SCM Microsystems

Reference Manual – version 1.3

SCL3711

Multiprotocol contactless mobile reader

Reference manual

SCL3711 Multiprotocol Contactless mobile Reader

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1. Legal information

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2. Introduction to the manual

2.1. Objective of the manual

This manual provides an overview of the hardware and software features of the SCL3711 multiprotocol mobile contactless reader, hereafter referred to as “SCL3711”.

This manual describes in details interfaces and supported commands available for developers using SCL3711 in their applications.

2.2. Target audience

This document describes the technical implementation of SCL3711.

The manual targets software developers. It assumes knowledge about 13.56 MHz contactless technologies like ISO/IEC 14443 and commonly used engineering terms.

Should you have questions, you may send them to support@scmmicro.com .

2.3. Product version corresponding to the manual

Item	Version
Hardware	0.2
Firmware	2.7.0
Driver	1.02

2.4. Definition of various terms and acronyms

Term	Expansion
APDU	Application Protocol Data Unit
ATR	Answer to Reset, defined in ISO7816
ATS	Answer to Select, defined in ISO14443
Byte	Group of 8 bits
CCID	Chip Card Interface Device
CID	Card Identifier
CL	Contactless
CLA	Class byte defined in ISO 7816
DFU	Device Firmware Upgrade
FeliCa™	Sony contactless technology standardized in ISO18092, technology underlying the NFC Forum tag type 3
INS	Instruction byte defined in ISO7816
Jewel/Topaz	Innovision contactless technology, technology underlying the NFC Forum tag type 1
LED	Light emitting diode
MIFARE	The ISO14443 Type A with extensions for security (NXP)
NA	Not applicable
NAD	Node Address
NDEF	NFC Data Exchange Format: data structure defined by the NFC Forum for NFC Forum tags.
NFC	Near Field Communication
Nibble	Group of 4 bits. 1 digit of the hexadecimal representation of a byte. *Example:* 0xA3 is represented in binary as (10100011)b. The least significant nibble is 0x3 or (0011)b and the most significant nibble is 0xA or (1010)b
P2P	Peer – to – Peer
PCD	Proximity Coupling Device
PC/SC	Personal Computer/Smart Card: software interface to communicate between a PC and a smart card
PICC	Proximity Integrated Chip Card
PID	Product ID
PPS	Protocol Parameter Selection
Proximity	Distance coverage till ~10 cm.
PUPI	Pseudo unique PICC identifier
RFU	Reserved for future use
RF	Radio Frequency
STC3	Smart card reader controller ASIC from SCM Microsystems
SW1 SW2	Status word defined in ISO7816
USB	Universal Serial Bus
VID	Vendor ID
(xyz)b	Binary notation of a number x, y, z $\in \{0,1\}$
0xYY	The byte value YY is represented in hexadecimal

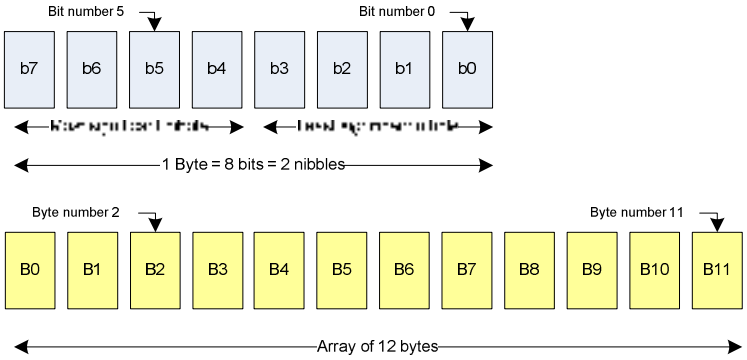
2.5. References

Doc ref in the manual	Description	Issuer
ISO/IEC 7816-4	Identification cards - Integrated circuit(s) cards with contacts Part 4: Interindustry commands for interchange ISO/IEC 7816-4: 1995 (E)	ISO / IEC
ISO/IEC 14443-4	Identification cards — Contactless integrated circuit(s) cards — Proximity cards Part 4: Transmission protocol ISO/IEC 14443-4:2001(E)	ISO / IEC
ISO/IEC 18092	Information technology — Telecommunications and information exchange between systems — Near Field Communication — Interface and Protocol (NFCIP-1) ISO/IEC 18092:2004(E)	ISO / IEC
NFC Forum tag type 1	NFCForum-TS-Type-1-Tag_1.0	NFC Forum
NFC Forum tag type 2	NFCForum-TS-Type-2-Tag_1.0	NFC Forum
NFC Forum tag type 3	NFCForum-TS-Type-3-Tag_1.0	NFC Forum
NFC Forum tag type 4	NFCForum-TS-Type-4-Tag_1.0	NFC Forum
PC/SC	Interoperability Specification for ICCs and Personal Computer Systems v2.01	PC/SC Workgroup
NFC wrapper	User manual of the NFC wrapper. This manual is part of SCM's Contactless SDK.	SCM Microsystems
CCID	Specification for Integrated Circuit(s) Cards Interface Devices 1.1	USB-IF
USB	Universal Serial Bus Specification 2.0	USB-IF

2.6. Conventions

Bits are represented by lower case ‘b’ where followed by a numbering digit.

Bytes are represented by upper case ‘B’ where followed by a numbering digit.



Example:

163 in decimal is represented

- in hexadecimal as 0xA3
- in binary as (10100011)b

The least significant nibble of 0xA3 is

- 0x3 in hexadecimal
- (0011)b in binary

The most significant nibble of =xA3 is

- 0xA in hexadecimal
- (1010)b in binary

3. General information about SCL3711

3.1. SCL3711 key benefits

With its functional solid mechanical design that has no removable parts that you may loose, SCL3711 is perfect for mobile uses.

While being slim, SCL3711 dimensions have been optimized to ensure best RF performance possible with such a form factor.

The state of the art multi-protocol feature set of SCL3711 qualifies it to be used in a wide range of applications such as payment, loyalty and ID schemes, or to enable devices with NFC connectivity.

As a latest generation product, SCL3711 can be supported by SCM's middleware that resides above the PC/SC API and offers better portability of applications and abstraction of smart card related details that need to be handled by applications developed on top of the PC/SC API.

3.2. SCL3711 key features

- Multi-protocol 13.56MHz contactless reader:
  - ISO14443 type A & B,
  - MIFARE,
  - FeliCa™
  - NFC Peer-to-peer communication will be available through driver upgrade
- PC/SC v2.0 compliant

3.3. SCL3711 ordering information

Item	Part number	
SCL3711	905108	
Contactless SDK	905124	

3.4. SCL3711 customization options

Upon request, SCM can customize:

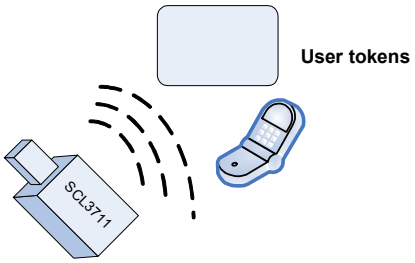
- The color of the casing
- The logo
- The product label
- The USB strings

Terms and conditions apply, please contact your local SCM representative or send an email to sales@scmmicro.com.

3.5. Contactless communication principles and SCL3711 usage recommendations

SCL3711 is a contactless reader[1] designed to communicate with user tokens.

User tokens[2] are made of a contactless integrated circuit card connected to an antenna



User tokens can take several form factors:

- Credit card sized smart card
- Key fob
- NFC mobile phone etc…

Communication between SCL3711 and user tokens uses magnetic field inductive coupling.

The magnetic field generated by SCL3711 has a carrier frequency of 13.56MHz.

3.5.1. Power supply

When the user token is put in the magnetic field of the reader, its antenna couples with the reader and an induction current appears in the antenna thus providing power to the integrated circuit. The generated current is proportional to the magnetic flux going through the antenna of the user token.

3.5.2. Data exchange

The carrier frequency of the magnetic field is used as a fundamental clock signal for the communication between the reader and the card. It is also use as a fundamental clock input for the integrated circuit microprocessor to function.

To send data to the user token the reader modulates the amplitude of the field. There are several amplitude modulation and data encoding rules defined in ISO/IEC 14443 and ISO/IEC 18092. The reader should refer to those standards for further details.

To answer to the reader, the integrated circuit card of the user token modulates its way of loading (impedance) the field generated by the reader. Here also further details can be found in ISO/IEC 14443 and ISO/IEC 18092.

[1] In the ISO/IEC 14443 standard, the reader is called the proximity coupling device (PCD)

[2] In the ISO/IEC 14443 standard, the user token is called proximity integrated chip card (PICC)

3.5.3. Recommendations

The communication between the reader and the user token is sensitive to the presence of material or objects interfering with the magnetic field generated by the reader.

The presence of conductive materials like metal in the vicinity of the reader and the user token can severally degrade the communication and even make it impossible. The magnetic field of the reader generates Eddy or Foucault's currents in the conductive materials; the field is literally absorbed by that kind of material.

It is recommended for proper communication to avoid putting SCL3711 in close proximity of conductive materials.

The presence of multiple user tokens in the field also interferes with the communication. When several user tokens are in the field of the reader, load of the field increases which implies that less energy is available for each of them and that the system is detuned. For this reason, SCM Microsystems has implemented in its driver the support for 1 slot only.

It is recommended to present only one user credential at a time in front of SCL3711.

The communication between the reader and the user token is sensitive to the geometry of the system {reader, user token}. Parameters like the geometry and specially the relative size of the reader and user token antennas directly influence the inductive coupling and therefore the communication.

SCL3711 was primarily designed and optimized to function with user credentials of various technologies having the size of a credit card.

It may happen that SCL3711 is not capable of communicating with extremely large or extremely small antennas.

In order to optimize the coupling between the reader and the user token, it is recommended to put both antennas as parallel as possible

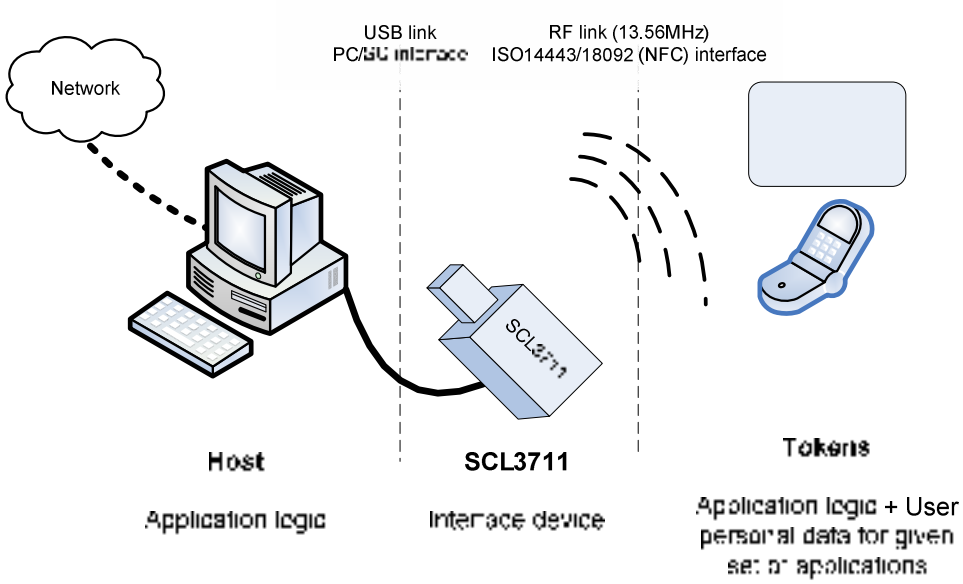
In order to optimize transaction speed between the reader and the card it is recommended to place the user token as close as possible to the reader. This will increase the amount of energy supplied to the user credential which will then be able to use its microprocessor at higher speeds

3.6. Applications

3.6.1. General

SCL3711 is a transparent reader designed to interface a personal computer host supporting PC/SC interface with 13.56MHz user tokens like public transport cards, contactless banking cards, NFC forum tags, electronic identification documents – e.g. e-passports, e-ID cards, driving licenses etc.

Those user tokens can have several form factors like credit cards, key fobs, NFC mobile phones or USB dongles like SCT3511 that SCM Microsystems markets.



SCL3711 itself handles the communication protocol but not the application related to the token. The application-specific logic has to be implemented by software developers on the host.

3.6.2. Applications provided by SCM Microsystems

SCM Microsystems does not provide payment or transport applications.

SCM Microsystems provides a few applications for development and evaluation purposes that can function with SCL3711. They are available within the software development kit. There are many tools provided but the two main ones are:

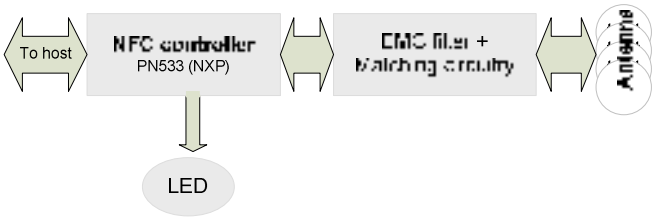
- The NFC forum tag reader/writer is a standalone application that enables the user to read and write NFC forum compliant records into NFC forum compatible tags. It is an easy to use tool to configure rapidly NFC forum tag demonstrations.
- Smart card commander version 1.1 provides a module which for NFC forum tags that parses and presents in XML format the content of the tag. Smart card commander also contains powerful scripting functionality which can be very useful for developers to develop and debug their applications.

4. SCL3711 characteristics

4.1. SCL3711 high level architecture

4.1.1. Block diagram

The link between SCL3711 and the host to which it is connected is the USB interface providing both the power and the communication channel.



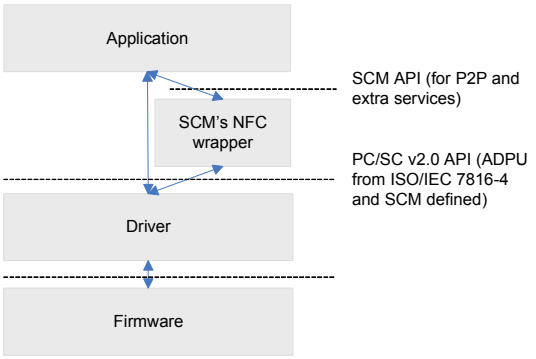
SCL3711 is based designed around an NFC controller which handles the USB communication to the host and the RF communication. This controller ensures the coding/decoding/framing modulation/demodulation required for the RF communication.

The matching circuitry provides the transmission and receiver paths adaptation for the antenna to function properly.

4.1.2. Software architecture

Applications can interface with the driver directly through the PC/SC interface or through the SCM proprietary interface to the NFC wrapper.

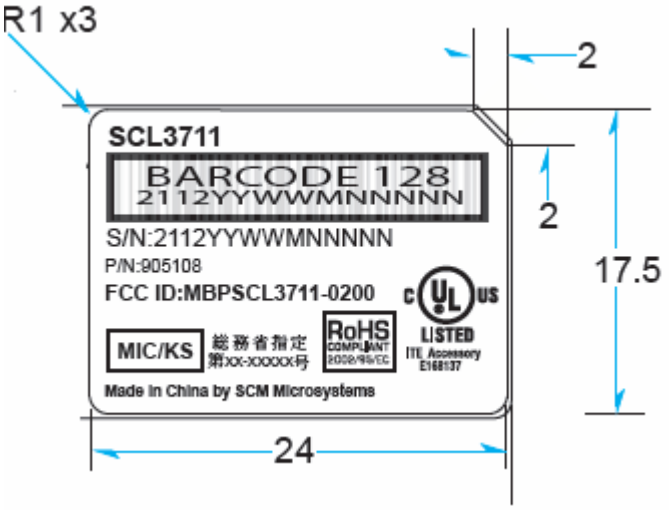
The NFC wrapper simplifies the usage of the different NFC Forum tags with the SCL3711 and other SCM contactless readers. It provides a unique API to application developers, which enables them to read and modify NDEF records without further knowledge of the underlying hardware and protocols. Detailed information about the NFC wrapper can be found in SCM's Contactless SDK.



The SCL3711 driver implements PC/SC v2.0 API towards upper layers.

4.2. Quick reference data

4.2.1. SCL3711 dimensions

Item	Characteristic	Value
SCL3711	Weight	10.2 Grams
	External dimensions(mm)	65.4(L) x 24(W) x 10 (H)
	Cable length	NA
	Default color	BLACK Textured Finish
	Default logo	SCM logo
	Default label	

Drawing with dimensions of the SCL3711 and accessories can be found in annex.

4.2.2. LED behavior

The LED behavior of the SCL3711 is given below.

SCL3711 states	LED Indication (GREEN)
After plug-in (no driver loaded)	OFF
Driver successfully loaded	ON
User token arriving in the field	One blink
User token removed from the field	ON, no specific visual indication
Suspend/hibernate/shutdown state	OFF
SCL3711 disabled	OFF

4.2.3. Other data

Parameter	Value/Description
DC characteristics	Low bus powered (SCL3711 draws power from USB bus) Voltage: 5V Max Current : 100mA Suspend current : 260uA
Clock of the device controller	Max 27.12MHz
RF carrier frequency	13.56 MHz +/- 50 ppm
Modulation	12 to 14 %
Unloaded field strength	1.5 A/m to 2.2 A/m (Un-modulated RF on reader casing)
USB specification	USB 2.0 FS Devise

USB Speed	Full Speed Device (12Mbit/s)
Device Class	Vendor
PID	0x5591
VID	0x04E6
API	PC/SC 2.0
ID1 format tokens supported	NFC forum tag type 1 through SCM-specific APDU NFC forum tag type 2 through PC/SC-defined APDUs NFC forum tag type 3 through SCM-specific APDU NFC forum tag type 4 through PC/SC APDUs ISO/IEC 14443-4 PICC type A and type B MIFARE, Non-Secure FeliCa™
Maximum baud rate	848 Kbps
Multiple PICC in field	Not supported
Operating temperature range	<TBC>
Operating humidity range	<TBC>
Storage condition range	<TBC>
Certifications	USB CE FCC VCCI WEEE RoHS WHQL UL Radio Frequency for Japan

** The 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"

Information to user

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

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.

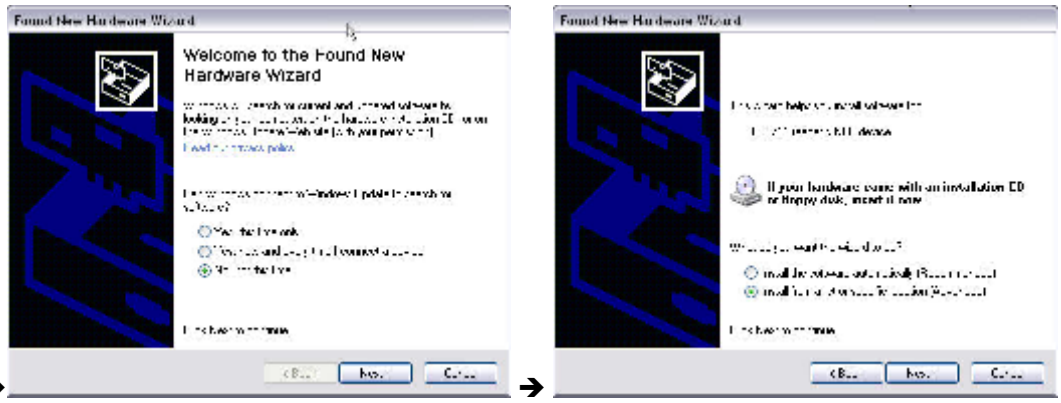
5. Software modules

5.1. Installation

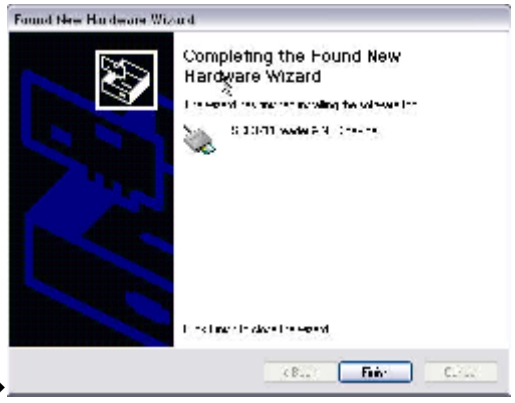
No installer is available for installing the version of the driver this manual covers.

To manually install the driver, please follow the following steps

- Extract the content of the ZIP file SCM Microsystems has sent you
- Plug-in the SCL3711



- Manually select the location where you extracted the driver to



5.2. Utilities

NA

5.3. Driver

The driver for Windows platforms is based on Microsoft WDF architecture.

The driver package contains INF, SYS, CAT and the co-installer DLL required for the WDF architecture.

5.3.1. SCL3711 listing

SCL3711 enumerates as *SCL3711-NFC&RW*

After the driver is installed, SCL3711 appears in Windows resource manager as *SCL3711 reader & NFC device:*

SCL3711 is listed by PC/SC applications as *SCM Microsystems Inc. SCL3711 reader & NFC device N*. Where N=0 if only one SCL3711 is connected but is incremented in case several SCL3711 are connected to the host.

5.3.2. Supported operating systems

Operating systems supported by the driver:

- Windows 2000 SP4
- Windows 2003 Server (32 & 64 bit)
- Windows XP (32 & 64 bit)
- Windows Vista (32 & 64 bit)
- Windows Server 2008 (32 & 64 bit)
- Linux (32 & 64 bit)
- MACOSX

5.3.3. PC/SC 2.0 compliant ATR

5.3.3.1. Determining the technology of the user credential

The ScardControl method of PC/SC (see http://msdn.microsoft.com/en-us/library/aa379474(VS.85).aspx) should be used to send the 0x90 IOCTL to SCL3711 in order to determine what type of technology is the user token based on. The output buffer is a BYTE with the following meaning:

Technology	Value
MIFARE1K	0x01
MIFARE4K	0x02
MIFARE Ultralight	0x03
ISO14443-4A	0x04
FeliCa	0x05
Topaz	0x06
ISO14443-4B	0x07

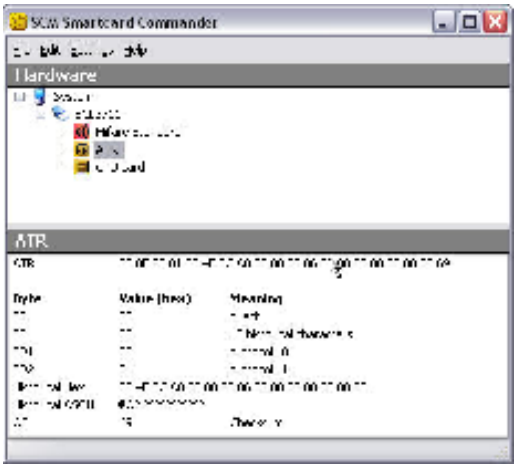
Once a user credential is selected the driver constructs an ATR from the fixed elements that identify the token. Depending on the user technology this ATR can be analyzed as described hereunder.

5.3.3.2. ATR for type A memory user tokens

The ATR of the user token is composed as described in the table below. In order to allow the application to identify the storage card properly, it's Standard and Card name describing bytes must be interpreted according to the Part 3 Supplemental Document, maintained by PC/SC.

Byte#	Value	Designation	Description
0	0x3B	Initial header	
1	0x8n	T0	n indicates the number of historical bytes in following ATR
2	0x80	TD1	Nibble8 indicates no TA2, TB2, TC2 Nibble 0 means T=0
3	0x01	TD2	Nibble8 indicates no TA3, TB3, TC3 Nibble 1 means T=1
4...3+n	0x80		A status indicator may be present in an optional TLV data object
	0x4F	Optional TLV data object	Tag: Application identifier
	Lentgh		1 byte
	RID		Registered identifier on 5 bytes
	PIX		Proprietary identifier extension on 3 bytes
	0x00 0x00 0x00 0x00		4 RFU bytes
4+n	0x91	TCK	XOR of all previous bytes

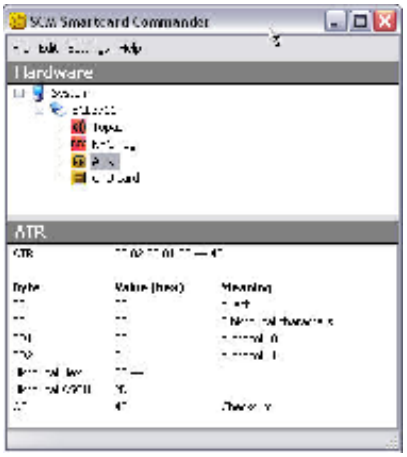
Example of the ATR built for a MIFARE Classic 4K card:



5.3.3.3. ATR for an NFC Forum tag type 1 user token (Topaz)

Byte#	Value	Designation	Description
0	0x3B	Initial header	
1	0x82	T0	TD1 present. 2 historical bytes in following ATR
2	0x80	TD1	Nibble8 indicates no TA2, TB2, TC2 and TD2 present Nibble 0 means T=0
3	0x01	TD2	Nibble8 indicates no TA3, TB3, TC3 Nibble 1 means T=1
4	0x02	Card Mode	NFC TAG operating at Passive 106 baud rate
5	0x44	Card Type	Card type is Topaz
6	0xXX	TCK	XOR of all previous bytes

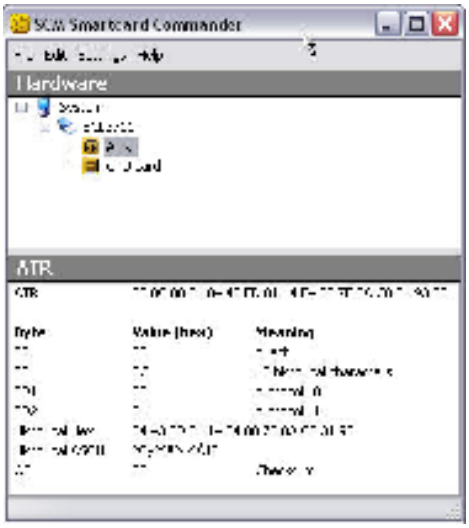
Example of the ATR built for a Topaz tag:



5.3.3.4. ATR for a NFC Forum tag type 3 user token (FeliCa)

Byte#	Value	Designation	Description
0	0x3B	Initial header	
1	0x8C	T0	TD1 present. 12 historical bytes in following ATR
2	0x80	TD1	Nibble8 indicates no TA2, TB2, TC2 and TD2 present Nibble 0 means T=0
3	0x01	TD2	Nibble8 indicates no TA3, TB3, TC3 Nibble 1 means T=1
4	0x04	Card Mode	NFC TAG operating at Passive 212 baud rate
5	0x43	Card Type	Card type is Felica
6	0xFD	IFS	Maximum frame size of felica card
7-14	-	ID	Felica card Identifier – 8 bytes
15	0xXX	Timeout	Write Timeout indicated by card
16	0xXX	TCK	XOR of all previous bytes

Example of the ATR built for a FeliCa user token:



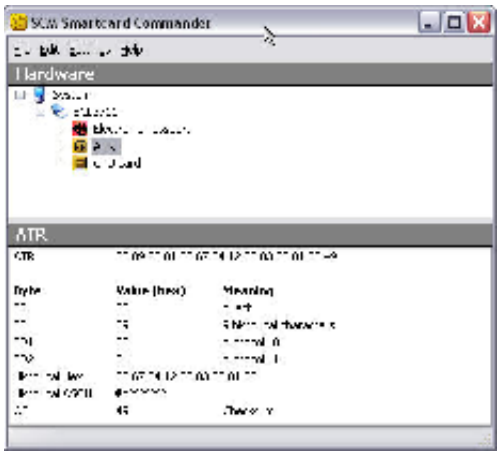
5.3.3.5. ATR for ISO/IEC 14443-4 user tokens

The user token exposes its ATS or application information which is mapped to an ATR. The table describes how this mapping is done.

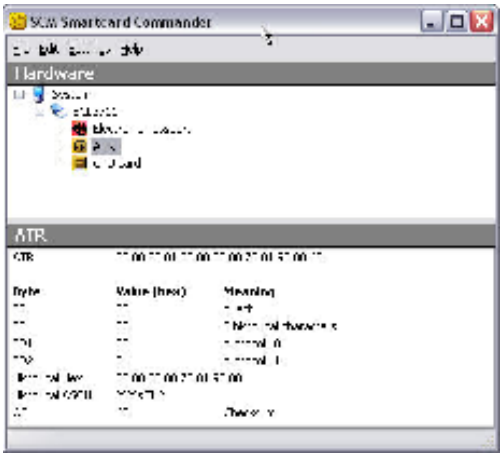
Byte#	Value	Designation	Description
0	0x3B	Initial header	
1	0x8n	T0	n indicates the number of historical bytes in following ATR
2	0x80	TD1	Nibble8 indicates no TA2, TB2, TC2 Nibble 0 means T=0
3	0x01	TD2	Nibble8 indicates no TA3, TB3, TC3 Nibble 1 means T=1
4...3+n		Historical bytes or application information	Type A: the historical bytes from the ATS (up to 15 bytes) Type B (8 bytes): • Byte 0 through 3: application data from ATQB, • Byte 4 through 6: protocol info byte from ATQB, • Byte 7: higest nibble is the MBLI (maximum buffer length index) from ATTRIB, lowest nibble is 0x0
4+n		TCK	XOR of all previous bytes

Example of the ATR built for an ISO14443-4 user tokens:

Type A



Type B



5.4. Firmware

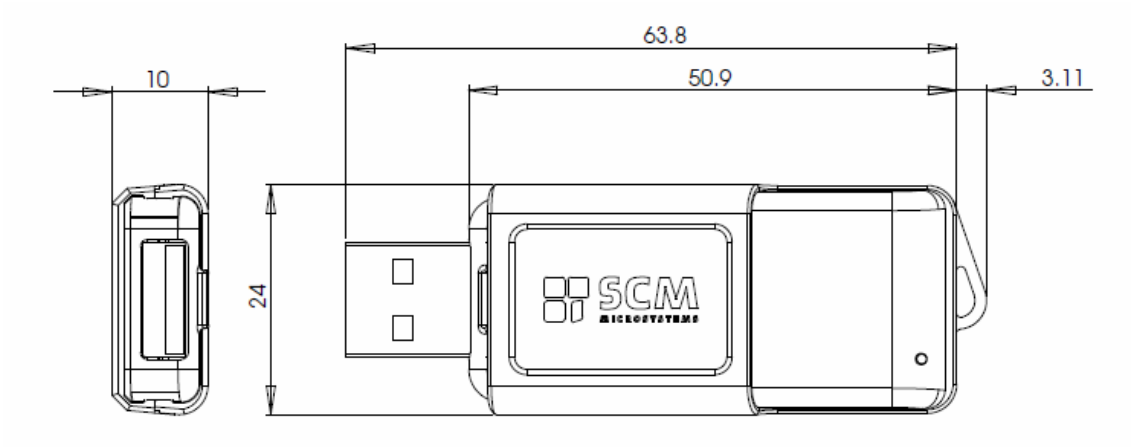
5.4.1. Transport protocol

SCL3711 implements a transport protocol which is proprietary to NXP Semiconductors.

5.4.2. Automatic PPS

Automatic PPS implemented is implemented. SCL3711 will automatically switch the highest baud rate commonly supported by the SCL3711 and the user token

The maximum speed supported by SCL3711 is 848Kbps by default.


63.8
10
50.9
3.11
24
SCM