RFID MODULE

Mifare Reader / Writer

SL030
User Manual

Version 3.1
Jan, 2018
StrongLink

CONTENT

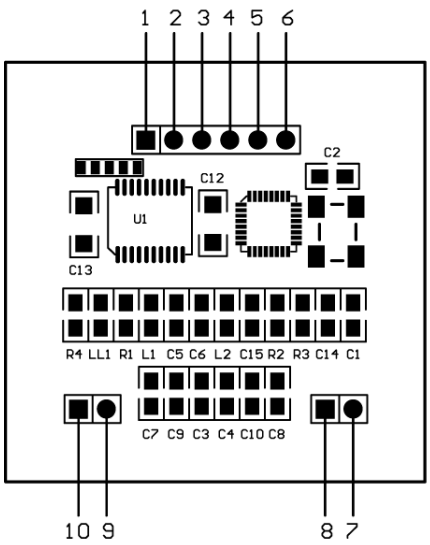
1. MAIN FEATURES

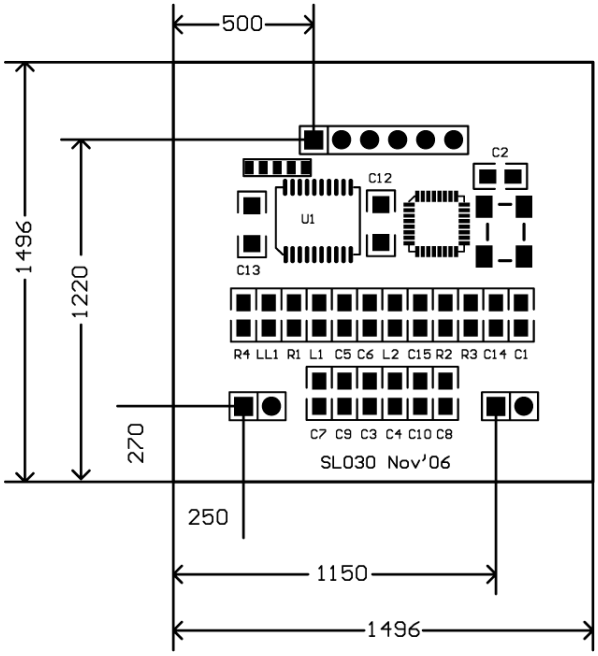
*This picture may not be exactly the same as real object.

- Tags supported: Mifare 1k, Mifare 4k, Mifare UltraLight, Mifare UltraLight C, NTAG203, DESFire, DESFire EV1 and Mifare Plus 2K/4K
- Built-in antenna
- 0 to 400 KHz bit-wide I^2C-bus communication
- 2.7 ~ 3.6V VDC operating, I/O pins are 5V tolerant
- Work current less than 45mA @3.3V
- Power down current less than 10uA
- Operating distance: Up to 50mm, depending on tag
- Storage temperature: -40 ºC ~ +85 ºC
- Operating temperature: -25 ºC ~ +55 ºC
- Dimension: 38 × 38 × 3 mm
- The OUT pin at low level indicates tag in detective range, and high level indicating tag out
- Auto-detection: LED is on when card is in the detection range[1]
- Support IAP firmware update

[1] Suppots all cards above except ISO14443-4 cards like DESFire/DESFire EV1 and MifarePlus L0/L2/L3. There is Auto-detection command to control its on/off.

2. PINNING INFORMATION





Uint: mil
100 mil between two pads

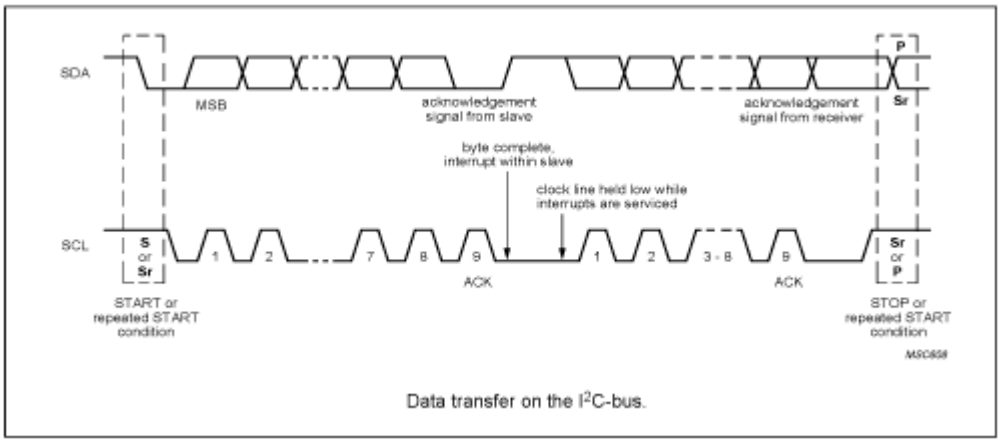
PIN	SYMBOL	TYPE	DESCRIPTION
1	VDD	PWR	Power supply, 2.7V to 3.6VDC
2	IN	Input	Falling edge wake up SL030 from power down mode
3	SDA	Input/Output	Serial Data Line
4	SLC	Input	Serial Clock Line
5	Out	Output	Tag auto-detection signal low level indicating tag in high level indicating tag out
6	GND	PWR	Ground
7	NC		
8	NC		
9	NC		
10	NC		

Attention: Pin IN must be connected HIGH voltage when working, so SL030 can enter power down mode properly.

3. Device Operation

3-1. Clock and Data Transitions:

The SDA pin is normally pulled high with an external device. Data on the SDA pin may change only during SCL low time periods. Data changes during SCL high periods will indicate a start or stop condition as defined below.



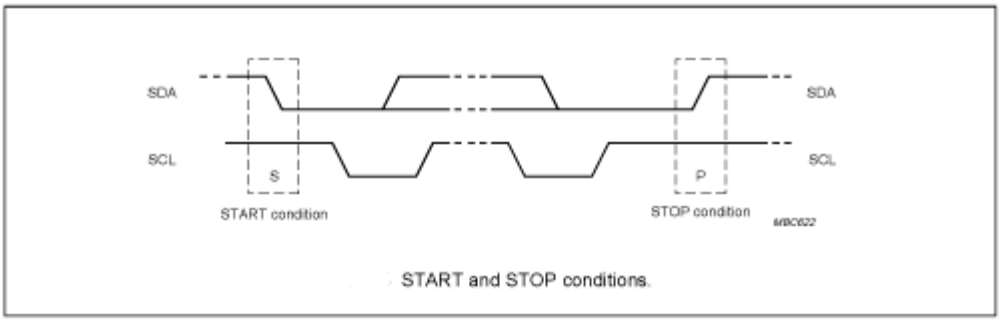
Data transfer on the I²C-bus.

3-2. Start Condition

A high-to-low transition of SDA with SCL high is a start condition which must precede any other command

3-3. Stop Condition

A low-to-high transition of SDA with SCL high is a stop condition.



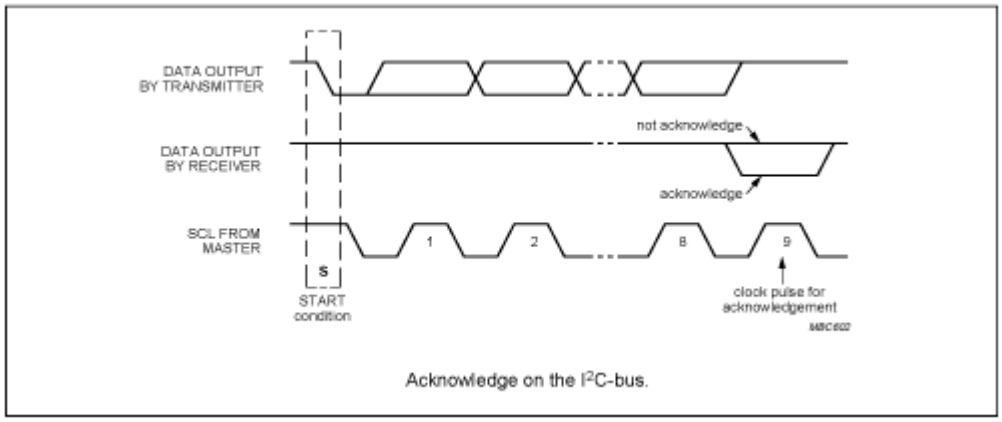
START and STOP conditions.

3-4. Acknowledge

All addresses and data words are serially transmitted to and from the SL030 in 8-bit words. The SL030 sends a zero to acknowledge that it is not busy, and has received each word. This happens during the ninth clock cycle.

3-5. Busy State

When the SL030 has received command, then don't acknowledge IIC bus until ends with the card communication.



Acknowledge on the I²C-bus.

3-6. Device Addressing

The SL030 devices require an 8-bit device address word following a start condition to enable the chip for a read or write operation.

The device address word consists of 7 bits addressing and 1 bit operation select bit.

The first 7 bits are the SL030 addressing, is 10100xx depend on JP1 and JP2 status as below table

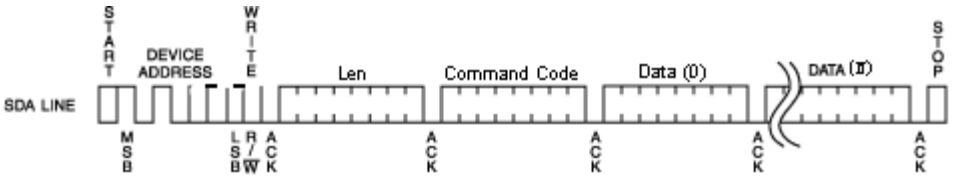
	JP1	JP2	Address
shorted	no	no	1010000 (default)
	no	yes	1010001
	yes	no	1010010
	yes	yes	1010011

The eighth bit of the device address is the read/write operation select bit. A read operation is initiated if this bit is high and a write operation is initiated if this bit is low.

The first byte after the START procedure.

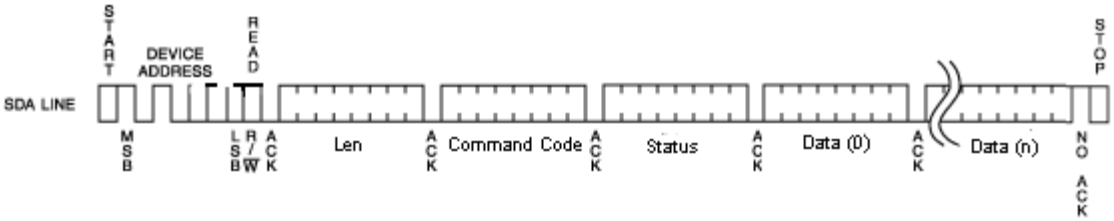
3-7. Write Operations

The host device send a command(refer chapter 4) to SL030 via write operation, then SL030 will carry out the order that receive. Finished time according to different order



3-8. Read Operations

The host device passes to read the operation gets the order carries out the result



4. COMMAND DESCRIPTION

4-1. FORMAT

Host Write Command to SL030:

Address	Len	Command	Data

Address: 1 byte, 0xA0
Len: 1 byte indicating the number of bytes from Command to the end of Data
Command: 1 byte Command code, see Table 3
Data: Variable length depends on the command type

Host Read The Result:

Address	Len	Command	Status	Data

Address: 1 byte, 0xA1
Len: 1 byte indicating the number of bytes from Command to the end of Data
Command: 1 byte Command code, see Table 3
Status: 1 byte Command status, see Table 4
Data: Variable length depends on the command type.

4-2. Command Overview

Table 3

Command	Description
0x01	Select Mifare card
0x02	Login to a sector
0x03	Read a data block
0x04	Write a data block
0x05	Read a value block
0x06	Initialize a value block
0x07	Write master key (key A)
0x08	Increment value
0x09	Decrement value
0x0A	Copy value
0x10	Read a data page (Ultralight & NATG203)
0x11	Write a data page (Ultralight & NTAG203)
0x12	Download Key
0x13	Login sector via stored Key
0x20	Request for Answer to Select (ISO14443-4)
0x21	Exchange Transparent Data according to T = CL
0x40	LED control
0x50	Go to Power Down mode
0x80	MFP WritePerso
0x81	MFP CommitPerso
0xF0	Get firmware version
0xFE	Turn on/off Auto-detection

STATUS OVERVIEW

Table 4

Status	Description
0x00	Operation succeed
0x01	No tag
0x02	Login succeed
0x03	Login fail
0x04	Read fail
0x05	Write fail
0x06	Unable to read after write
0x08	Address overflow
0x09	Download Key fail
0x0A	Collision occur
0x0C	Load key fail
0x0D	Not authenticate
0x0E	Not a value block
0x0F	Input len invalid
0x12	MFP WritePerso fail
0x13	MFP CommitPerso fail
0xF1	Invalid command

4-3. COMMAND LIST

4-3-1. Select Mifare card

Host Write:

Len	0x01

Host Read:

Len	0x01	Status	UID	Type

Status: 0x00: Operation succeed
0x01: No tag

UID: The uniquely serial number of Mifare card

Type:

MFMini_4B	0x01
MFMini_7B	0x02
MF1K_4B UID/ MFPLUS2K SL1_4B UID	0x03
MF1K_7B UID/ MFPLUS2K SL1_7B UID	0x04
MF4K_4B UID/ MFPLUS4K SL1_4B UID	0x05
MF4K_7B UID/ MFPLUS4K SL1_7B UID	0x06
MF Ultralight/MF Ultralight C/Ntag 203	0x07
MF DESFire/MF DESFire EV1	0x09
MF PROX	0x0B
MFPLUS2K SL2_4B UID	0x21
MFPLUS4K SL2_4B UID	0x22
MFPLUS2K SL2_7B UID	0x23
MFPLUS4K SL2_7B UID	0x24
MFPLUS2K SL0/SL3_4B UID[2]	0x31
MFPLUS4K SL0/SL3_4B UID	0x32
MFPLUS2K SL0/SL3_7B UID	0x33
MFPLUS4K SL0/SL3_7B UID	0x34
Other	0x00

4-3-2. Login to a sector

Host Write:

Len	0x02	Sector	Type	Key

Sector: Sector need to login, 0x00 – 0x27

Type: Key type (0xAA: authenticate with KeyA, 0xBB: authenticate with KeyB)

Key: Authenticate key, 6 bytes

Host Read:

Len	0x02	Status

Status: 0x02: Login succeed
0x01: No tag
0x03: Login fail
0x08: Address overflow

4-3-3. Download Key into SL030

[2] Mifare Plus SL0 and SL3 can tell differences via ATS(ISO14443-4). Before ATS, they have the same ATQA and SAK(ISO14443-3). SL030 judges card type only via ISO14443-3 layer for the compatibility.

Host Write:

Len	0x12	Sector	Type	Key

Sector: 0x00 – 0x27
Type: Key type (0xAA: KeyA, 0xBB: KeyB)
Key: 6 bytes, stored into SL030

Host Read:

Len	0x12	Status

Status: 0x00: Operation succeed
0x08: Address overflow
0x09: Download fail

Note: Some delay is needed between Host Write and Host Read.

4-3-4. Login sector via stored key

Host Write:

Len	0x13	Sector	Type

Sector: Sector need to login, 0x00 – 0x27
Type: Key type (0xAA: KeyA, 0xBB: KeyB)

Host Read:

Len	0x13	Status

Status: 0x02: Login succeed
0x03: Login fail
0x08: Address overflow

4-3-5. Read a data block

Host Write:

Len	0x03	Block

Block: The absolute address of block to be read, 1 byte

Host Read:

Len	0x03	Status	Data

Status: 0x00: Operation succeed
0x01: No tag
0x04: Read fail
0x0D: Not authenticate

Data: Block data returned if operation succeeds, 16 bytes.

4-3-6. Write a data block

Host Write:

Len	0x04	Block	Data

Block: The absolute address of block to be written, 1 byte.
Data: The data to write, 16 bytes.

Host Read:

Len	0x04	Status	Data

Status: 0x00: Operation succeed

0x01: No tag
0x05: Write fail
0x06: Unable to read after write
0x0D: Not authenticate
Data: Block data written if operation succeeds, 16 bytes.

4-3-7. Read a value block

Host Write:

Len	0x05	Block

Block: The absolute address of block to be read, 1 byte.

Host Read:

Len	0x05	Status	Value

Status: 0x00: Operation succeed
0x01: No tag
0x04: Read fail
0x0D: Not authenticate
0x0E: Not a value block
Value: Value returned if the operation succeeds, 4 bytes.

4-3-8. Initialize a value block

Host Write:

Len	0x06	Block	Value

Block: The absolute address of block to be initialized, 1 byte.
Value: The value to be written, 4 bytes.

Host Read:

Len	0x06	Status	Value

Status: 0x00: Operation succeed
0x01: No tag
0x05: Write fail
0x06: Unable to read after write
0x0D: Not authenticate
Value: Value written if the operation succeeds, 4 bytes.

4-3-9. Write master key (KeyA)

Host Write:

Len	0x07	Sector	Key

Sector: The sector number to be written, 0x00 – 0x27.
Key: Authentication key, 6 bytes

Host Read:

Len	0x07	Status	Key

Status: 0x00: Operation succeed
0x01: No tag
0x05: Write fail

0x08: Address overflow
0x0D: Not authenticate
Key: Authentication key written if the operation succeeds, 6 bytes.
Attention: Be sure KeyB is readable, otherwise KeyB will be change to 000000000000 after this command.

4-3-10. Increment value
Host Write:

Len	0x08	Block	Value

Block: The absolute address of block to be increased, 1 byte.
Value: The value to be increased by, 4 bytes.
Host Read:

Len	0x08	Status	Value

Status: 0x00: Operation succeed
0x01: No tag
0x05: Write fail
0x06: Unable to read after write
0x0D: Not authenticate
0x0E: Not a value block
Value: The value after increment if the operation succeeds, 4 bytes

4-3-11. Decrement value
Host Write:

Len	0x09	Block	Value

Block: The absolute address of block to be decreased, 1 byte
Value: The value to be decreased by, 4 bytes
Host Read:

Len	0x09	Status	Value

Status: 0x00: Operation succeed
0x01: No tag
0x05: Write fail
0x06: Unable to read after write
0x0D: Not authenticate
0x0E: Not a value block
Value: The value after decrement if the operation succeeds, 4 bytes

4-3-12. Copy value
Host Write:

Len	0x0A	Source	Destination

Source: The source block copy from, 1 byte
Destination: The destination copy to, 1 byte
The source and destination must in the same sector
Host Read:

Len	0x0A	Status	Value

Status: 0x00: Operation succeed
0x01: No tag
0x05: Write fail
0x06: Unable to read after write
0x0D: Not authenticate
0x0E: Not a value block (Source)
Value: The value after copy if the operation succeeds, 4 bytes

4-3-13. Read a data page (UltraLight & NTAG203)

Host Write:

Len	0x10	Page

Page: The page number to be read, 1 byte

Host Read:

Len	0x10	Status	Data

Status: 0x00: Operation succeed
0x01: No tag
0x04: Read fail
0x08: Address overflow
Data: Block data returned if operation succeeds, 4 bytes.

4-3-14. Write a data Page (UltraLight & NTAG203)

Host Write:

Len	0x11	Page	Data

Page: The page number to be written, 1 byte.
Data: The data to write, 4 bytes.

Host Read:

Len	0x11	Status	Data

Status: 0x00: Operation succeed
0x01: No tag
0x05: Write fail
0x06: Unable to read after write
0x08: Address overflow
Data: page data written if operation succeeds, 4 bytes.

4-3-15. Request for Answer to Select (ISO14443-4)

Len	0x20

Response:

Len	0x20	Status	ATS

Status: 0x00: Operation succeed
0x10: Address overflow
ATS: According to ISO14443-4 protocol
Len + T_0 + TA_1 + TB_1 + TC_1 + A_1 + A_K

4-3-16. Exchange Transparent Data (T = CL)

Len	0x21	Data

Data: COS command

Response:

Len	0x21	Status	Data

Status: 0x00: Operation succeed
0x11: Communicate with card failed

Data: Response data from card

4-3-17. LED Control

Host Write:

Len	0x40	Data

Data: 0x00: LED off
0x01: LED on

Host Read:

Len	0x40	Status

Status: 0x00: Operation succeed

4-3-18. Power Down

Host Write:

Len	0x50

Host Read:

Len	0x50	Status

Status: 0x00: Operation succeed

Note: Some delay is needed when waking up SL030.

4-3-19. Write Perso

Host Write:

Len	0x80	Bnr	Data

Bnr: 2Byte Block or Key Address to be written, MSB first.

For example,

Master Key Address is 0x9000, and write it as 0xFFFF..FF(16Bytes)

13809000FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFh

Configuration Key Address is 0x9001, and write it as 0xFFFF..FF(16Bytes)

13809001FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFh

Switch to Level 2 Key Address is 0x9002, and write it as 0xFFFF..FF(16Bytes)

13809002FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFh

Switch to Level 3 Key Address is 0x9003, and write it as 0xFFFF..FF(16Bytes)

13809003FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFh

Data: Value of the key or data

Host Read:

Len	0x80	Status

Status: 0x00: Operation succeed
0x11: Communicate with card failed
0x12: Card Write Perso failed

4-3-20. Commit Perso

Host Write:

Len	0x81

This command commit the Write Perso and switch the card to security level 1(SL1 card) or level 3(SL3 card).

Host Read:

Len	0x81	Status

Status: 0x00: Operation succeed
0x11: Communicate with card failed
0x13: Card Commit Perso failed

Attention: According to NXP MifarePlus card document, Commit Perso will make effect after you have "Write Perso" the Master KEY, Configuration KEY and SWL3 KEY.
If your card is L1 card, after Commit Perso, the card will switch L0 to L1;
If your card is L3 card, after Commit Perso, the card will switch L0 to L3.

4-3-21. Get firmware version

Host Write:

Len	0xF0

Host Read:

Len	0xF0	Status	Data

Status: 0x00: Operation succeed
Data: firmware version.

4-3-22. Turn on/off Auto-detection

Host Write:

Len	0xFE	Data

Data: 0x00: Turn off Auto-detection
0x01: Turn on Auto-detection
For example,
02FE00h // Turn off Auto-detection
02FE01h // Turn on Auto-detection

Host Read:

Len	0xFE	Status

Status: 0x00: Operation succeed

5. DIFFERENCES FROM PREVIOUS VERSION

Although we make efforts on the compatibility between the new SL030 V3.0 and the old SL030 V1.0-V2.3, there are still some differences you need to know.

1. New SL030 has a new auto-detection function which can close automatically when there is a DESFire or MifarePlus L0/L2/L3 card coming into the detection range, and the light will be on even if the card is out of field. By the way, we also offer you the Turn On/Off Auto-detection command.
2. New SL030 supports nearly all cards of NXP Mifare series now and we rebuilt the card type characters.(Details see to Command Select Mifare Card Description)

Product Information

Product Name:	MIFARE MODULE
Model No.:	SL030_V3.1, SL031_V3.0
RFID:	13.56MHz
Antenna Type:	Integrated Antenna

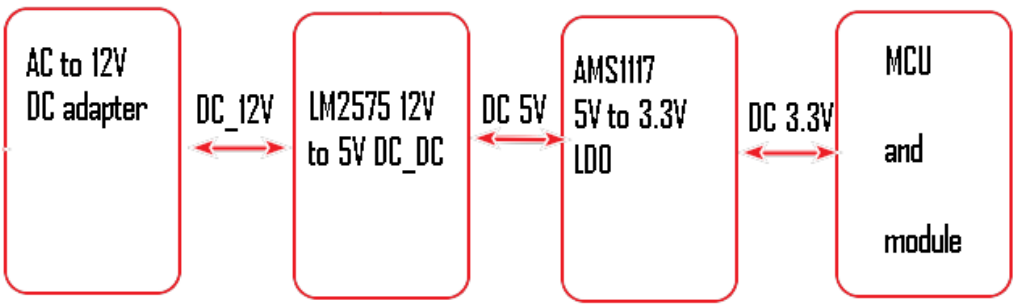
Host Information

Product Name:	Host device
Model No.:	T030
Manufacturer:	BEIJING STRONGLINK TECHNOLOGY CO,. LTD.

The regulated power supply of the host is as below:

T030 is a host device of SL030_V3.1 for command sets testing.
Its power supply is obtained by 12V AC-DC adapter, and converting 12V to 5V through DC to DC LM2575 and 5V to 3.3V through LDO AMS1117, to power stable 3.3V to MCU and the SL030_V3.1 module.

The host device power block diagram



Federal Communications Commission (FCC) Interference Statement

The limited modular transmitter is **only** FCC authorized for the specific rule part (FCC Part15.225) listed on the grant, and that the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification.

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.
FCC Caution: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

For additional hosts other than the specific host originally granted with a limited module, a Class II permissive change is required on the module grant to register the additional host as a specific host also approved with the module.

OEM/Host integrator is responsible for complying with the instructions and requirements for each transmitter they choose to integrate into a host product.

RF exposure warning

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment.
This product may not be collocated or operated in conjunction with any other antenna or transmitter. This equipment must be installed and operated in accordance with provided instructions and the antenna(s) used for this transmitter must be installed to provide a separation distance from all persons and must not be collocated or operating in conjunction with any other antenna or transmitter. Additional text needed for the host product manufacturer to provide to end users in their end-product manuals.

OEM Integration Instructions：

This device is intended only for OEM integrators under the following conditions:
The module can be used to installation in other host. 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 transmit or antenna. The module shall be only used with the integral antenna(s) that has been originally tested and certified with this module. As long as 3 conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirement with this module installed (for example, digital device emission, PC peripheral requirements, etc.)

IMPORTANT NOTE：

In the event that these conditions cannot be met (for example certain laptop configuration or co-location with another transmitter), then the FCC authorization for this module in combination with the host equipment is no longer considered valid and the FCC ID of the module cannot be used on the final product. In these and circumstance, the OEM integrator will be responsible for re-evaluating. The end product (including the transmitter) and obtaining a separate FCC authorization. The final end product must be labeled in a visible area with the following:
“**Contains Transmitter Module FCC ID: 2ADI8-SL03SER** or **Contains FCC ID: 2ADI8-SL03SER**”.