# Air780E

## Hardware Design Manual

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| version number | edit a record | dates | author |
|---|---|---|---|
| V1.0.0 | newly built | 2023-9-25 | Chengong |
| V1.0.3 | Modify some pin descriptions incorrectly | 2023-11-13 | Chengong |
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| V1.1.0 | Adding an IO Interrupt Description | 2024-4-9 | Chengong |

# catalogs

# 1. preface

Air780E is a LTE wireless communication module designed based on MobileChip EC716S platform. It supports FDD-LTE/TDD-LTE 4G long-range wireless transmission technology. In addition, the module provides universal interfaces such as USB/UART/I2C to meet the requirements of various applications in the IoT industry.

The following figure shows the functional block diagram of the Air780E module:

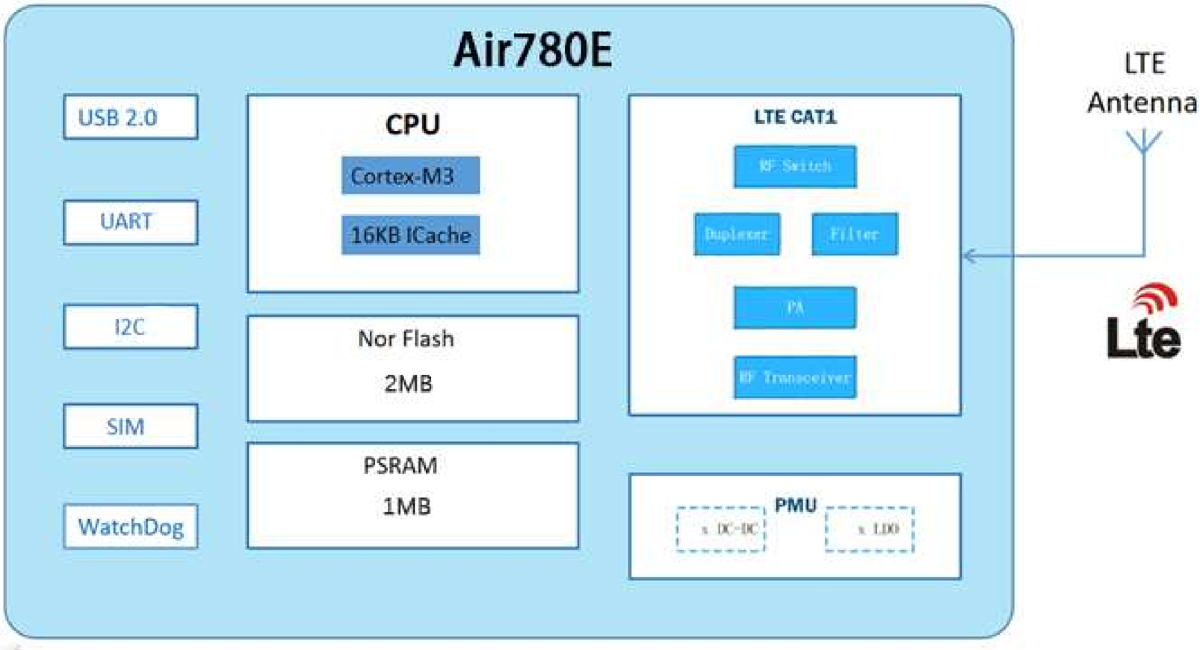



Chart1 Functional Block Diagram

# 2. summarize

## 2.1 Model Information

Tables1 : List of Module Models

| model number | Air780E |
|---|---|
| LTE-FDD | B2/B4/B5/B12/B13 |
| LTE-TDD | B66 |
| IO level | 1.8V |
| Module Size | 17.7mm*15.8mm*2.3mm |
| seal inside | LGA |
| note | 4G Full Netcom |

## 2.2 Main performance

Tables2 : Module Main Performance

| hallmark | clarification |
|---|---|
| CPU | ♦ Cortex M3 @ 204MHz*2<br>♦ 16KB ICache |
| Flash | ♦ Nor Flash 2MB |
| RAM | ♦ PSRAM 1MB |
| Supported Frequency Bands | ♦ LTE-FDD: B2/B4/B5/B12/B13<br>♦ LTE-TDD: B66 |
| firing power | ♦ LTE-FDD: Class3 (23dBm+-2dB)<br>♦ LTE-TDD: Class3 (23dBm+1/-3dB) |
| electricity supply | ♦ VBAT 3.3V ~ 4.3V, 3.8V typical |
| LTE Features | ♦ Maximum support for non-CA CAT1<br>♦ Support 1.4~20MHz RF bandwidth<br>♦ LTE-FDD: Maximum uplink rate 5Mbps, maximum downlink rate 10Mbps<br>♦ LTE-TDD: uplink and downlink configuration1<br>Maximum uplink rate 4Mbps, maximum downlink rate 6Mbps<br>♦ LTE-TDD: uplink and downlink configurations2<br>Maximum uplink rate 2Mbps, maximum downlink rate 8Mbps |
| Network Protocol Characterization | ♦ TCP/UDP/HTTP/NITZ/NDIS/NTP/HTTPS/MQTT is supported. |
| USIM card interface | ♦ USIM/SIM card support: 1.8V and 3V |
| USB port | ♦ Supports USB 2.0 High speed (slave mode only), data transfer rate up to 480Mbps.<br>♦ For AT commands, data transfer, software debugging, software upgrades<br>♦ USB Virtual Serial Driver: Support USB driver under Windows 7/8.1/10, Linux 2.6.x/3.x/4.1, Android 4.x/5.x/6.x/7.x and other operating systems. |

| | |
|---|---|
| serial port (computing) | MAIN_UART:<br>♦ Universal serial port for AT commands and data transfer<br>♦ Maximum baud rate 921600bps<br>♦ Supports hardware flow control (RTS/CTS)<br>AUX_UART:<br>♦ Universal Serial Port<br>DBG_UART:<br>♦ Used to output debugging information |
| WatchDog | ♦ software watchdog |
| Antenna Interface | ♦ One LTE antenna connector |
| temperature range | ♦ Normal operating temperature: -35° C to +70° C<br>♦ Extreme operating temperature: -40° C to +85° C |
| RoHS | ♦ All devices are fully RoHS compliant |
| physical property | ♦ Size: 17.7mm*15.8mm*2.3mm<br>♦ Weight: about 2.6g |
| seal inside | ♦ 109 pins, actual available pins are shown in the pinout diagrams |

# 3. application interface

The module is packaged in an LGA package with 109 SMT pad pins. The following sections describe the function of each Air780E interface in detail.

## 3.1. Pin Description

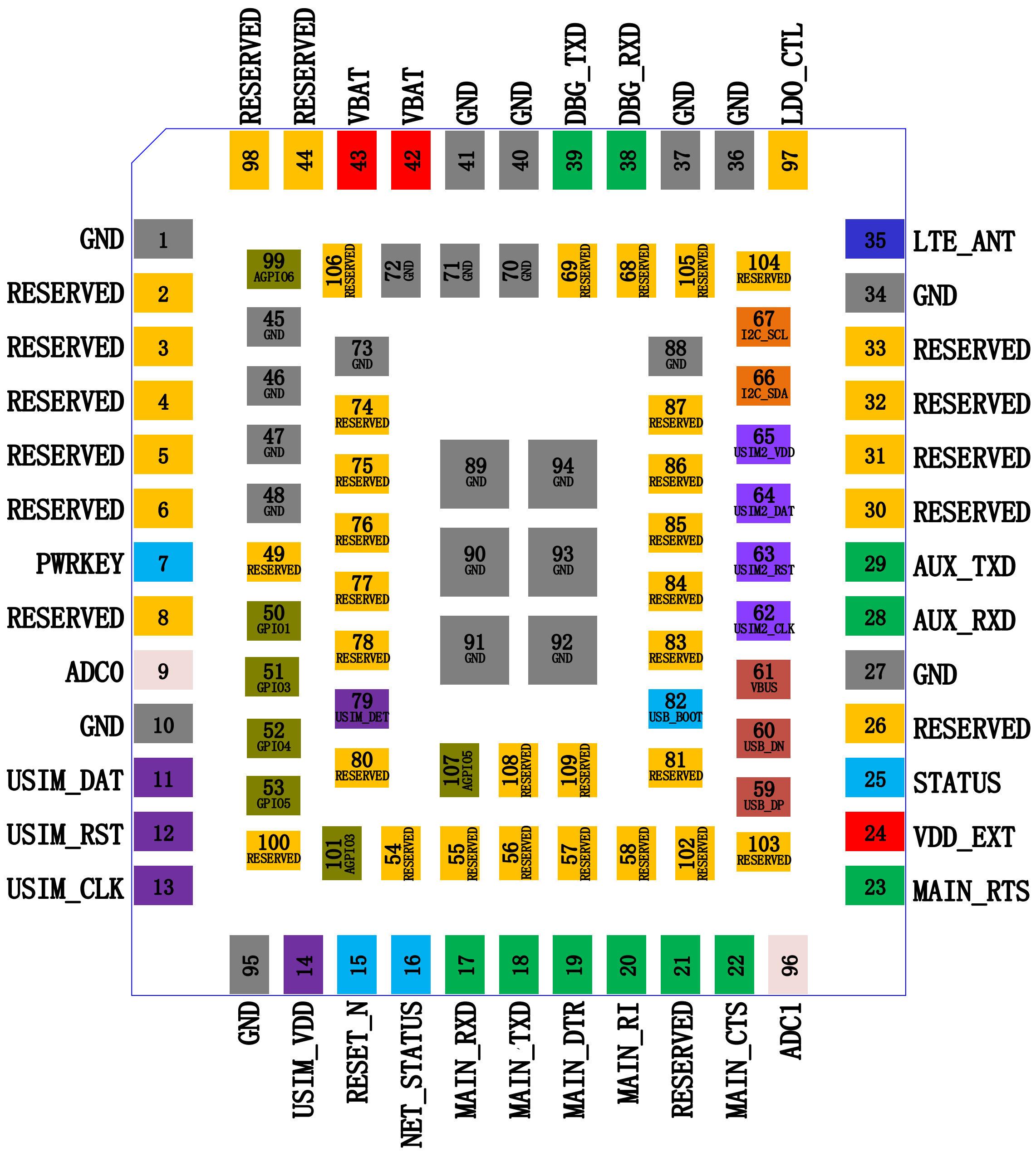



Chart2 : Air780E Pin Arrangement Diagram (Front View)

Tables3 : Pin Descriptions

## electric power source

| pin name | pin number | IO | descriptive | Electrical Characteristics | note |
|---|---|---|---|---|---|
| **VBAT** | 42,43 | PI | Module mains power supply | VBAT=3.3V~4.3 | Power supply capacity to meet instantaneous current greater than 1.5A |
| **VDD_EXT** | 24 | DO | Fixed output 1.8V | VDD_EXT=1.8V<br>Imax= 4mA | Note that VDD_EXT is only used for external pull-ups, not for other peripheral supplies. |
| **GND** | 1,10,27,34,36,37,40.<br>41,45,46,47,89,90,91.<br>92, 93, 94, 95 | | reference point | | |

## control pin

| pin name | pin number | IO | descriptive | Electrical Characteristics | note |
|---|---|---|---|---|---|
| **PWRKEY** | 7 | DI | Switching Control Pin, Low Active | | |
| **RESET_N** | 15 | DI | Module reset input, low pulse is valid, the module is in hardware shutdown state after reset | | If you don't use it, it hangs in the air. |
| **USB_BOOT** | 82 | DI | Download Mode Control Pin, High Active | | Pull up to VDDEXT during power up to enter download mode |

## serial port (computing)

| pin name | pin number | IO | descriptive | Electrical Characteristics | note |
|---|---|---|---|---|---|
| **MAIN_TXD** | 18 | DO | Main Serial Port Data Transmission | DC Level:VDD_EXT | If you don't use it, it hangs in the air. |
| **MAIN_RXD** | 17 | DI | Main serial port data reception | DC Level:VDD_EXT | If you don't use it, it hangs in the air. |
| **MAIN_RTS** | 23 | DI | DTE request sent | DC Level:VDD_EXT | If you don't use it, it hangs in the air. |
| **MAIN_DCD** | 21 | DO | UART output carrier detection | DC Level:VDD_EXT | If you don't use it, it hangs in the air. |
| **MAIN_DTR** | 19 | DI | Main serial port data terminal ready, ground active, wake module from hibernation | VDD= 1.8V<br>VIH= 0.7*VDD<br>VIL=0.2* VDD | Drive capability < 30uA<br>Internal pull-up level measured around 1.1V due to internal partial voltage |
| **MAIN_RI** | 20 | DO | Main serial port data ringing signal | DC Level:LDO_AON | If you don't use it, it hangs in the air. |
| **AUX_TXD** | 29 | DO | Extended Serial Data Transmission | DC Level:VDD_EXT | If you don't use it, it hangs in the air. |
| **AUX_RXD** | 28 | DI | Extended serial data reception | DC Level:VDD_EXT | If you don't use it, it hangs in the air. |
| **DBG_TXD** | 39 | DO | Debugging Serial Digital Transmission | DC Level:VDD_EXT | Can only be used to monitor debugging information |
| **DBG_RXD** | 38 | DI | Debugging Serial Inputs | DC Level:VDD_EXT | Can only be used to monitor debugging information |

## USB port

| pin name | pin number | IO | descriptive | Electrical Characteristics | note |
|---|---|---|---|---|---|
| **VBUS** | 61 | DI | USB plug-in wake-up | Recommended not to exceed 5.5V | Internal Resistor Voltage Divider |
| **USB_DP** | 59 | IO | USB Data Differential Signaling | | 90 Ohm differential master control |
| **USB_DN** | 60 | IO | USB Data Differential Signaling | | 90 Ohm differential master control |

## USIM interface

| pin name | pin number | IO | descriptive | Electrical Characteristics | note |
|---|---|---|---|---|---|
| **SIM_RST** | 12 | DO | USIM card interface reset signal | 1.8V/3.3V | |
| **SIM_CLK** | 13 | DO | USIM card interface clock signal | 1.8V/3.3V | |
| **SIM_DAT** | 11 | IO | USIM card connects to data signal | 1.8V/3.3V | |
| **SIM_VDD** | 14 | PO | USIM card connected to power signal | 1.8V/3.3V | |
| **USIM2_VDD** | 65 | PO | USIM2 card connected to power signal | 1.8V/3.3V | |
| **USIM2_RST** | 63 | DO | USIM2 card interface reset signal | 1.8V/3.3V | |
| **USIM2_CLK** | 62 | DO | USIM2 card interface clock signal | 1.8V/3.3V | |
| **USIM2_DAT** | 64 | IO | USIM2 card for data signal | 1.8V/3.3V | |

## Analog-to-digital ADC interface

| pin name | pin number | IO | descriptive | Electrical Characteristics | note |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| **ADC0** | 9 | AI | Analog-to-digital ADC Channel 0 | Range 0~1.2V | External resistor divider required if over range |
| **ADC1** | 96 | AI | Analog-to-digital ADC Channel 1 | Range 0~1.2V | External resistor divider required if over range |

## Antenna Interface

| pin name | pin number | IO | descriptive | Electrical Characteristics | note |
|---|---|---|---|---|---|
| **LTE_ANT** | 35 | | 4G LTE RF Antenna Interface | | Recommended to reserve Π-shaped antenna to match, the alignment needs to be 50 ohm impedance matching |

## LED indicator interface

| pin name | pin number | IO | descriptive | Electrical Characteristics | note |
|---|---|---|---|---|---|
| **NET_STATUS** | 16 | DO | Network Status Indicator | DC Level:LDO_AON | If you don't use it, it hangs in the air. |
| **STATUS** | 25 | DO | Power-on status indication, high level indicates power-on status | DC Level:LDO_AON | If you don't use it, it hangs in the air. |

## General Purpose GPIO (not supported yet)

| pin name | pin number | IO | descriptive | Electrical Characteristics | note |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| **GPIO1** | 50 | IO | General Purpose GPIOs | DC Level:VDD_EXT | If you don't use it, it hangs in the air. |
| **GPIO3** | 51 | IO | General Purpose GPIOs | DC Level:VDD_EXT | If you don't use it, it hangs in the air. |
| **GPIO4** | 52 | IO | General Purpose GPIOs | DC Level:VDD_EXT | If you don't use it, it hangs in the air. |
| **GPIO5** | 53 | IO | General Purpose GPIOs | DC Level:VDD_EXT | If you don't use it, it hangs in the air. |
| **AGPIO3** | 101 | IO | General Purpose GPIOs | DC Level:LDO_AON | If you don't use it, it hangs in the air. |
| **AGPIO5** | 107 | IO | General Purpose GPIOs | DC Level:LDO_AON | If you don't use it, it hangs in the air. |
| **AGPIO6** | 99 | IO | General Purpose GPIOs | DC Level:LDO_AON | If you don't use it, it hangs in the air. |

## Other IO ports

| pin name | pin number | IO | descriptive | Electrical Characteristics | note |
|---|---|---|---|---|---|
| **RESERVED** | 5,8,44,98 | | Reserve GPIO | | Stay in the air. |
| **RESERVED** | 2, 3, 4, 6, 21, 26, 30-33 | | Reserved Pins | | Stay in the air. |

***Note.**

**1. For details of the secondary development of GPIO reuse functions, please refer to the corresponding "_GPIO_table".**

**2.LDOAON for the chip internal part of the GPIO power supply, the power supply from this power supply IO port sleep state can be maintained.**

**3. All io's support interrupts;**

**The io that can be reused as wakeup supports double edge or high and low level interrupts, and can be used in both sleep and wakeup states;**

**The rest of the io's only support single edge or single level interrupts, which are available in the wake-up state and not available in the sleep state.**

Tables4 : IO Parameter Definitions

| typology | descriptive |
| --- | --- |
| **IO** | Input/Output |
| **DI** | Digital Input |
| **DO** | Digital Output |
| **PI** | Power Input |
| **PO** | Power Output |
| **AI** | Analog Input |
| **AO** | Analog Output |
| **OD** | Open Drain Output |

## 3.2. operating mode

The following table briefly describes the various operating modes mentioned in the next few chapters.

Tables5 Table 5: Operating Modes

| paradigm | | descriptive |
|---|---|---|
| **proper functioning** | ACTIVE | The connection works properly. There is data or voice or SMS interaction. In this mode, the module power consumption depends on the strength of the ambient signal, the dynamic DTX control and the RF operating frequency. |
| | IDLE | MCU kernel clock is off and system interruptions can wake up the module at any time. The module registers on the network with no data, voice and SMS interaction. Entering and exiting IDLE mode is automatically managed by the system. |
| **sleep mode** | SLEEP1 | In hibernation mode. Peripherals are turned off, most of the IOs are powered down, and only AGPIO is able to maintain the level, which greatly reduces the power consumption. This mode is accessed by AT+CSCLK=1 or AT+CSCLK=2. |
| **shutdown mode** | OFF | In this mode, the PMU stops supplying power to the baseband and RF, the software stops working, the serial port is not available, but the VBAT pin is still energized. |

Attention:

- When the module enters hibernation mode or deep hibernation mode, the VDD_EXT power supply will be powered down, and the GPIOs and serial ports in the corresponding voltage domains (except MAIN_UART) will be in the state of power-down shutdown, and the IO ports will not be able to respond to interrupts, and will not be able to wake the module up to exit hibernation mode.
- After the module enters the hibernation state, it can only be woken up to exit the hibernation mode by the following pin interrupt.

| pin name | serial number | **functionality** | descriptive |
|---|---|---|---|
| PWRKEY | 7 | power on and off | Pull-through low power-on pin triggered interrupt |
| MAIN_TXD/RXD | 17,18 | main serial port | Wake up the module by sending data to the serial port |
| MAIN_DTR | 19 | Module wake-up pin | Pull down to trigger wake up interrupt |
| VBUS | 61 | USB plug-in wake-up | USB plugged in, or pulled up trigger |

## 3.3. power supply

| pin name | pin number | descriptive |
|---|---|---|
| VBAT | 42,43 | Module baseband power supply, supply range 3.3V~4.3V |

### 3.3.1. Modular Power Supply Operating Characteristics

Power supply design is an important part of module application design. As the LTE RF works with a maximum peak current of up to 1.5A, there will be a continuous operating current of about 700mA at maximum transmit power, the power supply must be able to provide sufficient current, otherwise it may cause the supply voltage to drop or even the module directly power down and restart.

### 3.3.2. Reduced voltage drop

Module power supply VBAT voltage input range of 3.3V ~ 4.3V, but the module in the RF transmitter usually produces a power supply voltage drop phenomenon on the VBAT power supply, which is due to the power supply or the impedance on the alignment path, generally difficult to avoid. Therefore, special attention should be paid to the module's power supply design, in the VBAT input, it is recommended that a low ESR (ESR = 0.7Ω) of 100uF tantalum capacitors in parallel, as well as 100nF, 33pF, 10pF filter capacitance, VBAT input reference circuit shown in Figure 4. It is also recommended that the PCB alignment of the VBAT be as short as possible and wide enough to reduce the equivalent impedance of the VBAT alignment, to ensure that there will not be too large a voltage drop under high currents at maximum transmit power. It is recommended that the width of the VBAT alignment should be not less than 1mm, and the longer the alignment, the wider the line width.

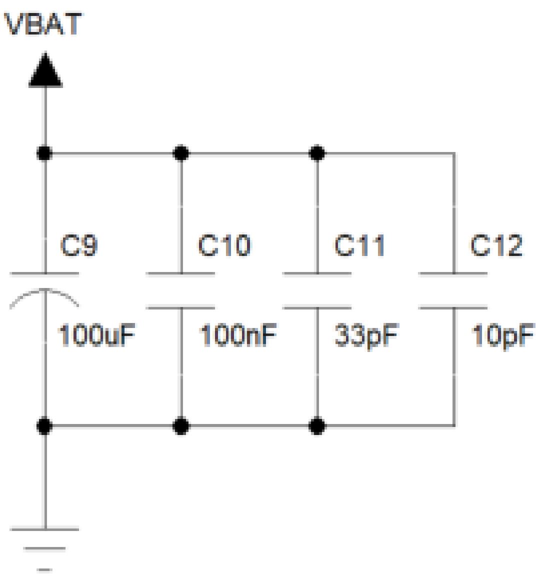


Chart3 : VBAT Input Reference Circuit

### 3.3.3. Power Supply Reference Circuit

The power supply design is critical to the power supply of the module, and it is important to select a power supply that is capable of supplying at least 1A of current. If the voltage difference between the input voltage and the module's supply voltage is less than 2V, it is recommended that an LDO be used as the power supply. If the voltage difference between input and output is greater than 2V, a switching power converter is recommended to improve power conversion efficiency.

**LDO power supply:**

The following figure shows a reference design for a 5V supply, using a Micrel LDO, model MIC29302WU. It has an output voltage of 4.16V and a peak load current of 3A. To ensure the stability of the output power supply, it is recommended that a regulator be reserved at the output and placed close to the VBAT pin of the module. It is recommended to choose a regulator with a reverse breakdown voltage of 5.1V and a power dissipation of 1W or more.

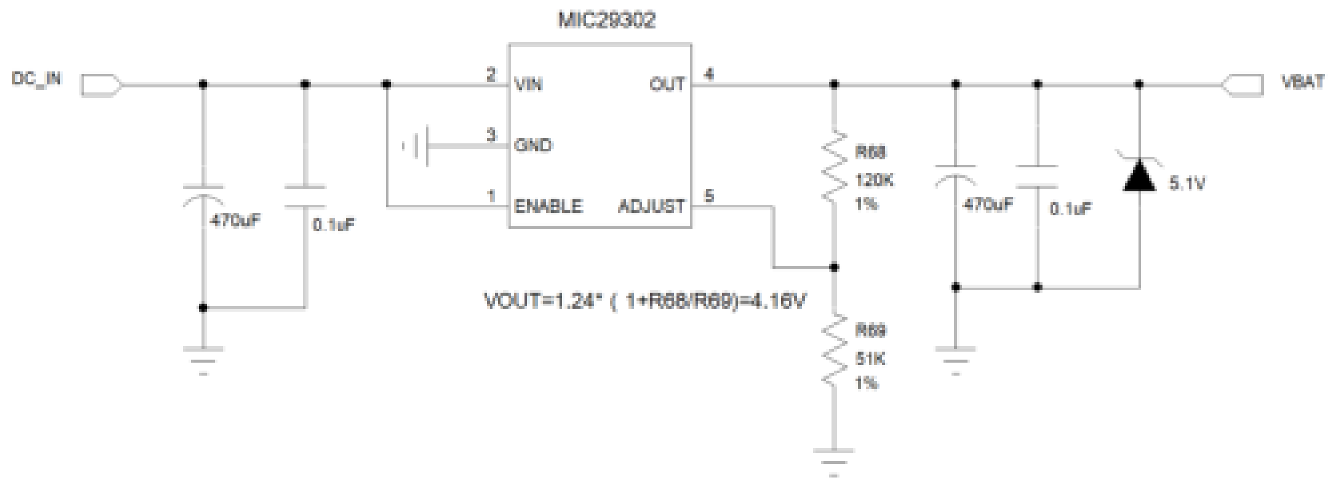



Chart4 : Power Supply Input Reference Design

**DC-DC powered:**

The following figure shows the reference design of a DC-DC switching power supply, using the JW5359M switching power supply chip from JWT, which has a maximum output current of 2A and an input voltage range of 3.7V~18V. Note that the selection of C25 should be based on the input voltage to select the appropriate voltage withstand value.

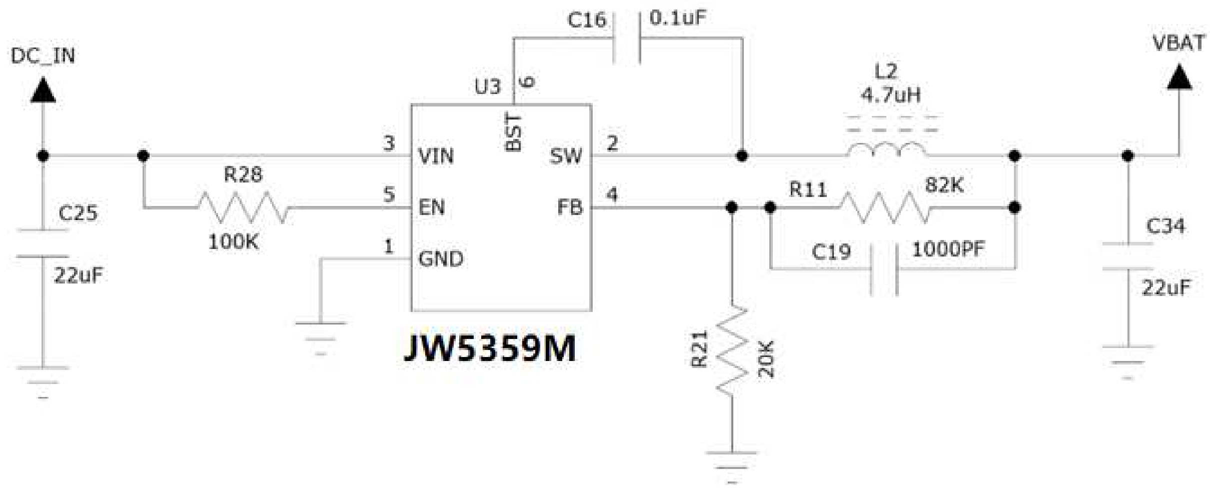



Figure 6: DCDC Power Supply Input Reference Design

# 3.4. power switch

## 3.4.1. Power on

| pin name | typology | serial number | descriptive |
|---|---|---|---|
| **PWRKEY** | DI | 7 | Module power on/off control pin |

After the VBAT is powered up, the Air780E can be triggered to power up in the following two ways:

1. Key on: PWRKEY pin is connected to ground by lightly touching the key, and the key is pressed for more than 1 second to realize power on.
2. Power on: short the PWRKEY pin directly to ground, VBAT power on can realize power on.

### 3.4.1.1 PWRKEY pin on

After VBAT is powered on, the module can be started through the PWRKEY pin, after pulling the PWRKEY pin down for more than 1 second, the module will enter the power-on process, and the software will detect the voltage of the VBAT pin, if the voltage of the VBAT pin is greater than the power-on voltage set by the software (3.3V), it will continue the power-on action until the power-on of the system is completed; otherwise, it will stop the execution of power-on action, and the system will be shut down, and the power-on will be completed. The PWRKEY pin can be released after success. The level of VDD_EXT pin can be detected to determine whether the module is powered on or not. It is recommended to use an open-collector driver circuit to control the PWRKEY pin. The following figure shows the reference circuit:

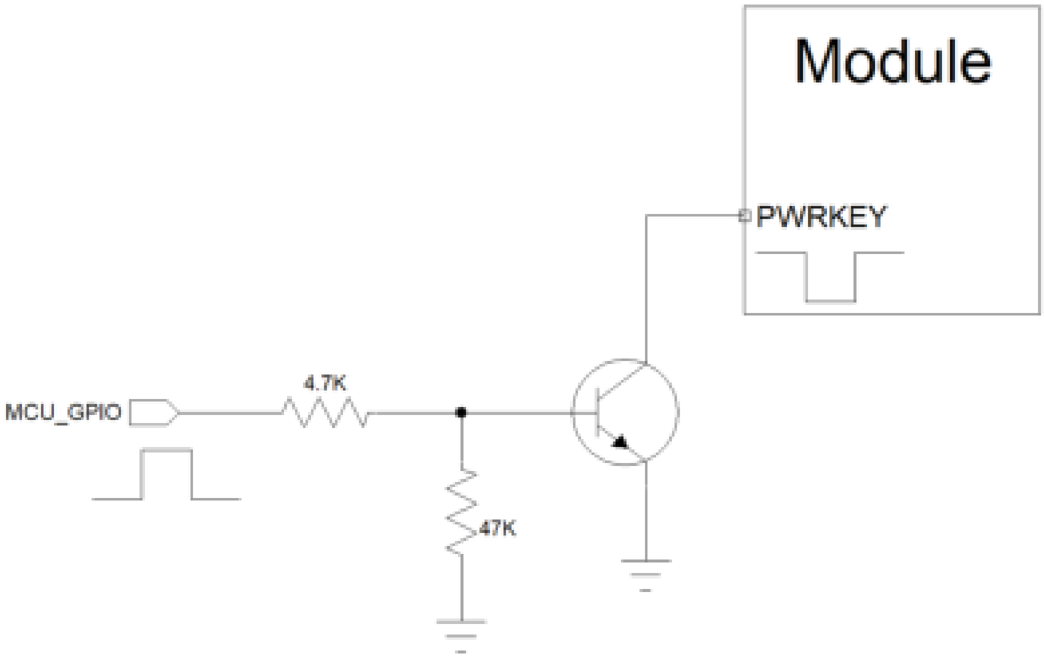



Chart5 : Open Set Driver Reference Power-Up Circuit

Another way to control the PWRKEY pin is to use a pushbutton switch directly. A TVS tube needs to be placed near the pushbutton for ESD protection. The figure below shows the reference circuit:

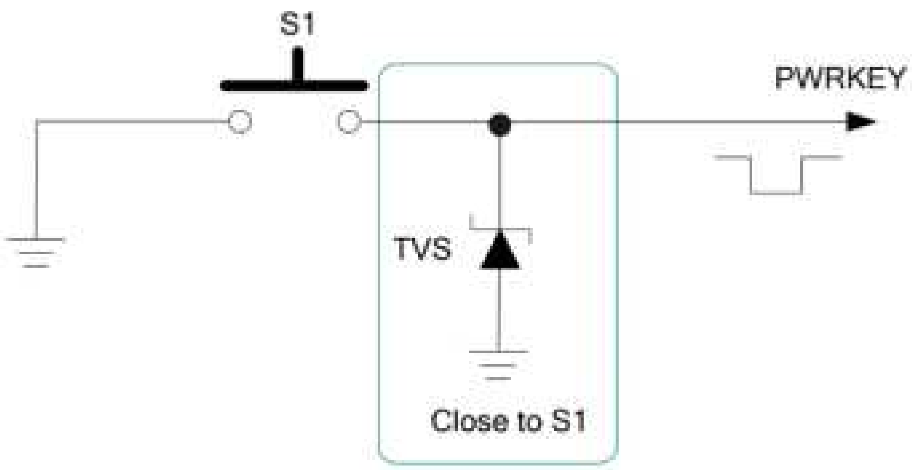



Chart6 : Key On Reference Circuit

#### 3.4.1.2 Power-up and start-up

The power-on auto power-on function can be realized by grounding the PWRKEY of the module directly. Note that it will not be possible to turn off the power in the power-on mode, the

**The PWRKEY grounded power-on auto-boot method is not recommended for battery-powered application scenarios.**

## 3.4.2. turn off (a machine or device)

The following ways are available to close the module:

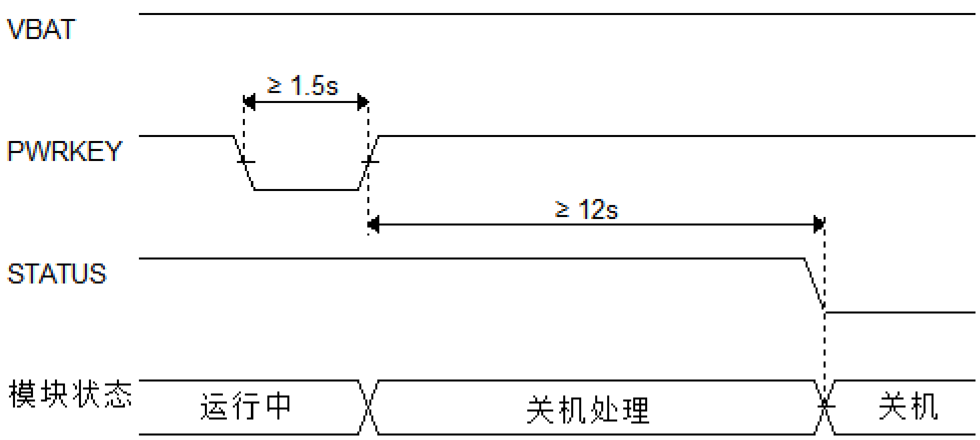
- Normal shutdown: Shutdown using PWRKEY pin
- Normal shutdown: shutdown via AT command AT+CPOWD

### 3.4.2.1 PWRKEY pin shutdown

The module performs a shutdown action when the PWRKEY pin is pulled low for more than 1.5s.

During the shutdown process, the module needs to log out of the network, the logout time is related to the current network status, which is measured to take about 2s~12s, so it is recommended to extend the 12s before powering off or restarting to ensure that the software saves the important data before completely powering off.

The timing diagram is shown below:




### 3.4.2.2 Low voltage auto shutdown

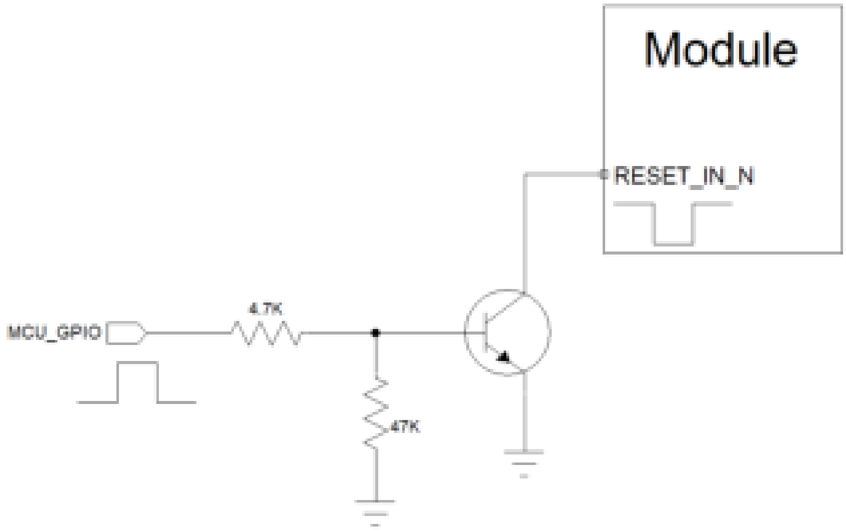
When the VBAT pin voltage is lower than the minimum operating voltage for module operation (default setting 3.3V), the software will perform shutdown action to shut down the module in order to prevent all kinds of abnormality under low voltage operation.

## 3.4.3. reset (a dislocated joint, an electronic device etc)

| pin name | typology | serial number | voltage domain | descriptive |
|---|---|---|---|---|
| **RESET_N** | DI | 15 | - | Module reset input, active low; no external pull-up required, system in shutdown state after reset |

The RESET_N pin can be used to reset the module. Pulling down the RESET_N pin for more than 100ms can reset the module. The RESET_N signal is sensitive to interference, so it is recommended that the wiring on the module interface board be as short as possible and be ground-protected.

**Reference Circuit**:




**Attention**:

1. The reset function is recommended for use only after AT+CPOWD and PWRKEY shutdown failures.

2. After the RESET_N reset pin is pulled low and released, the module will be in a hardware shutdown state, if you want to reboot the function, you need to pull down the POWERKEY pin again after the RESET_N reset to perform the power-on action.

## 3.5. serial port (computing)

The module provides three general-purpose asynchronous transceivers: the main serial port MAIN_UART, AUX_UART, and DBG_UART.

### 3.5.1. MAIN_UART

Tables6 : MAIN_UART Pin Definitions

| pin name | typology | serial num | voltage domain | descriptive |
|---|---|---|---|---|
| **MAIN _TXD** | DO | 18 | VDD_EXT | MAIN_UART Send data |
| **MAIN _RXD** | DI | 17 | VDD_EXT | MAIN_UART Receive data |
| **MAIN _CTS** | DO | 22 | VDD_EXT | Flow control pin, MAIN_UART Request to send data |

| | | | | |
|---|---|---|---|---|
| **MAIN _RTS** | DI | 23 | VDD_EXT | Flow control pin, MAIN_UART Clear Transmit |

For AT development mode, 3.5.1. MAIN_UART is used for AT command communication, MAIN_UART supports fixed baud rate, not adaptive baud rate.

By default, the hardware flow control of the module is turned off. When the client needs hardware flow control, pins **RTS,CTS** must be connected to the client, **AT** command **"AT+IFC=2,2"** can be used to turn on the hardware flow control, **AT** command **"AT+IFC=0,0"** can be used to turn off the flow control. Please refer to "AirM2M Wireless Module AT Command Manual" for details.

MAIN_UART Function held in sleep state to wake up the module

MAIN_UART is characterized as follows:

- Includes data lines TXD and RXD, and hardware flow control lines RTS and CTS.
- 8 data bits, no parity, one stop bit.
- Hardware flow control is turned off by default.
- Used for AT command transmission, digital transmission, etc.
- Support baud rate as follows: 600,1200,2400,4800,14400,9600,19200,38400,57600,115200,230400,460800,921600bps

Attention:

MAIN_UART outputs a fixed debug message for a short period of time during power-up.

### 3.5.2. AUX_UART

Tables7 : AUX_UART Pin Definitions

| pin name | typology | serial num | voltage domain | descriptive |
|---|---|---|---|---|
| **AUX_TXD** | DO | 29 | VDD_EXT | AUX_UART Send data |
| **AUX_RXD** | DI | 28 | VDD_EXT | AUX_UART Receive data |

AUX_UART is an auxiliary serial port that does not support AT command interaction and is used for certain peripheral communications such as docking GNSS.

The AUX_UART turns off when it is dormant and cannot be woken up by sending data to the AUX_UART.

### 3.5.3. DBG_UART

| pin name | typology | serial numb | voltage domain | descriptive |
|---|---|---|---|---|
| **DBG_TXD** | DO | 39 | VDD_EXT | Debugging the serial port, outputting AP logs, the |

| | | | | |
|---|---|---|---|---|
| **DBG_RXD** | DI | 38 | VDD_EXT | Debug serial port to receive debug commands |

DBG_UART is used to output AP trace during software debugging, and it is recommended to reserve a test point.

DBG_UART outputs fixed debugging information for a short time during power-up.

DBG_TX and DBG_RX function as the system bottom log port by default. When carrying out module hardware design, avoid using DBG_TX and DBG_RX as long as the remaining function pins are sufficient.

If this pin is multiplexed to other functions, it is not possible to grab the syslog from DBG_TX and DBG_RX.

In some scenarios, if the module has an abnormality and can't catch the problem logs, it can only be done by hardware revision, which leads to DBG_TX and DBG_RX, and catch the logs and then analyze them.

This includes, but is not limited to, the following two scenarios:

1. Low power consumption scenarios:

In low-power scenarios, USB is not available and logs can only be captured via DBG_TX, DBG_RX.

2. non-low-power scenarios:

The module works normally when it is connected to USB and abnormally when it is not connected to USB, you can only capture the logs through DBG_TX and DBG_RX.

### 3.5.4. Serial connection method

Serial port connection is more flexible, the following are three commonly used connection methods.

Please refer to the following connection method for the 3-wire serial port:

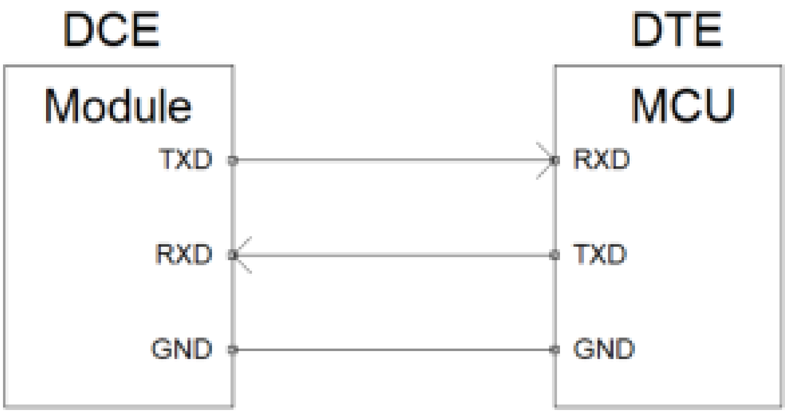


Chart7 : Diagram of the three-wire connection of the serial port

For serial port connection with flow control, please refer to the following circuit connection. This connection can improve the reliability of large data volume transmission and prevent data loss.

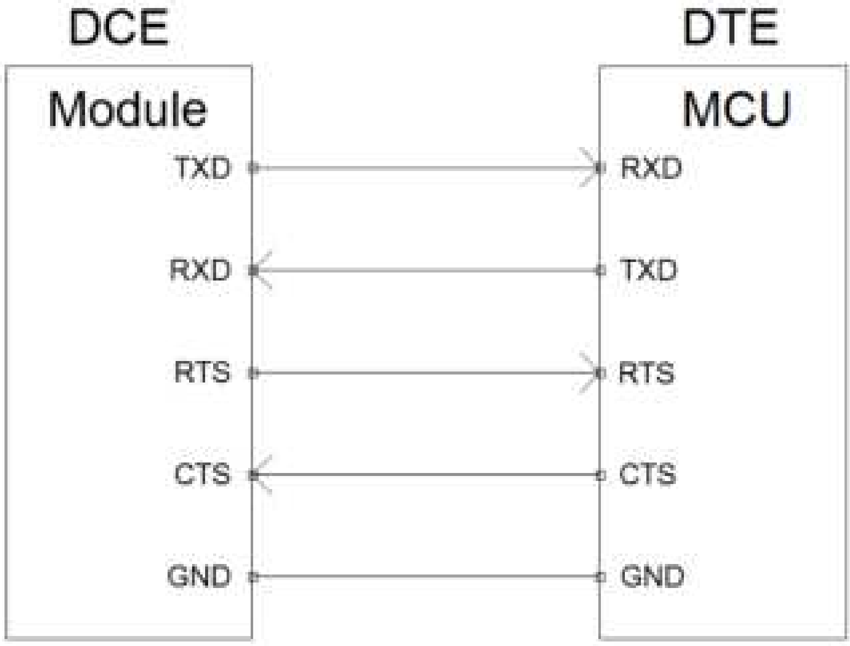
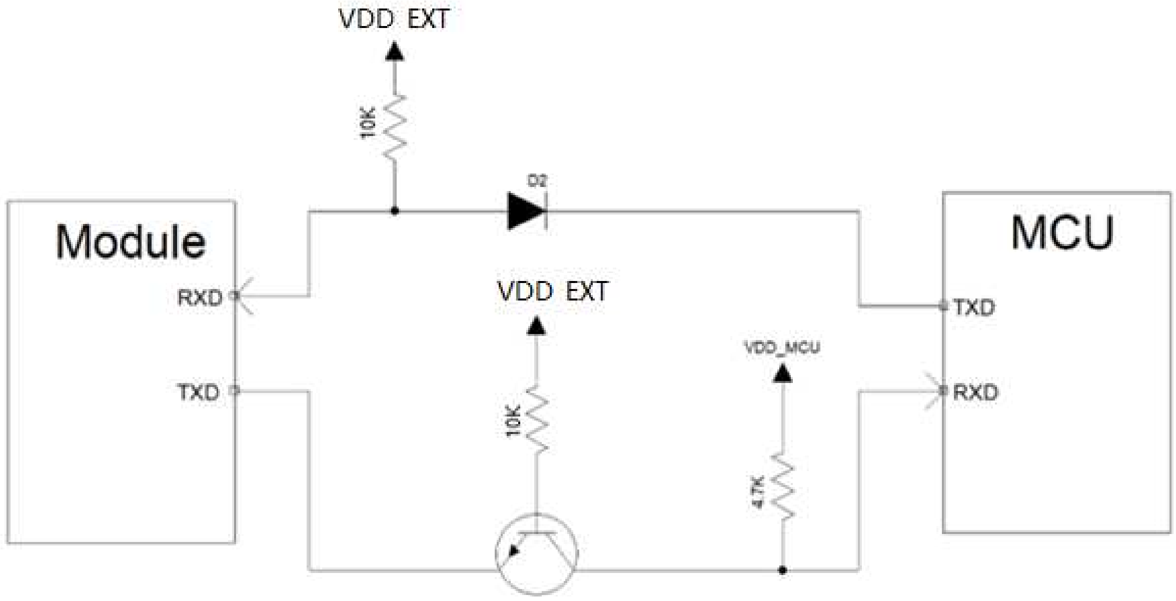



Chart8 : Diagram of serial port connection with flow control

### 3.5.5. Serial Voltage Conversion

The serial port level of Air780E module is fixed at 1.8V, which can meet the direct serial port requirements of most MCU masters, but if you want to communicate with MCUs or other serial peripherals that are 3.3V or above, then you must add a level conversion circuit:

The level shifting reference circuit is as follows:



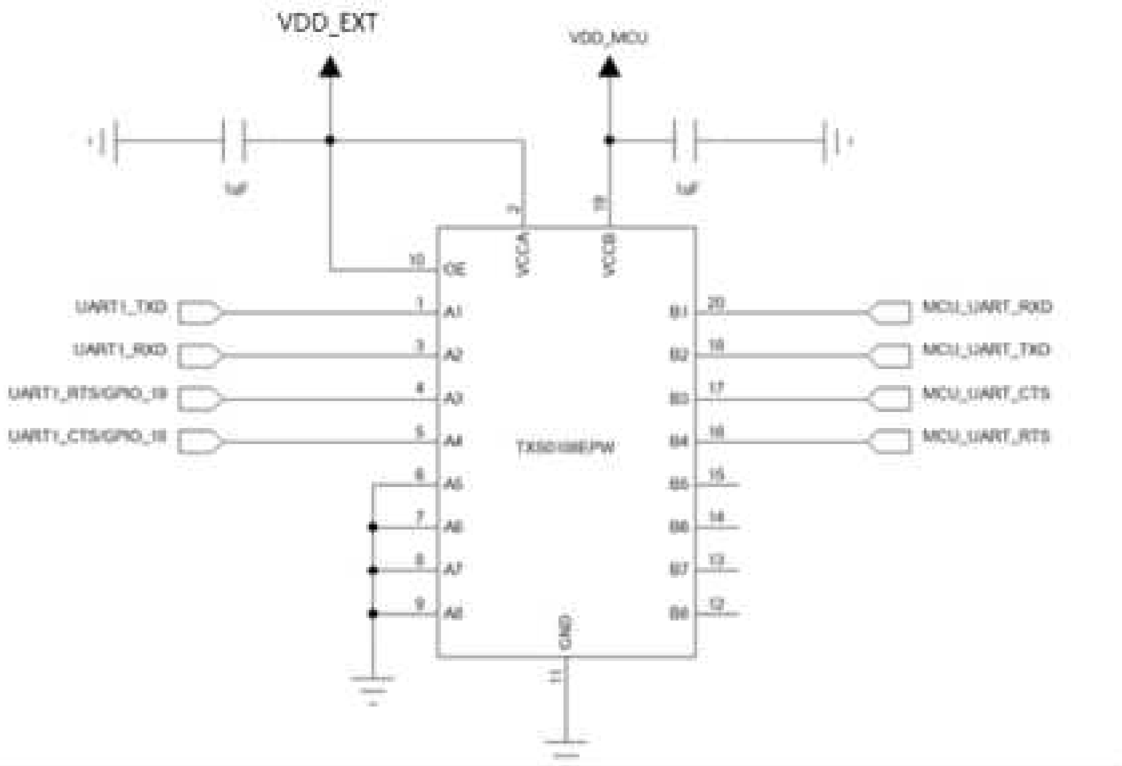

take note of

- If low-power demand pull-ups can't be done with vdd-ext, you have to use agpio or external ldo to do the pull-ups
- This level shifting circuit is not suitable for applications with baud rates higher than 460800 bps.
- D2 A Schottky diode with a low on-state voltage drop must be used.

Recommended models for Schottky diodes as well as NPN transistors are listed below:

| Material Name | model number | company | descriptive |
|---|---|---|---|
| **Schottky diode** | RB521S-30 | Jiangsu Changdian | Schottky Diode;30V;200mA;SOD523;1.6*0.8*0.6mm |
| | PSB521S-30 | Shanghai Zhijing | Schottky Diode;30V;200mA;SOD523;1.6*0.8*0.6mm |
| | LRB521S-30T1G | LRC | Schottky Diode;30V;200mA;SOD523;1.6*0.8*0.6mm |
| | PSBD521S-30 | Prisemi | Schottky Diode;30V;200mA;SOD523;1.6*0.8*0.6mm |
| **NPN Triode** | MMBT3904 | Jiangsu Changdian | Transistor;NPN;40V;200mA;SOT23;1.1mm;ROHS |
| | MMBT3904 | Shanghai Zhijing | Transistor;NPN;40V;200mA;SOT23;1.1mm;ROHS |
| | LMBT3904LT1G | LRC | Transistor;NPN;40V;200mA;SOT23;1.1mm;ROHS |

For applications with baud rates higher than 460800bps, voltage conversion can be achieved by an external level shifter chip with the following reference circuit:




This circuit uses a level shifter chip is TI's TXS0108E, an 8-bit bi-directional voltage level shifter for open-drain and push-pull applications, with maximum support rate:

Push-Pull: 110Mbps

Open leakage: 1.2Mbps

## 3.6. USB port

The Air780E's USB is compliant with the USB 2.0 specification and supports high-speed (480Mbps), full-speed (12Mbps) modes and low-speed (1.2Mbps) modes.The USB interface can be used for AT command transfer, data transfer, software debugging and software upgrades.

Tables8 : USB Pin Definitions

| pin name | typolo gy | serial numbe | descriptive |
|---|---|---|---|
| **USB_DP** | IO | 59 | USB differential signal is positive, the alignment needs to control 90 ohms differential impedance |
| **USB_DN** | IO | 60 | USB differential signal negative, the alignment needs to control 90 ohms differential impedance |
| **VBUS** | DI | 61 | USB plug-in wake-up, module internal resistor divider. (not required) |

The USB interface reference design circuit is as follows:

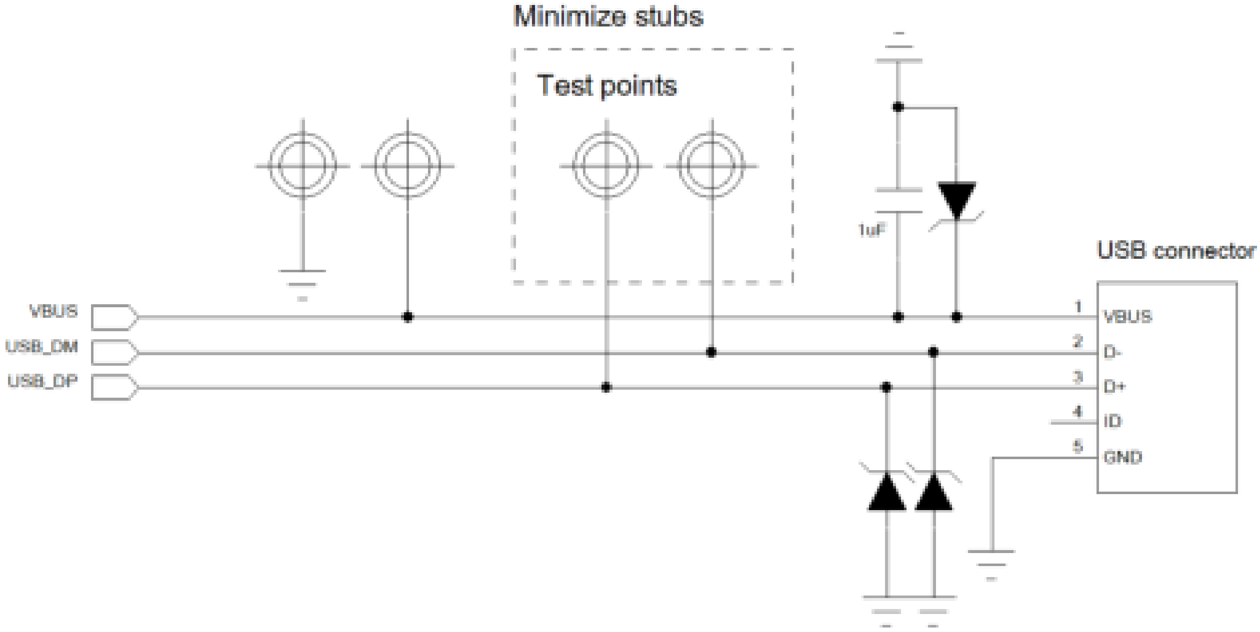



Chart9 : USB Interface Reference Design

The notes are as follows:

1. USB alignment needs to be strictly controlled by differential lines to be parallel and equal length;
2. The impedance of the USB alignment needs to be controlled to a differential 90 ohms;
3. It is necessary to minimize the stubs of the USB alignment to reduce signal reflection; the test point of the USB signal is best placed directly on the alignment to reduce stubs;
4. Minimize the number of cross-holes for USB routing;
5. Near the USB connector or test point to add TVS protection tube, due to the high rate of USB, need to pay attention to the selection of TVS tube, to ensure that the selection of TVS protection tube parasitic capacitance of less than 1pF
6. VBUS as USB insertion wake-up role, and not directly involved in USB insertion detection, non-essential, in the scene does not require USB insertion wake-up can not be connected to the

## 3.7. USB Download Mode

| pin name | typology | serial num | voltage domain | descriptive |
|---|---|---|---|---|
| **USB_BOOT** | DI | 82 | LDOAON | Pull up to VDD_EXT before power on, the module will be forced into USB download mode, USB_BOOT must leave |

The Air780E module enters USB download mode:

1. Pull up USB_BOOT to VDD_EXT before powering on the computer

## 3.8. SIM card interface

Air780E supports 2-way SIM card interface, supports ETSI and IMT-2000 card specification, supports 1.8V and 3.0V USIM card. to meet the needs of dual-SIM card switching.

### 3.8.1. SIM interface

The following table describes the pin definitions for the SIM interface.

Tables9 : SIM Card Interface Pin Definitions

| connector | pin name | serial number | descriptive |
|---|---|---|---|
| **SIM1** | USIM_VDD | 14 | SIM card power supply, maximum power supply current 10mA.<br>The module can automatically recognize 1.8V or 3V (U) SIM |
| | USIM_RST | 12 | SIM card reset signal |
| | USIM_DAT | 11 | SIM card data signal |
| | USIM_CLK | 13 | SIM card clock signal |
| **SIM2** | USIM2_VDD | 65 | SIM2 card power supply, maximum supply current 10mA.<br>The module can automatically recognize 1.8V or 3V (U) SIM cards. |
| | USIM2_RST | 63 | SIM2 card reset signal |
| | USIM2_DAT | 64 | SIM2 card data signal |
| | USIM2_CLK | 62 | SIM2 card clock signal |

### 3.8.2. Dual SIM switching instructions

Air780ET supports dual SIM card single standby, only one of the SIM channels can be used at the same time. SIM channel switching can be done through the corresponding AT commands: or select the automatic switching function, the system will automatically switch according to the external network signal strength (the automatic switching function is usually used in the scenario of using SIM cards of different carriers at the same time). For specific commands, please refer to "4G Module AT Command Manual".

Attention:

- The module power on will detect the SIM1 channel by default, and will only go to detect the SIM2 channel if the SIM1 channel detects that the SIM card is not in position.
- USIM_DET signal is the SIM card insertion/removal detection pin, the upper and lower edge levels trigger interrupts, triggering the system to carry out card-in-position detection for SIM1 channel. The SIM2 channel does not support SIM card insertion/removal detection.

◆ For dual-card application scenarios with built-in patch SIM cards, such as webcam (IPC) scenarios, it is recommended that the patch SIM card be placed in the SIM2 channel, and the external plug-in SIM card holder be placed in the SIM1 channel in order to prioritize the use of the external plug-in SIM card.

### 3.8.3. SIM interface reference circuit

The following figure shows the reference circuit for the SIM interface, using a 6-pin SIM card holder.

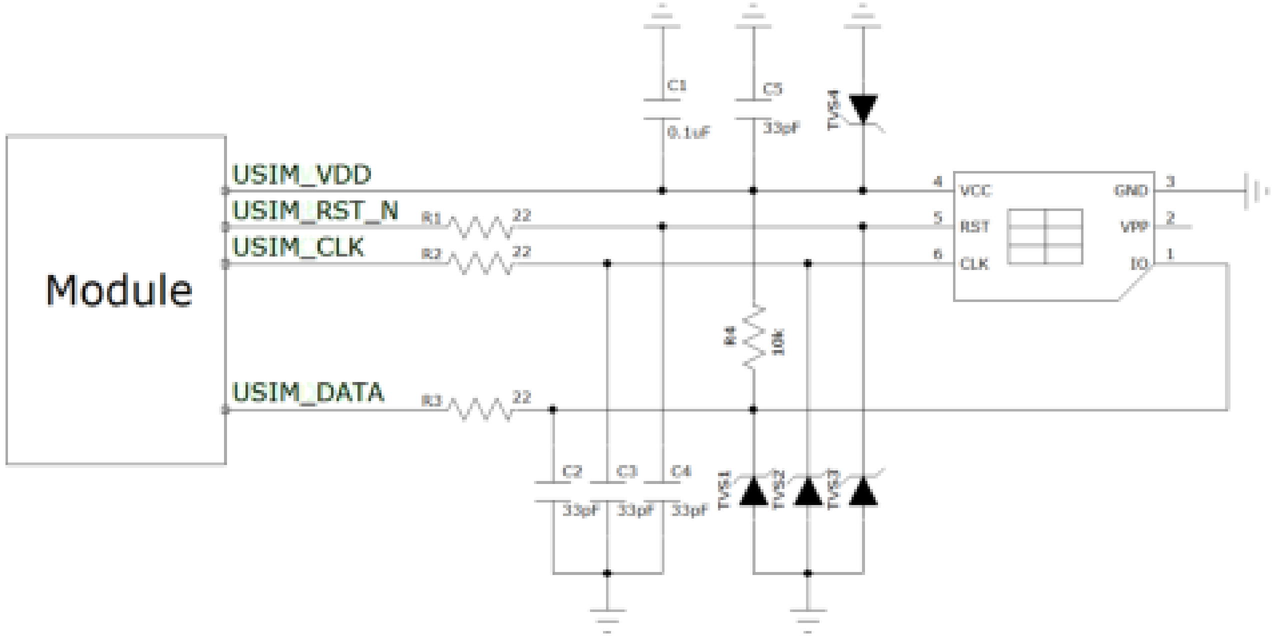



Chart10 : Reference Circuit Diagram for Using 6pin SIM Card Holder (SIM)

In the circuit design of the SIM card interface, the following design principles are recommended in the circuit design in order to ensure good functional performance of the SIM card and not to be damaged:

1. SIM card holder and module distance from the pendulum can not be too far, the closer the better, try to ensure that the SIM card signal line wiring does not exceed 20cm.
2. SIM card signal wiring is routed away from RF lines and VBAT power lines.
3. To prevent possible crosstalk of the USIM_CLK signal to the USIM_DATA signal, do not route the two too close together and add ground shielding between the two alignments. And ground protection is also required for the USIM_RST_N signal.
4. To ensure good ESD protection, it is recommended to add TVS tubes and place them close to the SIM card holder. The parasitic capacitance of the selected ESD device should not be greater than 50pF. 22 ohm resistors can also be connected in series between the module and the SIM card to suppress stray EMI and enhance ESD protection. the peripheral circuits of the SIM card must be placed as close as possible to the SIM card holder.

## 3.9. LDO output

| pin name | typology | serial number | descriptive |
|---|---|---|---|

| | | | |
|---|---|---|---|
| **VDD_EXT** | PO | 24 | Fixed output 1.8V, driving capacity 4mA, only for external pull-ups |

Attention:

- VDD_EXT is not recommended for powering peripherals and can only be used for external pull-ups

## 3.10. Function Pins

### 3.10.1. MAIN_RI

| pin name | typology | serial number | voltage domain | corresponds English -ity, -ism, -ization |
|---|---|---|---|---|
| MAIN_RI | DO | 20 | LDO_AON | Ring signal, wake-up output pin, used to wake up the AP |

Tables10 : MAIN_RI Signal Action

| state of affairs | MAIN_RI answer |
|---|---|
| pragmatic | high level |
| voice call | goes low afterward:<br>（1） Goes high when the call is established<br>（2） Using the AT command ATH hangs up the voice and MAIN_RI goes high<br>（3） Caller hangs up, MAIN_RI first goes high, then pulls low for 120ms, receives auto-reply URC message "NO CARRIER", then goes high again afterward<br>（4） Goes high when a text message is received |
| data transmission | goes low afterward:<br>1. Goes high when a data connection is established<br>2. Use the AT command ATH to hang up the data connection, MAIN_RI goes high<br>3. Caller hangs up, MAIN_RI first goes high, then pulls low for 120ms, receives auto-reply URC message "NO CARRIER", then goes high again afterward<br>4. Goes high when a text message is received |
| text messaging | When a new SMS is received, MAIN_RI goes low for 120ms and goes high again |
| URC | Certain URC messages can trigger MAIN_RI to pull down for 120ms. |

If the module is used as the calling party, MAIN_RI will remain high, except when a URC message or SMS is received. And when the module is used as the called party, the timing of MAIN_RI is shown below:

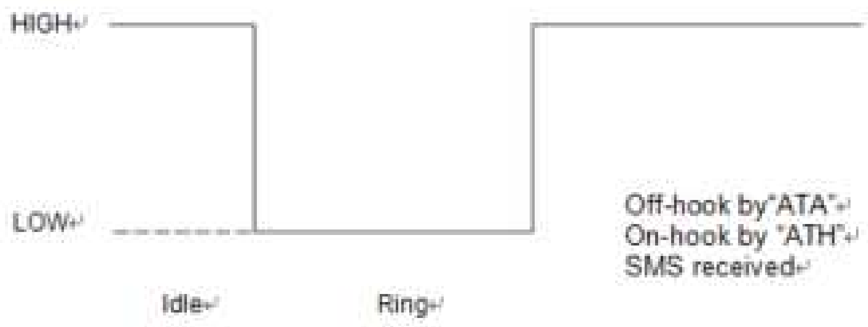


Chart11 : Module used as called party MAIN_RI timing for voice calls

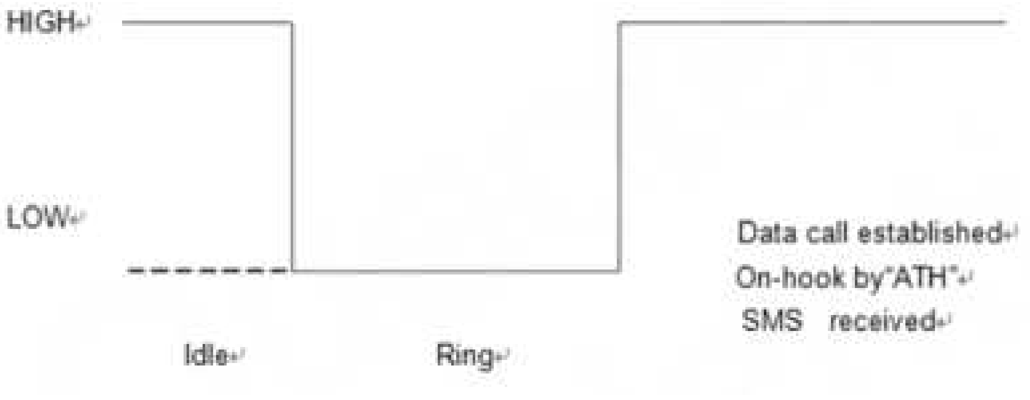



Chart12 : Module used as called party MAIN_RI timing for data calls

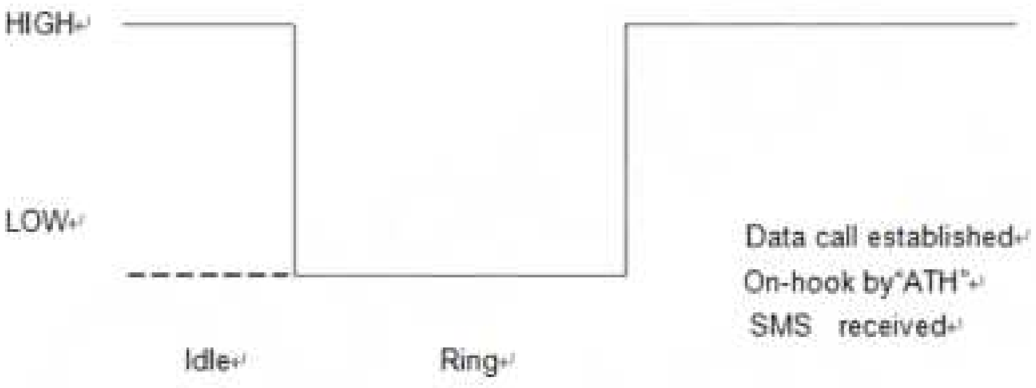



Chart13 : MAIN_RI Timing for Module Calls

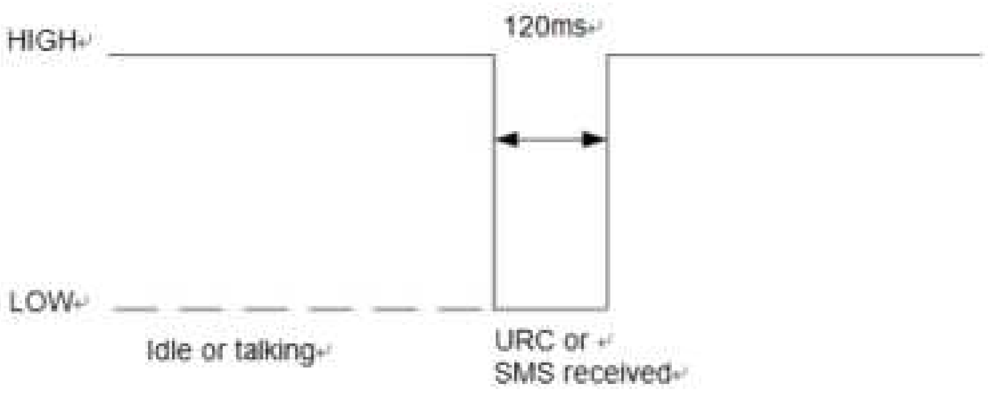



Chart14 : MAIN_RI timing when receiving URC messages or SMS messages

### 3.10.2. MAIN_DTR

| pin name | typology | serial number | voltage domain | corresponds English -ity, -ism, -ization |
|---|---|---|---|---|
| **MAIN_DTR** | DI | 19 | LDO_AON | Module sleep wake-up pin, pull high to allow the module to enter sleep mode; in sleep mode, pull low to wake up the module |

The module supports two sleep modes:

Sleep mode 1: send AT+CSCLK=1 to control whether the module goes to sleep or not by MAIN_DTR pin level

Sleep mode 2: send AT+CSCLK=2, the module automatically enters sleep after the serial port has been idle for a period of time

For details, refer to 3.20.2 Sleep mode

### 3.10.3. Status Indicator

The Air780E uses one pin to indicate the power-on state and two pin signals to indicate the state of the network. The following two tables describe the pin definitions and the logic level changes for different network states:

Tables11 : Network Indication Pin Definitions

| pin name | typology | serial number | voltage domain | corresponds English -ity, -ism, -ization |
|---|---|---|---|---|
| **NET_STATUS** | DO | 16 | LDO_AON | Indicates the network operational status of the module |

Tables12 : Indicates the operating status of the network pins

| state of affairs | Pin operating status | network state |
|---|---|---|
| **NET_STATUS** | Lights up for 0.2 | search network status |
| | 1.8 seconds on, 0.2 | pragmatic |
| | Lights up for 0.125 seconds, goes out for 0.125 seconds | data transmission status<br>Note: This status indication is limited to PPP dialing success or AT command active activation of PDP success and RNDIS networking success. |

The indicator reference circuit is shown below:

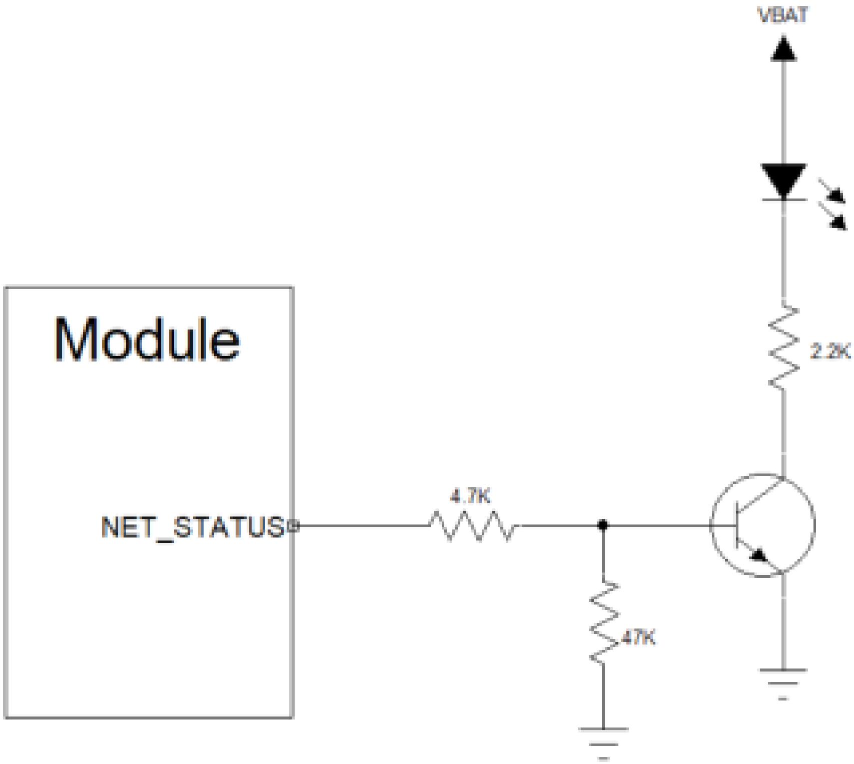



Chart15 : Indicator Light Reference Circuit

## 3.11. power saving feature

Depending on the system requirements, there are two ways to put the module into a low power state. For the AT version, the "AT+CFUN" command can be used to put the module into the least functional state.

### 3.11.1. Minimum Function Mode/Flight Mode

Minimum function mode can minimize the module function, this mode can be set by sending "AT+CFUN=<fun>" command. The <fun> parameter can be selected from 0, 1, 4.

- 0: Minimum function (disable RF and SIM card);
- 1: Full function (default);
- 4: Disable the RF send and receive function;

If you use "AT+CFUN=0" to set the module to the least functional mode, the functions of the RF part and the SIM card part will be disabled. The serial port is still valid, but the AT commands related to the RF and SIM card sections are not available.

If you use "AT+CFUN=4" to set the module, the RF part of the function will be disabled, while the serial port is still valid. All AT commands related to the RF part are not available.

After the module is set by "AT+CFUN=0" or "AT+CFUN=4", it can be set to return to the full-function state by "AT+CFUN=1" command. The command "AT+CFUN=1" can be used to return to the full function state.

## 3.11.2. Sleep mode (slow clock mode)

### 3.20.2.1 Serial port applications

Two sleep modes are supported under serial applications:

- Sleep Mode 1: Controls whether the module goes to sleep via the MAIN_DTR pin level
- Sleep mode 2: the module automatically goes to sleep after the serial port has been idle for a period of time

#### 3.20.2.1.1 Sleep mode 1

**Open conditions**:

Send AT command AT+CSCLK=1

**The module goes to sleep:**

Control the MAIN_DTR pin to pull high, the module will enter sleep mode 1

**The module exits sleep:**

Pull down the MAIN_DTR pin for more than 50ms, the module will exit the sleep mode can accept the AT instruction

**Software function of the module in sleep mode 1:**

Doesn't respond to AT commands, but receives data/SMS/incoming calls with URC reporting

**How to wake up the HOST when the module receives data/SMS/incoming calls while the HOST is sleeping**:

MAIN_RI signal

#### 3.20.2.1.2 Sleep mode 2

**Open conditions**:

Send AT command AT+CSLCK=2

**The module goes to sleep**:

The serial port is idle for more than the time configured by AT+WAKETIM (default 5s), the module automatically enters sleep mode 2

**The module exits sleep**:

The serial port continuously sends AT until the module responds, then it exits sleep mode 2. does not respond to the DTR pin interrupt wakeup

**Software function of the module in sleep mode 2:**

Doesn't respond to AT commands, but receives data/SMS/incoming calls with URC reporting

**How to wake up the HOST when the module receives data/SMS/incoming calls while the HOST is sleeping**:

MAIN_RI signal

#### 3.20.2.2 USB applications

**Open conditions:**

USB HOST must support USB suspend/resume.

**The module goes to sleep:**

HOST initiates USB suspend

**The module exits sleep:**

HOST initiates USB resume

**How to wake up the HOST when the module receives data/SMS/incoming calls while the HOST is sleeping:**

MAIN_RI signal

## 3.12. Mode switching summary

Tables13 Summary of Mode Switching

| current mode | Next mode | | |
|---|---|---|---|
| | turn off (a machine or device) | normal mode | sleep mode |
| turn off (a machine or | / | Booting with PWRKEY | / |
| normal mode | Using the PWRKEY pin, or VBAT voltage below the shutdown voltage | / | Software call sleep interface, AT version does not do the action of 30s automatic hibernation |
| sleep mode | Using the PWRKEY pin, or VBAT voltage below the shutdown voltage | GPIO pin interrupt, timer, receive SMS or network data | / |

For specific power consumption data, please consult 5.4 Power Consumption section.

# 4. RF interface

The antenna interface pins are defined below:

Tables14 : RF_ANT Pin Definitions

| pin name | serial number | descriptive |
|---|---|---|
| LTE_ANT | 35 | LTE Antenna Interface |

## 4.1. RF reference circuit

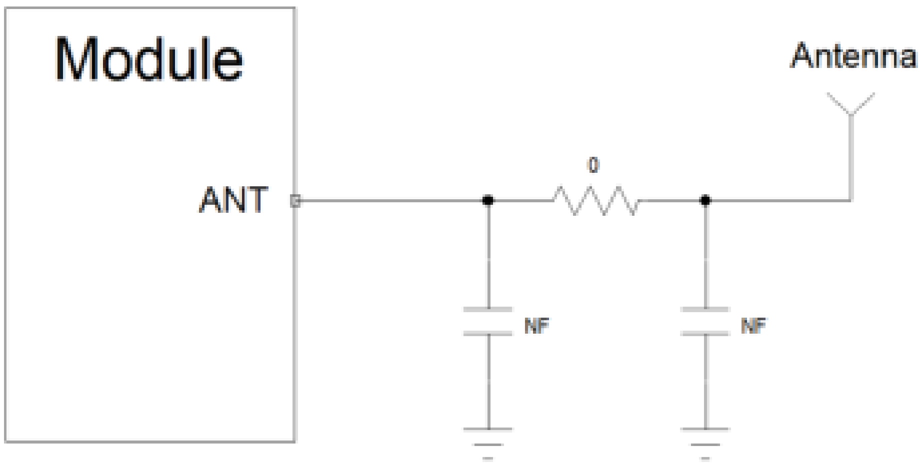



Chart16 : RF Reference Circuit

Attention:

- The RF traces connected to the module's RF antenna pads must be microstrip or other types of RF traces with an impedance of about 50 ohms.
- Reserve the Π-type matching circuit near the antenna, the two capacitors are not patched by default, and the resistor is patched with 0 ohm by default, and then the matching circuit will be patched with the actual debugging after the antenna factory debugs the antenna;
- Luat module impedance line and antenna design recommendations: https://doc.openluat.com/article/2430

## 4.2. RF Output Power

Tables15 Table 15: RF Conducted Power

| (radio) band | greatest | minimal |
|---|---|---|
| **LTE FDD B2/B4/B5/B12/B13** | 23dBm +-2dB | <-44dBm |
| **LTE TDD B66** | 23dBm +-2dB | <-42dBm |

## 4.3. RF conduction sensitivity

Tables16 : RF Conductivity Sensitivity

| (radio) band | receiver sensitivity |
|---|---|
| **LTE FDD B2 (10M)** | < -99dBm |
| **LTE FDD B4 (10M)** | < -99dBm |
| **LTE FDD B5 (10M)** | < -99dBm |
| **LTE FDD B12(10M)** | < -99dBm |
| **LTE FDD B13(10M)** | < -99dBm |
| **LTE TDD B66 (10M)** | < -99dBm |

## 4.4. operating frequency

| 3GPP frequency band | dispatch | reception (of transmitted signal) | unit (of measure) |
|---|---|---|---|
| **LTE-FDD B2** | 1850~1910 | 1930~1990 | MHz |
| **LTE-FDD B4** | 1710~1755 | 2110~2155 | MHz |
| **LTE-FDD B5** | 824~849 | 869~894 | MHz |
| **LTE-FDD B12** | 699~716 | 729~746 | MHz |
| **LTE-TDD B13** | 777~787 | 746~756 | MHz |

| | | | |
|---|---|---|---|
| **LTE-TDD B66** | 1710~1780 | 2110~2180 | MHz |

## 4.5. Recommended RF Soldering Methods

If the RF connector connecting the external antenna is connected to the module by soldering, please be sure to pay attention to the stripping method of the connecting wires and the soldering method, especially the ground should be soldered sufficiently, please follow the correct soldering method in the following figure to avoid the increase of the wire loss due to the poor soldering.

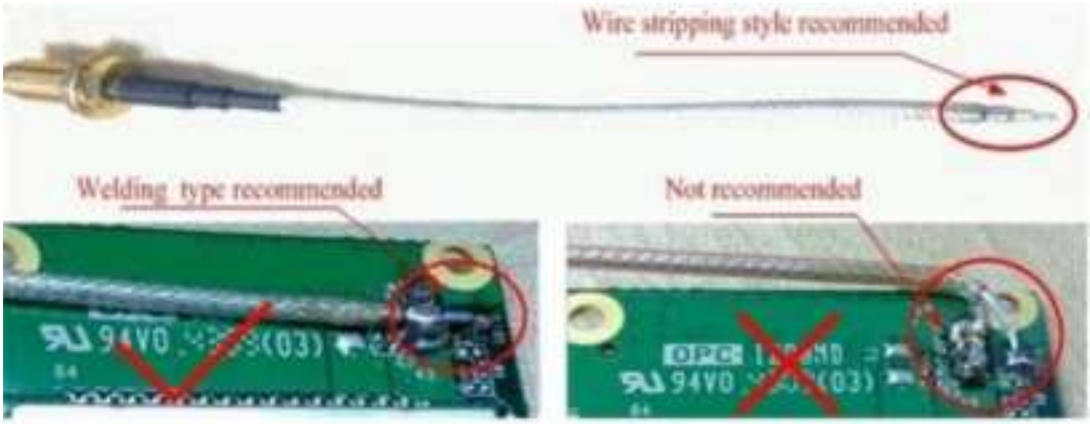



Chart17 : Recommendations for RF Welding Methods

# 5. Electrical Characteristics, Reliability, RF Characteristics

## 5.1. absolute maximum

The following table shows the maximum withstand values for the power supply voltage and current for the digital and analog pins of the module.

Tables17 Absolute Maximum

| parameters | minimal | greatest | unit (of measure) |
|---|---|---|---|
| **$V_{BAT}$** | -0.3 | 4.7 | V |
| **VBUS** | -0.3 | 5.5 | V |
| **Power supply peak current** | 0 | 1.5 | A |
| **Power supply average current (TDMA one frame time)** | 0 | 0.7 | A |
| **Voltage at digital pins** | -0.3 | 3.6 | V |
| **Voltage at analog pin (ADC)** | -0.3 | 3.6 | V |

## 5.2. Recommended working conditions

Tables18 : Recommended Conditions of Employment

| parameters | minimal | typical case | greatest | unit (of measure) |
|---|---|---|---|---|
| **$V_{BAT}$** | 3.3 | 3.8 | 4.3 | V |
| **VBUS** | 3.3 | 5.0 | 5.25 | V |

## 5.3. operating temperature

Tables19 Table 19: Operating Temperatures

| temp | lowest | typical case | supreme | unit (of measure) |
|---|---|---|---|---|
| **normal working temperature** | -35 | 25 | 75 | ℃ |
| **Limit working temperature** | -40~-35 | | 75~85 | ℃ |

| | | | | |
|---|---|---|---|---|
| **Storage temperature** | -45 | | 90 | ℃ |

## 5.4. power wastage

### 5.4.1. Real network simulation of long connection power consumption

#### Module networking power consumption data

Module low-power mode networking connected to the server timed heartbeat test, simulating the actual application of the timed reporting scenarios under the power consumption, so as to be able to estimate the battery life. Ultra-low power consumption program reference: https://doc.openluat.com/wiki/50

| Test conditions: mobile network B34 RSRP=48 (medium strength) power supply 4V; TCP connection XX minutes automatic heartbeat packets | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Average power consumption mA (5 min heartbeat) | Heartbeat Packet Sending | | Average hibernation power consumption | | 500mAH battery standby (days) | | |
| | | Power consumption mA | Power consumption uAH | Power consumption mA | Power consumption uAH (5-minute interval) | 5-minute reporting interval | 1-hour reporting interval | 24-hour reporting interval |
| AT+POWERMODE="PRO" | 0.79 | 37 | 16.4 | 0.599 | 47.9 | 26 | 35.2 | 36.2 |
| AT+POWERMODE="SRD" | 0.58 | 36 | 16.2 | 0.384 | 32.1 | 36 | 52 | 54 |
| AT+POWERMODE="PSM" | 0.0028 (no heartbeat) | \windshield | \windshield | \windshield | \windshield | 104.4 | 1085 | >10 years |

#### Stage-by-stage flow consumption (tested in real network test at medium signal strength)

| point | average current | span | total energy consumption |
|---|---|---|---|
| **Boot Registration Successful** | 19ma | 4s | 24uAH |
| **Send data (20 bytes)** | 36ma | 1.2s | 16.2uAH |
| **Send data (20 bytes)** | 23.1ma | 2.8s | 18.3uAH |

Attention:

Since this is a real network test, network signal strength, registration band, server response time will have a greater impact on the value of the test, therefore, this data is for reference only.

## 5.5. electrostatic protection

In the module application, due to human body static electricity, microelectronics between the charged friction and other static electricity, through a variety of ways to discharge to the module, may cause some damage to the module, so the ESD protection must pay attention to, whether it is in the production and assembly, testing, research and development process, especially in the design of the product should be taken to prevent ESD protection measures. Such as circuit design at the interface or vulnerable to ESD points to increase ESD protection, production with anti-ESD gloves and so on.

The following table shows the ESD withstand voltage of the module's key PIN pins.

Tables20 ESD Performance Parameters (Temperature: 25℃, Humidity: 45%)

| pin name | contact discharge | air discharge |
|---|---|---|
| **VBAT,GND** | ±5KV | ±10KV |
| **LTE_ANT** | ±5KV | ±10KV |
| **Others** | ±0.5KV | ±1KV |

# 6. Module Dimensions Fig.

This section describes the mechanical dimensions of the module and the recommended package dimensions for customer designs using the module. Tolerances are +-0.2mm.

## 6.1. Mechanical dimensions


Chart18 : Dimensional drawings in top and side view (in millimeters)

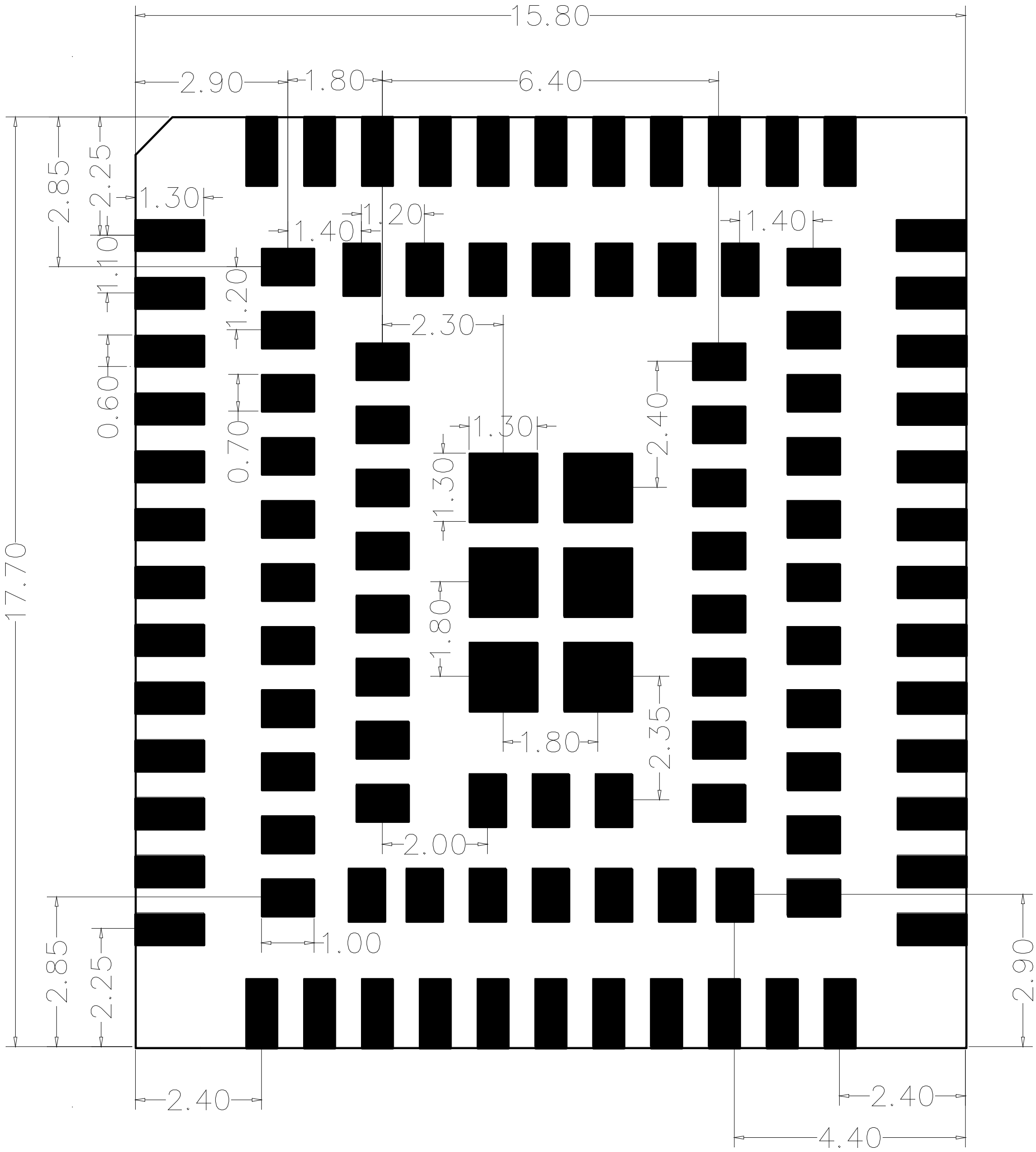



Chart19 : Diagram of bottom view dimensions (in millimeters)

## 6.2. Recommended PCB Packages

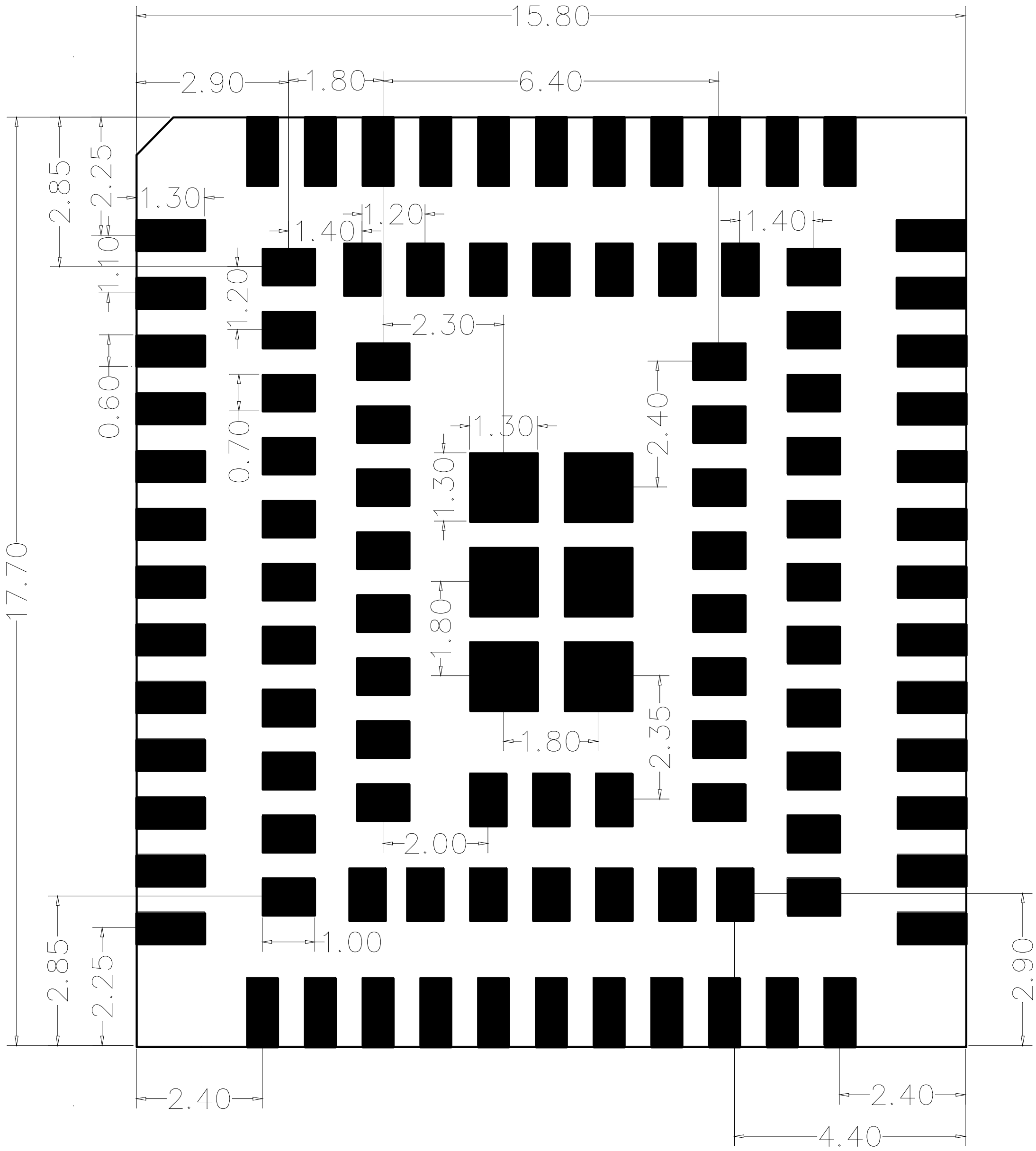



Chart20 : Front View, Air780E PCB Package (in millimeters)

Attention:

1. The spacing between modules and other components on the **PCB** is recommended to be at least **3mm;**
2. Please visit: https://www.openluat.com/ for a library of schematic PCB packages for the module.

# 7. Storage and production

## 7.1. stockpile

The Air780E is shipped in vacuum sealed bags. Storage of the modules is subject to the following conditions:

Modules can be stored in vacuum sealed bags for up to 12 months at ambient temperatures below 40 degrees Celsius and air humidity of less than 90%.

When the vacuum sealed bag is opened, the module can be directly reflowed or other high temperature processes if the following conditions are met:

- ♦ Module ambient temperature is less than 30 degrees Celsius, air humidity is less than 60%, and the factory completes the patch in less than 72 hours.
- ♦ Air humidity less than 10%

If the module is in the following conditions, it needs to be baked before placement:

- ♦ When the ambient temperature is 23 degrees Celsius (5 degrees Celsius fluctuation allowed), the humidity indicator card shows humidity greater than 10%.
- ♦ When the vacuum sealed bag is opened, the module ambient temperature is less than 30 degrees Celsius and the air humidity is less than 60%, but the factory fails to complete the patch in less than 72 hours
- ♦ Module storage air humidity greater than 10% when vacuum sealed bag is opened

If the modules need to be baked, bake them at 125 degrees Celsius (allowing for fluctuations of 5 degrees Celsius up or down) for 48 hours.

NOTE: The module packaging cannot withstand such high temperatures, remove module packaging before baking the module. If only a short baking time is required, please refer to **IPC/JEDECJ-STD-033** specification.

## 7.2. Production Welding

Printing squeegee on the stencil printing paste, so that the paste through the opening of the stencil leakage printed on the PCB, printing squeegee strength should be adjusted appropriately, in order to ensure the quality of the module printing paste, Air780E module pad part of the corresponding thickness of the stencil should be 0.2mm.

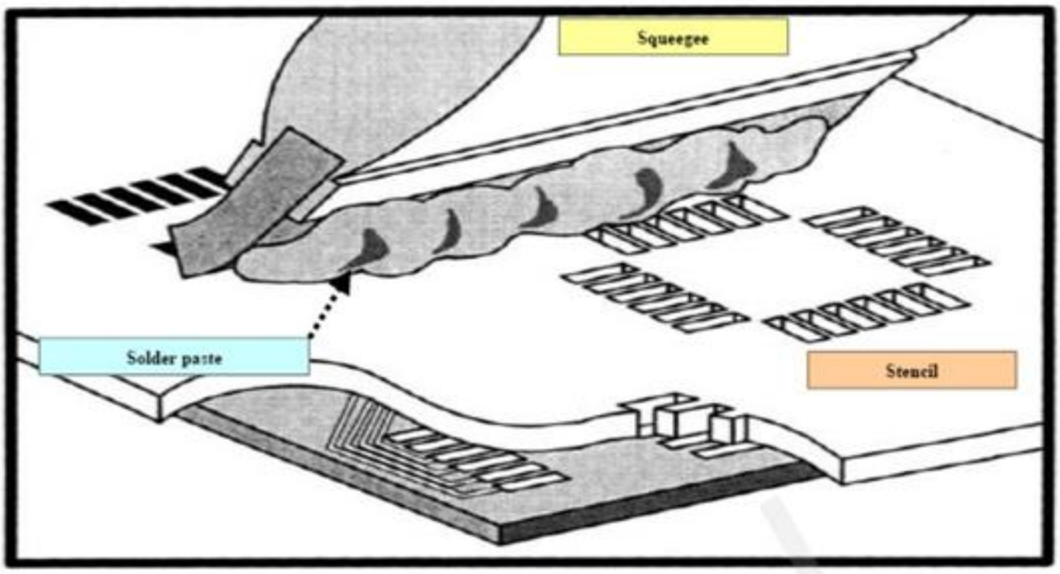



Chart21 : Printing Paste Chart

In order to avoid repeated heat damage to the module, it is recommended that customers reflow the first side of the PCB board before attaching the module. The recommended oven temperature profile is shown below:

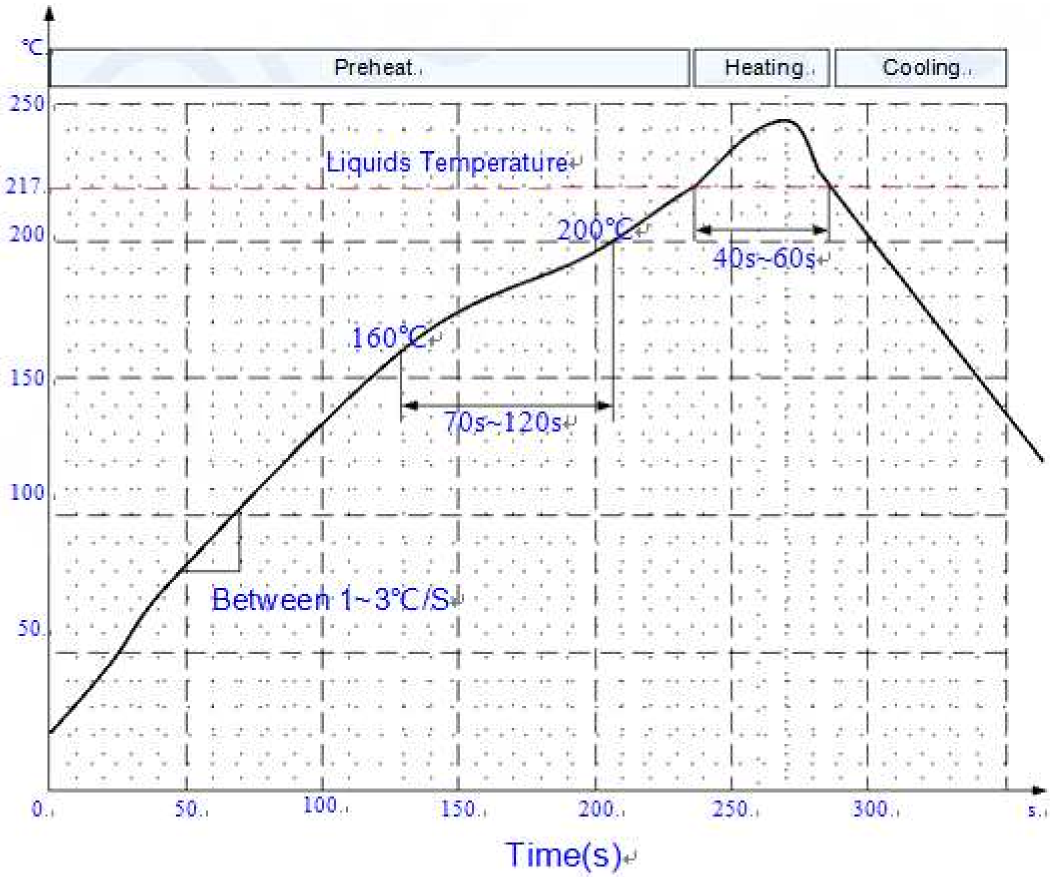



Chart22 Furnace Temperature Curve

# 8. Abbreviations

Tables21 : Terminology Abbreviations

| nomenclature | Full name in English | Full name in Chinese |
|---|---|---|
| **ADC** | Analog to Digital Converter | analog-to-digital converter |
| **bps** | Bits Per Second | bit/s |
| **CTS** | Clear to Send | Clear Send |
| **DFOTA** | Differential Firmware Over-the-Air | Wireless Differential Firmware Upgrade |
| **DTR** | Data Terminal Ready | Data Terminal Ready |
| **ESD** | Electro Static discharge | electrostatic discharge |
| **ESR** | Equivalent Series Resistance | equivalent series resistance |
| **EVB** | Evaluation Board | evaluation board |
| **FDD** | Frequency Division Duplex | frequency division duplexing |
| **FTP** | File Transfer Protocol | File Transfer Protocol |
| **FTPS** | FTP-over-SSL | Extended protocols for adding Transport Layer Security (TLS) and Secure Sockets Layer (SSL) encryption support to the popular File Transfer Protocol (FTP). |
| **GPIO** | General Purpose Input Output | General purpose input and output pins |
| **GPS** | Global Positioning System | global positioning system (GPS) |
| **HTTP** | Hypertext Transfer Protocol | hypertext transfer protocol (HTTP) |
| **HTTPS** | Hypertext Transfer Protocol over Secure Socket Layer | HTTP |
| **LCC** | Leadless Chip Carriers | Square package without pins |
| **LGA** | Land Grid Array | Raster Array Package |
| **LTE** | Long Term Evolution | Long-term evolution |
| **MQTT** | Message Queuing Telemetry Transport | Message Queue Telemetry Transport |
| **MSL** | Moisture Sensitivity Levels | Humidity sensitivity class |
| **NITZ** | Network Identity and Time Zone | Network identifiers and time zones |
| **NTP** | Network Time Protocol | network time protocol |
| **PA** | Power Amplifier | power amplifier |
| **PCB** | Printed Circuit Board | printed circuit board |

| | | |
|---|---|---|
| **PCM** | Pulse Code Modulation | pulse code modulation |
| **PDU** | Protocol Data Unit | Protocol Data Unit |
| **PMIC** | Power Management IC | Power Management ICs |
| **PPP** | Point-to-Point Protocol | P2P protocol |
| **RF** | Radio Frequency | a radio frequency |
| **RTS** | Require To Send | Request sent |
| **SMS** | Short Message Service | text messaging |
| **SSL** | Secure Sockets Layer | Secure Sockets Layer (SSL) (computing) |
| **TCP** | Transmission Control Protocol | transmission control protocol |
| **TDD** | Time Division Duplexing | time division duplex |
| **UART** | Universal Asynchronous Receiver & Transmitter | universal asynchronous transceiver |
| **UDP** | User Datagram Protocol | User Datagram Protocol |
| **UMTS** | Universal Mobile Telecommunications System | Universal Mobile Communications System (UMCS) |
| **USB** | Universal Serial Bus | Universal Serial Bus, USB (computer) |
| **(U)SIM** | (Universal) Subscriber Identity Module | （User identification module (generic) |
| **VSWR** | Voltage Standing Wave Ratio | VSWR |

## FCC Statement

This device complies with part 15 of the FCC rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user’ s authority to operate the equipment.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursua nt to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful inte rference in a residential installation. This equipment generates uses and can radiate radio frequency energy a nd, if not installed and used in accordance with the instructions, may cause harmful interference to radio com munications. 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 turn ing the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

- Consult the dealer or an experienced radio/TV technician for help important announcement Important Note:

## 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 and your body.

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter. Country Code selection feature to be disabled for products marketed to the US/Canada.

This device is intended only for OEM integrators under the following conditions:

- The antenna must be installed such that 20 cm is maintained between the antenna and users, and
- The transmitter module may not be co-located with any other transmitter or antenna,
- For all products market in US, OEM has to limit the operation channels in CH1 to CH11 for 2.4G band by supplied firmware programming tool. OEM shall not supply any tool or info to the end-user regarding to Regulatory Domain change. (if modular only test Channel 1-11)

As long as the three conditions above are met, further transmitter testing will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.

## Important Note:

In the event that these conditions cannot be met (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID cannot be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

## End Product Labeling

The final end product must be labeled in a visible area with the following"

Contains FCC ID: **2AEGG-AIR780E** "

## Manual Information to the End User

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module.

The end user manual shall include all required regulatory information/warning as show in this manual.

# Integration instructions for host product manufacturers according to

# KDB 996369 D03 OEM Manual v01r01

### 2.2 List of applicable FCC rules

CFR 47 FCC PART 22H/24E/27 has been investigated. It is applicable to the modular transmitter

### 2.3 Specific operational use conditions

This module is stand-alone modular. If the end product will involve the Multiple simultaneously transmitting condition or different operational conditions for a stand-alone modular transmitter in a host, host manufacturer have to consult with module manufacturer for the installation method in end system.

### 2.4 Limited module procedures

Not applicable

### 2.5 Trace antenna designs

Not applicable

### 2.6 RF exposure considerations

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.

### 2.7 Antennas

This radio transmitter **FCC ID:2AEGG- AIR780E** has been approved by Federal Communications Commission to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

| Antenna No. | Model No. of antenna: | Type of antenna: | Gain of the antenna (max.) | Frequency range: |
|---|---|---|---|---|
| LTE Antenna | / | PIFA Antenna | 2.21dBi (max.) For E-UTRA Band 2<br>2.09dBi (max.) For E-UTRA Band 4<br>0.78dBi (max.) For E-UTRA Band 5<br>0.61dBi (max.) For E-UTRA Band 12<br>0.56dBi (max.) For E-UTRA Band 13<br>2.09dBi (max.) For E-UTRA Band 66 | 1850-1910MHz<br>1710-1755MHz<br>824-849MHz<br>699-716MHz<br>777-787MHz<br>1710-1780MHz |

### 2.8 Label and compliance information

The final end product must be labeled in a visible area with the following" Contains **FCC ID:2AEGG-AIR780E**".

### 2.9 Information on test modes and additional testing requirements

Host manufacturer is strongly recommended to confirm compliance with FCC requirements for the transmitter when the module is installed in the host.

### 2.10 Additional testing, Part 22H/24E/27 disclaimer

Host manufacturer is responsible for compliance of the host system with module installed with all other applicable requirements for the system such as Part 22H/24E/27.

### 2.11 Note EMI Considerations

Host manufacture is recommended to use D04 Module Integration Guide recommending as "best practice" RF

design engineering testing and evaluation in case non-linear interactions generate additional non-compliant limits due to module placement to host components or properties.

### 2.12 How to make changes

This module is stand-alone modular. If the end product will involve the Multiple simultaneously transmitting condition or different operational conditions for a stand-alone modular transmitter in a host, host manufacturer have to consult with module manufacturer for the installation method in end system. According to the KDB 996369 D02 Q&A Q12, that a host manufacture only needs to do an evaluation (i.e., no C2PC required when no emission exceeds the limit of any individual device (including unintentional radiators) as a composite. The host manufacturer must fix any failure.