RFID   MODULE

Mifare Reader / Writer

SL030
User Manual

Version 3.1
Mar, 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^{2}C-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

- Support IAP firmware update

2. PINNING INFORMATION
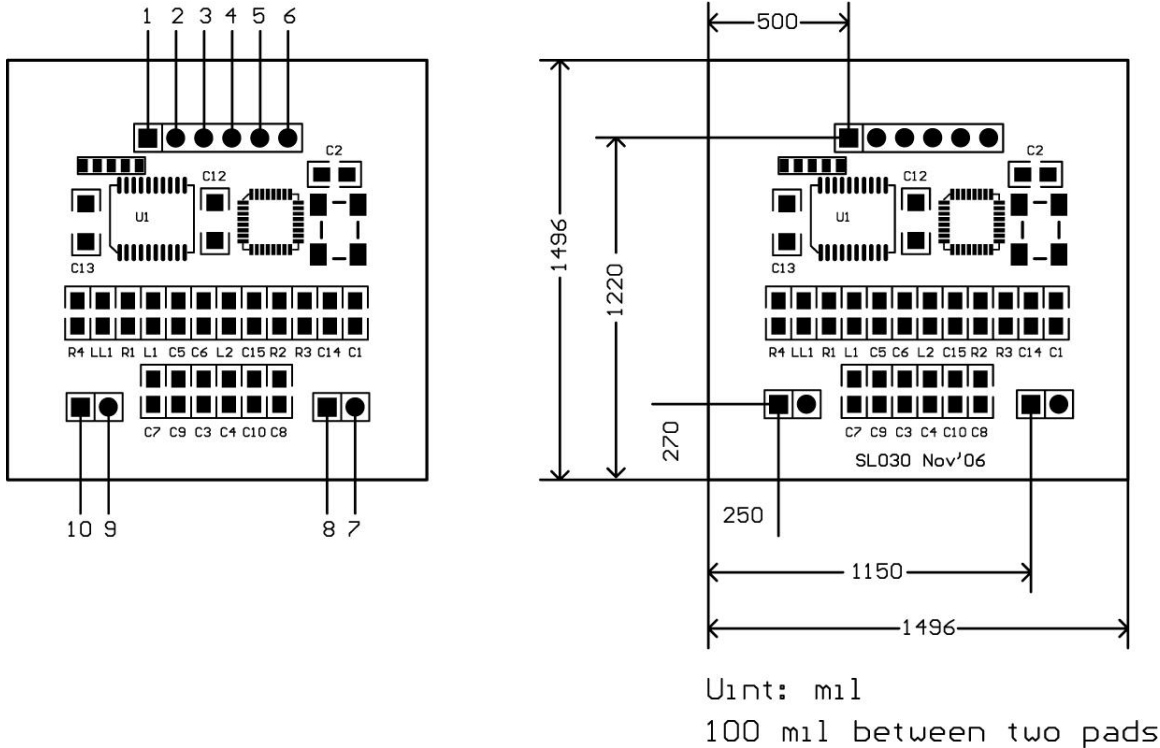
PIN	SYMBOL	TYPE	DESCRIPTION
1	VDD	PWR	Power supply, 2.7V to 3.6VDC
2	IN	Input	Falling edge wake up SL030 from power down mode
3	SDA	Input/Output	Serial Data Line
4	SLC	Input	Serial Clock Line
5	Out	Output	Tag auto-detection signal low level indicating tag in high level indicating tag out
6	GND	PWR	Ground
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.
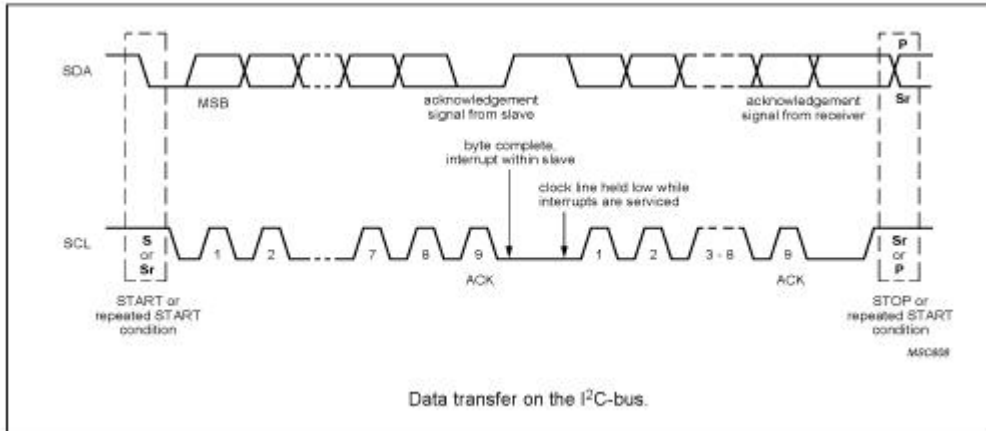
3-2. Start Condition
A high-to-low transition of SDA with SCL high is a start condition which must precede any other command

3-3. Stop Condition
A low-to-high transition of SDA with SCL high is a stop condition.

START and STOP conditions.
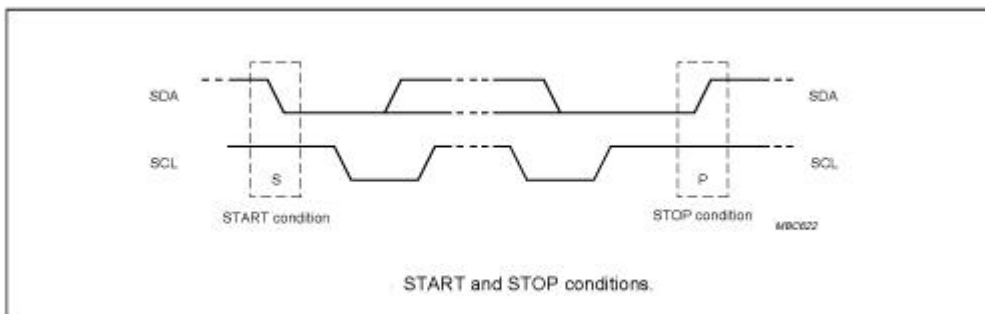
3-4. Acknowledge
All addresses and data words are serially transmitted to and from the SL030 in 8-bit words. The SL030 sends a zero to acknowledge that it is not busy, and has received each word. This happens during the ninth clock cycle.

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.
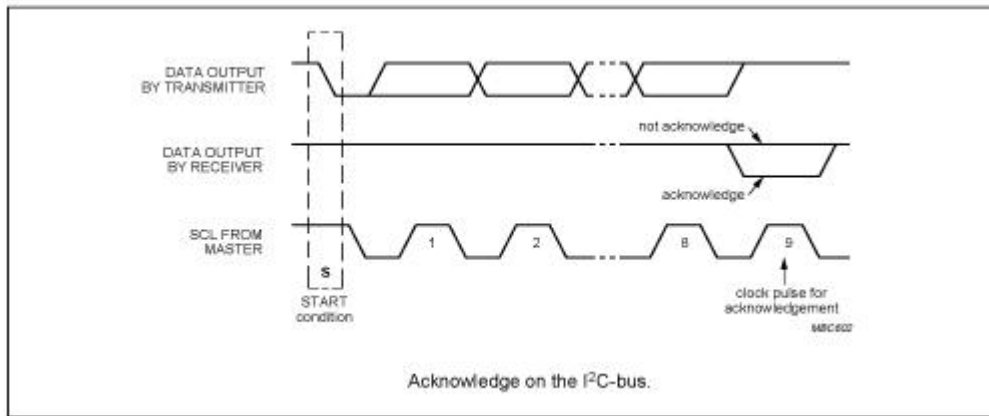
3-6. Device Addressing

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
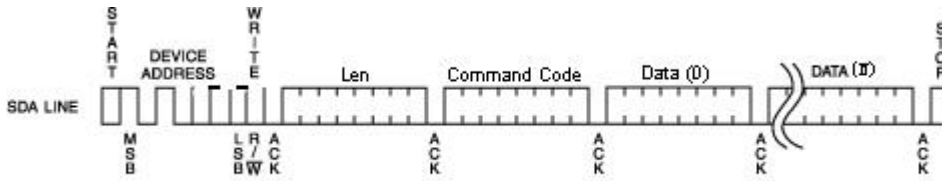
3-8. Read Operations

The host device passes to read the operation gets the order carries out the result
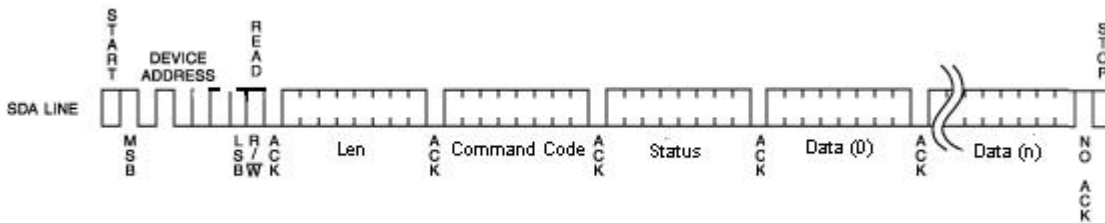
4. COMMAND DESCRIPTION

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: 0x01: MF1K_4B UID/ MFPLUS2K SL1_4B UID
      0x02: MF1K_7B UID/ MFPLUS2K SL1_7B UID
      0x03: MF Ultralight/MF Ultralight C/Ntag 203
      0x04: MF4K_4B UID/ MFPLUS4K SL1_4B UID
      0x05: MF4K_7B UID/ MFPLUS4K SL1_7B UID
      0x06: MF DESFire/MF DESFire EV1
      0x07: MFMini_4B
      0x08: MFMini_7B
      0x09: MF PROX
      0x21: MFPLUS2K SL2_4B UID
      0x22: MFPLUS4K SL2_4B UID
      0x23: MFPLUS2K SL2_7B UID
      0x24: MFPLUS4K SL2_7B UID
      0x31: MFPLUS2K SL0/SL3_4B UID
      0x32: MFPLUS4K SL0/SL3_4B UID
      0x33: MFPLUS2K SL0/SL3_7B UID
      0x34: MFPLUS4K SL0/SL3_7B UID
      0x0A: Other

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
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 V3.1 and the old SL030 V3.0, there are still some differences you need to know.
   1. Auto-detection: Suppots all cards.
   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)

FCC Statement
   15.19

1. 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.
(2) This device must accept any interference received, including interference that may cause undesired operation.

   15.21

Note: The grantee is not responsible for any changes or modifications not expressly approved by the party responsible for compliance. Such modifications could void the user's authority to operate the equipment.
   15.105(b)
  NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation.
This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. 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 turning 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

ORIGINAL EQUIPMENT MANUFACTURER (OEM) NOTES

- The OEM must certify the final end product to comply with unintentional radiators (FCC Sections 15.107 and 15.109) before declaring compliance of the final product to Part 15 of the FCC rules and regulations. Integration into devices that are directly or indirectly connected to AC lines must add with Class II Permissive Change.

- The OEM must comply with the FCC labeling requirements. If the module's label is not visible when installed, then an additional permanent label must be applied on the outside of the finished product which states: "Contains transmitter module FCC ID: 2ADI8-SL30120P. Additionally,the
following statement should be included
on the label and in the final product's user manual: "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 interferences, and (2) this device must accept any interference received, including interference that may cause undesired operation."

- The module is limited to installation in mobile or fixed applications. Separate approval is required for all other operating configurations, including portable configuration with respect to Part 2.1093 and different antenna configurations.

- A module or modules can only be used without additional authorizations if they have been tested and granted under the same intended end-use operational conditions, including simultaneous transmission operations. When they have not been tested and granted in this manner, additional testing and/or FCC application filing may be required. The most straightforward approach to address additional testing conditions is to have the grantee responsible for the certification of at least one of the modules submit a permissive change application. When having a module grantee file a permissive change is not practical or feasible, the following guidance provides some additional options for host manufacturers. Integrations using modules where additional testing and/or FCC application filing(s) may be required are: (A) a module used in devices requiring additional RF exposure compliance information (e.g., MPE evaluation or SAR testing); (B) limited and/or split modules not meeting all of the module requirements; and (C) simultaneous transmissions for independent collocated transmitters not previously granted together.

This Module is full modular approval, it is limited to OEM installation ONLY.
Integration into devices that are directly or indirectly connected to AC lines must add with Class II Permissive Change.
(OEM) Integrator has to assure compliance of the entire end product incluld the integrated Module.
Additional measurements (15B) and/or equipment authorizations (e.g Verification) may need to be addressed depending on co-location or simultaneous transmission issues if applicable.
(OEM) Integrator is reminded to assure that these installation instructions will not be made available to the end user of the final host device.

Test with the host (host model:T030, brand:StrongLink)