my-d™ vicinity plain

Extended Datasheet

Intelligent EEPROM with contactless interface compliant to ISO/IEC 15693 or ISO/IEC 18000-3 Mode 1

Devices

- SRF 55V02P
- SRF 55V02P HC
- SRF 55V10P
- SRF 55V10P HC

Key features

Contactless interface

- Physical interface and anticollision compliant to ISO/IEC 15693
  - Contactless transmission of data and supply energy
  - Data rate up to 26 kbit/s
  - Operation frequency: 13.56 MHz
  - Anticollision logic: Several cards may be operated in the field simultaneously with identification of up to 30 Tags per second
- Read/write distance up to 150 cm (influenced by external circuitry i.e. reader and inlay design)

EEPROM

- Up to 10 kbit EEPROM memory
- ISO mode-block organization of memory, accessible with ISO optional commands
  - Up to 248 blocks of user memory (block size 4 bytes) applicable for plain memory only
- Custom mode-page organization of memory, accessible with ISO custom commands
  - Up to 128 pages of user memory (page size 8 bytes for data storage and 2 bytes for administration purposes)
- Unique identification number (UID)
- EEPROM programming time per page < 4 ms
- EEPROM endurance minimum 100,000 erase/write cycles[1)]
- Data retention minimum 10 years[1)]

Value counters: Up to 65536 (value range from 0 to 2^{16} - 1)

- Each page in the User Area is configurable as a value counter
- Support of anti-tearing

Electrical characteristics

- ESD protection minimum 2 kV
- Ambient temperature -25°C ... +70°C (for the chip)
- Chip capacitance 23.1 pF ± 5%
- High on-chip capacitance chip available (97 pF ± 5%) allowing small tag antenna designs

Development tool

- Evaluation kit my-d™ including my-d™ manager software

1 Values are temperature dependent

About this document

Scope and purpose

This Extended Datasheet describes features, functionality and operational characteristics of my-d™ vicinity plain.

Intended audience

This document is primarily intended for system and application developers.

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1 Ordering and packaging information

Table 1 Ordering information my-d™ vicinity

Type	Package	Total[1] /user memory [bytes]	Total/user pages[2]	User blocks[3]	Ordering code
SRF 55V02P C	Wafer unsawn/sawn	320/232	32/29	56	On request
SRF 55V02P NB	NiAu Bumped				On request
SRF 55V02P MCC8	P-MCC8-2-6				On request
SRF 55V10P C	Wafer unsawn/sawn	1280/1000	128/125	248	On request
SRF 55V10P NB	NiAu Bumped				On request
SRF 55V10P MCC8	P-MCC8-2-6				On request

1) Total memory size and page count includes the Service Area and the 2 administrative bytes per page whereas user memory size and page count is freely programmable for user data
2) Page size 8 bytes, accessible via ISO custom commands
3) Page size 4 bytes, accessible via ISO optional commands

Table 2 Ordering information my-d™ vicinity high on-chip capacitance

Type	Package	Total[1] /user memory [bytes]	Total/user pages[2]	User blocks[3]	Ordering code
SRF 55V02P HC C	Wafer unsawn/ sawn	320/232	32/29	56	On request
SRF 55V02P HC NB	NiAu Bumped				On request
SRF 55V10P HC C	Wafer unsawn/ sawn	1280/1000	128/125	248	On request
SRF 55V10P HC NB	NiAu Bumped				On request

1) Total memory size and page count includes the Service Area and the 2 administrative bytes per page whereas user memory size and page count is freely programmable for user data
2) Page size 8 bytes, accessible via ISO custom commands
3) Page size 4 bytes, accessible via ISO optional commands

Note: For more ordering information (wafer thickness and height of NiAu-Bump) please contact your local Infineon sales office.

Pin description

Figure 1 Pin configuration module contactless card-MCC8 (top/bottom view)

1 Ordering and packaging information

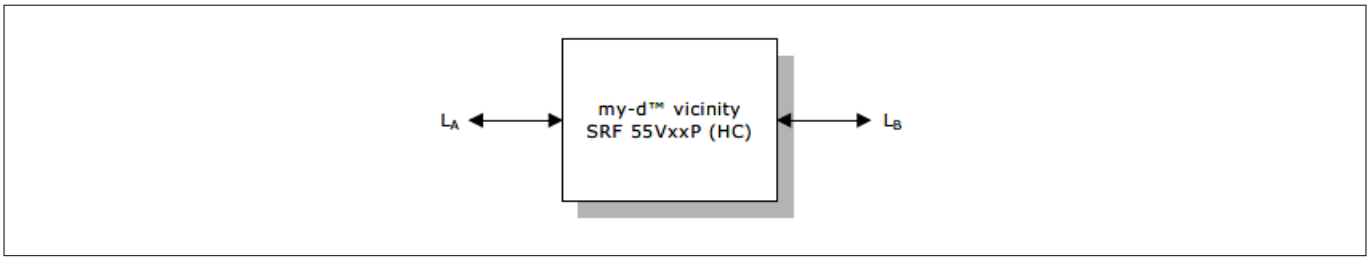

Figure 2 **Pad configuration die my-d™ vicinity plain**

Table 3 **Pin description and function**

Symbol	Function
L_A	Antenna connection
L_B	Antenna connection

2 my-d™ product family

The my-d™ products are designed to meet increased demands for basic security and design flexibility. The my-d™ family of contactless memories supplies the user with different memory sizes and incorporates security features to enable considerable flexibility in the application design.

2.1 Product variants-plain/secure operation, high on-chip capacitance

The my-d™ products are available in the following configurations:

- Plain mode with open memory access
- Secure mode with both memory access controlled by authentication procedures (up to 14 sectors) and plain mode operation (plain sector)
- Additional small tag antenna designs are possible with the HC variant providing a high on-chip capacitance chip for small communication distances

Applications may start with the my-d™ ICs in plain mode operation and individual page locking; for more complex applications various settings in secure mode can be used for multi-user or multi-application configurations.

In secure mode a cryptographic algorithm based on a 64-bit key is available. Mutual authentication, message authentication code (MAC) and customized access conditions protect the memory against unauthorized access.

Configurable value counters, featuring anti-tearing functionality, are suitable for value token applications such as limited use applications.

Architectural interoperability of all my-d™ products enables easy migration from simple to more demanding applications.

2.2 General memory structure

The fundamental structure of my-d™ vicinity products consists of the following memory structure:

- **User Area** → For storing user data
- **Service Area** → Storing the unique identifier (UID) number and manufacturer data
- **Administration Area** → For storing
  - Sector index (SI), defining either plain or secure memory access
  - Access condition (AC) holding information on access rights (example: Read/write, read-only)

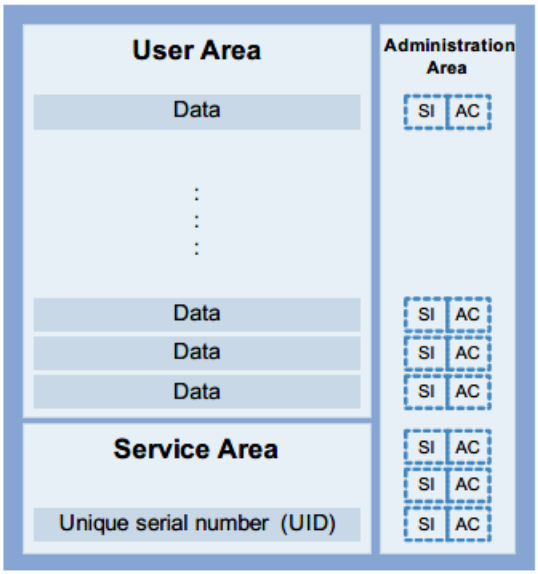

Figure 3 General memory structure of my-d™ products

Communication

The physical contactless interface and communication protocols are defined for vicinity by ISO/IEC 15693 [4]. The my-d™ products support a set of standardized commands. Additionally, custom commands are also implemented example: 8-byte page memory access and optionally authentication (secure variant).

Security

The memory can be accessed without security precautions (i.e: Authentication) in plain mode.
The secure variants additionally require the mutual authentication procedure before memory access is granted.

2.3 Application segments

The my-d™ products are optimized for personal and object identification. Please find the following table for some dedicated examples:

Table 4 my-d™ products overview

Product	Features	Application
my-d™ vicinity plain: • SRF 55V02P • SRF 55V10P	• ISO/IEC 15693 or ISO/IEC 18000-3 Mode 1 • Up to 1000-byte free user memory • Plain access	Factory automation, health care, ticketing, access control
my-d™ vicinity plain HC: • SRF 55V02P HC • SRF 55V10P HC	• ISO/IEC 15693 or ISO/IEC 18000-3 Mode 1 • High on-chip capacitance • Up to 1000-byte free user memory • Plain access	Ticketing, brand protection, loyalty schemes, ski passes
my-d™ vicinity secure: • SRF 55V02S • SRF 55V10S	• ISO/IEC 15693 or ISO/IEC 18000-3 Mode 1 • Up to 992-byte free user memory • Secure access	Ticketing, brand protection, loyalty schemes, access control
my-d™ vicinity secure HC: • SRF 55V02S HC • SRF 55V10S HC	• ISO/IEC 15693 or ISO/IEC 18000-3 Mode 1 • High on-chip capacitance • Up to 992-byte free user memory • Secure access	Ticketing, brand protection, loyalty schemes, access control

3 my-d™ vicinity plain-SRF 55VxxP

The my-d™ vicinity products are based on ISO/IEC 15693 [4] or ISO/IEC 18000-3 Mode 1 [6] standards for contactless vicinity cards.

The my-d™ vicinity focuses on applications with memory demands of up to 10 kbit EEPROM.

3.1 Circuit description

The my-d™ vicinity is made up of an EEPROM memory unit, an analog interface for contactless energy and data transmission and a control unit.

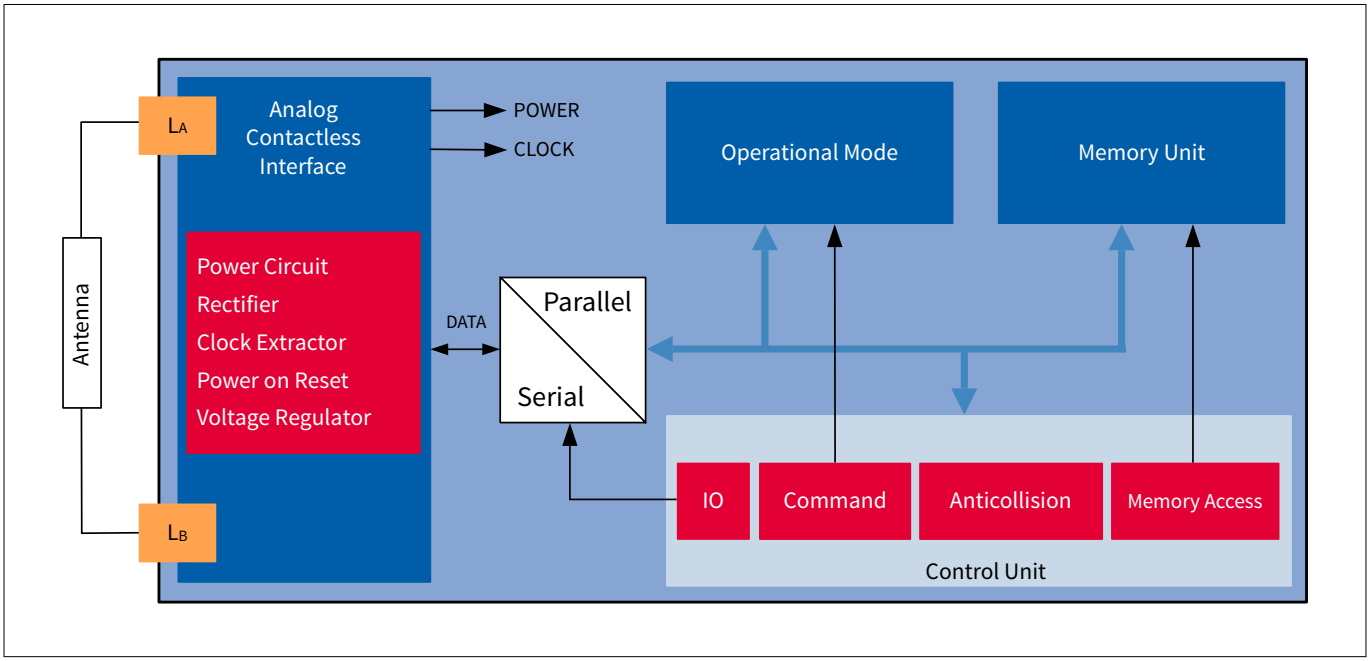

Figure 4 Block diagram of the my-d™ vicinity plain

- **Analog contactless interface**
  - The analog contactless interface comprises the voltage rectifier, voltage regulator and system clock to supply the IC with appropriate power. Additionally, the data stream is modulated and demodulated
- **Operational mode**
  - The access to the memory depends on the actual configuration of the my-d™ vicinity. The memory is accessible after the VICC is selected
- **Memory unit**
  - The memory unit consists of up to 1280 bytes of memory organized in up to 128 pages each of 8 users and 2 administration bytes
- **Control unit**
  - The control unit decodes and executes all commands. Additionally, the control unit is responsible for the correct anticollision flow

3.2 Memory access

Organization: Using ISO optional commands the memory is accessed in 4-byte blocks, whereas ISO custom commands support 8-byte page accesses and further my-d™ vicinity commands. Write protection is possible for each page respectively each block.

Security: The memory can be accessed (example: Read, write) without security (That is authentication) in plain mode.

Commands: The my-d™ vicinity supports the following commands according to ISO/IEC 15693 [4]:

- Mandatory commands (Inventory, stay quiet)
- Optional commands (example: Read/write 4-byte blocks)
- Custom commands (example: Read/write 8-byte pages)

3.3 Memory principle

The memory is organized in 3 areas:

- User Area
- Service Area
- Administration Area

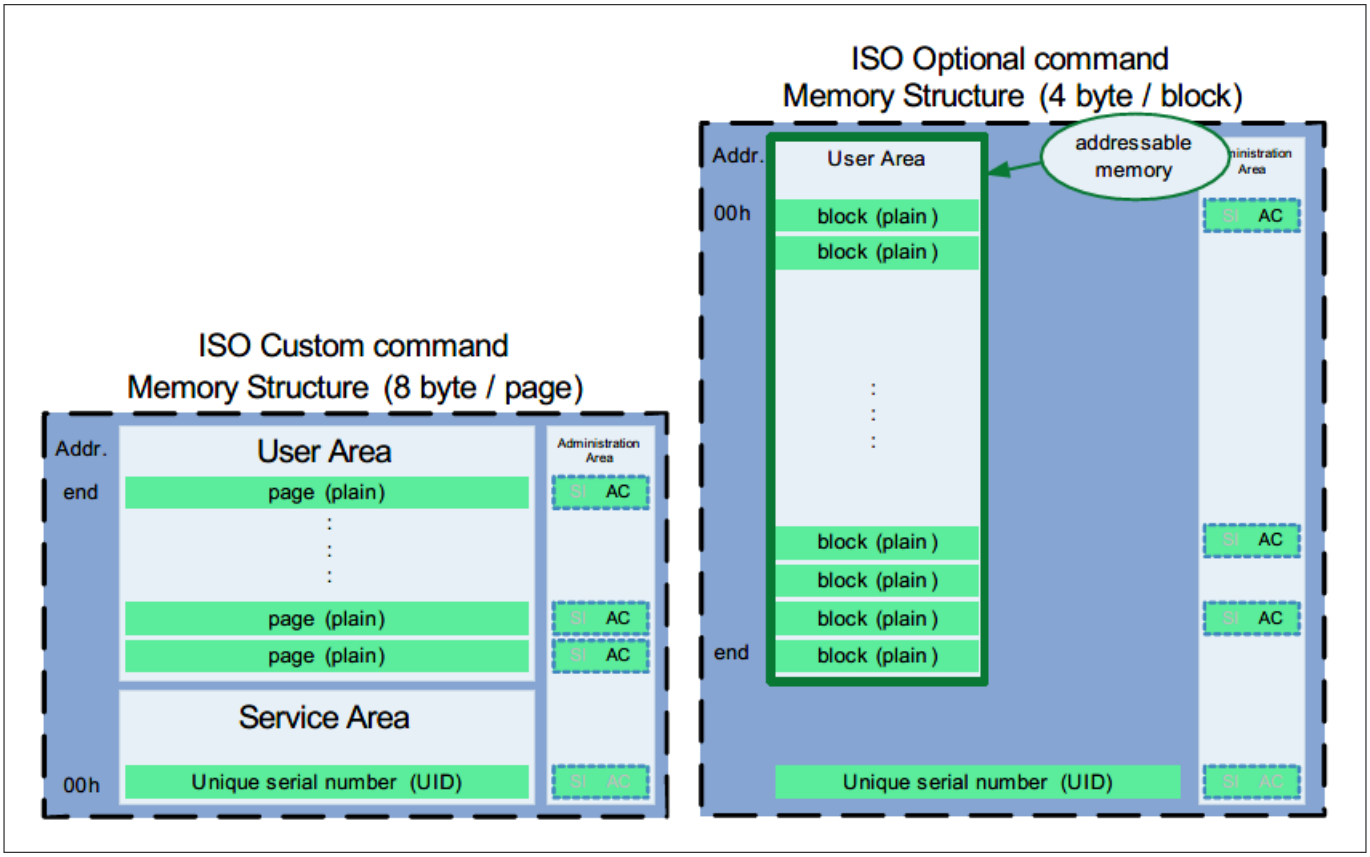

Figure 5 my-d™ vicinity plain memory organization

The **User Area** stores user data up to 125 pages. Data in the plain sector are accessible both via ISO optional and ISO custom commands.

The **Service Area** stores the UID, manufacturer data and configuration data. This information is programmed at the manufacture of the chip and cannot be changed. Data are accessible via ISO custom commands only, except the UID being available also via the inventory command.

The **Administration Area** stores 2 bytes of information about page administration (sector index and access condition).

- Sector index (SI) defines plain memory access
- Access condition (AC) holds information on access rights (example: Read/write, read-only)

The sector index and access condition of each page store each bit non-inverted and inverted to ensure data integrity.

Data are accessible via ISO custom commands only.

3.4 System overview

The system consists of a host system (that is computer with database), one or more my-d™ vicinity plain or other ISO/IEC 15693 [4] compliant cards and tags (VICC) and an ISO/IEC 15693 [4] compatible contactless reader (VCD) with an antenna.

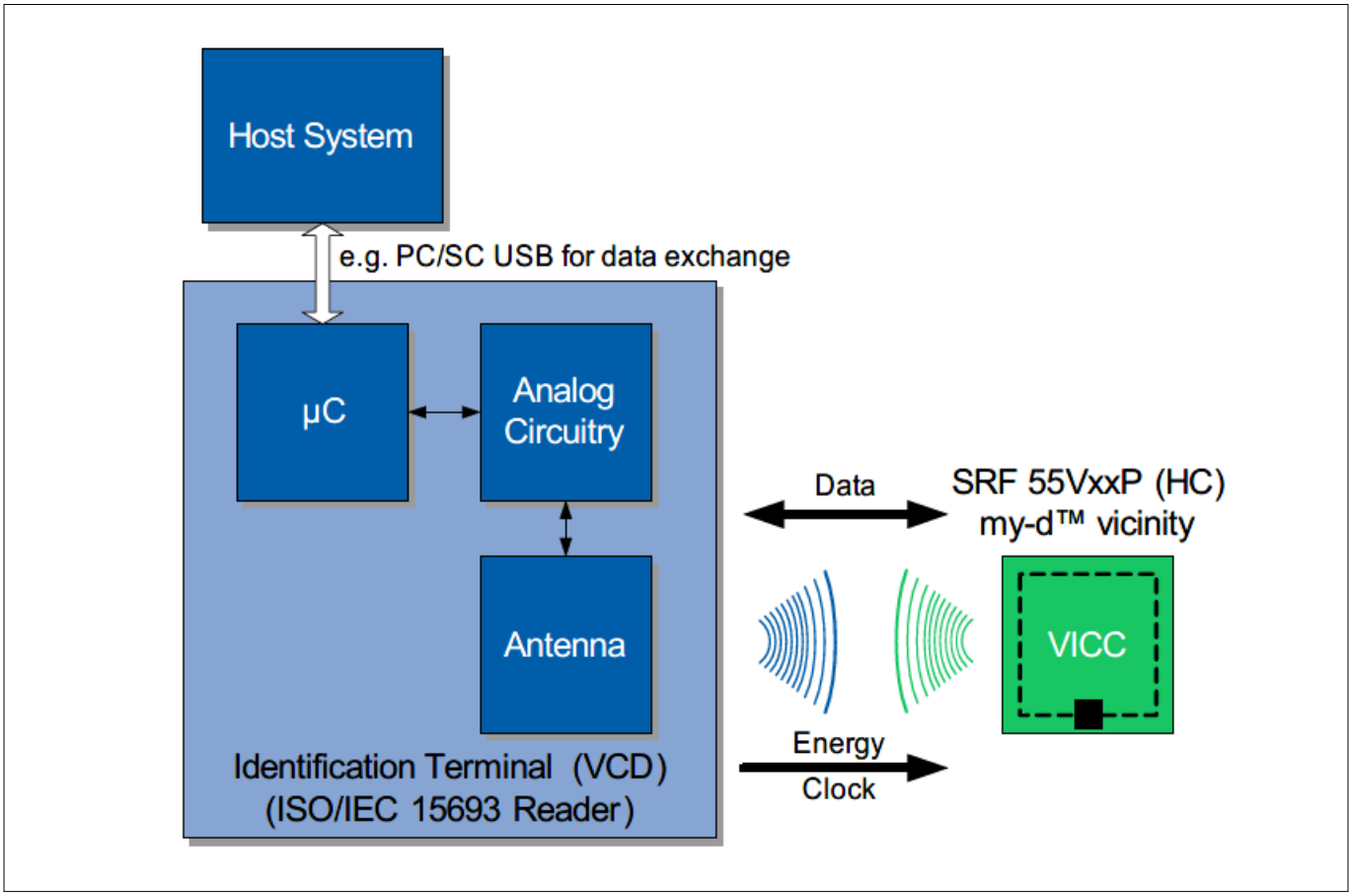

Figure 6 my-d™ vicinity plain RFID system

3.5 Product versions

ISO/IEC 15693 [4] or ISO/IEC 18000-3 Mode 1 [6] respectively define procedures to identify VICCs being in the reader field. The unique identification (UID) number is used to perform the anticollision procedure identifying each VICC. Then a reader (VCD) is able to recognize the Infineon chip functionality is based on the UID as described.

3.5.1 UID coding

To identify the different types of my-d™ vicinity contactless memories chip type information is coded into the UID according to the format defined in ISO/IEC 15693-3 [5].

The following table briefly describes the values for the different chip versions.

Table 5 UID coding

Type	Byte 7	Byte 6	Byte 5	Byte 4 ... Byte 0
	ISO	IC Mfg code	IC manufacturer serial number	
			Chip ID byte	Unique number
SRF 55V02P (HC)	$E0_H$	05_H	40_H	XX_H XX_H XX_H XX_H XX_H
SRF 55V10P (HC)	$E0_H$	05_H	00_H	XX_H XX_H XX_H XX_H XX_H
SRF 55V02S (HC)	$E0_H$	05_H	50_H	XX_H XX_H XX_H XX_H XX_H
SRF 55V10S (HC)	$E0_H$	05_H	10_H	XX_H XX_H XX_H XX_H XX_H

The 64-bit unique identification (UID) number is stored in the Service Area in page 00_H and programmed by the IC manufacturer. According to ISO/IEC 7816-6 [1] the IC manufacturer code (IC Mfg code) for Infineon is 05_H. The UID is unique for each single IC within the ISO/IEC 15693 world and cannot be changed.

3.5.2 Memory sizes

The my-d™ vicinity contactless memories are available with the following memory sizes:

Table 6 Memory size of my-d™ vicinity (in bytes)

Type	Memory			
	Total	Service Area[1)]	User Area (addressable memory)	
			ISO optional	ISO custom
SRF 55V02P (HC)	320	24	224	232
SRF 55V10P (HC)	1280	24	992	1000
SRF 55V02S (HC)	320	24	224	232
SRF 55V10S (HC)	1280	24	992	1000

1) Addressable only via ISO custom command

4 Memory, access rights and chip states

Memory organization describes the memory structure of the my-d™ vicinity plain chip.

Counter values are detailed in Counter format and operations.

Memory access gives an overview of the chip mode and describes access conditions.

4.1 Memory organization

The my-d™ vicinity in plain mode has a total memory size of up to 1280 bytes.

The memory can be accessed in two ways using:

- **ISO optional commands**: The user memory is structured into blocks of 4 bytes (for a detailed description see ISO optional commands of my-d™ vicinity)
- **ISO custom commands**: The memory is structured in pages of 8 bytes used for data storage and 2-byte for administration purposes (for a detailed description see ISO custom commands of my-d™ vicinity)

The following description of the memory organization refers to the page-oriented structure of the my-d™ vicinity.

Note: The plain pages can be accessed with ISO optional commands. Pages from 0 to 3 are accessible with ISO custom commands only.

Table 7 shows detailed memory organization of the SRF 55VxxP on delivery.

Table 7 Memory organization SRF 55VxxP

Memory location	Block address	Page address	Byte number within a page								Administration area	
			0	1	2	3	4	5	6	7	Sector index	Access condition
User Area	$00_H/01_H$	XX_H [1]	User data								55_H	AA_H
	$02_H/03_H$	...	...								55_H	AA_H
	...	...	...								55_H	AA_H
	...	...	...								55_H	AA_H
	yy-1/YY_H [2]	04_H	User data								55_H	AA_H
	Not accessible	03_H	User Data								55_H	AA_H
Service Area		02_H	AFI [3]	AC_{AFI} [4]	Manufacturer data						55_H	$A6_H$
		01_H	-	-	-	-	-	-	-	-	55_H	66_H
		00_H	Unique identification number								55_H	46_H

1) Highest available page address XX_H depending on the product variant
2) Highest available block address YY_H depending on the product variant
3) AFI byte according to ISO/IEC 15693, only accessible via ISO optional command 'Write AFI'
4) Access condition for AFI byte; only accessible via ISO LockAFI command

Each page in memory consists of ten bytes. Eight bytes (bytes 0 to 7) are data bytes and the two most significant bytes are administration bytes that carry information about the access condition (AC) and the sector index (SI, set to 55_H) valid for that page.

Only the 8 data bytes can be read or written with the page-oriented commands, bytes 8 and 9 can only be written using the 'write byte' command (ISO custom command). Using ISO optional commands allows to access the data in blocks of 4-byte each.

The available memory size of SRF 55VxxP is shown in Table 8.

Table 8 Memory size of SRF 55VxxP (in bytes)

Type	Memory in bytes					Highest page address XX_H	Highest block address YY_H
	Total	Service Area	Addressable user		Administration Area		
			ISO optional	ISO custom			
SRF 55V02P (HC)	320	24	224	232	64	$1F_H$	37_H
SRF 55V10P (HC)	1280	24	992	1000	256	$7F_H$	$F7_H$

Memory is organized in 3 Areas:

1. **Service Area** stores manufacturer data, configuration data and personalization data which are configured at chip delivery. This area is located from page 00_H to page 02_H

   Data are accessible via ISO custom commands only, except the UID being available also via the inventory command.
2. **User Area** which stores the user data on up to 125 pages, depending on the product variant

   Data in the plain sector are accessible via both ISO optional and ISO custom commands.
3. **Administration Area** stores access rights. Two bytes per page, byte 8 and byte 9, are reserved for sector index (SI) and access condition (AC)

   Data are accessible via ISO custom commands only.

4.1.1 Service area

The Service Area consists of 3 pages:

- **Page 00_H**: Holds the unique identification (UID) number which is individual for each chip
- **Page 01_H**: Holds manufacturing data
- **Page 02_H**: Holds the AFI byte and the access condition for the AFI. Also, manufacturing data are located within this page

Data are accessible via ISO custom commands only.

4.1.1.1 Unique identification number (page 00_H)

The 64-bit unique identification (UID) number is stored at manufacturing and can not be changed later on. The UID is programmed by the IC manufacturer according to the format defined in ISO/IEC 15693-3 [5].

In the following table please find the detailed definition of the UID as used by Infineon.

Table 9 Description of the UID coding

Bit (63...56)	Bit (55...48)	Bit (47...40)	Bit (39...00)
ISO[1] $E0_H$	IC Mfg code[2] 05_H	IC manufacturer serial number	
		Chip ID byte	Unique number

1) According to ISO/IEC 15693-3 this byte is assigned to $E0_H$
2) According to ISO/IEC 7816-6 the IC manufacturer code (IC Mfg code) for Infineon is assigned to 05_H

Table 10 Chip ID byte (byte 5 of UID)

Bit 47	Bit 46	Bit 45	Bit 44	Bit 43	Bit 42	Bit 41	Bit 40
EEPROM size			Security bit	Chip type			

Table 11 Chip ID byte: EEPROM size, security bit

Bit (47...45)	Bit 44	Meaning	Comment
000_B	-	10 kbit	SRF 55V10P (and SRF 55V10S)
010_B	-	2.5 kbit	SRF 55V02P (and SRF 55V02S)
Other	-	RFU	Reserved for future use
-	0_B	Chip supports plain mode only	SRF 55VxxP
-	1_B	Chip supports secure mode	SRF 55VxxS

Table 12 Chip ID byte: Chip type

Bit (43...40)	Meaning	Comment
0000_B	my-d™ vicinity IC functionality	Default
Other values	RFU	Reserved for future use

A reader or an application shall check the "chip type" bits (UID bits (43…40)) to ensure the operation with a chip out of the my-d™ vicinity family.

4.1.1.2 Manufacturer data and AFI (page 02_H)

The manufacturer page is located on page 02_H. It contains the AFI byte (byte 00_H), the access condition for the AFI (byte 01_H) and data which are programmed and locked at manufacture.

Table 13 Definition of page 02_H

Bit (63...16)	Bit (15...08)	Bit (07...00)
Manufacturer data	AC_{AFI}	AFI byte

Table 14 Definition of the AFI byte

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
As defined in ISO/IEC 15693				-	EAS bit	-	-

4.1.2 User area

The pages 03_H up to $1F_H$/$7F_H$ (SRF 55V02P/SRF 55V10P) are reserved for user data.

The access condition (AC) and the sector index (SI) of a page are defining the access rights for that page.

Note: The data format of one page can be either value counter or plain data.

Note: Invalid sector indexes (other than 55_H) prevent any access to my-d™ vicinity plain.

Note: Invalid access conditions (other than XA_H, $X5_H$ or $X6_H$) are preventing any access to my-d™ vicinity.

Data in the plain sector are accessible both via ISO optional and ISO custom commands.

4.1.3 Administration area

Two administration bytes are assigned to each page. They hold the followings:

- Access condition (define information on access to the page)
- Sector index of the page (always preset to 55_H indicating sector 0 for this chip variant)

These bytes are accessible by the use of the ISO custom command write byte only.

The access condition and sector index bytes are corruption protected. Each bit in each byte is stored non-inverted and inverted. Valid values for each of the two nibbles are 5_H, 6_H, or A_H.

Data are accessible via ISO custom commands only.

For a detailed description of the access conditions please refer to Access conditions.

For a detailed description of the sector index please refer to Sector index.

4.2 Memory access

After completing the inventory procedure my-d™ vicinity is ready for memory operations. Using ISO optional commands the memory is accessed in 4-byte blocks, whereas ISO custom commands support 8-byte page accesses and further my-d™ vicinity commands.

Furthermore, the access to a page is defined by the access conditions (AC):

- ISO custom commands allow to write the complete access condition byte defining the access condition for the respective page
- ISO optional command 'Lock Block' allows to change the access to a block from read/write to read only by programming the respective nibble of the access condition byte

Additionally, the sector index (SI) defines the allocation of each page to a plain sector.

4.2.1 Selection of a sector

ISO/IEC 15693 or ISO/IEC 18000-3 Mode 1 defines the selection procedure of a VICC. After a successful select command, the sector 0 is opened by default (plain mode). In plain mode, memory pages in sector 0 are accessible according to their access conditions.

4.2.2 Sector index

For my-d™ vicinity plain, the sector index is always set to 55_H (sector 0). Changing SI to any other value than 55_H will result in inaccessibility of the corresponding page.

4.2.3 Access conditions

Access conditions are stored in byte 9 of each page. The access condition (AC) byte stores each bit non-inverted and inverted to ensure data integrity.

The following access rights are defined and can be combined for one page:

- Read-only
- Write and read
- Restricted write

Table 15 Access conditions and rights (byte 9 of each page)

Access condition	Access rights		Comment
	Even block	Odd block	
55_H	Read/restricted write	Read/restricted write	Value counter
56_H	Read-only	Read/restricted write	Value counter
$5A_H$	Read/write	Read/restricted write	Value counter
65_H	Read/restricted write	Read-only	Value counter
66_H	Read-only	Read-only	User data
$6A_H$	Read/write	Read-only	User data
$A5_H$	Read/restricted write	Read/write	Value counter
$A6_H$	Read-only	Read/write	User data
AA_H	Read/write	Read/write	User data
Any other value	None[1)]	None[1)]	Invalid AC

1) Pages which have no valid access condition are not accessible anymore

Access conditions and rights (byte 9 of each page) can be changed by using the **ISO custom command 'Write Byte'**.

Using the **ISO optional command 'Lock Block'** sets the access condition for a single block. The higher nibble of the access condition byte locks blocks with an odd address, whereas the blocks with even addresses are set to read-only with the lower nibble.

4.3 Counter format and operations

Each page of the data area may be defined as a counter page. A counter page is a single 8-byte page which is initialized with two 4-byte counters and the access conditions set accordingly.

Counter data are accessible via ISO custom commands only.

4.3.1 Counter mechanism

The concept incorporates that a counter page is divided into two counters with one counter being valid where the other is normally 00_H, 00_H, 00_H, 00_H. This principle allows supporting an anti-tearing mechanism.

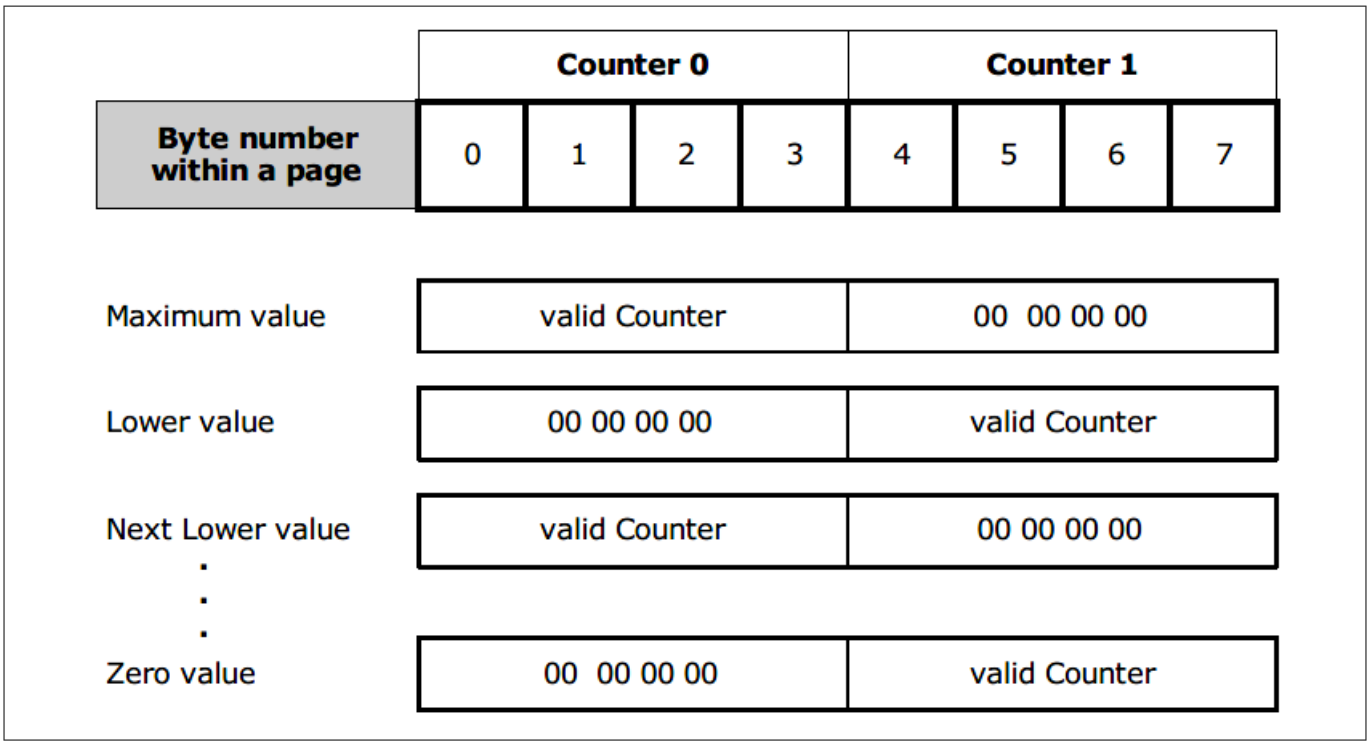

Figure 7 Counter mechanism

So a normal decreased counter page always contains 4-byte with a valid counter value and the other 4-byte set to '00_H, 00_H, 00_H, 00_H'. Cases with 4-byte containing a valid counter and the other 4-byte with any value indicate an aborted counting operation, for further information please refer to Anti-tearing.

Counting is done by transmitting counter data fulfilling the condition "lower than previous value".

- Debit the value counter
  - Using the 'Restricted Write' or 'Restricted Write and Reread' command. With each successful command SRF 55VxxP switches from counter 0 to counter 1 and vice versa
  - Lower byte/LSB is transmitted first

The counter data must fulfill a dedicated counter format to ensure data redundancy.

4.3.2 Anti-tearing

SRF 55VxxP supports the detection of an interrupted counting operation due to the concept of using two counters on a page defined as a counter page.

A malfunction of the counting may be caused by a power loss during the update of the counter data stored in the EEPROM. Due to physical characteristics, the change of EEPROM data requires an erase/write cycle. So, the chip needs several intermediate states during a counter update. Especially during the erase and write also random data may appear because of the physical process.

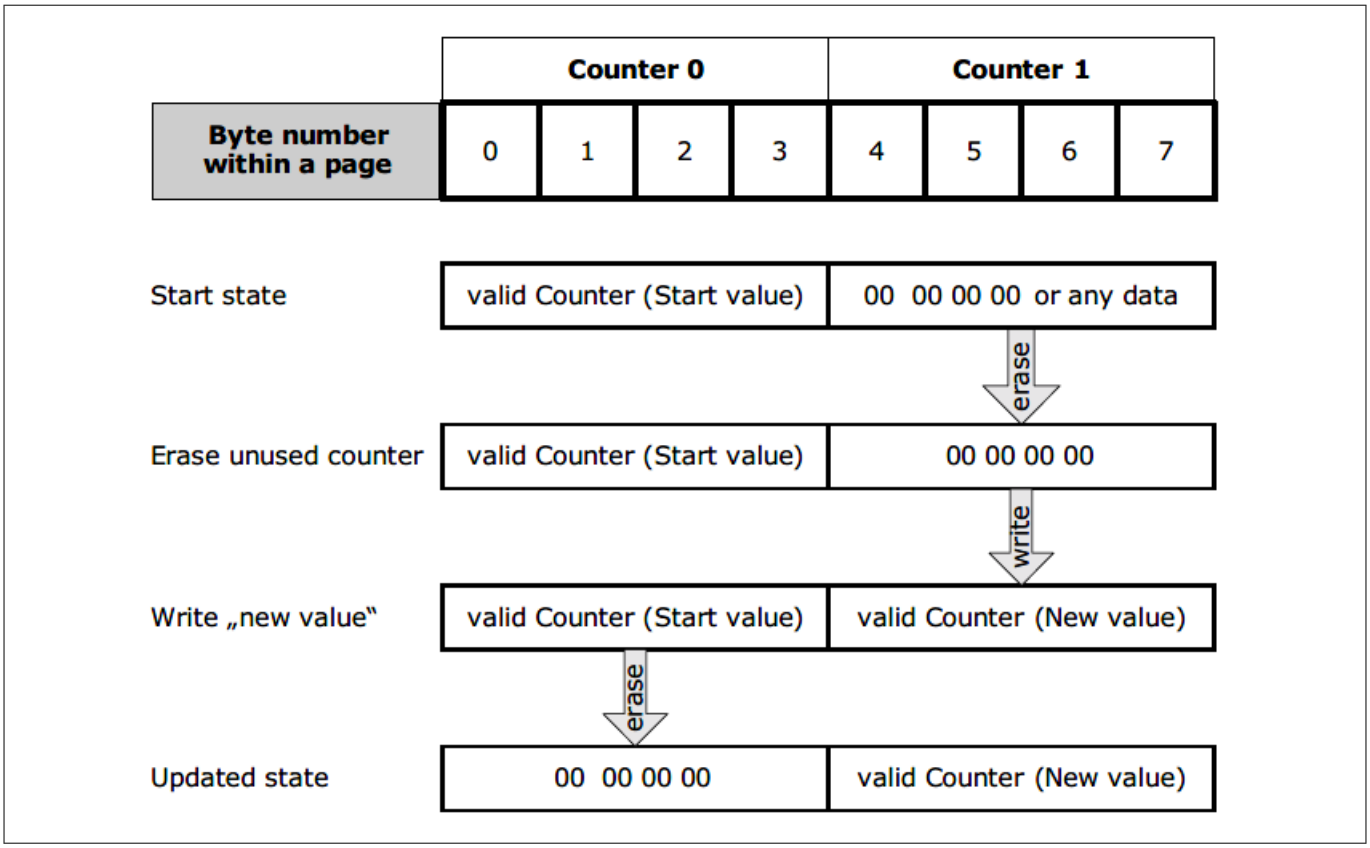

Figure 8 Intermediate counter states

So a normal counting operation looks as follows:

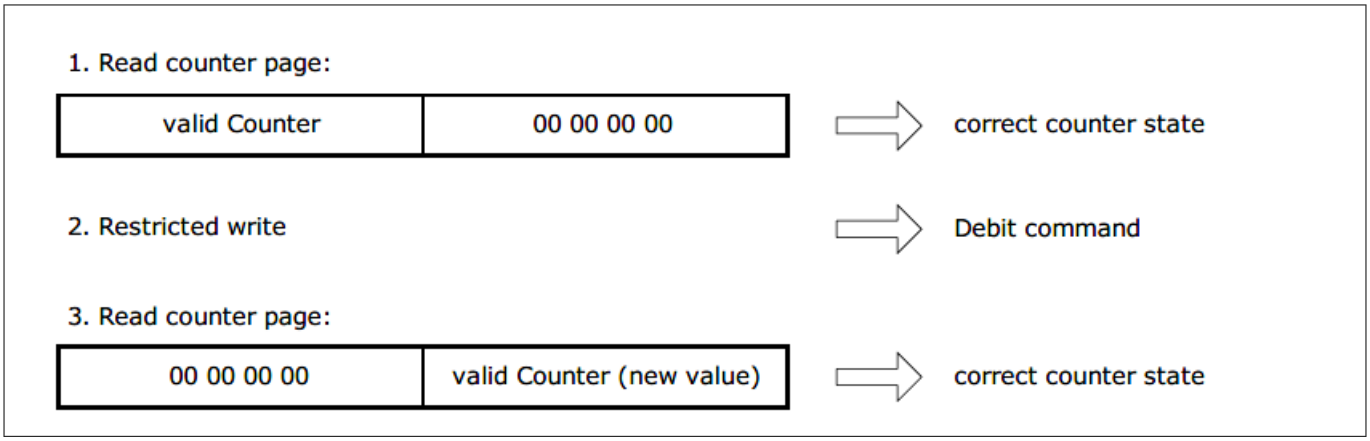

Figure 9 Counter update sequence

If the initial read of a counter page looks like the following operation, this indicates a previously interrupted counting operation:

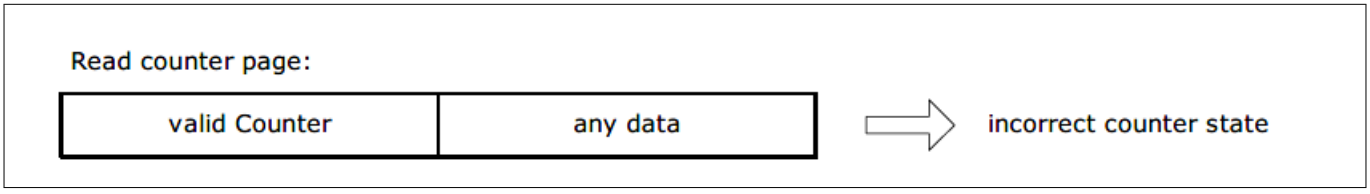

Figure 10 Incorrect counter state

The anti-tearing mechanism is controlled by the VCD software and is based on the two value counters per counter page. It ensures that in case of power loss at least one correct value is stored in the counter.

The following procedure is executed by the **VCD**:

1. **Determine the actual counter**: Read the value counter page with a 'Read' command and separate counter 0 from counter 1
   - Case a) Valid counter is the actual counter

     Only one counter data is valid (the other holds either all bits set to zero or a corrupted counter format).
   - Case b) Higher value is actual counter

     The card was torn during the last operation: Both counters have a valid counter format.
2. **Calculate the new counter value**: New counter value **must** be lower than the actual counter value and has to be sent to the chip in the correct counter value format
3. The **new counter value is programmed** to the non-actual counter with a 'Restricted Write' or 'Restricted Write and Reread' command to the SRF 55VxxP
4. Finally, the old counter value (actual counter) is cleared by the chip (all bits set to zero) and the new counter value becomes the new actual counter

Programming and clearing the counter value pages are processed in one EEPROM erase/write cycle and one EEPROM erase operation. First, the invalid counter value (or lower value) will be erased and programmed with the new value. Then the old valid value will be erased from all zeroes. If there is any interrupt (example: Power loss etc.) at least one counter will have a valid format and data. With this check and backup procedure, a reader can always determine if the 'Restricted Write' command has been performed correctly or not. Additionally, at least the old counter data is always available until the new counter data is programmed.

4.3.3 Value counter pages

Each page in the data area of the memory may be configured and used as a counter value page. A counter value page is a single 8-byte page that is programmed with a dedicated counter format (see Figure 11 and the following explanation). The counter can hold values from 0 to 65535.

4.3.3.1 Value counter format

SRF 55VxxP supports a value counter with a range of 2^{16} (0 to 65535) units.

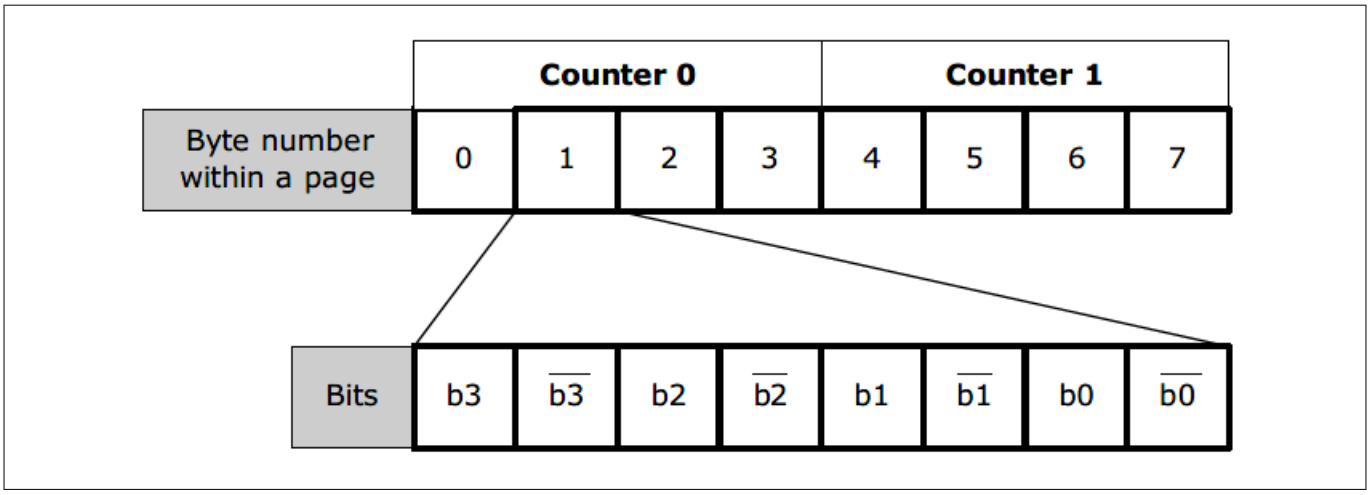

Figure 11 Data structure of a value counter page

The counter page consists of two counters of 4-byte length to support backup/anti-tearing. For data security and integrity reasons, each data bit is stored twice: Non-inverted and inverted (see Figure 11). One 2-byte

value is therefore extended to a 4-byte value for example the one-byte value 0000 0001_B (01_H) is extended to 0101010101010110_B (5556_H). The two counters stored on a counter page (counter 0 and counter 1) must always have different values. This counter format is mandatory to perform the on-chip redundancy and anti-tearing functionality included in the 'Restricted Write' command for the counter block as well as a data integrity check (see Anti-tearing).

4.3.3.2 Initialization of a value counter page

The following steps have to be performed to initialize a page as value counter:

- Initialize the counter value page using the 'Write' and 'Write Byte' commands
- The data to be written to the page must have a counter format (see Value counter format)
- The access condition has to be set to read/restricted-write (see Access conditions)

Example:

To set the counter value 1010_H to one of the plain pages in user memory, an issuer has to:

- Write 8 bytes with the 'Write' command; in this case, the data will be '55 56 55 56 00 00 00 00_H'
- Set the access condition for this page to 55_H with the 'Write Byte' command

Then, the value counter page is ready to be used and can be performed by any 'Restricted Write' command.

- Use the 'Restricted Write' command to decrement the value by 1 by sending $100F_H$ in counter value format 'AA 55 56 55_H', low significant byte first

5 Frames and command set_new

Communication from VCD to VICC and from VICC to VCD is according to ISO/IEC 15693 or ISO/IEC 18000-3 Mode 1.

The standard defines the following command types:

- Mandatory commands
- Optional commands
- Custom commands
- Proprietary commands

Note: The memory of my-d™ vicinity can be accessed both with ISO optional commands (memory structured in blocks of 4 bytes each) and ISO custom commands (memory structured in pages of 8 bytes each).

5.1 ISO command frame

The ISO command frame for the communication from VCD to VICC is according to ISO/IEC 15693-3 [5].

The request format consists of the following fields:

- Flags
- Command opcode
- Parameter field
- Data field
- CRC

These fields are embedded into the general request format and are enframed by a start of frame (SOF) and an end of frame (EOF).

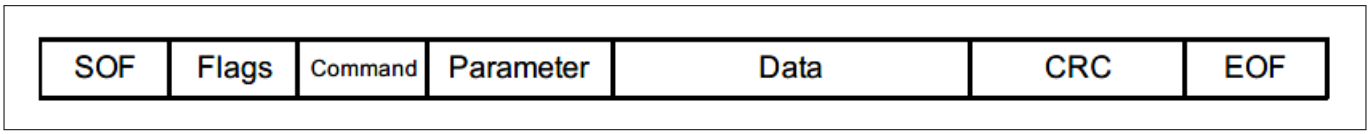

Figure 12 General request format

Flags and parameter settings are defined in ISO/IEC 15693-3 [5].

5.1.1 Supported ISO/IEC 15693-3 commands

The following commands are implemented in the my-d™ vicinity:

Table 16 my-d™ vicinity supported ISO/IEC 15693-3 commands

Command code	Command type	Function	Available modes[1)]
01_H	Mandatory	Inventory	U
02_H	Mandatory	Stay quiet	A
20_H	Optional	Read single block	A/S/U
21_H	Optional	Write single block	A/S/U
22_H	Optional	Lock block	A/S/U
23_H	Optional	Read multiple blocks	A/S/U
25_H	Optional	Select	A

(table continues...)

Table 16 (continued) my-d™ vicinity supported ISO/IEC 15693-3 commands

Command code	Command type	Function	Available modes[1)]
26_H	Optional	Reset to ready	A/S/U
27_H	Optional	Write AFI	A/S/U
28_H	Optional	Lock AFI	A/S/U
$2C_H$	Optional	Get multiple block security status	A/S/U
$A0_H$	Custom	my-d™ vicinity specific command set	A/S/U

1) U → non-addressed, A → addressed, S → selected according to ISO/IEC 15693-3

5.1.2 Error codes

The ISO/IEC 15693-3 [5] standard defines error codes.

The my-d™ vicinity supports the following response error codes:

Table 17 Error codes

Error code	Meaning	Command mode
01_H	Command not supported, that is the request code is not recognized	Optional
$0F_H$	Error with no information given or a specific error code is not supported	Optional/custom
10_H	The specified block is not available (does not exist)	Optional
11_H	The specified block is already locked and so cannot be locked again	Optional
12_H	The specified block is locked and its content cannot be changed	Optional
$A0_H$	Error during authentication or wrong MAC	Custom
$A1_H$	Access denied: Page is locked and its content cannot be changed	Custom

5.1.3 Inventory

The transponder performs an anticollision sequence after receiving a valid inventory request.

Table 18 Inventory request format

SOF	Flags	Inventory command opcode	Optional AFI	Mask length	Mask value	CRC16	EOF
-	8-bit	8-bit	8-bit	8-bit	(0 to 64) bit	16-bit	-

The transponder response contains the data storage format identifier (DSFID) and unique identifier (UID) number.

Table 19 Inventory response format

SOF	Flags	DSFID	UID	CRC16	EOF
-	8-bit	8-bit	64-bit	16-bit	-

Please refer to the ISO/IEC 15693-3 [5] standard for more details on the request and response formats.

5.1.4 Stay quiet

After receiving a valid stay quiet request the transponder enters the quiet state. There is no response to a stay quiet command.

Table 20 Stay quiet request format

SOF	Flags	Stay quiet command opcode	UID	CRC16	EOF
-	8-bit	8-bit	64-bit	16-bit	-

Please refer to the ISO/IEC 15693-3 [5] standard for more details on the request and appropriate state transitions.

5.2 ISO optional commands of my-d™ vicinity

For the ISO optional commands the following memory organization is applicable.

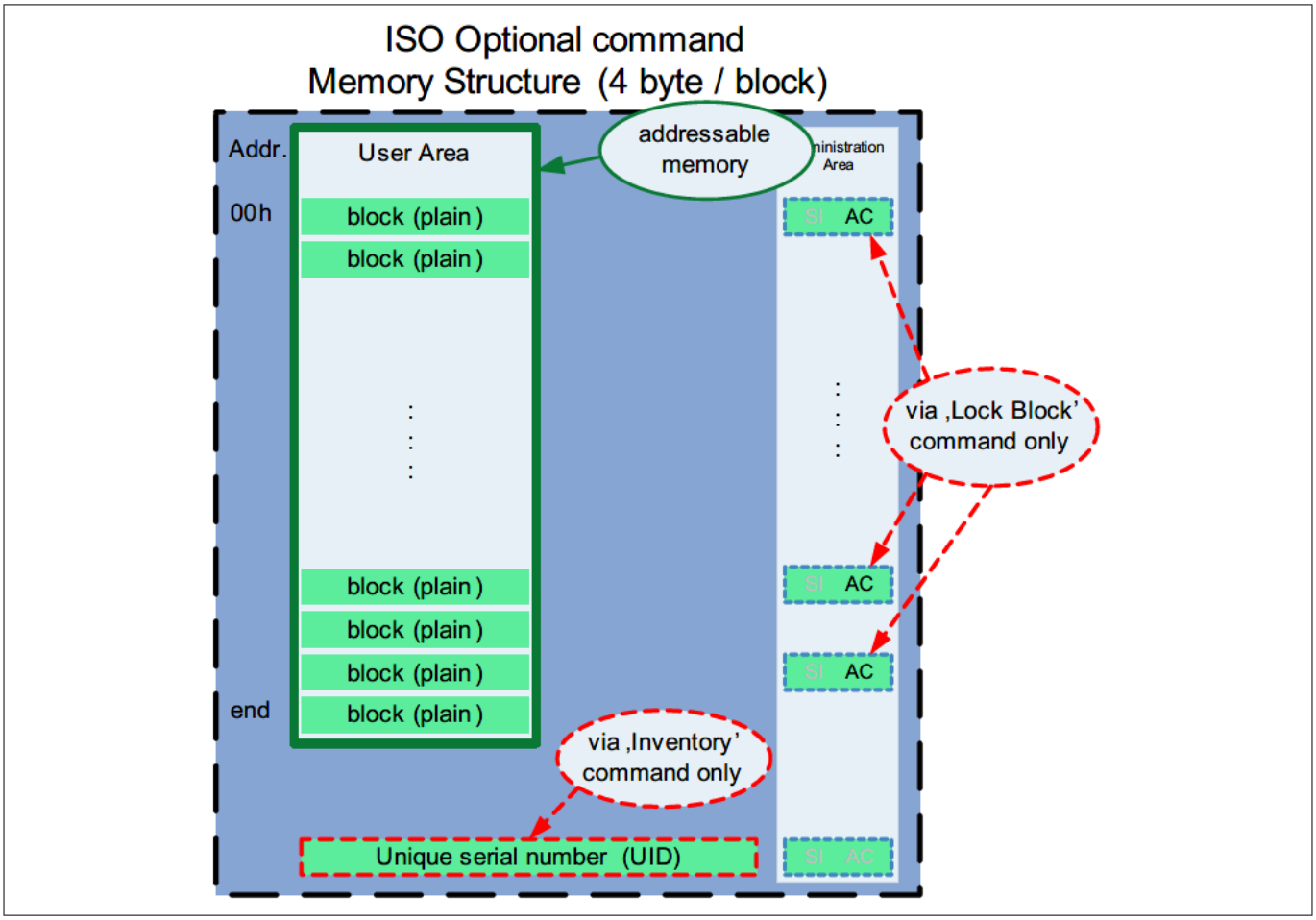

Figure 13 Memory map for ISO optional commands

Table 21 ISO optional commands of my-d™ vicinity

Command code	Function	Available modes[1)]	Reply time in µs[2)]
20_H	Read single block	A/S/U	320 ± 2.36 (t1)
21_H	Write single block	A/S/U	3942.54 ... 3947.26
22_H	Lock block	A/S/U	3942.54 ... 3947.26
23_H	Read multiple blocks	A/S/U	320 ± 2.36 (t1)
25_H	Select	-	320 ± 2.36 (t1)
26_H	Reset to ready	A/S/U	320 ± 2.36 (t1)
27_H	Write AFI	A/S/U	3942.54 ... 3947.26
28_H	Lock AFI	A/S/U	3942.54 ... 3947.26
$2C_H$	Get multiple block security status	A/S/U	320 ± 2.36 (t1)

1) U → non-addressed, A → addressed, S → selected according to ISO/IEC 15693-3
2) After receiving a valid command the transponder starts its reply. For more details related to the reply timing please refer to ISO/IEC 15693-3 [5]

General notes:

- The unique identification (UID) number is accessible via the ISO command 'inventory'
- Using ISO optional commands the my-d™ vicinity memory is accessible in blocks of 4 bytes each
- Each block may be changed from read/write access to read-only using the ISO optional command 'Lock Block'. This command writes the access condition of the respective block (for more information please refer to Access conditions)

For more details on ISO optional commands please refer to the ISO/IEC 15693-3 [5] standard.

Table 22 Addressable memory using ISO optional commands

Type	Memory in bytes	Number of blocks	Address range
SRF 55V02P (HC)	224	56	00_H - 37_H 1)
SRF 55V10P (HC)	992	248	00_H - $F7_H$ 2)

1) Using ISO custom commands the block addresses 00_H/01_H are mirrored to page address $1F_H$, block addresses 02_H/03_H are mirrored to page address $1E_H$ and so on.

2) Using ISO custom commands the block addresses 00_H/01_H are mirrored to page address $7F_H$, block addresses 02_H/03_H are mirrored to page address $7E_H$ and so on.

5.3 ISO custom commands of my-d™ vicinity

For the ISO custom commands the following memory organization is applicable.

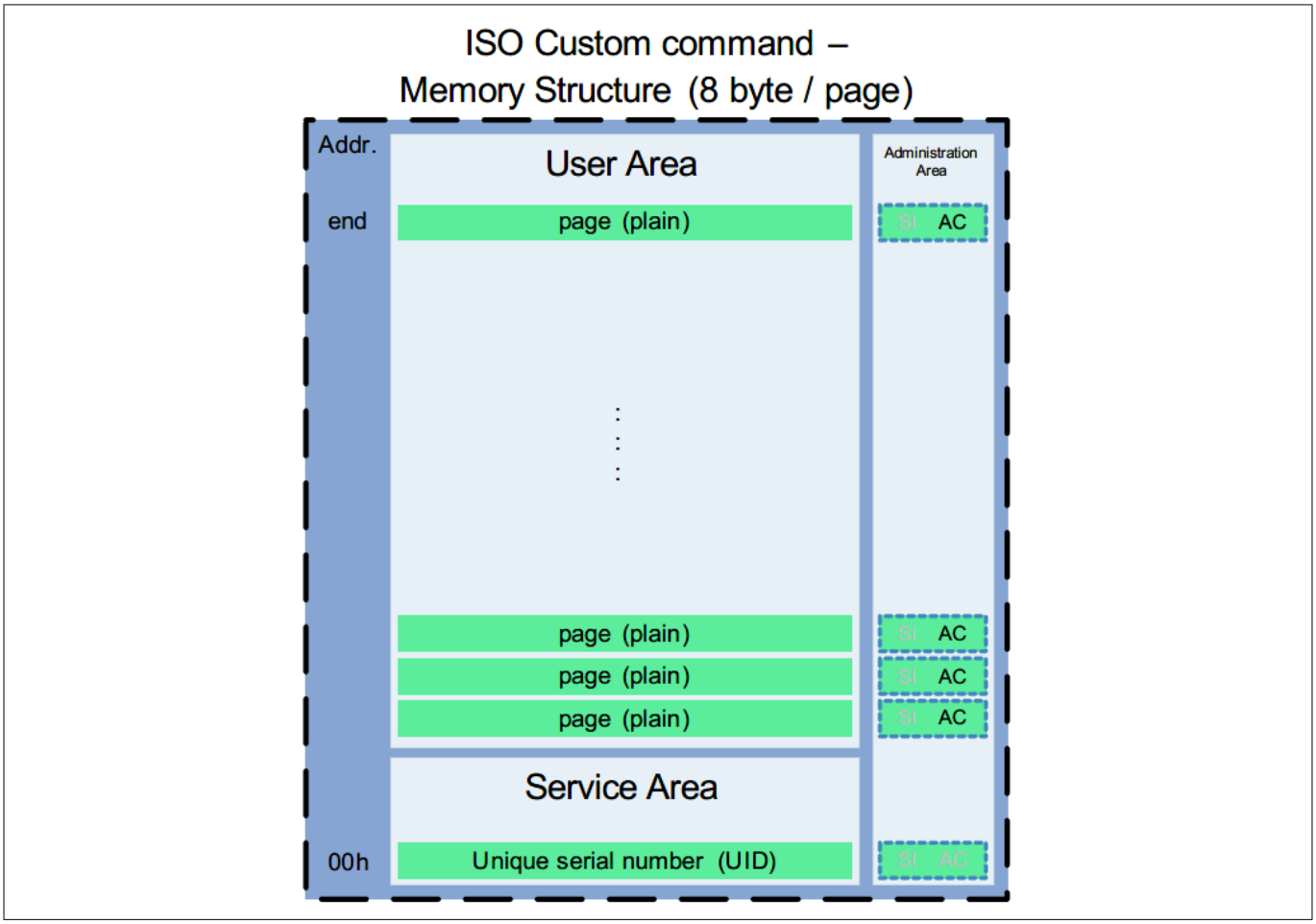

Figure 14 Memory map for ISO custom commands

Table 23 my-d™ custom commands

Command code	Function	Remark	Reply time in µs[1)]
10_H	Read	Reads one page from the memory and transmits it to the VCD	320 ± 2.36 (t1)
30_H	Write	Writes data to the specified page	3942.54 ... 3947.26
90_H	Write Byte	Writes data to the specified byte; writing to byte 9 is used to change the access condition from read/write to read-only	3942.54 ... 3947.26
$B0_H$	Write and Reread	Writes data to the specified page; then the page is read automatically and the data is transmitted to VCD instead of an acknowledge	4545.54 ... 4550.26
00_H	Restricted Write	Used for setting and overwriting value counters	5755.75 ... 5760.47

(table continues...)

Table 23 (continued) my-d™ custom commands

Command code	Function	Remark	Reply time in µs[1)]
80_H	Restricted Write and Reread	Used for setting and overwriting value counters and reading them back in one turn	6359.88 ... 6364.60

1) After receiving a valid command the transponder starts its reply. For more details related to the reply timing please refer to ISO/IEC 15693-3

General notes:

- The my-d™ custom commands can be applied to pages of 8-byte each only
- Each page can be changed only with the access condition set to either AA_H (read/write) or 55_H (restricted write). Otherwise, the chip responds with error code $A1_H$
- Each page may be changed from read/write access to read-only using the ISO custom command 'Write Byte' programming 66_H to byte 9 of the respective page
- Whenever a plain page is to be changed with an ISO optional command, only the access conditions of the accessed block is checked

For detailed information on access conditions please refer to Access conditions.

Table 24 Addressable memory using ISO custom commands

Type	Memory in bytes	Number of pages	Address range[1)]
SRF 55V02P (HC)	256	32	00_H - $1F_H$[2)]
SRF 55V10P (HC)	1024	128	00_H - $7F_H$[3)]

1) Using ISO optional commands the page addresses 00_H to 03_H are not addressable

2) Using ISO optional commands the page address 04_H is mirrored to block addresses $36_H/37_H$, page address 05_H is mirrored to block addresses $34_H/35_H$ and so on.

3) Using ISO optional commands the page address 04_H is mirrored to block addresses $F6_H/F7_H$, page address 05_H is mirrored to block addresses $F4_H/F5_H$ and so on.

5.3.1 my-d™ custom command frame

The my-d™ custom commands are embedded in the data section of the ISO command frame.

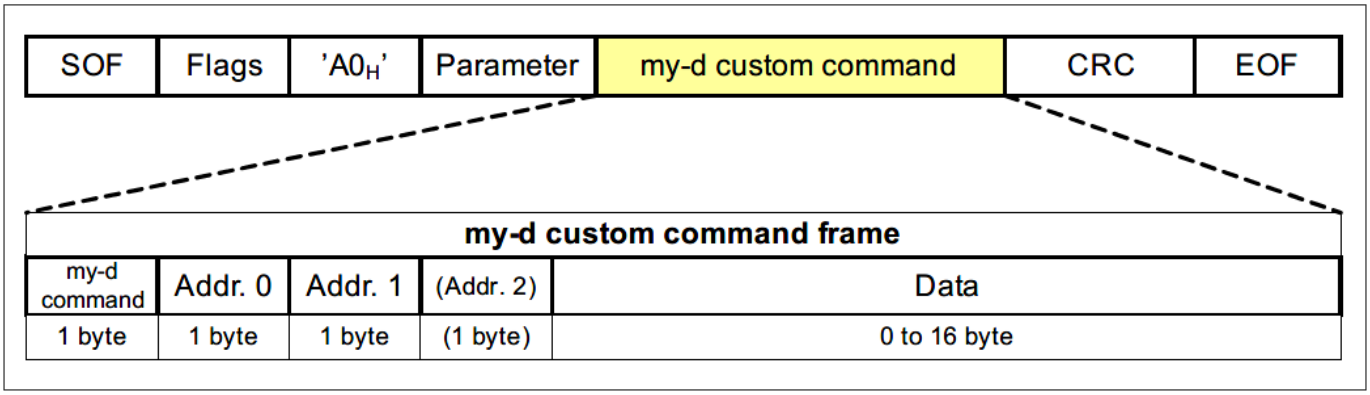

Figure 15 my-d™ vicinity custom command frame

Table 25 ISO command frame with embedded my-d™ custom command frame

Field	Value	Description
SOF	Start of frame	According to ISO/IEC 15693-3 [5]
Flags	-	According to ISO/IEC 15693-3 [5]
ISO command code	$A0_H$	Used to indicate my-d™ custom command
Parameter	05_H [UID]	IC manufacturer code for Infineon + optionally UID of the VICC
my-d™ custom command	As defined for my-d™	For more details please see the following
Address 0	Page address	Page address of my-d™ vicinity
Address 1	00_H	Reserved for future use
Address 2	Byte address of a page	Only for 'Write Byte' command
CRC	Cyclic redundancy check	According to ISO/IEC 15693-3 [5]
EOF	End of frame	According to ISO/IEC 15693-3 [5]

- Timing: VICC response according to ISO/IEC 15693-3 [5]
- Error handling according to ISO/IEC 15693-3 [5]

5.3.1.1 my-d™ custom command 'Read' (10_H)

This command reads one 8-byte page from the memory.

Table 26 my-d™ custom Read command

SOF	Flags	Command opcode	Parameter	my-d™ custom command frame data			CRC16	EOF
-	8-bit	$A0_H$	05_H, [UID]	10_H	Address 0	00_H	16-bit	-

Table 27 Data field (my-d™ custom Read command)

Code	Description	Comment
10_H	Command code for 'my-d™ custom Read'	-
Address 0	Page address	Address range: • 00_H - $1F_H$ for SRF 55V02P (HC) • 00_H - $7F_H$ for SRF 55V10P (HC)
00_H	RFU	Shall be set to 00_H

Table 28 Response, no error (my-d™ custom Read)

SOF	Flags	Data	CRC16	EOF
-	00_H	64-bit (page content)	16-bit	-

Table 29 Response, error_flag (my-d™ custom Read)

SOF	Flags	Data	CRC16	EOF
-	01_H	Error code (according to ISO/IEC 15693-3 [5]) or refer to Table 17	16-bit	-

5.3.1.2 my-d™ custom command 'Write' (30_H)

The custom command 'Write' performs an erase/write cycle on the specified page. In case of successful programming the VICC replies an acknowledge frame consisting of 3 bytes (see below). In case of an error or if the access condition is set to read only an error code ($0F_H$) is transmitted by the VICC (see below).

Table 30 my-d™ custom command 'Write'

SOF	Flags	Command opcode	Parameter	my-d™ custom command frame data				CRC16	EOF
-	8-bit	$A0_H$	05_H, [UID]	30_H	Address 0	00_H	64-bit	16-bit	-

Table 31 Data field (my-d™ custom Write command)

Code	Description	Comment
30_H	Command code for 'my-d™ custom Write'	-
Address 0	Page address	Address range: • 00_H - $1F_H$ for SRF 55V02P (HC) • 00_H - $7F_H$ for SRF 55V10P (HC)
00_H	RFU	Shall be set to 00_H
64-bit	Page data to be written	8-byte user data

Table 32 Response, no error (my-d™ custom Write)

SOF	Flags	CRC16	EOF
-	00_H	16-bit	-

Table 33 Response, error_flag set (my-d™ custom Write)

SOF	Flags	Data	CRC16	EOF
-	01_H	Error code (according to ISO/IEC 15693-3 [5]) or refer to Table 17	16-bit	-

5.3.1.3 my-d™ custom command 'Write Byte' (90_H)

The 'Write Byte' command writes the data of the specified byte. In case of successful programming, the VICC replies with an acknowledge frame consisting of 3 bytes (see below). In case of an error or if the access condition is set to read-only an error code ($0F_H$) is transmitted by the VICC (see below).

Table 34 my-d™ custom command 'Write Byte'

SOF	Flags	Command opcode	Parameter	my-d™ custom command frame data					CRC16	EOF
-	8-bit	$A0_H$	05_H, [UID]	90_H	Address 0	00_H	Byte no.	Value (8-bit)	16-bit	-

Table 35 Data field (my-d™ custom command 'Write Byte')

Code	Description	Comment
90_H	Command code for 'my-d™ custom Write Byte'	-
Address 0	Page address	Address range: • 00_H - $1F_H$ for SRF 55V02P (HC) • 00_H - $7F_H$ for SRF 55V10P (HC)
00_H	RFU	Shall be set to 00_H
Byte number	Byte address within the page	Address range: • 00_H - 09_H
8-bit	Data to be written	One byte of user data

Table 36 Response, no error (my-d™ custom Write Byte)

SOF	Flags	CRC16	EOF
-	00_H	16-bit	-

Table 37 Response, error_flag set (my-d™ custom Write Byte)

SOF	Flags	Data	CRC16	EOF
-	01_H	Error code (according to ISO/IEC 15693-3 [5]) or refer to Table 17	16-bit	-

5.3.1.4 my-d™ custom command 'Write and Reread' ($B0_H$)

The 'Write and Reread' command writes and verifies data to the specified page. In case of successful programming of the page the VICC replies the programmed data. So the command allows a fast verification after the write operation. In case of an error or if the access condition is set to read only an error code ($0F_H$) is transmitted by the VICC.

Table 38 my-d™ custom command 'Write and Reread'

SOF	Flags	Command opcode	Parameter	my-d™ custom command frame data				CRC16	EOF
-	8-bit	$A0_H$	05_H, [UID]	$B0_H$	Address 0	00_H	64-bit	16-bit	-

Table 39 Data field (my-d™ custom Write and Reread command)

Code	Description	Comment
$B0_H$	Command code for 'my-d™ custom Write and Reread'	-
Address 0	Page address	Address range: • 00_H - $1F_H$ for SRF 55V02P (HC) • 00_H - $7F_H$ for SRF 55V10P (HC)
00_H	RFU	Shall be set to 00_H
64-bit	Page data to be written	8-byte of user data

Table 40 Response, no error (my-d™ custom Write and Reread)

SOF	Flags	Data	CRC16	EOF
-	00_H	64-bit (page content)	16-bit	-

Table 41 Response, error_flag set (my-d™ custom Write and Reread)

SOF	Flags	Data	CRC16	EOF
-	01_H	Error code (according to ISO/IEC 15693-3 [5]) or refer to Table 17	16-bit	-

5.3.1.5 my-d™ custom command 'Restricted Write' (00_H)

The 'Restricted Write' command is used for setting and overwriting value counters. To set a new and lower value of a counter, a 'Read' command on the counter page has to be executed in advance. After the determination of the actual counter value, the new value can be set. Only the new counter value (32 bits) in the counter value format has to be transmitted.

In case of successful programming, the VICC replies with an acknowledge frame consisting of 3 bytes (see response formats). In case of an error or if the access condition is set to read-only an error code ($0F_H$) is transmitted by the VICC (see below).

Table 42 my-d™ custom command 'Restricted Write'

SOF	Flags	Command opcode	Parameter	my-d™ custom command frame data				CRC16	EOF
-	8-bit	$A0_H$	05_H, [UID]	00_H	Address 0	00_H	32-bit	16-bit	-

Table 43 Data field (my-d™ custom Restricted Write command)

Code	Description	Comment
00_H	Command code for 'my-d™ custom Restricted Write'	-
Address 0	Page address	Address range: • 00_H - $1F_H$ for SRF 55V02P (HC) • 00_H - $7F_H$ for SRF 55V10P (HC)
00_H	RFU	Shall be set to 00_H
32-bit	New counter value	New 32-bit counter value (counter value in special counter value data format)

Table 44 Response, no error (my-d™ custom Restricted Write)

SOF	Flags	CRC16	EOF
-	00_H	16-bit	-

Table 45 Response, error_flag set (my-d™ custom Restricted Write)

SOF	Flags	Data	CRC16	EOF
-	01_H	Error code (according to ISO/IEC 15693-3 [5]) or refer to Table 17	16-bit	-

5.3.1.6 my-d™ custom command 'Restricted Write and Reread' (80_H)

The 'Restricted Write and Reread' command is used for setting and overwriting value counters and reading them back at once. To set the new or to lower the value of a counter, a 'Read' command on the counter page has to be executed previously. After the determination of the actual counter value, the new value can be set. Only the new counter value (32 bits) in counter value format has to be transmitted.

In case of successful programming, the VICC returns with the new value of the counter. In case of an error or if the access condition is set to read only an error code ($0F_H$) is transmitted by the VICC (see below).

Table 46 my-d™ custom command 'Restricted Write and Reread'

SOF	Flags	Command opcode	Parameter	my-d™ custom command frame data				CRC16	EOF
-	8-bit	$A0_H$	05_H, [UID]	00_H	Address 0	00_H	32-bit	16-bit	-

Table 47 Data field (my-d™ custom Restricted Write command)

Code	Description	Comment
00_H	Command code for 'my-d™ custom Restricted Write and Reread'	-
Address 0	Page address	Address range: • 00_H - $1F_H$ for SRF 55V02P (HC) • 00_H - $7F_H$ for SRF 55V10P (HC)
00_H	RFU	Shall be set to 00_H
32-bit	New counter value	New 32-bit counter value (counter value in special counter value data format)

Table 48 Response, no error (my-d™ custom Restricted Write and Reread)

SOF	Flags	Data	CRC16	EOF
-	00_H	64-bit (page content)	16-bit	-

Table 49 Response, error_flag set (my-d™ custom Restricted Write and Reread)

SOF	Flags	Data	CRC16	EOF
-	01_H	Error code (according to ISO/IEC 15693-3 [5]) or refer to Table 17	16-bit	-

6 Operational characteristics

The listed characteristics are ensured over the operating range of the integrated circuit. Typical characteristics specify mean values expected over the production spread. If not otherwise specified, typical characteristics apply at T_A = 25°C and the given supply voltage.

6.1 Electrical characteristics

f_C = 13.56 MHz sinusoidal waveform, voltages refer to V_{SS}.

Table 50 Operating range and conditions

Parameter	Symbol	Values			Unit	Note or test condition
		Min.	Typ.	Max.		
Operating field	$H_{operating}$	0.15	-	5	A/m	ISO/IEC 15693-2 [4] and ISO/IEC 18000-3 Mode 1 [6]
Operating temperature	T_A	-25	-	+70	°C	For the chip
Endurance (write/erase cycles)[1)]	-	10^5	-	-	-	-
Data retention[1)]	-	10	-	-	Years	-
EEPROM erase and write time	t_{prog}	-	-	3.96	ms	Combined erase and write; excluding time for command/response transfer between VCD and VICC

1) Values are temperature-dependent. Please contact your local Infineon Technologies office or representative for more information.

Table 51 Input characteristics my-d™ vicinity

Parameter	Symbol	Values			Unit	Note or test condition
		Min.	Typ.	Max.		
Chip input capacitance L_A - L_B	C_{chip}	24.9	23.1	24.3	pF	$V_{AB\ RMS}$ = 1.6 V T_A = 25°C
Chip input resistance L_A - L_B	R_{IC}	-	15	-	kΩ	$V_{AB\ RMS}$ = 1.6 V T_A = 25°C

Table 52 Input characteristics my-d™ vicinity HC

Parameter	Symbol	Values			Unit	Note or test condition
		Min.	Typ.	Max.		
Chip input capacitance L_A - L_B	C_{AB}	92.1	97	101.9	pF	$V_{AB\ RMS}$ = 1.6 V T_A = 25°C
Chip input resistance L_A - L_B	R_{AB}	-	4.2	-	kΩ	$V_{AB\ RMS}$ = 1.6 V T_A = 25°C

6.2 Absolute maximum ratings

Stresses above those listed may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this Extended Datasheet is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability, including EEPROM data retention and write/erase endurance.

Table 53 Absolute maximum ratings

Parameter	Symbol	Values			Unit	Note or test condition
		Min.	Typ.	Max.		
Input peak voltage L_A - L_B	$V_{IN\ peak}$	-	-	4.2	V	On-chip limitation by voltage regulator
Input current L_A - L_B	I_{IN}	-	-	100	mA	Maximum current
ESD protection (L_A, $L_{B\ pins}$)	V_{ESD}	2	-		kV	JEDEC STD EIA/JESD22 A114-B
Storage temperature	T_S	-40	-	+125	°C	For the chip

6.3 Timings

All timings are according to ISO/IEC 15693 [5] or ISO/IEC 18000-3 Mode 1 [6] standard.

References

[1] ISO/IEC 7816-6:2016: *Identification cards - Integrated circuit cards - Part 6: Interindustry data elements for interchange (Third edition)*; 2016-06

[2] ISO/IEC 10373-7:2019: *Cards and security devices for personal identification — Test methods — Part 7: Contactless vicinity objects (Third edition)*; 2019-10

[3] ISO/IEC 15693-1:2010 *Identification cards — Contactless integrated circuit cards — vicinity cards — Part 1: Physical characteristics (Second edition)*; 2010-10

[4] ISO/IEC 15693-2:2019: *Cards and security devices for personal identification — Contactless vicinity objects — Part 2: Air interface and initialization (Third edition)*; 2019-04

[5] ISO/IEC 15693-3:2019: *Cards and security devices for personal identification — Contactless vicinity objects — Part 3: Anticollision and transmission protocol (Third edition)*; 2019-04

[6] ISO/IEC 18000-3:2010: *Information technology — Radio frequency identification for item management — Part 3: Parameters for air interface communications at 13.56 MHz (Third edition)*; 2010-11

Glossary

AC
access condition (AC)

AFI
application family identifier (AFI)

CRC
cyclic redundancy check (CRC)
A procedure that uses a checksum to check the validity of a data transfer.

DSFID
data storage format identifier (DSFID)

EAS
electronic article surveillance (EAS)

EEPROM
electrically erasable programmable read-only memory (EEPROM)

EOF
end of frame (EOF)

ESD
electrostatic discharge (ESD)
The sudden draining of electrostatic charge. Even with small charges, it poses a considerable risk to small semiconductor structures, in particular MOS structures. It is therefore essential to take precautions when dealing with unprotected semiconductors.

IC
integrated circuit (IC)

IEC
International Electrotechnical Commission (IEC)
The international committee responsible for drawing up electrotechnical standards.

ISO
International Organization for Standardization (ISO)

LSB
least significant byte (LSB)

MAC
message authentication code (MAC)
Used to prove message integrity.

MCC
module contactless card (MCC)

RFID
radio frequency identification (RFID)

RFU
reserved for future use (RFU)

SI
sector index (SI)

SOF
start of frame (SOF)

UID
unique identifier (UID)

VCD
vicinity coupling device (VCD)

VICC
vicinity integrated circuit card (VICC)

Revision history

Reference	Description
Revision 3.0, 2022-09-23	
All	Migrated to latest template and updated editorial changes
Revision 2.0, 2009-03-31	
All	• Removed EAS feature • ISO write multiple blocks command removed from list of supported optional commands • Updated editorial changes, document split into plain and secure variant
Revision 1.0, 2004-02-29	
All	Initial release

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