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650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
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Introduction

The present document defines a communication interface between the UICC and a contactless frontend (CLF) in the terminal. This interface allows the card emulation mode independent of the power state of the terminal as well as the reader mode when the terminal is battery powered.

The aim of the present document is to ensure interoperability between a UICC and the CLF in the terminal independently of the respective manufacturer, card issuer or operator. Any internal technical realization of either the UICC or the CLF is only specified where these are reflected over the interface.

1 Scope

The present document specifies the Single Wire Protocol (SWP). SWP is the interface between the UICC and the CLF.

The present document defines:

- Layer 1: The physical layer which is responsible for activating, maintaining and deactivating the physical link between the UICC and the CLF. It defines electrical (voltage and current levels, timing and coding of voltage and current levels), mechanical (physical contacts) and functional (data rates) specifications. It also defines the initial communication establishment and the end of the connection.
- Layer 2: The data link layer which is responsible for the physical addressing of the data through frames and Link Protocol Data Units (LPDU). The data link layer is also responsible for error notification, ordered delivery of frames and flow control. This layer can be split into two sub-layers:
  - The Medium Access Control (MAC) layer which manages frames.
  - The Logical Link Control layer which manages LPDUs and is responsible for the error-free exchange of data between nodes. Three different Logical Link Control layers are defined in the present document.

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

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The following referenced documents are necessary for the application of the present document.

[1] ETSI TS 102 221: "Smart Cards; UICC-Terminal interface; Physical and logical characteristics".

[2] ISO/IEC 14443-2: "Identification cards -- Contactless integrated circuit cards -- Proximity cards -- Part 2: Radio frequency power and signal interface".

[3] ISO/IEC 14443-3: "Cards and security devices for personal identification -- Contactless proximity objects -- Part 3: Initialization and anticollision".

[4] ISO/IEC 14443-4: "Cards and security devices for personal identification -- Contactless proximity objects -- Part 4: Transmission protocol".

[5] ISO/IEC 13239: "Information technology -- Telecommunications and information exchange between systems -- High-level data link control (HDLC) procedures".

[6] ETSI TS 102 600: "Smart Cards; UICC-Terminal interface; Characteristics of the USB interface".

[7] ETSI TS 102 223: "Smart Cards; Card Application Toolkit (CAT)".

[8] ISO/IEC 18092: "Information technology -- Telecommunications and information exchange between systems -- Near Field Communication -- Interface and Protocol (NFCIP-1)".

[9] ETSI TS 103 666-1: "Smart Secure Platform (SSP); General characteristics".

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The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

Not applicable.

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the following terms apply:

card emulation mode: mode where the UICC emulates a contactless card through the CLF

class A operating conditions: terminal or a smart card operating at 5 V ± 10 %

class B operating conditions: terminal or a smart card operating at 3 V ± 10 %

class C operating conditions: terminal or a smart card operating at 1,8 V ± 10 %

contactless frontend: circuitry in the terminal which:

- handles the analogue part of the contactless communication;
- handles communication protocol layers of the contactless transmission link;
- exchanges data with the UICC.

ETSI TS 102 221 [1] interface: asynchronous serial UICC-Terminal interface defined in ETSI TS 102 221 [1], using RSET on contact C2, CLK on contact C3 and I/O on contact C7

full duplex: simultaneous bidirectional data flow

half duplex: sequential bidirectional data flow

idle bit: bit with logical value 0 sent outside a frame

master: entity which provides the S1 signal

reader mode: mode where the UICC act as a contactless reader through the CLF

state H: high electrical level of a signal (voltage or current)

state L: low electrical level of a signal (voltage or current)

S1: signal from the master to a slave

S2: signal from the slave to the master

slave: entity which is connected to the master and provides the S2 signal

transition sequence: signal sent by the master during *RESUME*, consisting of the falling edge, the state L period and the rising edge of an idle bit

UICC powering modes:

- **Full power mode:** the UICC is powered according to ETSI TS 102 221 [1] limitations in operating state.
- **Low power mode:** the UICC is running in a reduced power mode as defined in the present document.

wakeup sequence: sequence transmitted by the slave before each frame

3.2 Symbols

For the purposes of the present document, the following symbols apply:

Gnd	Ground
I_H	Current signalling state H of S2
I_L	Current signalling state L of S2
T	Bit duration
T_{H1}	Duration of the state H for coding a logical 1 of S1
T_{H0}	Duration of the state H for coding a logical 0 of S1
T_{CLF}	Processing time of the CLF for a packet of data
T_{RFn}	Transfer time of contactless command or response over the RF interface
T_{SWP}	Transfer time a single SWP packet of date
T_{UICC}	Processing time of the UICC for a contactless command
t_F	Fall time
t_R	Rise time
Vcc	Supply Voltage
V_{IH}	Input Voltage (high)
V_{IL}	Input Voltage (low)
V_{OH}	Output Voltage (high)
V_{OL}	Output Voltage (low)

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

ACT	ACTivation protocol
ATR	Answer To Reset
CLF	ContactLess Frontend
CLK	CLocK
CLT	ContactLess Tunnelling
CMD	CoMmanD
CRC	Cyclic Redundancy Check
EOF	End Of Frame
FR	Frame Repeat
HCI	Host Controller Interface
HDLC	High level Data Link Control
HLTA	HALT Command, Type A
I/O	Input/Output
ICC	Integrated Circuit Card
ISO	International Organization for Standardization
LEN	LENgth
LLC	Logical Link Control
LPDU	Link Protocol Data Unit
LSB	Least Significant Bit
MAC	Medium Access Control
MSB	Most Significant Bit

NFCIP-1	Near Field Communication - Interface and Protocol
PCD	Proximity Coupling Device
PICC	Proximity Integrated Circuit Card
RATS	Request for Answer To Select
REJ	Reject
RF	Radio Frequency
RFU	Reserved for Future Use
RNR	Receive Not Ready
RR	Receive Ready
RSET	ReSeT
SAK	Select AcKnowledge, Type A
SCL	SSP Common Layer

NOTE: See ETSI TS 103 666-1 [9].

SHDLC	Simplified High Level Data Link Control
SOF	Start Of Frame
SREJ	Selective Reject
SWIO	Single Wire protocol Input/Output
SWP	Single Wire Protocol
TPICC	Total processing time of a Contactless card
UA	Unnumbered Acknowledgment
USB	Universal Serial Bus
WTX	Waiting Time eXtension
WUPA	Wake-Up Command, Type A

3.4 Void

The content of this clause has been moved to clause 3A.

3A Coding conventions

For the purposes of the present document, the following coding conventions apply:

- All lengths are presented in bytes, unless otherwise stated.
- Each byte is represented by bits b8 to b1, where b8 is the Most Significant Bit (MSB) and b1 is the Least Significant Bit (LSB). In each representation, the leftmost bit is the MSB.
- Hexadecimal values are enclosed in single quotes ('xx').

In the UICC, all bytes specified as RFU shall be set to '00' and all bits specified as RFU shall be set to 0.

4 Principle of the Single Wire Protocol

The SWP interface is a bit oriented, point-to-point communication protocol between a UICC and a ContactLess Frontend (CLF) as shown in figure 4.1.

The CLF is the master and the UICC is the slave.

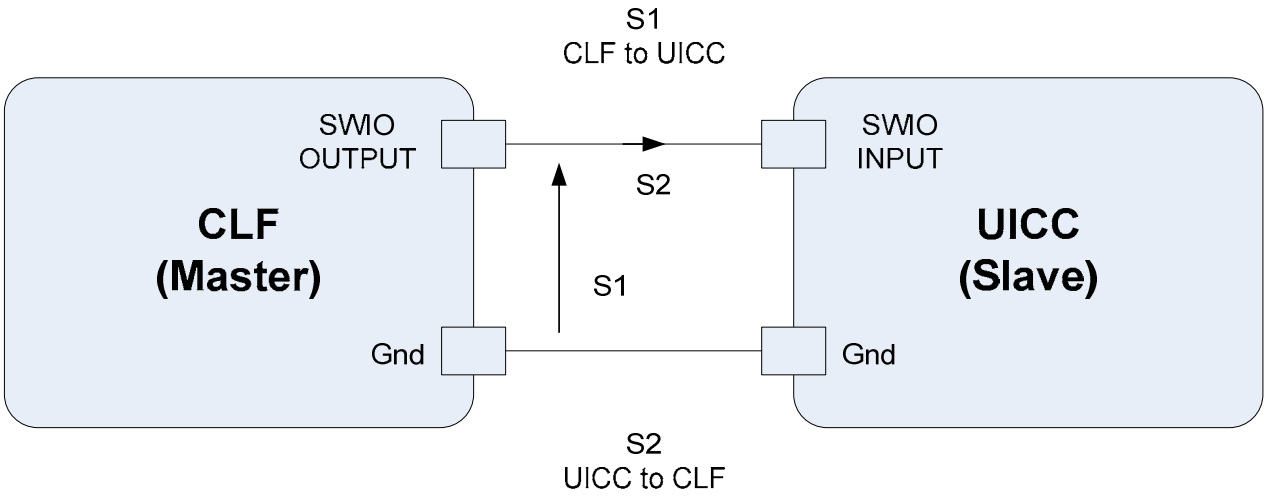

Figure 4.1: SWP data transmission

The principle of the Single Wire Protocol is based on the transmission of digital information in full duplex mode:

- The signal S1 is transmitted by a digital modulation (L or H) in the voltage domain.
- The signal S2 is transmitted by a digital modulation (L or H) in the current domain.

When the master sends S1 as state H then the slave may either draw a current (state H) or not (state L) and thus transmit S2. With pulse width modulation bit coding of S1, it is possible to transmit a transmission clock, as well as data in full duplex mode. This bit coding of S1 is described in clause 8.1 of the present document. S2 is meaningful only when S1 is in state H.

5 System architecture

5.1 General overview

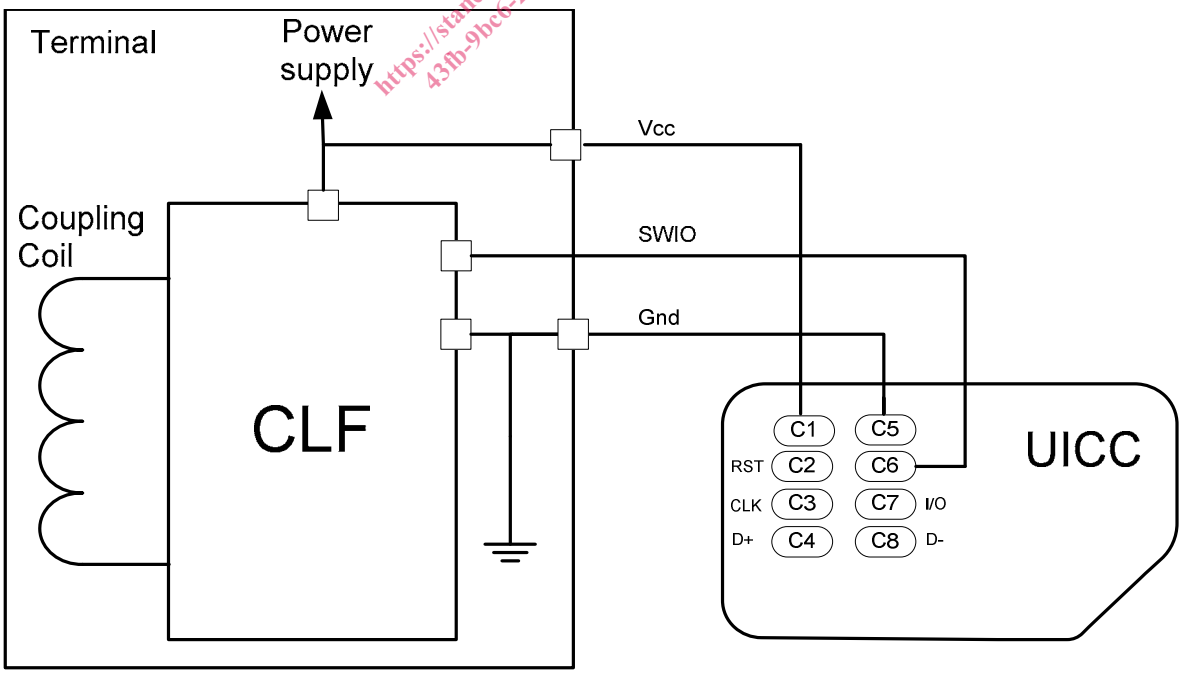

Figure 5.1: CLF-UICC physical link

Figure 5.1 represents the physical link between the CLF and the UICC. The contact C6 of the UICC is connected to the CLF for the transmission of S1 and S2.

5.2 ETSI TS 102 221 support

A UICC supporting the SWP interface and a terminal supporting SWP shall remain compliant with ETSI TS 102 221 [1].

A terminal supporting the SWP interface utilizes contact C6; therefore class A operation cannot be supported.

For the low power mode, the electrical characteristics of contact C1 (Vcc) are extended by the present document. Contacts C2, C3 and C7 shall behave as specified in ETSI TS 102 221 [1].

5.3 Configurations

The terminal indicates the support of SWP interface in the terminal capability as defined in ETSI TS 102 221 [1]. The UICC indicates support of SWP interface in the Global Interface bytes of the ATR as defined in ETSI TS 102 221 [1].

When both the terminal and the UICC are supporting the SWP interface, several operation modes become possible in addition to the operation modes already supported by terminal not supporting the SWP interface and the UICC:

- Only the SWP interface is activated. This may occur while the whole terminal is powered and other interfaces (e.g. the ETSI TS 102 221 [1] or ETSI TS 102 600 [6] interfaces) are not activated, or while the terminal is switched OFF (i.e. the whole terminal may not be operative).
- The SWP interface is activated while a session on another terminal-UICC interface is in progress (e.g. the ETSI TS 102 221 [1] or ETSI TS 102 600 [6] interface). In this case, the different interfaces shall be active concurrently, and therefore actions on the SWP interface shall not disturb the terminal-UICC exchange on the other interfaces and vice-versa.

5.4 Interaction with other interfaces

Communication between a terminal supporting the SWP interface and a UICC supporting the SWP interface take place either over the SWP interface on contact C6 as specified in the present document, or over the interfaces using contacts C2, C3, C4, C7 and C8 as defined in ETSI TS 102 221 [1] and ETSI TS 102 600 [6]. Signalling on a contact assigned to one interface shall not affect the state of other contacts assigned to another interface. This also applies to the activation sequence of the UICC. The power provided on contacts C1 (Vcc) and C5 (Gnd) shall cover the power consumption of all active interfaces of the UICC.

Operation of the SWP interface after activation shall be independent from operation of other interfaces (e.g. the ETSI TS 102 221 [1] or ETSI TS 102 600 [6] interface) that may be implemented on the UICC.

Any reset signalling (RSET signal on contact C2 as specific to the ETSI TS 102 221 [1] interface or logical reset on ETSI TS 102 600 [6] interface) shall only affect the UICC protocol stack related to these interfaces. SWP-related processes shall not be affected by another interface reset signal.

A logical reset signalling on the data link layer (SHDLC RSET) over the SWP interface as well as activation and deactivation of SWP interface shall not affect any of the other interfaces.

6 Physical characteristics

6.1 Temperature range for card operation

In the present document, all parameter values for the SWP interface shall apply for the standard temperature range for storage and full operation as defined in ETSI TS 102 221 [1].