PHYCHIPS

RED 5

# UHF RFID Reader/Writer Module
# Specification


Rev.2.0.3 2019-11-25

# Contents

## Revision History

| Version | Date | Page | Description |
|---|---|---|---|
| 1.0.0 | 2014.12.15 | | Preliminary |
| 1.1.0 | 2015.05.11 | | Modified pin diagram |
| 1.1.1 | 2015.05.14 | | Added available GPIO and footprint information |
| 1.1.2 | 2015.06.02 | | Changed name<br>Modified pin description: VCCIN and VCC36P<br>Modified application note<br>Removed description about deepsleep mode |
| 1.1.3 | 2015.07.07 | | Modified Frequency range and table |
| 1.1.4 | 2015.07.28 | | Added reflow chart<br>Added information to 2. Electrical specification |
| 1.1.5 | 2015.07.30 | | Typo error fixed |
| 1.1.6 | 2015.08.10 | | Fixed dimension and footprint |
| 1.1.7 | 2017.01.12 | 4<br>17<br>20 | Modified the block diagram<br>Modified the label part of module, figure 8<br>Modified the dimension of inner form & outer box |
| 2.0.0 | 2017.11.29 | 5,6,7,<br>8,12,<br>17,20 | Changed DTC control method from I2C to SPI<br>Fixed typo error of dimension<br>Changed the packing method |
| 2.0.1 | 2019.06.14 | | Changed the name of channel table |
| 2.0.2 | 2019.10.17 | 11 | Fixed typo error in section 4.9 Operation Mode Control |
| 2.0.3 | 2019.11.25 | | Fixed pin description table : SWDIO&SWCLK |

# 1 Overview

The RED5 is a UHF RFID Reader hybrid module which integrates high performance UHF RFID reader chipset, TCXO, Balun, Coupler, Saw filter, Power amp and low pass filter.
UHF RFID reader chipset uses PR9200 of PHYCHIPS which integrates 900MHz radio, baseband processor, industry standard enhanced Cortex-M0 MCU, memory (64k Flash & 16k SRAM) and many other features. This module fully compliant with ISO18000-6C/EPC Global Gen II reader protocol and provide all functions of PR9200. Also reduce size, cost and power consumption. The RED5 includes automatic tx leakage cancellation to improve reader's performance and compensate sensitivity for some variation according to the surrounding environment. Also it helps a developer adopt the proper antenna and realize the optimized RFID reader system more easily and quickly.

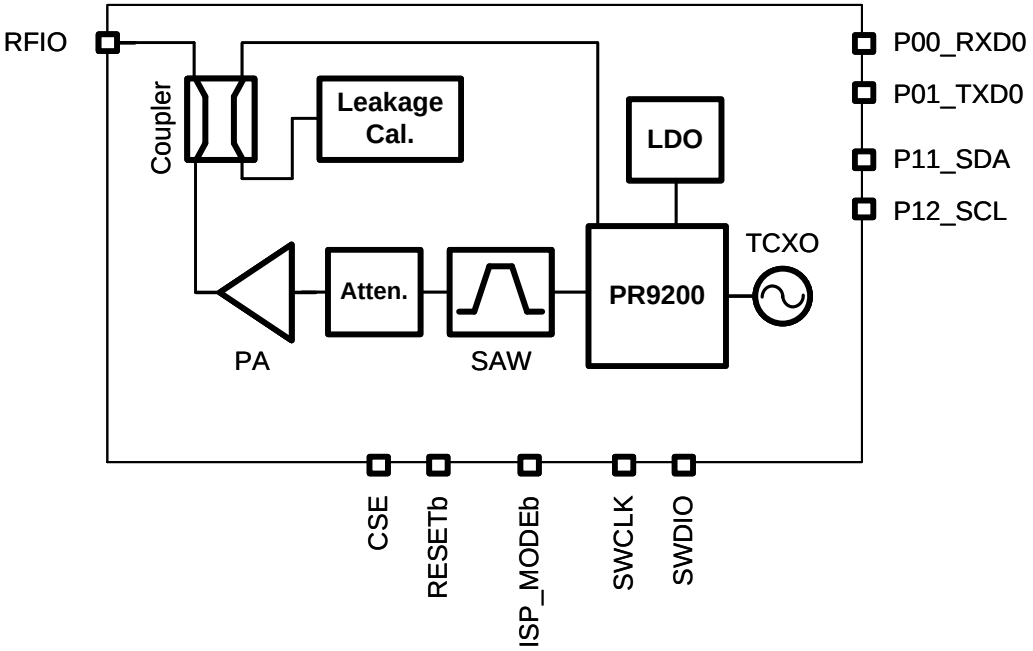


**Figure 1 Block Diagram**

# 2 Electrical Specification

## 2.1 Absolute Maximum Ratings

| No. | Item | Unit | Test Condition | Specification | | | Remark |
|---|---|---|---|---|---|---|---|
| | | | | min | Typ. | max | |
| 1 | Supply voltage : VCCIN | V | - | - | - | 6.0 | |
| 2 | Supply voltage : VCC36P | V | - | - | - | 4.5 | |
| 3 | Storage temperature | °C | - | -40 | | 85 | |

## 2.2 Functional specification

| No. | Item | | Unit | Test Condition | Specification | | | Remark |
|---|---|---|---|---|---|---|---|---|
| | | | | | min | Typ. | max | |
| 1 | Frequency Range NOTE1 | | MHz | | 860 | | 960 | |
| 2 | Tx Power | | dBm | | 0 | | 30 | |
| 3 | Dynamic Range | | dB | | | 30 | | |
| 3 | Spurious NOTE2 | | dBm | | Meet to national regulation : Korea (KCC) US (FCC 15C) Europe (ETSI EN 302 208) | | | |
| 4 | Impedance | | Ω | | | 50 | | RF I/O |
| 5 | DC Power | VCCIN | V | | 3.5 | | 5 | |
| | | VCC36P | V | | | 3.6 | 4.2 | |
| 6 | Digital interface IO voltage | | V | | | 3.3 | | |
| 7 | Operating Temperature | | °C | | -20 | | 70 | |
| 8 | Operating Humidity | | % | | 0 | | 90 | |
| 9 | Current | Power Down | uA | Active current is measured at 30dBm output CW. | | | 20 | |
| | | Idle | mA | | | | 20 | |
| | | Active | A | | | 1.37 | | |

NOTE1. If you want to know the supportable channel and frequency, refer to 5. Channel number table.
NOTE2. Other regulation such as SRRC will be updated soon.

Firmware Default Function

| No. | Item | Status | Remark |
|---|---|---|---|
| 1 | Firmware Version | RED5_v3.x.x or later | |
| 2 | Region | - | |
| 3 | Frequency Hopping | ON | |
| 4 | Q | Dynamic Q | |
| 5 | Modulation Type | DSB-ASK | |
| 6 | Back Link Frequency(BLF) | 250 kHz | |

# 3 Pin Description

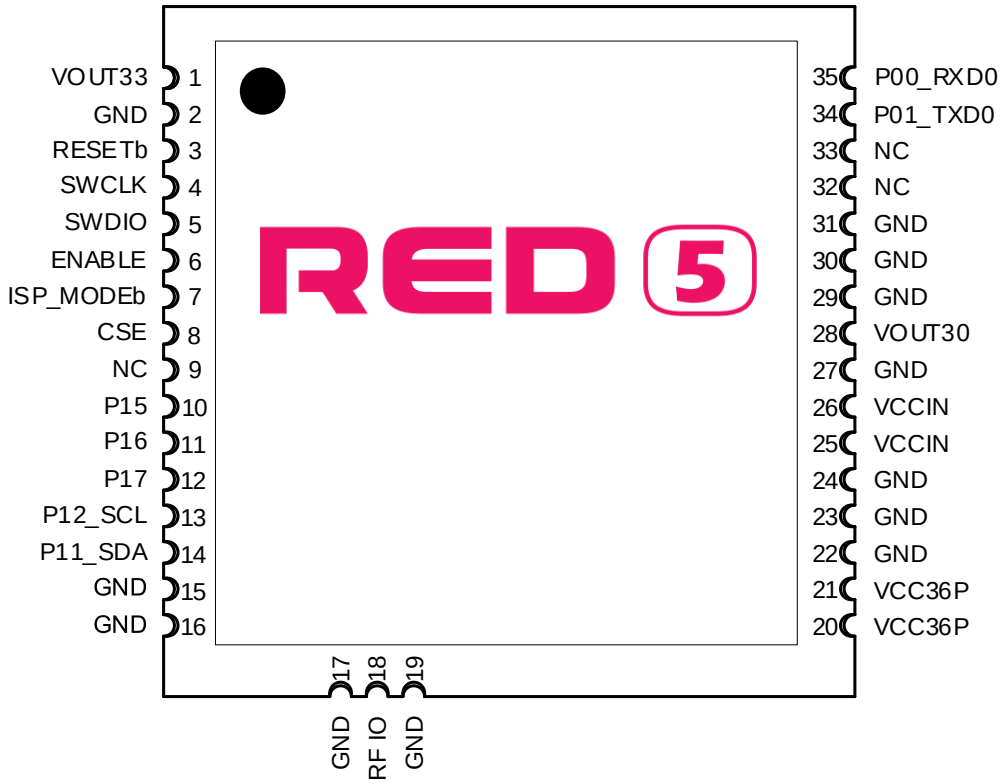


**Figure 2 Pin Description**

<table>
<tr><th>No.</th><th>Pin Name</th><th>Description</th></tr>
<tr><td>1</td><td>VOUT33</td><td>Internal LDO 3.3V output for PR9200 SOC</td></tr>
<tr><td>2</td><td>GND</td><td>Ground</td></tr>
<tr><td>3</td><td>RESETb</td><td>Reader SOC Reset signal 0: reset</td></tr>
<tr><td>4</td><td>SWCLK</td><td>Serial Wire Debug Clock</td></tr>
<tr><td>5</td><td>SWDIO</td><td>Serial Wire Debug data in out</td></tr>
<tr><td>6</td><td>ENABLE</td><td>Enable pin for RED5. It turns on/off internal LDOs<br>Logic high : enable, Logic low : disable (POWER DOWN)</td></tr>
<tr><td>7</td><td>ISP_MODEb</td><td>When ISP_MODEb is Logic ‘Low’, ISP mode is set as shown below table
<table>
<tr><th>Pin No.</th><th>7</th><th>12</th><th>11</th><th>10</th></tr>
<tr><td>Pin Name</td><td>ISP_MODEb</td><td>P17</td><td>P16</td><td>P15</td></tr>
<tr><td>Normal</td><td>1</td><td>GPIO/INT</td><td>GPIO/INT</td><td>GPIO/INT</td></tr>
<tr><td>FLASH UART ISP</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
</table>
[CAUTION] Except ISP mode, ISP_MODEb should be set logic ‘High’ for robust stability for FLASH memory</td></tr>
<tr><td>8</td><td>CSE</td><td>Chip Select Enable. Internally connected to VCC33.<br>For the power control of RED5, use ENABLE pin</td></tr>
<tr><td>9</td><td>NC</td><td>Not Connection</td></tr>
<tr><td>10</td><td>P15</td><td>User configurable general purpose I/O port</td></tr>
<tr><td>11</td><td>P16</td><td>User configurable general purpose I/O port or External Interrupt 4</td></tr>
<tr><td>12</td><td>P17</td><td>User configurable general purpose I/O port or External Interrupt 5</td></tr>
<tr><td>13</td><td>P12_SCL</td><td>User configurable general purpose I/O port or I2C Clock<br>The pull-up resistor is always switched on.<br>Reserved Address : 0x70, 0x71</td></tr>
<tr><td>14</td><td>P11_SDA</td><td>User configurable general purpose I/O port or I2C Data In / Out<br>The pull-up resistor is always switched on.<br>Reserved Address : 0x70, 0x71</td></tr>
<tr><td>15</td><td>GND</td><td>Ground</td></tr>
<tr><td>16</td><td>GND</td><td>Ground</td></tr>
<tr><td>17</td><td>GND</td><td>Ground</td></tr>
<tr><td>18</td><td>RF IO</td><td>RF input/output. Antenna port</td></tr>
<tr><td>19</td><td>GND</td><td>Ground</td></tr>
<tr><td>20</td><td>VCC36P</td><td>DC power input for Power Amp</td></tr>
<tr><td>21</td><td>VCC36P</td><td>DC power input for Power Amp</td></tr>
<tr><td>22</td><td>GND</td><td>Ground</td></tr>
<tr><td>23</td><td>GND</td><td>Ground</td></tr>
<tr><td>24</td><td>GND</td><td>Ground</td></tr>
<tr><td>25</td><td>VCCIN</td><td>DC power input for module except PA</td></tr>
<tr><td>26</td><td>VCCIN</td><td>DC power input for module except PA</td></tr>
<tr><td>27</td><td>GND</td><td>Ground</td></tr>
<tr><td>28</td><td>VOUT30</td><td>Internal LDO output for PA BIAS</td></tr>
<tr><td>29</td><td>GND</td><td>Ground</td></tr>
<tr><td>30</td><td>GND</td><td>Ground</td></tr>
<tr><td>31</td><td>GND</td><td>Ground</td></tr>
<tr><td>32</td><td>NC</td><td>Not Connection</td></tr>
<tr><td>33</td><td>NC</td><td>Not Connection</td></tr>
<tr><td>34</td><td>P01_TXD0</td><td>User configurable general purpose I/O port or UART0 Output</td></tr>
<tr><td>35</td><td>P00_RXD0</td><td>User configurable general purpose I/O port or UART0 Input</td></tr>
</table>

# 4 Application Circuit

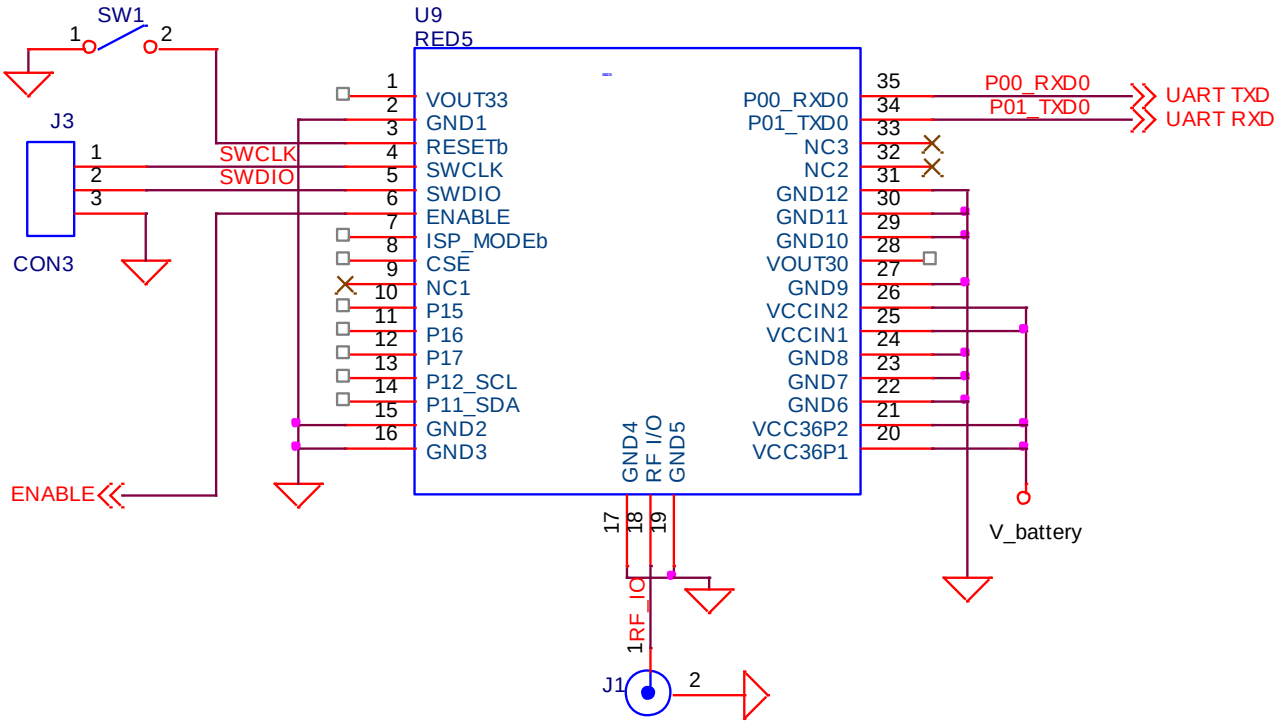


Figure 3 Application Circuit

## 4.1 Power Supply

DC power for RED5 is VCCIN (pin25,26) and VCC36P (pin20,21). There are 2 LDO inside module. One is to supply for PR9200 which DC voltage is 3.3 volts (typ.). The other is to supply for VBIAS for power amp which is 3.0V. VCCIN is connected to input of LDOs. But, VCC36P is connected to PA without internal LDO. Total current consumption of RED5 is typically 1.37A at 30dBm Tx CW output power.

## 4.2 RESETb

RED5 provides RESET for controlling PR9200, which can control by RESETb (Pin 3).
In order to properly operate RESET function, RESETb pin should be connected to ground during at least 2us.
[NOTE] RED5 have internal RESET circuit including POR (Power On Reset) and BOD (Brown Output Detector).

## 4.3 UART

The serial interface is assigned with two wires. RXD0, which pin is assigned to pin 35, is for receiving command from host and TXD0, which pin is assigned to pin 34, is for transmitting response to host. Pin connection is shown as below figure.

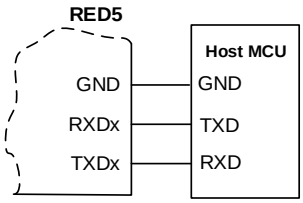


**Figure 4 Host MCU Connection**

RS232C transceiver is required to interface with PC that connection diagram is shown as below figure.

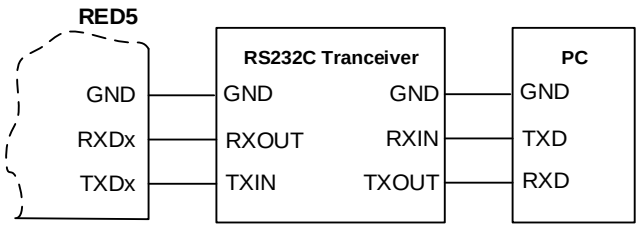


**Figure 5 RS232 transceiver connection**

Following configuration is used for interfacing to USB transceiver.

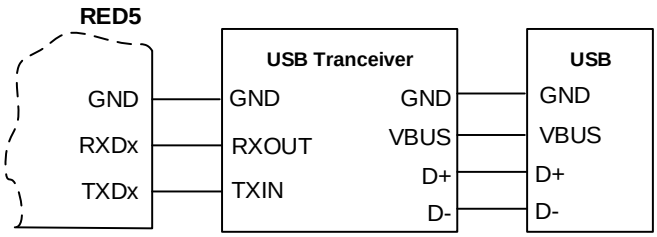


**Figure 6 USB transceiver connection**

## 4.4 I2C Interface

The I2C bus uses 2-wires (SDA and SCL) to transfer information between devices connected to the bus.

- Only two bus wires are required; a serial data line (SDA) and a serial clock line (SCL)
- The completely integrated I2C-bus protocol eliminates the need for address decoders and other glue logic.
- Each device connected to the bus is software addressable by a unique address and simple master/slave relationships exist at all times; master can operate as master-transmitter or as master-receiver.
- It's a true multi-master bus including collision detection and arbitration to prevent data corruption if two or more masters simultaneously initiate data transfer.
- Serial, 8-bit oriented, bi-directional data transfers can be made at up to 100kbit/s in the Standard-mode, up to 300kbit/s in the Fast-mode.
- The number of Ics that can be connected to the same bus is limited only by a maximum bus capacitance of 400pF.

## 4.5 GPIO

RED5 provides 7 bi-directional I/O ports including I2C while default serial interface is UART.

## 4.6 External Interrupt

RED5 provides 3 external interrupt that is unstoppable except by reset.

- Dedicated non-maskable Interrupt input.
- Support for both level-sensitive and pulse-sensitive interrupt lines.

## 4.7 ISP Mode

In order to enter UART ISP mode, some hardware setting is required.
Set pins ISP_MODEb, P17, P16 and P15 to logic “Low”.

| Mode name | H/W control | | | | Programming Port |
|---|---|---|---|---|---|
| | ISP_MODEb | P17 | P16 | P15 | |
| ISP UART | 0 | 0 | 0 | 0 | UART0 |

If your module has normally operated firmware, you can update firmware without hardware setting.
It is IAP mode. Please refer to RED_FDM.pdf

## 4.8 Debugger

In order to debug firmware, these ports should be connected with H/W debugger which is available on both the ULINK2 and Co-LINK. (for details, please refer to the ‘RED_FDM.pdf’)

## 4.9 Operation Mode Control

RED5 is configured in 5 main modes of operation according to PR9200.
The following table describes block condition and current according to each operation state.

Operation state

| State name | H/W set | PR9200 | | PA | current | Function |
|---|---|---|---|---|---|---|
| | | Analog | Digital | PA | | |
| POWER DOWN | ENABLE=0 | OFF | OFF | OFF | 20uA | Module power off |
| SLEEP | ENABLE=1 | OFF | Sleep | OFF | 15mA | Sleep mode, Wake-up internal/external interrupt. |
| IDLE | ENABLE=1 | OFF | ON | OFF | 20mA | Block initialization |
| ACTIVE | ENABLE=1 | ON | ON | ON | 1.37A[NOTE1] | Ramp-up Tag read / write / access / lock .. Ramp-down |

NOTE1. Active current is measured at Tx CW condition.

The state diagram shows the modes RED5 can operate in. it also include transition time between the states. When RED5 enter ACTIVE mode, RF Block is activated and ramp-up the system and it start to read RFID tag. Entering IDLE mode from POWER DOWN mode, initial time is needed. The initial time of RED5 is 21ms including system power ON.

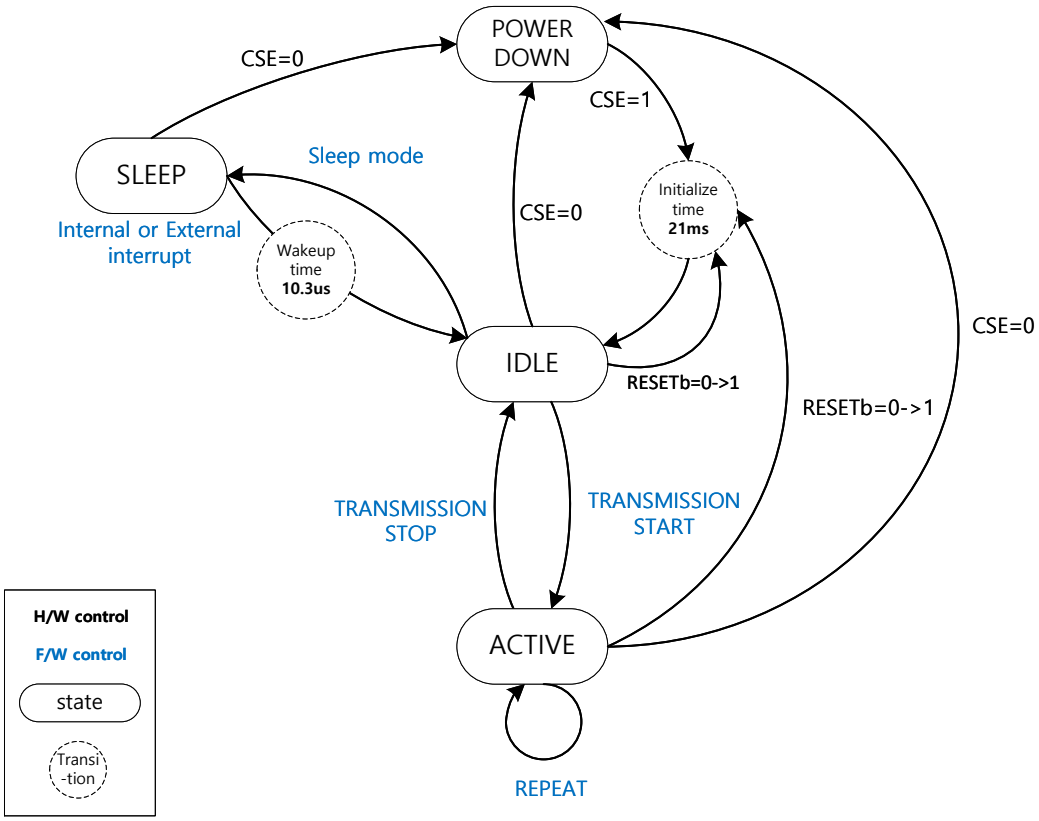


**Figure 7 Operation Sequence**

## 4.10 **Available GPIO**

RED5 is based on PR9200 SOC. In order to configure the functions of module, some GPIO of PR9200 are already used. Below table shows the available GPIO which is marked in yellow box.

| GPIO | GPIO Function | RED5 |
|---|---|---|
| P00 | UART0 RXD | UART_RXD0 |
| P01 | UART0 TXD | UART_TXD0 |
| P02 | Ext.0 | Internally used (Ext PA_EN) |
| P03 | Ext.1 | Internally used |
| P04 | SSP TXDS | Internally used |
| P05 | SSP RXDS | Internally used |
| P06 | SSP SCK | Internally used |
| P07 | SSP SEL | Reserved |
| P10 | Ext.2 | Internally used |
| P11 | I2C SDA | Internally used NOTE1 |
| P12 | I2C SCL | Internally used NOTE1 |
| P13 | UART1 RXD(Ext.3) | Internally used |
| P14 | UART1 TXD | Internally used |
| P15 | - | |
| P16 | Ext.4 | IRQ (SPI, I2C)NOTE2 |
| P17 | Ext.5 | |

NOTE1. Current Slave address 0x70, 0x71 are used. Other Slave address are available
NOTE2. When you use I2C Interface, P16 is required. If not, you can use this pin

# 5 Channel Number Table

## 5.1 Narrow US band

| Channel | Channel Frequency | Channel | Channel Frequency |
|---|---|---|---|
| 1 | 917.10 MHz | 26 | 922.10 MHz |
| 2 | 917.30 MHz | 27 | 922.30 MHz |
| 3 | 917.50 MHz | 28 | 922.50 MHz |
| 4 | 917.70 MHz | 29 | 922.70 MHz |
| 5 | 917.90 MHz | 30 | 922.90 MHz |
| 6 | 918.10 MHz | 31 | 923.10 MHz |
| 7 | 918.30 MHz | 32 | 923.30 MHz |
| 8 | 918.50 MHz | 33 | 923.50 MHz |
| 9 | 918.70 MHz | 34 | 923.70 MHz |
| 10 | 918.90 MHz | 35 | 923.90 MHz |
| 11 | 919.10 MHz | 36 | 924.10 MHz |
| 12 | 919.30 MHz | 37 | 924.30 MHz |
| 13 | 919.50 MHz | 38 | 924.50 MHz |
| 14 | 919.70 MHz | 39 | 924.70 MHz |
| 15 | 919.90 MHz | 40 | 924.90 MHz |
| 16 | 920.10 MHz | 41 | 925.10 MHz |
| 17 | 920.30 MHz | 42 | 925.30 MHz |
| 18 | 920.50 MHz | 43 | 925.50 MHz |
| 19 | 920.70 MHz | 44 | 925.70 MHz |
| 20 | 920.90 MHz | 45 | 925.90 MHz |
| 21 | 921.10 MHz | 46 | 926.10 MHz |
| 22 | 921.30 MHz | 47 | 926.30 MHz |
| 23 | 921.50 MHz | 48 | 926.50 MHz |
| 24 | 921.70 MHz | 49 | 926.70 MHz |
| 25 | 921.90 MHz | 50 | 926.90 MHz |

NOTE1. The available band in US is from 902MHz to 928MHz. but in many application, antennas can't cover this all range. So RED series support narrow US band. It also meet FCC regulation.
If you want, you can use all US band named Wide US (North America previously) band as table 5.2

## 5.2 **Wide US band**

| Channel | Channel Frequency | Channel | Channel Frequency |
|---|---|---|---|
| 1 | 902.75 MHz | 26 | 915.25 MHz |
| 2 | 903.25 MHz | 27 | 915.75 MHz |
| 3 | 903.75 MHz | 28 | 916.25 MHz |
| 4 | 904.25 MHz | 29 | 916.75 MHz |
| 5 | 904.75 MHz | 30 | 917.25 MHz |
| 6 | 905.25 MHz | 31 | 917.75 MHz |
| 7 | 905.75 MHz | 32 | 918.25 MHz |
| 8 | 906.25 MHz | 33 | 918.75 MHz |
| 9 | 906.75 MHz | 34 | 919.25 MHz |
| 10 | 907.25 MHz | 35 | 919.75 MHz |
| 11 | 907.75 MHz | 36 | 920.25 MHz |
| 12 | 908.25 MHz | 37 | 920.75 MHz |
| 13 | 908.75 MHz | 38 | 921.25 MHz |
| 14 | 909.25 MHz | 39 | 921.75 MHz |
| 15 | 909.75 MHz | 40 | 922.25 MHz |
| 16 | 910.25 MHz | 41 | 922.75 MHz |
| 17 | 910.75 MHz | 42 | 923.25 MHz |
| 18 | 911.25 MHz | 43 | 923.75 MHz |
| 19 | 911.75 MHz | 44 | 924.25 MHz |
| 20 | 912.25 MHz | 45 | 924.75 MHz |
| 21 | 912.75 MHz | 46 | 925.25 MHz |
| 22 | 913.25 MHz | 47 | 925.75 MHz |
| 23 | 913.75 MHz | 48 | 926.25 MHz |
| 24 | 914.25 MHz | 49 | 926.75 MHz |
| 25 | 914.75 MHz | 50 | 927.25 MHz |

## 5.3 **Korea band**

| Channel | Channel Frequency | Channel | Channel Frequency |
|---|---|---|---|
| 1 | 917.1 MHz | **17** | **920.30 MHz** |
| **2** | **917.30 MHz** | 18 | 920.50 MHz |
| 3 | 917.50 MHz | 19 | 920.70 MHz |
| 4 | 917.70 MHz | 20 | 920.90 MHz |
| **5** | **917.90 MHz** | 21 | 921.10 MHz |
| 6 | 918.10 MHz | 22 | 921.30 MHz |
| 7 | 918.30 MHz | 23 | 921.50 MHz |
| **8** | **918.50 MHz** | 24 | 921.70 MHz |
| 9 | 918.70 MHz | 25 | 921.90 MHz |
| 10 | 918.90 MHz | 26 | 922.10 MHz |
| **11** | **919.10 MHz** | 27 | 922.30 MHz |
| 12 | 919.30 MHz | 28 | 922.50 MHz |
| 13 | 919.50 MHz | 29 | 922.70 MHz |
| **14** | **919.70 MHz** | 30 | 922.90 MHz |
| 15 | 919.90 MHz | 31 | 923.10 MHz |
| 16 | 920.10 MHz | 32 | 923.30 MHz |

NOTE1. The channels written in Bold can be used by 4W (CH 2,5,8,11,14,17)
The channels (CH1,3,4,6,7,9,10,12,13,15,16,18,19) are used by 3mW

## 5.4 **China band**

| Channel | Channel Frequency | Channel | Channel Frequency |
|---|---|---|---|
| 1 | 920.125 MHz | 11 | 922.625 MHz |
| 2 | 920.375 MHz | 12 | 922.875 MHz |
| 3 | 920.625 MHz | 13 | 923.125 MHz |
| 4 | 920.875 MHz | 14 | 923.375 MHz |
| 5 | 921.125 MHz | 15 | 923.625 MHz |
| 6 | 921.375 MHz | 16 | 923.875 MHz |
| 7 | 921.625 MHz | 17 | 924.125 MHz |
| 8 | 921.875 MHz | 18 | 924.375 MHz |
| 9 | 922.125 MHz | 19 | 924.625 MHz |
| 10 | 922.375 MHz | 20 | 924.875 MHz |

## 5.5 **EU band**

| Channel | Channel Frequency |
|---|---|
| 1 | - |
| 2 | - |
| 3 | - |
| 4 | 865.70 MHz |
| 5 | - |
| 6 | - |
| 7 | 866.30 MHz |
| 8 | - |
| 9 | - |
| 10 | 866.90 MHz |
| 11 | - |
| 12 | - |
| 13 | 867.50 MHz |
| 14 | - |
| 15 | - |

# 6 Dimension

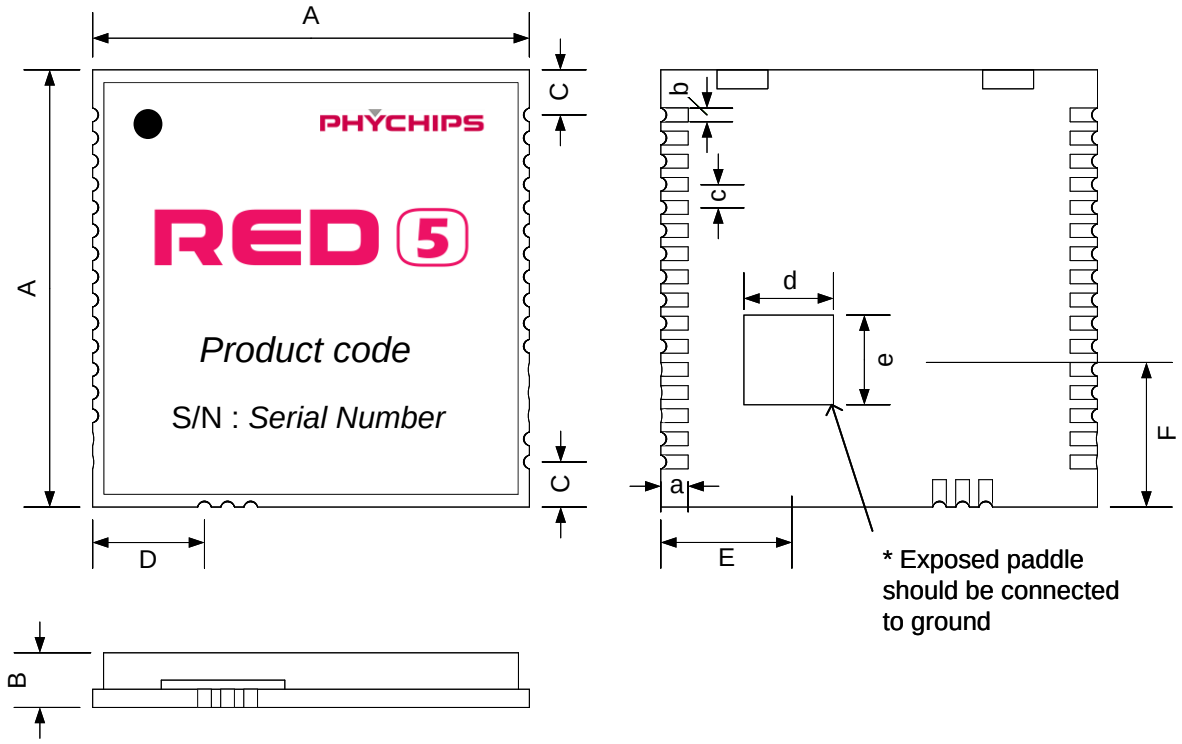


**Figure 8 Dimension**

| Package on Dimension (Unit : mm) | | | | |
|---|---|---|---|---|
| **SYM** | **MIN** | **TYP** | **MAX** | **Remark** |
| A | 23.5 | 24 | 24.5 | |
| B | 2.9 | 3 | 3.3 | |
| C | | 2.475 | | |
| D | | 6.145 | | |
| E | | 6.55 | | |
| F | | 8.37 | | |
| a | | 1.5 | | |
| b | | 0.75 | | |
| c | | 1.27 | | |
| d | | 3.3 | | |
| e | | 3.3 | | |

# 7 Footprint

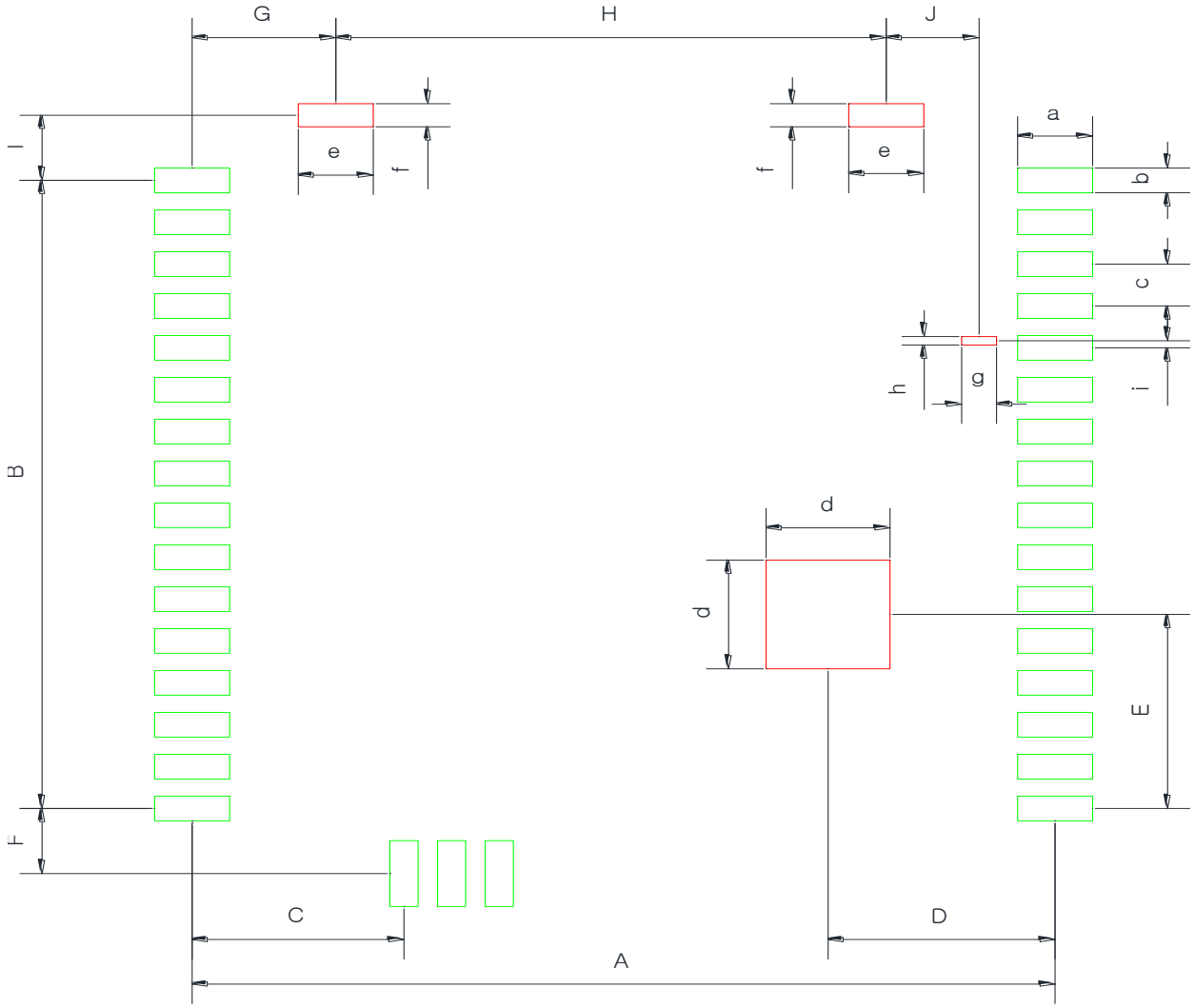


**Figure 9 Footprint**

| Footprint on Dimension (Unit : mm) | | | | |
|---|---|---|---|---|
| **SYM** | **MIN** | **TYP** | **MAX** | **Remark** |
| A | | 23.00 | | |
| B | | 19.05 | | |
| C | | 5.65 | | |
| D | | 6.05 | | |
| E | | 5.89 | | |
| F | | 1.98 | | |
| G | | 3.83 | | |
| H | | 14.67 | | |
| I | | 1.98 | | |
| J | | 2.48 | | |

| Footprint on Dimension (Unit : mm) | | | | |
|---|---|---|---|---|
| **SYM** | **MIN** | **TYP** | **MAX** | **Remark** |
| a | | 2.10 | | |
| b | | 0.80 | | |
| c | | 1.27 | | |
| d | | 3.30 | | |
| e | | 2.00 | | |
| f | | 0.70 | | |
| g | | 0.93 | | |
| h | | 0.26 | | |
| i | | 0.22 | | |

NOTE1. Red box of Figure 9 can be connected to GND.
NOTE2. the area ‘d x d’ and ‘g x h’ are heat sink. The area ‘dxd’ is for PA.

# 8 Packing Information

Packing materials for the RED5 shipment consist of the anti-static tray and the outer box which can hold up to five hundred pieces of the RED5 each box.

## 8.1 Tray dimension

Dimension of the tray to store the RED5, which can hold up to 25 pcs of the RED5, is approximately measured to W = 280mm, L = 240mm, H = 10mm. Tray helps to avoid both interference between the products and static from the outside. Detailed shape refer to figure 10 as below.

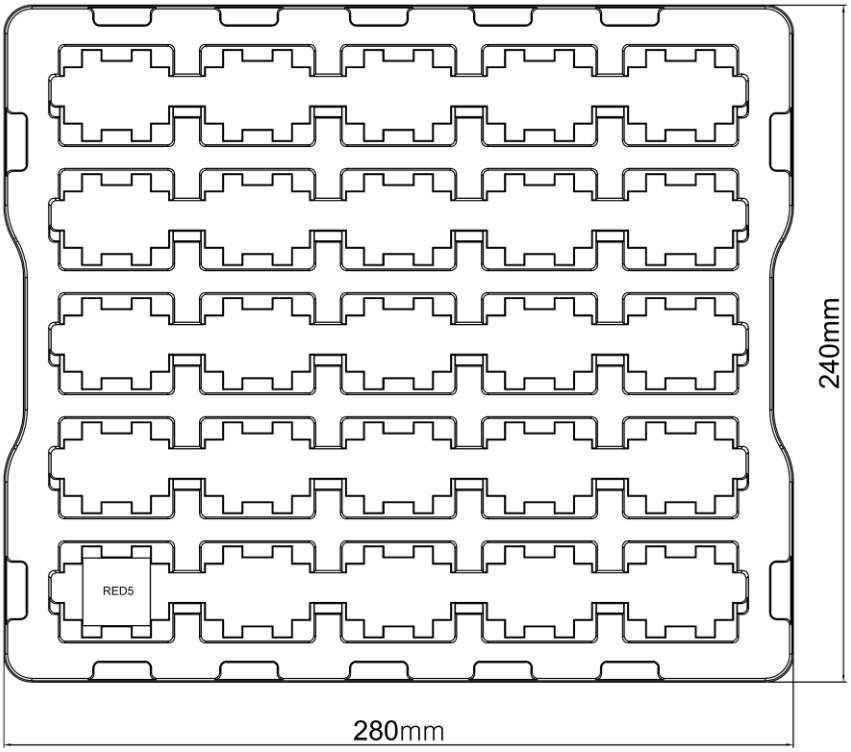


**Figure 10 Dimension of the tray**

## 8.2 Outer box dimension

The outer box is made printed card board, which may avoid dust, moisture and shock from the outside and convenient to ship. Dimension of the outer box is approximately measured to W = 285mm, L = 250mm, H = 115mm.

※ Packing materials are able to change dimension larger or smaller according to shipped quantity of mass product or/and internal policies so that shipment can be controlled easily and safely.

# 9 Reflow information

The recommended reflow profile is shown in figure 11.

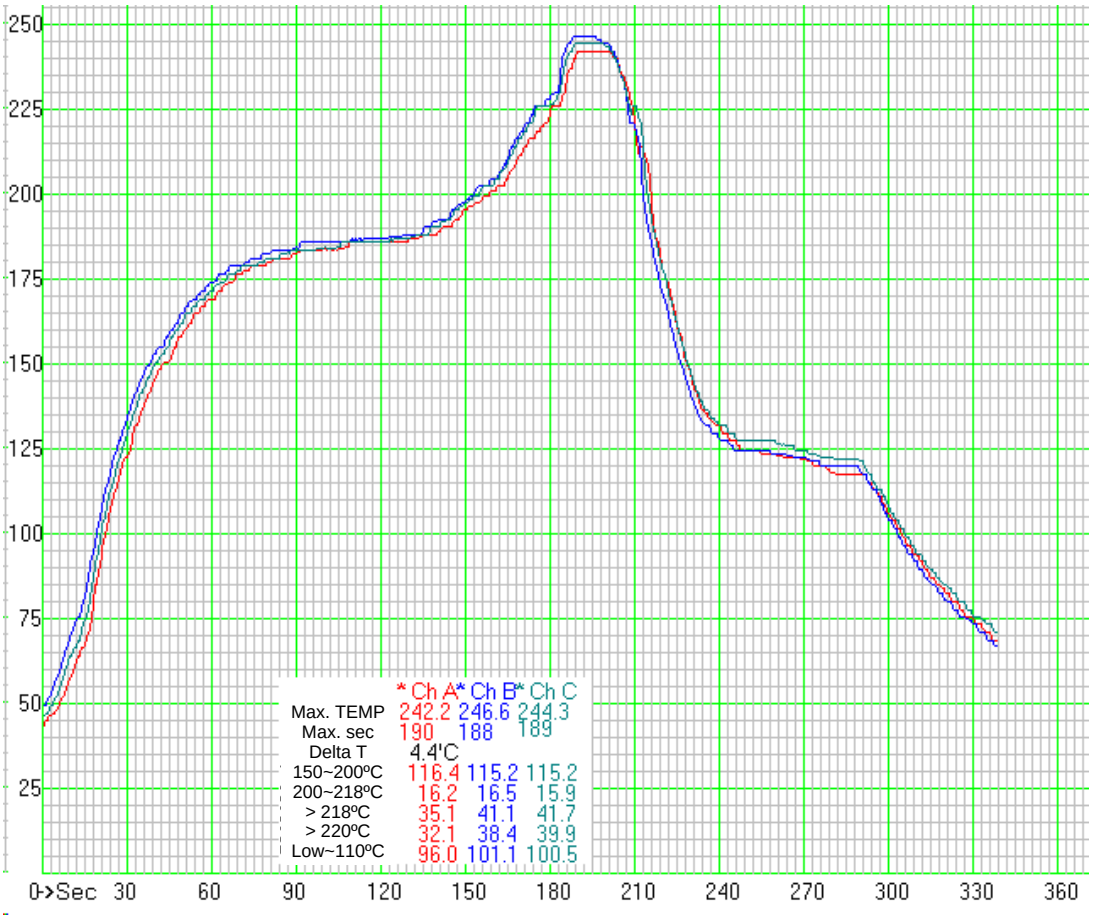


Figure 11 Reflow chart

# 10 Address Information

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