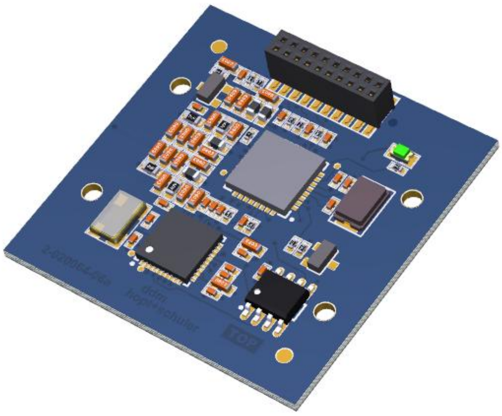
die zeichen lesen
die zeichen setzen

reading the signs
setting the signs



RFID Reader 881 Protocol & CMD

Reference Manual
Rev. 1.1 (November 2016)

FCC ID: 2AJ4J-reader881
IC UPN: 22050-reader881

ddm
hopt+schuler
D-78628 Rottweil
Königsberger Straße 12
Tel. (++49) 741 / 2607-0
Fax (++49) 741 / 1 33 98
ddm@hopt-schuler.com
www.hopt-schuler.com

The contents of this document are subject to revision without notice due to continued progress in methodology, design and manufacturing.

No part of this document may be reproduced or transmitted in any form or by any means, for any purpose, without the prior written permission of "ddm hopt+schuler".

ddm hopt+schuler shall have no liability for any errors or damages of any kind resulting from the use of this document.

History

Date	Rev	Note
07.07.2016	1.0	First revision
19.11.2016	1.1	Remarks and new chapter 8 because FFC

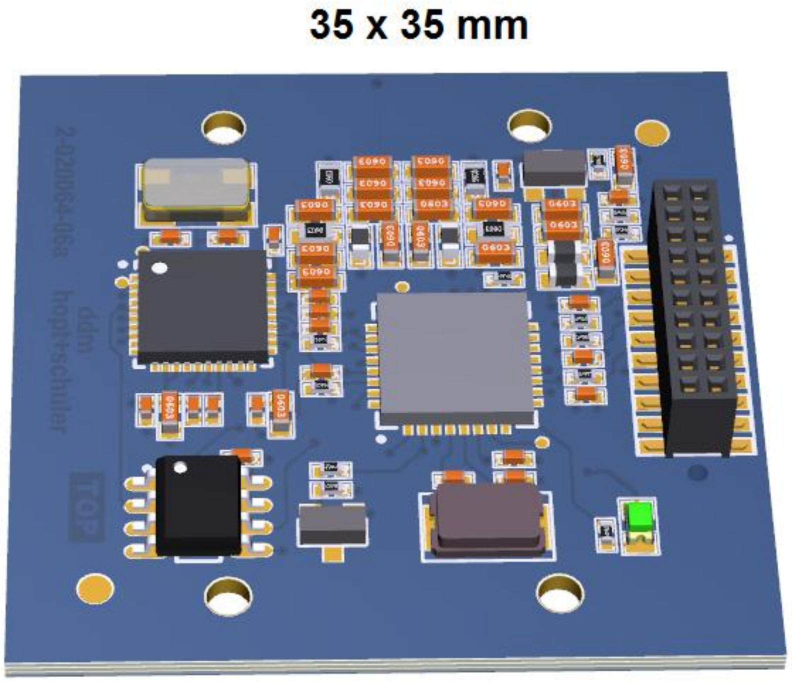
NOTICE:
This device complies with Part 15 of the FCC Rules and with Industry Canada licence-exempt RSS standard(s).
Operation is subject to the following two conditions:
(1) this device may not cause harmful interference, and
(2) this device must accept any interference received, including interference that may cause undesired operation.

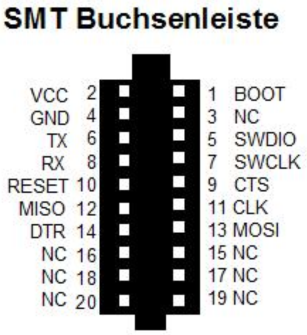
Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio
exempts de licence. L'exploitation est autorisée aux deux conditions suivantes:
(1) l'appareil ne doit pas produire de brouillage, et
(2) l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

NOTE: *This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.*

Table of Content

1 INTRODUCTION





The NFC reader is a multiple protocol reader for contactless communication at 13.56 MHz. It is designed with the best full NFC frontend (PN5180) of the market.

It supports the following operating modes:

- Reader/Writer mode supporting ISO/IEC 14443-A up to 848 kBit/s, MIFARE
- Reader/Writer mode supporting ISO/IEC 14443-B up to 848 kBit/s
- Reader/Writer mode supporting JIS X 6319-4 (comparable with FeliCa scheme)
- Read/write mode supporting ISO/IEC 15693
- Read/write mode supporting ISO/IEC 18000-3 Mode 3
- ISO/IEC18092 (NFC-IP1)
- ISO/IEC21481 (NFC-IP-2)
- NFC-FORUM
- ISO14443-type A Card emulation up to 848 kBit/s

This document describes the common protocol and command set for the NFC Reader.

1.1 Features

- UART (3.3V) serial interface up to 230KBaud
- Full NFC support
- Integrated antenna
- 2MBit external flash memory
- Bootloader for firmware update
- Max. 150mA @ +3.3V current consumption
- 35 x 35 x 10 mm

1.2 Board-to-Board Interface Connector

A 20-pin 1.27mm SMT board-to-board connector is used to embed the module on a host board.

Reader	Pinning	Description
BOOT	1	ISP entry pin (leave it not connected)
VCC	2	+3.3V (optional +5V)
NC	3	Not connected
GND	4	Ground
SWDIO	5	SWDIO
TX	6	UART-TX
SWCLK	7	SWCLK
RX	8	UART-RX
CTS	9	UART-CTS
RESET	10	Module reset (active LOW)
CLK	11	SPI-CLK
MISO	12	SPI-MISO
MOSI	13	SPI-MOSI
DTR	14	UART-DTR
NC	15	Not connected
NC	16	Not connected
NC	17	Not connected
NC	18	Not connected
NC	19	Not connected
NC	20	Not connected

1.3 DC Characteristics

Symbol	Parameter	Condition	Min	Typ	Max	Units
V_{CC}	Supply Voltage	V_{CC} = +5V V_{CC} = +3.3V	4.5 3.0	5.0 3.3	5.5 3.6	V
I_{VCC}	Supply Current	V_{CC} = +5V V_{CC} = +3.3V			150 150	mA
T_{amb}	Operating ambient temperature		-20		+80	ºC

1.4 Reset Monitor Circuit

A system supervisor circuit is monitoring the VCC and providing a reset signal to the host module when necessary. The reset is driven active within 10 µsec of VCC falling through the reset voltage ***V_{TH}*** threshold.

1.5 External Reset

An External Reset is generated by a low level on the RESET pin. Reset pulses longer than the minimum pulse width will generate a reset. Shorter pulses are not guaranteed to generate a reset.

1.6 Reset Characteristics

Symbol	Parameter	Condition	Min	Typ	Max	Units
V_{TH}	Reset monitor threshold voltage		2.83	2.93	2.96	V
V_{RST}	RESET pin threshold voltage		0.3 V_{CC}		0.7 V_{CC}	V
t_{RST}	Minimum pulse width on RESET Pin		50ns			µs

1.7 Transmission Format

The default parameter settings are:

Format: 1 start bit, 8 data bits, 1 stop bit, no parity
Baud rate: 115200 bps (baud)
Handshaking: No DTR/CTS control

1.8 Possible Transmission Formats

Baud rate: Supported baud rates are; 2400, 4800, 9600, 19200, 38400, 57600, 76800, 115200 and 230400.

1.9 Frame Format

All frames are structured as followed:

SOH	ADDR	LEN	DATA	BCC

SOH = 01h
ADDRESS (default 01h): The device address field is one byte.
LEN: This field is the DATA length and is encoded in two bytes (MSB first).
DATA: This is the command or the response message. The next section defines it.
BCC: Is the “Block Check Character”. Its value is equal to the results of exclusive OR of all preceding bytes (SOH byte is included).

A maximum of 500ms is allowed between two consecutive characters.

1.10 Data Format

The DATA format is structured as followed:

Host-to-Reader (Command)

Command (1 Byte)	**Message (may be 0 length)**

Reader-to-Host (Answer)

Status (1 Byte)	**Message (may be 0 length)**

2 MEMORY CONFIG

The reader stores the configuration data in the internal EEPROM memory.

Address	Name	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
0	**MEMSTAT**	Memory status (Read only)							
1	**NETADDR**	Address for network configuration							
2	**SERIAL0**	Serial Number byte0							
3	**SERIAL1**	Serial Number byte1							
4	**SERIAL2**	Serial Number byte2							
5	**SERIAL3**	Serial Number byte3							
6	**SERIAL4**	Serial Number byte4							
7	**SERIAL5**	Serial Number byte5							
8	**SERIAL6**	Serial Number byte6							
9	**SERIAL7**	Serial Number byte7							
10	**MODCON**	Type B Modulation Conductance							
11	**ANT1PW**	Antenna 1 transmitter power level							
12	**ANT2PW**	Antenna 2 transmitter power level							
13	**CONFIG0**	DLED	CI	TYPEA	TYPEB	RM1	RM0	RFU	RFU
14	**CONFIG1**	RFU	RFU	RFU	RFU	RFU	RFU	RFU	RFU
15	**CONFIG2**	RFU	RFU	RFU	RFU	RFU	RFU	RFU	RFU
16	**CONFIG3**	RFU	RFU	RFU	RFU	RFU	RFU	RFU	RFU
17	**CONFIG4**	RFU	RFU	RFU	TAG	RFU	RFU	RFU	RFU
18	**CONFIG5**	RFU	RFU	RFU	RFU	RFU	RFU	RFU	POL
19	**RXTHA**	Receiver threshold A							
20	**RXTHB**	Receiver threshold B							
21	**RFU**	Reserved for future use							
22	**PDATE**	Production Date DAY							
23	**PDATE**	Production Date MONTH							
24	**PDATE**	Production Date YEAR							

2.1 Main Configuration CONFIG0

Register: CONFIG0

Bit	7	6	5	4	3	2	1	0	
	DLED	**CI**	**TYPEA**	**TYPEB**	**RM1**	**RM0**	**RFU**	**RFU**	**CONFIG0**
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Init Value	0	0	0	0	1	0	0	0	0x08

Bit 3-2 – RM1, RM0: Running Mode

RM1	RM0	Running Mode	Description
0	0	Normal	Do nothing
0	1	Polling	Polling TypeA/B/C
1	0	Polling	Polling TypeA/B/C
1	1	Polling	Polling TypeA/B/C

To activate a running mode, use the SET_RUNNING_MODE command.

Normal: Do nothing.
Polling: In this mode, the reader polls for only TypeA/B/C PICCs.

TYPEB: If this bit is set, the reader polls for Type B/C cards
TYPEA: If this bit is set, the reader polls for Type A cards
CI Card Interrupt: If this bit is set, card detection interrupt will be active.
DLED: A one disables the red LED blinking.

2.2 Communication Parameters CONFIG1

Register: CONFIG1

Bit	7	6	5	4	3	2	1	0	
	RFU	RFU	RFU	RFU	RFU	RFU	RFU	RFU	CONFIG1
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Init Value	0	0	0	0	0	1	1	1	0x07

2.3 Interface Configuration CONFIG2

Register: CONFIG2

Bit	7	6	5	4	3	2	1	0	
	RFU	RFU	RFU	RFU	RFU	RFU	RFU	RFU	CONFIG2
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Init Value	0	0	0	0	0	0	0	1	0x01

2.4 Function Select CONFIG3

Register: CONFIG3

Bit	7	6	5	4	3	2	1	0	
	RFU	RFU	RFU	TAG	RFU	RFU	RFU	RFU	CONFIG3
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Init Value	0	0	0	0	0	0	0	0	0x00

2.5 Behavior Select CONFIG4

Register: CONFIG4

Bit	7	6	5	4	3	2	1	0	
	RFU	RFU	RFU	RFU	RFU	RFU	RFU	RFU	CONFIG4
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Init Value	0	0	0	0	0	0	0	0	0x00

2.6 Behavior Select CONFIG5

Register: CONFIG5

Bit	7	6	5	4	3	2	1	0	
	RFU	**RFU**	**RFU**	**RFU**	**RFU**	**RFU**	**RFU**	**POL**	**CONFIG4**
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Init Value	0	0	0	0	0	0	0	0	0x00

Bit 0 – POL: Start polling after reset. If this bit is set; the reader starts automatically the polling mode DETECTION.

3 COMMAND SET

3.1 Reader Commands

READ_REGISTER	Send	Len
Transmit	0x30	1
	ADDR[0]-ADDR[1] (MSB first)	2
	LEN[0]-LEN[1] (MSB first)	2
Receive	0x00 (stat_OK) or error code	1
	DATA[0]-DATA[n]	n
Description	Read the module configuration registers	

WRITE_REGISTER	Send	Len
Transmit	0x31	1
	ADDR[0]-ADDR[1] (MSB first)	2
	LEN[0]-LEN[1] (MSB first)	2
	DATA[0]-DATA[n]	n
Receive	0x00 (stat_OK) or error code	1
Description	Update the module configuration registers	

MODULE_RESET	Send	Len
Transmit	0x33	1
Receive	0x00 (stat_OK) or error code	1
Description	Reader reset	

GET_INFO	Send	Len
Transmit	0x72	1
	INDEX 0 : All Infos (92 Bytes) 1: Serial number (4 Bytes) 2: Firmware Version (6 Bytes) 3: Version & Copyright (58 Bytes) 4: Model (6 Bytes) 5: PCB (11 Bytes) 6: Cycle (4 Bytes) 7: Production date (3 Bytes DDMMYY)	1
Receive	0x00 (stat_OK) or error code	1
	Info string	n
Description	Read reader information data. The model information can be used to identify the hardware.	

SET_RUNNING_MODE	Send	Len
Transmit	0x5D	1
	MODE 0: Normal 1/2/3: Polling	1
Receive	0x00 (stat_OK) or error code	1
Description	Set polling mode **Normal:** Do nothing. **Polling:** In this mode, the reader polls only for Type A/B/C PICCs. If the reader receives a contactless card command, it stops polling to avoid collisions.	

3.2 PCD Commands

PCD_KILL	Send	Len
Transmit	0x1F	1
Receive	0x00 (stat_OK) or error code	1
Description	Hard power down of the PCD. The RF part of the reader will be switched off.	

PCD_TYPEA_INIT	Send	Len
Transmit	0x20	1
Receive	0x00 (stat_OK) or error code	1
Description	Initialize the PCD with Type A configuration, set RF on	

PCD_TYPEB_INIT	Send	Len
Transmit	0x50	1
Receive	0x00 (stat_OK) or error code	1
Description	Initialize the PCD with Type B configuration, set RF on	

PCD_RESETPHASE	Send	Len
Transmit	0x23	1
Receive	0x00 (stat_OK) or error code	1
Description	Run the reset and initialization phase as defined in EMVCo spec. RF carrier is set off a while and the PCD is reinitialized and RF carrier is set on again.	

PCD_RF_RESET	Send	Len
Transmit	0x25	1
	X (milliseconds)	1
Receive	0x00 (stat_OK) or error code	1
Description	Reset the RF field	

PCD_RF_OFF	Send	Len
Transmit	0x26	1
Receive	0x00 (stat_OK) or error code	1
Description	Switch RF field off and keep it off.	

WRITERC	Send	Len
Transmit	0x57	1
	ADDR	1
	DATA	1
Receive	0x00 (stat_OK) or error code	1
Description	Write a byte to PCD’s given register.	

READRC	Send	Len
Transmit	0x58	1
	ADDR	1
Receive	0x00 (stat_OK) or error code	1
	DATA	1
Description	Read a byte from PCD’s given register.	

PCD_SET_ATTRIB	Send	Len
Transmit	0x29	1
	DSI (Divisor Send Integer)	1
	DRI (Divisor Receive Integer)	1
Receive	0x00 (stat_OK) or error code	1
Description	Set RF communication baud rate	

PICC_EXCHANGE_BLOCK	Send	Len
Transmit	0x2A	1
	TX_LEN	1
	RX_LEN	1
	TXDATA[0]-TXDATA[n]	n
Receive	0x00 (stat_OK) or error code	1
	RX_DATA[0]-RX_DATA[n]	n
Description	Transparent communication with the PN5180	

3.3 ISO14443-A Commands

PICC_REQUEST	Send	Len
Transmit	0x10	1
	REQA: 0x26 (Request idle) WUPA: 0x52 (Request all)	1
Receive	0x00 (stat_OK) or error code	1
	ATQA[0]-ATQA[1] (Request code)	2
Description	Request for a Type A PICC.	

PICC_ANTICOLL	Send	Len
Transmit	0x11	1
	SEL_CODE (Anti-collision level) Level1: 0x93 Level2: 0x95 Level3: 0x97	1
	nbits (known bits)	1
Receive	0x00 (stat_OK) or error code	1
	UID[0]-UID[3]	4
Description	Get UID from one of the PICCs	

PICC_SELECT	Send	Len
Transmit	0x12	1
	SEL_CODE (level) Level1: 0x93 Level2: 0x95 Level3: 0x97	1
	UID[0]-UID[1]	4
Receive	0x00 (stat_OK) or error code	1
	SAK (Select ACK)	1
Description	Activate a PICC by selecting the UID	

PICC_ANTICOLLSEL	Send	Len
Transmit	0x19	1
	BR (Baud rate) Default: 0	1
Receive	0x00 (stat_OK) or error code	1
	UID_LEN	1
	UID[0]-UID[n]	n
	SAK (Select ACK)	1
Description	Anti-collision and select performed together	

PICC_HALTA	Send	Len
Transmit	0x1C	1
Receive	0x00 (stat_OK) or error code	1
Description	Set PICC to Halt state	

PICC_DO_PPS	Send	Len
Transmit	0x2B	1
	DSI (Data Send Integer) 0: 106 kbit/s 1: 212 kbit/s 2: 424 kbit/s 3: 848 kbit/s	1
	DRI (Data Receive Integer) 0: 106 kbit/s 1: 212 kbit/s 2: 424 kbit/s 3: 848 kbit/s	1
Receive	0x00 (stat_OK) or error code	1
Description	Perform protocol parameter selection	

PICC_REQUEST_ATS	Send	Len
Transmit	0x3A	1
Receive	0x00 (stat_OK) or error code	1
	ATS_LEN	1
	ATS[0]-ATS[n]	n
Description	Activate an ISO14443-4 compliant PICC	

3.4 ISO14443-B Commands

PICC_REQUESTB	Send	Len
Transmit	0x51	1
	iswup 0: Request 1: Wakeup	1
	afi	1
	num_slots	1
Receive	0x00 (stat_OK) or error code	1
	ATQB[0]-ATQB[11] (Request code)	12
Description	Request for a Type B PICC.	

PICC_SLOTMARKER	Send	Len
Transmit	0x5F	1
	num_slots	1
Receive	0x00 (stat_OK) or error code	1
	ATQB[0]-ATQB[11] (Request code)	12
Description	Request for a Type B PICC with a defined slot.	

PICC_ATTRIB	Send	Len
Transmit	0x52	1
	UID[0]-UID[3]	4
Receive	0x00 (stat_OK) or error code	1
	ATA	1
Description	Activate a Type B PICC	

PICC_ATTRIB_HBR	Send	Len
Transmit	0x2C	1
	DSI (Data Send Integer) 0: 106 kbit/s 1: 212 kbit/s 2: 424 kbit/s 3: 848 kbit/s	
	DRI (Data Receive Integer)	1

	0: 106 kbit/s 1: 212 kbit/s 2: 424 kbit/s 3: 848 kbit/s	
	UID[0]-UID[3]	4
Receive	0x00 (stat_OK) or error code	1
	ATA	1
Description	Activate a Type B PICC with higher baud rate	

PICC_HALTB	**Send**	**Len**
Transmit	0x53	1
Receive	0x00 (stat_OK) or error code	1
Description	Set PICC to Halt state	

3.5 ISO14443-4 (T=CL) Commands

PICC_DETECT	**Send**	**Len**
Transmit	0x5B	1
Receive	0x00 (stat_OK) or error code	1
	PICC_TYPE 0x70: TypeA PICC 0x71: TypeB PICC 0x72: TypeC VICC (ISO15693)	1
	Type A: ATQA[0]-ATQA[1] + SAK + UID[0]-UID[n] + ATS[0]-ATS[m] Type B: ATQB[0]-ATQB[11] + ATTRIBRESPONSE Type C: UID[0]-UID[7]	n+m+5 13 8
Description	Detects and activates the PICC	

PICC_SEND_BLOCK	**Send**	**Len**
Transmit	0x54	1
	LEN[0]-LEN[1] (MSB first)	2
	DATA[0]-DATA[n]	n
Receive	0x00 (stat_OK) or error code	1
	RCVDATA[0]-RCVDATA[n]	n
Description	Send and receive data (APDU exchange)	

PICC_SEND_ACK	**Send**	**Len**
Transmit	0x55	1
	ACK: 0x00 NACK: 0x10	1
Receive	0x00 (stat_OK) or error code	1
Description	Send an ACK or a NAK NAK could be sent to check whether the PICC is in the field or not.	

PICC_SEND_REQ	**Send**	**Len**
Transmit	0x56	1
	DESELECT: 0x00 WTX: 0x30	1
	WTXM	1
Receive	0x00 (stat_OK) or error code	1
Description	Send T=CL request, the reader waits until the PICC is removed. This command is obsolete.	

PICC_DESELECT	**Send**	**Len**
Transmit	0x86	1
Receive	0x00 (stat_OK) or error code	1
Description	T=CL deselect command	

PICC_REMOVE	Send	Len
Transmit	0x62	1
Receive	0x00 (stat_OK) or error code	1
Description	Wait until the tag is out of the field An event_PICC_REMOVED will be sent, after the tag exits the field.	

3.6 ISO14443 mifare Commands

PICC_AUTHENT	Send	Len
Transmit	0x13	1
	MODE 0x60: Auth. with Key A 0x61: Auth. with Key B	1
	Key sector (0x00-0x0F	1
	Block number (0x00-0x3F)	1
Receive	0x00 (stat_OK) or error code	1
Description	Performs mifare authentication with stored keys	

PICC_AUTHENT_KEY	Send	Len
Transmit	0x14	1
	MODE 0x60: Auth. with Key A 0x61: Auth. with Key B	1
	KEYS[0]-KEYS[5]	6
	Block number (0x00-0x3F)	1
Receive	0x00 (stat_OK) or error code	1
Description	Performs mifare authentication with given keys	

PICC_READ	Send	Len
Transmit	0x15	1
	Block number (0x00-0x3F)	1
Receive	0x00 (stat_OK) or error code	1
	DATA[0]-DATA[15]	16
Description	Read 16 bytes from mifare block	

PICC_WRITE	Send	Len
Transmit	0x16	1
	Block number (0x00-0x3F)	1
	DATA[0]-DATA[15]	16
Receive	0x00 (stat_OK) or error code	1
Description	Write 16 bytes to mifare block	

PICC_WRITE4	Send	Len
Transmit	0x17	1
	Block number	1
	DATA[0]-DATA[3]	4
Receive	0x00 (stat_OK) or error code	1
Description	Write 4 bytes to mifare ultralight block	

PICC_VALUE	Send	Len
Transmit	0x18	1
	MODE 0xC0: Decrement 0xC1: Increment 0xC2: Restore	1

	ADDRESS (0x00-0x3F)	1
	VALUE[0]-VALUE[3]	4
	TRANSFER_ADDR (0x00-0x3F)	1
Receive	0x00 (stat_OK) or error code	1
Description	Perform a value operation	

PCD_LOADKEYE2	**Send**	**Len**
Transmit	0x1E	1
	KEY_TYPE 0x60: Key A 0x61: Key B	1
	SECTOR (0x00-0x0F)	1
	DATA[0]-DATA[5]	6
Receive	0x00 (stat_OK) or error code	1
Description	Load given keys in PCD's secure eeprom	

3.7 ISO15693 Vicinity Commands (+Optional)

VCD_INIT	**Send**	**Len**
Transmit	0xD0	1
Receive	0x00 (stat_OK) or error code	1
Description	Initializes the vicinity interface	

VCD_KILL	**Send**	**Len**
Transmit	0xD1	1
Receive	0x00 (stat_OK) or error code	1
Description	Hard power down of the VCD. The RF part of the reader will be switched off.	

VICC_INVENTORY	**Send**	**Len**
Transmit	0xD2	1
Receive	0x00 (stat_OK) or error code	1
	UID[0]..UID[7]	8
Description	This command is an inventory request. It returns the UID of the VICC.	

VCD_SELECT	**Send**	**Len**
Transmit	0xD3	1
Receive	0x00 (stat_OK) or error code	1
Description	Selects the last UID	

VICC_GET_SYSTEM_INFO	**Send**	**Len**
Transmit	0xD4	1
Receive	0x00 (stat_OK) or error code	1
	AFI DSFID BLOCKS BYTES_PER_BLOCK RFU	1 1 1 1 1
Description	This command get the system information of the VICC.	

VICC_READ_BLOCK	**Send**	**Len**
Transmit	0xD5	1
	BLOCK_NR	1
Receive	0x00 (stat_OK) or error code	1
	DATA[0]..DATA[n] (n: block size)	n
Description	Read a byte from PCD's given register.	

VICC_WRITE_BLOCK	Send	Len
Transmit	0xD6	1
	BLOCK_NR	1
	DATA[0]..DATA[n] (n: block size)	n
Receive	0x00 (stat_OK) or error code	1
Description	Write a byte to PCD's given register.	

VICC_SEND_BLOCK	Send	Len
Transmit	0xD7	1
	DATA[0]-DATA[n]	n
Receive	0x00 (stat_OK) or error code	1
	RCVDATA[0]-RCVDATA[n]	n
Description	Transparent communication (ISO15693) Read block example: 22200D55A32F500104E000 (FLAG+CMD+UID+BLOCK) Answer: 0000000000 (STATUS+BLOCKDATA)	

4 READER RESPONSE MESSAGES

The reader sends in some cases automatic messages to inform the host. To distinguish the events from the response messages, the status bytes are divided into two areas. The status values from 0x00 to 0x2F are reserved to status codes for command responses. All other values greater than 0x30 are considered as event reports.

4.1 Status Codes <0x30

Codes which are returned as command status.

Status	Code	Description
stat_OK	0x00	Command successfully performed
stat_NO_TAG_ERR	0x01	No tag in the field or no response
stat_COLL_ERR	0x02	There is more than one tag in the field. According to the EMVCo specifications, an error during the activation is also considered as a collision
stat_AUTH_ERR	0x03	mifare sector authentication error
stat_PROTOCOL_ERR	0x04	Protocol error will be reported when the coding of the frame is not compliant to the EMVCo specifications
stat_TRANSMISSION_ERR	0x05	Transmission error will be reported when the received frame includes; crc error, parity error, coding error, framing error or bit count error. This error mostly happens when the tag enters the operating field. While polling about every 10ms, the reader can catch the tag outside the safe operating distance. In this case, an RF reset and a second activation should be performed
stat_TIMEOUT_ERR	0x06	Timeout error will be reported when the tag doesn't answer to the APDU. In this case the tag should be reactivated
stat_BUFFER_OVERFLOW_ERR	0x07	The received frame is too long
stat_ADR_OVERFLOW_ERR	0x08	The given address + length overflows
stat_UNKNOWN_CMD	0x09	This command is not supported
stat_ERROR	0x0A	Non categorized error
stat_COMM_TIMEOUT	0x0B	Communication timeout
stat_BOOT_ERROR	0x0D	Non categorized boot command error
stat_BOOT_OVERFLOW	0x0E	Boot command length or address overflows
stat_BOOT_TIMEOUT	0x0F	Boot command timeout error
stat_NO_USER_CODE	0x10	User firmware doesn't exists
stat_INVALID	0x11	Invalid operation
stat_NO_DATA	0x12	No magnetic data decoded
stat_UNAVAILABLE	0x13	Cannot perform this command
stat_PICC_ACK	0x14	Contactless tag is detected (Legacy support)
stat_BCC_ERROR	0x16	Received frame has a wrong BCC

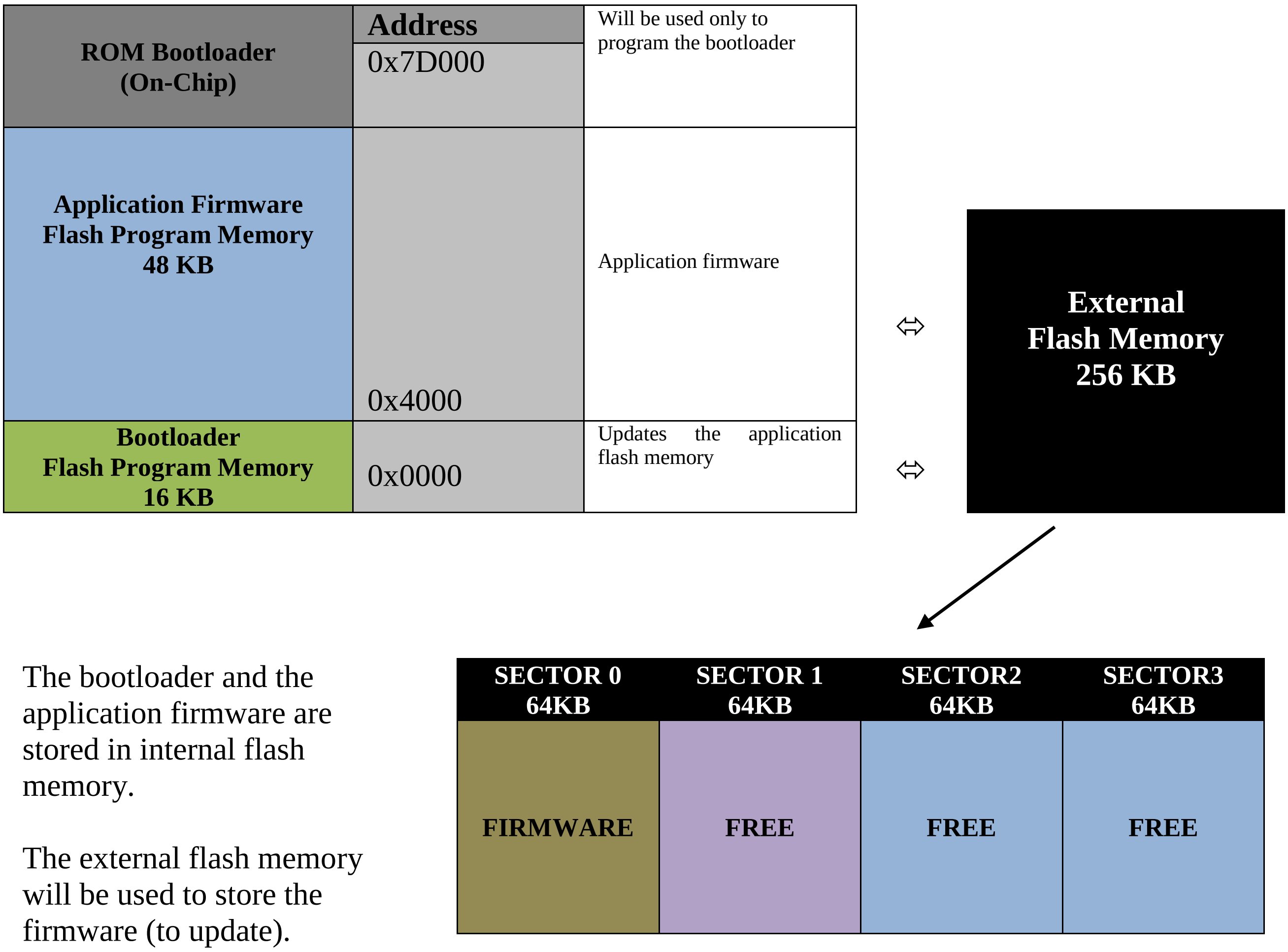
4.2 Event Codes >0x30

Event	Code	Description
event_REMOVED	0x30	Contactless tag is removed
event_PICC_ACK	0x31	Contactless tag is detected
event_PICC_PPSE	0x3F	Contactless card detected and activated
event_LOG_DATA	0x40	Log output

<table>
<tr><th>event_PICC_ACK</th><th>Send</th><th>Len</th></tr>
<tr><td rowspan="3"><b><i>Sent by the Reader</i></b></td><td>0x14: PICC_ACK (Legacy support)
0x31: PICC_ACK
0x30: PICC_REMOVED</td><td>1</td></tr>
<tr><td>TAG_INFO
<table>
<tr><td>SL3</td><td>SL2</td><td>SL1</td><td>SL0</td><td>COLL</td><td>ISO4</td><td>TYPE</td><td>AA</td></tr>
<tr><td>BIT 7</td><td>BIT 6</td><td>BIT 5</td><td>BIT 4</td><td>BIT 3</td><td>BIT 2</td><td>BIT 1</td><td>BIT 0</td></tr>
</table>
AA: Activated antenna. 0 for Ant1 and 1 for Ant2
TYPE: Detected PICC type. 0 for Type A PICC and 1 for Type B/C PICC
ISO4: ISO14443-4 compliant PICC
COLL: Collision detected, at least one more tag in the field
SL: UID length (default: 4, extended UID: 7 or 10)</td><td>1</td></tr>
<tr><td>UID[0]-UID[n]</td><td>n</td></tr>
<tr><td><b><i>Description</i></b></td><td colspan="2">PICC acknowledged or PICC removed</td></tr>
</table>

5 FLASH LAYOUT AND FIRMWARE UPDATE

The internal flash memory of the microcontroller and the external flash memory are divided into several sections to store the required data and the firmware.



	Address	
ROM Bootloader (On-Chip)	0x7D000	Will be used only to program the bootloader
Application Firmware Flash Program Memory 48 KB	0x4000	Application firmware
Bootloader Flash Program Memory 16 KB	0x0000	Updates the application flash memory

SECTOR 0 64KB	SECTOR 1 64KB	SECTOR2 64KB	SECTOR3 64KB
FIRMWARE	FREE	FREE	FREE

The bootloader and the application firmware are stored in internal flash memory.

The external flash memory will be used to store the firmware (to update).

Only sector or bulk erases are supported on the flash memories.

5.1 FLASH Commands

In contrast to the FRM and CFG flash commands; these commands can be applied for the entire flash memory.

MEMORY_READ	Send	Len
Transmit	0x47	1
	ADDR[0]-ADDR[2] (MSB first) Value between 0x00000-0x3FFFF	3
	LEN[0]-LEN[1] (MSB first) Value between 0x0000-0x0400	2
Receive	0x00 (stat_OK) or error code	1
	DATA[0]-DATA[n]	n
Description	Read the external flash.	

MEMORY_WRITE	Send	Len
Transmit	0x46	1
	ADDR[0]-ADDR[2] (MSB first) Value between 0x00000-0x3FFFF	3
	LEN[0]-LEN[1] (MSB first) Value between 0x0000-0x0400	2
	DATA[0]-DATA[n]	n
Receive	0x00 (stat_OK) or error code	1
Description	Program the external flash.	

MEMORY_ERASE	Send	Len
Transmit	0x4D	1
	SECTOR 0x00: Sector 0 (CONFIG1) 0x01: Sector 1 (CONFIG2) 0x02: Sector 2 (FIRMWARE) 0x03: Sector 3 (FIRMWARE) 0xA0: Bulk erase (Erase all)	1
Receive	0x00 (stat_OK) or error code	1
Description	Erase the selected sector of the external flash.	

5.1.1 FIRMWARE Commands

These commands apply only to the firmware sectors.

FRM_MEM_READ	Send	Len
Transmit	0x35	1
	ADDR[0]-ADDR[2] (MSB first) Value between 0x00000-0x1FFFF	3
	LEN[0]-LEN[1] (MSB first) Value between 0x0000-0x0400	2
Receive	0x00 (stat_OK) or error code	1
	DATA[0]-DATA[n]	n
Description	Read the external flash, starting from the FIRMWARE offset.	

FRM_MEM_WRITE	Send	Len
Transmit	0x34	1
	ADDR[0]-ADDR[2] (MSB first) Value between 0x00000-0x1FFFF	3
	LEN[0]-LEN[1] (MSB first)	2

	Value between 0x0000-0x0400	
	DATA[0]-DATA[n]	n
Receive	0x00 (stat_OK) or error code	1
Description	Program the external flash, starting from the FIRMWARE offset.	

FRM_MEM_ERASE	**Send**	**Len**
Transmit	0x36	1
Receive	0x00 (stat_OK) or error code	1
Description	Erase the FIRMWARE sectors of the external flash.	

5.2 Bootloader

The bootloader is a piece of code which allows user’s application code to be updated from the external flash memory. It must be pre-programmed via the ISP interface.

After each power on, the bootloader checks the external flash for a new firmware. If a new firmware is detected, it checks the length, ID and the checksum of the firmware and programs it into the flash. If no new firmware exists, the application firmware will be executed immediately.

In case of both internal and external firmware areas are bulk, the bootloader opens the USB interface to communicate with the host and to load a new firmware.

5.2.1 Firmware Update Sequence

Firmware update sequence:

1- Erase the firmware sectors with FRM_MEM_ERASE
2- Program the new firmware with FRM_MEM_WRITE
3- Execute a reset with MODULE_RESET
4- Wait 10 seconds

After reset, the bootloader programs the new firmware into the internal flash memory of the microcontroller and runs it.

6 COMMUNICATION EXAMPLES

Each byte is represented as a two character hexadecimal number.

6.1.1 Request Example

TX: 01 00 00 02 **10 52** 40 // SOH + Add + Len (2B) + DATA (2B) + BCC
RX: 01 00 00 03 **00 04 00** 07 // SOH + Add + Len (2B) + DATA (3B) + BCC

10 52: Request command + Request all

00 04 00: Command status + Request Code

6.1.2 Reading Example

- **Initialise the contactless interface:** Send PCD_TYPEA_INIT command.

TX: 01 00 00 01 **20** 20 // SOH + Add + Len (2B) + DATA (1B) + BCC
RX: 01 00 00 01 **00** 00 // SOH + Add + Len (2B) + DATA (1B) + BCC

After a successful init, the 13.56 MHz carrier signal is switched on.

- **Request a card:** Send PICC_REQUEST command.

TX: 01 00 00 02 **10 52** 41
RX: 01 00 00 03 **00 04 00** 06 // Status = 00, card is present
or
RX: 01 00 00 03 **FF 00 00** FD // Status = FF, no card

- **Get the serial number:** Send PICC_ANTICOL command.

TX: 01 00 00 03 **11 93 00** 80
RX: 01 00 00 05 **00 D1 40 CE A2** F9 // Status = 00, card serial 0xA2CE40D1

- **Select the card:** Send PICC_SELECT command.

TX: 01 00 00 06 **12 93 D1 40 CE A2** 7B
RX: 01 00 00 02 **00 88** 2B // Status = 00, select code 0x88

- **Authenticate KeyA sector 0:** Send PICC_AUTHENTKEY command.

TX: 01 00 00 09 **14 60 FF FF FF FF FF FF 03** 7F // Sector trailer address = 3
RX: 01 00 00 01 **00** 00 // Status = 00

- **Read block 1:** Send PICC_READ command.

TX: 01 00 00 02 **15 01** 17

RX: 01 00 00 11 **00 FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF** 10

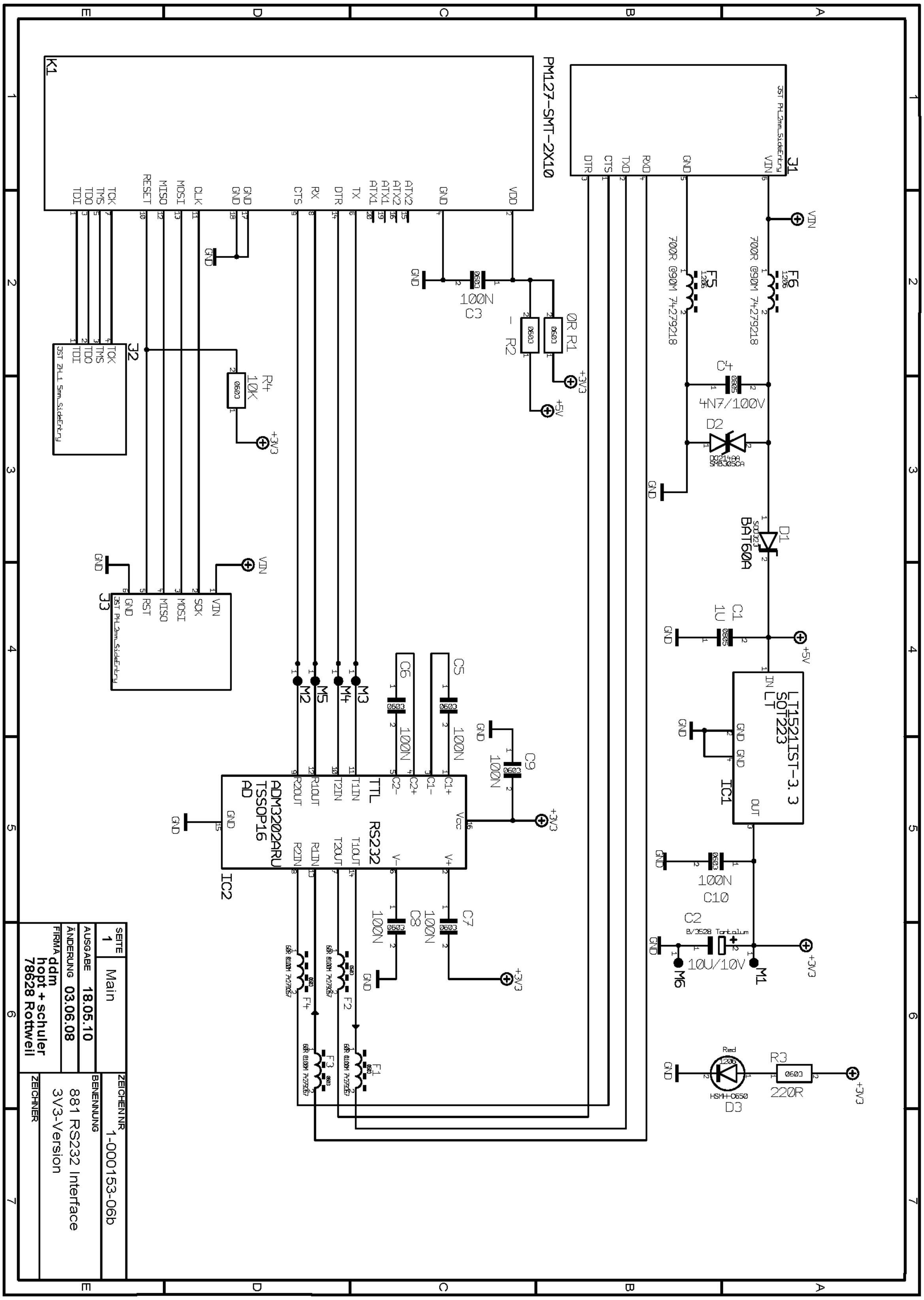
- **Close the contactless interface:** Send PICC_RESET command.

TX: 01 00 00 01 **1F** 1F
RX: 01 00 00 01 **00** 00 // Status = 00

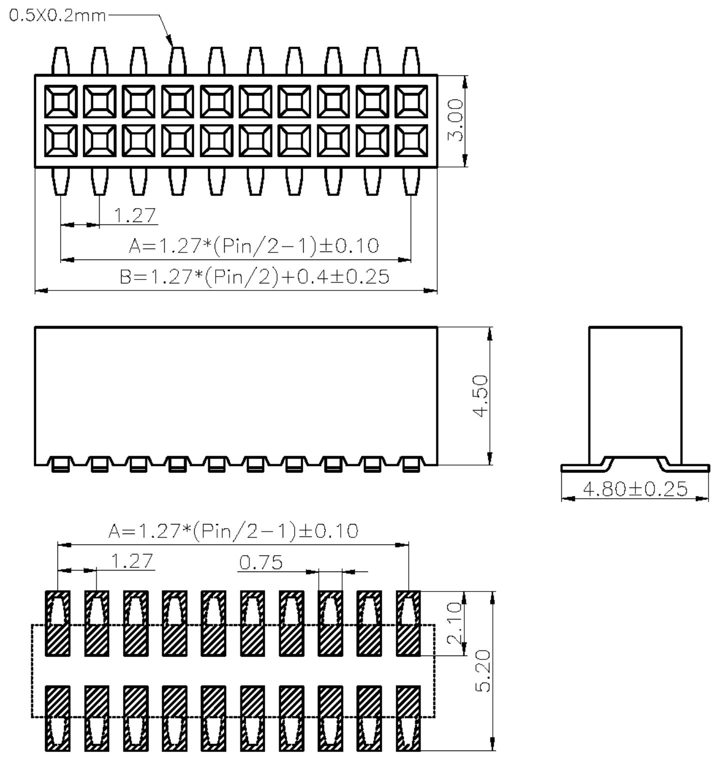
After this command, the 13.56 MHz carrier signal will be switched off and the reader will be kept in RESET state.

7 APPENDIX

7.1 RS232 INTERFACE SCHEMATIC



7.2 Module SMT Socket Header Datasheet



TECHNICAL CHARACTERISTICS

MATERIAL
INSULATOR: NYLON 6T
COLOR: BLACK
CONTACT MATERIAL: COPPER ALLOY
CONTACT TYPE: STAMPED
CONTACT PLATING: GOLD
QUALITY CLASS: 3 AS PER CECC 75 301-802
PITCH: 1.27MM

ENVIRONMENTAL
OPERATING TEMPERATURE: -40 UP TO 125°C
FLAMABILITY RATING: UL94-V0
COMPLIANCE: LEAD FREE AND ROHS

ELECTRICAL
CURRENT RATING: 1A MAX
WORKING VOLTAGE: 50V AC
INSULATOR RESISTANCE: >1000 MOHM
DIELECTRIC WITHSTANDING VOLTAGE: 500V AC/MN
CONTACT RESISTANCE: 20 mOHM MAX

SOLDERING
REFLOW PROCESS ONLY

PACKAGING
TUBE

DIMENSION
A = 1.27 x (NB. PIN - 1)
B = 1.27 x (NB. PIN / 2) + 0.40

RoHS Compliant

REV	DATE	FILE	BY
G			
F			
E			
D	23-NOV-07	MODIFICATIONS	EC
C	19-DEC-06	DRAW	EC
B	31-MAR-04	LEAD FREE	JP
A	12-JUN-01	PDF	JP

PROJECTION:

APPROVAL: RJ

GENERAL TOLERANCE
.X = +/- 0.2
.XX = +/- 0.15

UNIT: MM
SCALE:
SHEET: 1/1
DRAW: PEARL

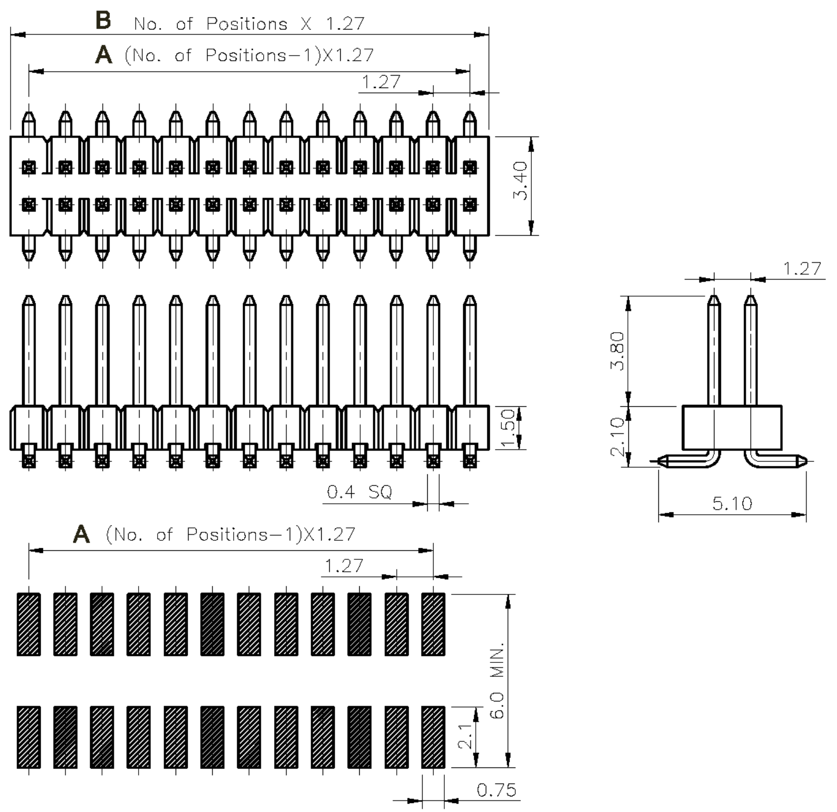
WÜRTH ELEKTRONIK

DESCRIPTION: 1.27MM DUAL SMT SOCKET HEADER H=4.50MM

WERI PART NO: 6230 xx 21021

SIZE
A4

7.3 Recommended Host Side SMT Header


B No. of Positions X 1.27
A (No. of Positions−1)X1.27
1.27
3.40
1.50
0.4 SQ
1.27
3.80
2.10
5.10
A (No. of Positions−1)X1.27
1.27
6.0 MIN.
2.1
0.75

TECHNICAL CHARACTERISTICS

MATERIAL
INSULATOR: NYLON 6T
COLOR: BLACK
CONTACT MATERIAL: COPPER ALLOY
CONTACT TYPE: STAMPED
CONTACT PLATING: GOLD
QUALITY CLASS: 3 AS PER CECC 75 301-802
PITCH: 1.27MM

ENVIRONMENTAL
OPERATING TEMPERATURE: -40 UP TO 125°C
FLAMABILITY RATING: UL94-V0
COMPLIANCE: LEAD FREE AND ROHS

ELECTRICAL
CURRENT RATING: 1A MAX
WORKING VOLTAGE: 50V AC
INSULATOR RESISTANCE: >1000 MOHM
DIELECTRIC WITHSTANDING VOLTAGE: 500V AC/MN
CONTACT RESISTANCE: 20 mOHM MAX

SOLDERING
REFLOW PROCESS ONLY

PACKAGING
TUBE

DIMENSION
A = 1.27 x (NB. PIN - 1)
B = 1.27 x NB. PIN

RoHS Compliant

REV	DATE	FILE	BY
G			
F			
E			
D	23-NOV-07	MODIFICATIONS	EC
C	19-DEC-06	DRAW	EC
B	31-MAR-04	LEAD FREE	JP
A	03-AUG-01	PDF	JP

PROJECTION:

APPROVAL: RJ

GENERAL TOLERANCE
.X = +/- 0.2
.XX = +/- 0.15

UNIT: MM
SCALE:
SHEET: 1/1
DRAW: PEARL

WÜRTH ELEKTRONIK

DESCRIPTION: 1.27MM DUAL SMT PIN HEADER H=3.80MM

WERI PART NO: 6210 xx 21021

SIZE A4

8. Important Remarks for using the device in U.S.A. and Canada

Changes or modifications made to the equipment not expressly approved by ddm hopt + schuler gmbh + co. KG may void the FCC / IC authorization to operate this equipment.

The use of the transceiver module is authorized in mobile or fixed host devices taking into account the conditions listed below:

- *OEM Integrator must ensure that the end user manual may not contain any information about the way to install or remove the module from the final product.*
- *Depending on the final host device additional authorization requirements for the non-transmitter functions of the transmitter module may be required (i.e., Verification, or Declaration of Conformity) The OEM integrator is responsible for ensuring that after the module is installed and operational the host continues to be compliant with the Part 15B unintentional radiator requirements.*
- *The information on the label and in the user manual is required to be incorporated in the user manual of the final host. see 47 CFR15 requirements for more details (e.g. 15.19 / 15.21 / 15.101 / 15.105 / RSS-GEN / ICES)*
- *Additional label with the words ‘Contains FCC ID:* ***2AJ4J-reader881****’ and ‘Contains IC:* ***22050-reader881****’ shall be applied and visible from the outside of the host product.*
- *The module must be installed and used in strict accordance with the manufacturer’s instructions as described in the user documentation that comes with the module.*
- *The end user manual for the final host product operating with this transmitter must include operating instructions to satisfy RF exposure compliance requirements.*

Radiofrequency radiation exposure Information:
This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance of 20 cm between the radiator and your body.
This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Cet équipement est conforme aux limites d'exposition aux rayonnements IC établies pour un
environnement non contrôlé. Cet équipement doit être installé et utilisé avec un minimum de
20 cm de distance entre la source de rayonnement et votre corps.

- *The antenna of the module may not be removed, replaced nor modified. The antenna must not be co-located or operating in conjunction with any other antenna or transmitter. No additional antenna must be used.*

- *When the final host product operating with this transmitter deviate from above, installation of this module into specific final hosts may require the submission of a Class II permissive change application containing data pertinent to RF Exposure, spurious emissions, ERP/EIRP, and host/module authentication, or new application if appropriate.*
  Feel free to contact us if additional guidance is required.