bottom)	Pin pitch
18 mm	20 mm	3 mm	1,7 mm X 0,9 mm	1.5 mm

WRF01-M24A has 18 pins, see the pin definitions in Table 2-2.

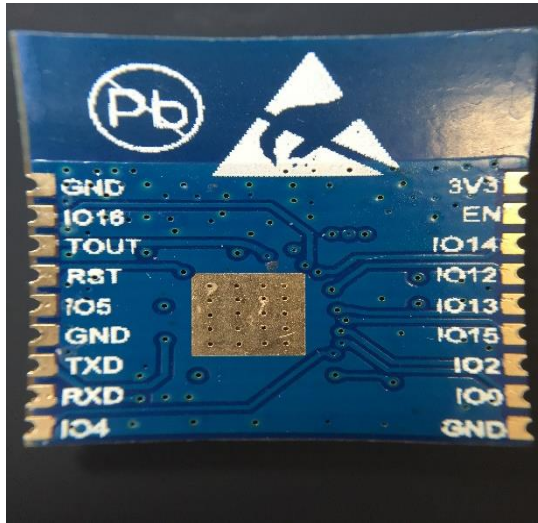


Figure 1-1. WRF01-M24A module



Table 2-2. WRF01-M24A pin definitions, fig.1-1

No.	Pin name	Functional description
1	3V3	3.3V power supply (VDD)
2	EN	Chip enable pin. Active high
3	IO14	N.C
4	IO12	N.C
5	IO13	N.C
6	IO15	10k pull-down resistor
7	IO2	Debug TX port
8	IO0	VCC, 10k pull-up resistor
9	GND	GND
10	IO4	N.C
11	RXD	UART0_RXD
12	TXD	UART0_TXD
13	GND	GND
14	IO5	N.C
15	RST	# Reset, active low
16	TOUT	N.C
17	IO16	Must be permanently connected to RST (pin 15) in order to support deep sleep. Wakes up from deep sleep when this connection is pulled low (falling edge). Typical power consumption in deep sleep amounts to 10uA.
18	GND	GND

## 6 Functional description

### 6.1 MCU

WRF01-QFP32 integrates the Tensilica L106 32-bit microcontroller (MCU), which features extra low power consumption and 16-bit RISC. The Diamond std. 106Micro is an extremely low power, cache-less controller. It employs a 5-stage pipeline so it can easily achieve 250MHz in 130nm (=0,13uG) process. The Tensilica L106 MCU is solely dedicated to run the WiFi-stack, and not available for host-application. The “Diamond” is the brand of the L106 core series.

#### Tensilica L106 versus ARM7 and Cortex M3.

	ARM 7TDMI-S	Diamond 106Micro	Cortex M3
<b>AREA AND PERFORMANCE</b>			
Max Frequency (0.13u G) worst case, Sage-X library, speed optimized	160 MHz	<b>250 MHz</b>	135 MHz
Dhrystone MIPS	152	<b>305</b>	169
Area (0.13G) for base core (without bus interface, interrupt controller and timers)	0.24 mm <sup>2</sup>	<b>0.18 mm<sup>2</sup></b>	0.23 mm <sup>2</sup>
<b>POWER</b>			
mW per MHz (0.13G) Sage-X library, area optimized	0.10 (does not include bus interface, interrupt controller, trace)	<b>0.1</b>	0.12 (extrapolated from 0.84 using Metro libraries)
<b>FEATURES</b>			
Pipeline stages	3	<b>5</b>	3
Code density	Mode bit to switch between 32- & 16-bit instructions	<b>Modelessly switch between 24- and 16-bit instructions</b>	Supports only ARM Thumb2 ISA
Memory architecture	Unified instruction and data interface	<b>Separate instruction and data RAM TCMS</b>	No TCMS
Interrupt controller	Needs external interrupt controller	<b>Has integrated interrupt controller with 15 interrupts &amp; 2 priority levels</b>	Has optional interrupt controller
Number of integrated timers	0	<b>1</b>	1

## 6.2 Memory

### 6.2.1 Internal SRAM dedicated for JSON services

WRF01-QFP32 WiFi buffer size for JSON messages.

### 6.2.2 Internal SPI Flash on module

WRF01-M24A is preloaded with DD cloud-on-chip firmware available through Cloud OTA upgrade

## 6.3 Crystal oscillators

WRF01-M24A can support 40 MHz, 26 MHz and 24 MHz crystal oscillators. The accuracy of crystal oscillators applied should be  $\pm 10$  PPM, and the operating temperature range should be between  $-20^{\circ}\text{C}$  and  $85^{\circ}\text{C}$ .

## 6.4 JSON interface description

Please see WRF01 serial command interface description.

Download from <https://devicedrive.com/downloads/>

## 7 Electrical characteristics

### 7.1 Absolute maximum ratings

Table 4-1. Absolute Maximum Ratings

Rating	Condition	Value	Unit
Storage temperature	—	-40 ~ 85	°C
Maximum soldering temperature	—	260	°C
Supply voltage	IPC/JEDEC J-STD-020	+3.0 ~ +3.6	V

### 7.2 Recommended operating conditions

Table 4-2. Recommended operating conditions

Operating condition	Symbol	Min	Typ	Max	Unit
Operating temperature	—	-40	20	85	°C
Supply voltage	VDD	3.0	3.3	3.6	V

### 7.3 Digital terminal characteristics

(VDD = 3.3V, TA = 20°C, unless otherwise specified.)

Table 4-3. Digital terminal characteristics

Terminals	Symbol	Min	Typ	Max	Unit
Input logic level low	V <sub>IL</sub>	-0.3	—	0.25V <sub>D</sub> D	V
Input logic level high	V <sub>IH</sub>	0.75VDD	—	VDD+0. 3	V
Output logic level low	V <sub>OL</sub>	N	—	0.1VDD	V
Output logic level high	V <sub>OH</sub>	0.8VDD	—	N	V

## 7.4 RF performance

Table 4-4. RF performance

Description	Min	Typ	Max	Unit
Input frequency	2400	-	2483.5	MHz
Input impedance	-	50	-	ohm
Input reflection	-	-	-10	dB
Output power of PA for 72.2 Mbps	15.5	16.5	17.5	dBm
Output power of PA for 11b mode	19.5	20.5	21.5	dBm
Sensitivity				
CCK, 1 Mbps	-	-98	-	dBm
CCK, 11 Mbps	-	-91	-	dBm
6 Mbps (1/2 BPSK)	-	-93	-	dBm
54 Mbps (3/4 64-QAM)	-	-75	-	dBm
HT20, MCS7 (65 Mbps, 72.2 Mbps)	-	-72	-	dBm
Adjacent channel rejection				
OFDM, 6 Mbps	-	37	-	dB
OFDM, 54 Mbps	-	21	-	dB
HT20, MCS0	-	37	-	dB
HT20, MCS7	-	20	-	dB

## 7.5 Sensitivity

Table 4-5. Sensitivity

Parameters	Min	Typ	Max	Unit
Input frequency	2412	-	2484	MHz
Input impedance	-	50	-	$\Omega$
Input reflection	-	-	-10	dB
Output power of PA for 72.2 Mbps	15.5	16.5	17.5	dBm
Output power of PA for 11b	19.5	20.5	21.5	dBm
Sensitivity	-	-	-	-
DSSS, 1 Mbps	-	-98	-	dBm
CCK, 11 Mbps	-	-91	-	dBm
6 Mbps (1/2 BPSK)	-	-93	-	dBm
54 Mbps (3/4 64-QAM)	-	-75	-	dBm
HT20, MCS7 (65 Mbps, 72.2 Mbps)	-	-72	-	dBm
Adjacent channel rejection	-	-	-	-
OFDM, 6 Mbps	-	37	-	dB
OFDM, 54 Mbps	-	21	-	dB
HT20, MCS0	-	37	-	dB
HT20, MCS7	-	20	-	dB

## 7.6 Power consumption

Table 4-6. Power consumption

Modes	Min	Typ	Max	Unit
Tx 802.11b, CCK 11 Mbps, P <sub>OUT</sub> =+17dBm	-	170	-	mA
Tx 802.11g, OFDM 54 Mbps, P <sub>OUT</sub> =+15dBm	-	140	-	mA
Tx 802.11n, MCS7, P <sub>OUT</sub> =+13dBm	-	120	-	mA
Rx 802.11b, 1024 bytes packet length, -80dBm	-	50	-	mA
Rx 802.11g, 1024 bytes packet length, -70dBm	-	56	-	mA
Rx 802.11n, 1024 bytes packet length, -65dBm	-	56	-	mA
Modem-Sleep <sup>①</sup>	-	15	-	mA
Deep-Sleep <sup>③</sup>	-	10	-	uA
Power Off	-	0.5	-	uA

## Notes:

- Deep-sleep does not require WiFi connection to be maintained. The below example shows 1 year battery lifetime with a battery of 540,2mAh when the WiFi sends a 4kbyte message every 50 minutes.

	Current [mA]	Active [S]	Period [s]	Average [mA]		1 year	
WRF01 Active WIFI TX	140	0,5	3000,0	<b>0,02</b>	mA	<b>204,4</b>	mAh
WRF01 Active WIFI RX	56	2,0	3000,0	<b>0,04</b>	mA	<b>327</b>	mAh
WRF01 Deep sleep	0,010	300,0	3000,0	<b>0,001</b>	mA	<b>8,76</b>	mAh
Message data size: 4kbyte					Sum	<b>540,2</b>	mAh

## Deep sleep

The "deep\_sleep" serial command puts the WRF01 into deep sleep mode. While in deep sleep, only the internal Real Time Clock (RTC) is alive, to assure extremely low power consumption (for more information see [www.devedrive.com/downloads](http://www.devedrive.com/downloads) Serial Command Specification).

In order to wake up from deep sleep, the following two pins must be permanently connected:

- XPD\_DCDC (GPIO16)
- EXT\_RSTB (Reset)

Wake up from deep sleep is done by generating a low pulse on this connection. If a timeout is indicated, the pulse will automatically be generated from the RTC. Otherwise the client application must generate the pulse.

Wake up will cause a normal start-up scenario.

Benefits:

- Extremely low power consumption while asleep
- Quicker connection time when waking up from deep sleep

## 7.7 Reflow profile

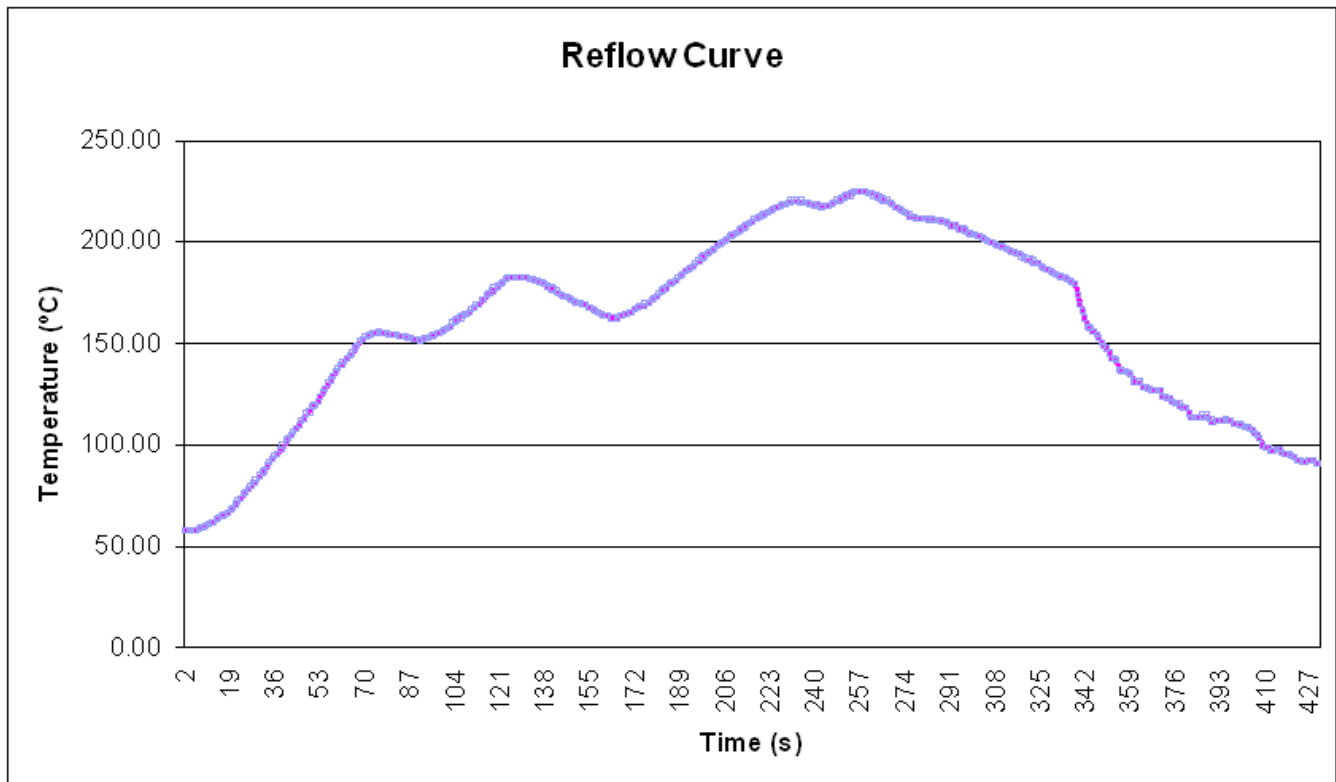
Table 4-7. Reflow profile

T <sub>S</sub> max to TL (Ramp-up Rate)	3°C/second max
Preheat	
Temperature Min. (T <sub>S</sub> Min.)	150°C
Temperature Typ. (T <sub>S</sub> Typ.)	175°C
Temperature Min. (T <sub>S</sub> Max.)	200°C
Time (T <sub>S</sub> )	60 ~ 180 seconds

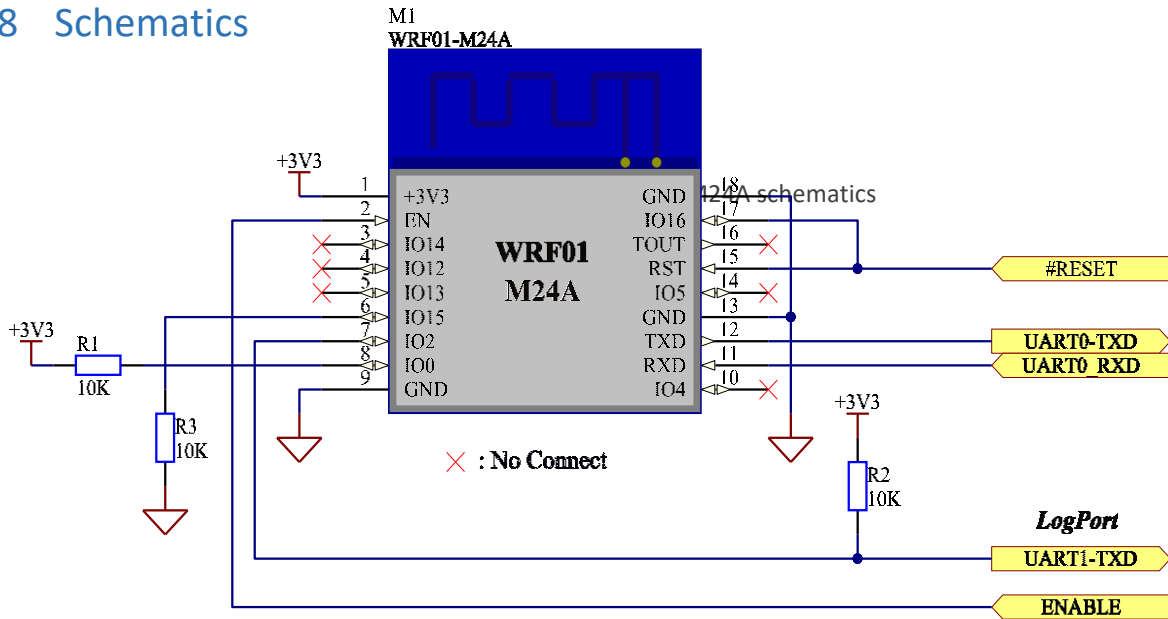


Table 4-7. Reflow profile

Ramp-up rate ( $T_L$ to $T_P$ )	3°C/second max
Time maintained above: -- Temperature( $T_L$ )/Time( $T_L$ )	217°C/60 - 150 seconds
Peak temperature ( $T_P$ )	260°C max, for 10 seconds
Target peak temperature ( $T_P$ Target)	260°C +0/-5°C
Time within 5°C of actual peak( $t_p$ )	20 ~ 40 seconds
$T_S$ max to $T_L$ (Ramp-down Rate)	6°C/second max
Tune 25°C to Peak Temperature (t)	8 minutes max



## 8 Schematics

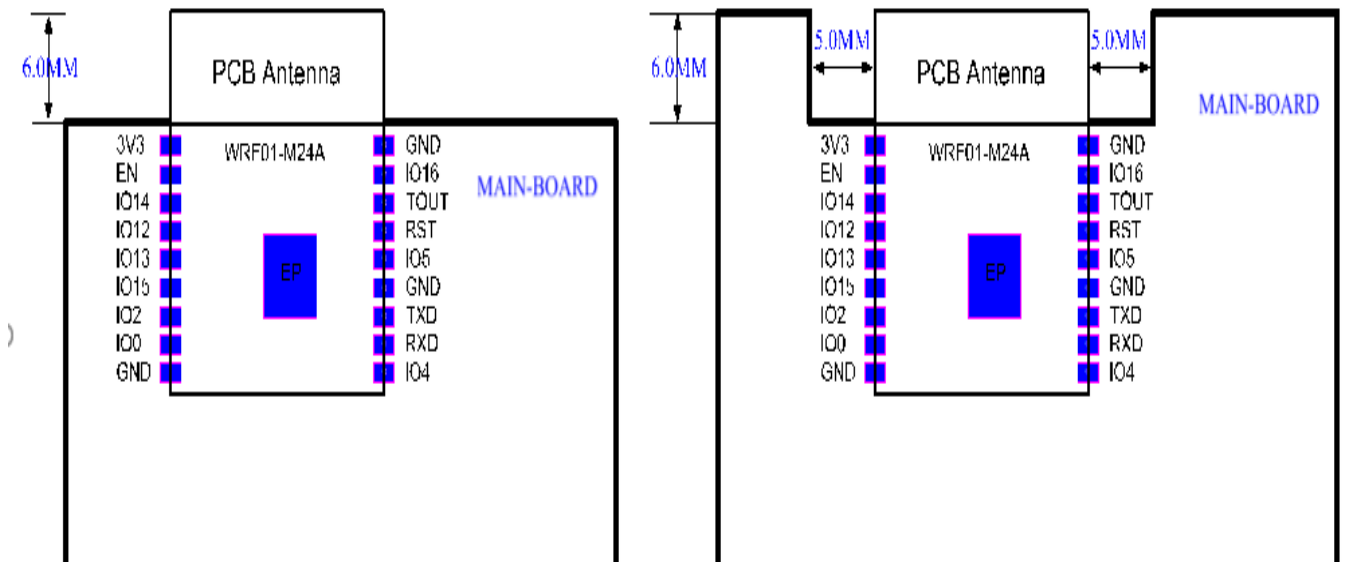


Power - and signal connections for the WRF01-M24A module

Pin 1	3V3	3.3V power supply. Power consumption: typical 170mA
Pin 2	EN	Chip Enable. Active high. Typical power consumption when disabled is 0.5uA
Pin 6	IO15	10K pull-down resistor
Pin 7	IO2	UART1_TXD. Log/debug port
Pin 8	IO0	10K pull-up resistor
Pin 11	RXD	UART0_RXD
Pin 12	TXD	UART0_TXD
Pin 15	RST	#RESET. Active low
Pin 17	IO16	GPIO16; Wake up the chipset from deep sleep mode when connected to RST pin. Power consumption in Deep Sleep is typical 10uA
Pin 9, 13, 18	GND	GND

## 9. Module placement

The PCB antenna used on WRF01-M24A is a meandered inverted F Antenna (MIFA) for the 2.4GHz WiFi band. The figure shows the placement options for the best performance on the PCB.



## 10. GND plane

**Good practices:** High speed signal traces must be routed over ground plane to minimize size of return loops in the host PCB. This ensures minimal radiation of electromagnetic noise from the PCB. Also, it is good practice to have a large, uninterrupted ground plane on one layer of the host PCB. The pad on the bottom of WRF01-M24A, must be provided sufficient plane contact for proper dissipation.

# Appendix - Notices

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## I. Federal Communications Commission (FCC) Declaration of Conformity

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 the 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.

Any changes or modifications to this equipment not expressly approved by DeviceDrive may cause harmful interference and void the user's authority to operate this equipment.

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 undesired operation.

### FCC Radiation Exposure Statement

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator& your body.

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

## II. EC Declaration of Conformity

This equipment can be used in member states of the European Union once the corresponding administrative license is obtained.

DeviceDrive, as manufacturer of the product WRF01-M24A, declares that the said product complies with the essential requirements established in Article 3 of the Council of Europe Directive 1999/5/ CE, dated 9th March, 1999.

### III. Industry Canada (IC) Compliance Notice

#### III.1. IC RSS warning

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.

#### III.2. IC Radiation Exposure Statement

This equipment complies with IC RF radiation exposure limits set forth for an uncontrolled environment. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

Any changes or modifications not expressly approved by DeviceDrive responsible for compliance could void the user's authority to operate the equipment.

#### Life support applications:

DeviceDrive AS products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury.

DeviceDrive AS customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify DeviceDrive AS for any damages resulting from such improper use or sale.



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