# MS45SF1

## Dual-core/Multi-Protocol
## Bluetooth Low Energy module

Specification V1.0

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# Dual-core/Multi-potocol nRF5340 Module MS45SF1 Specification

MS45SF1 is a compact size(18.5 x 12.5 x 2.0 mm), most advance, powerful, secure, ultra-low power wireless Dual-core/Multi-protocol BLE 5.3 Module based on nRF5340 SoCs. Supporting Bluetooth Low Energy, Bluetooth mesh, NFC, Thread, Zigbee and Matter, makes it an ideal choice for LE Audio, professional lighting, advanced wearables, smart home and other complex IoT applications.

## Features

1. Two ARM ® Cortex ® -M33 128/64 MHz processor
2. BLE 5 data rate: 2Mbps,1Mbps, 500 kbps,125kbps. IEEE 802.15.4 Thread and Zigbee data rate: 250kbps, Proprietary 2.4 GHz: 2 Mbps, 1 Mbps
3. High-performance Application Processor: 1 MB Flash/512 KB Flash
4. Fully-programmable Network Processor: 256 KB Flash/64 KB Flash
5. GPIO:48
6. 2×UART/4×SPI masters/3×SPI slaves
7. SoC TX power: -20dB to +3dB
8. Operating temperature: -40℃ to +85℃
9. Antenna: PCB
10. Module size: 18.5mm×12.5mm×2.0mm
11. Range: 125kbps: up to 250 meters in open space.

## Application

1. Medical devices
2. Heart rate monitor
3. Blood pressure monitor
4. Blood glucose meter
5. Thermometer
6. Sport facilities
7. Weighing machine
8. Sports and fitness sensors
9. Accessories
10. 3D glasses and gaming controller
11. Mobile accessories
12. Remote controllers / Toys
13. Electronic devices
14. Cycle computer
15. Audio Device


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# 1 Product Introduction

MS45SF1 module is the most advance, compact size(18.5mm×12.5mm×2.0mm), highest performance, secure ultra-low power wireless dule-core/multi protocl BLE 5.3 Module based on nRF5340 SoCs. It combines two flexible Arm Cortex-M33 processors, a 1 MB flash memory, 512 KB RAM application processor, and a 256 KB Flash and 64 KB RAM network processor.

It's a all-in-one module including a superset of the most prominent nRF52® Series features. An extensive range of wireless protocols are supported: Bluetooth 5.1 AOA/AOD, Bluetooth 5.2 LE Audio, Long Range, Bluetooth mesh, Thread and Zigbee can be run concurrently with Bluetooth LE, enabling applications using Matter or HomeKit. NFC, ANT, 802.15.4 and 2.4 GHz proprietary protocols are also supported.

MS45SF1 brings out all features of Nordic nRF5340 Soc, which meets the most complex and security-conscious applications, it allow faster time to market with highest performance, ultra low power management and reduced development cost with multi certifications acquired. MS45SF1 module speed up your IoT solution and make it easier and reliable.

## 1.1 Ordering information

| Ordering number | Description |
|---|---|
| MS45SF1-1Y40AIR | nRF5340-QIAA BT 5.3 Module, PCB Antenna, Reel pack |


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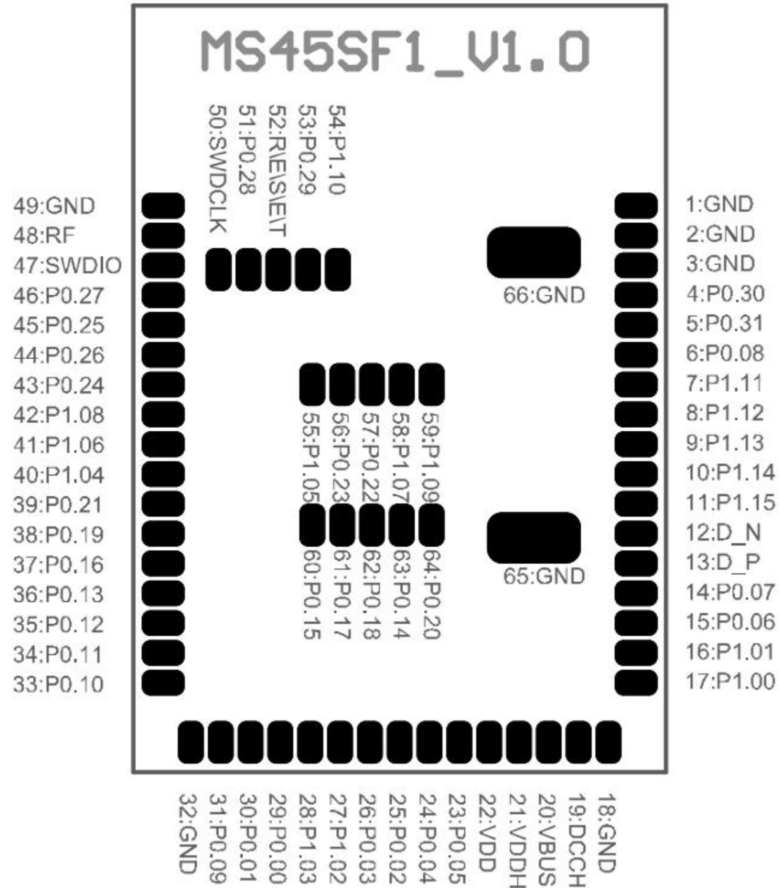
# 2 Pin Description

## 2.1 Pin assignment





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## 2.2 Pin definition

| Symbol | Type | Description |
|---|---|---|
| VBUS | Power | 5 V input for USB 3.3 V regulator |
| P1.13 | Digital I/O | General purpose I/O |
| D_P | USB | USB D+ |
| D_N | USB | USB D- |
| P1.15 | Digital I/O | General purpose I/O |
| P1.14 | Digital I/O | General purpose I/O |
| P1.12 | Digital I/O | General purpose I/O |
| P1.11 | Digital I/O | General purpose I/O |
| P0.31 | Digital I/O | General purpose I/O |
| P0.30 | Digital I/O | General purpose I/O |
| VDD | Power | Power supply |
| VDDH | Power | Power supply |
| GND | Power | Ground |
| DCCH | Power | DC/DC converter output |
| RF | ANT | Single-ended antenna connection |
| P1.00 | Digital I/O | General purpose I/O |
| P0.00<br>XL1 | Digital I/O Analog input | General purpose I/O<br>Connection for 32 kHz crystal |
| P1.01 | Digital I/O | General purpose I/O |
| P0.01<br>XL2 | Digital I/O Analog input | General purpose I/O<br>Connection for 32 kHz crystal |
| P1.10 | Digital I/O | General purpose I/O |
| P0.29 | Digital I/O | General purpose I/O |
| P0.04<br>AIN0 | Digital I/O Analog input | General purpose I/O<br>Analog input |
| P0.02<br>NFC1 | Digital I/O NFC input | General purpose I/O<br>NFC antenna connection |


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| | | | |
|---|---|---|---|
| SWDCLK | Debug | Serial wire debug clock input for debug and programming | |
| P0.05<br>AIN1 | Digital I/O Analog input | General purpose I/O<br>Analog input | |
| P0.03<br>NFC2 | Digital I/O NFC input | General purpose I/O<br>NFC antenna connection | |
| SWDIO | Debug | Serial wire debug I/O for debug and programming | |
| P0.06<br>AIN2 | Digital I/O Analog input | General purpose I/O<br>Analog input | |
| nRESET | Reset | Pin RESET with internal pull-up resistor | |
| P0.07<br>AIN3 | Digital I/O Analog input | General purpose I/O<br>Analog input | |
| P1.02<br>TWI | Digital I/O TWI 1 Mbps | General purpose I/O<br>High-speed pin for 1 Mbps TWI | TWI |
| P0.28<br>AIN7 | Digital I/O Analog input | General purpose I/O<br>Analog input | |
| P1.03<br>TWI | Digital I/O<br>TWI 1 Mbps | General purpose I/O<br>High-speed pin for 1 Mbps TWI | TWI |
| P0.08<br>TRACEDATA3<br>SCK | Digital I/O Trace data SCK for SPIM4 | General purpose I/O<br>Trace buffer TRACEDATA[3]<br>Dedicated pin for high-speed SPI | Trace, SPIM4 |
| P0.09<br>TRACEDATA2<br>MOSI | Digital I/O Trace data MOSI for SPIM4 | General purpose I/O<br>Trace buffer TRACEDATA[2]<br>Dedicated pin for high-speed SPI | Trace, SPIM4 |
| P0.10<br>TRACEDATA1<br>MISO | Digital I/O Trace data MISO for SPIM4 | General purpose I/O<br>Trace buffer TRACEDATA[1]<br>Dedicated pin for high-speed SPI | Trace, SPIM4 |
| P0.11<br>TRACEDATA0<br>CSN | Digital I/O Trace data CSN for SPIM4 | General purpose I/O<br>Trace buffer TRACEDATA[0]<br>Dedicated pin for high-speed SPI | Trace, SPIM4 |
| P0.12<br>TRACECLK<br>DCX | Digital I/O Trace clock DCX for SPIM4 | General purpose I/O<br>Trace buffer clock<br>Dedicated pin for high-speed SPI | Trace, SPIM4 |
| P0.14<br>IO1 | Digital I/O IO1 for QSPI | General purpose I/O<br>Dedicated pin for Quad SPI | QSPI |
| P0.15<br>IO2 | Digital I/O IO2 for QSPI | General purpose I/O<br>Dedicated pin for Quad SPI | QSPI |
| P0.17<br>SCK | Digital I/O SCK for QSPI | General purpose I/O<br>Dedicated pin for Quad SPI | QSPI |


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| | | | |
|---|---|---|---|
| P0.18<br>CSN | Digital I/O CSN for QSPI | General purpose I/O<br>Dedicated pin for Quad SPI | QSPI |
| P0.20 | Digital I/O | General purpose I/O | |
| P0.22 | Digital I/O | General purpose I/O | |
| P0.23 | Digital I/O | General purpose I/O | |
| P1.05 | Digital I/O | General purpose I/O | |
| P1.07 | Digital I/O | General purpose I/O | |
| P1.09 | Digital I/O | General purpose I/O | |
| P0.25<br>AIN4 | Digital I/O Analog input | General purpose I/O<br>Analog input | |
| P0.27<br>AIN6 | Digital I/O Analog input | General purpose I/O<br>Analog input | |
| P0.13<br>IO0 | Digital I/O IO0 for QSPI | General purpose I/O<br>Dedicated pin for Quad SPI | QSPI |
| P0.16<br>IO3 | Digital I/O IO3 for QSPI | General purpose I/O<br>Dedicated pin for Quad SPI | QSPI |
| P0.19 | Digital I/O | General purpose I/O | |
| P0.21 | Digital I/O | General purpose I/O | |
| P1.04 | Digital I/O | General purpose I/O | |
| P1.06 | Digital I/O | General purpose I/O | |
| P1.08 | Digital I/O | General purpose I/O | |
| P0.24 | Digital I/O | General purpose I/O | |
| P0.26<br>AIN5 | Digital I/O Analog input | General purpose I/O<br>Analog input | |


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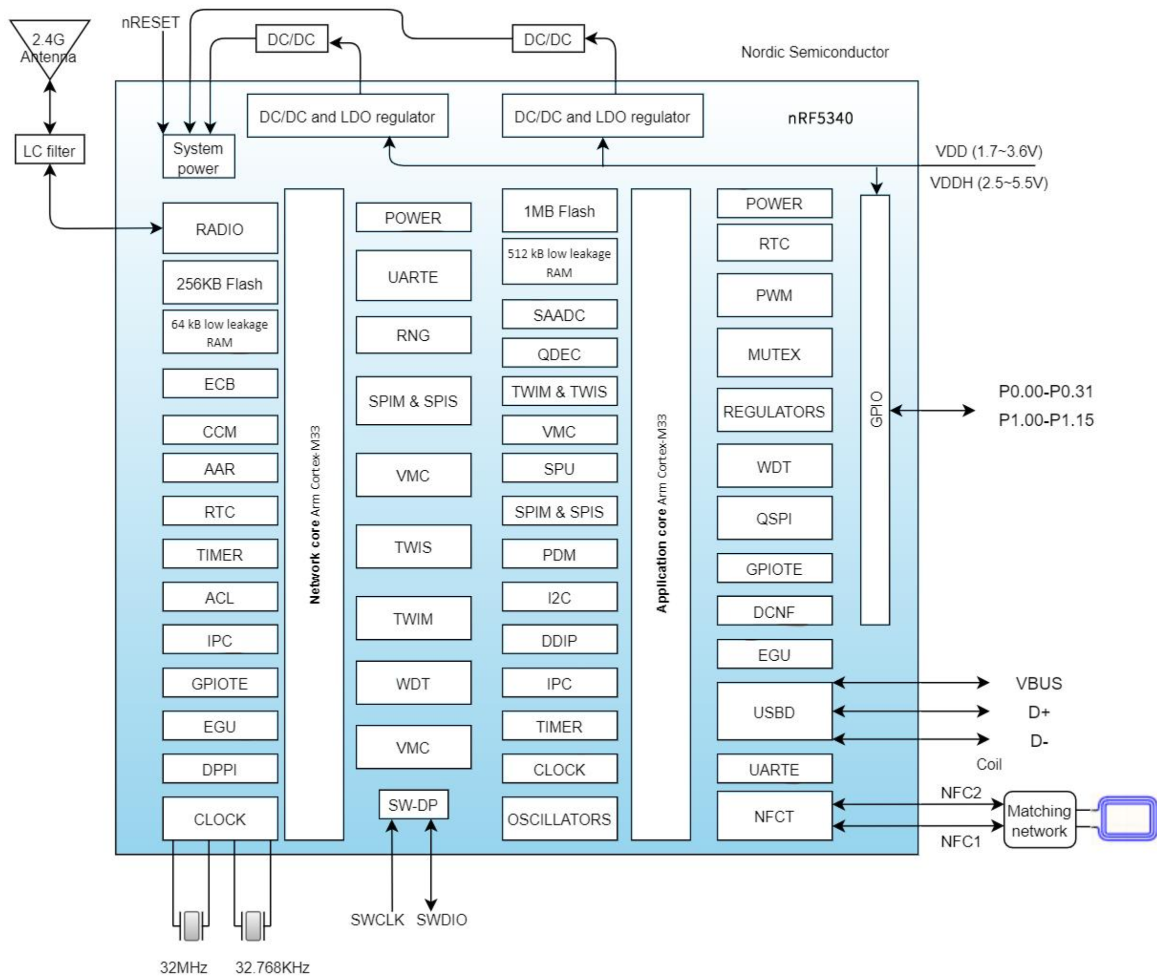
## 2.3 Block diagram





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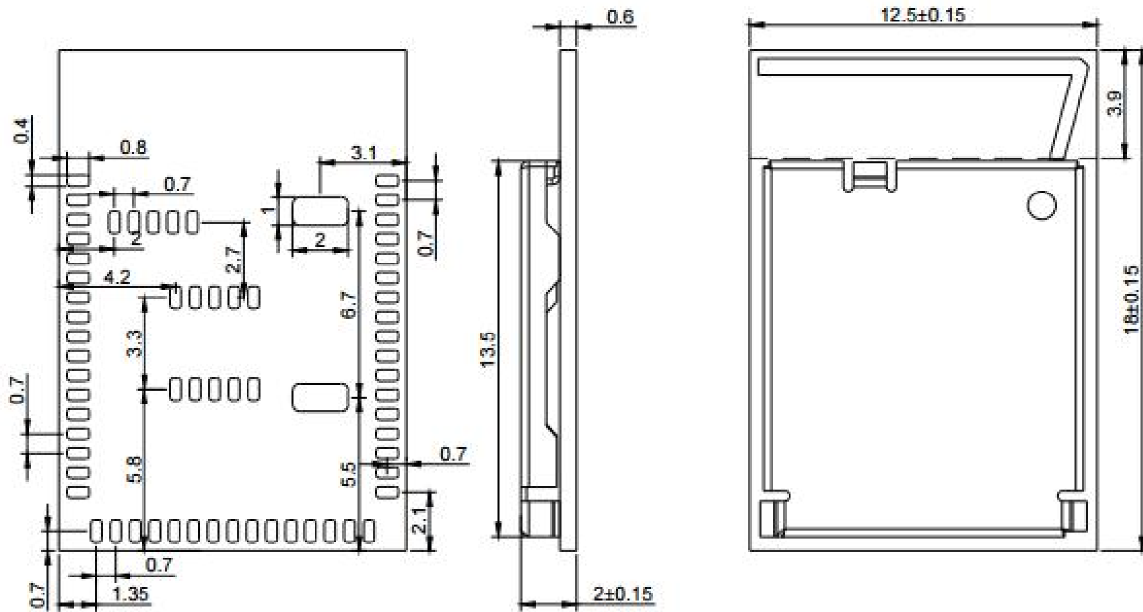
## 2.4 Mechanical Drawing




**Important:** Unit: mm Tolerance: +/- 0.1, default
Recommend pad size for general I/O : 0.4*1.0mm
Recommend pad size for I/O 65/66: 1.2*2.2mm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# 3 Electrical Specification

The electrical specifications of the module are directly related to the Nordic semiconductor Specifications for the nRF5340 chipset. The below information is only the extract from nRF5340 specification. For more detailed information, please refer to the up-to-date specification of the chipset available on the Nordic semiconductor website.

## 3.1 Absolute maximum ratings

| | Min. | Max. | Unit |
|---|---|---|---|
| **Supply voltages** | | | |
| VDD | -0.3 | +3.9 | V |
| VDDH | -0.3 | +5.8 | V |
| VBUS | -0.3 | +5.8 | V |
| VSS | | 0 | V |
| **I/O pin voltage** | | | |
| $V_{I/O}$, VDD ≤ 3.6 V | -0.3 | VDD + 0.3 | V |
| $V_{I/O}$, VDD > 3.6 V | -0.3 | 3.9 | V |
| **NFC antenna pin current** | | | |
| $I_{NFC1/2}$ | | 80 | mA |
| **Radio** | | | |
| RF input level | | 10 | dBm |
| **Environmental aQFN package** | | | |
| Storage temperature | -40 | +125 | ℃ |
| Moisture Sensitivity Level(MSL) | | 2 | kV |
| ESD Human Body Model(HBM) | | 2(all pins except DECR and DECN, rated at 1.4 kV) | KV |
| ESD Charged Device Model(CDM) | | 500 | V |
| **Flash memory** | | | |
| Endurance | 10 000 write/erase cycles | | |
| Retention | 10 years at 40°C | | |

**Important:** Maximum ratings are the extreme limits to which the chip can be exposed for a limited amount of time without permanently damaging it. Exposure to absolute maximum ratings for prolonged periods of time may affect the reliability of the device.


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## 3.2 Recommended operating conditions

The operating conditions are the physical parameters that the chip can operate within.

| Symbol | Parameter | Min. | Nom. | Max. | Units |
|---|---|---|---|---|---|
| VDD | VDD supply voltage, independent of DCDC enable | 1.7 | 3.0 | 3.6 | V |
| VDDH | VDDH supply voltage,independent of DCDC enable | 2.5 | 3.7 | 5.5 | V |
| VBUS | VBUS USB supply voltage | 4.35 | 5.0 | 5.5 | V |
| TA | Operating temperature | -40 | 25 | 85 | °C |

**Important:** The on-chip power-on reset circuitry may not function properly for rise times longer than the specified maximum.

## 3.3 Electronic characteristic

### 3.3.1 General radio characteristics

| Symbol | Description | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| $f_{OP}$ | Operating frequencies | 2360 | | 2500 | MHz |
| $f_{PLL,CH,SP}$ | PLL channel spacing | | 1.0 | | MHz |
| $f_{DELTA,1M}$ | Frequency deviation @ 1 Mbps | | ±170 | | kHz |
| $f_{DELTA,BLE,1M}$ | Frequency deviation @ Bluetooth LE 1 Mbps | | ±250 | | kHz |
| $f_{DELTA,2M}$ | Frequency deviation @ 2 Mbps | | ±320 | | kHz |
| $f_{DELTA,BLE,2M}$ | Frequency deviation @ Bluetooth LE 2 Mbps | | ±500 | | kHz |
| $fsk_{BPS}$ | On-the-air data rate | 125 | | 2000 | kbps |
| $f_{chip, IEEE\ 802.15.4}$ | Chip rate in IEEE 802.15.4 mode | | 2000 | | kchip/s |


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### 3.3.2 Radio current consumption (Transmitter)

| Symbol | Description | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| $I_{TX,PLUS3dBM,DCDC}$ | TX only run current DC/DC, 3 V, $P_{RF}$ = +3 dBm | | 5.1 | | mA |
| $I_{TX,PLUS3dBM}$ | TX only run current $P_{RF}$ = +3 dBm | | 11.3 | | mA |
| $I_{TX,0dBM,DCDC}$ | TX only run current DC/DC, 3 V, $P_{RF}$ = 0 dBm | | 3.4 | | mA |
| $I_{TX,0dBM}$ | TX only run current $P_{RF}$ = 0 dBm | | 9.1 | | mA |
| $I_{TX,MINUS4dBM,DCDC}$ | TX only run current DC/DC, 3 V, $P_{RF}$ = -4 dBm | | 2.7 | | mA |
| $I_{TX,MINUS4dBM}$ | TX only run current $P_{RF}$ = -4 dBm | | 7.2 | | mA |
| $I_{TX,MINUS8dBM,DCDC}$ | TX only run current DC/DC, 3 V, $P_{RF}$ = -8 dBm | | 2.2 | | mA |
| $I_{TX,MINUS8dBM}$ | TX only run current $P_{RF}$ = -8 dBm | | 5.8 | | mA |
| $I_{TX,MINUS12dBM,DCDC}$ | TX only run current DC/DC, 3 V, $P_{RF}$ = -12 dBm | | 2.0 | | mA |
| $I_{TX,MINUS12dBM}$ | TX only run current $P_{RF}$ = -12 dBm | | 5.0 | | mA |
| $I_{TX,MINUS16dBM,DCDC}$ | TX only run current DC/DC, 3 V, $P_{RF}$ = -16 dBm | | 1.8 | | mA |
| $I_{TX,MINUS16dBM}$ | TX only run current $P_{RF}$ = -16 dBm | | 4.5 | | mA |
| $I_{TX,MINUS20dBM,DCDC}$ | TX only run current DC/DC, 3 V, $P_{RF}$ = -20 dBm | | 1.7 | | mA |
| $I_{TX,MINUS20dBM}$ | TX only run current $P_{RF}$ = -20 dBm | | 4.2 | | mA |
| $I_{TX,MINUS40dBM,DCDC}$ | TX only run current DC/DC, 3 V, $P_{RF}$ = -40 dBm | | 1.5 | | mA |
| $I_{TX,MINUS40dBM}$ | TX only run current $P_{RF}$ = -40 dBm | | 3.8 | | mA |
| $I_{START,TX,DCDC}$ | TX start-up current DC/DC, 3 V, $P_{RF}$ = 3 dBm | | 2.4 | | mA |
| $I_{START,TX}$ | TX start-up current, $P_{RF}$ = 3 dBm | | 5.4 | | mA |


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### 3.3.3 Radio current consumption (Receiver)

| Symbol | Description | Min | Typ. | Max. | Units |
|---|---|---|---|---|---|
| $I_{RX,1M,DCDC}$ | RX only run current DC/DC, 3 V, 1 Mbps/1 Mbps Bluetooth LE mode | | 2.7 | | mA |
| $I_{RX,1M}$ | RX only run current LDO, 3 V, 1 Mbps/1 Mbps Bluetooth LE mode | | 6.7 | | mA |
| $I_{RX,2M,DCDC}$ | RX only run current DC/DC, 3 V, 2 Mbps/2 Mbps Bluetooth LE mode | | 3.1 | | mA |
| $I_{RX,2M}$ | RX only run current LDO, 3 V, 2 Mbps/2 Mbps Bluetooth LE mode | | 7.9 | | mA |
| $I_{START,RX,1M,DCDC}$ | RX start-up current DC/DC, 3 V, 1 Mbps/1 Mbps Bluetooth LE mode | | 2.1 | | mA |
| $I_{START,RX,1M}$ | RX start-up current 1 Mbps/1 Mbps Bluetooth LE mode | | 5.3 | | mA |

### 3.3.4 Transmitter specification

| Symbol | Description | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| $P_{RF}$ | Maximum output power | | 3.0 | | dBm |
| $P_{RFC}$ | RF power control range | | 23.0 | | dB |
| $P_{RFCR}$ | RF power accuracy | | ±2 | | dB |
| $P_{RF1,1}$ | 1st Adjacent Channel Transmit Power 1 MHz (1 Mbps) | | -24 | | dBc |
| $P_{RF2,1}$ | 2nd Adjacent Channel Transmit Power 2 MHz (1 Mbps) | | -52 | | dBc |
| $P_{RF1,2}$ | 1st Adjacent Channel Transmit Power 2 MHz (2 Mbps) | | -25 | | dBc |
| $P_{RF2,2}$ | 2nd Adjacent Channel Transmit Power 4 MHz (2 Mbps) | | -50 | | dBc |
| $E_{VM}$ | Error vector magnitude in IEEE 802.15.4 mode | | .. | .. | %rms |
| $P_{harm2nd,IEEE\ 802.15.4}$ | 2nd harmonics in IEEE 802.15.4 mode | | -51 | | dBm |
| $P_{harm3rd,IEEE\ 802.15.4}$ | 3rd harmonics in IEEE 802.15.4 mode | | -51 | | dBm |
| $P_{ACP,R,\ IEEE\ 802.15.4}$ | IEEE 802.15.4 Relative adjacent Channel Power, offset > 3.5 MHz | | -36 | | dBc |
| $P_{ACP,A,\ IEEE\ 802.15.4}$ | IEEE 802 15.4 Absolute adjacent Channel Power, offset > 3.5 MHz | | -36 | | dBm |


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### 3.3.5 Receiver operation

| Symbol | Description | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| $P_{RX,MAX}$ | Maximum received signal strength at < 0.1% PER | | 0 | | dBm |
| $P_{SENS,IT,1M}$ | Sensitivity, 1 Mbps nRF mode ideal transmitter [1] | | -95 | | dBm |
| $P_{SENS,IT,2M}$ | Sensitivity, 2 Mbps nRF mode ideal transmitter [2] | | -92 | | dBm |
| $P_{SENS,IT,SP,1M,BLE}$ | Sensitivity, 1 Mbps Bluetooth LE ideal transmitter, packet length ≤ 37 bytes BER = 1E-3[3] | | -98 | | dBm |
| $P_{SENS,IT,LP,1M,BLE}$ | Sensitivity, 1 Mbps Bluetooth LE ideal transmitter, packet length ≥ 128 bytes BER = 1E-4[4] | | -97 | | dBm |
| $P_{SENS,IT,SP,2M,BLE}$ | Sensitivity, 2 Mbps Bluetooth LE ideal transmitter, packet length ≤ 37 bytes | | -95 | | dBm |
| $P_{SENS,IT,BLE\ LE125k}$ | Sensitivity, 125 kbps Bluetooth LE mode | | -104 | | dBm |
| $P_{SENS,IT,BLE\ LE500k}$ | Sensitivity, 500 kbps Bluetooth LE mode | | -100 | | dBm |
| $P_{SENS,IEEE\ 802.15.4}$ | Sensitivity in IEEE 802.15.4 mode | | -101 | | dBm |

[1] Typical sensitivity applies when ADDR0 is used for receiver address correlation. When ADDR[1...7] are used for receiver address correlation, the typical sensitivity for this mode is degraded by 3dB.

[2] Desired signal level at PIN = -67 dBm. One interferer is used, having equal modulation as the desired signal. The input power of the interferer where the sensitivity equals BER = 0.1% is presented.

[3] As defined in the Bluetooth Core Specification v4.0 Volume 6: Core System Package (Low Energy Controller Volume)

[4] Equivalent BER limit < 10E-04


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## 3.3.6 RX selectivity

| Symbol | Description | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| $C/I_{1M,co-channel}$ | 1Mbps mode, co-channel interference | .. | .. | .. | dB |
| $C/I_{1M,-1MHz}$ | 1 Mbps mode, Adjacent (-1 MHz) interference | .. | .. | .. | dB |
| $C/I_{1M,+1MHz}$ | 1 Mbps mode, Adjacent (+1 MHz) interference | .. | .. | .. | dB |
| $C/I_{1M,-2MHz}$ | 1 Mbps mode, Adjacent (-2 MHz) interference | .. | .. | .. | dB |
| $C/I_{1M,+2MHz}$ | 1 Mbps mode, Adjacent (+2 MHz) interference | .. | .. | .. | dB |
| $C/I_{1M,-3MHz}$ | 1 Mbps mode, Adjacent (-3 MHz) interference | .. | .. | .. | dB |
| $C/I_{1M,+3MHz}$ | 1 Mbps mode, Adjacent (+3 MHz) interference | .. | .. | .. | dB |
| $C/I_{1M,\pm6MHz}$ | 1 Mbps mode, Adjacent (≥6 MHz) interference | .. | .. | .. | dB |
| $C/I_{1MBLE,co-channel}$ | 1 Mbps Bluetooth LE mode, co-channel interference | | 6.9 | | dB |
| $C/I_{1MBLE,-1MHz}$ | 1 Mbps Bluetooth LE mode, Adjacent (-1 MHz) interference | | -2.6 | | dB |
| $C/I_{1MBLE,+1MHz}$ | 1 Mbps Bluetooth LE mode, Adjacent (+1 MHz) interference | | -8.5 | | dB |
| $C/I_{1MBLE,-2MHz}$ | 1 Mbps Bluetooth LE mode, Adjacent (-2 MHz) interference | | -27 | | dB |
| $C/I_{1MBLE,+2MHz}$ | 1 Mbps Bluetooth LE mode, Adjacent (+2 MHz) interference | | -45 | | dB |
| $C/I_{1MBLE,>3MHz}$ | 1 Mbps Bluetooth LE mode, Adjacent (≥3 MHz) interference | | -50 | | dB |
| $C/I_{1MBLE,image}$ | Image frequency interference | | -27 | | dB |
| $C/I_{1MBLE,image,1MHz}$ | Adjacent (1 MHz) interference to in-band image frequency | | -41 | | dB |
| $C/I_{2M,co-channel}$ | 2 Mbps mode, co-channel interference | .. | .. | .. | dB |
| $C/I_{2M,-2MHz}$ | 2 Mbps mode, Adjacent (-2 MHz) interference | .. | .. | .. | dB |
| $C/I_{2M,+2MHz}$ | 2 Mbps mode, Adjacent (+2 MHz) interference | .. | .. | .. | dB |
| $C/I_{2M,-4MHz}$ | 2 Mbps mode, Adjacent (-4 MHz) interference | .. | .. | .. | dB |
| $C/I_{2M,+4MHz}$ | 2 Mbps mode, Adjacent (+4 MHz) interference | .. | .. | .. | dB |
| $C/I_{2M,-6MHz}$ | 2 Mbps mode, Adjacent (-6 MHz) interference | .. | .. | .. | dB |


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| Symbol | Description | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| $C/I_{2M,+6MHz}$ | 2 Mbps mode, Adjacent (+6 MHz) interference | .. | .. | .. | dB |
| $C/I_{2M,\geq 12MHz}$ | 2 Mbps mode, Adjacent (≥12 MHz) interference | .. | .. | .. | dB |
| $C/I_{2MBLE,co-channel}$ | 2 Mbps Bluetooth LE mode, co-channel interference | | 7.1 | | dB |
| $C/I_{2MBLE,-2MHz}$ | 2 Mbps Bluetooth LE mode, Adjacent (-2 MHz) interference | | -2 | | dB |
| $C/I_{2MBLE,+2MHz}$ | 2 Mbps Bluetooth LE mode, Adjacent (+2 MHz) interference | | -11 | | dB |
| $C/I_{2MBLE,-4MHz}$ | 2 Mbps Bluetooth LE mode, Adjacent (-4 MHz) interference | | -22 | | dB |
| $C/I_{2MBLE,+4MHz}$ | 2 Mbps Bluetooth LE mode, Adjacent (+4 MHz) interference | | -47 | | dB |
| $C/I_{2MBLE,\geq 6MHz}$ | 2 Mbps Bluetooth LE mode, Adjacent (≥6 MHz) interference | | -54 | | dB |
| $C/I_{2MBLE,image}$ | Image frequency interference | | -22 | | dB |
| $C/I_{2MBLE,image, 2MHz}$ | Adjacent (2 MHz) interference to in-band image frequency | | -42 | | dB |
| $C/I_{125k\ BLE\ LR,co-channel}$ | 125 kbps Bluetooth LE LR mode, co-channel interference | .. | .. | .. | dB |
| $C/I_{125k\ BLE\ LR,-1MHz}$ | 125 kbps Bluetooth LE LR mode, Adjacent (-1 MHz) interference | .. | .. | .. | dB |
| $C/I_{125k\ BLE\ LR,+1MHz}$ | 125 kbps Bluetooth LE LR mode, Adjacent (+1 MHz) interference | .. | .. | .. | dB |
| $C/I_{125k\ BLE\ LR,-2MHz}$ | 125 kbps Bluetooth LE LR mode, Adjacent (-2 MHz interference | .. | .. | .. | dB |
| $C/I_{125k\ BLE\ LR,+2MHz}$ | 125 kbps Bluetooth LE LR mode, Adjacent (+2 MHz) interference | .. | .. | .. | dB |
| $C/I_{125k\ BLE\ LR,>3MHz}$ | 125 kbps Bluetooth LE LR mode, Adjacent (≥3 MHz) interference | .. | .. | .. | dB |
| $C/I_{125k\ BLE\ LR,image}$ | Image frequency interference | .. | .. | .. | dB |
| $C/I_{IEEE\ 802.15.4,-5MHz}$ | IEEE 802.15.4 mode, Adjacent (-5 MHz) rejection | | -33 | | dB |
| $C/I_{IEEE\ 802.15.4,+5MHz}$ | IEEE 802.15.4 mode, Adjacent (+5 MHz) rejection | | -38 | | dB |
| $C/I_{IEEE\ 802.15.4,\pm 10MHz}$ | IEEE 802.15.4 mode, Alternate (±10 MHz) rejection | | -50 | | dB |


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### 3.3.7 RX intermodulation

| Symbol | Description | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| $P_{IMD,5TH,1M}$ | IMD performance, 1 Mbps, 5th offset channel, packet length ≤ 37 bytes | | .. | .. | dBm |
| $P_{IMD,5TH,1M,BLE}$ | IMD performance, Bluetooth LE 1 Mbps, 5th offset channel, packet length ≤ 37 bytes | | -26 | | dBm |
| $P_{IMD,5TH,2M}$ | IMD performance, 2 Mbps, 5th offset channel, packet length ≤ 37 bytes | | .. | .. | dBm |

### 3.3.8 Radio timing

| Symbol | Description | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| $t_{TXEN,BLE,1M}$ | Time between TXEN task and READY event after channel FREQUENCY configured (1Mbps Bluetooth LE and 150 µsTIFS) | | 140 | | µs |
| $t_{TXEN,FAST,BLE,1M}$ | Time between TXEN task and READY event after channel FREQUENCY configured (1Mbps Bluetooth LE with fast ramp-up and 150 µs TIFS) | | 40 | | us |
| $t_{TXDIS,BLE,1M}$ | When in TX, delay between DISABLE task and DISABLED event for MODE = Nrf_1Mbit and MODE =Ble_1Mbit | | 6 | | us |
| $t_{RXEN,BLE,1M}$ | Time between the RXEN task and READY event after channel FREQUENCY configured (1 Mbps Bluetooth LE) | | 140 | | us |
| $t_{RXEN,FAST,BLE,1M}$ | Time between the RXEN task and READY event after channel FREQUENCY configured (1 Mbps Bluetooth LE with fast ramp-up) | | 40 | | us |
| $t_{RXDIS,BLE,1M}$ | When in RX, delay between DISABLE task and DISABLED event for MODE = Nrf_1Mbit and MODE = Ble_1Mbit | | 0 | | us |
| $t_{TXDIS,BLE,2M}$ | When in TX, delay between DISABLE task and DISABLED event for MODE = Nrf_2Mbit and MODE = Ble_2Mbit | | 4 | | us |
| $t_{RXDIS,BLE,2M}$ | When in RX, delay between DISABLE task and DISABLED event for MODE = Nrf_2Mbit and MODE = Ble_2Mbit | | 0 | | us |
| $t_{TXEN,IEEE\ 802.15.4}$ | Time between TXEN task and READY event after channel FREQUENCY configured (IEEE 802.15.4 mode) | | 130 | | us |
| $t_{TXEN,FAST,IEEE\ 802.15.4}$ | Time between TXEN task and READY event after channel FREQUENCY configured (IEEE 802.15.4 mode with fast ramp-up) | | 40 | | us |
| $t_{TXDIS,IEEE\ 802.15.4}$ | When in TX, delay between DISABLE task and DISABLED event (IEEE 802.15.4 mode) | | 21 | | us |
| $t_{RXEN,IEEE\ 802.15.4}$ | Time between the RXEN task and READY event after channel FREQUENCY configured (IEEE 802.15.4 mode) | | 130 | | us |


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| | | | |
|---|---|---|---|
| $t_{RXEN,FAST,IEEE\ 802.15.4}$ | Time between the RXEN task and READY event after channel FREQUENCY configured (IEEE 802.15.4 mode with fast ramp-up) | 40 | us |
| $t_{RXDIS,IEEE\ 802.15.4}$ | When in RX, delay between DISABLE task and DISABLED event (IEEE 802.15.4 mode) | 0.5 | us |
| $t_{RX\text{-}to\text{-}TX\ turnaround}$ | Maximum TX-to-RX or RX-to-TX turnaround time in IEEE 802.15.4 mode | 40 | us |

### 3.3.9 Received signal strength indicator (RSSI) specifications

| Symbol | Description | Min | Typ. | Max. | Units |
|---|---|---|---|---|---|
| $RSSI_{ACC}$ | RSSI Accuracy | | ±2 | | dB |
| $RSSI_{RESOLUTION}$ | RSSI resolution | | 1 | | dB |
| $RSSI_{PERIOD}$ | RSSI sampling time from RSSI_START task | | 0.25 | | us |
| $RSSI_{SETTLE}$ | RSSI settling time after signal level change | | 15 | | dBm |


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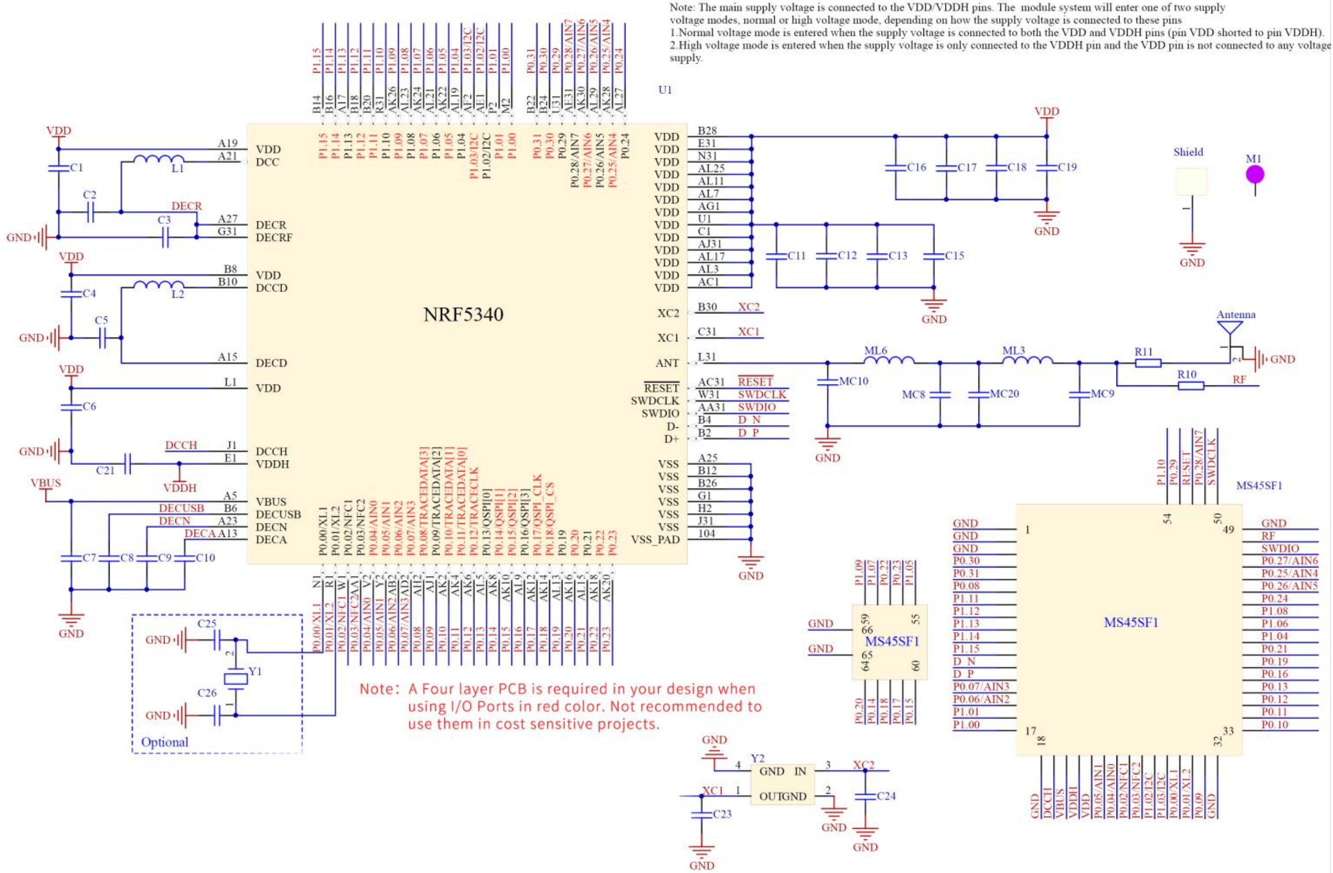
# 4 Electrical Schematic





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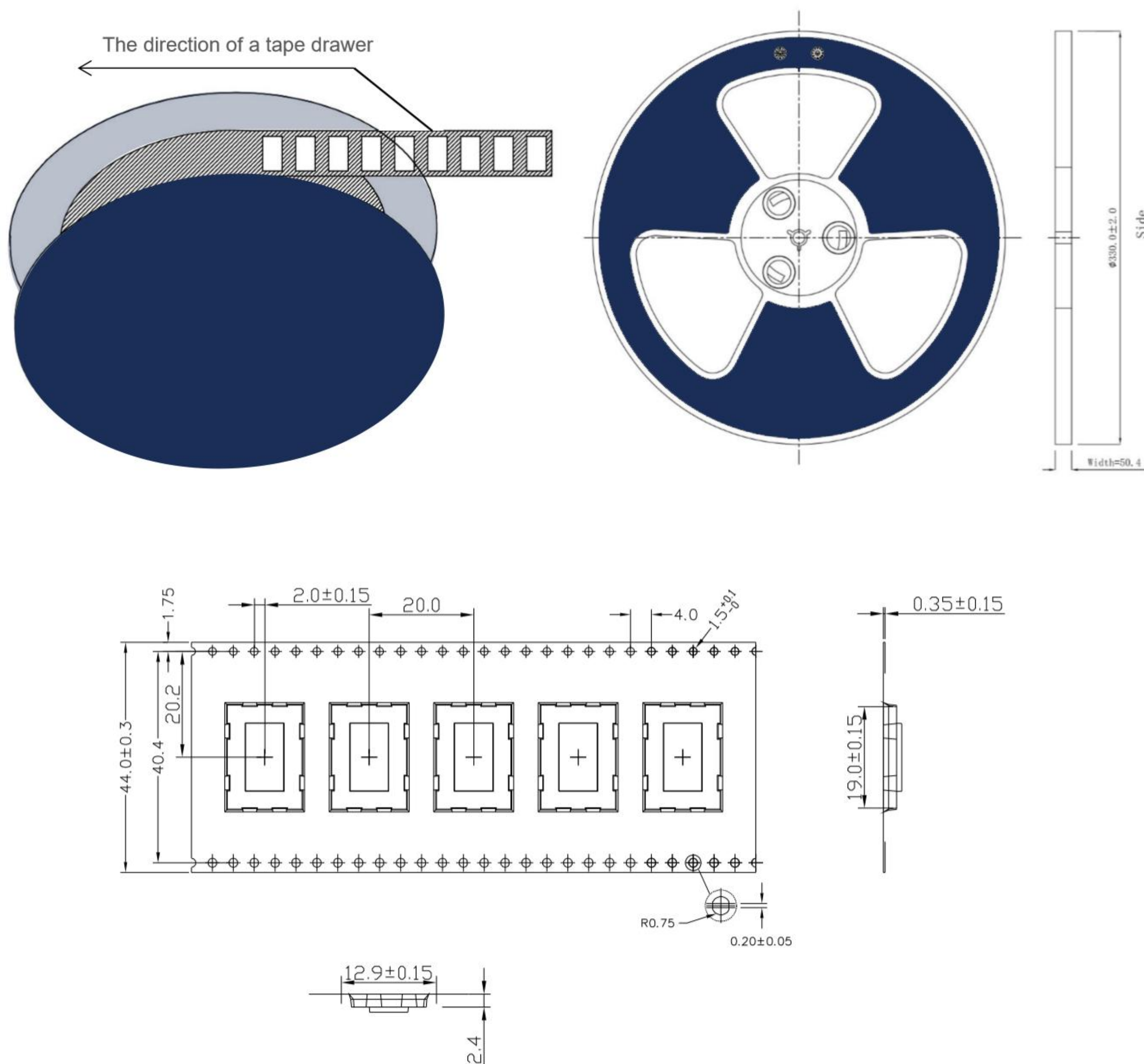
# 5 Package Information

## 5.1 Package dimension





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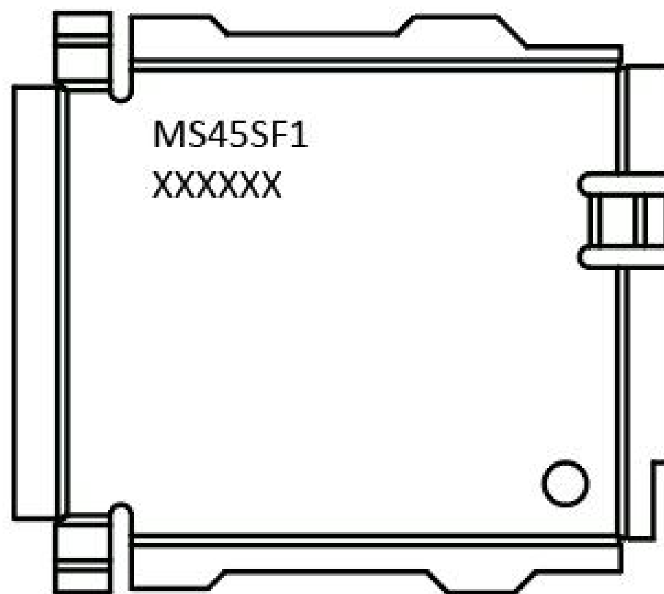
## Details of Package Dimension:

| Details | Reel-MS45SF1 |
| --- | --- |
| Quantity(module) | 850PCS |
| Tape Weight | 723g |
| Single module Weight | 0.54g |
| Gross Weight | 1183g |
| Dimension | W: 44mm T: 0.35mm |

## 5.2 Mark on metal shield





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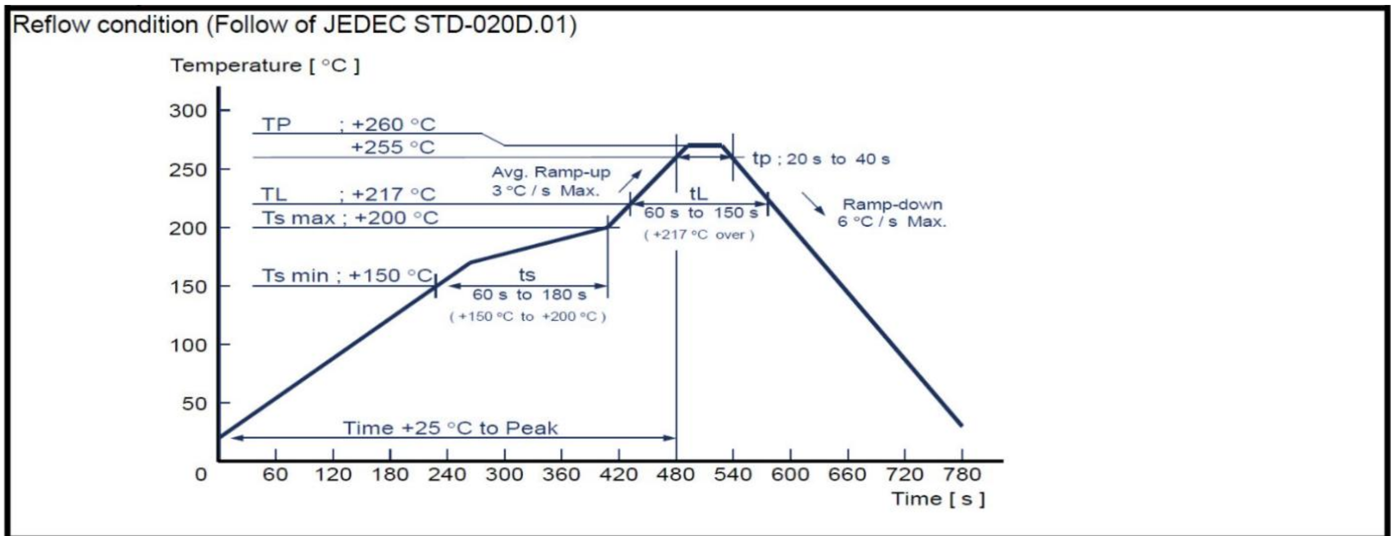
# 6 Reflow and Soldering




| Profile Feature | Sn-Pb Assembly | Pb-Free Assembly |
|---|---|---|
| Solder Paste | Sn63/Pb37 | Sn96.5/Ag3/Cu0.5 |
| Preheat Temperature min (Tsmin) | 100°C | 150°C |
| Preheat Temperature max (Tsmax) | 150°C | 200°C |
| Preheat Time (Tsmin to Tsmax)(ts) | 60-120 sec | 60-120 sec |
| Average ramp-up rate (Tsmax to Tp) | 3°C/second max | 3°C/second max |
| Liquidous Temperature (TL) | 183°C | 217°C |
| Time (tL)Maintained Above (TL) | 60-90 sec | 30-90 sec |
| Peak Temperature (Tp) | 220-235°C | 230-250°C |
| Average ramp-down rate (Tp to Tsmax) | 6°C/second max | 6°C/second max |
| Time 25°C to peak temperature | 6 minutes max | 8 minutes max |

**Important:**

- When SMT involves double-sided patch, it is recommended that the module surface be reflowed only once.
- For module SMT, it is recommended to make a partial stepped stencil with a thickness of 0.2mm, and the stencil hole should be extended by 0.8mm size.
- After opening the package, it should be stored in vacuum environment. Module should not be exposed to the air for a long time to prevent moisture and pad oxidation. If there is an interval of 7 to 30 days during SMT process, it is recommended to bake it with reel at 65-70 degrees for 24 hours before using for SMT again.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# 7 Notes & Cautions

We cannot assure that the specification has no errors and omission even though this specification is under collate and check strictly.

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## 7.1 Design notes

- It is critical to following the recommendations of this document to ensure the module meets the specifications.
- The module should be placed at the edge of the circuit board as far as possible to keep away from other circuits.
- Antenna should be kept away from other circuits. It can prevent low radiation efficiency and the normal use of other circuits from being affected.
- The landing of components should be appropriate and that is better for reducing the parasitic inductance.
- Please refuse to supply voltage that is not within the range of specification.
- Please make sure the module or its surface may not suffer from the physical shock or extreme stress.

## 7.2 Layout notes

To make sure wireless performance is at its best condition, please layout the MS45SF1 module on the carrier board as below instructions and picture.

### a) Placement of the antenna

The antenna area of module shall lay clearance completely and should not be blocked by the metal. Otherwise it will have effect on antenna performance (As the picture indicated below).

### b) Placement of top-layer

The placement of top-layer in carrier board shall be lay copper completely to reduce the signal line in carrier board or other interference.

### c) Clearance

The upper and below area of antenna (including the case) shall have 4mm or more than 4mm clearance to reduce the influences for antenna.


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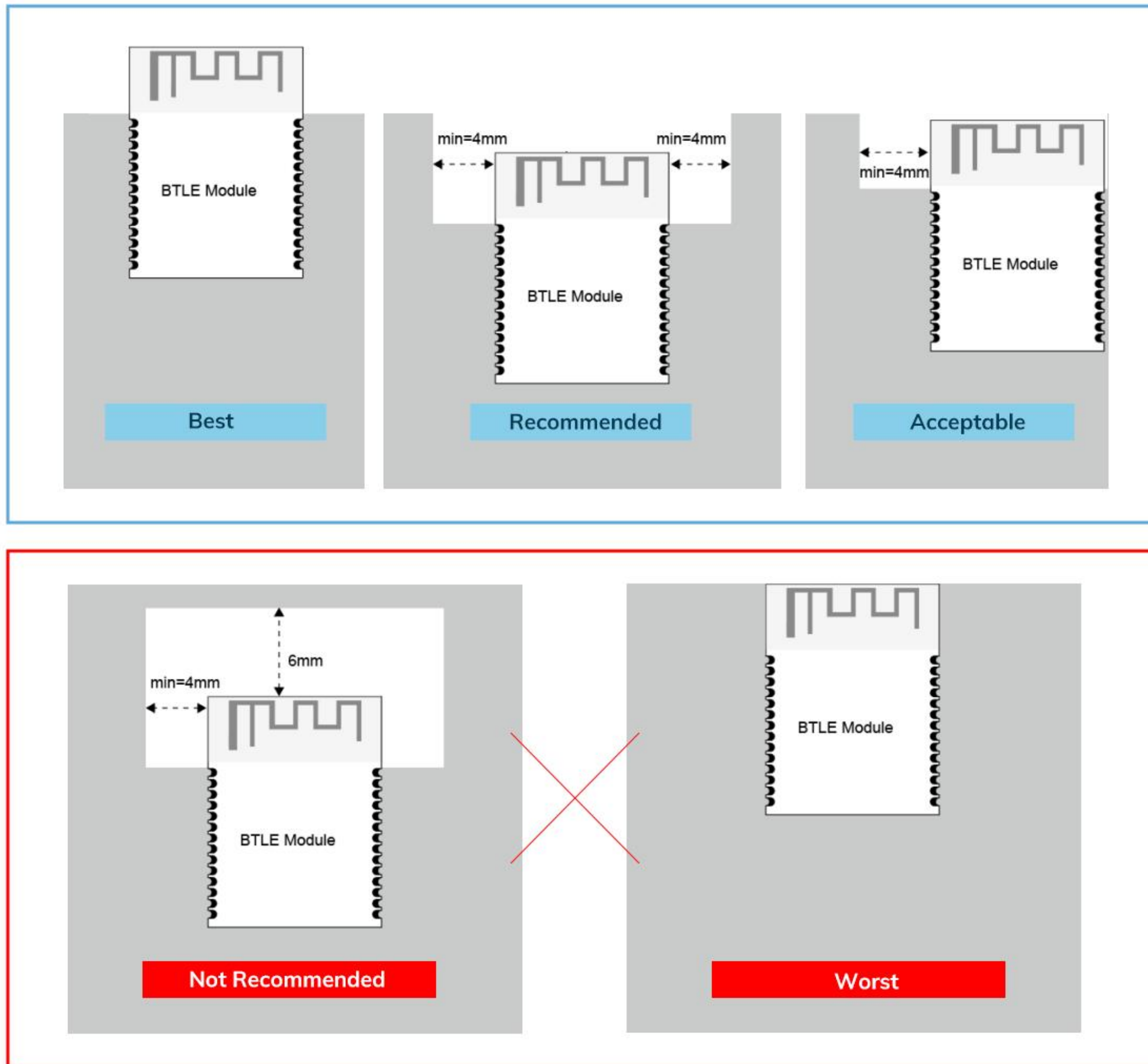


*The Grey area above is Carrier board.

## 7.3 Installation and soldering

Please do not lay copper under the module antenna. It can prevent the influence of signal radiation and the transmission distance from being affected.

## 7.4 Handling and storage

a) Due to the fact that CMOS components are included in the module, it is better to eliminate static electricity at any methods when transporting or working with the module. Moreover, it is strongly recommended adding anti-ESD components to circuit design to hinder damage from real-life ESD events. Anti-ESD methods can be also used in mechanical design.


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b) Please store the modules within -40℃ to +125℃ before and after installation and make sure the modules is away from the direct sunlight exposure for a long duration. Modules should be far away from humid and salty air conditions, and any corrosive gasses or substances.

c) Please not to wash the module. No-Clean Paste is used in production. The metal shield may be oxidized by the washing process and may lead to chemistry reaction with No-Clean Paste. If modules goes through the washing process, functions of the module may not guaranteed.

d) After opening the package, it should be stored in vacuum environment. Module should not be exposed to the air for a long time to prevent moisture and pad oxidation. If there is an in terval of 7 to 30 days during SMT process,

## 7.5 Life support applications

a) The module is not design for life support device or system and not allowed to be used in destructive devices or system in any direct, or indirect ways. Minewsemi is not responsible for compensation of any losses when applying modules under such application as described above.

b) Minewsemi shall not responsible for the customer's products or application.


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# 8 Disclaimer

The factory has passed the ISO9001 quality management system, ISO14001 environmental management system and OAHS18001 occupational health and safety assessment . Each product has been rigorously tested (transmission power test, sensitivity test, power consumption test, stability test, aging test, etc.).

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# 9 Revision History

| Version | Date | Notes | Contributor(s) | Person of Approve |
|---|---|---|---|---|
| 1.0 | 2022-03-22 | First edition | Eddie | Coral |


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