M519-SUV Data Sheet and Integration Guide

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Document Identification

Category	Datasheets
Group/Family	SpringCore / M519
Reference & Version	PFT23234-AB
Date	27/09/2023
Diffusion	Public
Keywords	M519-SUV

Revision History

Version	Date	Author	QC	Description
AA	12/09/2023	CFE		Preview
AB	24/10/2023	JDA	CFE	First public release (but still with a lot of *TBD*)

Table of Contents

1 Introduction

1.1 Overview

This document describes the functionalities and electrical specifications of the SpringCard SpringSeed M519-SUV OEM NFC/RFID HF module with antenna, using firmware version 1.30 or higher.

1.2 Related documents

1.2.1 Documents available as PDF

Reference	Title / Description
PFT22217	M519 Datasheet and Hardware Integration Guide
PMD23175	M519-SRK Getting Started Guide
PNA23174	Using the M519 in PC/SC Coupler mode over a Serial interface
PNA23207	Using the M519 in PC/SC Coupler mode over a USB interface
PNA23208	Using the M519 in Smart Reader or RFID Scanner mode
PNA23189	Using the M519 in SpringProx Legacy mode

1.2.2 Online material

Documentation of the SpringCore firmware.

https://docs.springcard.com/books/SpringCore/Welcome

SpringCard Tech Zone, the blog of the R&D Team

https://tech.springcard.com/

1.3 Order codes

The M519 is highly configurable, and supports many operating modes. The M519-SUV adds a selectable electrical layer for the Serial interface. A variety of order codes are available, enabling customers to tailor the M519-SUV to streamline their integration process. However, it must be remembered that changing the configuration of the device is straightforward, ensuring flexibility in deployment scenarios.

Order code	Model	USB	Serial	Mode	Option	MOQ
SC23219	M519-SUV	Yes	**RS-TTL**	**PC/SC**		10 units
SC23220	M519-SUV	Yes	**RS-232**	**PC/SC**		30 units
SC23222	M519-SUV	Yes	**RS-TTL**	**RFID Scanner**	**QWERTY**	30 units
SC23221	M519-SUV	Yes	**RS-TTL**	**RFID Scanner**	**AZERTY**	10 units
SC23223	M519-SUV	Yes	**RS-TTL**	**Smart Reader**	**Protocol MK1**	10 units
SC23224	M519-SUV	Yes	**RS-232**	**Smart Reader**	**Protocol MK1**	30 units
SC23225	M519-SUV	Yes	**RS-485**	**Smart Reader**	**Protocol MK1**	30 units
SC23226	M519-SUV	Yes	**RS-TTL**	**SpringProx Legacy**		10 units
SC23227	M519-SUV	Yes	**RS-232**	**SpringProx Legacy**		30 units

Custom configurations may be created upon request (typically, Smart Reader mode with a different protocol, RFID Scanner mode with a different keyboard layout, and/or customer-specific Card Acceptance Templates), with a MOQ of 120 units. Contact SpringCard Sales team for more information.

Warning: The in-the-field reconfigurability of the M519-SUV, encompassing even the electrical layer, allows for post-deployment modifications. Consequently, a device's actual setup is likely to differ from its delivery setup. This may be a source of confusion for after-sales services, when doing a retrofit or when ordering new batches.

2 About the SpringSeed M519-SUV

2.1 General description

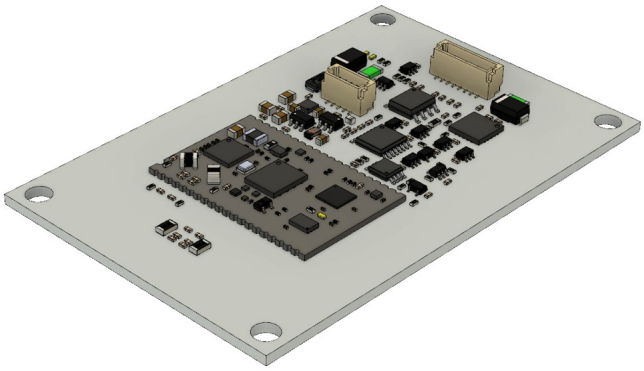


Figure 1: 3D view of the M519-SUV

The SpringCard SpringSeed M519-SUV is a compact OEM NFC/RFID HF versatile device that integrates a M519 module and a coil antenna. It is designed to be used in industrial equipments or consumer devices.

The M519-SUV inherits all the operating modes from the M519 (PC/SC Coupler, Smart Reader, RFID Scanner, etc), with a choice between USB and Serial interfaces. The Serial option encompasses three electrical layers: RS-TTL, RS-232 or RS-485.

The overall dimensions (69x45mm), the location of the mounting holes and the connectivity (Serial on JST-8, USB on JST-5) make it a drop-in replacement for earlier SpringCard products from the K531, K632, K663 and H663 families.

The M519-SUV is able to communicate with virtually any contactless smart card, RFID label, NFC tag or NFC smartphone compliant with one of the standard technologies in the 13.56MHz range. The 69x45mm antenna is optimised for ID-1 cards (class I, II and III as per ISO/IEC 14443-1) and smartphones, while maintaining compatibility with smaller form factors tags.

2.2 Features and benefits

2.2.1 Ease of integration into any machine or assembly

- Small design (69.0x45.0mm, 5.9mm max. thickness),
- NXP PN5190 NFC/RFID HF frontend allowing best in-class performance/power ratio,
- Self-antenna tuning capability to deliver optimal performance even in harsh environments,
- Single-source power supply, power saving modes, low power card detection features on less than 5µA.

2.2.2 Ease of integration for any application and use case

- Serial interface supporting a various choice of protocols, making it easy to operate the module even from low-end MCUs,
- Single hardware supporting three electrical layers for the Serial interface (RS-TTL, RS-232, RS-485),
- USB interface supported by Linux (even low-end embedded SOCs), Windows and macOS,
- In-the-field configuration and firmware upgrade (flash) without interruption,
- Comprehensive starter kit and a wide range of SDK and samples available for free on GitHub,
- Compliant with earlier SpringCard SDKs and software libraries (PC/SC, SpringProx, etc).

2.2.3 Open and interoperable

- Standard-compliant USB CCID (PC/SC) and USB HID keyboard wedge (RFID Scanner) profiles,

- Digital layer of the Contactless stack pre-validated against the following test suites[1]:
  - EMV CL L1,
  - NFC Forum CR12 and CR13,
  - CEN/TS 16794 aka ISO/IEC/TS 24192, RCTIF 5,
- Support of Apple Pay ECP1 and ECP2 for Passkit / Apple VAS applications, support of Google Smart Tap,
- Support of NXP Mifare and NTAG families, the largest portfolio of contactless cards.

2.3 Typical applications

- Public transport, public bike systems, car sharing,
- Car-park gates or cashiers,
- Kiosk, vending machines,
- Mobile or affixed terminals for loyalty, events, gaming...
- Access control, secure identification,
- and more.

2.4 Integration, development and ready-to-use derived products

The M519-SRK is a complete Starter Kit for customers who want to evaluate the M519 module and then build their own solution around it. It makes it easy for integration and development engineers to get to grips with the module. Software developers who want

1 Actual conformance (Digital and Analogue layers) depends on the hardware integration and on the configuration; complete validation must be performed on the assembled product. The analogue characteristics of the M519-SUV may not fulfil all the requirements of all these standards. Contact us for expertise should you need to pass a certification.

to integrate the M519-SUV in their solution will find all relevant information in the Getting Started Guide that comes with the M519-SRK ([PMD23175]) and with the related Application Notes.

3 Technical data

3.1 General

Dimensions	69.0 x 45.0 x 5.9 mm
Weight	Approx. 12g
Power supply	3.3V or 5V nominal for Serial operation 5V (powered by the bus) for USB operation
Power requirement	Nominal: 200mA Max: 400mA Power saving: < 1mA
Temperature range	Operating temperature: -20 to +70°C Storage temperature: -20 to +70°C
Environment	Humidity 0 – 90% (non condensing)

3.2 NFC/RFID HF (contactless) Interface

3.2.1 Coupler and Smart Reader operation

NFC/RFID HF carrier	13.56MHz
Antenna	Integrated balanced coil, gain -57dBi
RF power	Max 2W (33dBm)
Field level	2.5A/m at 25mm
Operating distance	Up to 80mm depending on card and environment
Supported standards	ISO/IEC 14443 A & B (PCD) / NFC-A and NFC-B ISO/IEC 15693 (VCD) and ISO/IEC 18000-3M1 / NFC-V ISO/IEC 18000-3M3 (RFID HF) / EPC HF JIS X 6319-4 / NFC-F ISO/IEC 21481 (NFCIP-2)
Bitrates	26, 53, 106, 212, 424, 848 kbit/s depending on the protocol
Supported card technologies (partial list)	NFC Forum types 1, 2, 3, 4 and 5 Mifare Classic with CRYPTO1 All cards in NXP Mifare families: Mifare Plus, Mifare UltraLight, Desfire, All cards in NXP NTAG and ICODE families Innovatron (Calypso cards) STMicroElectronics SR & LR Infineon SLE44, SLE66, SRF55 Texas Instrument Tag-it Sony FeliCa Lite Apple ECP, Apple VAS (PassKit NFC), Google Smart Tap and other NFC applications on smartphones Inside Secure PicoPass / HID iClass (ID only)
Advanced features	Low power card detection Automatic waveform control

3.2.2 Card emulation and peer-to-peer operation

Supported standards	ISO/IEC 14443 A (PICC) / emulation of NFC Forum Type 4A Tag ISO/IEC 18092 (NFCIP-1) active and passive, initiator and target
Bitrates	106, 212, 424 kbit/s depending on the protocol

3.3 Host Interfaces

3.3.1 USB

Standard	USB 2.0 device, compatible with USB 3
Bitrate	Full speed (12Mbps)
Profiles	CCID (PC/SC) HID keyboard CDC-ACM (serial emulation) SpringCore Direct

3.3.2 Serial

The serial interface of the M519-SUV supports 3 different electrical configurations (see § 6.4).

Warning: the default, out-of-factory configuration (that is defined by the order code and namely written on the label or the packaging) may have be overwritten by a user-defined configuration. Observe the LEDs (§ 4.3 and § 6.4) to know the active configuration.

3.3.2.1 Common data

Bitrate	38400bps (default), up to 500kbps after handshaking
Format	8 data bits, 1 stop bit, no parity, no flow control
Protocols	CCID over Serial SpringProx Legacy SpringCore Direct RDR MK1 $SCRDR

3.3.2.2 RS-TTL configuration

Physical interface	RX/TX @ 0/3.3V or 0/5V (compliant with TTL & CMOS peers)

3.3.2.3 RS-232 configuration

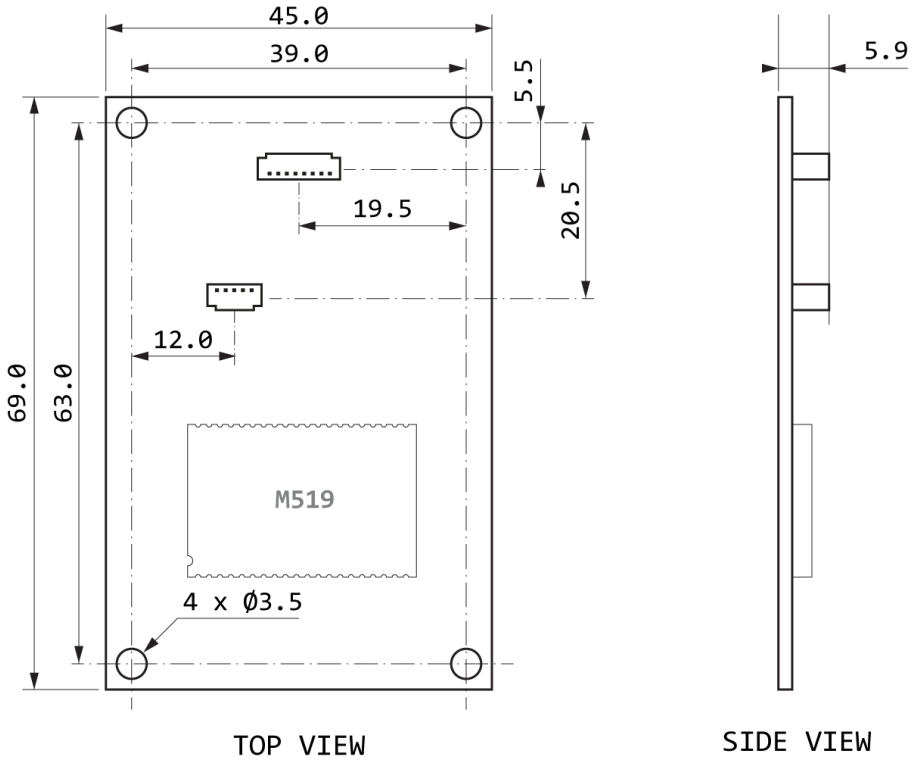
Physical interface	RX/TX @ -12/+12V according to EIA-232

3.3.2.4 RS-485 configuration

Physical interface	Bus A / Bus B according to EIA-485

4 Mechanical specification

4.1 Dimensions



ALL DIMENSIONS IN MILLIMETERS
PRINT VERSION NOT TO SCALE
(APPROX 1:1)
OUTLINE TOLERANCE ±0.25MM - TOLERANCE ON DRILLING Ø ±0.05MM

Figure 2: Mechanical specifications

4.2 Pinout

4.2.1 USB connector

J2 is a SM05B-SRSS-TB JST 5-position connector, dedicated to connecting the M519-SUV with its host, using USB as primary interface.

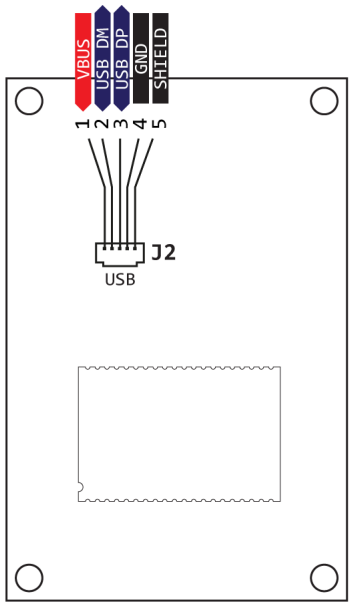


Figure 3: Pinout of J2

Pin	Symbol	Type	Description
# 1	**VBUS**	USB	Digital power supply + USB presence, 5V
# 2	**USB_DM**	USB	USB D- signal
# 3	**USB_DP**	USB	USB D+ signal
# 4	**GND**	Ground	Ground signal inside the USB cable
# 5	**SHIELD**	Ground	Shield of the USB cable

4.2.2 Serial connector

J1 is a BM08B-SRSS-TB(LF)(SN) JST 8-position connector. It is dedicated to connecting the M519-USB with its host, using the Serial port as primary interface. Power is supplied to the device through the VCC (5V) power input.

The role of the communication pins depends on the electrical configuration of the serial interface (see § 6.4): RX/TX for RS-TTL or RS-232, Bus A/ Bus B for RS-485.

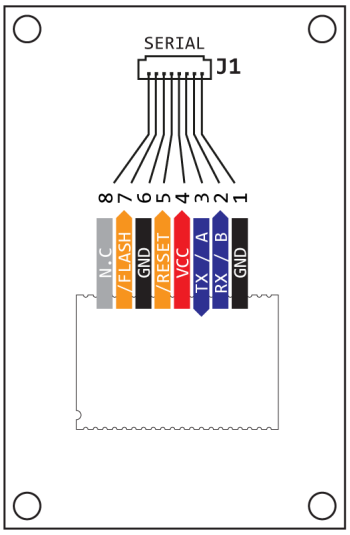
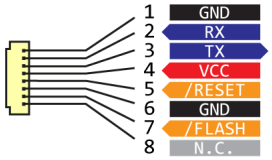


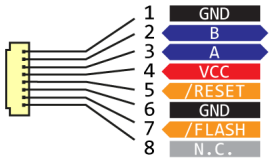
Figure 4: Pinout of J1

4.2.2.1 RS-TTL and RS-232



Pin	Symbol	Type	Description
# 1	**GND**	Ground	
# 2	**RX**	In	Main UART, host to module
# 3	**TX**	Out	Main UART, module to host
# 4	**VCC**	Power	External power supply 5V
# 5	**/RESET**	In	Reset the module
# 6	**GND**	Ground	
# 7	**/FLASH**	In	Force DFU (bootloader) mode upon reset
# 8	**N.C.**		Leave unconnected

4.2.2.2 RS-485



Pin	Symbol	Type	Description
# 1	**GND**	Ground	
# 2	**BUS_A**	In	Main UART, RS-485 bus A line
# 3	**BUS_B**	Out	Main UART, RS-485 bus B line
# 4	**VCC**	Power	External power supply 5V
# 5	**/RESET**	In	Reset the module
# 6	**GND**	Ground	
# 7	**/FLASH**	In	Force DFU (bootloader) mode upon reset
# 8	**N.C.**		Leave unconnected

4.3 LEDs

The M519-SUV features 3 LEDs:

- LED 0 is on the M519 module itself and shows its the status (see [PFT22217] for details),
- LED 1 and LED 2 are on the antenna; they show the configuration of the Serial interface (see § 6.4 for details).

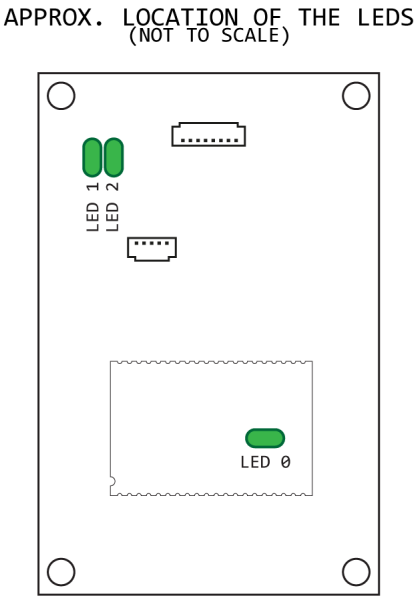


Figure 5: Location of the 3 LEDs

5 Electrical specification

5.1 Limiting values

Stresses beyond those listed under 'Limiting values' may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these conditions is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Symbol	Parameter	Conditions	Min	Max	Unit
VCC_{ABS}	Supply voltage on pin VCC		0	5.5	V
$VBUS_{ABS}$	Supply voltage on pin VBUS		0	5.5	V
V_{DIG}	Voltage on any digital pin		0	VCC or VBUS + 0.2	V
V_{ESD}	Electrostatic discharge voltage		-500	500	V
$T_{JUNCTION}$	Junction temperature		—	+120	°C
$T_{STORAGE}$	Storage temperature	No voltage applied	-20	+70	°C

5.2 Power

5.2.1 Power supply voltage

5.2.1.1 USB operation

Symbol	Parameter	Min	Typical	Max	Unit
VBUS	Digital supply voltage, USB	4.5	5.0	5.2	V

J1 shall be left unconnected for USB operation.

5.2.1.2 Serial operation

Symbol	Parameter	Min	Typical	Max	Unit
VCC	Digital supply voltage, Serial	3.0	—	5.2	V

J2 shall be left unconnected for Serial operation.

5.2.2 Current consumption

5.2.2.1 USB operation

Symbol	Parameter / Conditions	Min	Typical	Max	Unit
$I_{VBUS,IDLE}$	VBUS active but device not enumerated	—	30	40	mA
$I_{VBUS,RF\ OFF}$	Device enumerated, RF not active	—	30	40	mA
$I_{VBUS,RF\ ON}$	Device enumerated, RF active	—	140	340*	mA

* Max RF power may be restricted by configuration, to reduce the total power requirement (at the price of a shorter operating range).

5.2.2.2 Serial operation, VCC=3.3V

Symbol	Parameter / Conditions	Min	Typical	Peak	Unit
$I_{VCC,RF\ OFF}$	RF not active	—	35	50	mA
$I_{VCC,RF\ ON}$	RF active	—	150	360*	mA
$I_{VCC,LPCD}$	Waiting for a card, low power mode	—	0.2	1	mA

* Max RF power may be restricted by configuration, to reduce the total power requirement (at the price of a shorter operating range).

5.2.2.3 Serial operation, VCC=5V

Symbol	Parameter / Conditions	Min	Typical	Peak	Unit
$I_{VCC,RF\ OFF}$	RF not active	—	30	40	mA
$I_{VCC,RF\ ON}$	RF active	—	140	340*	mA
$I_{VCC,LPCD}$	Waiting for a card, low power mode	—	0.2	1	mA

* Max RF power may be restricted by configuration, to reduce the total power requirement (at the price of a shorter operating range).

5.3 /RESET and /FLASH pins

This digital input pin has a permanent internal pull-up resistor.

Symbol	Parameter	Min	Typical	Max	Unit
V_{IL}	Low level input voltage	—	—	1.0	V
V_{IH}	High level input voltage	2.4	—	—	V
I_{IL}	Low level input leakage current	55	80	165	µA
I_{IH}	High level input leakage current	-1	±0.01	1	µA

5.4 Serial interface, RS-TTL mode

5.4.1 RX pin

Symbol	Parameter	Min	Typical	Max	Unit
V_{IL}	Low level input voltage	—	—	0.8	V
V_{IH}	High level input voltage	2	—	VCC	V
I_I	Input leakage current	—	—	±5	µA

5.4.2 TX pin

Symbol	Parameter	Conditions	Min	Typical	Max	Unit
V_{OL}	Low level output voltage	I_{OL}=1mA	—	—	0.65	V
V_{OH}	High level output voltage	I_{OH}=1mA	2.4	—	VCC	V
I_{OS}	Short circuit output current		—	±24	±32	mA
SR	Up or down transition time		—	—	0.04	µs

5.5 Serial interface, RS-232 mode

5.5.1 RX pin

Symbol	Parameter	Min	Typical	Max	Unit
V_{IL}	Low level input voltage	—	-5	0.6	V
V_{IH}	High level input voltage	2.4	5	—	V
R_I	Input resistance	3	5	7	kΩ

5.5.2 TX pin

Symbol	Parameter	Conditions	Min	Typical	Max	Unit
V_{OL}	Low level output voltage	I_{OL}=1mA	—	-5.4	-5	V
V_{OH}	High level output voltage	I_{OH}=1mA	5	5.4	—	V
I_{OS}	Short circuit output current		—	±35	±60	mA
SR	Up or down transition time		—	—	0.4	µs
R_O	Output resistance		300	10M	—	Ω

5.6 Serial interface, RS-485 mode

Symbol	Parameter	Conditions	Min	Typical	Max	Unit
V_{ID}	Differential input voltage, limits	Receiver	-12	—	12	V
I_I	Bus input current	Receiver	-100	—	130	µA
V_{IL}	Low level differential voltage	Receiver	—	-1.5	-0.2	V
V_{IH}	High level differential voltage	Receiver	-0.1	0	—	V
V_{OD}	Differential output voltage	Transmitter	—	-1.5	—	V
I_{OS}	Short circuit output current	Transmitter	—	—	±265	mA

6 Application information

6.1 Operating modes, profiles and protocols

The M519-SUV is a versatile device, based on the SpringCard SpringCore firmware, that supports many operating modes. Every operating mode is associated to one or more USB profile and Serial communication protocol. The choice of the operating mode and of the host interface is done upon reset (see § 6.3).

The paragraphs below summarizes the options and explains the basics; for a complete reference, please read the documentation of the SpringCore firmware:

https://docs.springcard.com/books/SpringCore/Introduction/Operating_Modes

6.1.1 PC/SC Coupler mode

In this mode, the M519-SUV is a complete smart card coupler: it can perform any transaction with a smart card, under full control of an application running in the host computer.

The smart card may be either contact or contactless (NFC/RFID) depending on only on its hardware interface, but operated the same way seen from the software interface.

As a PC/SC device, the M519-SUV is typically associated to a PC/SC driver and is supported by the computer's PC/SC stack.

The PC/SC Coupler mode is selected by writing $_{H}02$ into configuration register $_{H}02C0$.

6.1.1.1 USB

When the PC/SC Coupler mode is selected and the host interface is USB, the M519-SUV is a compound device that exposes both the CCID profile and the SpringCore Direct profile.

The CCID profile of the M519 is fully supported by the open-source CCID driver available on Linux together with the PC/SC-Lite stack, and by the CCID driver and PC/SC stack

provided by Apple for macOS. For Microsoft Windows, SpringCard driver SD16055 shall be used[2].

6.1.1.2 Serial

When the PC/SC Coupler mode is selected and the host interface is Serial, the M519-SUV uses the CCID over Serial protocol.

See Application Note PNA23174 “Using the M519 in PC/SC Coupler mode over a Serial interface” for reference.

6.1.2 Smart Reader mode

In this mode, the M519-SUV is an autonomous or NFC/RFID reader.

It automatically grabs a token from a contactless cards, NFC tags or RFID labels, before transmitting it to the host. This simplifies the development of the host application, because the M519-SUV runs the transaction with the card, tag or label in a standalone-reader approach.

This also makes it possible to use a fast anticollision/inventory scheme, overriding the bottleneck introduced by a slow computer-based transaction or a too complex driver stack.

The Smart Reader mode is selected by writing $_H$03 into configuration register $_H$02C0.

6.1.2.1 USB

When the Smart Reader mode is selected and the host interface is USB, the M519-SUV is a compound device that exposes both the HID keyboard profile and the SpringCore Direct profile.

Thanks to the standard HID keyboard profile, the M519-SUV is automatically recognized as a keyboard by all the major operating systems that support USB (Windows, macOS, Linux, Android, iOS…), and the data collected from NFC/RFID tags are automatically received as key-strokes in the active application. SpringCard calls this feature “RFID Scanner”.

2 Microsoft also provides a CCID driver that works fine with the M519-SUV, but unfortunately this driver does not work with all configurations of the M519, nor with all SpringCard products. Using SpringCard driver instead simplifies the development and the technical support.

For correct operation, the user must configure the M519-SUV with the same keyboard layout as the host system.

6.1.2.2 Serial

When the Smart Reader mode is selected and the host interface is Serial, the M519-SUV sends the data collected from NFC/RFID tags over its serial line, using the protocol selected in configuration register $_H$02A0.

- **$SCRDR protocol** (default): data come as ASCII strings, starting with constant value "$SCRDR".

Format specification:

```
$SCRDR;<Interface>;<Protocol>;<Template>;<RSSI>;<TagId>;<Move>;<TagData>;<TagDetails>*<Checksum><CR><LF>
```

Example:

```
$SCRDR;13.56;NFC-A;1;;047DAE02C84080;;00047DAE02C84080;*47<CR><LF>
```

- **MK1 protocol**: this is a legacy protocol, taken from earlier SpringCard devices, that provides only the TagId. The $SCRDR protocol shall be preferred.

Example:

```
+047DAE02C84080<CR><LF>
```

- **JSON protocol**: data is encapsulated in a JSON object.

Example:

```
{
      "Interface":"13.56",
      "Protocol":"NFC-A",
      "Template":1,
      "TagId":"047DAE02C84080",
      "TagData":"00047DAE02C84080",
      "Uptime":"699:16.850"
}
```

- **TLV protocol**: data object uses ASN.1 binary encoding rule.

Example:

```
B0 0E C1 04 00 03 01 01 C2 07 04 7D AE 02 C8 40 80
```

6.1.3 SpringProx Legacy

SpringProx Legacy is the proprietary protocol and mode of operation introduced in the 2000's with the first generation of SpringCard devices. PC/SC Coupler mode and the CCID protocol shall be preferred when designing a new system.

It must be understood by the developer/implementer that the M519-SUV is not a drop-in replacement for earlier devices of the K531, K632 or K663 generations. The high-level behaviour is the same, but low-level control of the RF interface has to be rewritten. Anyway, in most situations, the migration process is straightforward provided that you have access to the source code of the Legacy application.

The SpringProx Legacy mode and protocol are selected by writing $_H$01 into configuration register $_H$02C0.

6.1.3.1 USB

When the SpringProx Legacy is selected and the host interface is USB, the M519-SUV uses the USB CDC ACM profile (communication device class, abstract control model). It is automatically recognized as a (virtual) communication port by all the major desktop operating systems (Windows, macOS, Linux...). The M519-SUV accepts SpringProx Binary and ASCII messages (not OSI3964) and it is possible to use the `springprox.dll` over this (virtual) communication port without a change.

6.1.3.2 Serial

When the SpringProx Legacy is selected and the host interface is Serial, the M519-SUV accepts SpringProx Binary and ASCII messages (not OSI3964) and it is possible to use the `springprox.dll` without a change.

6.2 Firmware upgrade

6.2.1 USB

When the device is connected to the host through its USB interface, upgrading the firmware of the M519-SUV could be done in-the-field, over a live system (Live upgrade). The typical firmware upgrade procedure is:

- A new firmware is transmitted using the Direct protocol while the M519-SUV is operating “normally” (this new firmware is written in a temporary storage area),
- When the M519-SUV resets, its bootloader copies the new firmware from the storage area to the ROM of the microcontroller,
- The M519-SUV resets again, running its new firmware.

To perform the upgrade over USB, use either:

- SpringCoreFlash, a command line tool (member of the SpringCore Tools suite) that is easy to deploy and run unattended

  https://www.springcard.com/fr/download/find/file/sq20029

- SpringCard Companion, a web application + local service, for a more user-friendly experience.

  https://companion.springcard.com

6.2.2 Serial

Live upgrade is possible over the Serial interface only when the device is configured for the SpringCore Direct protocol, fail-safe mode—which normally never happens in the field.

There are 3 different ways to upgrade a device that is connected through a Serial line,

1. Send the software RESET command to the device, with $_{H}$FA $_{H}$DA as parameters to have the device restart in bootloader mode, and write the new firmware using the bootloader over the Serial interface,

Documentation of the RESET command:

https://docs.springcard.com/books/SpringCore/Host_Protocols/Direct_Protocol/CONTROL_class/Actions/RESET

Documentation of the bootloader protocol:

https://docs.springcard.com/books/SpringCore/Host_Protocols/Direct_Protocol/DFU_class/index

2. Assert the /FLASH input line to LOW level and perform a hardware RESET of the device to have it restart in bootloader mode, and write the new firmware using the bootloader over the Serial interface,

Documentation of the bootloader protocol:

https://docs.springcard.com/books/SpringCore/Host_Protocols/Direct_Protocol/DFU_class/index

3. Connect a USB cable temporarily, and perform the firmware upgrade through USB.

Solution 3 is definitively the easiest to implement, but it requires a human intervention over the device.

6.3 Reset configuration

When the M519-SUV is powered-up or its /RESET pin is risen (Low to High transition), the module resets and probes VCC, VBUS and /FLASH to read its reset configuration.

The reset configuration defines:

1. whether the host interface is the serial line or the USB bus,

VBUS	VCC	Host interface
5V	—	USB
unconnected	**5V**	Serial

Do not connect anything to the J2 connector unless you want to use USB.

2. whether the M519 activates its main firmware or stays in bootloader mode,

/FLASH	Firmware activation
LOW	M519 runs its bootloader
HIGH	M519 runs its firmware

You may leave the /FLASH pin unconnected if your application does not need to activate the bootloader.

6.4 Type of Serial interface

The hardware configuration (electrical levels) of the Serial interface is driven by register $_H$029F.

On startup, the two LEDs on the antenna show which configuration has been activated during. After ten seconds, both LEDs go OFF to reduce the overall power consumption.

Register $_H$029F	Serial interface	LED 1	LED 2	Remark
$_H$00	RS-TTL	ON	ON	
$_H$01	RS-232	ON	OFF	
$_H$02	RS-485	OFF	ON	
other	RS-TTL	OFF	OFF	*Do not use*

6.5 Serial shell

The M519-SUV features a “human console” shell, that is available over its Serial interface

- whatever the operating mode,
- whether the host interface is Serial or USB.

The shell is namely used to explore or fine-tune the M519-SUV, or debug the system.

The communication parameters are:

- Baudrate: 38400bps,
- Format: 8 data bits, 1 stop bit, no parity, no flow control.

Note that if the shell is always enabled with these parameters when the device resets, it is generally disabled once the host has activated another protocol or changed the communication parameters. Always reset the device before trying to use the shell.

Send *<CR><LF>* to get the prompt of the device, that exposes its version and current operating mode.

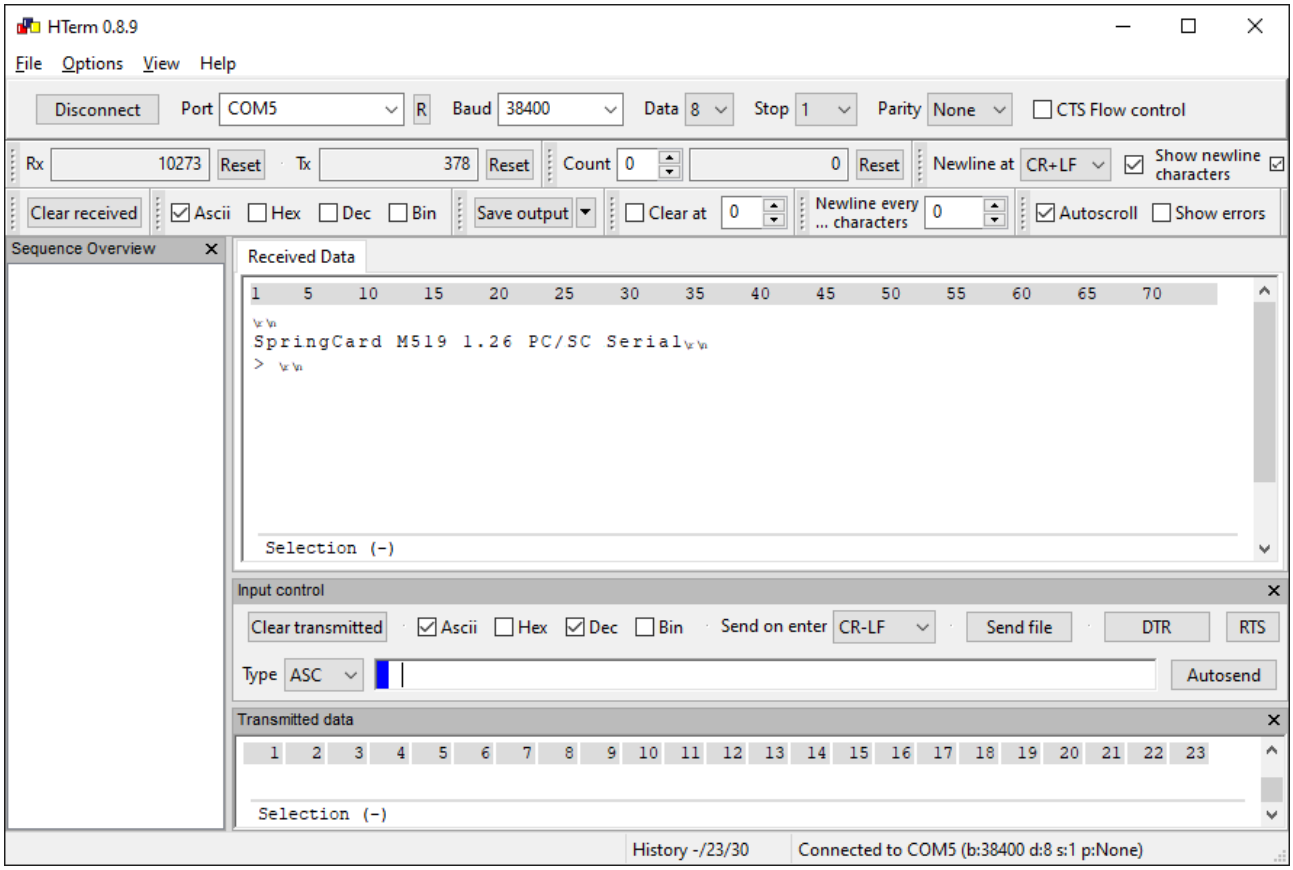


Figure 6: Terminal application 'HTerm' showing the M519's prompt

In the snapshot above,

- "v1.26" is the version number of the firmware. Newer firmwares will show another version number,
- "PC/SC" is the operating mode. Other possible values are "Direct", "SmartReader", "RFIDScan" and "Legacy",
- "Serial" is the primary host interface. Other possible value is "USB".

Enter `help`*<CR><LF>* to read the list of available commands.

Remark: the prompt does not reflect the fact that the device is a M519-SUV. The firmware is generic and its prompt is “M519” in all situations.

6.6 Configuring the M519-SUV

The M519-SUV is highly configurable. You may download a configuration file from SpringCard Companion, or use a configuration file provided by SpringCard or a 3rd party. Configuration files use either the JSON or the CFG format.

The new configuration may be injected into the M519-SUV by the mean of a software provided by SpringCard, by the host application itself, or using a Master Card. When exploring/evaluating the M519-SUV, it is also possible to edit the configuration with the shell.

Warning: writing an invalid configuration may disable the host interface(s) and prevent any communication with the device. Pay particular attention to register $_{H}$029F since it drives the electrical level of the Serial interface.

6.6.1 SpringCard configuration software

When the host uses the USB interface, in-the-field, Live configuration by SpringCard-provided software is always possible, because the Direct protocol is always available (at least as a secondary profile in the compound device).

To write a new configuration over USB, use either:

- SpringCoreConfig, a command line tool (member of the SpringCore Tools suite) that is easy to deploy and run unattended

  https://www.springcard.com/fr/download/find/file/sq20029

- SpringCard Companion, a web application + local service, for a more user-friendly experience.

  https://companion.springcard.com

6.6.2 Configuration through Master Cards

This feature is not yet implemented in the current version of the firmware.

6.6.3 Configuration by shell commands

In the Serial shell (§ 6.5),

- Send command `cfg<CR><LF>` to read the current configuration,
- Send command `cfgXX=YYYY<CR><LF>` to write value $_{H}$YYYY in configuration register H02XX,
- Send command `cfgXX=<CR><LF>` to erase configuration register $_{H}$02XX (the default value will apply).

6.6.4 Configuration by the host application

The CONTROL class of the Direct protocol, that is also available through the SCardControl function of the PC/SC Coupler mode, let the host application configure the M519-SUV.

For reference, please read:

https://docs.springcard.com/books/SpringCore/Host_Protocols/Direct_Protocol/CONTROL_class/index

7 Integration Guide

The M519-SUV supports either USB or Serial as host interface.

The USB interface is enabled by connecting the device to a USB host through the J2 connector.

If VBUS is not active when the module starts, then the Serial interface is enabled.

Warning: for debugging and manufacturing reasons, the Serial interface remains active when the USB interface is enabled, but using both interfaces at the same time is absolutely not supported and is likely to make the M519-SUV reset or behave incorrectly. Leave the J1 unconnected when J2 is connected.

7.1 USB

7.1.1 Overview

The M519-SUV is a USB 2.0 full-speed (12Mbps) device, compliant with USB 3. Connect the device to the host through J2 to activate its USB interface.

7.1.2 Precautions

- Use only the USB cables provided by SpringCard, or developed by SpringCard for your target system,
- Fully extend the USB cable to avoid inductive coupling,
- Route the USB cable perpendicular to the antenna, ensuring that no segment of the cable runs parallel to any side of the antenna,
- Connect the product directly to the computer or exclusively through a USB-certified hub with external power supply; never use a hub that is powered by the bus; avoid low-quality hubs that have unstable supply voltage or poor noise immunity.

7.1.3 USB IDs, profile and descriptors

The USB profile —and therefore the Product ID and the descriptors announced by the device— depends on the operating mode as selected by configuration register $_H$02C0 or by the MODE0/MODE1 pins.

Operating mode	Vendor ID	Product ID	Profile
SpringCore Direct[A]	$_H$1C34	$_H$6210	WinUSB
SpringProx Legacy[B]	$_H$1C34	$_H$6211	Compound, CDC-ACM + WinUSB
PC/SC Coupler[C]	$_H$1C34	$_H$6212	Compound, CCID + WinUSB
RFID Scanner[D]	$_H$1C34	$_H$6213	Compound, HID keyboard + WinUSB
Smart Reader[E]	$_H$1C34	$_H$6214	Compound, CDC-ACM + WinUSB
PC/SC Coupler, no Direct interface[F]	$_H$1C34	$_H$621A	CCID

A: selected by $_H$02C0=$_H$00 and $_H$02C1.bit3=$_B$0
B: selected by $_H$02C0=$_H$01 and $_H$02C1.bit3=$_B$0
C: selected by $_H$02C0=$_H$02 and $_H$02C1.bit3=$_B$0
D: selected by $_H$02C0=$_H$03 and $_H$02C1.bit3=$_B$0
E: selected by $_H$02C0=$_H$04 and $_H$02C1.bit3=$_B$0
F: selected by $_H$02C0=$_H$02 and $_H$02C1.bit3=$_B$1

7.2 Serial

7.2.1 Overview

The serial interface of the M519 is enabled by leaving J2 unconnected, and by powering the module by the mean of a unique 5V supply over VCC on J1.

The electrical interface (RS-TTL, RS-232 or RS-485) is selected by register $_H$029F (see § 6.4).

Warning: check the module configuration before connecting it; observe LED1 and LED2 to determine the selected electrical interface. Connecting the M519-SUV to a communication port that uses different electrical levels may damage the M519-SUV and/or the host.

7.2.2 Precautions

- Use short cables and genuine JST male connectors,
- Fully extend the Serial cable to avoid inductive coupling,
- Route the Serial cable perpendicular to the antenna, ensuring that no segment of the cable runs parallel to any side of the antenna.

7.3 Electromagnetic environment

7.3.1 Overview

Communication between the M519-SUV and the contactless target (proximity/vicinity card, RFID label, NFC tag, NFC object...) uses an alternating magnetic field at 13.56MHz and rely on the principle of a transformer (inductive coupling). At the exception of smartphones and battery-powered NFC objects, the M519-SUV also provides remote power to the target.

Such a system is largely impacted by its electromagnetic environment:

- RF waves radiated by surrounding electronics parts, cables or PCB traces alter the signal over noise ratio. This is particularly the case with some displays that radiate their 27.12MHz clock frequency (2x13.56MHz) or with badly shielded USB devices that radiate side-bands around 12MHz.
- RF waves cannot cross conductive materials (PCB ground plane, metallic shield or shell…). More than that, conductive materials in the nearby will host eddy currents (Foucault's currents) so that the RF field will be wasted in heating the material instead of providing power to the contactless objects.

7.3.2 Precautions

To ensure optimal functionality of the SpringSeed M519-SUV, adherence to the following installation guidelines is crucial:

- Avoid any conductive materials in close proximity to the antenna's front. When embedding the M519-SUV within metallic structures such as kiosks or gates, create an aperture of at least 130x105mm within the metal framework *(Figure 7)*.
- The permeability factor (μ) of materials placed in front of the antenna should be considered. For instance, the permeability of glass or glass-filled plastics have a permeability differing from that of vacuum (μ_0) and air.

Conductive elements, including PCBs featuring ground planes or parallel traces, as well as cables, must not be situated near the antenna.

- Maintain a minimum clearance of 30mm around the periphery of the antenna *(Figure 7)*.
- Ensure a minimum clearance of 50mm behind the antenna *(Figure 7)*.

The vicinity should be free of other devices that emit radio frequencies.

- A minimum distance of 250mm is advised from any adjacent contactless readers or couplers operating at 13.56MHz *(Figure 8)*.
- Implement appropriate measures as to mitigate radiated noise within the 12 to 16MHz frequency band.

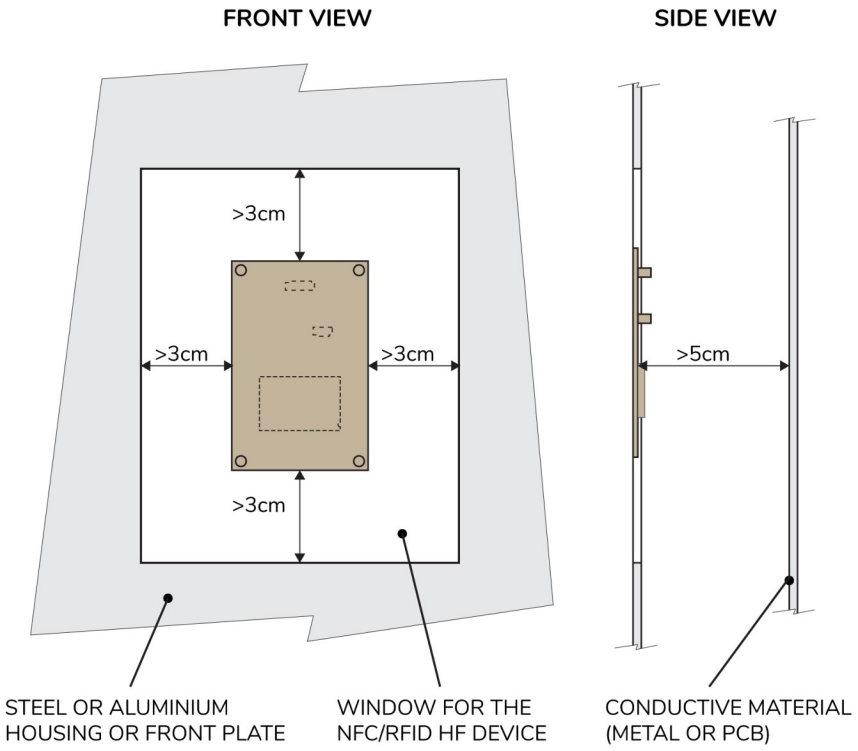


Figure 7

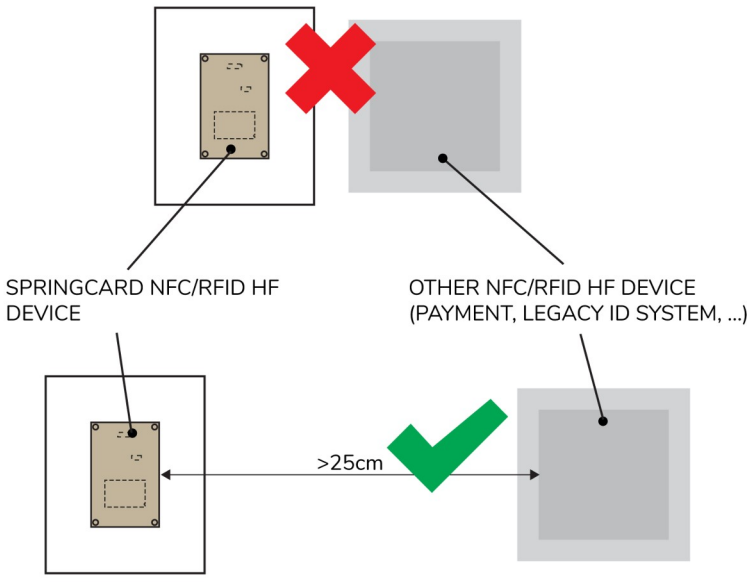


Figure 8

7.3.3 Advices for an optimal user experience

For the most effective power transfer and communication link quality, consider the following recommendations during system design:

- Optimal performance is achieved when the card is aligned parallel to the antenna, with the longest sides corresponding. Take the user gesture in account when designing the product, and/or position a pictogram over the antenna to indicate the preferred card orientation *(Figure 9)*.

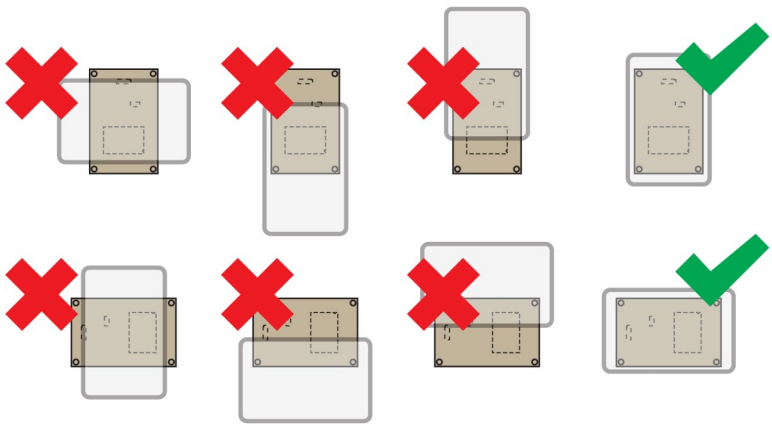


Figure 9

- Ensure the design intuitively guides the user to position the card parallel to the antenna, avoiding any angled placement for consistent communication *(Figure 10)*.

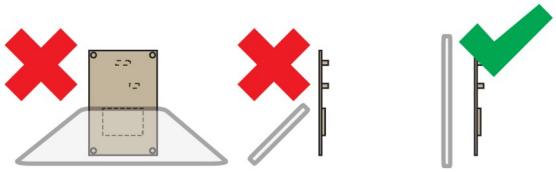


Figure 10

- NFC smartphones generally have a preferred axis that is different from that of standard cards *(Figure 11)*, and many are now engineered to communicate more effectively when held at an angle to the antenna *(Figure 12)*. Smaller NFC tags or RFID labels usually achieve better performance when positioned near the coil's

edge as opposed to the antenna's central axis *(Figure 13)*. End-users should be made aware of these particularities via strategically positioned labels, detailed documentation, or targeted educational content to ensure the best possible user experience.

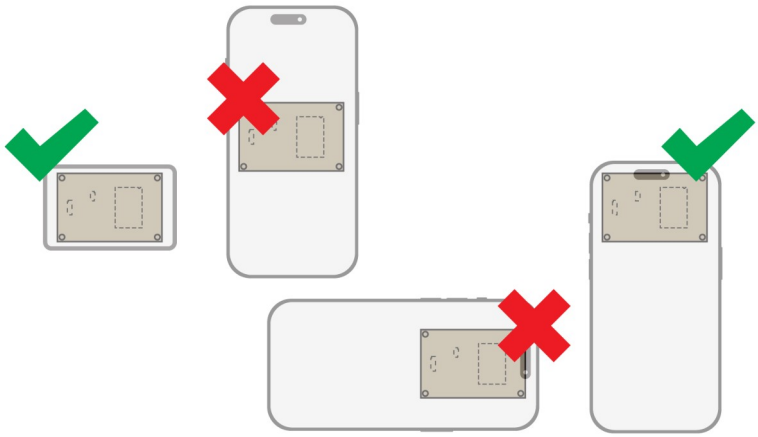


Figure 11

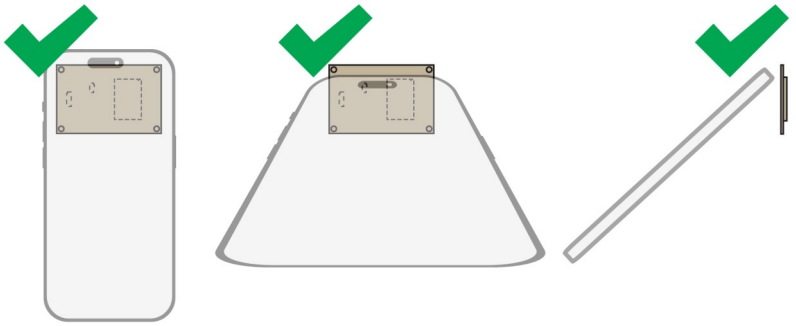


Figure 12

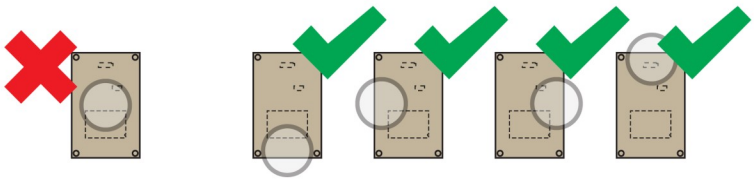


Figure 13

- Design the shell so a clearance of about 8mm is maintained between the card and the antenna. This enhance the interaction with poorly-tuned cards or with NFC smartphones that expose a significant static load to the base-station *(Figure 14)*.

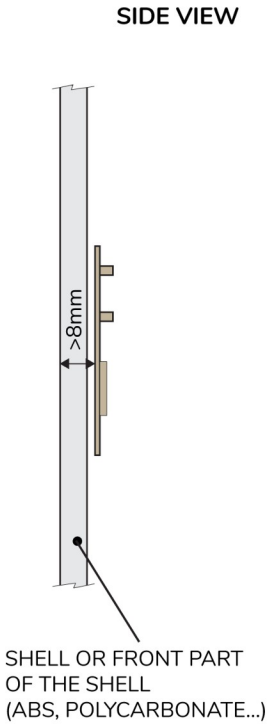


Figure 14

SpringCard has a strong experience in designing NFC/RFID HF devices. Don't hesitate to contact us should you need the assistance of an expert in validating your design.

7.4 Testing, validation and qualification

EMC product qualification is imperative for compliance with CE, FCC markings, and other regulatory standards, and must be carried out on the final product. Although the M519-SUV is qualified as an independent device, the performance of the NFC/RFID HF and USB interfaces is contingent upon the integration's quality.

Furthermore, certifications specific to the application, including those from NFC Forum, EMVCo, CEN/TS 16794, and RCTIF, must be obtained for the complete product. This typically encompasses the full software solution and the device's actual configuration in situ.

SpringCard has a strong experience in designing NFC/RFID HF devices. Don’t hesitate to contact us should you need the assistance of an expert in designing or qualifying your own product.

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