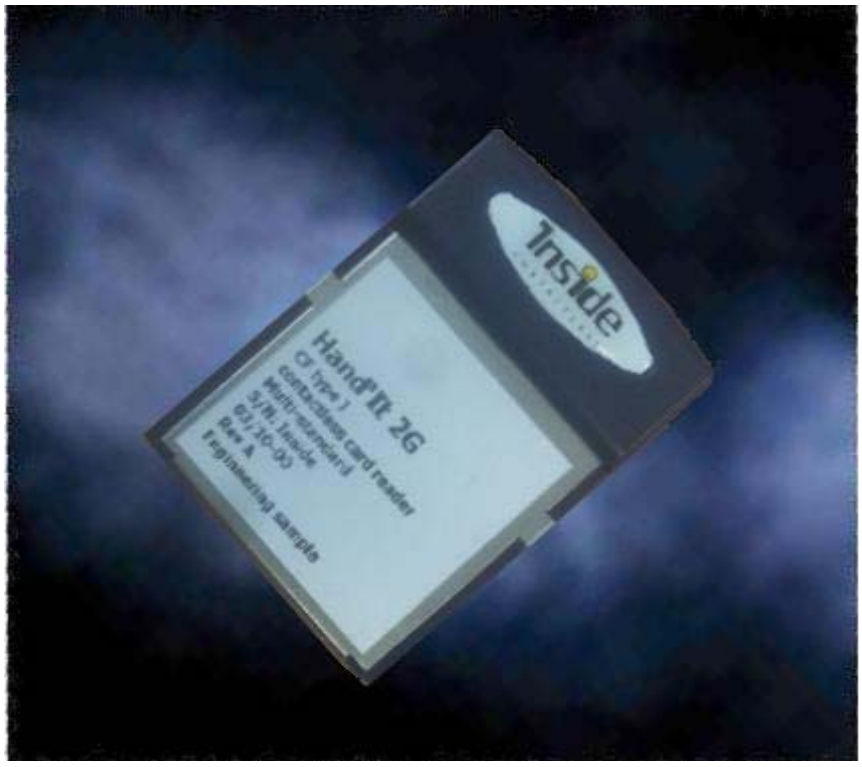
Hand'IT-2G - Preliminary Datasheet

# INSIDE CONTACTLESS

## DATASHEET




# Hand'IT-2G
# Compact Flash READER

**13.56 MHz for ISO chips**
**- 14 443 type A and B**
**- 15 693**
**- FeliCa**

*Chips > Packaging > Readers > more...*

Inside CONTACTLESS

Version 1.0

Hand'IT-2G - Preliminary Datasheet

Version 1.0

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# Main Features

√ **Security management:**
- ☞ Security module
- ☞ Secure key loading

√ **Secured Key Storage**

√ **Contactless interfaces:**
- ☞ ISO 15 693
- ☞ ISO 14 443 type A
- ☞ ISO 14 443 type B
- ☞ FELICA ™

√ **Contactless transmission of data and energy supply**

√ **Carrier frequency: 13.56MHz**

√ **On board antenna**

√ **Transparent mode for contactless data exchange**

√ **Supply voltage: 5 or 3,3V**

√ **Low power consumption < 50 mA**

√ **Idle mode < 5 mA**

√ **Stand-by mode < 50 µA**

√ **Small size: extended CF type I form factor (61 x 43 mm)**

√ **Operating temperature range: -20°C to +50°C**

√ **Emission approval* : FCC, IDA singapore, Canadian, CE**

# Product Ordering Code

| *Product* | *Ordering code* | *Package* | *Tools* |
|---|---|---|---|
| Proximity Coupler Hand'IT-2G | Hand'IT-2G/F | CF | - |

-

# CHAPTER 1
# HAND'IT-2G DESCRIPTION

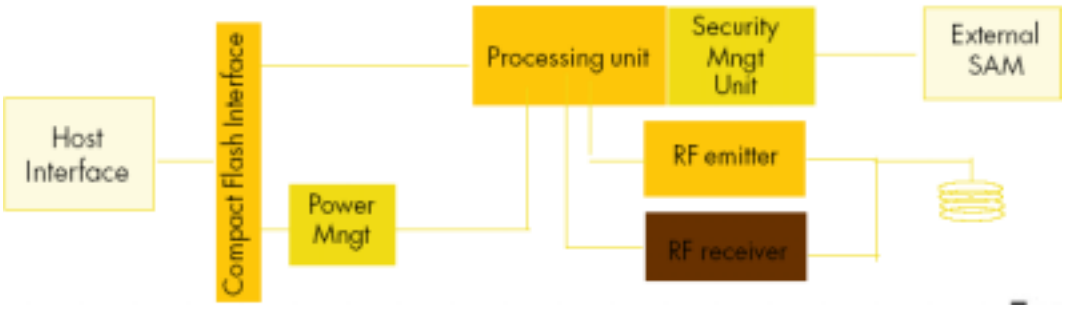
HAND'IT-2G couplers are developed by INSIDE contactless for managing the RF communication interface with 13.56 MHz standard chips.

They have the following features :

- **Operating frequency** 13.56MHz
- **Host interface** CF card
- **Compatibility** Windows 98/XP/Me/2000/PPC2002-2003
- **Target applications** Proximity and short range applications
- **Target chip** All INSIDE's chips, 15693 chips, 14443 chips (type A and type B), FELICA ™

Afterwards, the term «coupler» stands for an electronic board or device that converts numeric commands into contactless chip commands using the RF interface.

## HAND-IT 2G Block Diagram



# HAND'IT-2G dimensions

## *Mechanical Interface – Top View*


- HAND'IT size : L 61 mm * l 43 mm * h 3,3-8mm

## *HAND'IT-2G with PCMCIA Compact Flash Adaptor (not supplied)*

# CHAPTER 2
# HAND'IT-2G CONNECTION

This chapter describes :

- ☞ How to power the coupler
- ☞ How to communicate with the coupler

## *Physical Description*

The host is connected to the Compact Flash Hand'IT 2G using a standard 50pin connector.
The host must be equiped with a CF+ type 1 or 2 slot.
Refer to the host user manual for the Compact Flash card insertion.

## *Electrical Description*

The HandIT 2G acts as a standard PC Card ATA using I/O Mode.
Refer to PC Card standards for details.

# Power supply

## *CHARACTERISTICS*

To power up the coupler, just insert the device into a CF type I or II slot.
Note that opening the associated COM port will power on the device and closing will Power it off.
Refer to the host operating system for more details.

| *Description* | *Min.* | *Typical* | *Max.* | *Unit* |
|---|---|---|---|---|
| DC voltage | 3,135 | 3,3 | 3,465 | V |
| RF active current | | 50 | TBD | mA |
| Idle Mode current | | 5 | TBD | mA |
| Standby current | | 50 | TBD | µA |

**Electrical characteristics**

# Software & Drivers

***System requirements***

The Hand'It 2G works with laptops or PDAs running Microsoft Windows 98/2000/XP/CE /Pocket PC2002&2003.

***Pocket PC Users***

PDA running Pocket PC don't need any specific driver to manage the Hand'IT 2G as a standard COM Port.
Depending on the device, the COM port number can take any value.
Refer to the Register DataBase to get the correct COM number under HKEY_LOCAL_MACHINE\ DRIVERS\ACTIVE\xx
Search the Key with PnpId = Hand_It-INSIDE-D9A6
You will find the COM number in the *Name* Field.

***Laptops users***

You need to install the HandIT 2G drivers from the Inside installation disk
Insert the HandIT 2G into the laptop (using an CF to PCCARD adapter.).
Follow screen instructions and select the folder containing *HandIT2G.inf* file from the Installation Disk.
The HandIT 2G will appear as a standard COM Port named *Compact Flash HandIT.*
You can adjust COM settings from the hardware profil menu.

***Coupler Communication***

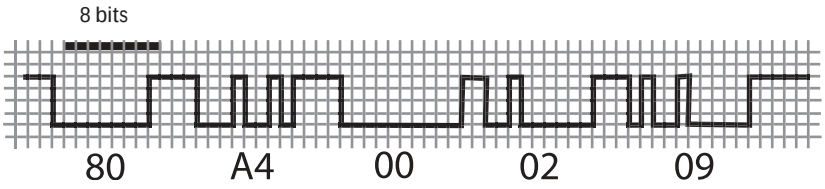
Once installed, the Hand'IT 2G works as a standard coupler connected to a serial COM port.

# Serial Interface

This interface allows a serial connection to the host via the CF interface:

## *Character Format*

| | |
|---|---|
| *Data Rate* | 115200 baud (default value) |
| *Parity* | Even |
| *Number of bits* | 8 |
| *Transmission Mode* | LSB first |
| *Stop bits* | 2 |
| *Flow control* | none |




**SelectCard command frame**

## *Baud rate*

The default data rate is set at 115200baud, but this can be changed by software to select following data rates :

- 9600
- 19200
- 38400
- 57600
- 115200

# How to reset HAND'IT-2G couplers

Resetting the coupler may be useful in two situation :

*a. to set the parameters (speed, disable mode, protocol settings, keys ) to the defaults values. All these values are stored in coupler's internal EEPROM*

*b. if it is impossible to communicate with the coupler (bad setting for serial communication speed mainly)*

## *SOFTWARE RESET*

It is possible to reset the coupler's EEPROM by sending 2 commands thanks to the SET STATUS command.

Command = $80,$F4,$80,$3E,$01 - Data = $00
Command = $80,$F4,$80,$7E,$01 - Data = $00

Then the coupler has the default setting : 115200 bds, defaults protocols....

## *HARDWARE RESET*

If for any reason it becomes impossible to communicate with the coupler, follow this procedure :

- remove the hand'IT 2G from the CF slot
- remove the plastic top cover as shown

- connect the 2 reset pins as indicated in the drawing


- reinsert the Hand'IT 2G and open the COM port: it will start with the default factory parameters

- remove the hand'IT 2G from the CF slot and the the reset pins connection

# CHAPTER 3
# COMMAND INTERFACE REFERENCE MANUAL

In this chapter you will find the command format, and the description of all the commands used by the coupler.
User may refer to this chapter to find the following information :

- ***low level description of data exchange between coupler and host, mainly when using microcontroller or an automat***

- ***check the signification and/or a value of a command parameter***

# HOST - COUPLER protocol

## *DESCRIPTION*

The commands are modeled on the ISO 7816 command set. This protocol is used by all INSIDE"s couplers

A typical protocol exchange includes:

1. The host sends a command to the coupler
2. The coupler executes the command
3. The host receives a response from the coupler

Coupler command is always constituted of 5 bytes :

- CLASS : always 80h
- INSTRUCTION : command to be executed by the coupler (like SelectCard)
- P1 : Command parameter
- P2 : Command parameter
- P3 : Command parameter

Depending on the command, coupler answers data, status words.

There are 4 cases of data exchange:

| *Case* | *Host to coupler* | *Coupler to Host* | *ISO Type* |
|---|---|---|---|
| 1 | None | None | ISO None |
| 2 | None | Yes | ISO Out |
| 3 | Yes | None | ISO In |
| 4 | Yes | Yes | ISO In / Out |

**Note** : In case 4, data has to be sent and received from the coupler. With T=0 protocol, it is not possible in a single command, so this command has to be split into 2 commands:

**ISO In** : The host sends a command + data and receives the status words.
**ISO Out** : The host sends a command and receives data + the status words.

Coupler with firmware former than 40-017F has only ISO NONE, ISO IN and ISO OUT protocol available.

In all cases, status words are returned (SW1 and SW2).

## Case 1: ISO None Data Exchange

| | *Command* | | | | | *Status words* | |
|---|---|---|---|---|---|---|---|
| **Host** | Cla. | Ins. | P1 | P2 | P3 | | |
| **Coupler** | | | | | | SW1 | SW2 |
| **nb of bytes** | 5 bytes | | | | | 2 bytes | |

## Case 2 : ISO Out Data Exchange - Coupler ⇨ Host

| | *Command* | | | | | *Ack.* | *Data* | *Status words* | |
|---|---|---|---|---|---|---|---|---|---|
| **Host** | Cla. | Ins. | P1 | P2 | P3 | | | | |
| **Coupler** | | | | | | = Ins. | data | SW1 | SW2 |
| **nb bytes** | 5 | | | | | 1 | = P3 | 2 | |

**Class** : always 80h
**Instruction** : command code
**P1 & P2** : command parameters
**P3**: number of data bytes expected from the coupler

**Ack**. : coupler acknowledgement. It is always equal to the command code, except when an error occurs. If the Acknoledgement value is different than the instruction byte, then the received byte is the first byte of a status error code coded on 2 bytes.

**Data** : data sent to the host by the coupler. Size of the command has to be P3.

**Status word** : 90 00h if correct, error code.

## Case 3: ISO In Data Exchange - Host ⇨ Coupler

| | *Command* | | | | | *Ack.* | *Data* | *Status words* | |
|---|---|---|---|---|---|---|---|---|---|
| **Host** | Cla. | Ins. | P1 | P2 | P3 | | Data | | |
| **Coupler** | | | | | | = Ins. | | SW1 | SW2 |
| **nb bytes** | 5 | | | | | 1 | = P3 | 2 | |

**Class** : always 80h
**Instruction** : command code
**P1 & P2** : command parameters

**P3**: number of data bytes sent to the coupler.

**Ack**. : coupler acknowledgement. It is always equal to the command code, except when an error occurs. If Acknowledgement value is different than instruction byte, then the received byte is the first byte of a status error code coded on 2 bytes.

**Data** : data sent by host to the coupler. Size of data array has to be P3.

**Status word** : 90 00h if correct / error code.

**Error** : If the Acknowledgement value is different than the instruction byte, then the received byte is the first byte of a status error code coded on 2 bytes.

**Case 4 : ISO InOut Data Exchange - Host ⇔ coupler**

| | *Command* | | | | | *Ack.* | *Data in* | *Ack.* | *Data out* | *Status words* | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Host** | Cla. | Ins. | P1 | P2 | P3 | | Data in | | | | |
| **Coupler** | | | | | | = Ins. | | = Ins. | Data out | SW1 | SW2 |
| **nb bytes** | 5 | | | | | 1 | = P3 | 1 | =P2 | 2 | |

**Class** : always 80h
**Instruction** : command code
**P1 :** command parameters
**P2 :** number of data bytes expected from the coupler.
**P3 :** number of data bytes sent to the coupler.

**Ack**. : coupler acknowledgement. It is always equal to the command code, except when an error occurs. If Acknowledgement value is different than instruction byte, then the received byte is the first byte of a status error code coded on 2 bytes.

**Data** : data sent to the host by the coupler. Size of the command has to be P3.

**Status word** : 90 00h if correct / error code.

# Coupler commands overview

| Command | INS | Description |
|---|---|---|
| SELECT_CARD | "A4h" | Selects one contactless card following list of possible cards in the field |
| SELECT_PAGE | "A6h" | Selects a page in a multi-application chip |
| TRANSMIT | "C2h" | Sends and retrieve data from chip through contactless interface : Transparent mode |
| GET_RESPONSE | "C0h" | Reads the internal buffer of the coupler to retrieve chip answer for ISO 7816 T=0 protocol. |

| Command | INS | Description |
|---|---|---|
| READ_STATUS | "F2h" | Reads coupler status or EEPROM memory. |
| SET_STATUS | "F4h" | Sets the coupler status or write in EEPROM memory. |
| DISABLE_COUPLER | "ADh" | Disables the coupler. it will only respond after a ENABLE_COUPLER command. |
| ENABLE_COUPLER | "AEh" | Enable the coupler. It wakes up the coupler after a DISABLE_COUPLER command. |

**Security module functions†:**

| Command | INS | Description |
|---|---|---|
| LOAD_KEY_FILE | "D8h" | Load new master keys for authentication purposes. |
| ASK_RANDOM | "84h" | Ask for a random number from the coupler. |
| SELECT_CURRENT_KEY | "52h" | Select the key to be used for authentication purposes. |

# SELECT_CARD

## Use

Select a card in order to get the serial number. This command manages anti-collision and authentication features.
This command is able to test several communication protocol. It answers the number of protocol used to select the card.

## Prototyping

- Command sent : A4h
- Command type : ISO out

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Host | 80h | A4h | P1 | P2 | P3 | | | | | |
| Coupler | | | | | | A4h | Card type | Serial number | 90h | 00h |

## Parameters

| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| Function | - | - | Key | Auth | Presel. | Loop | Halt | Wait |

**P1: Parameter used for contactless configuration**

**IMPORTANT: " - " are reserved for future use, and values should be set to 0.**

WAIT :
1: Wait until a card is selected or a character received from the host (e.g. PC).
0: Exit if no card is detected after 3 attempts.

> ***Note**: When SELECT_CARD uses the option ´LOOPª, the coupler sends ACK=60h (See T=0 specifications) after each unsuccessful selection until a card is selected. When a card is selected, ´90h 00hª is returned. In order to stop this scanning, host has to send a byte through the RS232 interface.*

HALT:
1: Halts card after selection for fast serial numbers capture.
0: No halt after selection.

LOOP:
1: returned a frame composed of ACK | CARD TYPE | SN | 9000h or wait character 60h
0: no loop performed.

PRE:
1: Increases pre-selection with INSIDE CONTACTLESS anti-collision and a large number of cards.
0: Standard anti-collision (best for 5 cards max.).

AUTH:

1: Performs a standard INSIDE authentication.
Authentication is performed if the key is set as the current key.
Please refer to appendix A : ´How to low a keyª for key loading and key management operations details.
0: Does not perform an authentication.

KEY:

1: Authenticates with Debit Key (Kd = Key 1) if AUTH is set.
0: Authenticates with Credit Key (Kc = Key 2) if AUTH is set.

**P2: Parameter used for selecting the card types to be read**

| b7 - b4 | b3 | b2 | b1 | b0 |
|---|---|---|---|---|
| 0 | Protocol 3 | Protocol 2 | Protocol 1 | Protocol 0 |

INSIDE couplers manage the following protocols :
- Protocol 0 : ISO 14 443 type B & Inside anticollision (only for INSIDE chip)
- Protocol 1 : ISO 15 693 & Inside anticollision (only for INSIDE chip)
- Protocol 2 : ISO 14 443 type B-3
- Protocol 3 : User defined protocol - see ´Other ISO chip managementª chapter for more information about Protocol 3 use.

If bit related to protocol x is set to one, coupler will run an anticollision using this protocol. If several protocols are selected, coupler will test all of them, starting from protocol 0 to protocol 3.

**P3: Number of bytes to be return by the coupler**
Set P3 = 09h for reading Pico Family Chips serial numbers.

**Response: Card type (1 byte) and serial number (8 bytes)**
Card type is the protocol number used by the card that has been selected for its answer. For 15 693 INSIDE"s chips, card type value is 1 as protocol 1 is used for selection. This value is the one to use to indicate protocol in the transmit command.

# SELECT_PAGE

## Use

This command is used to select and authenticate in an INSIDE multi-application chip (8*2Ks...).

## Prototyping

- Command sent : A6h
- Command type : ISO Out

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ***Host*** | 80h | A6h | P1 | P2 | 08h | | | | |
| ***Coupler*** | | | | | | A6h | Chip 's configuration block | 90h | 00h |

## Parameters

| ***Bit*** | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| ***Function*** | - | - | - | - | Auth | Page selection | Protocol type | |

**P1: Parameter used for contactless configuration**

**b3 : Auth**

0 - Does not perform authentication after PAGESEL.
1 - Performs authentication after PAGESEL

**b2: Select Page**

0 - Does not send the PAGESEL command before authentication
1 - Sends the PAGESEL command with page contained in P2 before authentication

***Note :*** *b2=b3=0 imply that no operation is performed*

**b1-b0: Protocol type:**
This command can only work with PICO family chips

| ***Contactless Communication Protocol*** | |
|---|---|
| 00 | ISO14 443 B PICO family chips |
| 01 | ISO15 693 PICO family chips |
| 10 | ISO14 443 B-3 |
| 11 | User"s protocol |

**P2 : Page number to select and authenticate and cryptographic key to use**

| ***Bit*** | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| ***Function*** | Reader key number | | | | - | Page number | | |

**b7-b4** : **Reader key number**

***Note :*** *0 correspond to Kd0, 1 to Kc0, Ö, 14 to Kd7 and 15 to Kc7.*
*This is the reader key number to use during authentication. The reader will use this key number (EEPROM) to diversify and authenticate the requested page with Kd or Kc.*

**b3** : **Page"s key to use to perform the authentication**
0 : authentication will be performed with page"s debit key.
1 : authentication will be performed with page"s credit key.

**b2-b0** : **Page number to select**

**P3 : Chip answer length**
This parameter has to be set to 8 as the chip answers the page"s configuration block (8 bytes).

# TRANSMIT

## *Use*

Transmits data from the coupler to the chip and read back chip response.
This command is the one to use to read and write data in the chip.

## *Prototyping*

- Command sent : C2h
- Command type : ISO In / Out

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Host*** | 80h | C2h | P1 | P2 | P3 | | Data | | | |
| ***Coupler*** | | | | | | C2h | | Chip answer | 90h | 00h |

P1 : Defines the contactless communication protocol
P2 : Chip answer length
P3 : Chip command and data

## *Parameters*

**P1: Parameter used for contactless configuration**

| ***Bit*** | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| ***Function*** | Send CRC | Check CRC | Time out | | Send signature | ISO type | RF protocol type | |

**b7: Send CRC:**

1: The coupler automatically sends the CRC (function of the Data bytes) to the chip. Coupler uses the CRC associated to the choosen protocol (bit 1 & 0)
0: Only P3 data bytes are sent.

**b6: Compare CRC:**

1: Compares the returned CRC with the expected value calculated by the coupler (verify the data sent by the chip).
0: CRC is not checked.

**b5-b4: Time Out:**

The time out value depends of the protocol used (b1 and b0 values).
The time out is the time from the command"s EOF (End Of Frame) to the chip response SOF (Start of Frame).

| ***Bits 4& 5*** | ***Time-out 15 693*** | ***Time-out 14 443*** |
|---|---|---|
| 00 | 800 µs | 200 µs |
| 01 | 4 ms | 1 ms |
| 10 | 24 ms | 6 ms |
| 11 | 40 ms | 10 m |

**b3: Send Signature:**

1: Send a cryptographic signature calculated thanks to the coupler security module. This option may be used only for UPDATE command performed on secure PICO family chip. Set this value to 0 for non secure chip or any other manufacturer chips

0: Cryptographic signature is not sent.

**b2 : HOST - COUPLER protocol type**

1 : Communication is ISO IN-OUT. Coupler send back the data as soon as it receives chip answer.
0 : Commucation between HOST and coupler follows the ISO 78-16 T=0 protocol. Thus TRANSMIT command is only ISO IN, and user has to use the GET REPONSE command to retrieve chip DATA from the coupler.

**b1-b0: Protocol type:**

Defines the contactless communication protocol number to be used. When coupler"s EEPROM is set with the default values, the protocol types are as follows:

| | ***Contactless Communication Protocol*** |
|---|---|
| 00 | ISO14 443 B PICO family chips |
| 01 | ISO15 693 PICO family chips |
| 10 | ISO14 443 B-3 |
| 11 | User protocol (default value : ISO 14 443 A-3) |

**P2 : Number of data bytes received from the chip after transmission of the command.**
If the Compare CRC bit of P1 is enabled, P2 should not include the CRC bytes.

*Note: P2<=35 (23h).*

**P3 : Number of bytes in the data field of the command.**

If the Send CRC or the Send Signature bit of P1 is enabled, P3 should not include the CRC bytes or the signature.

*Note: P3<=32 (20h).*

**Data**: Commands and data to send to the chip
All PICOTAG commands are detailed in PICOTAG datasheet.

**Response:**

- Chip answer
- Status word.

# GET_RESPONSE

## Use

This command returns the value contained in the internal buffer of the coupler.
It has to be used to get chip answer when the TRANSMIT command is used with the ISO IN type to retreive the chip answer.

## Prototyping

- Command sent :C0h
- Command type : ISO out

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ***Host*** | 80h | C0h | 00h | 00h | P3 | | | | |
| ***Coupler*** | | | | | | C0h | Coupler buffer | 90h | 00h |

## Parameters

**P3:** Number of bytes of the coupler response. It has to be less than 35 (23h).

**Response :** Coupler"s buffer and status words

# READ_STATUS

## Use

This command is used to get coupler parameters (communication speedÖ).

## Prototyping

- Command sent : F2h
- Command type : ISO out

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ***Host*** | 80h | F2h | *P1* | *P2* | 01h | | | | |
| ***Coupler*** | | | | | | F2h | Read bytes | 90h | 00h |

## Parameters

**P1: type of parameter to read**

| ***b7 - b2*** | ***b1 - b0*** |
|---|---|
| 0 (RFU) | Parameter location |

**b1-b0 : Parameter location**

- 00 : Parameter value is read in coupler"s EEPROM (setting when power on)
- 01 : Coupler"s I/O
- 10 : Reserved for Future Use
- 11 : Parameter value is read in coupler"s RAM (current setting)

**P2: set the parameter address to read**

Valid values for P2 according to P1 value:

- EEPROM: 00h to FFh.
- I/O: 05h and 07h.
- Parameter: 50h to 6Fh.

**Response** : byte value at the transmitted address + status word

***Note**: When reading the I/O, the Read byte returned indicates the IN1, OUT1, OUT2 pin states as follows: (OUT2P is connected to VDD via a 1kŸ- resistor).*

| ***I/O Address*** | ***b7*** | ***b6*** | ***b5*** | ***b4*** | ***b3*** | ***b2*** | ***b1*** | ***b0*** |
|---|---|---|---|---|---|---|---|---|
| 05h : Output | - | - | - | - | OUT2 | OUT1 | - | - |
| 07h : Input | - | - | - | - | - | - | - | IN |

# SET_STATUS

## Use

This command sets configuration parameters and coupler"s I/O :

- Communication speed
- Protocols
- State at Power ON
- 2 outputs & 1 input

The various parameters and data used by INSIDE couplers are stored in the EEPROM. When coupler is powered on, a part of these parameters are load in coupler"s RAM, so that parameters may be modified in coupler"s EEPROM and in coupler"s RAM.
For a given parameter, RAM and EEPROM address are the same. For example, speed parameter is located at address 6Dh for both RAM and EEPROM.

☞ When updating a value in the coupler"s EEPROM, this value will be the default value after turning the coupler on.
☞ When updating a value in the coupler"s RAM, this value will be the current value until the next Power Off.
☞ When writing to EEPROM occurs, EEPROM parameters are reloaded into processor memory (RAM).

## Prototyping

- Command sent : F4h
- Command type : ISO In

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ***Host*** | 80h | F4h | P1 | P2 | 01h | | Data | | |
| ***Coupler*** | | | | | | F4h | | 90h | 00h |

## Parameters

**P1: Sets the type of configuration parameter to update**

| *b7* | *b6* | *b5-b2* | *b1 - b0* |
|---|---|---|---|
| Reset coupler | Reset magnetic field | - (RFU) | Address |

**b7 : Resets coupler**
if this bit is set to 1, coupler will fully reload EEPROM in RAM as if the coupler is powered on.
*Note : when b7 = 1, the coupler responds 3Bh 00h.*

**b6 : Reset magnetic field**
Magnetic field is cut for 20 ms.
When this bit is set to 1, coupler will execute no other action, including EEPROM or RAM update.

**b5-b2 : RFU (reserved for future use)**

**b1-b0 : Parameter location**

- 00 : Parameter value is read in coupler"s EEPROM (setting when power on)
- 01 : Coupler"s I/O
- 10 : Reserved for Future Use
- 11 : Parameter value is read in coupler"s RAM (current setting)

**P2: Sets the parameter address to update**

Valid values for P2 according to P1 value:

- EEPROM : 00h to 07h *and* 3Eh to FFh.
- I/O : 05h, 06h, 07h.
- RAM : 50h to 6Fh.

**Response:** Status words

## *MODIFIABLE PARAMETERS*

User can change the following parameters in coupler"s memory :

- **Protocols** - Please refer to ´Managing ISO protocol with INSIDE coupler[a] application note for more information about protocol management
- **Serial communication speed** - from 9600 to 424000 bauds depending on the reader

| *Name* | *Address* | *State* | *Hex. value* | *Available on...* |
|---|---|---|---|---|
| Serial communication speed | 6Dh | 9600 | 57h | All readers |
| | | 19200 | 2Dh | |
| | | 38400 | 15h | |
| | | 57600 | 0Eh | |
| | | 115200 | 06h | |

***Note 1 :*** *When updating the COMSPEED parameter, the coupler returns the Status Words with the previous COMSPEED before the COMSPEED update.*

Example : the baudrate is set to 9600 bauds and needs to be temporarily updated to 115 200 bauds.
Send a SET_STATUS command (80h F4h 03h 6Dh 01h & 06h). The coupler responds (Status words) using 9600 bauds.

- **State at power on** - Is coupler emitting a field when it is powered on ? (please refer to ENABLE and DISABLE command chapters)

| Name | Address | State | Hex. value | Available on... |
|---|---|---|---|---|
| State at power on | 42h | Enable | 01h | All reader |
| | | Disable | 00h | |

***Note 2 :*** *The ACTIVATE AT POWER ON parameter defines the state of the coupler when you turn it on.*
If you turn the coupler on and if 00h is written in the EEPROM at address 42h , it will be ´asleepª until you send an ENABLE_COUPLER command.

***IMPORTANT NOTE : If change in the EEPROM is followed by a reset of the coupler and if address 42h contains 00h then the coupler will be asleep until you send an ENABLE command.***

## COUPLER"S INPUTS AND OUTPUTS

Please refer to chapter 1 for connection.

| Reader | Input / Output | I/O address | Command to use | Value |
|---|---|---|---|---|
| M21xH | OUT1 | 05h - Bit 1 | Set Status | Bit at 0 : low level<br>Bit at 1 : High level |
| | OUT 2 | 05h - bit 2 | Set Status | |
| | IN 1 | 07h - bit 0 | Read Status | |
| M22xH | OUT | 05h - bit 2 | Set Status | |
| M302H | OUT | 06h - bit 4 | Set Status | |
| ACCESSO | LED | 05h | Set Status | Byte value & color<br>04h : Red<br>08h : Orange<br>0Ch : Green |

## EEPROM FREE AREA

User can use EEPROM bytes from 70h to 7Dh to write some data.

# DISABLE_COUPLER

## Use

The coupler goes in SLEEP mode that allows low power consumption and RF carrier is desactivated.
After this command, the coupler will not respond to any command except the ENABLE_COUPLER command.
A new feature available only on M21xH 2G is that coupler can detect if a card approach the antenna and wake up on its own.

## Prototyping

- Command sent : ADh
- Command Type : ISO none

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ***Host*** | 80h | ADh | BCh | DAh | 01h | | |
| ***Coupler*** | | | | | | 90h | 00h |

## Parameters

Response: **Status words**

**Note :** It is possible using the SET_STATUS command to have the coupler in a sleep mode each time it turns on. The coupler will then be asleep until you send an ENABLE_COMMAND. Please refer to the SET_STATUS command for activating this feature.

# DISABLE_COUPLER ENHANCED

## Use

As the DISABLE_COUPLER command, this specific version enables the user to asleep the reader.
But M210H 2G and M260H 2G have the possibility to detect that a card approaches their antenna.
As sooon as the card is detected, the coupler will turn the RF field on, and start a card selection.
If no card answers to the anticollision process, the coupler go back asleep. If a card is selected, then the coupler stay awake.

## Prototyping

- Command sent : ADh
- Command Type : ISO none

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ***Host*** | 80h | ADh | BCh | *P2* | 01h | | |
| ***Coupler*** | | | | | | 90h | 00h |

## Parameters

***P2*** : specify the anticollision to process when a card is detected. If several bit are set at 1, all selected anticollision will be performed.

| ***b7*** | ***b6*** | ***b5*** | ***b4*** | ***b3*** | ***b2*** | ***b1*** | ***b0*** |
|---|---|---|---|---|---|---|---|
| - | 0 | - | Pulse OUT1 | Ant3 | Ant2 | Ant1 | Ant0 |

ï If Antx bit is set, then the anti-collision x will be processed else not.
ï If no Antx is set, then the coupler will wake-up only by detecting a field change over the reader.
ï If b4 is set, then the OUT1 PIN is set to high for 10 ms when a card is selected.

**Note :** It is possible using the SET_STATUS command to have the coupler in a sleep mode each time it turns on. The coupler will then be asleep until you send an ENABLE_COMMAND. Please refer to the SET_STATUS command for activating this feature.

**Note** : This command is only available on :
- M210-2G
- ACCESSO-2G

# ENABLE_COUPLER

## Use

This command restores a normal coupler running, with RF emission.
This command can only be used after a DISABLE_COUPLER command or if the coupler is desactivated after power on.

## Prototyping

- Command sent : AEh
- Command type : ISO none

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ***Host*** | 80h | AEh | DAh | BCh | 00h | | |
| ***Coupler*** | | | | | | 3Bh | 00h |

## Parameters

**Response** : Status words
The coupler will respond ´Instruction not recognized[a] (6Dh 00h) if already activated.

***Important note : You have to send the ENABLE_COUPLER command in a window of 16ms. To be sure that your command will be received, send it twice. The time between the sending of the 2 commands has to be less than 10 ms.***

This is automatically done when using MX.Enable method (ActiveX component).

# ASK_RANDOM

## Use

This command returns an 8 bytes random value from the coupler.This command has to be used to initialize the key loading procedure.

## Prototyping

- Command sent : 84h
- Command type : ISO out

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ***Host*** | 80h | 84h | 00h | 00h | 08h | | | | |
| ***Coupler*** | | | | | | 84h | Random number | 90h | 00h |

## Parameters

**Response :** Random number; Status words

# LOAD_KEY_FILE

## Use

This function loads into the coupler"s security module a key to be used for authentication and security purposes.
Key loading is a security sensitive operation. In order to protect the confidentiality of the keys transferred to the coupler, data is encrypted. A 4-byte checksum is also sent in order to guarantee the authenticity of the data, which could be corrupted either through transmission errors or by a deliberate attempt to fraud the system.

Refer to ´Coupler"s key loading[a] chapter for more information about security and the way to calculate encrypted key and checksum.

## Prototype

- Command sent : D8h
- Command type : ISO In

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ***Host*** | 80h | D8h | P1 | P2 | OCh | | Data | | |
| ***Coupler*** | | | | | | D8h | | 90h | 00h |

## Parameters

**P1 : Parameter used for key operations**
00: Load and activate the key pointed by P2.
01: Deactivate the key pointed by P2 (Forbidden option to Exchange Key Ke).
02: Delete the key pointed by P2 (Forbidden option to Exchange Key Ke).
Others value are reserved for future use.

***Notes:***
*With the 00 option, this command will replace the old value of the key with the new value.*
*With the 01 and 02 options, the command has to be sent with 12-byte data at any value (Data = XX XX XX XX XX XX XX XX XX XX XX XX).*
*When a key is deactivated, you need to reload it to reactivate the key.*

**P2 : Key number.**
00h - Exchange Key Ke: used for key loading operation.
01h - Debit Key Kd0
02h - Credit Key Kc0
03h - Debit Key Kd1
04h - Credit Key Kc1
.....
0Fh - Debit Key Kd7
10h - Credit key Kc7

**Data**:
This field contains:
- the 8-byte encrypted master key
- the 4-byte checksum

**Response**: Status Words

# SELECT_CURRENT_KEY

## Use

This function allows to choose a key for future authentications. A key that has been deactivated or deleted cannot be selected. Only one of the 16 keys can be current at the same time.

## Prototype

- Command sent : 52h
- Command type : ISO In

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ***Host*** | 80h | 52h | 00h | P2h | 08h | | 8 * 00h | |
| ***Coupler*** | | | | | | 52h | | 90h | 00h |

## Parameters

**P2 : Key number**

01h - Debit Key Kd0
02h - Credit Key Kc0
03h - Debit Key Kd1
04h - Credit Key Kc1
.....
0Fh - Debit Key Kd7
10h - Credit key Kc7

**Remark:** if the specified key is deactivated, the status bytes returned is 6Bh 00h.

# DIVERSIFY_KEY

## *Use*

This function enables the user to calculate the result of key diversication with selected chip serial number.
The key diversified value is used for authentication and signature calculation while writing a secure chip.
This can have 2 uses :
- before an authentication (SELECT_PAGE or AUTHENTIFY command)
- to calculate the keys that will be written in a chip during a personalization phase (only working with a dedicated personalization coupler)

## *Prototype*

- Command sent : 52h
- Command type : ISO In

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ***Host*** | 80h | 52h | 00h | P2h | 08h | | Chip serial number | | |
| ***Coupler*** | | | | | | 52h | | 90h | 00h |

## *Parameters*

**P2 : Key number**
01h - Debit Key Kd0
02h - Credit Key Kc0
03h - Debit Key Kd1
04h - Credit Key Kc1
.....
0Fh - Debit Key Kd7
10h - Credit key Kc7

**Remark:** if the specified key is deactivated, the status bytes returned is 6Bh 00h.

# GET_CONFIG

## Use

This command is used to read the ID of the MCU part.

## Prototype

- Command sent : CAh
- Command type : ISO In

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Host*** | 80h | CAh | 00h | 00h | 09h | | | | | |
| ***Coupler*** | | | | | | CA | ID (8) | Code Info (1) | 90h | 00h |

## Parameters

**Data** : MCU part"s ID
**Code Info (1 byte)** : RFU

# CHAPTER 4
# USERíS GUIDE

In this chapter ou will learn how to use the coupler to...

- ☞ Use INSIDE chip
- ☞ Manage the security

# MANAGING INSIDE CHIPS

The various steps in INSIDEís chips management are the following :

- **Set the used key (if your application is secured)**
- **Select a chip**
- **If it is a multi-application chip, select the page in which you want to work**
- **Read, Write data in the chip memory**
- **Halt the chip to enable another chip selection**

Using INSIDE couplers, authentication and signature calculations are managed automatically by the SELECT_PAGE or the SELECT_CARD command. Just indicate in these commands that you want to use the security features.

In this chapter is just indicated the way and the functions and commands to use to reach your goal. Please refer to the Reference Manuals for more information about the functions and its parameters.

In this chapter you will also learn :

- **how to manage the various protocol at low level or with the activeX component**

- **how to make a chips inventory and select a chip within several ones.**

## *SECURITY CONFIGURATION*

Before using the security features, please take a look at the ´**Security management**ª chapter. You will find there basic principles on which is based INSIDE chips security.

If your application is secured, you have to ...

a. Load the key in the coupler. This operation has to be performed only once. As soon as keys are loaded, they are stored in the couplerís EEPROM.

b. tell to the coupler which key you want to use for your application (Kd1, Kc1, Kd2 ...)

## *a. Loading the key...*

You have to indicate the following parameter :
- Exchange key to enable you to load the key
- New key value
- Key number (is it ´Debit Key 3ª, ´Credit key 2ª)

☞ **ActiveX :** ***Mx.KeyLoading*** method

☞ **C Library :** ***Clib_w_KeyLoading*** procedure

☞ **Low level :** **LOAD_KEY_FILE** command

## *b. Activating the current key...*

Two commands are available to tell to the coupler which key you want to use. One has to be used before the selectcard command, and the other before the SelectPage or Authentify command if you want to use a key different than the one used to authentify the chip (or if you selected the card without authentication).

### Use the following commands before the *SelectCard* command :

☞ **ActiveX method :** ***Mx.CurrentKey*** property

☞ **C Library :** ***CLib_w_SelectCurrentKey*** procedure

☞ **Low level :** **SELECT_CURRENT_KEY** command

Please refer to the chapter ´Managing the securityª for more details about the way it works, and to the reference manual chapter for more details about the commands.

### Use the following commands before the *SelectPage* and *Authentify* commands :

☞ **ActiveX method :** ***Mx.DiversifyKey*** property

☞ **C Library :** ***Clib_w_DiversifyKey*** procedure

☞ **Low level :** **DIVERSIFY_KEY** command

Please refer to the chapter ´Managing the securityª for more details about the way it works, and to the reference manual chapter for more details about the commands.

## *SELECTING A CHIP*

During this operation, you will choose the protocol you want to use (14 443 type A, 14 443 type B or 15 693), and if you want to authentify the chip. The answer will give you the protocol used by the chip, and its serial number

| *Security...* | *P1 value* |
|---|---|
| none | 00h |
| Kd authentication | 30h |
| Kc authentication | 10h |

| *Which protocol...* | *P2 value* |
|---|---|
| 14 443 B-2 | 01h |
| 15 693 | 02h |
| 14 443 B-3 | 04h |

Then use the following command :

☛ **ActiveX method :** ***Mx.SelectCard*** (P1, P2, Type_SerialNumber)

☛ **C Library :** ***Clib_w_SelectCard*** (P1, P2, Type_SerialNumber)

☛ **Low level :** **SELECT_CARD** : 80h A4h P1h P2h 09h...

**Note 1** : Coupler will answer the protocol number used to communicate with the chip, and the chip serial number. This ´protocol numberª is the value to use with the TRANSMIT command as ´protocol valueª

**Note 2** : The above table show 2 protocols ISO 14 443 type B

☛ **14 443 type B-2 :** RF protocol is the one defined in the 14 443 B standard level 2, and anticollision is INSIDE contactless one.

☛ **14 443 type B-3 :** RF protocol follows the 14 443 B standard level 2, and anticollision is defined in 14 443 B standard level 3.

## SELECTING A PAGE

If you are using a Multi-application chip ( 8*2K for example ) you have to select the page in which you want to work.
The SelectCard command selects by default page 0. The SelectPage command enables you to work in all other pages. It will manage the authentication if the page is secured.

*You have to enter...*
- page number
- key to use for authentication
- protocol to use

*You will get...*
- page configuration block (block 1)

Then use the following command :

☛ **ActiveX method :** ***Mx.SelectAuthPage*** (Key number, PageNumber, ConfigBlock)

☛ **C Library :** ***Clib_w_SelectAuthPage*** (Key number, Protocol, PageNumber, ConfigBlock)

☛ **Low level :** **SELECT_PAGE**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ***Host*** | 80h | A6h | P1 | P2 | 08h | | | | |
| ***Coupler*** | | | | | | A6h | Chip 's configuration block | 90h | 00h |

The following table gives you parameters to select and authenticate a secured page. P2 values are just examples.

| ***Protocol*** | ***P1 value...*** |
|---|---|
| 14 443 B | 0Ch |
| 15 693 | 0Dh |
| 14 443 A | 0Eh |

| ***Page & key number*** | ***P2 value...*** |
|---|---|
| Key Kd1 & Page 1 | 21h |
| Key Kc1 & Page 1 | 31h |
| Key kd7 & Page 7 | E7h |

***Note*** : if the page is secured, use the diversify command to select in the coupler the key that will be use for the authentication.

## *READING CHIP MEMORY*

You will find a full memory description in the chip datasheet, but the easiest way to discover the chip memory is to use the MX3 software (PICO MEMORY page).

***You have to enter...***
- block number
- protocol to use

***You will get...***
- memory data

Then use the following command :

☛ **ActiveX method :** ***Mx.ReadBlock*** (BlockStart, BlockCount, ChipResponse)

***Mx.Read property*** : ActiveX component optimizes reading speed by using READ or READ4 chip command depending on chip possibilities.

☛ **C Library :** ***Clib_w_ReadBlock*** (BlockStart, BlockCount, Protocol, ChipResponse)

***Clib_w_ReadBlockBy4***(BlockStart, BlockCount, Protocol, ChipResponse)

☛ **Low level :** **TRANSMIT command** **+ 0Ch chip command** (single read)
**+ 06h chip command** (read4)

All communication with a chip is done thanks to this command, including INSIDEís chips. You will find there how to read one block with the 15 693 standard.

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Host*** | 80h | C2h | C5h | 08h | 02h | | 0Ch Addh | | | | |
| ***Coupler*** | | | | | | C2h | | Chip's answer | 90h | 00h | |

You can also use the Read4 chip command :

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Host*** | 80h | C2h | C5h | 20h | 02h | | 06h Addh | | | | |
| ***Coupler*** | | | | | | C2h | | Chip's answer | 90h | 00h | |

***Note : To use another protocol, just change the bit in P2 parameter.***
14 443 B-2 : Use 80h C2h C4h...
14 443 B-3 : Use 80h C2h C6h...

## *WRITING CHIP MEMORY*

When writing data to a memory block you have to know if you are communicating to a secure or non secure chip. Parameters will be different as you ask the coupler to send or not the signature to authenticate the data you want to write (this is automatically managed by the ActiveX component).

☛ **ActiveX method :** ***Mx.WriteBlock*** (BlockStart, BlockCount, BlocksValue)

☛ **C Library :** ***Clib_w_WriteBlock*** (BlockStart, BlockCount, Protocol, Auth, BlocksValue)

☛ **Low level :** **TRANSMIT command + 87h chip command**

This command enables you to write one block. The following example are for a 15 693 communication.

### *Non secure chips*

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Host*** | 80h | C2h | E5h | 08h | 0Ah | | 87h Addh &Data | | | | |
| ***Coupler*** | | | | | | C2h | | Written data | 90h | 00h | |

### *Secure chips*

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Host*** | 80h | C2h | 6Dh | 08h | 0Ah | | 87h Addh &Data | | | | |
| ***Coupler*** | | | | | | C2h | | Written data | 90h | 00h | |

***Note : To use another protocol, just change the appropriate bit in P2 parameter :***

Non secured chip : 14 443 B-2 : Use 80h C2h E4h...
14 443 B-3 : Use 80h C2h E6h...

Secured Chip : 14 443 B-2 : Use 80h C2h 6Ch...
14 443 B-3 : Use 80h C2h 6Eh...

## *HALTING A CHIP*

The following command halts the current selected chip :

- **ActiveX method :** ***Mx.Halt***
- **C Library :** ***Clib_w_Halt*** (protocol)
- **Low level :** **TRANSMIT command + 00h chip command**

| ***Host*** | 80h | C2h | 31h | 00h | 01h | | 00h | | |
|---|---|---|---|---|---|---|---|---|---|
| ***Coupler*** | | | | | | C2h | | 90h | 00h |

**TIPS** : to halt the chip as soon as you get its serial number, use P1 parameter in the SELECT_CARD command

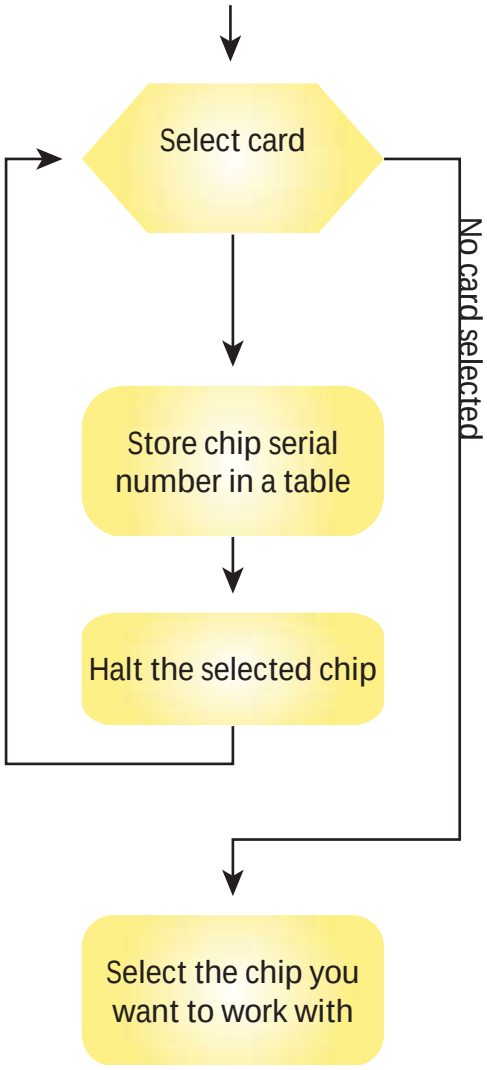
***Note : To use another protocol, just change the appropriate bit in P2 parameter :***

14 443 B-2 : Use 80h C2h 30h...
14 443 B-3 : Use 80h C2h 32h...

**TIPS** : The low level command SELECT_CARD includes an option that halts the chip as soon as it is selected. This enables to earn time by avoiding to send the HALT command. Just use the following P1 parameters : P1 = 02h.

## *HOW TO WORK WITH SEVERAL CHIPS IN THE FIELD*

Here is the basic algorithm to get serial numbers of all chips in a given RF field :




### *Chips inventory*

Make a loop with the SELECT_CARD COMMAND with HALT option enable (P1 = 02h).

### *Chip selection with its serial number*

Use the following command to select a given chip thanks to its serial number. The chip will answer you its serial number.

- **ActiveX method :** ***Mx.ReSelect*** (ChipSN)
- **C Library :** ***Clib_w_ReSelect*** (ChipSN)
- **Low level :** **TRANSMIT command + 81h chip command**

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Host*** | 80h | C2h | C5h | 08h | 09h | | 81h & Serial Number | | | |
| ***Coupler*** | | | | | | C2h | | Serial number | 90h | 00h |

Replace C5h by C4h (C6) to use 14 443 type B-2 (type B-3) protocol.

# MANAGING INSIDEíS CHIPS PROTOCOLS

## *Low level command and C library*

Protocols are always indicated in the command parameters (P2 for SELECT_CARD, P1 for TRANSMIT). You will find the appropriate value in this **Userís Guide**, and in the description of each command in the ´**Reference manual**[a] .

## *ActiveX component*

There are 2 command types :
- Card selection
- Select page, read, write...

### *Card selection*

When selecting a card, you set the protocol to use in P2 parameter of the ***Mx.SelectCard*** method. Coupler is able to test several protocols, and return the protocol use for card detection.

### *Other operation (Read, Write, SelectPage etc...)*

For any other operation, use the ActiveX propertie ***Mx.MxProtocolIndex*** to set the protocol you want to use.
This property is automatically set after a SelectCard command thanks to the value returned by the coupler indicating the protocol use for card selection.

If you want to change communication protocol when using a dual protocol chip (PICOPASS - 15 693 & 14 443 type B), just change this protperty value to the desired one, and all activeX command for INSIDE chip will use this protocol.

*INSIDE security protects memory from READING and/or WRITING.*

*Security control e-purse (stored value) management*

*Security is based on :*
*- key diversification*
*- authentication*
*-signature*

*Key diversification implies that each security calculation is different for each card*

# MANAGING THE SECURITY

INSIDE chips security is based on secret keys that protect and authentify the chip content.
On one hand, keys are stored in the chip. On the other hand, coupler includes a security module in which are stored the application keys.
Security is based on checking that keys are the same in the chip and in the coupler.

First paragraph explains on what is based our security and what it is for :

- Authentication
- Signature
- Diversified keys

The following paragraphs explain how to :

- load the key into the coupler / SAM
- select and / or authenticate a chip with a given key

## *INSIDE CHIPS SECURITY*

Security consists in protecting memory access and e-purse use by secret keys. User will be able to modify card content only if the coupler contains same secret keys as PICO chip.

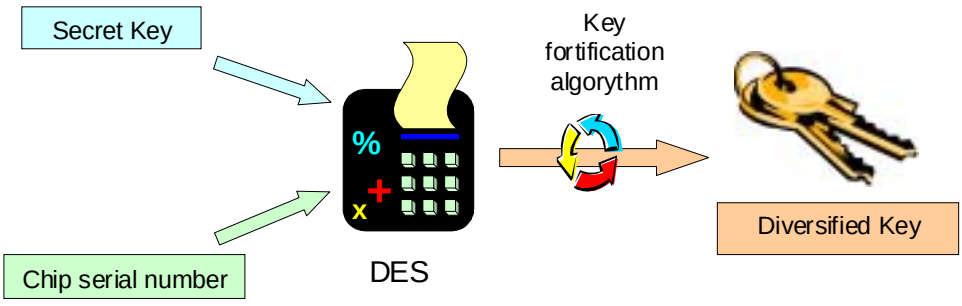
Security is checked several times :

- **Authentication** : Just after having selected the chip user has to perform an authentication before being able to access any memory data.
- **Signature** : for any memory modification the chip user has to send a signature calculated as a function of sent data, secret keys and chip serial number. Thus it is impossible to modify the chip content without knowing the application keys.

In each security calculation, a diversified key is being used, based on the chip serial number and the application key.
All security calculations are automatically manage by INSIDEís couplers.

## *Key diversification*

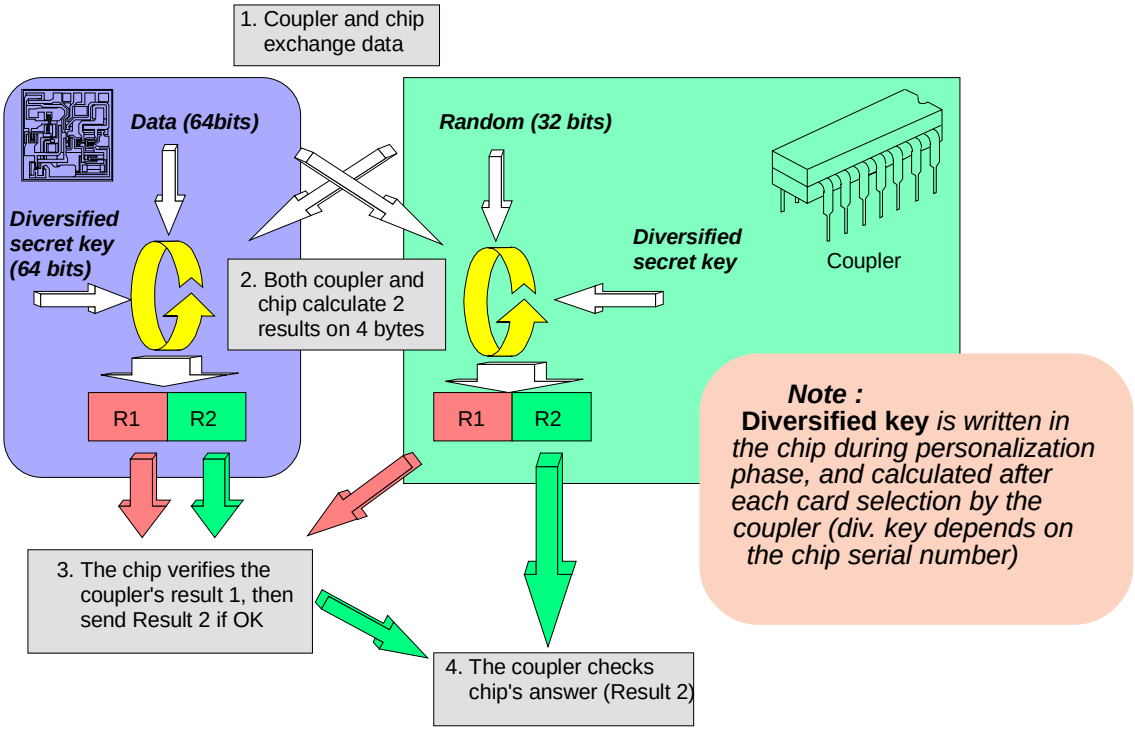
To ensure a reliable security, every security operation (authentication, signature calculation) is based on diversified key value.
The diversified key is an 8 bytes result of calculation including chip serial number and key value.
Thus, 2 chips using same keys contain different diversified key values. This ensures that it is not possible to repeat some sequence registered on one card on another card.



***Authentication protects the memory from reading and writing***

## *Authentication*

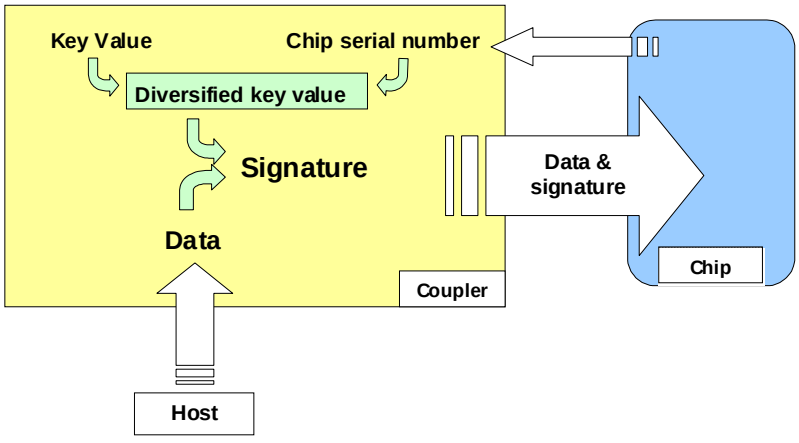
Authentication algorithm performs a *mutual* authentication.
The principle is as follows : Data are exchanged then both device perform secret calculations on them to obtain 2 results on 4 bytes. Authentication is done if they get the same results. The chip first checks couplerís response then reader verifies chipís results.




***Signature when writing increases memory content security***

## *Signature*

Each time you want to send data to the chip, a 32 bits signature is automatically calculated and added. Signature calculation takes into account the diversified key value (result of operation between key value and chip serial number) and the data. Chip will check the signature to allow data writing. This ensures very good security on the chip content.




***Signature calculation principle***

***First step in security is to load the secret keys into the coupler***

## *KEY LOADING*

To perform this complex operation, use the function supplied with the libraries (C Libraries, ActiveX component). You will find encryption algorithm in annex. C source code is provided in the C libary, and ActiveX component manage automatically all security calculation.

You need to give the following parameter :

- Key number
- Exchange Key
- New Key value

### ☞ *ActiveX method : Mx.KeyLoading*

Use **Mx.KeyLoading (KeyNum, LoadingType, ExchangeKey,NewValue)** method to load the key in the coupler at the appropriate place.
*Keynum* may have to following value :
- **mpkP$_i$Kd** (i=0 to 7)
- **mpkP$_i$Kc** (i=0 to 7)

Example : to load the default keys as keys 6 using the default exchange key ...

***Mx.*KeyLoading *(*mpkP$_6$Kd*, mklmXORKe,´$5C$BC$F1$DA$45$D5$FB$5Fª, ´$F0$E1$D2$C3$B4$A5$96$87ª)***
***Mx.*KeyLoading *(*mpkP$_6$Kc*, mklmXORKe,´$5C$BC$F1$DA$45$D5$FB$5Fª, ´$76$65$54$43$32$21$10$00ª)***

### ☞ *C Library : Clib_w_KeyLoading*

**Clib_w_KeyLoading (KeyNum, LoadingType, ExchangeKey,NewValue)**

### ☞ *Low level : LOAD_KEY_FILE*

Calculate the Encrypted key thanks to the C library algorythm (see annexe A) and use the LOAD_KEY_FILE command...

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ***Host*** | 80h | D8h | 00h | P2 | OCh | | Encrypted key | | |
| ***Coupler*** | | | | | | D8h | | 90h | 00h |

**P2 : Key number**

00h - Exchange Key Ke: used for key loading operation.
01h - Debit Key Kd0
02h - Credit Key Kc0
03h - Debit Key Kd1
04h - Credit Key Kc1
.....
0Fh - Debit Key Kd7
10h - Credit key Kc7

# HOW TO SET A KEY AS THE ACTIVE ONE

## A - Before SelectCard command

☞ ***ActiveX component : Mx.CurrentKey***

Possible values are :
- **mpkP$_i$Kd** (i=0 to 7)
- **mpkP$_i$Kc**(i=0 to 7)

☞ ***C Library : Clib_w_SelectCurrentKey***

***Clib_w_SelectCurrentKey*** **(KeyNum)**

☞ ***Low level :*** **SELECT_CURRENT_KEY command**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ***Host*** | 80h | 52h | 00h | P2h | 08h | | 8 * 00h | |
| ***Coupler*** | | | | | | 52h | | 90h | 00h |

**P2 : Key number**

00h - Exchange Key Ke: used for key loading operation.
01h - Debit Key Kd0
02h - Credit Key Kc0
03h - Debit Key Kd1
04h - Credit Key Kc1
.....
0Fh - Debit Key Kd7
10h - Credit key Kc7

## B - Before SelectPage and Authentify command

At this stage you need to precise both the key number and the chip serial number (as you may be working with several chips).
Actually this operation is performed automatically by the selectCard command as it knows the key number thanks to the CurrentKey property, and the Serial Number is given by the chip during the selection phase.
When using a standard coupler, the ***DiversifyKey*** command returns a useless data (random number). The returned data are used only with a personalisation coupler. More information are given in the personalisation kit.

☞ ***ActiveX component : Mx.DiversifyKey***

***Mx.DiversifyKey (KeyNum, Chip Serial Number, Databack)***

☞ ***C Library : Clib_w_DiversifyKey***

***Clib_w_DiversifyKey (KeyNum, Chip Serial Number, Databack)***

☞ ***Low level :*** **DIVERSIFY_KEY command**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ***Host*** | 80h | 52h | 00h | P2h | 08h | | Serial Number | |
| ***Coupler*** | | | | | | 52h | | 90h | 00h |

**P2 : Key number**

00h - Exchange Key Ke: used for key loading operation.
01h - Debit Key Kd0
02h - Credit Key Kc0
03h - Debit Key Kd1
04h - Credit Key Kc1
.....
0Fh - Debit Key Kd7
10h - Credit key Kc7

*Last step : Authentication is performed during chip selection and/or page selection*

*Tips : Key diversification is automatically done by the select card command*

*Tips : Key diversification has to be done only once. You donít need to use the Diversify command as soon as you work with the same chip and the same key*

## HOW TO AUTHENTIFY A CHIP

Authentication may be done while selecting the card (or the page). It can also be done later, for example when you want to work with both Credit key and Debit key authentication.

☞ ***ActiveX component : Mx.SelectCard***

***SelectCard*** (30h ...) authenticates selected chip with Kd
***SelectCard*** (10h ...) authenticates selected chip with Kc

☞ ***C Library : Clib_w_SelectCard***

**Clib_w_*SelectCard* (SelectMode , ChipType, TypeSN)**
SelectMode = 30h : Authentify with the chip debit key
SelectMode = 10h : Authentify with the chip credit key

☞ ***Low level : SELECT_CARD***

80h A4h 10h P2 09h => Authenticate with Kc
80h A4h 30h P2 09h => Authenticate with Kd

## HOW TO AUTHENTIFY A PAGE

Authentication follows the same principle as for the SelectCard authentication.
If you want to use a different key than the one used during the card selection, or if selection has been done without you have to use the DiversifyKey command to set a key as the active key if you want to change the active key.

☞ ***ActiveX component :***
***Mx.DiversifyKey*** (KeyNum, Chip Serial Number, Databack)
***SelectAuthPage*** (Key, Page, BlockConfig)

☞ ***C Library :***
***Clib_w_Mx.DiversifyKey*** (KeyNum, Chip Serial Number, Databack)
***Clib_w_SelectAuthPage*** (Key, Page, BlockConfig)

☞ ***Low level : DIVERSIFY_KEY & SELECT_PAGE***

**DIVERSIFY_KEY**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ***Host*** | 80h | 52h | 00h | P2h | 08h | | Serial Number | |
| ***Coupler*** | | | | | | 52h | | 90h | 00h |

P2 : key number

**SELECT_PAGE**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ***Host*** | 80h | A6h | P1 | P2 | 08h | | | | |
| ***Coupler*** | | | | | | A6h | Chip 's configuration block | 90h | 00h |

P1 : contacless configuration
P2 : key and page number

## *PROTECTING THE KEYS*

Thus all the security depends on making sure that these keys are kept secret. To ensure a good secury, key loading has to be done in a secure environment.

The key loading procedure ensures that :
1 - nobody decrypts the key loaded in the coupler by listenning to the HOST-COUPLER communication
2 - nobody records and uses the communication between HOST and COUPLER to load keys in another coupler

To protect the communication, all data exchange is ciphered thanks to an exchange key known only by the coupler. Therefore, nobody will be able decipher serial communication and find the application key value

## *Protect key storage (coupler, security module) so that nobody can use your keys.*

Use our coupler security protection features or store coupler or SAM keys in a secured place.

To ensure a very good security to your application, contact us so we help you to give to your system the security it deserves.

# MANAGING STANDARD CHIPS PROTOCOLS

This chapter explains how to communicate with any chips that follow the 13.56MHz standards : 15 693, 14 443 Type A and B. More over, you will find there how to communicate with the FeliCa chip (SONY).

Note : userís will find there the commands to use to send byte to the chip, and to get the chip answer, but we will not mention the way to manage these chips. User has to refer to the chip datasheet or ISO standards to find more information about these chips.

## *TIME OUT ADJUSTMENT*

When communicating with a chip, and particularly a microprocessor, user may need to increase the time out value.

The TimeOut configuration enables the user to change the value of the TRANSMIT command to be sure that no ISO command will fail because a too short timeout.

Users can change 4 timeout values corresponding to the 4 Timeout "slots" that one can use in TRANSMIT command:

- Timeout 0 (command timeout option = b00) : Address h68
- Timeout 1 (command timeout option = b01) : Address h69
- Timeout 2 (command timeout option = b10) : Address h6A
- Timeout 3 (command timeout option = b11) : Address h6B

Where "b" prefix is for binary value, "h" is for hexadecimal

To put a specific value for one of these TimeOut "slots", developper can use the following formulas:
ISO 14443 (A-B) : TimeOut = X . 380µs + 200µs
ISO 15693 : TimeOut = (X << 2) . 380µs + 200µs

Where X is the value of the byte and << is the operation that execute a binary right shift of the byte value.

## *15 693-3 PROTOCOL*

This example shows how to configure the protocol, then how to send the INVENTORY command.

```
Public sub Sample_15693()
ë Configure USER protocol as 15693
        Mx.MxUserProtocol = mupISO_15693_3_10pc

        ëLow level command : use the SetStatus function
                ëMx.SetStatus &H3, &H5E, &H21
                ëMx.SetStatus &H3, &H5F, &H31

' Send Inventory command "1 slot" to retrieve chip serial number
        Command =  "$36$01$00$00"
        CommandSize = &H04
        AnswerSize = &H0A
        UserProtocol = &HF3
        Mx.Transmit UserProtocol, AnswerSize, CommandSize, Command, ChipAnswer

' Send slot marker for anticollision management
        Mx.Transmit &H73, &H0A, &H00, ´ª, ChipAnswer

End Sub
```

## ISO 14 443 TYPE A

```
Public sub Sample_14443_A()

ë Configure USER protocol as 14443-A level 3
        Mx.MxUserProtocol = mupISO_14443A_3

        ' Low level : use the set status command
                ëMx.SetStatus &H03, &H5E, &H32
                ëMx.SetStatus &H03, &H5E, &H12
                ëMx.SetStatus &H03, &H64, &H63
                ëMx.SetStatus &H03, &H65, &H63

' Use the SelectCard command to manage anticollision
        Mx.SelectCard &H00, &H08, Type_SN

'Send the RATS command :
        Buffer length = 32
        Name the card as card 0
        Command =  "$50$00"
        CommandSize = &H02
        AnswerSize = &H06
        UserProtocol = &HF3
        Mx.Transmit UserProtocol, AnswerSize, CommandSize, Command, ChipAnswer

End Sub
```

## ISO 14 443 TYPE B

```
Public sub Sample_14443_B()

ë Card selection with the select Card command : manage the anticollision
        Mx.SelectCard &H00, &H04, Type_SN

ëSend REQB command
        Command =  "$05$00$00"
        CommandSize = &H03
        AnswerSize = &H0C
        UserProtocol = &HF2
        Mx.Transmit UserProtocol, AnswerSize, CommandSize, Command, ChipAnswer

End Sub
```

## FELICA ( NEW VERSION)

```
' Low level : use the set status command to configure the protocol
                Mx.SetStatus &H03, &H5E, &H79
                Mx.SetStatus &H03, &H5E, &H02
                Mx.SetStatus &H03, &H64, &H00
                Mx.SetStatus &H03, &H65, &H00

' Send a command to the chip and retrieve the answer
        Command =  "$06$00$FF$FF$00$01"
        CommandSize = &H06
        AnswerSize = &H12
        UserProtocol = &HF7
        Mx.Transmit UserProtocol, AnswerSize, CommandSize, Command, ChipAnswer
```

# MANAGING THE RF FIELD

Possible operations you can perform on the RF field are the following :

- Cut RF emission, mainly when couplers are powered on battery
- Start RF emission
- ´Reset[a] RF field (i.e. cut it for 20 ms in order to reset any halted chip in the field)

## *HOW TO RESET THE RF FIELD ?*

This command will cut the RF field for 20 ms in order to reset all chips that are in the field.

☞ **ActiveX method :** ***Mx.ResetField***

☞ **C Library *: Clib_w_ResetField ()***

☞ **Low level :** **SET_STATUS command**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ***Host*** | 80h | F4h | 40h | 00h | 01h | | 00h | | |
| ***Coupler*** | | | | | | F4h | | 90h | 00h |

## *HOW TO ASLEEP THE COUPLER*

Just use the disable command which will cut the RF field so that no energy is wasted.

☞ **ActiveX method :** ***Mx.Disable***

☞ **C Library :** ***Clib_w_Disable ()***

☞ **Low level :** **DISABLE command**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ***Host*** | 80h | ADh | BCh | DAh | 00h | | |
| ***Coupler*** | | | | | | 90h | 00h |

## *HOW TO WAKE UP THE COUPLER*

☞ **ActiveX method :** ***Mx.Enable***

☞ **C Library :** ***Clib_w_Enable ()***

☞ **Low level :** **ENABLE command**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ***Host*** | 80h | AEh | DAh | BCh | 00h | | |
| ***Coupler*** | | | | | | 90h | 00h |

***Important note***
Low level command : You have to send this command in a window of 16 ms so that the coupler catches it. To be sure that this command is detected, send it twice, with no more than 10 ms between the 2 commands sending. This is automatically managed by the ActiveX method.

# APPENDICES

# APPENDIX A
# HOW TO LOAD A KEY IN A COUPLER

This procedure consists in several operations on the key. The final result will be sent to the coupler using the **Loag_Key_File** function.

## EXCHANGE KEY

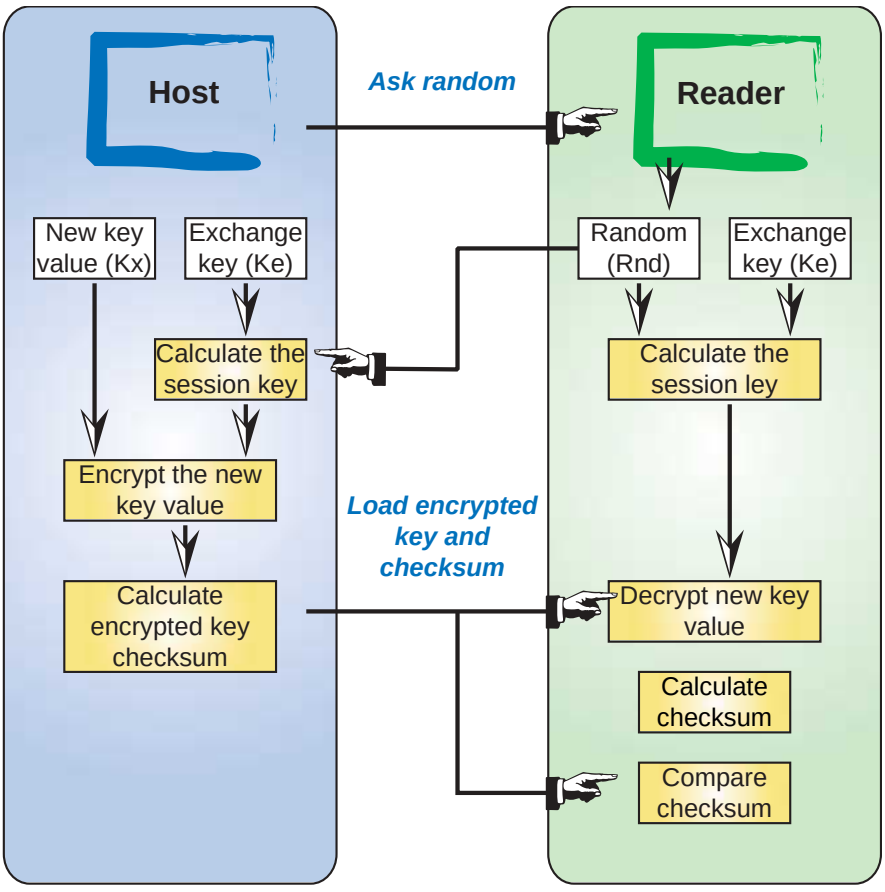
To ensure the security, an **exchange key** will protect all key loading operations.
This key is in the coupler memory and has 2 functions :

- only host knowing this key will be able to modify the Debit and Credit keys.
- New key value are encrypted with this exchange key so it is not possible to read the new value on the serial line.

You have to know this exchange key to modify the value of any other key. For any modification, the Exchange key is managed exactly as the Debit key and the Credit key : you have to use the Key Loading Procedure described in the next paragraphs.

## GENERAL KEY LOADING PROCEDURE

Before the key loading starts with the LOAD_KEY_FILE command, the host must generate a session key. This key is generated by the encryption of the current Exchange Key (Ke) with an 8-byte random number.



# TERMINOLOGY AND NOTATION

Adding ***p*** after the key name means that the key is permuted.
Adding ***chk*** means that the 8th byte replaced by the Checksum byte value.
A **C** before the key name means that the key has been encrypted.

| **Abbreviation** | **Meaning** |
|---|---|
| $K_{ex}$ | Exchange Key. |
| $K_{ex}p$ | Permuted Exchange Key. |
| $K_{ex}p\_chk$ | Kep with the 8th byte replaced by the Checksum byte value. |
| Rnd | Random number. |
| $K_x$ | Master key. ($K_x$ equals to $K_d$ or $K_c$) |
| $K_xp$ | Permuted master key. ($K_xp$ equals to $K_dp$ or $K_cp$) |
| CKxp | Encrypted permuted master key. ($CK_xp$ equals to $CK_dp$ or $CK_cp$) |
| SK | Session key. |
| CHK | 4-byte checksum. |

# KEY LOADING STEP BY STEP

We assume that the default keys are used.

| STEP DESCRIPTION | Example |
|---|---|
| **Step 1 : Get a random number from the coupler** | |
| ☞ Send the ***Ask_Random*** command | **Send** 80h 84h 00h 00h 08h. The coupler answer a random number.For this example, we assume that Rnd = 00 00 00 00 00 00 00 00. |
| **Step 2 : Calculate the Session Key** | |
| The session key is define by the following formula : SK = Kexp_chk ⊕ Rnd (⊕ : bit to bit x-or operation)<br>$K_{ex}p\_chk$ means that we have to permute $K_{ex}$ then to replace the 8th byte by the checksum byte<br>☞ Permute the exchange key to get $K_{ex}p$<br>☞ replace the 8th byte by the checksum byte to get $K_{ex}p\_chk$<br>☞ Calculate the session key | <br><br><br><br>$K_{ex}p$ = 6E FD 46 EF CB B3 C8 OB<br>$K_{ex}p\_chk$ = 6E FD 46 EF CB B3 C8 75<br>SK = 6E FD 46 EF CB B3 C8 75 |
| **Step 3 : Calculate the Encrypted master key** | |
| This calculation include the exchange key through the session key (SK). This insure the protection of the new key value.<br>$CK_xp = SK \oplus K_xp$ (⊕ : bit to bit x-or operation)<br>☞ Permute the new key value $K_x$ to get $K_xp$<br>☞ Make a bit to bit X-OR operation with the session key SK | <br><br>$CK_dp$ = 91 F2 75 BA CB 43 04 20 |
| **Step 4 : Send the *Load_Key_File* command** | |
| ☞ Calculate the CheckSum<br>☞ Send the command to the coupler.<br>***Load_Key_File*** (CKxp + CheckSum) | **CheckSum** = 73 27 FF 01<br>**Send** 80 D8 00 01 0C & 91 F2 75 BA CB 43 04 20 & 73 27 FF 01 |

# ALGORITHMS

## *KEY PERMUTATION*

Proceed as described below to permute a key.

Example: Permute the key $K_{ex}$.

| Kex = | 0x5C | 0xBC | 0xF1 | 0xDA | 0x45 | 0xD5 | 0xFB | 0x5F |
|---|---|---|---|---|---|---|---|---|
| (0x5F) ☞ | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 |
| (0xFB) ☞ | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 |
| (0xD5) ☞ | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| (0x45) ☞ | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 |
| (0xDA) ☞ | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| (0xF1) ☞ | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 |
| (0xBC) ☞ | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 |
| (0x5C) ☞ | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 |
| | ⇩ | ⇩ | ⇩ | ⇩ | ⇩ | ⇩ | ⇩ | ⇩ |
| | 0x6E | 0xFD | 0x46 | 0xEF | 0xCB | 0xB3 | 0xC8 | (0xF4) |

Replace the last byte by : $\overline{0xF4}$ = 0B

**Kexp = 0x6E 0xFD 0x46 0xEF 0xCB 0xB3 0xC8 0x0B**

## *CHECKSUM BYTE CALCULATION*

Proceed as described below to calculate a key checksum byte.
*Note:* the ⊕ symbol means a bit to bit x-or operation.

Example:

K = 0x5C 0xBC 0xF1 0xDA 0x45 0xD5 0xFB 0x5F
Kp = 0x6E 0xFD 0x46 0xEF 0xCB 0xB3 0xC8 0x0B

Checksum = 0x6E ⊕ 0xFD ⊕ 0x46 ⊕ 0xEF ⊕ 0xCB ⊕ 0xB3 ⊕ 0xC8 = 0x8A

Checksum = 0x8A = 0x75

and then,

$\overline{K_xp\_chk}$ = $\overline{0x6E}$ 0xFD 0x46 0xEF 0xCB 0xB3 0xC8 0x75

## *LOAD KEY CHECKSUM CALCULATION*

- ☞ Complete the 5 command bytes with 3 bytes 00 so to get 8 bytes
- ☞ Calculate RES = (Command bytes) ⊕ $K_x$p.
- ☞ Calculate the checksum CHK = Most Significant 4-Bytes(RES) ⊕ Least Significant 4-Bytes(RES).

Example:

The checksum when sending the default Debit Key $K_d$ is :

Command = 80 D8 00 01 0C 00 00 00
$K_d$p = FF 0F 33 55 00 F0 CC 55
RES = 7F D7 33 54 0C F0 CC 55
CHK = 73 27 FF 01

| | | | | | |
|---|---|---|---|---|---|
| | MSB(RES) | 7F | D7 | 33 | 54 |
| ⊕ | LSB(RES) | 0C | F0 | CC | 55 |
| | CHK = | 73 | 27 | FF | 01 |

# APPENDIX B
# ERROR CODE

When an error occurs, coupler response is only status words SW1 SW2. No data is returned.
The following table sums up the various values.

| *SW1* | *SW2* | *Error description* |
|---|---|---|
| **90h** | **00h** | Command successful |
| **Common status errors** | | |
| **67h** | **00h** | Data length, P3 incorrect |
| **6Bh** | **00h** | Parameters P1, P2 incorrect |
| **6Eh** | **00h** | Class not recognized |
| **6Dh** | **00h** | Instruction not recognised, parity error |
| **Security errors** | | |
| **69h** | **82h** | Card not identified (CRC or authentication problem) |
| **98h** | **35h** | Command flow incorrect |
| **Execution error** | | |
| **6Ah** | **82h** | Card not found |
| **62h** | **00h** | EEPROM erro |