RFID MODULE

Mifare Reader / Writer

SL030
User Manual

Version 2.6
Nov 2012
StrongLink

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.

Please take attention that changes or modification not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Note: This product 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 product 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 product 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.

Important Information:

When the FCC identification number is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording such as the following: "Contains Transmitter Module FCC ID: 2ADI8-303132" or "Contains FCC ID: 2ADI8-303132" and the information should be also contained in the devices' user manual

This is a RFID module which can read and write data from/to a tag.
When a command(data) is sent to the module via its UART port, input data is bufferred in the MCU chip(LPC922). Then the data is translated and sent to RF chip(RC522) where the data is sent to the tag.
When the tag responds - it send response data back which is bufferred in the RC522, then sent to LPC922 where the data is also buffered.

The shielding should be made of matel material and the pitch of shielding grid should be smaller than 3cm. The shielding should cover every direction and the module is installed in the center. The distance between the module and the shielding should be more than 1cm. Pay attention, there should be no shielding above the top of the module and the size of the shieding vacancy should be at least the same size as the module's.Otherwise the RF signal can not reach the tag.

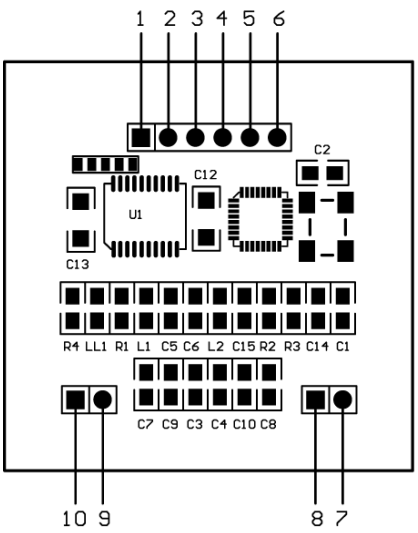
This module is powered via the VCC line soldered on the pin VCC of the interface port. The voltage range should be according to <User Manual>. And power supply's GND should be conneted with pin GND. The power supply should have short-circuit protection.

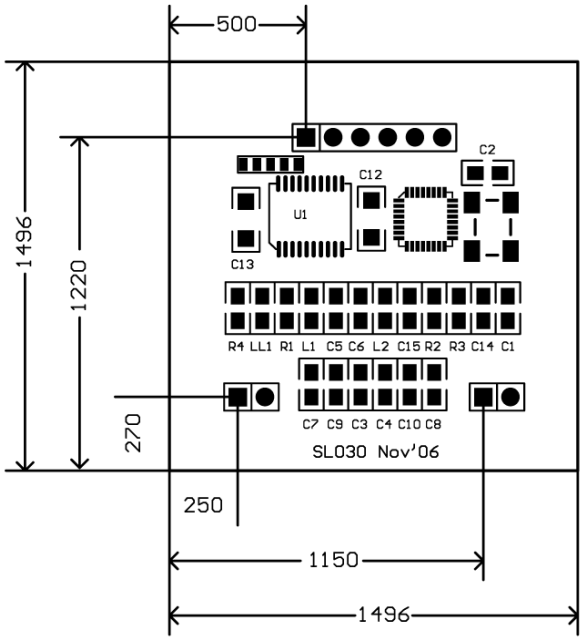
CONTENT

1. MAIN FEATURES

- Tags supported: Mifare 1k, Mifare 4k, Mifare UltraLight and NFC NTAG203
- Auto-detecting tag
- Built-in antenna
- 0 to 400 KHz bit-wide I^2C-bus communication
- 2.5 ~ 3.6V VDC operating, I/O pins are 5V tolerant
- Work current less than 40mA @3.3V
- Power down current less than 10uA
- Operating distance: Up to 50mm, depending on tag
- Storage temperature: -40 ℃ ~ +85 ℃
- Operating temperature: -25 ℃ ~ +70 ℃
- Dimension: 38 × 38 × 3 mm
- The OUT pin at low level indicates tag in detective range, and high level indicating tag out

2. PINNING INFORMATION





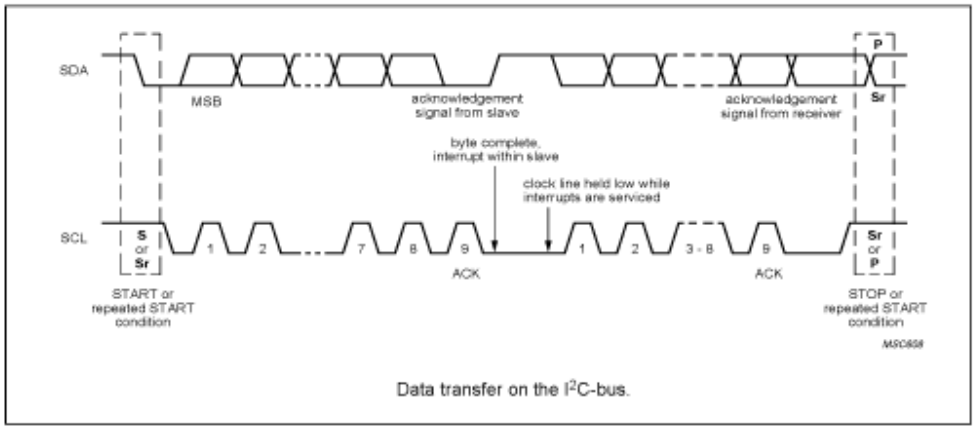
Uint: mil
100 mil between two pads

PIN	SYMBOL	TYPE	DESCRIPTION
1	VDD	PWR	Power supply, 2.5V 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 detect signal low level indicating tag in high level indicating tag out
6	GND	PWR	Ground
7	NC		
8	NC		
9	NC		
10	NC		

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.



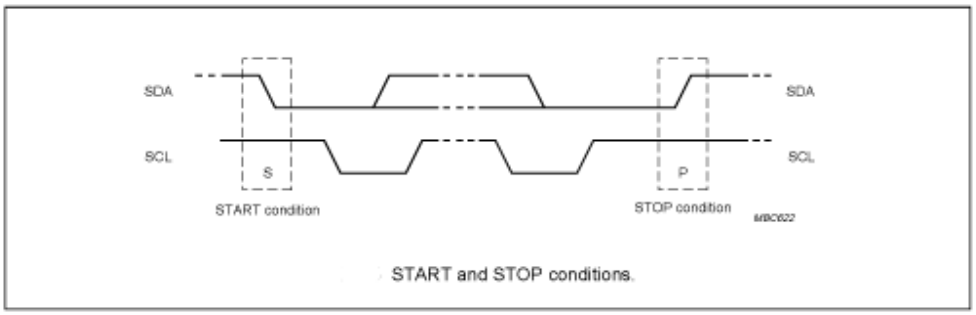
Data transfer on the I²C-bus.

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.



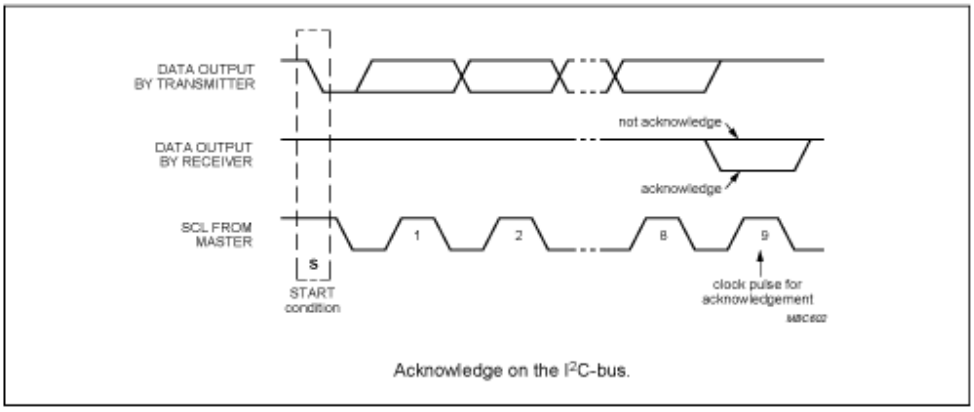
START and STOP conditions.

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

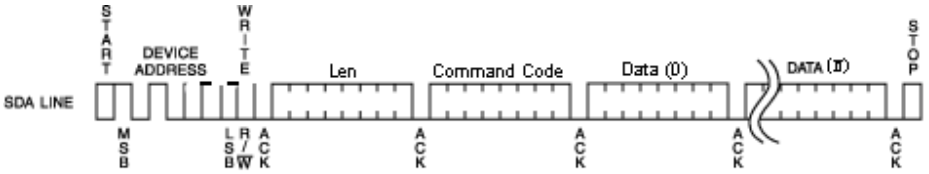
	JP1	JP2	Address
shorted	no	no	1010000 (default)
	no	yes	1010001
	yes	no	1010010
	yes	yes	1010011

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.

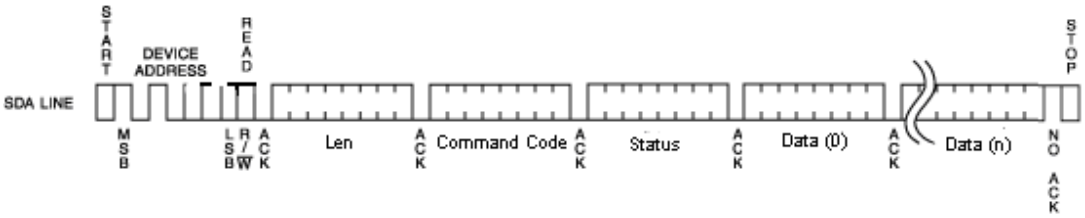
3-7. Write Operations

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
0x50	Go to Power Down mode
0xF0	Get firmware version

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

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: Mifare 1k, 4 byte UID
0x02: Mifare 1k, 7 byte UID [1]
0x03: Mifare UltraLight or NATG203[2], 7 byte UID
0x04: Mifare 4k, 4 byte UID
0x05: Mifare 4k, 7 byte UID [1]
0x06: Mifare DesFire, 7 byte 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

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
0xF0: Checksum error

Data: page data written if operation succeeds, 4 bytes.

4-3-15. Power Down

Host Write:

Len	0x50

Host Read:

No response until falling edge at PIN2 or repower

4-3-16. Get firmware version

Host Write:

Len	0xF0

Host Read: [3]

Len	0xF0	Status	Data

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

Remark

[1] In order to support 7 byte UID Mifare class, the firmware of SL030 has been updated to Ver3.2 in Mar 2011.
And older firmware version (such as Ver1.0, 2.0, 2.2, etc) only supports 4 byte UID.
Please refer to NXP Customer Letter UID for detailed information of 4 byte & 7 byte UID of Mifare products.

[2] To support NATG203, the firmware of SL030 has been updated to Ver3.9 in May 2012. The older firmware version only supports reading/writing data page address less than 16.

[3] One sample of SL030 response

	Len	Command	Status	Data (Firmware version)
HEX	0B	F0	00	53 4C 30 33 30 2D 33 2E 32
ASCII				"SL030-3.2"