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BM78

Bluetooth® 4.2 Dual-Mode Module

Features

- Bluetooth Classic (BR/EDR) and Low Energy (LE)
- Certified to FCC, IC, MIC, KCC, and NCC radio regulations
- European R&TTE Directive Assessed Radio module
- Bluetooth SIG 4.2 qualified
- Transparent UART mode for seamless serial data over UART interface
- Easy to configure with User Interface (UI) tool, a Windows® configuration utility or directly by MCUs
- Firmware can be upgraded in the field over UART (Flash version)
- Integral chip antenna (BM78SPPS5MC2/NC2) or external antenna (BM78SPP05MC2/NC2)
- Integrated crystal, internal voltage regulator, and matching circuitry
- Configurable I/O pins for control and status
- Supports Apple® iPod Accessory Protocol (iAP2), (only BM78SPPx5MC2)
- Supports Bluetooth 4.2 LE secure connections
- Bluetooth 4.2 LE data packet length extension
- Small and compact surface mount module
- Castellated SMT pads for easy and reliable PCB mounting
- Ideal for portable battery operated devices
- One LED driver with 16 steps brightness control

RF/Analog

- Frequency: 2.402 GHz to 2.480 GHz
- Receive Sensitivity: -90 dBm (BR/EDR), -92 dBm (LE)
- Class 2 output power (+1.5 dBm typical)

Data Throughput

Data Throughput at 1 Mbps UART baud rate:

- BR/EDR: up to 32 Kbps
- LE: up to 7 Kbps

Data Throughput at 115200 bps UART baud rate

- BR/EDR: upto 10 Kbps
- LE: up to 6 Kbps

MAC/Baseband/Higher Layer

- Secure AES128 encryption
- Bluetooth 3.0: GAP, SPP, SDP, RFCOMM, and L2CAP
- Bluetooth 4.2: GAP, GATT, ATT, SMP, and L2CAP

Operating Conditions

- Operating voltage range: 3.3V to 4.2V
- Operating temperature: -20ºC to +70ºC

Applications

- Internet of Things (IoT)
- Secure Payment
- Home and Security
- Health and Fitness
- Industrial and Data Logger
- LED Lighting (16 configurations)

General Description

The BM78 module is a fully-certified, Bluetooth version 4.2 module for customers to easily add dual-mode Bluetooth wireless capability to their products. The BM78 is built around Microchip's IS1678 Bluetooth dual-mode module, and it is available in ROM-based (BM78SPPx5NC2) and Flash-based (BM78SPPx-5MC2) versions. Refer to **Section 9.0 "Ordering Information"** for additional information on the BM78 SKUs.

The BM78 bridges the customer products to smart phones or tablets for convenient data transfer, control, and access to cloud applications delivering local connectivity for IoT. The BM78 supports GAP, SDP, SPP, and GATT profiles. Data transfer is achieved through the Bluetooth link by sending or receiving data through transparent UART mode, making it easy to integrate with any microprocessor or Microcontroller (MCU) with a UART interface. It also enables a easy configuration by using a UI tool, a Windows configuration utility, or directly through UART by MCUs.

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NOTES:

1.0 SYSTEM OVERVIEW

The BM78 module is a fully certified, embedded 2.4 GHz Bluetooth version 4.2 (BR/EDR/LE) wireless module. It includes an on board Bluetooth stack, a power management subsystem, a 2.4 GHz transceiver, and an RF power amplifier. Customers can embed Bluetooth functionality into any applications using the BM78.

The BM78 enables rapid product development and faster time to market, and it is designed to provide integrators with the following features:

- Simple integration and programming
- Reduced development time
- Superior wireless module with low-cost system
- Interoperability with Bluetooth host
- Wide range of applications

The BM78 has four Stock Keeping Units (SKUs). For additional information on SKUs, refer to **Section 9.0 "Ordering Information"**. The BM78SPPS5MC2/NC2 is a complete and fully regulatory certified module with an integral ceramic chip antenna and RF shield. The BM78SPP05MC2/NC2 is a low-cost alternative with RF out PAD (for external antenna) and no RF shield. The integrator is responsible for the antenna, antenna matching, and regulatory certifications.

The BM78 is a small, compact, and surface mounted module with castellated pads for easy and reliable host PCB mounting. It is compatible with standard pick-and-place equipment and can independently maintain a low-power wireless connection. Low power usage and flexible power management maximize the lifetime of the BM78 in battery-operated devices. A wide operating temperature range enables its applications in indoor and outdoor environments. Figure 1-1 illustrates the internal block diagram of the BM78.

FIGURE 1-1: INTERNAL BLOCK DIAGRAM OF BM78

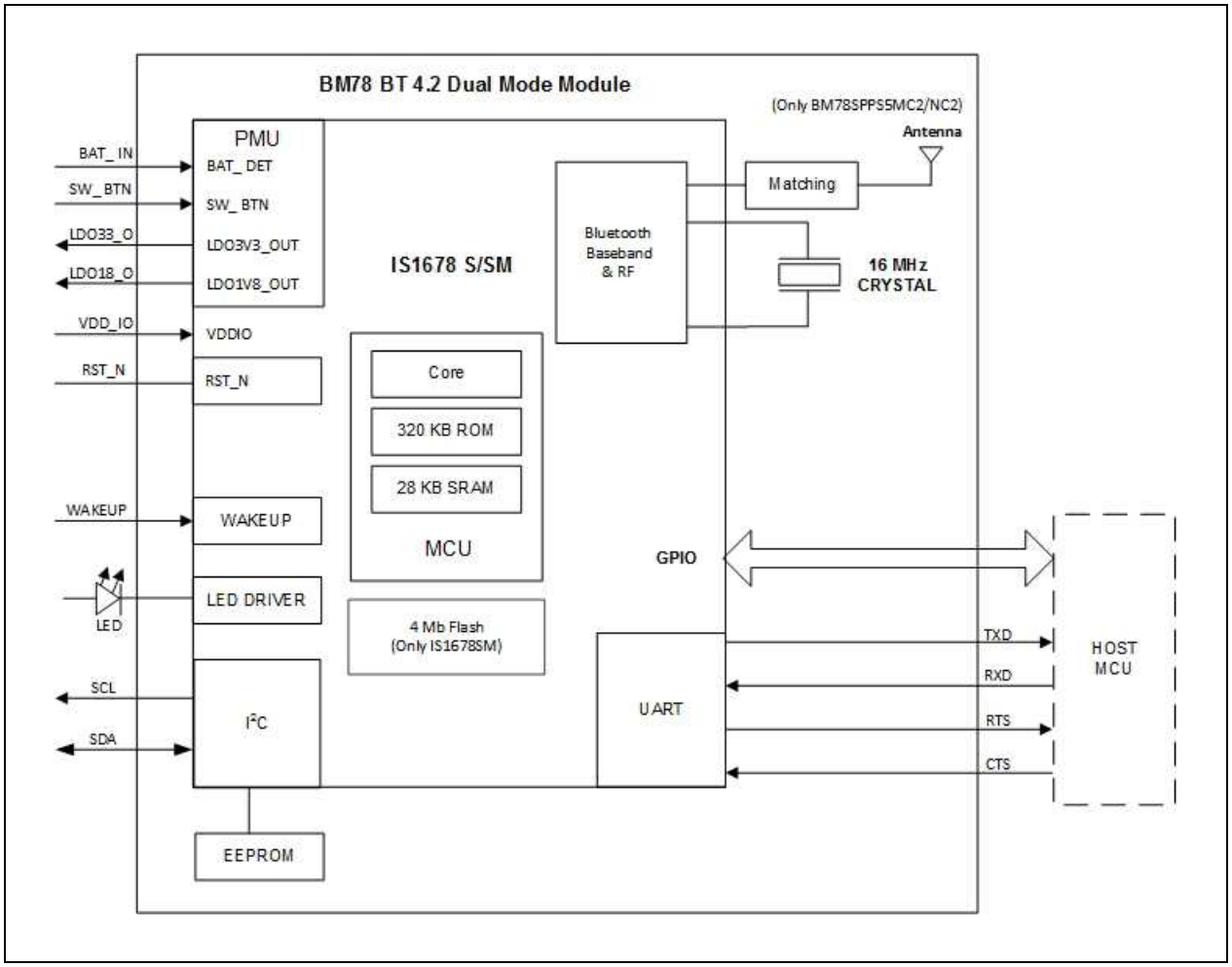


Table 1-1 provides various pins of the BM78SPPx5MC2/NC2 module.

TABLE 1-1: PIN DESCRIPTION

S5 Pin	05 Pin	Symbol	Type	Description
1	—	GND	Power	Ground reference
2	—	GND	Power	Ground reference
3	1	GND	Power	Ground reference
4	2	BAT_IN	Power	Battery Input (3.3V to 4.2V) Main positive supply input Connect to 10 uF (X5R/X7R) capacitor
5	3	SW_BTN	DI	Software Button H: Power On L: Power Off
6	4	LDO33_O	Power	Internal 3.3V LDO output, can source no more than 50 mA
7	5	VDD_IO	Power	I/O positive supply input. Internal use only, do not connect to other devices
8	6	LDO18_O	Power	Internal 1.8V LDO output. Internal use only, do not connect to other devices
9	7	WAKEUP	DI	Wakeup from Sleep mode (active- low) (internal pull-up)
10	8	PMULDO_O	Power	Power management unit output. Internal use only, do not connect to other devices
11	9	P0_4	DO	Status Indication pin along with P1_5, refer to Table 2-3
12	10	P1_5	DO	Status Indication pin along with P0_4, refer to Table 2-3
13	11	P1_2/SCL	DO	I^2C SCL
14	12	P1_3/SDA	DIO	I^2C SDA
15	13	P1_7/CTS	DIO	Configurable Control or Indication pin or UART CTS (input)
16	14	P0_5	DIO	Configurable Control or Indication pin
17	15	P0_0/RTS	DIO	Configurable Control or Indication pin or UART RTS (output)
18	16	P2_0	DI	System configuration pin along with P2_4 and EAN pins, used to set the BM78 in any one of the following three modes: Application mode (for normal operation), Test mode (to change EEPROM values), and Write Flash mode (to enter the new firmware into the module), refer to Table 2-1
19	17	P2_4	DI	System configuration pin along with P2_0 and EAN pins, used to set the module in any one of the following three modes: Application mode (for normal operation), Test mode (to change EEPROM values), and Write Flash mode (to enter new firmware into the module), refer to Table 2-1

Legend: A = Analog D = Digital I = Input O = Output

TABLE 1-1: PIN DESCRIPTION (CONTINUED)

S5 Pin	05 Pin	Symbol	Type	Description
20	18	EAN	DI	External address-bus negative System configuration pin along with P2_0 and P2_4 pins, used to set the module in any of the three modes: Application mode (for normal operation), Test mode (to change EEPROM values), and Write Flash mode (to enter new firmware into the module), refer to Table 2-1 ROM: Must be pulled high to VDD_IO FLASH: Must be pulled down with 4.7Kohm to GND
21	19	RST_N	DI	Module Reset (active-low) (internal pull up) Apply a pulse of at least 63 ns
22	20	RXD	DI	UART data input
23	21	TXD	DO	UART data output
24	22	P3_1	DIO	Configurable Control or Indication pin (Internally pulled-up, if configured as an input)
25	23	P3_2	DIO	Configurable Control or Indication pin (Internally pulled-up, if configured as an input)
26	24	P3_3	DIO	Configurable Control or Indication pin (Internally pulled-up, if configured as an input)
27	25	P3_4	DIO	Configurable Control or Indication pin (Internally pulled-up, if configured as an input)
28	26	P3_6	DIO	Do not connect
29	27	P3_7	DIO	Configurable Control or Indication pin (Internally pulled-up, if configured as an input)
30	28	LED1	DO	Status LED, connect to LDO33_0
31	29	GND	Power	Ground reference
—	30	BT_RF	AIO	External antenna connection(50 ohms)
32	—	GND	Power	Ground reference

Legend: A = Analog D = Digital I = Input O = Output

Figure 1-2 and Figure 1-3 illustrate the pin diagrams of the BM78SPPS5MC2/NC2 and BM78SPP05MC2/NC2 modules.

FIGURE 1-2: BM78SPPS5MC2/NC2 PIN DIAGRAM

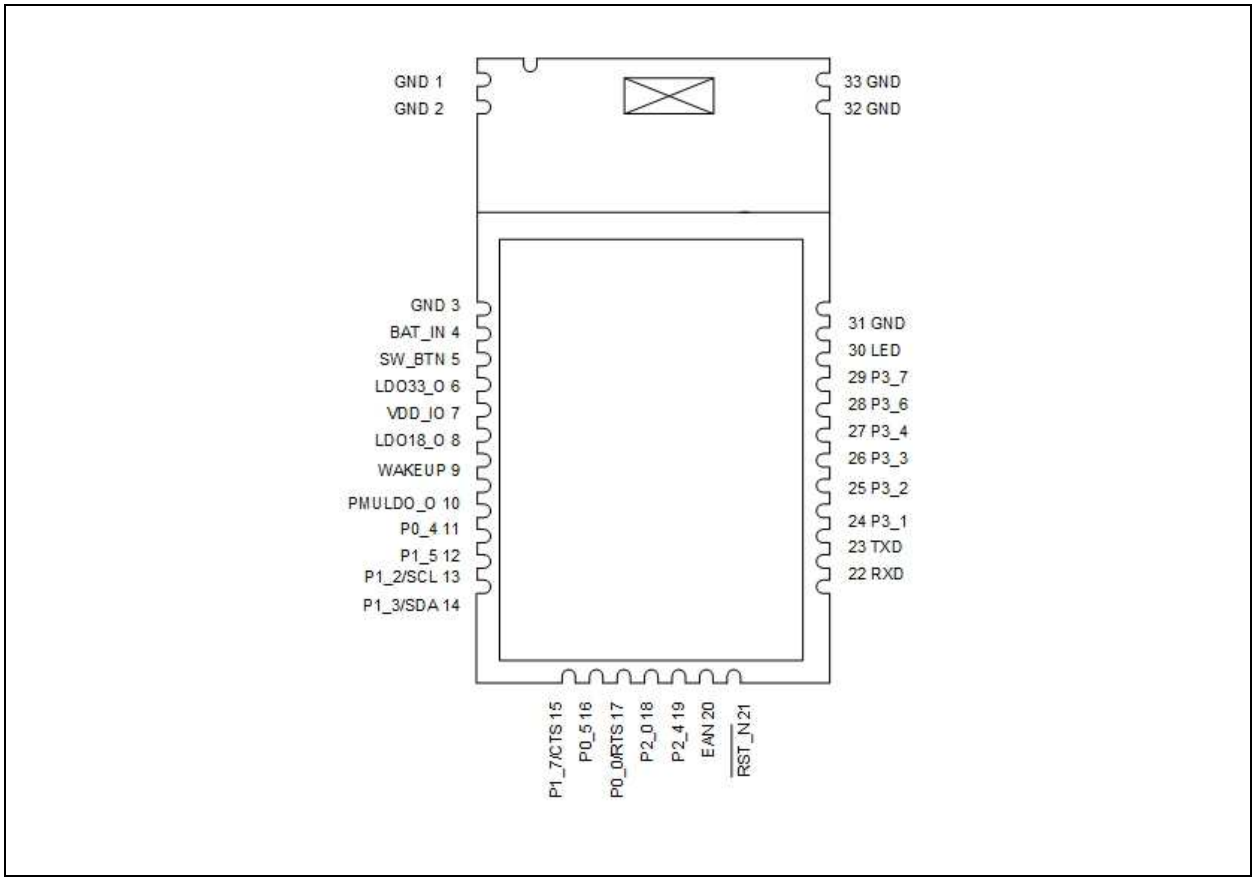
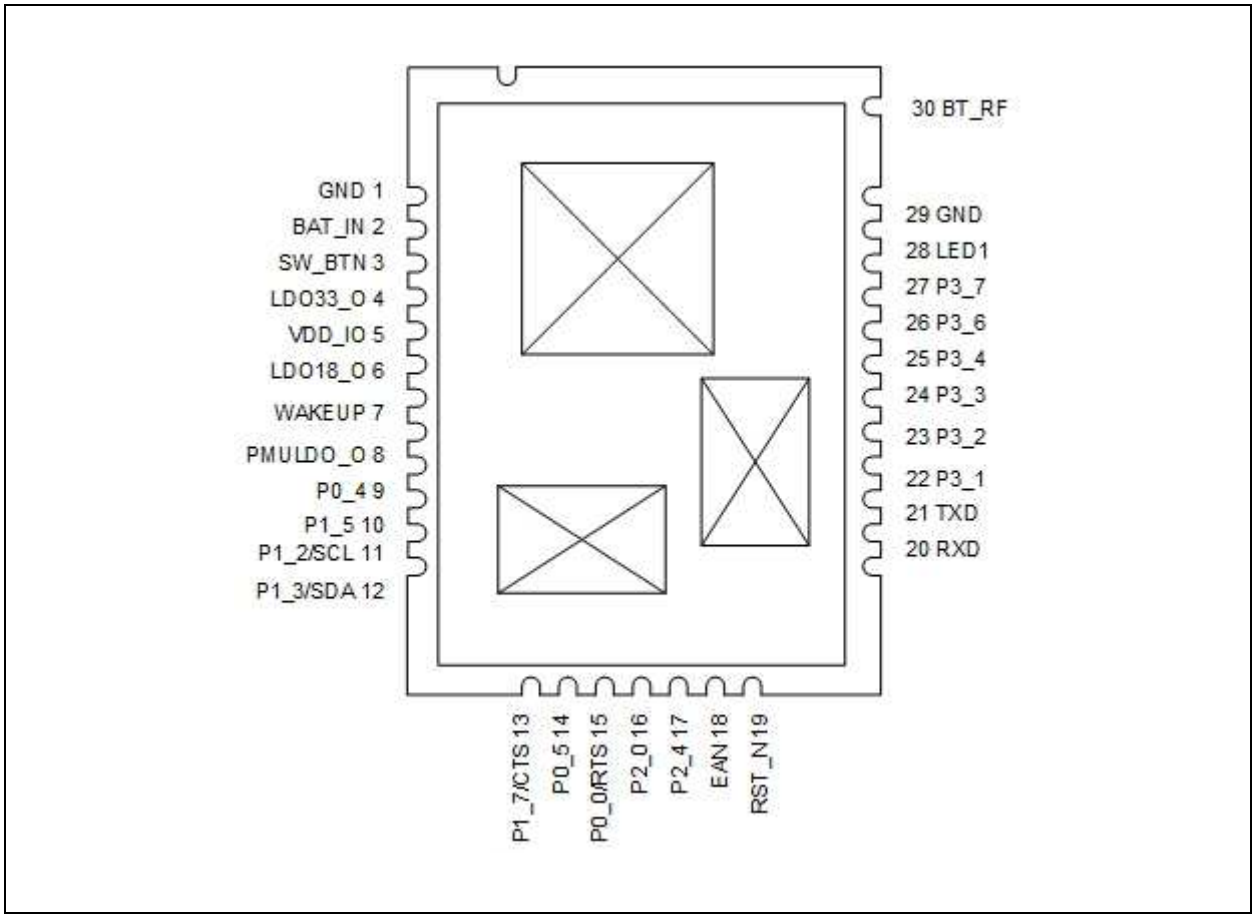


FIGURE 1-3: BM78SPP05MC2/NC2 PIN DIAGRAM



NOTES:

2.0 APPLICATION INFORMATION

2.1 System Configuration

The I/O pins, P2_0, P2_4 and EAN, place the BM78 into operating mode and each of these pins have internal pull up and allow configuration settings and firmware to be updated from UART. Table 2-1 provides system configuration details.

TABLE 2-1: SYSTEM CONFIGURATION SETTINGS

Module	P2_0	P2_4	EAN	Operational Mode
BM78SPPx5NC2 (ROM Variant)	Low	High	High	Write EEPROM and test mode
	High	High	High	Normal operation/application mode
BM78SPPx5MC2 (Flash Variant)	Low	Low	High	Write FLASH
	Low	High	Low	Write EEPROM and test mode
	High	High	Low	Normal operational/application mode

2.2 Control and Indication I/O Pins

The I/O pins, P0_0, P0_5, P1_7, P3_1, P3_2, P3_3, P3_4, and P3_7, are configurable control and indication pins. The control signals are inputs to the BM78 and the indication signals are outputs from the BM78. Table 2-2 provides default I/O pin configuration details.

TABLE 2-2: CONTROL AND INDICATION I/O PIN ASSIGNMENTS

PINS	N/C	UART_RTS(1,2)	UART_CTS(1,2)	LOW_BATTERY_IND	RSSI_IND	GET WIFI INFO KEY	LINK_DROP_CONTROL (DISCONNECT)	UART_RX_IND	PAIRING_KEY	INQUIRY CONTROL	PROFILE_IND
P0_0		■									
P0_5	■										
P1_7			■								
P3_1										■	
P3_2							■				
P3_3								■			
P3_4									■		
P3_7				■							

Note 1: The RTS pin can only be assigned to P0_0 and the CTS pin can only be assigned to P1_7.

2: The RTS and CTS pins can be configured as GPIOs if flow control is disabled.

2.3 Status Indication I/O Pins

The I/O pins, P1_5 and P0_4, are status indicator pins: Status_IND_1 and status_IND_2. Together these pins provide status indication to MCUs. Table 2-3 provides status indication of the P1_5 and P0_4 pins.

TABLE 2-3: STATUS INDICATION

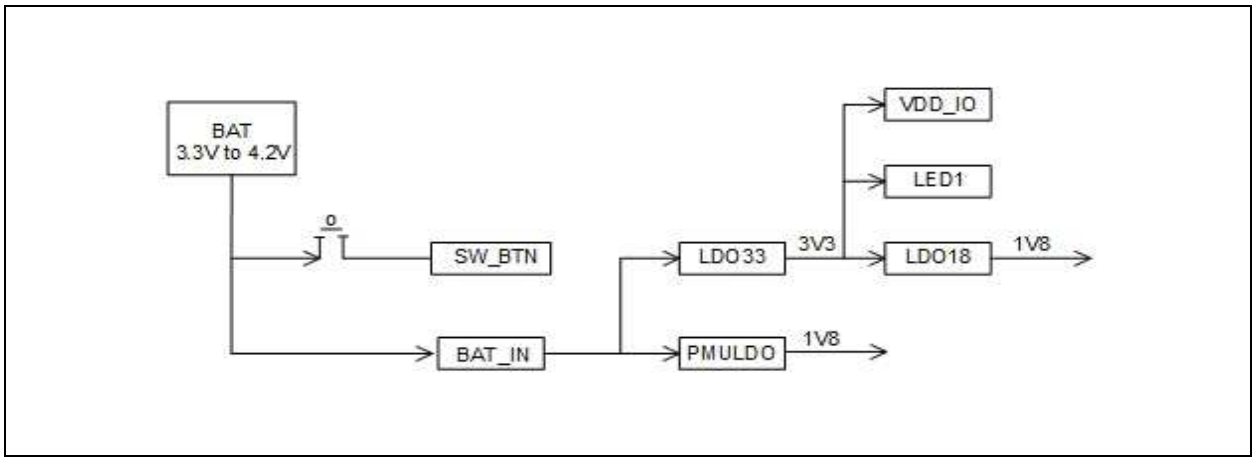
P1_5/STATUS_IND_1	P0_4/STATUS_IND_2	Indication
H	H	Power-on (default setting) and deep-sleep state. HH status should be stable for at least 500 ms.
H	L	Access state
L	H	Link state (UART data transmitting)
L	L	Link state (no UART data transmitted)

Legend: L = Low H = High

2.4 Power Tree

Figure 2-1 illustrates the power tree diagram of the BM78.

FIGURE 2-1: POWER TREE DIAGRAM

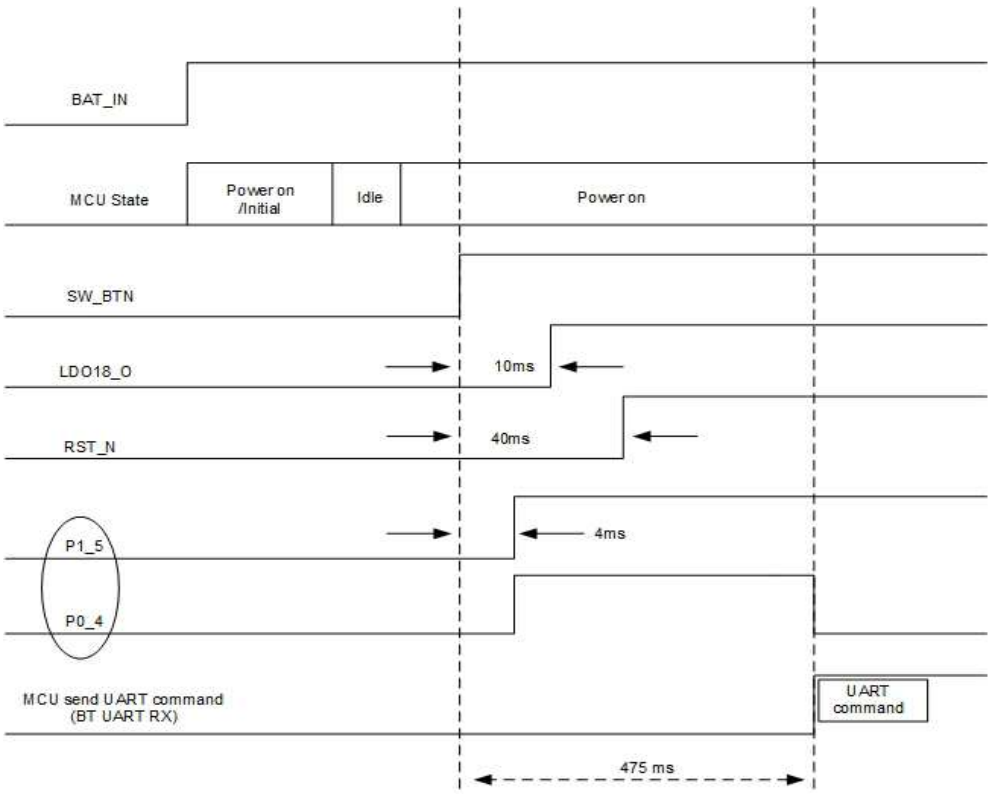


2.5 Software Button (SW_BTN)

The Software Button (SW_BTN) input pin powers the BM78 ON (high) or OFF (low) into the S4 mode. The S4 mode is the Deep-sleep mode and the S2 mode is the Sleep mode. The S4 mode can only be triggered by the SW_BTN pin, and the power consumption is lower in the S4 mode.

Figure 2-2 through Figure 2-4 display the waveforms for the BM78 in the high and low status, that is access and link status.

FIGURE 2-2: SW_BTN TIME (HIGH) AT APP MODE(1,2,3,4,5)



Note 1: MCU can send UART command, refer to Table 2-3.

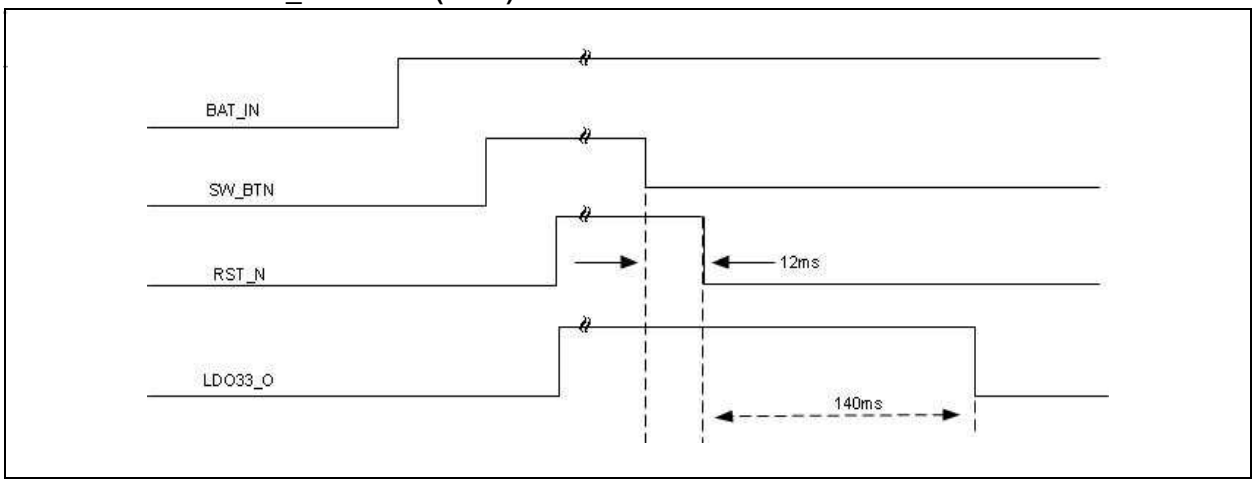
2: Time duration (475 ms) is for reference purpose only, check the status pin.

3: Reset is 'no connect'.

4: Time is configured as default setting.

5: Data corresponds to the BM78SPPx5NC2 (ROM variant) module.

FIGURE 2-3: SW_BTN TIME (LOW) AT ACCESS STATES(1,2,3)

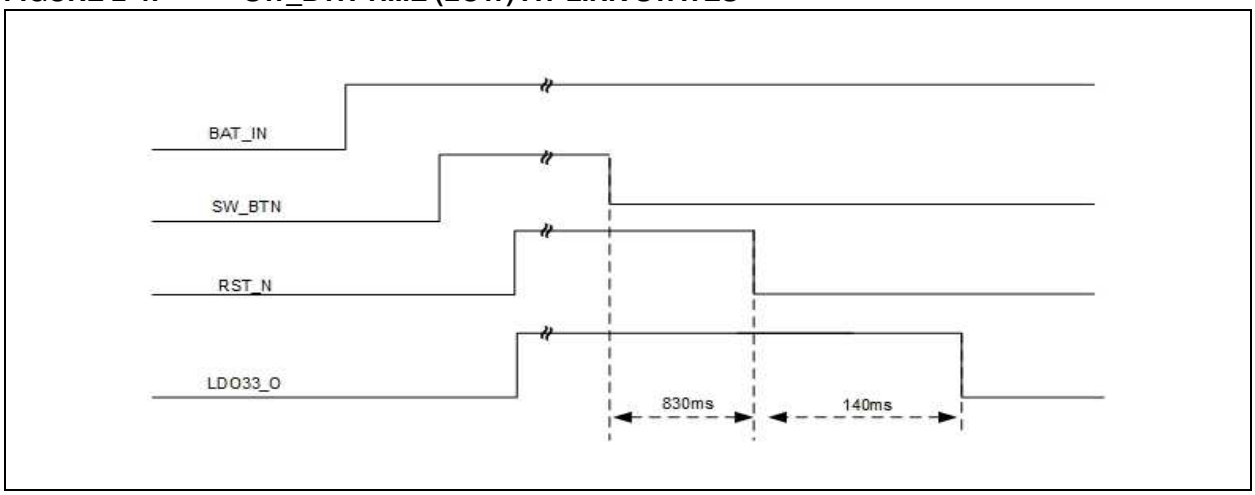


Note 1: Reset is 'no connect'.

2: Time is configured as default setting.

3: Data corresponds to the BM78SPPx5NC2 (ROM variant) module.

FIGURE 2-4: SW_BTN TIME (LOW) AT LINK STATES(1,2,3)



Note 1: 830 ms time duration is a typical value measured on iPhone 6 and this time duration can vary from one smart phone to another.

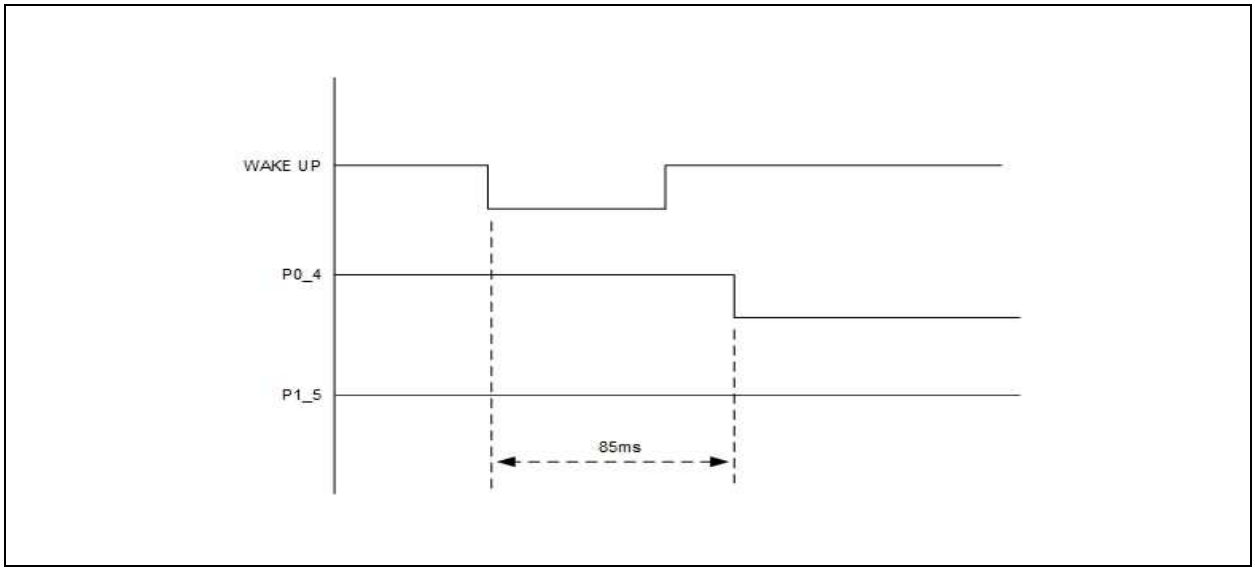
2: Reset is 'no connect'.

3: Time is configured as default setting.

2.6 WAKE UP

The WAKE UP input pin wakes the BM78 from Sleep mode (active-low) and wake up is always from Sleep mode (S2) to Standby mode. Figure 2-5 illustrates the timing diagram of the BM78 in the Wake Up mode.

FIGURE 2-5: WAKEUP TIME(1,2)



Note 1: 85 ms is for reference time and the user should check the status pin.

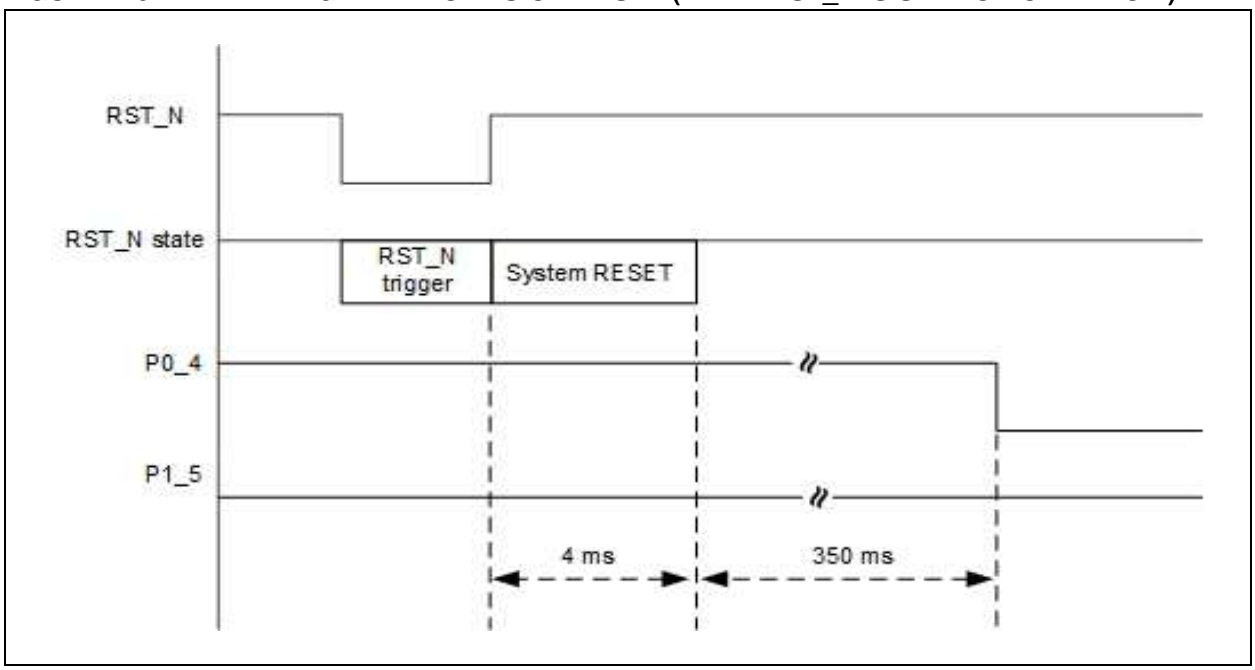
2: Refer to Table 2-3 for the status of the P0_4/P1_5 pin.

2.7 External Reset

The watchdog timer (WDT) can Reset the BM78 which has an integrated Power-on Reset (POR) circuit that reset all circuits to a known Power-on state. This action can also be driven by an external Reset signal that can be used to externally control the device, forcing it into a Power-on Reset state. The Reset signal input is active-low and connection is not required in most of the applications.

Figure 2-6 illustrates the timing diagram of the BM78 when it is in the Reset (RST_N is set to active low) state.

FIGURE 2-6: TIMING WAVEFORMS ON RESET (WHEN RST_N IS SET TO ACTIVE LOW)(1,2,3,4)



Note 1: Auto Pattern can use external Reset, refer to **Section 3.0 "Operating Pattern"**.

2: The RST_N state trigger must be greater than 63 ns.

3: Manual pattern can use external Reset and Reset command, refer to **Section 3.0 "Operating Pattern"**.

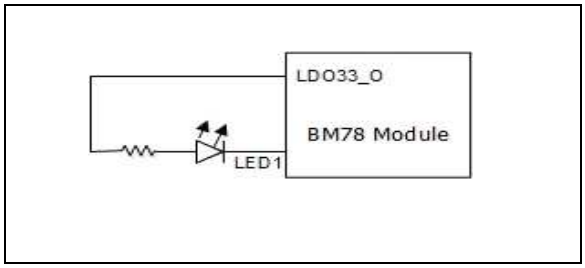
4: Time duration (350 ms) is for reference purpose only, check the status pin.

2.8 LED Driver

The BM78 has a dedicated LED driver and the LED (LED1) can be connected directly with the BM78 using this driver, see Figure 2-7.

The maximum current sourcing for the LED is 5 mA and it provides 16 options (steps) to trim the brightness. The LED brightness can be configured using the User Interface (UI) tool, a Windows® configuration utility.

FIGURE 2-7: LED DRIVER



The following are status indication of the LED and each indication is a configurable flashing sequence:

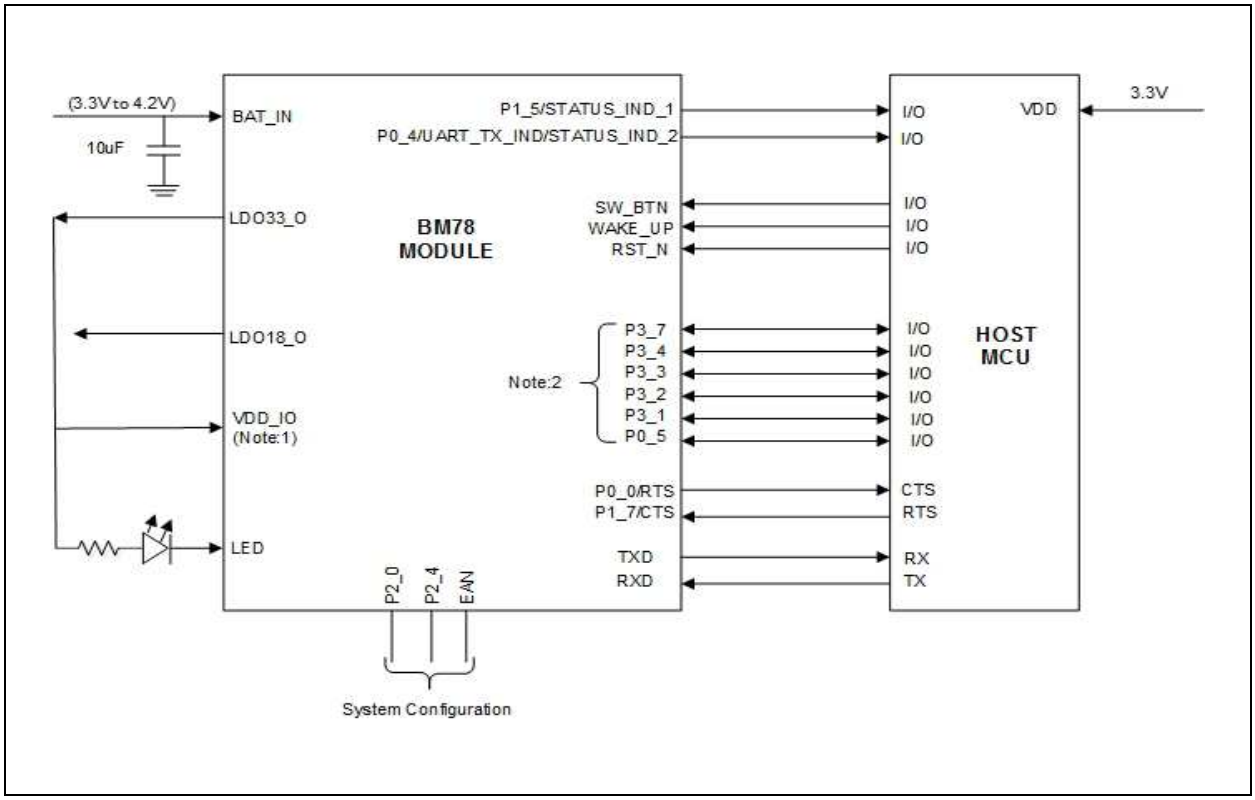
- Standby
- Link Back
- Low Battery
- Inquiry
- Link

2.9 Host MCU Interface over UART

Figure 2-8 illustrates an example of UART interface with host MCU and power scheme using 3.3V to the VDD. Battery power is applied to the BAT_IN pin. From the LDO33_O pin, voltage can be routed to the VDD_IO pin and external circuitry including the MCU. This power scheme ensures that the BM78 and MCU I/O voltages are compatible.

Note:	The internal 3.3V LDO current source should not exceed 50 mA (i.e maximum).

FIGURE 2-8: POWER AND MCU INTERFACE EXAMPLE FOR BM78



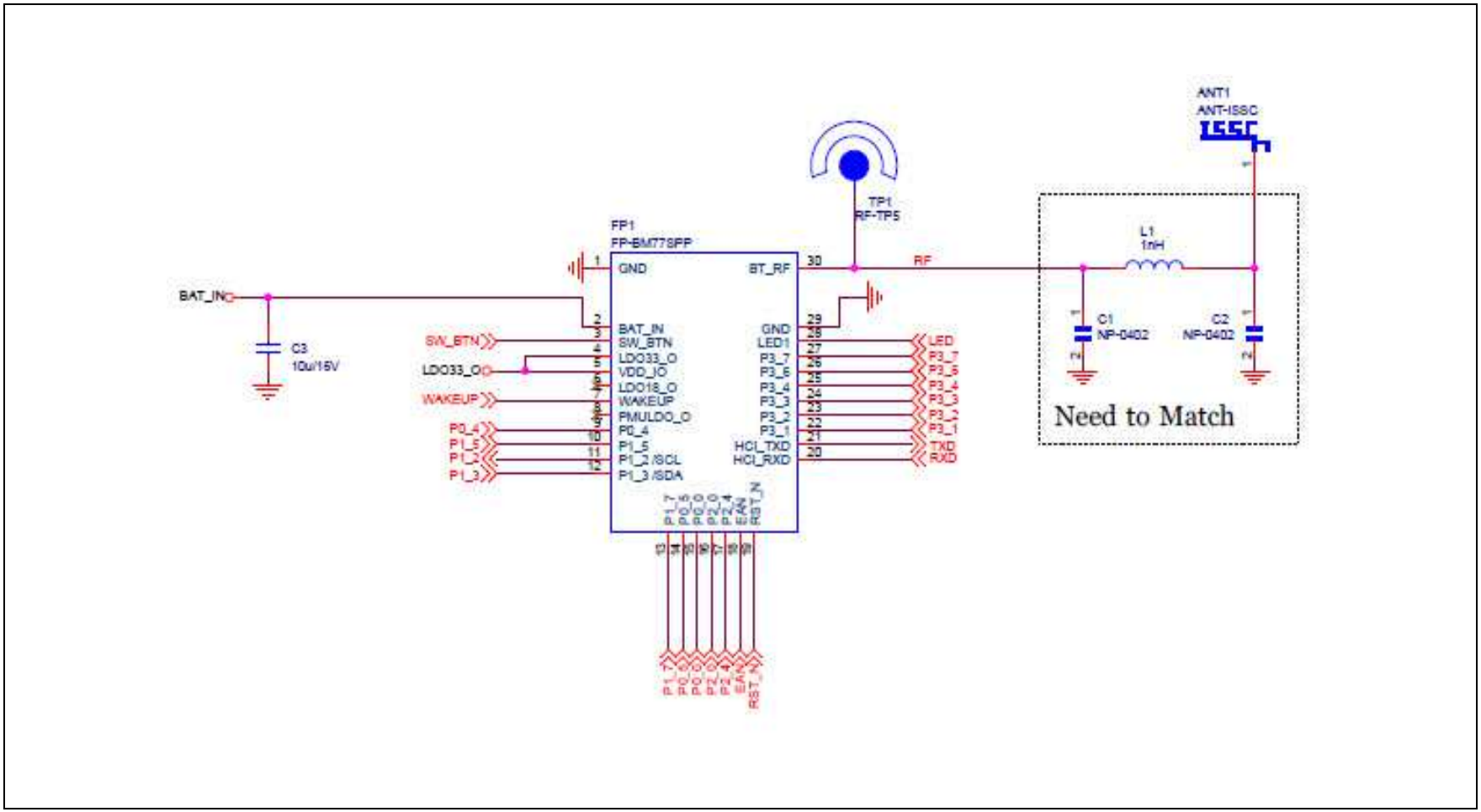
Note 1: Ensure that VDD_IO and MCU VDD voltages are compatible.

2: The control and indication ports are configurable

2.10 Reference Circuit

Figure 2-9 through Figure 2-12 illustrate the reference schematic of the power supply design implemented for the BM78.

FIGURE 2-9: BM78SPP05MC2/NC2 REFERENCE CIRCUIT



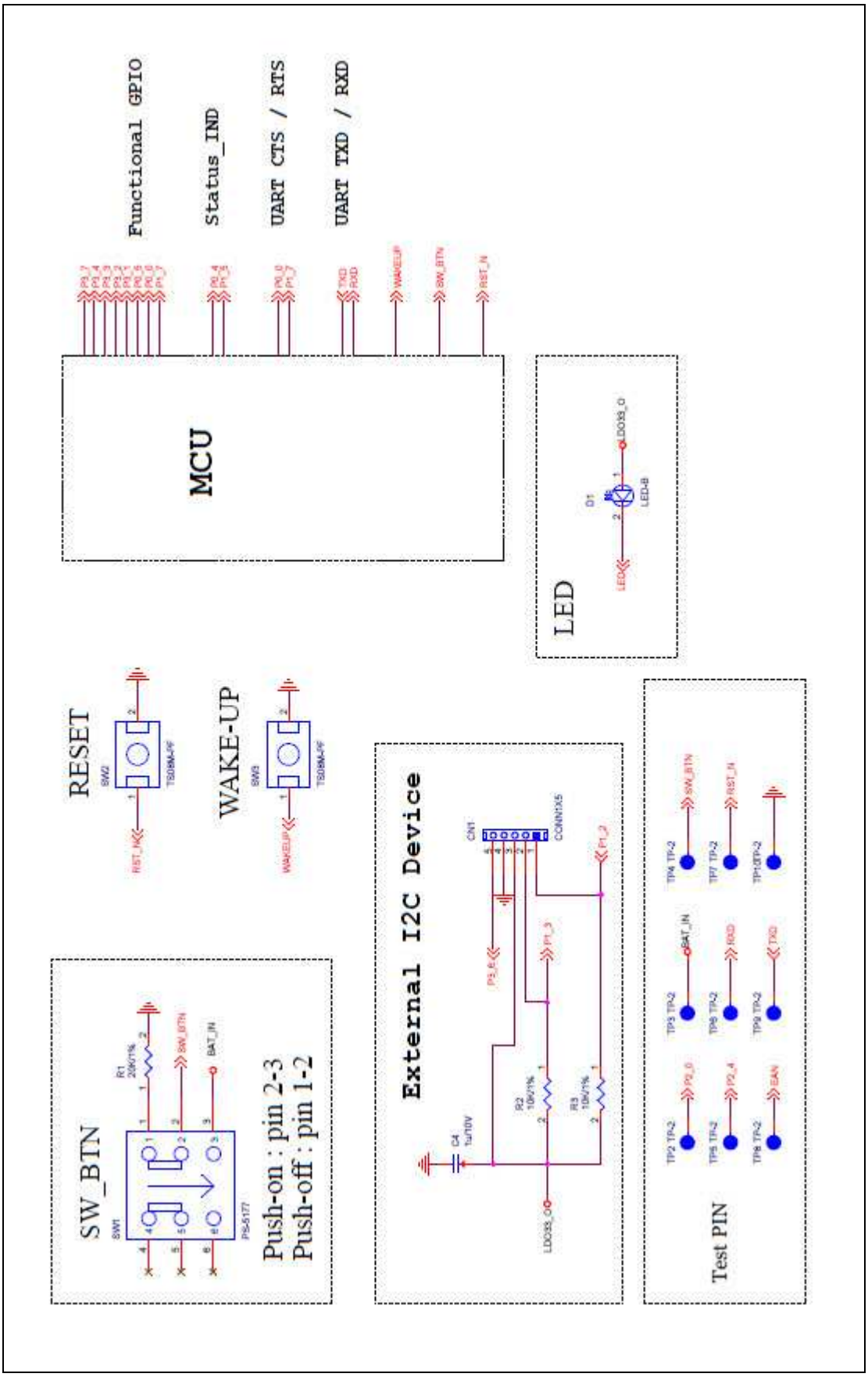


FIGURE 2-10: BM78SPP05MC2/NC2 REFERENCE CIRCUIT

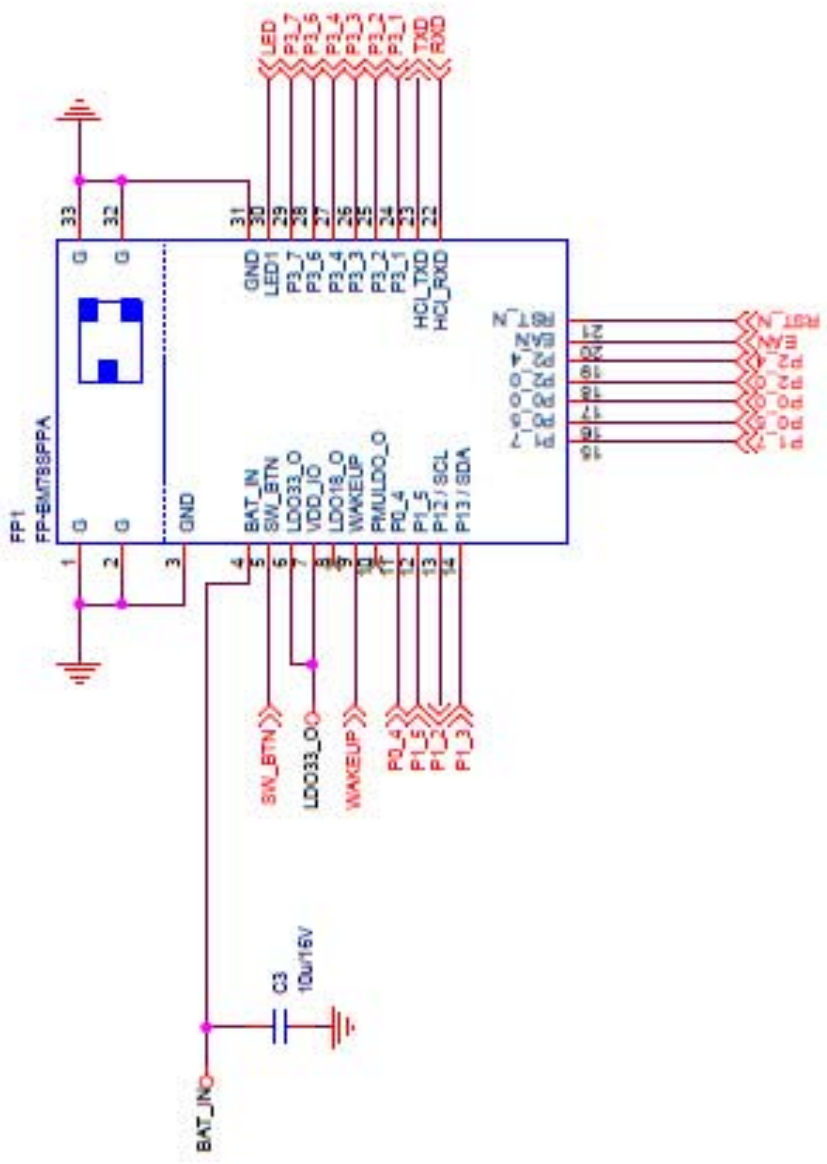


FIGURE 2-11: BM78SPPS5MC2/NC2 REFERENCE CIRCUIT

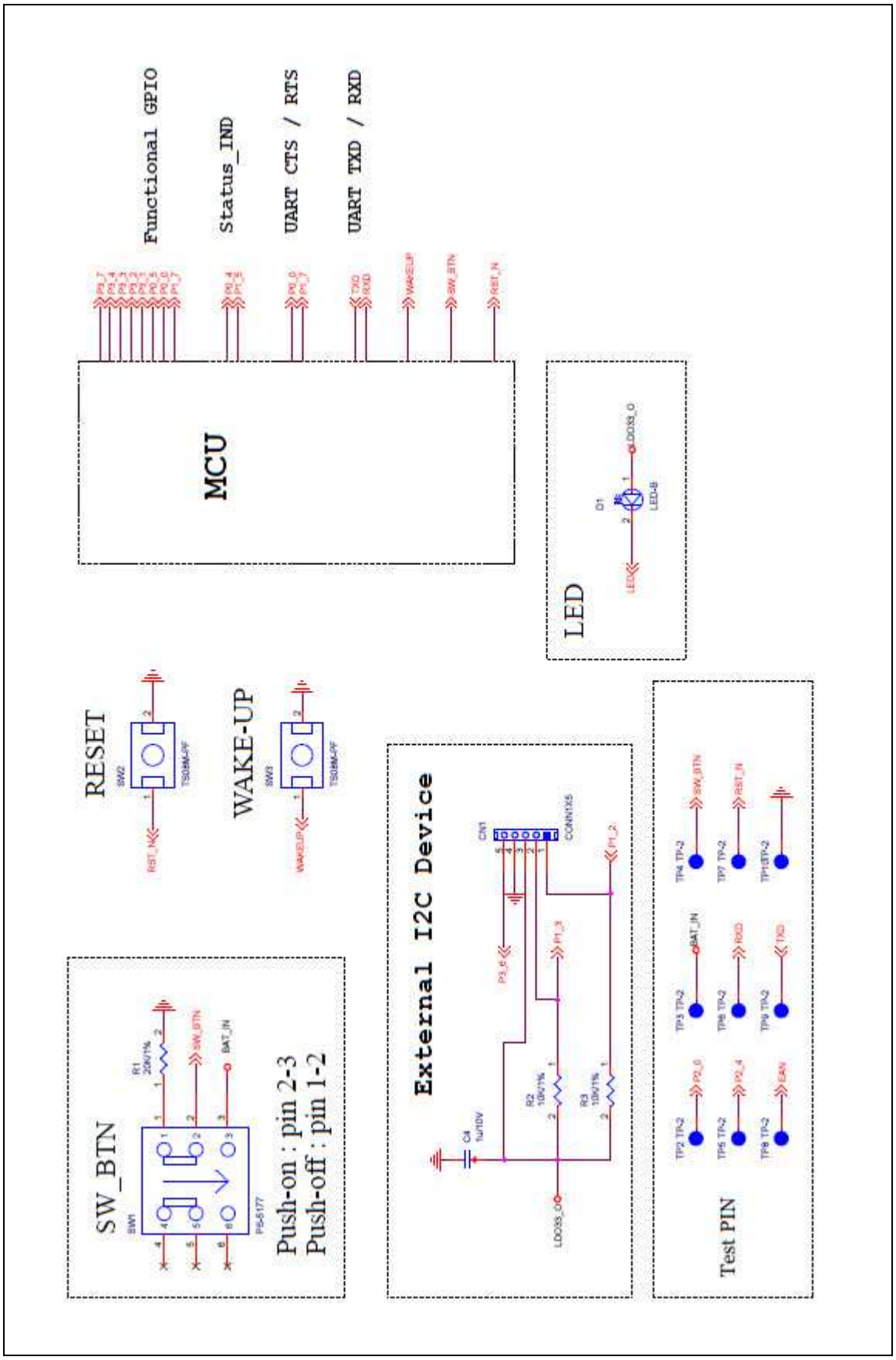


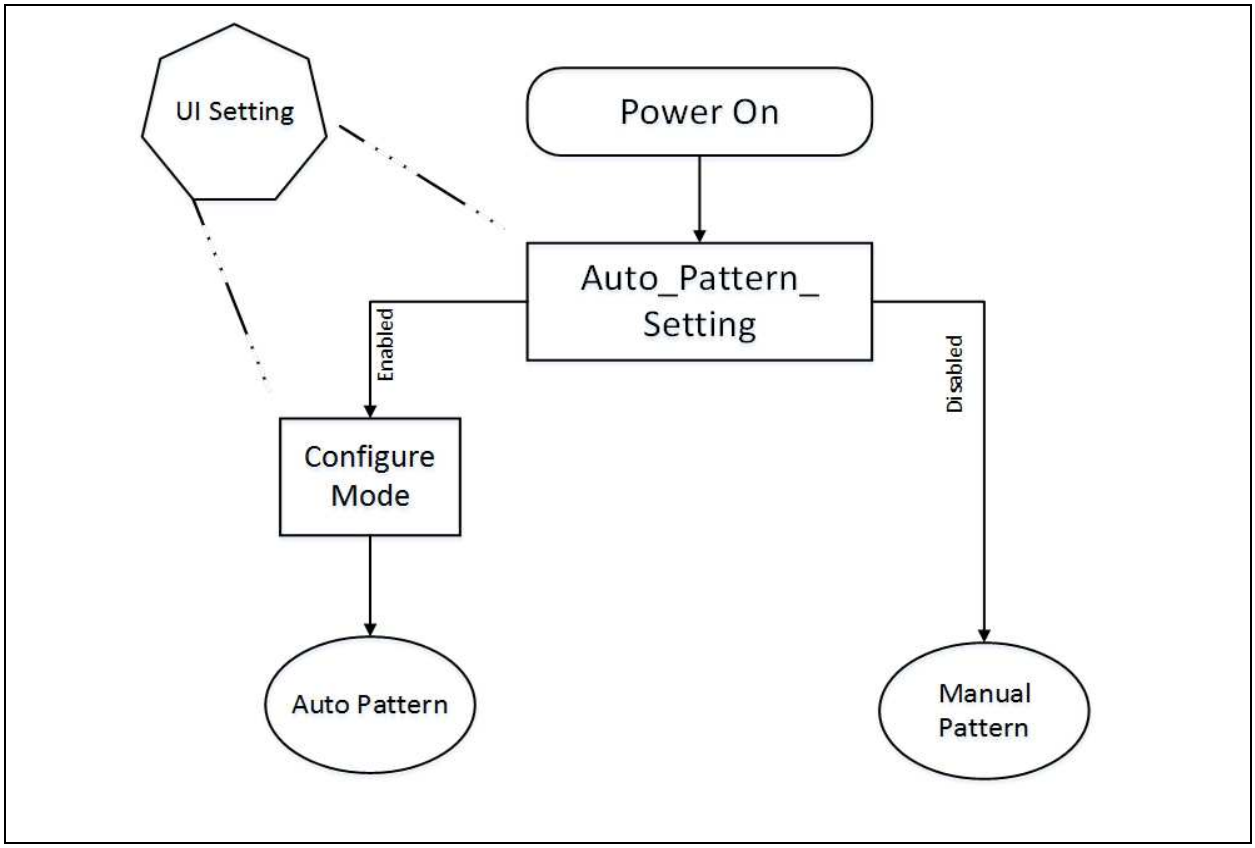
FIGURE 2-12: BM78SPPS5MC2/NC2 REFERENCE CIRCUIT

3.0 OPERATING PATTERN

The BM78 provides two operating patterns, Auto Pattern and Manual Pattern, and the operating modes can be configured through the UI tool or the host MCU. See Figure 3-1.

If the Auto_Pattern_Setting parameter is enabled, the BM78 triggers the Auto Pattern state machine otherwise Manual Pattern is used. Configure mode is available only in Auto Pattern and it can be enabled or disabled by the UI settings or host MCU.

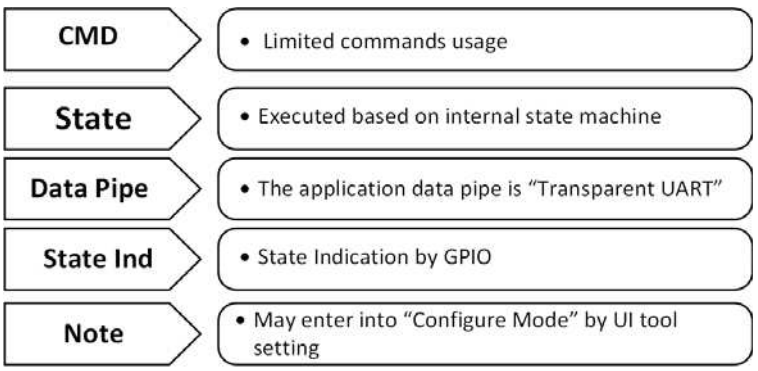
FIGURE 3-1: OPERATING PATTERN CONFIGURATION



3.1 Auto Pattern

In Auto Pattern, the BM78 automatically operates after power on without any interference from the MCU. Auto Pattern is the basic application of the BM78. Figure 3-2 illustrates the characteristics of Auto Pattern.

FIGURE 3-2: AUTO PATTERN CHARACTERISTIC



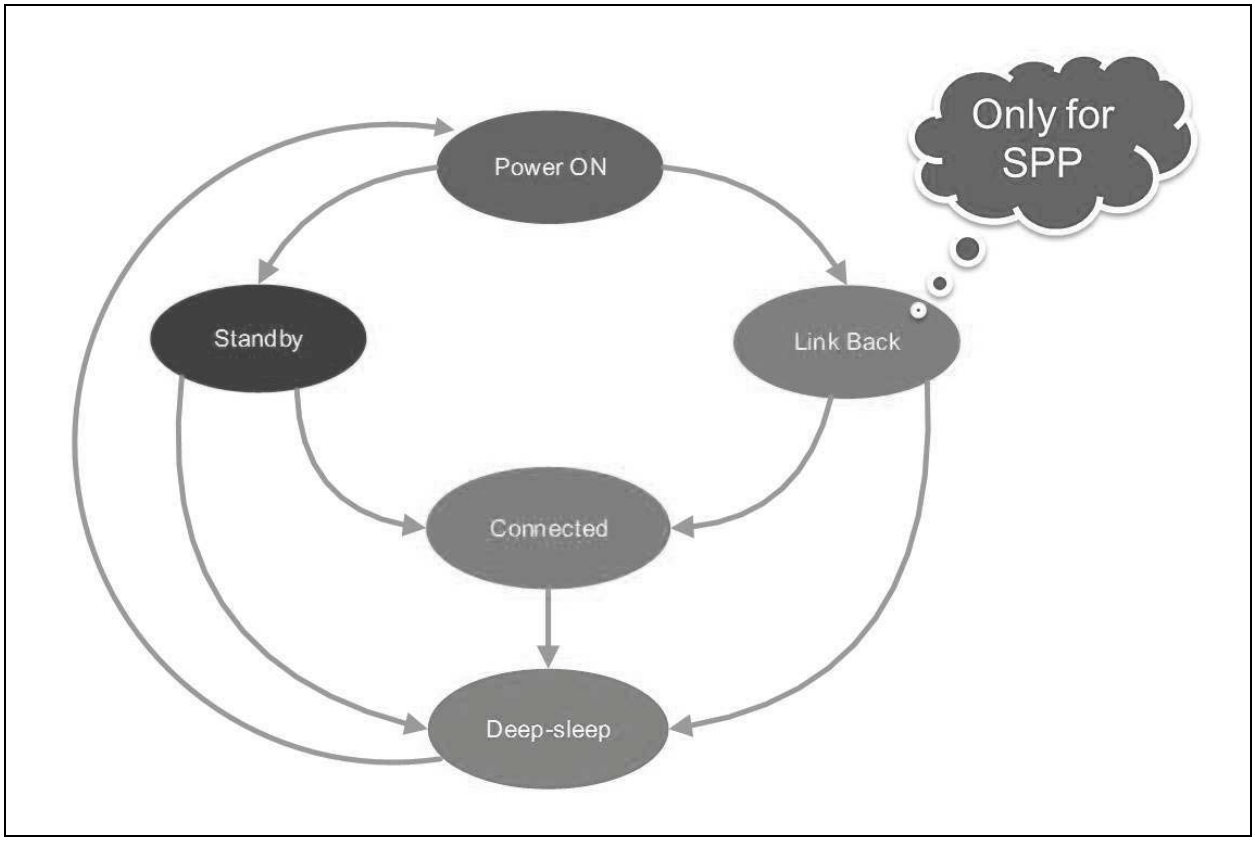
Although the BM78 is set to operate in Auto Pattern mode, it provides the flexibility for the MCU to perform some specific settings in Configure mode by command set. If the BM78 has enabled authenticated pairing, the command set is required to accomplish the Bluetooth link. The MCU doesn't have to deal with the BM78 state, and the BM78 changes its state after power on. However, the MCU can terminate the connection by using GPIOs. The transparent pipe is used for application data transmission and data is transmitted between the remote host and MCU.

The MCU knows the state of the BM78 by GPIOs. The configure mode is available only in Auto Pattern and it can be enabled or disabled by UI tool settings. Basically, the MCU is communicating with the BM78 by GPIOs, except for data transmission.

Figure 3-3 illustrates how the BM78 changes its own state. After power on, there are two options, one is to enter Stand-by mode and the other is to enter Link-Back mode, and it depends on if any device is recorded in the BM78. Irrespective of the mode, the BM78 waits for the remote side to establish a connection or tries to establish a connection with the remote side. Once the connection is established, the state of the BM78 changes to connected mode. If the connection is terminated, the BM78 goes into Deep-Sleep mode.

Note:	Link-Back mode is available only for SPP profile or mode.

FIGURE 3-3: BM78 INTERNAL STATE MACHINE



The BM78 stays in Access state and it is ready for a remote host to access. It either waits for the remote side to create a connection or tries to create a connection on its own.

TABLE 3-1: STATE INDICATION

State	Mode
Access State	Configure Mode Stand-by Mode Link-Back mode Pairing Procedure
Link State	Connected Mode
Deep-sleep State	Deep-Sleep Mode

Configure mode and pairing procedure are also defined as Access state. If the BM78 enters link state, it means not only the Bluetooth link has been established successfully, but also the data session is triggered. MCUs can transmit data to a remote host or receive data from a remote host in this state.