RRJ(XX)_RFID_USB & RRJ(XX)_RFID_RS2

V04 27.02.2020

RFID reader with USB or RS232 connection, reader with writing/reading function for mounting diameter 22.3mm. XX = SW stands for version in black.

General data

Panel cut-out:	Ø 22.3mm
Protection class:	III (protective low voltage)
Degree of protection:	IP65 / IP69K
Tightening torque of mounting nut with mounting tool S22:	1.5 Nm; VA version with max. 0.8Nm

Electrical data

Voltage supply:	+5V DC, from external voltage supply or USB
Power consumption RFID reader:	< 150 mA, standby mode < 1 mA
Power consumption with LED ring:	< 230 mA
Operating frequency:	13.56 MHz
Baud rate:	9600 ... 115200 Baud (bit/s)
Delivery status:	115200 baud (bit/s)
System driver USB:	USB driver for Windows, Linux, Android 4.2 and Macintosh, available for download on the Schlegel website.

Ambient conditions

Operating temperature:	-20°C ... +70°C
Storage temperature:	-40°C ... +85°C
Humidity:	up to 95%, non-condensing
Mean operation:	200 000h

Supported Standards / Tags

ISO 14443 A	reading/writing: MIFARE® Classic Mini / 1K /4K, MIFARE Ultralight®, MIFARE Ultralight® C, MIFARE® DESFire®EV1, MIFARE® Smart MX, MIFARE® Plus S / X, MIFARE® Pro X, NTAG 21x reading of the UID: all other RFID reader tags acc. to ISO14443A
ISO 14443 B	SRI4K, SRIX4K, AT88RF020, 66CL160S, SR176
ISO 15693	EM4135, EM4043, EM4x33, EM4x35, I-Code SLI / SLIX, M24LR16/64, TI Tag-it HF-I, SRF55Vxx (my-d vicinity)

Standard Transponder

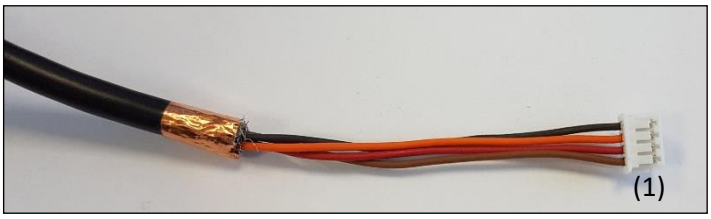
The standard transponders Schlegel is offering are drop-shaped and designed for the transponder tag holder.

ESRT1_X	MIFARE® Classic transponder with 1 kB useable memory
ESRT2_X	MIFARE® DESFire®EV1 transponder with 2 kB useable memory
ESRT4_X	MIFARE® Classic transponder with 4 kB useable memory
ESRT8_X	MIFARE® DESFire®EV1 transponder with 8 kB useable memory
_X	B = blue, G = green, R = red, S = black, Y = yellow

Connection

USB:	USB 2.1, 4-pole, type A	
RS232:	9-pole D-Sub connector	(with RFID_ST_24V)

(1) Connector — Manufacturer JST, Type SHR-04V-S-B

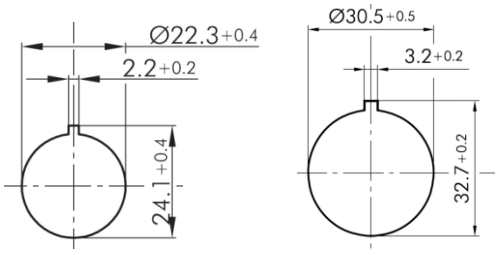


Pin	Function	colour
1	TXD	brown
2	RXD	red
3	+5V/DC	orange
4	GND	black

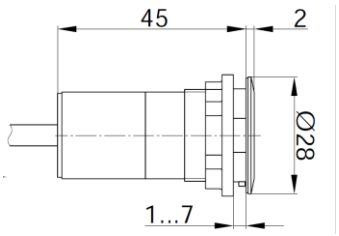
Status Indication

Ready for operation:	LED green
Transponder identified:	LED blue

Cut-out dimensions



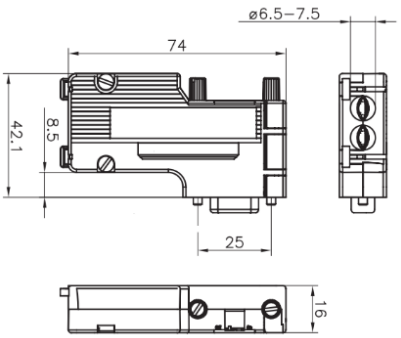
Dimensional drawing

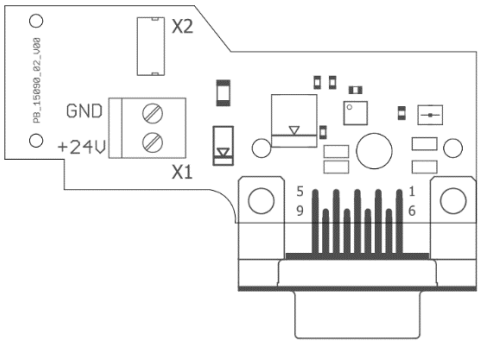


Accessories

RFID_ST_24V

RS232 interface connector with internal voltage converter from 24V/DC to 5V/DC to a 9-pole D-SUB connector.

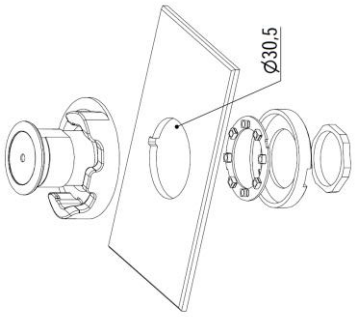




[1] X2 connector field for the pre-assembled RFID RS232 cable

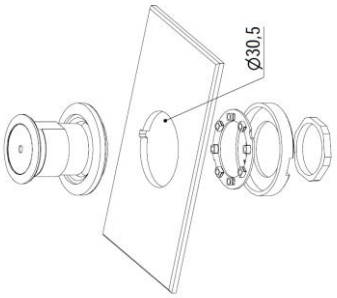
RRJ_RFID_HR_LBG

Tag holder for fixation
of the transponder in front of the RFID reader.
Panel thickness 1.5 to 4 mm.



LR22K5DUO_GB_619

LED illuminated ring for an external indication,
directly assembled to the RFID reader.
Panel thickness 1.5 to 4 mm.



RRJ_RFID_HR_WS und RRJ_RFID_HR_SW

Transponder clip holder in white or black.
Panel thickness 1.4 to 4 mm.
For further data please refer to our product data sheet.

Note for the communication protocol:

General

Checksum Calculation

The checksum is an XOR calculation on all bytes of the telegram.

For manual tests the checksum can be calculated on this website:

https://www.scadacore.com/tools/programming-calculators/online-checksum-calculator/

It is the value „CheckSum8 Xor".

Telegram Structure

The telegram:

Data bits	8
Start bit	1
Stop bit	1
Parity	none

Command Codes for the RFID Reader

Setting of the Baud Rate

In order to change the baud rate on the RFID reader the following command code is being used. On delivery the reader is set to 115200 baud.

Command from the PLC/PC to the RFID reader
Standard command:

50 00 01 01 01 51 (set to 57600 baud)

Telegram structure:

50	= telegram start
00 01	= 1 byte payload between command code and checksum
01	= command code, 5.1.1 SET_UR_BAUDRATE (0x01)
01	= assignment baud rate
52	= checksum

Response of the RFID reader to the PLC/PC to confirm the activation, however still based on the old baude rate.

The new baud rade is then being changed in the reader.

Standard response:

50 00 01 01 02 52

Telegram structure:

50	= telegram start
00 01	= 1 byte payload between command code and checksum
01	= command code, 5.1.1 SET_UR_BAUDRATE (0x01)
02	= parameter to baud rate
52	= checksum

The setting will be used immediately. Then the connection with the new baud rate has to be restarted.

Parameter assignment to the baud rate:

0x04 = 9600
0x03 = 19200
0x02 = 38400
0x01 = 57600
0x00 = 115200

Automated capturing of UIDs by cyclic transmission or individual transmission

In order to allow a status check of the RFID transponder without any initiation by a higher-level control, the possibility of cyclic transmission or individual transmission has been implemented to the Schlegel RFID reader.

Cyclic Transmission

The transponder transmits its UID number in fixed intervals which can be defined by byte 6 as long as it is within the range of the antenna. The central LED as well as the external LEDs of the LED illuminated ring LR22K5DUO_GB_619 are being controlled by the RFID reader. The LED colour green corresponds to the mode ready for operation. If the transponder is identified the colour changes to blue and is illuminated for the time fixed in byte 9.

Activate the cyclic transmission of the transponder UID (Unique Identification).

Command of the PLC/PC to the RFID reader

Standard command:

50 00 05 23 FF 64 00 04 05 EC

Telegram structure:

50	= telegram start
00 05	= 5 byte payload between command code and checksum
23	= command code
FF	= which data carrier type to be registered*
64	= 100 decimal, interval time for registration in ms ***
00	= antenna number
04	= transmission time of the transponder **
05	= LED status via the reader for 5s ****
EC	= checksum

Cyclic transmission with external control of the LEDs

Activate cyclic transmission of the transponder UID (Unique Identification), with external control of the LEDs.
The transponder transmits its UID number in fixed intervals as long as it is within the range of the antenna. The central LED as well as the external LEDs of the LED illuminated ring LR22K5DUO_GB_619 are **not** controlled by the RFID reader. The LED colours can be freely activated externally via the control by command code 03, see page 10.

Command of the PLC/PC to the RFID reader

Standard command:

50 00 05 23 FF 64 00 04 00 E9

Telegram structure:

00	= LED status via the reader is being switched off

Response of the RFID reader to the PLC/PC to confirm the activation

Standard response:

50 00 00 23 73

Telegram structure:

50	= telegram start
00 00	= 5 byte payload between command code and checksum
23	= command code
73	= checksum

Individual Transmission

Command of the PLC/PC to the RFID reader for individual transmission upon registration of the transponder. The transmission time of the transponder can be set freely. The transponder transmits its UID number one time according to the transmission time if it is within the range of the antenna. The central LED as well as the external LEDs of the LED illuminated ring LR22K5DUO_GB_619 are being controlled by the RFID reader. The LED colour green corresponds to ready for operation, if the transponder is identified the colour changes to blue and is illuminated for the time fixed in byte 9.

Standard command:

50 00 05 23 FF 01 00 01 05 8C

Telegram structure:

50	= telegram start
00 05	= 5 byte payload between command code and checksum
23	= command code
FF	= specify transponder types*
01	= interval time, 00 = reception switched off ***
00	= antenna number
01	= transmission time of the transponder **
05	= LED status via the reader for 5s ****
8C	= checksum

Individual transmission with external control of the LEDs

Command to the PLC/PC to the RFID reader for individual transmission, upon registration of the transponder and with external control of the LEDs. The transmission time of the transponder can be set freely. The transponder transmits its UID number one time according to the transmission time if it is within the range of the antenna. The central LED as well as the external LEDs of the LED illuminated ring LR22K5DUO_GB_619 are not controlled by the RFID reader. The LED colours can be freely activated externally via the control by command code 03, see page 10.

Command of the PLC/PC to the RFID reader

Standard command:

50 0 05 23 FF 64 00 01 00 EC

01	= transmission time of the transponder **
00	= LED status via the reader is being switched off

Response of the RFID reader to the PLC/PC to confirm the activation

Standard response:

50 00 00 23 73

Footnotes hereto

* Transponder type:

only ISO14443 A	0x01
only ISO15693	0x04
ISO15693 + ISO14443 A	0x05
all supported data carrier types	0xFF
RFID reader offline	0x00

** Transmission time of the transponder:

if a transponder is being registered for the first time	0x01
if a transponder is no longer registered 0x02	
in both cases (0x01 + 0x02)	0x03

cyclic transmission as long as the transponder is registered	0x04
*** Interval time	
calculate interval time, 1 decimal corresponds to 1ms	0x64
example: 0x64 = 100 decimal = 100ms	
**** Illumination time of status LED	
LED status illumination via the reader for 2s	0x02
LED status illumination via the reader for 5s	0x05
LED status illumination via external control	0x00

Response from the RFID reader to the PLC/PC in case of automatic registration acc. to **ISO 14443A – MIFARE® Classic 1K, 4 Bytes UID (ESRT1_X)**

Telegram:

50 00 0D 23 01 64 03 04 00 04 00 08 04 DB 09 74 6D DF

Telegram structure:

50	= telegram start
00 0D	= 13 byte payload between command code and checksum
23	= command code
01	= ISO 14443A
64	= 100ms interval ***
03	= antenna 3
04	= process: continuous output
00	= reserved
04 00 [1]	= ATQ
08 [2]	= SAK
04	= 4 byte UID
DB 09 74 6D	= UID
DF	= checksum
[1] 02 00 = ATQ	= with MIFARE® Classic 4K (**ESRT4_X**)
[2] 18 = SAK	= with MIFARE® Classic 4K (**ESRT4_X**)

Response from the RFID reader to the PLC/PC in case of automatic registration acc. to **ISO 15693 – µD card type**

For this telegram with ISO-15693 transponders the number of following UID bytes is not being sent, as the number is always 8 bytes.

Telegram:

50 00 0D 23 04 64 03 01 00 25 12 E1 01 00 00 05 E0 2E

Telegram structure:

50	= telegram start
00 0D	= 13 byte payload between command code and checksum
23	= command code
05	= ISO 15693
64	= 100ms interval ***
03	= antenna 3
01	= result: first registration
00	= reserved
25 12 E1 01 00 00 05 E0	= UID
2E	= checksum

Response from the RFID reader to the PLC/PC in case of automatic registration acc. to **ISO 14443A – MIFARE® DESFire®EV1 2K/8K,**
7 Bytes UID (ESRT2_X / ESRT8_X)

Telegram:

50 00 10 23 01 64 03 04 00 44 03 20 07 04 49 69 AA 2B 2B 80 6F

Telegram structure:

50	= telegram start
00 10	= 16 byte payload between command code and checksum
23	= command code
01	= ISO 14443A
64	= 100ms interval ***
03	= antenna 3
04	= process: continuous output
00	= reserved
4403	= ATQ
20	= SAK
07	= 7 byte UID
04 49 69 AA 2B 2B 80	= UID
6F	= checksum

Response from the RFID reader to the PLC/PC in case of automatic registration acc. to **ISO 15693 – HFI**

For this telegram with ISO-15693 transponders always 8 UID bytes are being sent.

Telegram:

50 00 0D 23 04 64 03 01 00 31 22 64 6E D8 80 07 E0 BA

Telegram structure:

50	= telegram start
00 0D	= 13 byte payload between command code and checksum
23	= command code
04	= ISO 15693
64	= 100ms interval ***
03	= antenna 3
01	= result: first registration
00	= reserved
31 22 64 6E D8 80 07 E0	= UID
BA	= checksum

Switch off of the cyclic transmission

By this command the cyclic transmission is being switched off and the manual reading is being activated.

Command from the PLC/PC to the RFID reader to switch off the cyclic transmission.

Standard command:

50 00 05 23 FF 00 00 00 00 89

Telegram structure:

50	= telegram start
00 05	= 5 byte payload between command code and checksum
23	= command code
FF	= specify transponder types*
00	= interval time, 00 = switched off ***
00	= antenna number
00	= transmission is being switched off, RFID reader is offline

00	= reserved
89	= checksum

Response of the RFID reader to the PLC/PC to confirm the activation
Standard response:
50 00 00 23 73

Manual reading of the transponder UID

For reading of the transponder the reader has not to be requested by the system. The central LED as well as the external LEDs of the LED illuminated ring LR22K5DUO_GB_619 are **not** controlled by the RFID reader, they have to be considered as manual and can be freely activated externally via the control by the command code 03, see page 10.

ISO 14443A (Mifare Classic, Mifare Ultralight, DESFire) Transponder

Manual reading of the transponder UID on ISO 14443A (Mifare Classic, Mifare Ultralight, DESFire) Transponder.
This command is being performing REQA, anti-collision and selection sequence at once, as described in the standard ISO 14443-3. Control of the LEDs via command 03, see page 10.
Command of the PLC/PC to the RFID reader
Standard command:
50 00 02 22 10 52 32
Telegram structure:

50	= telegram start
00 02	= 2 byte payload between command code and checksum
22	= command code
10	= switch off antenna for 10ms
52	= request IDLE, 26 = request ALL
32	= checksum

In case there is no transponder within the range the following response is being shown
Response: F0 00 0122 E0 33

Response from the RFID reader to the PLC/PC with **MIFARE® Classic 1K, 4 Bytes UID (ESRT1_X)**
Response example:
50 00 08 22 04 00 08 04 03 E7 FB 6B 06
Telegram structure:

50	= telegram start
00 08	= 8 byte payload between command code and checksum
22	= command code
04 00 [1]	= ATQ (Answer To Request), among others type identifier
08 [2]	= SAK (Select AcKnowledge)
04	= 4 byte UID is following
03 E7 FB 6B	= 4 byte UID
06	= checksum

[1] 02 00 = ATQ	= with MIFARE® Classic 4K (**ESRT4_X**)
[2] 18 = SAK	= with MIFARE® Classic 4K (**ESRT4_X**)

Response from the RFID reader to the PLC/PC with **MIFARE® DESFire®EV1 2K/8K, 7 Bytes UID (ESRT2_X / ESRT8_X)**
Response example:

50 00 0B 22 44 03 20 07 04 49 69 AA 2B 2B 80 17

Telegram structure:

50	= telegram start
00 0B	= 11 byte payload between command code and checksum
22	= command code
44 03	= ATQ (Answer To Request), among others type identifier
20	= SAK (Select AcKnowledge)
07	= 7 byte UID is following
04 49 69 AA 2B 2B 80	= 7 byte UID
17	= checksum

ISO 15693 Transponder

For this telegram with ISO-15693 transponders always 8 UID bytes are being sent.
Command of the PLC/PC to the RFID reader
Standard command:

50 00 03 A1 06 00 00 F4

Telegram structure:

50	= telegram start
00 03	= 3 byte payload between command code and checksum
A1	= command code
06	= Flag, 16 slot inventory; 26 would be 1 slot inventory
00	= AFI, 0x00 = unused
00	= no UID sent, no card to be directly addressed
F4	= checksum

Response from the RFID reader to the PLC/PC if a **transponder has been found**
Response example:

50 00 08 A1 F5 25 26 9F 00 01 04 E0 75

Telegram structure:

50	= telegram start
00 08	= 8 byte payload between command code and checksum
A1	= command code
F5 25 26 9F 00 01 04 E0	= UID
75	= checksum

Additional Functions

Control of the external LED ring LR22K5DUO_BG_619

By this function the central LED as well as the external LEDs of the LED illuminated ring LR22K5DUO_GB_619 can be illuminated independently from the RFID function. This function is switched off upon putting into operation and can be switched on separately.

Command of the PLC/PC to the RFID reader
Telegram:

50 00 03 03 FF 03 00 AC

Telegram structure:

50	= telegram start
00 03	= 3 byte payload between command code and checksum
03	= command code for external LED
FF	= time adjustable e.g. 3 × 50 ms lighting time. Pause time: 500 ms – lighting duration adjustable up to FF, this means continuous light.
07	= enabling of external LEDs
03	= assignment of the external LEDs which are being activated 01 = green / 04 = blue / 05 = mixed colour blue and green
AC	= checksum

Examples for activating the individual LEDs

Telegram:

50 00 03 03 FF 07 01 A9	= green
50 00 03 03 FF 07 04 AC	= blue
50 00 03 03 FF 07 05 AD	= mixed colour blue and green (aqua)
50 00 03 03 FF 07 00 A8	= all OFF

Response from the RFID reader to the PLC/PC

Telegram of the RFID reader:

50 00 00 03 53

Telegram structure:

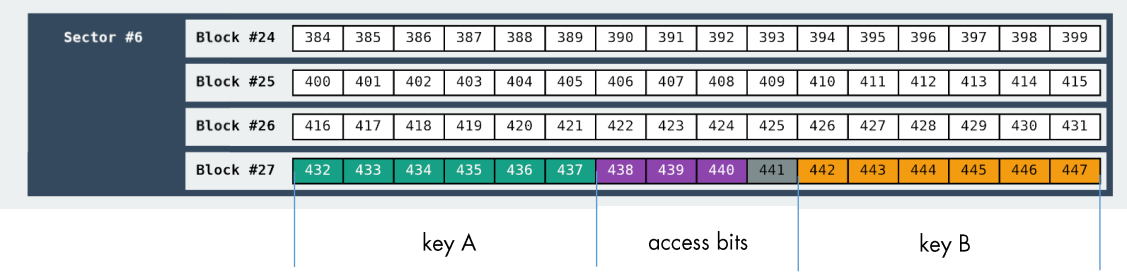
50	= telegram start
00 00	= 0 byte payload between command code and checksum
03	= command code
53	= checksum

Reading and writing of the internal memory in the transponder with MIFARE® Classic (ESRT1_X / ESRT4_X)

The memory area for Mifare Classic is divided into sectors and blocks. Each sector includes 4 blocks and is readable or can be encoded to outside by the superior block. Sector 0 is used for the UID and thus only authorised for reading.

The sectors 1 to 31 can be used for 48 byte. From sector 32 240 bytes per sector are available.

This is an example for the structure of a sector in the transponder:



In order to write on or read the transponder three commands, which always have to be run, are necessary:

Read

1.) opening sequence, PICCACTIVATE (0x22)
2.) authentication of the memory, PICCAUTHKEY (0x16)
3.) read block, PICCWRITE_A (0x17)

Write

1.) opening sequence, PICCACTIVATE (0x22)
2.) authentication of the memory, PICCAUTHKEY (0x16)
3.) write on block, PICCREAT_A (0x18)

Access assignment / access bits:

0x0F | 0x00 | 0xFF | 0x00 see page 13 ff

Attention!
Without knowledge on the functionality of the access bits those ones should not be changed. An incorrect change of the access bits of a sector can result in an irreversible blocking of the whole sector!

Log in to the Mifare data carrier (authenticate)
command from the PLC/PC to the RFID reader
Standard command:

50 00 02 22 10 26 46

Telegram structure:

50	= telegram start
00 02	= 2 byte payload between command code and checksum
22	= command code
10	= reset antenna for 10 seconds
26	= Response to all data carriers
46	= checksum

Response from the RFID reader to the PLC/PC for confirmation
Standard command:

50 00 08 22 04 00 08 04 xx xx xx xx 5B (xx = UID of the transponder, here 4 byte with Mifare Classic)

Log in memory block (authenticate) to the Mifare data carrier
command from the PLC/PC to the RFID reader
Standard command:

50 00 0C 16 60 05 xx xx xx xx FF FF FF FF FF FF 5B (take the UID from the authentication)

Telegram structure:

50	= telegram start
00 0C	= 12 byte payload between command code and checksum
16	= command code
60	= authenticate with key A, use 0x61 for key B
05	= authenticate for block #5
xx xx xx xx	= 4 byte long UID of card
FF FF FF FF FF FF	= key, on delivery of the transponder it is 6 x FF
5B	= checksum

Response from the RFID reader to the PLC/PC for confirmation
Standard command:

50 00 00 16 46

Read a data block on the Mifare data carrier upon log in (read block)
Command from the PLC/PC to the RFID reader
Standard command:

50 00 01 17 05 43

Telegram structure:

50	= telegram start
00 01	= 1 byte payload between command code and checksum
17	= command code
05	= read from block no. 5
43	= checksum

Response from RFID reader to the PLC/PC with 16 byte data block
Response example:

50 00 10 17 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 57

Telegram structure:

50	= telegram start
00 10	= 16 byte payload between command code and checksum
17	= command code
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00	= 16 bytes of the read data block
57	= checksum

Write a data block on the Mifare data carrier upon log in (write block)
Command from the PLC/PC to the RFID reader
Standard command:
50 00 11 18 05 55 55 55 55 55 55 55 55 55 55 55 55 55 55 55 55 5C
Telegram structure:

50	= telegram start
00 11	= 17 byte payload between command code and checksum
18	= command code
05	= write in block no. 5
55 55 55 55 55 55 55 55 55 55 55 55 55 55 55 55	= 16 bytes to write to target block
5C	= checksum

Responds from the RFID reader to the PLC/PC for confirmation
Standard telegram:
50 00 00 18 48
Telegram structure:

50	
00 00	= 0 byte payload between command code and checksum
18	= command code
48	= checksum

Use of ACCESS Bits

Attention: Without specific knowledge on the functionality of the access bits those ones should not be changed.

An incorrect change in the access bits of a sector can result in a blocking of a complete sector!

Please also read the data sheet of the corresponding transponder.

By the access bits of the individual sectors the access conditions are being set for the sector and the data block.

The access bits of the individual sector in the highest block are in the range of byte 6 to byte 8.

Byte 9 is not relevant. Via the access bit it is possible to block or to limitedly enable the corresponding sector for the external readers.

The default value of the Mifare Classic transponder is FF 07 80 and allows all possible functions via key A and key B. Key B can be read and can be used for further 6 bytes data memory. In the default value

key A and Key B are filed under FF FF FF FF FF FF, it can be changed at any time in order not to make the data publicly accessible and to enable reading or writing only by this key.

Examples:

78 77 88

With key A the memory blocks 0, 1, 2 in the sector can be read.

With key B the memory blocks 0, 1, 2 in the sector can be written.

With key A only the access bits can read in memory block 3.

With key B it can be read and written in the memory block.

The memory blocks 0, 1, 2 correspond to the the value in the sector, 0 is the lowest value block and 3 is the highest value block.

General error codes of the RFID reader

The following responses are transmitted by the RFID reader in case of an error:

F0 00 01 A1 E0 B0	= no transponder within the range
F0 00 01 23 F1 23	= checksum not correct

Further possible error codes

Status code	Description
0xF1	LRC error
0xF2	NO THIS CMD
0xF3	SET_ERROR
0xF4	PARA_ERROR
0xB1	NO_CARD
0xB2	ANTICOLL_ERROR
0xB3	SELECT_ERROR
0xB4	HALT_ERROR
0xB6	AUTH_ERROR
0xB7	READ_ERROR
0xB8	WRITE_ERROR
0xB9	VALUEOPER_ERROR
0xBA	VALUE_BAK_ERROR
0xBC	VLAUEBAK_ERROR
0xBE	TPCL_ERROR
0xD1	POWERUP_ERROR
0xD2	POWEROFF_ERROR
0xD3	APDU_ERROR
0xD4	PTS_ERROR
0xD5	NO_SLOT
0xD6	CHACK_ERROR

RF communication error		
0xE0	NO_RESPONSE	No card response within given time indicating by timeout from ASCI Timer
0xE1	FRAMING_ERR	Format of receive frame errors indicating by FramingErr bit in SIC9xx's ErrorFlag (Reg 0x0A)
0xE2	COLLISION_ERR	Bit collision is detected indicating by CollErr bit in IC's ErrorFlag register (Reg 0x0A)
0xE3	PARITY_ERR	Parity Bit Check is invalid indicating by ParityErr bit in IC's ErrorFlag register (Reg 0x0A)
0xE4	CRC_ERR	CRC Check is invalid indicating by CRCErr bit in IC's ErrorFlag register (Reg 0x0A)
0xE5	INVALID_RESP	Response is invalid or unexpected from operational protocol
0xE6	SUBC_DET_ERR	Subcarrier from card is detected indicating by SubC_Det bit in IC's Status register (Reg 0x05); but cannot recognized following standard (available only x410)