Smart Approach Macaron N Series NFC Controller Module with Integrated Antenna Instruction Manual

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Smart Approach

Smart Approach Macaron N Series NFC Controller Module with Integrated Antenna

Specifications

- **Product Name:** Macaron N Series SM-MSBTF-C01(ZX10 PN7160 NFC Module)
- **Manufacturer:** Smart Approach Co., Ltd
- **Features:** NFC Controller Module with Integrated Antenna
- **Datasheet Version:** 1.2
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Product Overview
The SM-MSBTF-C01 is a full-featured NFC controller designed for integration into portable equipment. It is optimized for low power consumption with fully host-controllable power states and a small footprint for portable equipment applications. The compact design with an exposed pad ensures robust performance.

Features

- Highly integrated demodulator and decoder
- Buffered output drivers for connecting an antenna with minimal external components
- Integrated RF level detector
- Integrated Polling Loop for automatic device discovery
- RF protocols supported
- Automatic wake-up via RF field, internal timer, and I2C-bus interface
- Integrated non-volatile memory for data and executable code storage

Application

The SM-MSBTF-C01 module is suitable for various applications including:

- Mobile devices
- Portable equipment (PDAs, tablets, notebooks, wearables)
- Consumer devices
- Smart home gateways

Product Usage Instructions

Installation

1. Ensure the host device is powered off before installing the SM-MSBTF-C01 module.
2. Locate the appropriate slot for the module on the host device.
3. Gently insert the module into the slot, ensuring proper alignment.
4. Secure the module in place according to the host device's instructions.

Configuration

To configure the SM-MSBTF-C01 module, follow these steps:

1. Access the configuration settings on the host device.
2. Adjust settings such as power states and RF protocols as needed.
3. Save the configuration changes before exiting the settings menu.

Usage

To use the SM-MSBTF-C01 module:

1. Power on the host device.
2. Ensure the module is properly configured and connected to an antenna.
3. Initiate NFC functions on the host device to interact with compatible devices.

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- Please contact **support@smart-approach.com.tw** for any technical question.

Revision History

This section describes the changes that were implemented in this document. The changes are listed by revision, starting with the most current publication.

- Revision 1.0

  Revision 1.0 of this datasheet was published in Jun. 2023. This was the first publication of the document.
- Revision 1.1

Revision 1.1 of this datasheet was published in Sep. 2023. Update card instructions and main board design reference. Add download mode concept.

- Revision 1.2

  Revision 1.2 of this datasheet was published in Mar. 2024. Update NFC MODULE OUTLINE on page

Product Overview

SM-MSBTF-C01 is full featured NFC controllers designed for integration in portable equipment. It is optimized for low power consumption with fully host controllable power states and for small footprint for portable equipment applications.
The module's compact, flexible design with and exposed pad is optimal for size-sensitive applications, assures robust performance.
The following illustration shows a high-level, generic view of a SM-MSBTF-C01 application.

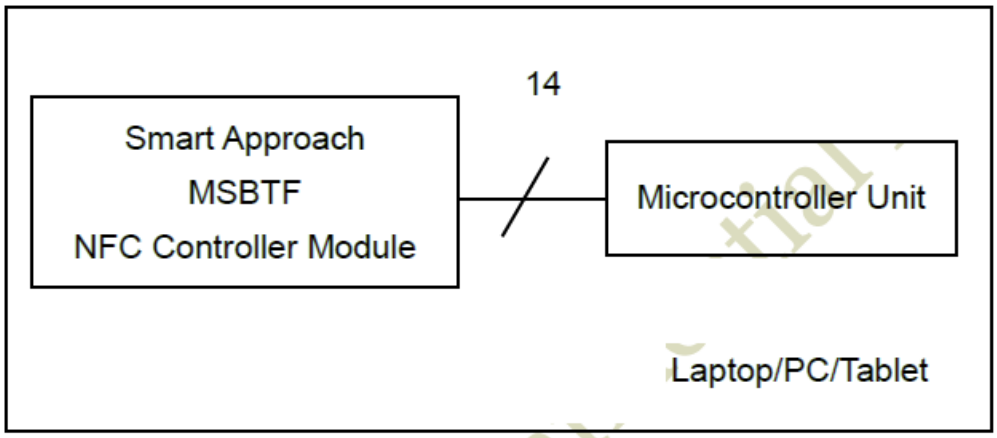


Figure 1 Typical Application

Features

- Highly integrated demodulator and decoder
- Buffered output drivers to connect an antenna with minimum number of external components
- Integrated RF level detector
- Integrated Polling Loop for automatic device discovery
- RF protocols supported
  - ISO/IEC 14443A, ISO/IEC 14443B PICC mode
  - ISO/IEC 14443A, ISO/IEC 14443B PCD mode designed according to NFC Forum digital protocol T4T platform and ISO-DEP
  - FeliCa PCD mode
  - MIFARE PCD encryption mechanism (MIFARE 1K/4K)
  - NFC Forum tags T1T, T2T, T3T, T4T and T5T
  - NFCIP-1, NFCIP-2 protocol
  - NFC Forum certification for P2P, reader and card mode
  - FeliCa PICC mode
  - ISO/IEC 15693/ICODE VCD mode
  - NFC Forum-compliant embedded T4T for NDEF short record
- Supported host interfaces
  - NCI protocol interface according to NFC Forum standardization

    - I2C-bus High-speed mode
- Flexible clock supply concept to facilitate PN7160 integration
    - Internal oscillator for 27.12 MHz crystal connection
    - Integrated PLL unit to make use of device reference clock and facilitate PN7160 integration
- Integrated power management unit
    - Direct connection to a battery (2.3 V to 5.5 V voltage supply range)
    - Support different low-power states configuration: Hard Power-Down state and Standby states activated by firmware
    - Autonomous mode when host is shut down
- Automatic wake-up via RF field, internal timer and I2C-bus interface
- Integrated non-volatile memory to store data and executable code for customization
    - Anti tearing support to recover from tearing events
- Standards compliance
    - NFC Forum Device Requirements
    - NCI 2.0

All card types and it’s protocol shall follow NXP’s and NFC forum recommendation.

Cards that comply with the protocol are subject to testing with the host.

Application
Suggested applications for the SM-MSBTF-C01 module include:

- Mobile devices
- Portable equipment (personal digital assistants, tablet, notebook, wearable)
- Consumer devices
- Smart home gateways

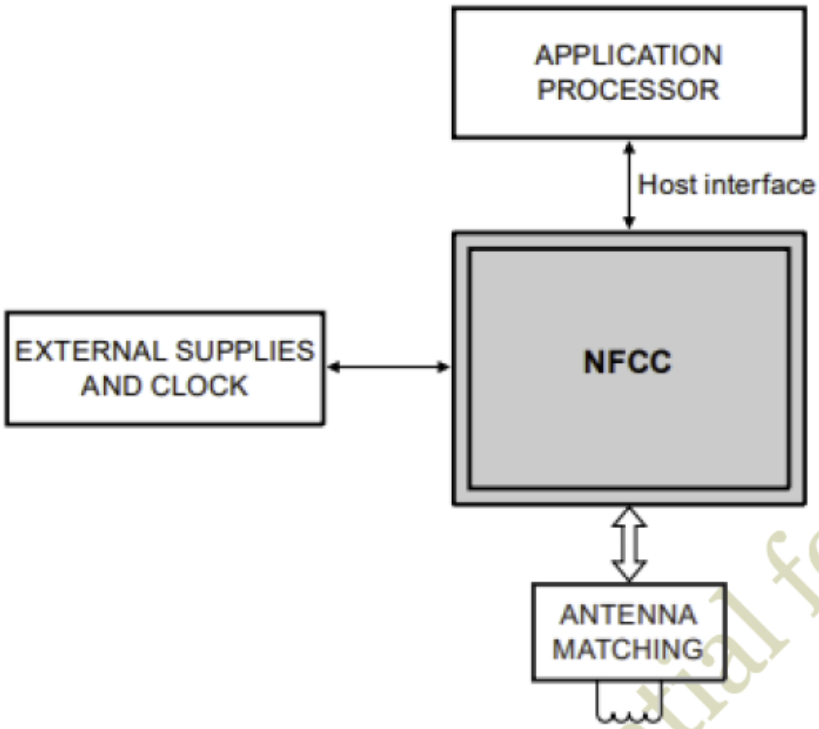


Figure 2 Typical Application II

SM-MSBTF-C01 can be connected on a host controller through I2C-bus interfaces. The logical interface towards the host base band is NCI-compliant with additional command set for SA specific product features.

Moreover, SM-MSBTF-C01 provides flexible and integrated power management unit in order to preserve energy supporting Powered by the Field and Power Off mode.

Functional Descriptions

This section provides detailed information about how SM-MSBTF-C01 module works, what configurations and operational features are available.
The following illustration shows the primary functional blocks of SM-MSBTF-C01 module.

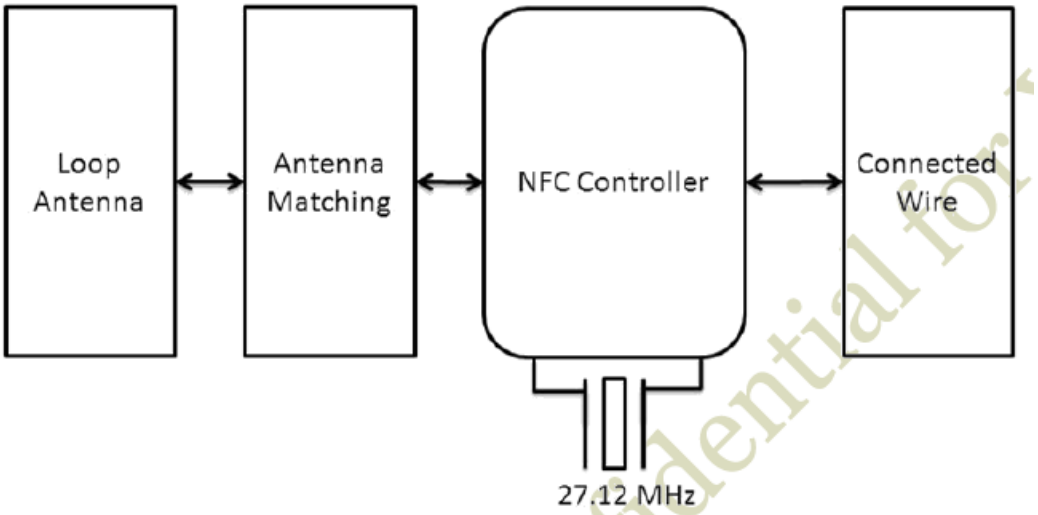
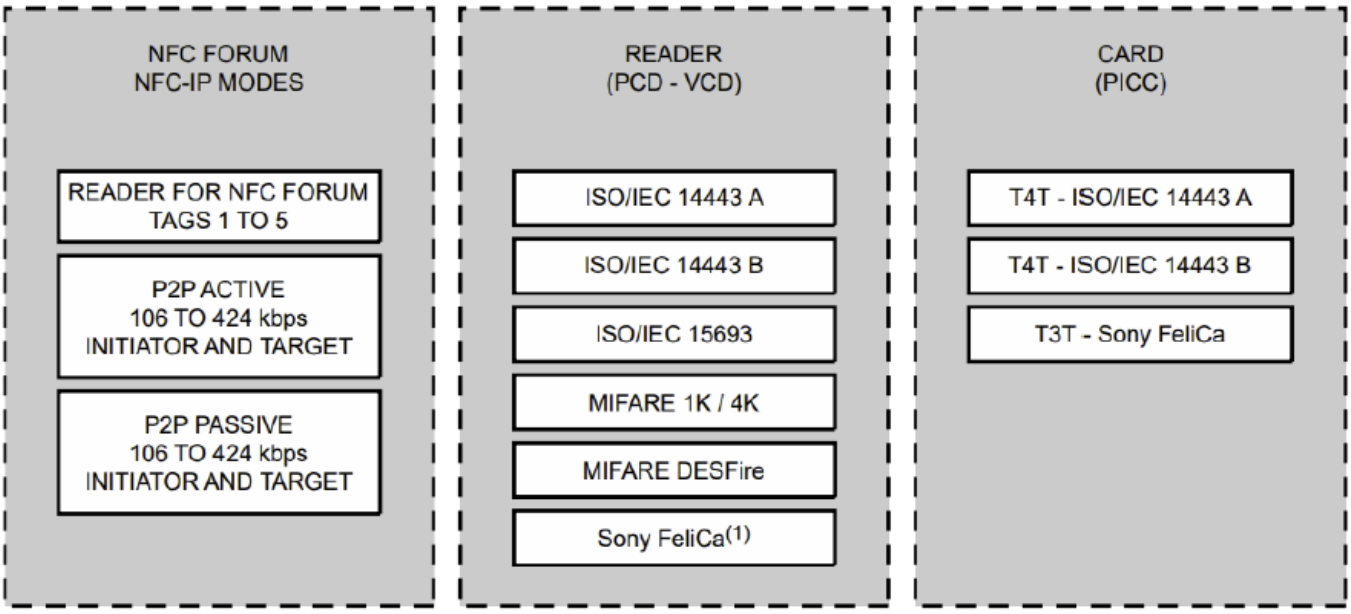


Figure 3 Module Block Diagram

Loop Antenna is Smart Approach customize solution, Antenna size of SM-MSBTF-C01 is 45mm x 35 mm.

Antenna matching is also a customize solution. NFC controller includes NXP PN7160 chipset, and has an I2C control interface through the connector to mother board.



1. According to ISO/IEC 18092(Ecma 340)standard.
2. PICC only for android HCE.

Figure 4 Transmission Modes

For contactless card functionality, SM-MSBTF-C01 can act autonomously if previously configured by the host in such a manner.

Communication overview for ISO/IEC 14443A / MIFARE Controller
The contactless coprocessor and the on-chip CPU of SM-MSBTF-C01 handle the complete ISO/IEC 14443A/MIFARE RF-protocol, nevertheless a dedicated external host has to handle the application layer communication.

Electrical Specifications

This section provides the DC characteristics, AC characteristics, recommended operating conditions. It includes information on the various timing functions of the module.

Pin Description
The following Table shows the pin description for SM-MSBTF-C01 module.
The connection ground is internally connected and should be connected to GND on the main board as well.

Table 1 Module Pin Description

PIN No.	Name	Description	Power Reference	P/I/O
1	VBAT	Battery Supply Voltage	3.3V	P
2	VBAT	Battery Supply Voltage	3.3V	P
3	I^2C_SCL	I^2C-bus Clock Line	VDD_IO	I
4	I^2C_SDA	I^2C-bus Data Line	VDD_IO	I/O
5	IRQ	Interrupt request from module to platform, Normal : Low; Interrupt : High	VDD_IO	O
6	VEN	Reset pin input from the host to wake up the device from standby and also to reset the device, Normal : High; Reset : Low	VBAT	I
7	DWL_REQ	Firmware download control: Normal : Low; Active : High	VDD_IO	I
8	Reserve2	N.C.	–	–
9	Reserve1	N.C.	–	–
10	MOD_GND	Module Ground	GND	P
11	MOD_GND	Module Ground	GND	P
12	VDD_IO	Pad Supply Voltage	1.8V/3.3V	P
13	VANT	N.C.	–	–
14	MOD_GND	Module Ground	GND	P

I2C Address

SM-MSBTF-C01 I2C 7bit address is defined to 0x28. To write data, this module is addressed using 0x50, to read data, this module is addressed using 0x51.

Table 2 I2C Address

I2C address (R/W=0, write)	I2C address (R/W=1, read)
0x50	0x51

Temperature Maximum Ratings

Thermal specifications for this module have been modeled using a two-layer test board.

Table 3 Temperature Maximum Ratings

Symbol	Definition	Value		Units
		Min	Max	
T	Operating Temperature	-25	85	℃
T_S	Storage Temperature	-40	100	℃

DC Electrical Parameters
DC Electrical specifications for this module have been modeled using a two-layer test board.

Table 4 DC Electrical Specification

Symbol	Definition	Value			Units	Note
		Min	Typ	Max		
VBAT	Power Supply	3.1	3.3	5.5	Volts	
IVBAT	DC Current			290	mA	(1)

Note:

1. continuous total current consumption in PCD mode at VBAT = 3.6 V

Antenna Specifications
Antenna specifications for this module have been modeled using a two-layer test board.

Table 5 Antenna Specifications

Item	Value			Unit	Note
	Min	Typ	Max		
DC Resistance	0.5	1	2	Ω	
AC Impedance		50		Ω	
Frequency	13.06	13.56	14.06	MHz	
Q factor	25	30	35		
Antenna Type	FR4 Loop Coil				Add the Ferrite sheet
Size	(45 ±0.3) X (35±0.3)			mm	

Power Consumption

Table 6 Current Consumption

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
IHPD	Hard power down current	V_{BAT}=3.6V, V_{EN}=0V	–	10	24	μA
ISTBY	Standby state current	V_{BAT}=3.6V	–	20	35	μA
IACT	Active state current	V_{BAT}=3.6V	–	4.55	–	mA
ITVDD	Transmitter supply current	V_{BAT}=3.6V	–	240	–	mA

Thermal Protection

Table 7 Thermal Protection

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
TOVERTEMP	Temperature protection trigger		–	125	125	0C

System power modes
Table 8 System Power Mode Configuration

VBAT	VDD_IO	VEN	Power mode
Off	X	X	Power Off
On	X	Off	Hard Power Down
On	Off	On	Standby
On	On	On	Active

Note: X: Don’t care

Table 9 System Power States

Power State name	Description
Hard Power Down	The MSBTF is supplied by V_{BAT} within its operating range and MSBTF is kept in Hard Power Down (V_{EN} voltage is kept low by host or SW programming) to have the minimum power consumption. The system mode is in Power Off.
Standby	The MSBTF is supplied by V_{BAT} within its operating range, V_{EN} voltage is high (by host or SW programming) and minimum part of MSBTF is kept supplied to enable configured wake-up sources which allow to switch to Active state; RF field, Host interface (if VDD_IO is high). The system mode is Low-power mode or Full power mode.
Active	The MSBTF is supplied by V_{BAT} within its operating range, V_{EN} voltage is high (by host or SW programming), VDD_IO is high and the MSBTF internal blocks are supplied. 3 sub-modes are defined: Idle, Listener and Poller. The system mode is Full power mode.

Reset concept

To enter reset, the VEN voltage shall be set to low (this is also the Hard Power Down state):
Reset means resetting the embedded FW execution and the registers values to their default values. Parts of these default values are defined from EEPROM data loaded values, others are hardware defined. To get out of reset:

- Pulling VEN voltage high with VBAT within its operating range

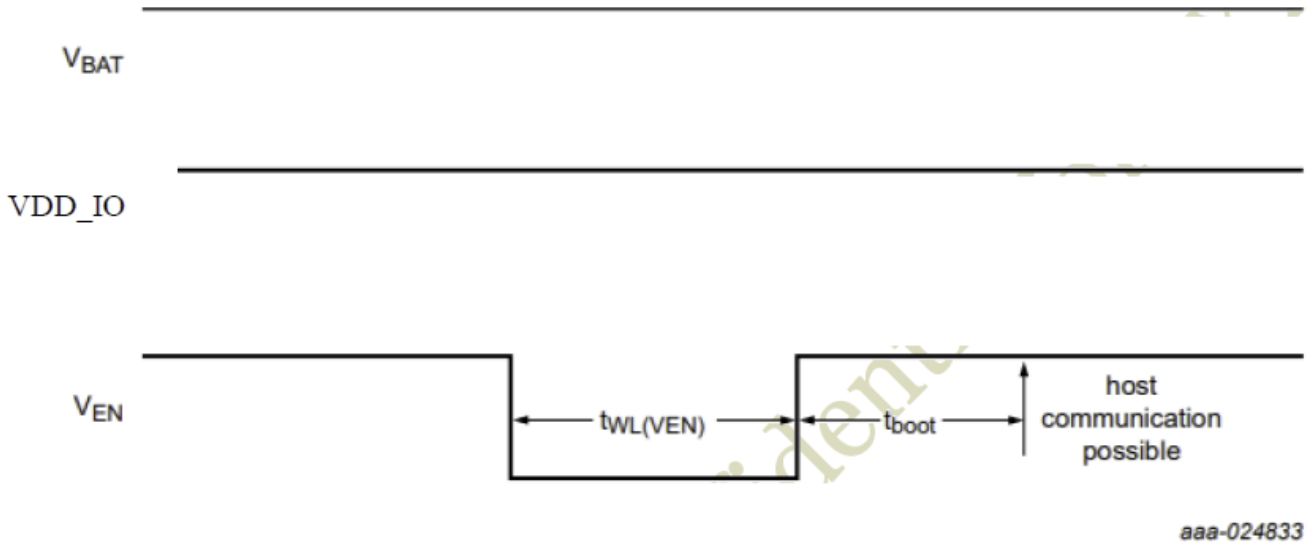


Figure 5 Reset via V_{EN} pin

Table 10 Reset Timing

Symbol	Parameter	Condition	Min	Typ	Max	Unit
tWL(VEN)	pulse width VEN LOW	to reset	10	–	–	µ s
tboot	boot time		–	–	2.5	ms

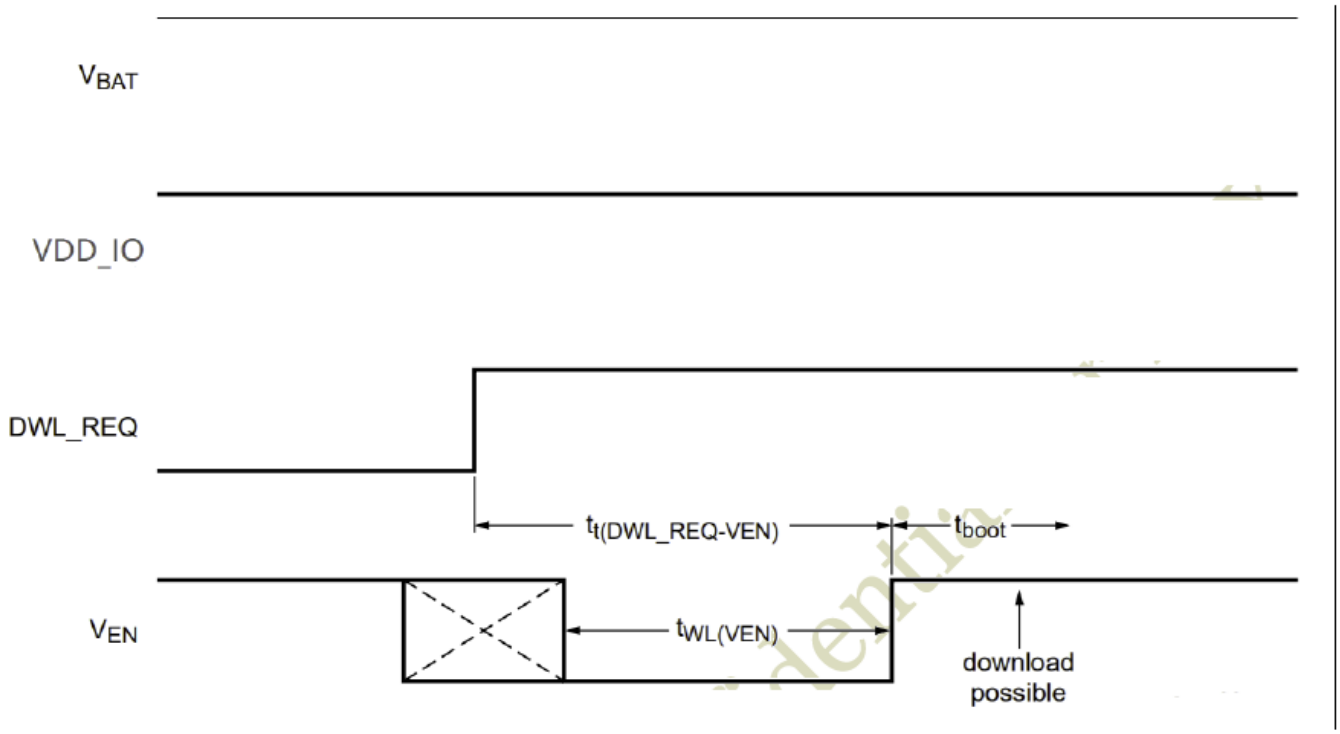


Figure 6 Download mode sequence

Download mode concept

To enter this mode, the pin DWL_REQ shall be pulled to VDD_IO before reset via VEN pin is done.

Symbol	Parameter	Condition	Min	Typ	Max	Unit
tt(DWL_REQ-VEN)	transition time from pin DWL_REQ to pin VEN	DWL_REQ, VEN voltages = HIGH	0	0.5	–	ms

NFC Connection Recommendation

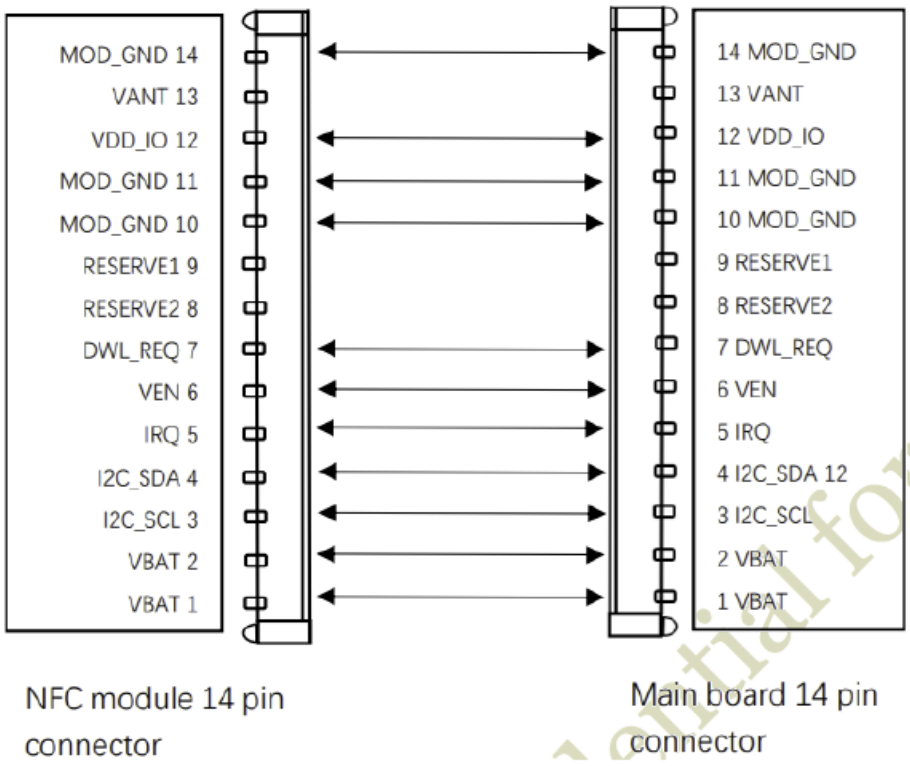
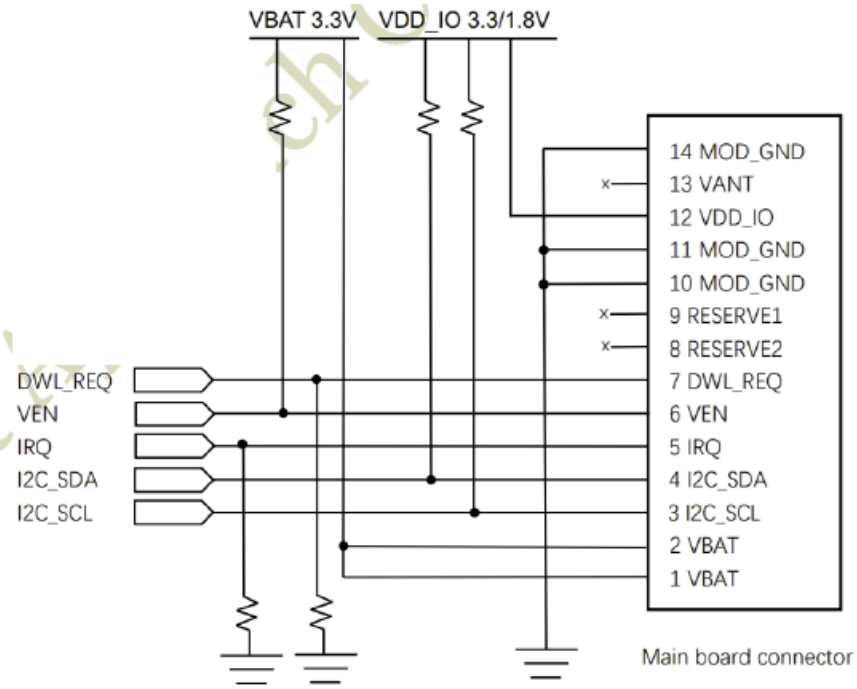


Figure 7 Connection Recommendation

Main Board Design Reference



I2C_SDA, I2C_SCL, VEN, DWL_REQ, IRQ have pull-up or pull-down resistors inside the module, the main board is recommended to reserve the pull-up or pull-down resistors position (not SMD components).

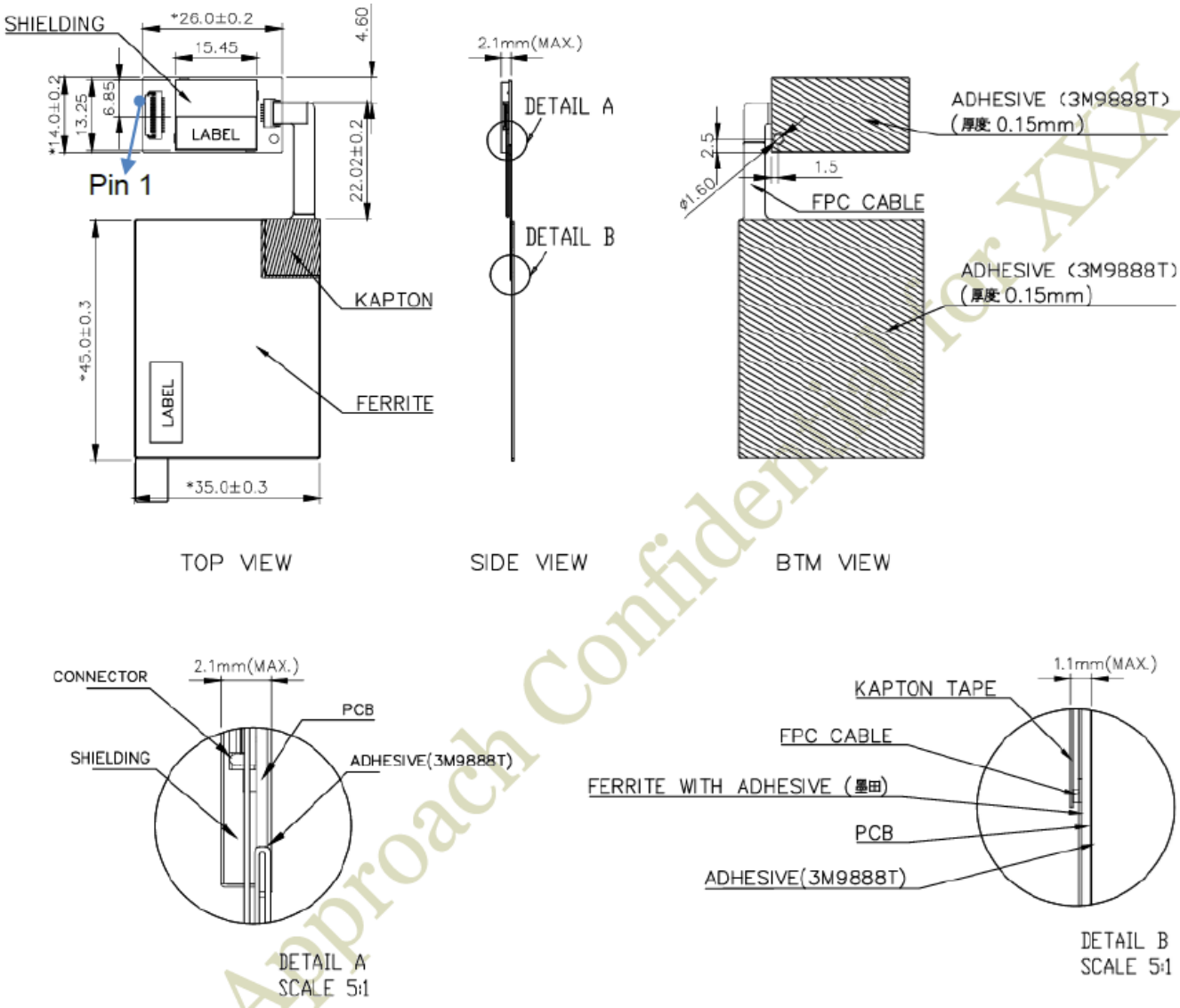
Ordering Information

Table 12 Ordering Information Table

Order Number	Descriptions
SM-MSBTF-C01	NFC Macaron Module (NXP PN7160) with Integrated Antenna
Dimension	Module: 71.62 x 35 x 2.1 mm

NFC Module Outline

The following illustration shows the package drawing for SM-MSBTF-C01 module. The drawing contains the detail views, dimensions, tolerances and notes.



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Tolerance unless otherwise specified				
Class	A grade	B grade	C grade	D grade
0~10	±0.1	±0.1	±0.2	±1.0
10~50	±0.15	±0.2	±0.3	±2.0
50~100	±0.15	±0.3	±0.3	±2.0
100~250	±0.2	±0.4	±0.5	±3.0
250~500	~	±0.5	±1.0	±3.0
ANGLE	±1/2	±1	~	~

Mark " * " is process control dimension.
Mark "(球號)" is FAI control dimension.

Figure 9 Antenna Module Drawing

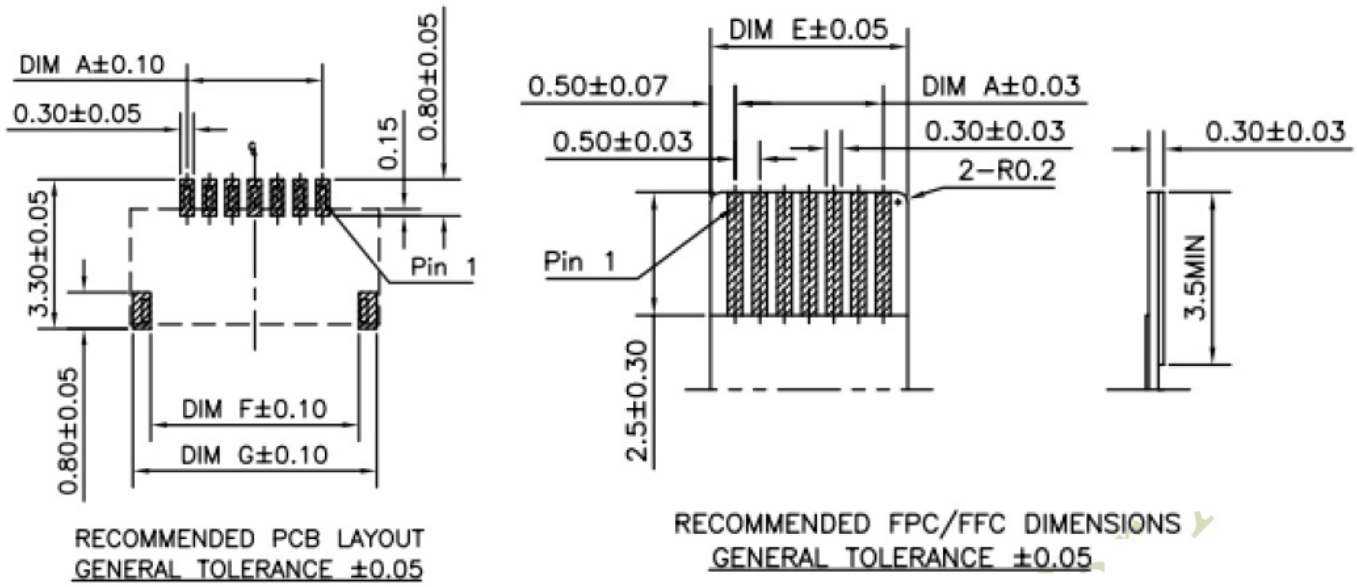


Figure 10 Module FPC Connection Footprint (Button Contact)

CKT	DIM A	DIM B	DIM C	DIM D	DIM E	DIM F	DIM G	DIM H	DIM J	DIM K
04	1.50	4.0	2.57	3.33	2.50	3.10	3.90			
05	2.00	4.5	3.07	3.83	3.00	3.60	4.40			
06	2.50	5.0	3.57	4.33	3.50	4.10	4.90			
07	3.00	5.5	4.07	4.83	4.00	4.60	5.40			
08	3.50	6.0	4.57	5.33	4.50	5.10	5.90		3.0	
09	4.00	6.5	5.07	5.83	5.00	5.60	6.40			
10	4.50	7.0	5.57	6.33	5.50	6.10	6.90			
11	5.00	7.5	6.07	6.83	6.00	6.60	7.40			
12	5.50	8.0	6.57	7.33	6.50	7.10	7.90			
13	6.00	8.5	7.07	7.83	7.00	7.60	8.40			
14	6.50	9.0	7.57	8.33	7.50	8.10	8.90	3.0		2.5
15	7.00	9.5	8.07	8.83	8.00	8.60	9.40			
16	7.50	10.0	8.57	9.33	8.50	9.10	9.90			
17	8.00	10.5	9.07	9.83	9.00	9.60	10.40			
18	8.50	11.0	9.57	10.33	9.50	10.10	10.90		6.0	
19	9.00	11.5	10.07	10.83	10.00	10.60	11.40			
20	9.50	12.0	10.57	11.33	10.50	11.10	11.90			

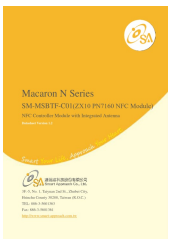
Figure 11 FPC Wire Dimension

Frequently Asked Questions

Q: Can the SM-MSBTF-C01 module be used with smart home devices?
A: Yes, the SM-MSBTF-C01 module is suitable for smart home gateways among other applications.

Q: How can I provide feedback on the product documentation?
A: You can contact Smart Approach at service@smart-approach.com.tw for feedback or any ordering inquiries.

Documents / Resources

	Smart Approach Macaron N Series NFC Controller Module with Integrated Antenna [pdf] Instruction Manual Macaron N Series, Macaron N Series NFC Controller Module with Integrated Antenna, NFC Controller Module with Integrated Antenna, Controller Module with Integrated Antenna, Module with Integrated Antenna, Integrated Antenna

References

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- User Manual

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