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## WF43 Datasheet

Amp'ed RF Technology, Inc.

## WF43 Product Specification



14.6mm x 13.5mm x 2.8 mm

### Description

Amp'ed RF Tech presents the WF43 Wi-Fi Stand-alone module: 802.11bgn + Host MCU with Wi-Fi protocol stack. The WF43 is a small footprint low cost RF module including chip antenna, 7 general purpose and ADC/DAC IO lines, several serial interface options, and up to 12M bps data throughput using the SPI interface.

The complete stack, TCP/IP with WLAN, is hosted on the integrated MCU. A simple AT command interface, artSerial, allows users to easily configure and operate the WF43.

### WLAN features

- 802.11b/g/n, 802.11d Regulatory Domain, 802.11r
- Power savings mode
- Transmit power back-off
- Wi-Fi Direct (concurrent)
- Wi-Fi Display
- Wi-Fi Protected Setup
- Soft Access Point
- Hotspot 2.0
- Security: WPAI/WPA2, AES, WEP

### Hardware configuration

- Cortex-M4 microprocessor up to 82MHz
- 256K bytes Flash memory
- 64K bytes RAM memory
- UART, up to 2.25M baud
- SPI and I2C interfaces
- 7 general purpose I/O
- 5x12-bit A/D inputs
- 1 DAC output
- 1 LPO input
- Standby current, 40  $\mu$ A
- RoHS conformance
- FCC/IC certified (pending)

### Embedded software

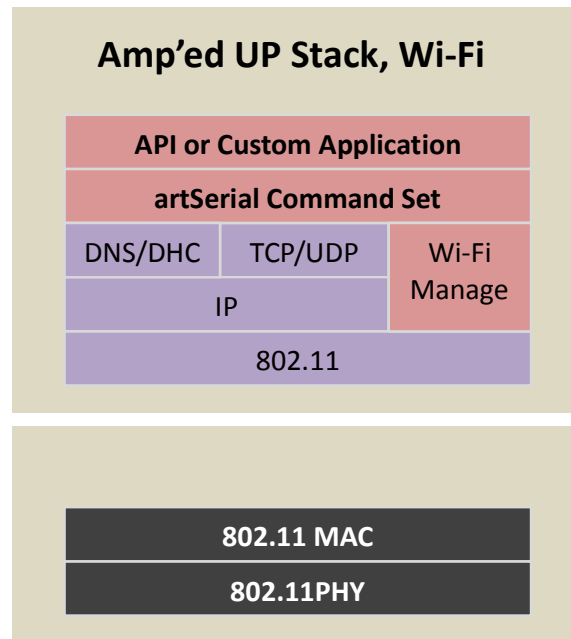
- Amp'edUP WiFi stack
- artSerial, AT command set, SDK, Software Development Kit (Optional)
- Mobile application software (Optional)

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# 1 Software Architecture

## 1.1 Protocol stack diagram



## 1.2 Wi-Fi features

- 802.11b/g/n, 802.11d Regulatory Domain, 802.11r
- Output Power, +23dBm
- Interface, SDIO 2.0, SPI
- Wi-Fi Direct (concurrent)
- Wi-Fi Display
- Wi-Fi Protected Setup
- Soft Access Point
- Hotspot 2.0
- Security: WPAI/WPA2, AES, WEP, TKIP

## 2 Hardware Specifications

General Conditions ( $V_{IN}$ = 3.6V and 25 °C)

### 2.1 Recommended Operating Conditions

| Rating                      | Min  | Typical | Max    | Unit  |
|-----------------------------|------|---------|--------|-------|
| Operating Temperature Range | -40  | -       | 85     | °C    |
| Supply Voltage $V_{IN}$     | 2.3  | 3.6     | 4.8    | Volts |
| Signal Pin Voltage          | -    | 2.0     | -      | Volts |
| RF Frequency                | 2400 | -       | 2483.5 | MHz   |

### 2.2 Absolute Maximum Ratings

| Rating                    | Min  | Typical | Max  | Unit  |
|---------------------------|------|---------|------|-------|
| Storage temperature range | -55  | -       | +150 | °C    |
| Supply voltage $V_{IN}$   | -0.3 | -       | +5.0 | Volts |
| I/O pin voltage $V_{IO}$  | -0.3 | -       | +2.5 | Volts |
| RF input power            | -    | -       | -5   | dBm   |

### 2.3 I/O Operating Conditions

| Symbol   | Parameter                 | Min | Max | Unit  |
|----------|---------------------------|-----|-----|-------|
| $V_{IL}$ | Low-Level Input Voltage   | -   | 0.6 | Volts |
| $V_{IH}$ | High-Level Input Voltage  | 1.3 | -   | Volts |
| $V_{OL}$ | Low-Level Output Voltage  | -   | 0.4 | Volts |
| $V_{OH}$ | High-Level Output Voltage | 2.0 | -   | Volts |
| $I_{OL}$ | Low –Level Output Current | -   | 4.0 | mA    |
| $I_{OH}$ | High-Level Output Current | -   | 4.0 | mA    |
| $R_{PU}$ | Pull-up Resistor          | 80  | 120 | KΩ    |
| $R_{PD}$ | Pull-down Resistor        | 80  | 120 | KΩ    |

## 2.4 Current Consumption

| <b>Modes (WLANMax Power Consumption)</b><br>V <sub>BAT</sub> =3.6v                                                 | <b>Avg</b> | <b>Unit</b> |
|--------------------------------------------------------------------------------------------------------------------|------------|-------------|
| Complete Power Down                                                                                                | 17         | μA          |
| Sleep                                                                                                              | 101        | μA          |
| Power save (beacon period (including DTIM) 100ms, beacon length 1ms)<br>-proprietary power saving features enabled | 0.77       | mA          |
| RX (idle, 2.4GHz)                                                                                                  | 62.07      | mA          |
| RX (active, 2.4GHz, OFDM)                                                                                          | 65.87      | mA          |
| TX (active, 2.4GHz, OFDM), 15.5dBm @RF port                                                                        | 257.67     | mA          |
| TX (active, 2.4GHz, OFDM), 20.5dBm @RF port                                                                        | 279.67     | mA          |
| A VoIP call using a standard codec G.711 (64Kb/s, 320 byte packets) and U-APSD (WMM power save) power-saving mode. | 4.65       | mA          |
| Video streaming; the device is receiving 2.0 Mbps of data using legacy PSM mode (for example, MPEG-4@2Mbps)        | 13.31      | mA          |
| I <sub>peak</sub> : system maximum peak current draw                                                               | 378        | mA          |
| <b>Modes (WLAN ReducedPower Consumption)</b><br>V <sub>BAT</sub> =2.7v                                             | <b>Avg</b> | <b>Unit</b> |
| Complete Power Down                                                                                                | TBD        | μA          |
| Sleep                                                                                                              | TBD        | μA          |
| Power save (beacon period (including DTIM) 100ms, beacon length 1ms)<br>-proprietary power saving features enabled | TBD        | mA          |
| RX (idle, 2.4GHz)                                                                                                  | TBD        | mA          |
| RX (active, 2.4GHz, OFDM)                                                                                          | TBD        | mA          |
| TX (active, 2.4GHz, OFDM), 15.5dBm @RF port                                                                        | TBD        | mA          |
| TX (active, 2.4GHz, OFDM), 20.5dBm @RF port                                                                        | TBD        | mA          |
| A VoIP call using a standard codec G.711 (64Kb/s, 320 byte packets) and U-APSD (WMM power save) power-saving mode. | TBD        | mA          |
| Video streaming; the device is receiving 2.0 Mbps of data using legacy PSM mode (for example, MPEG-4@2Mbps)        | TBD        | mA          |
| I <sub>peak</sub> : system maximum peak current draw                                                               | TBD        | mA          |
| <b>Modes (WLAN Min Power Consumption)</b><br>V <sub>BAT</sub> =2.3v                                                | <b>Avg</b> | <b>Unit</b> |
| Complete Power Down                                                                                                | TBD        | μA          |
| Sleep                                                                                                              | TBD        | μA          |
| Power save (beacon period (including DTIM) 100ms, beacon length 1ms)<br>-proprietary power saving features enabled | TBD        | mA          |
| RX (idle, 2.4GHz)                                                                                                  | TBD        | mA          |
| RX (active, 2.4GHz, OFDM)                                                                                          | TBD        | mA          |
| TX (active, 2.4GHz, OFDM), 15.5dBm @RF port                                                                        | TBD        | mA          |
| TX (active, 2.4GHz, OFDM), 20.5dBm @RF port                                                                        | TBD        | mA          |
| A VoIP call using a standard codec G.711 (64Kb/s, 320 byte packets) and U-APSD (WMM power save) power-saving mode. | TBD        | mA          |
| Video streaming; the device is receiving 2.0 Mbps of data using legacy PSM mode (for example, MPEG-4@2Mbps)        | TBD        | mA          |
| I <sub>peak</sub> : system maximum peak current draw                                                               | TBD        | mA          |

## 2.5 Selected RF Characteristics

| Parameters            | Conditions             | Typical | Unit |
|-----------------------|------------------------|---------|------|
| Antenna load          |                        | 50      | ohm  |
| <b>Wi-Fi Receiver</b> |                        |         |      |
| Sensitivity           | DSSS 1Mbps@FER<8%      | -98.5   | dBm  |
| Sensitivity           | DSSS 2Mbps@FER<8%      | -96     | dBm  |
| Sensitivity           | CCK 5.5Mbps@FER<8%     | -94     | dBm  |
| Sensitivity           | CCK 11Mbps@FER<8%      | -89     | dBm  |
| Sensitivity           | BPSK 6Mbps@PER<10%     | -94.5   | dBm  |
| Sensitivity           | BPSK 9Mbps@PER<10%     | -92.5   | dBm  |
| Sensitivity           | QPSK 12Mbps@PER<10%    | -91.5   | dBm  |
| Sensitivity           | QPSK 18Mbps@PER<10%    | -89     | dBm  |
| Sensitivity           | 16QAM 24Mbps@PER<10%   | -86     | dBm  |
| Sensitivity           | 16QAM 36Mbps@PER<10%   | -83     | dBm  |
| Sensitivity           | 64QAM 48Mbps@PER<10%   | -78.5   | dBm  |
| Sensitivity           | 64QAM 54Mbps@PER<10%   | -77     | dBm  |
| Sensitivity           | BPSK 6.5Mbps@PER<10%   | -92.5   | dBm  |
| Sensitivity           | QPSK 13Mbps@PER<10%    | -89.5   | dBm  |
| Sensitivity           | QPSK 19.5Mbps@PER<10%  | -87     | dBm  |
| Sensitivity           | 16QAM 26Mbps@PER<10%   | -84.5   | dBm  |
| Sensitivity           | 16 QAM 39Mbps@PER<10%  | -81     | dBm  |
| Sensitivity           | 64QAM 52Mbps@PER<10%   | -77     | dBm  |
| Sensitivity           | 64QAM 58.5Mbps@PER<10% | -75.5   | dBm  |
| Sensitivity           | 64QAM 65Mbps@PER<10%   | -73.5   | dBm  |

| Mode         | Channel | Gain(dBi) | Max EIRP Power(dBm) |
|--------------|---------|-----------|---------------------|
| 802.11b      | 1       | 0.5       | 9.51                |
|              | 7       | 0.5       | 9.44                |
|              | 13      | 0.5       | 9.27                |
| 802.11g      | 1       | 0.5       | 5.71                |
|              | 7       | 0.5       | 5.79                |
|              | 13      | 0.5       | 5.55                |
| 802.11n-HT20 | 1       | 0.5       | 5.45                |
|              | 7       | 0.5       | 5.52                |
|              | 13      | 0.5       | 5.38                |

| Test Mode | Bandwidth(MHz) | Channel No. | Frequency(MHz) | Data Rate(Mbps) | Peak Power(dBm) |
|-----------|----------------|-------------|----------------|-----------------|-----------------|
| 802.11b   | 20             | 6           | 2437           | 1               | 12.31           |
|           |                |             |                | 5.5             | 11.62           |
|           |                |             |                | 11              | 11.38           |
| 802.11g   | 20             | 6           | 2437           | 6               | 19.52           |
|           |                |             |                | 24              | 18.95           |
|           |                |             |                | 54              | 17.77           |
| 802.11n   | 20             | 6           | 2437           | 6.5/7.2(MCS0)   | 19.1            |
|           |                |             |                | 39/43.3(MCS4)   | 18.98           |
|           |                |             |                | 65/72.2(MCS7)   | 17.86           |

## 2.6 Transmit Power Back-off

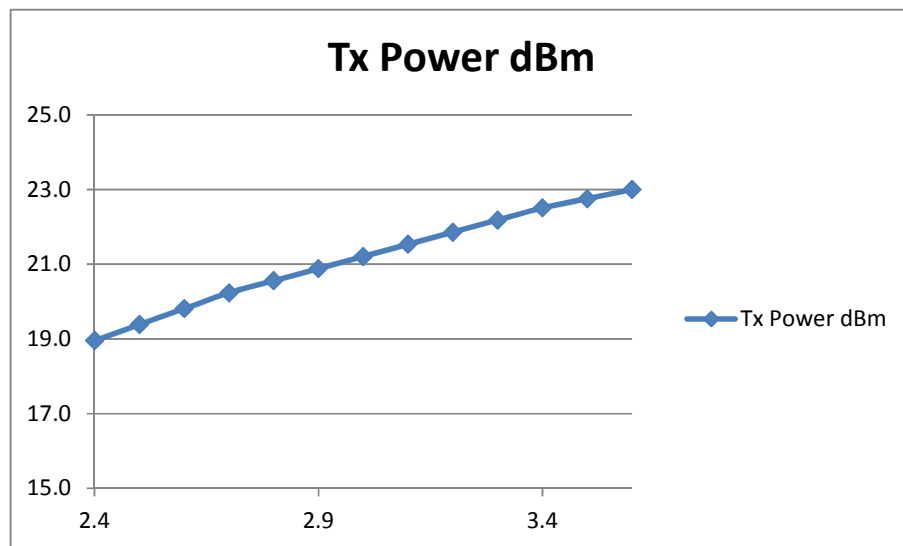
When  $2.7\text{ V} < \text{VBAT} < 3.6\text{ V}$ , the output power shall be backed off by 0.8 dB per 300 mV drop of Vbat below 3.6 V to guarantee meeting spectral mask, EVM, harmonic levels, spurious emissions and regulatory requirements in general.

When  $2.3\text{ V} < \text{VBAT} < 2.7\text{ V}$ , an additional back-off of the output power is needed to guarantee meeting spectral mask, EVM, harmonic levels, spurious emissions and regulatory requirements in general.

When the load is not  $50\Omega$ , the output power is backed off to guarantee meeting spectral mask, EVM, harmonic levels, spurious emissions and regulatory requirements in general. The device is able to withstand a VSWR of up to 12:1 without any damage.

When the temperature increases from  $+25^\circ\text{C}$  to  $+85^\circ\text{C}$ , the output power shall be backed off by 0.25 dB per  $10^\circ\text{C}$  increase to guarantee meeting spectral mask, EVM, harmonic levels, spurious emissions and regulatory requirements in general.

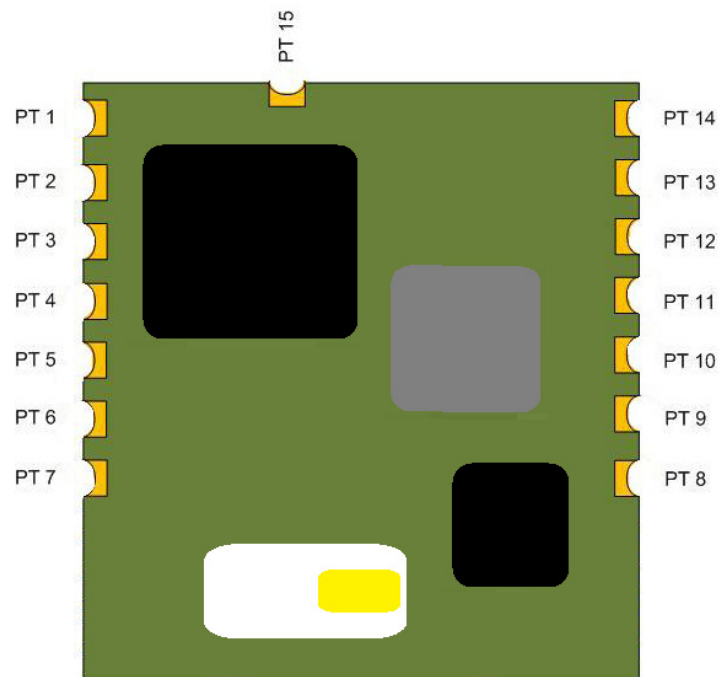
**Tx Power vs Vin**



## 2.7 Pin Assignment

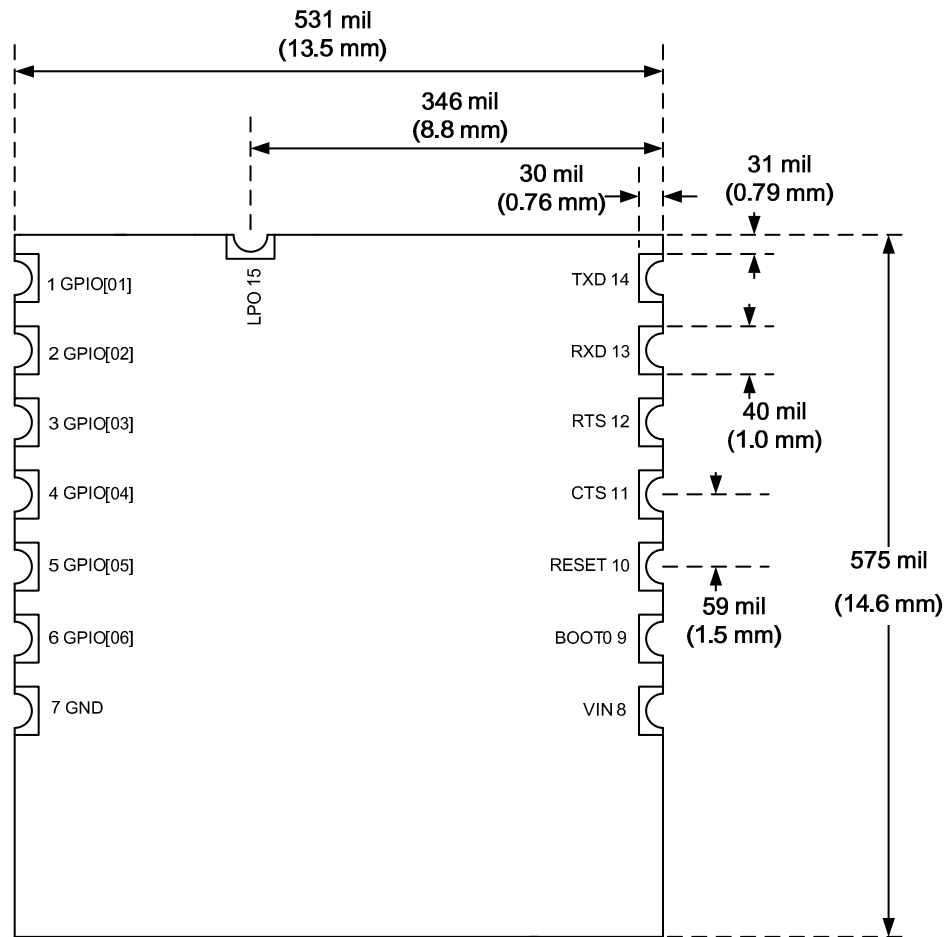
| Name                                       | Type | Pin # | Description                       | ALT Function          | 5V Tolerant | Initial State   |
|--------------------------------------------|------|-------|-----------------------------------|-----------------------|-------------|-----------------|
| <b>UART Interface</b>                      |      |       |                                   |                       |             |                 |
| RXD                                        | I    | 13    | Receive data                      |                       | Y           |                 |
| TXD                                        | O    | 14    | Transmit data                     |                       | Y           |                 |
| RTS                                        | O    | 12    | Request to send (active low)      | I2C Data/Aux Uart Rx  | Y           |                 |
| CTS                                        | I    | 11    | Clear to send (active low)        | I2C Clock/Aux Uart Tx | Y           |                 |
| <b>Reserved</b>                            |      |       |                                   |                       |             |                 |
| BOOT 0                                     | I    | 9     | Boot 0                            |                       |             |                 |
| <b>Power and Ground</b>                    |      |       |                                   |                       |             |                 |
| V <sub>in</sub>                            |      | 8     | V <sub>in</sub>                   |                       |             |                 |
| GND                                        |      | 7     | GND                               |                       |             |                 |
| <b>Reset</b>                               |      |       |                                   |                       |             |                 |
| RESETN                                     | I    | 10    | Reset input (active low for 5 ms) |                       | 2.5V max    |                 |
| <b>LPO</b>                                 |      |       |                                   |                       |             |                 |
| LPO                                        | I    | 15    | LPO input                         |                       |             |                 |
| <b>GPIO – General Purpose Input/Output</b> |      |       |                                   |                       |             |                 |
| GPIO [1]                                   | I/O  | 1     | General Purpose Input/Output      | SPI MISO/I2SextSD     | Y           | Input pull down |
| GPIO [2]                                   | I/O  | 2     | General Purpose Input/Output      | SPI MOSI/I2S SD       | Y           | Floating        |
| GPIO [3]                                   | I/O  | 3     | General Purpose Input/Output      | SPI SCLK/ I2S CK      | Y           | Input pull down |
| GPIO [4]                                   | I/O  | 4     | General Purpose Input/Output      | SPI SS/I2S WS         | Y           | Input pull down |
| GPIO [5]                                   | I/O  | 5     | General Purpose Input/Output      | ADC 0                 | Y           | Input pull down |
| GPIO [6]                                   | I/O  | 6     | General Purpose Input/Output      | ADC 1                 | Y           | Input pull down |

## 2.8 Pin Placement Diagram (Top View)



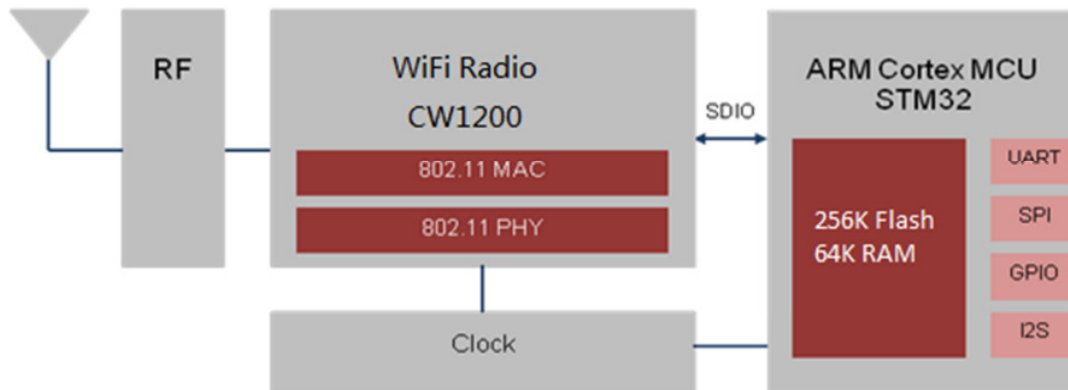
## 2.9 Layout Drawing

Size: 14.6 mm x 13.5 mm x 2.8 mm



### 3 Hardware Design

#### 3.1 Block Diagram



#### 3.2 Layout

- All unused pins should be left floating; do not ground.
- All GND pins must be well grounded.
- The area around the antenna should be free of any ground planes, power planes, trace routings, or metal for at least 6.5 mm in all directions.
- Traces should not be routed underneath the module.

#### 3.3 Module Reflow

The WF43 is a surface mount module supplied on a 15 pin, 6-layer PCB. The final assembly recommended reflow profiles are:

For RoHS/Pb-free applications, Sn96.5/Ag3.0/Cu0.5 solder is recommended.

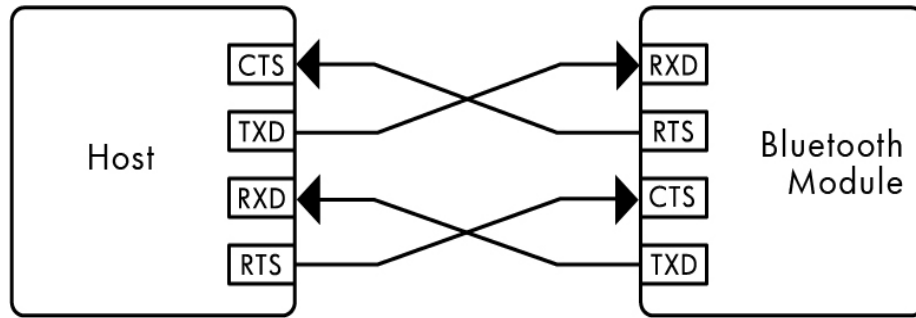
- Maximum peak temperature of 230° - 240°C (below 250°C).
- Maximum rise and fall slope after liquidous of < 2°C/second.
- Maximum rise and fall slope after liquidous of < 3°C/second.
- Maximum time at liquidous of 40 – 80 seconds.

#### 3.4 GPIO Interface

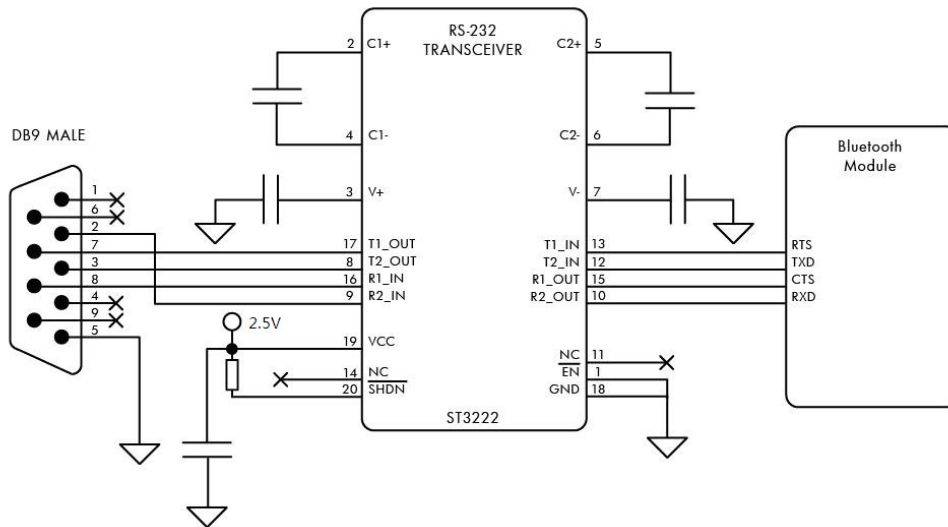
All GPIOs are capable of sinking and sourcing 4mA of I/O current.

### 3.5 UART Interface

The UART is compatible with the 16550 industry standard. Four signals are provided with the UART interface. The TXD and RXD pins are used for data while the CTS and RTS pins are used for flow control.

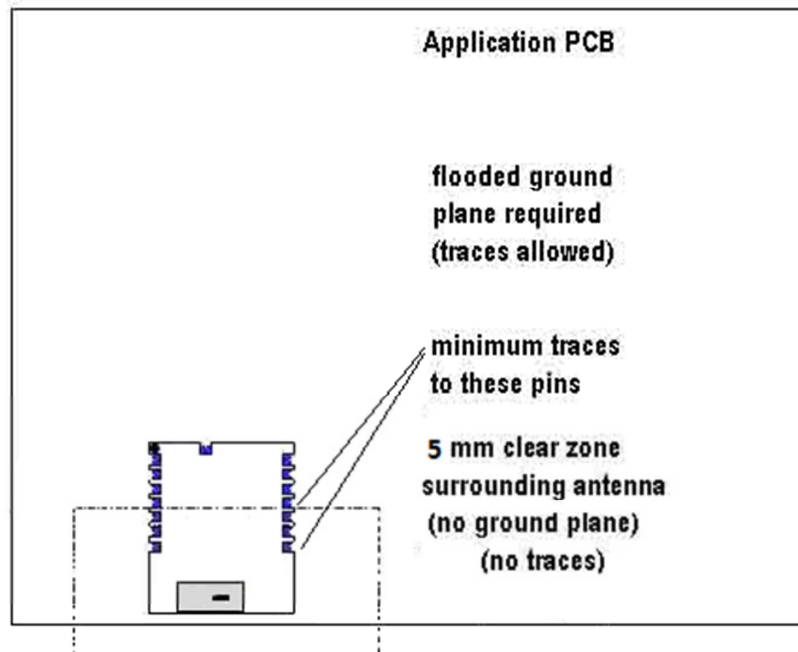


Connection to Host Device



Typical RS232 Circuit

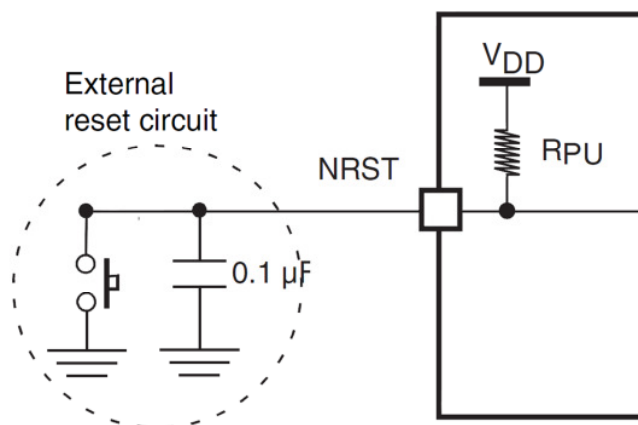
### 3.6 PCB Layout Guidelines



### 3.7 Reset Circuit

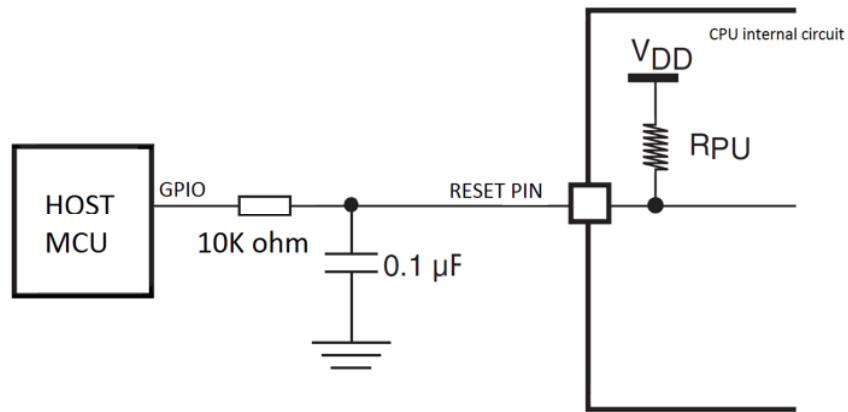
Two types of system reset circuits are detailed below.

#### 3.7.1 External Reset Circuit



Note:  $R_{PU}$  ranges from 30K ohm to 50K ohm internally.

### 3.7.2 Internal Reset Circuit



#### Notes:

- $R_{PU}$  ranges from 30K ohm to 50K ohm internally.
- $R_{RST}$  should be from 1K ohm to 10K ohm

## 4 Regulatory Compliance

### **Federal Communications Commission statement:**

This module has been tested and found to comply with the FCC Part15.

These limits are designed to provide reasonable protection against harmful interference in approved installations. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.

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.

Modifications or changes to this equipment not expressly approved by Amp'ed RF Technology may void the user's authority to operate this equipment.

The modular transmitter must be equipped with either a permanently affixed label or must be capable of electronically displaying its FCC identification number

(A) If using a permanently affixed label, the modular transmitter must be labeled with its own FCC identification number, and, if the FCC identification number 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: X3ZWFMOD9" or "Contains FCC ID: X3ZWFMOD9."

(B) If the modular transmitter uses an electronic display of the FCC identification number, the information must be readily accessible and visible on the modular transmitter or on the device in which it is installed. If the module is installed inside another device, then the outside of the device into which the module is installed must display a label referring to the enclosed module. This exterior label can use wording such as the following: "Contains FCC certified transmitter module(s)."

To satisfy FCC RF Exposure requirements for mobile and base station transmission devices, a separation distance of 20 cm or more should be maintained between the antenna of this device and persons during operation. To ensure compliance, operation at closer than this distance is not recommended. The antenna(s) used for this transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

### Industry Canada statement:

Label of the end product:

The final end product must be labeled in a visible area with the following "Contains transmitter module IC: 8828A-MOD9"

This Class B digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe B est conforme à la norme NMB-003 du Canada.

This device complies with RSS-210 of the Industry Canada 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.

Ce dispositif est conforme à la norme CNR-210 d'Industrie Canada applicable aux appareils radio exempts de licence. Son fonctionnement est sujet aux deux conditions suivantes: (1) le dispositif ne doit pas produire de brouillage préjudiciable, et (2) ce dispositif doit accepter tout brouillage reçu, y compris un brouillage susceptible de provoquer un fonctionnement indésirable.

### 4.1 Modular Approval, FCC and IC

FCC ID: X3ZWFMOD9

IC: 8828A-MOD9

In accordance with FCC Part 15, the WF43 is listed above as a Limited Modular Transmitter device.

### 4.2 FCC Label Instructions

The outside of final products that contain a WF43 device must display a label referring to the enclosed module. This exterior label can use wording such as the following:

Contains Transmitter Module

FCC ID: X3ZWFMOD9

IC: 8828A-MOD9

Any similar wording that expresses the same meaning may be used.

### 4.3 CE Label Instructions

CE Certification

## 5 Ordering Information

| Part Name | Description      |
|-----------|------------------|
| WF43      | Standard version |

## 6 Revision History

| Data             | Revision | Description                                                |
|------------------|----------|------------------------------------------------------------|
| 17-February-2014 | 1.2      | Added WF43LT option                                        |
| 20-June-2014     | 1.3      | Updated the picture of WF43                                |
| 16-Sep-2014      | 1.4      | Updated the ordering information                           |
| 24-Mar-2015      | 1.5      | Updated the description, pin assignment and block diagram. |
| 14-July-2015     | 1.6      | Updated the ordering information.                          |