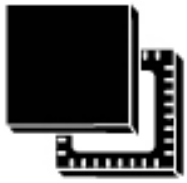
CR95HF

13.56-MHz multi-protocol contactless transceiver IC with SPI and UART serial access

Preliminary data

Features

- Operating modes supported:
  - Reader/Writer
- Hardware features
  - Dedicated internal frame controller
  - Highly integrated Analog Front End (AFE) for RF communications
  - Transmission and reception modes
  - Optimized power management
  - Tag Detection modes
- RF communication @13.56 MHz
  - ISO/IEC 14443 A and B
  - ISO/IEC 15693
  - ISO/IEC 18092
- Communication interfaces with a Host Controller
  - Serial peripheral interface (SPI) Slave interface
  - Universal asynchronous receiver/transmitter (UART)
- 32-pin VFQFPN (5 x 5 mm) ECOPACK® package



VFQFPN32 5x5 mm

Applications

Typical protocols supported:

- ISO/IEC 14443-3 Type A and B cards and tags
- ISO/IEC 15693 and ISO/IEC 18000-3M1 tags
- NFC forum tag: Types 2, 3 and 4
- ST Dual Interface EEPROM

Contents

1 Description

The CR95HF is an integrated transceiver IC for contactless applications.

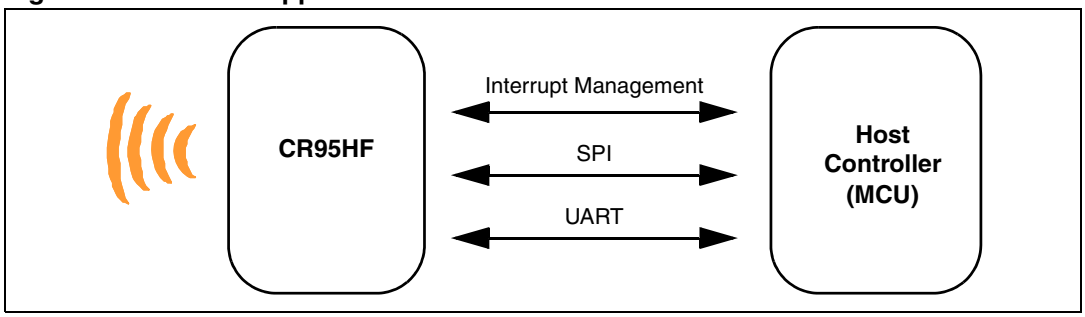
The CR95HF manages the frame coding and decoding in Reader mode for standard applications such as NFC, proximity and vicinity standards.

The CR95HF embeds the Analog Front End for 13.56 MHz Air Interface.

The CR95HF supports ISO/IEC 14443 A and B, ISO/IEC 15693 (single or double subcarrier) and ISO/IEC 18092 protocols.

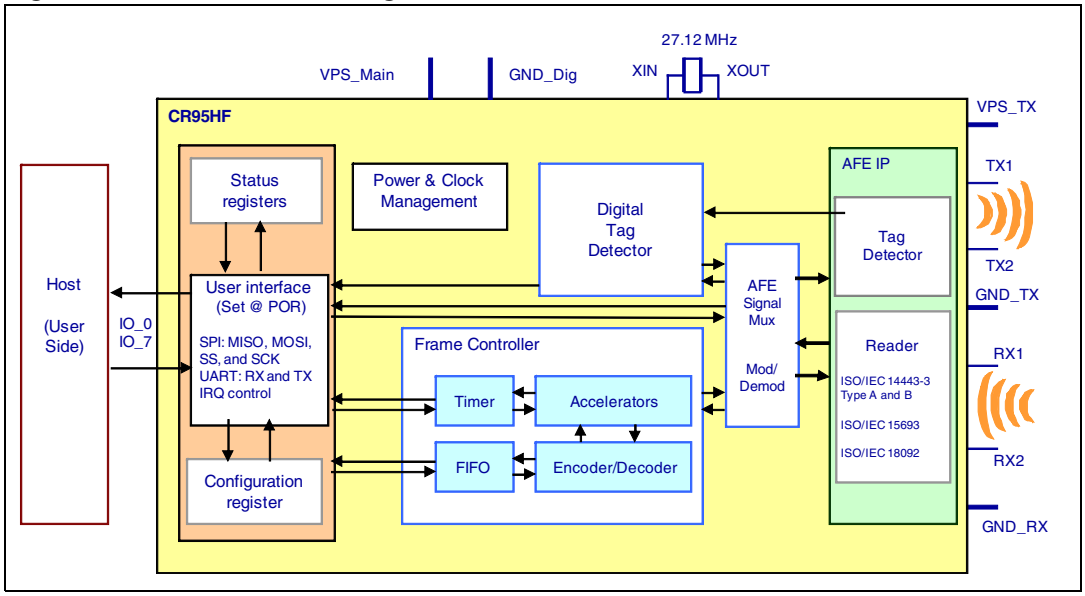
In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: *www.st.com*. ECOPACK® is an ST trademark.

Figure 1. CR95HF application overview



1.1 Block diagram

Figure 2. CR95HF block diagram



2 Pin and signal descriptions

Figure 3. Pinout description

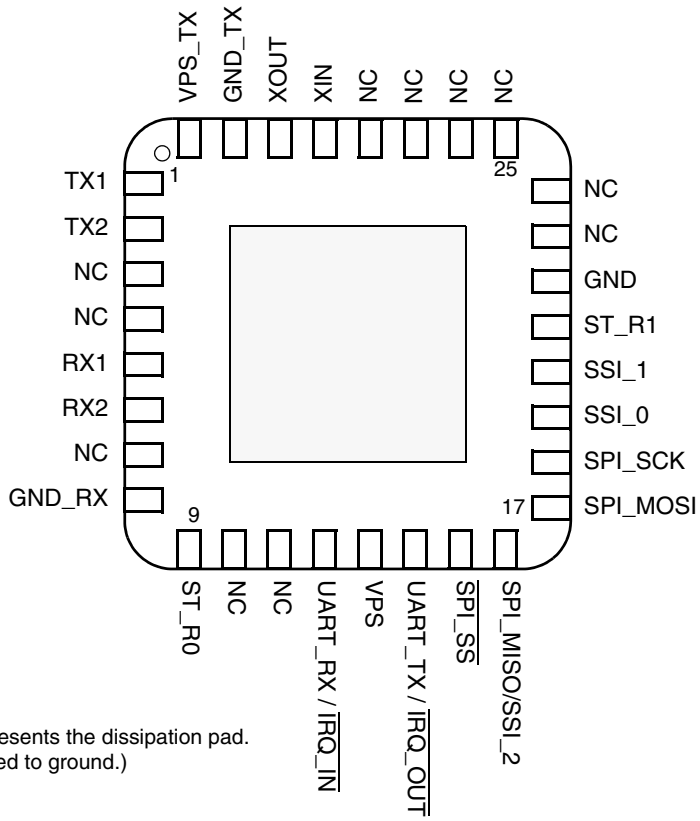


Table 1. Pin descriptions

Pin	Pin name	Type	Main function	Alternate function
1	TX1	O	Driver output_1	
2	TX2	O	Driver output_2	
3	NC		Not connected	
4	NC		Not connected	
5	RX1	I	Receiver input_2	
6	RX2	I	Receiver input_1	
7	NC		Not connected	
8	GND_RX	P	Ground (analog)	
9	ST_R0	O	ST Reserved(1)	
10	NC		Not connected	
11	NC		Not connected	
12	UART_RX / $\overline{\text{IRQ\_IN}}$	I	UART receive pin	Interrupt input
13	VPS	P	Main power supply	
14	UART_TX / $\overline{\text{IRQ\_OUT}}$	O	UART transmit pin	Interrupt output

Table 1. Pin descriptions (continued)

Pin	Pin name	Type	Main function	Alternate function
15	$\overline{\text{SPI\_SS}}$	I	SPI Slave Select (active low)	
16	SPI_MISO/SSI_2	O	SPI Data, Slave Output	
17	SPI_MOSI	I	SPI Data, Slave Input	
18	SPI_SCK	I	SPI serial clock	
19	SSI_0	I	Select serial communication interface	
20	SSI_1	I	Select serial communication interface	
21	ST_R1	I	ST Reserved (2)	
22	GND	P	Ground (digital)	
23	NC		Not connected	
24	NC		Not connected	
25	NC		Not connected	
26	NC		Not connected	
27	NC		Not connected	
28	NC		Not connected	
29	XIN		Crystal oscillator input	
30	XOUT		Crystal oscillator output	
31	GND_TX	P	Ground (RF drivers)	
32	VPS_TX	P	Power supply (RF drivers)	

1. Must add a capacitor to ground.
2. Must be connected to V_{PS}.

3 Power management and operating modes

3.1 Operating modes

The CR95HF has 2 operating modes: Idle and Active. In Active mode, the CR95HF communicates actively with a tag or an external MCU. Idle mode includes two low consumption states: Hibernate and Tag Detector.

The CR95HF can switch from one mode to another.

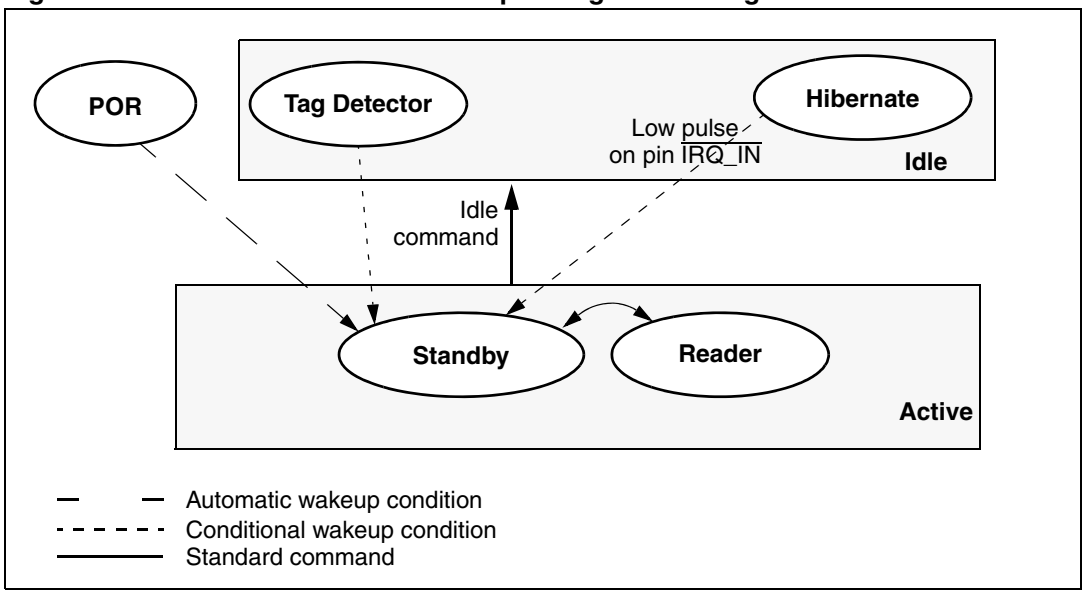
Table 2. Operating modes

Mode	State	Description
Idle	Hibernate	Lowest power consumption. CR95HF has to be waken-up in order to communicate. Low level on $\overline{\text{IRQ\_IN}}$ pin is the only wakeup source.
	Tag Detector	Low power consumption, Tag detection. Wakeup source is configurable: – Timer – $\overline{\text{IRQ\_IN}}$ pin – $\overline{\text{SPI\_SS}}$ pin – Tag detector LFO (low-frequency oscillator) is running in this state.
Active	Standby or Reader	Main communication mode. HFO (high-frequency oscillator) is running, CR95HF is able to decode and execute commands from external MCU. It can switch the reader ON and OFF and communicate with a tag or an external MCU.

Hibernate and Tag-Detector states can only be activated by a command from the external MCU. As soon as any of these states are activated, the CR95HF can no longer communicate with the external MCU. It can only be woken up.

The behavior of the CR95HF in 'Tag-Detector' state is defined by the Idle command.

Figure 4. CR95HF initialization and operating state change



3.2 Startup sequence

At power-on, the CR95HF automatically selects the external interface (SPI or UART) and enters Standby.

Table 3 lists the signal configuration used to select the serial communication interface.

Table 3. Select serial communication interface selection table

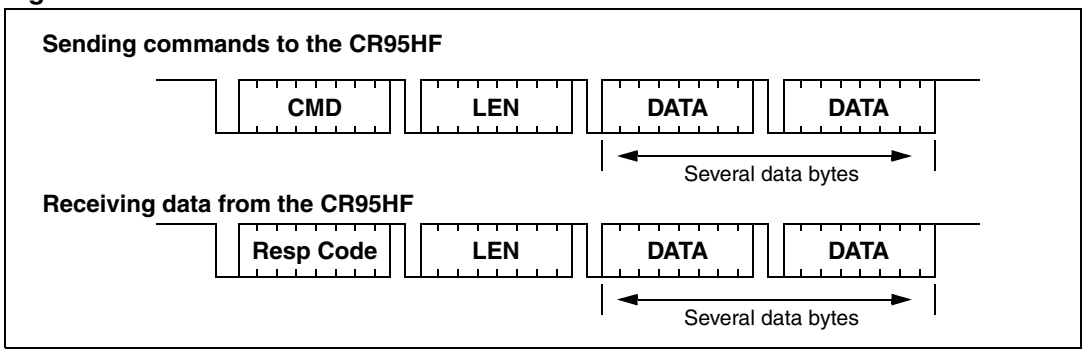
Pin	UART	SPI
SSI0	0	1
SSI1	0	0
SSI2	0	0

4 Communication protocols

4.1 Universal asynchronous receiver/transmitter (UART)

Application sends commands to the CR95HF and waits for replies. Polling for readiness is not necessary. The baud rate by default is 57600 baud. The maximum allowed baud rate is 2 Mbps.

Figure 5. UART communication



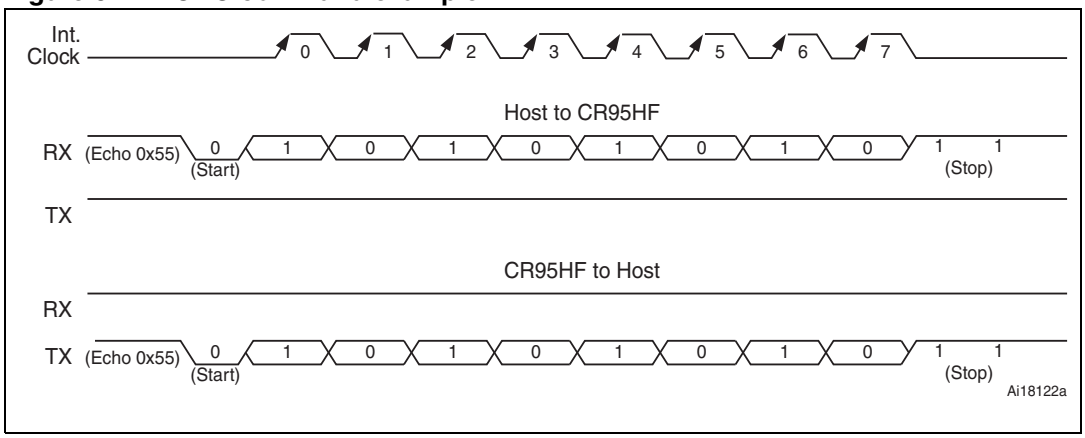
The value of the 'Length' field can be zero. In this case, no data must be sent.

The formats of send and receive packets are almost identical.

If an ECHO command is sent, only one byte (0x55) is sent.

Figure 6 shows an example of an ECHO command.

Figure 6. ECHO command example



Caution: UART communication is LSB first. Stop bit duration is two Elementary Time Units (ETUs).

4.2 Serial peripheral interface (SPI)

4.2.1 Polling mode

In order to send commands and receive replies, the application software has to pass 3 stages.

- Send the command to the CR95HF.
- Poll the CR95HF until it is ready to transmit the response.
- Read the response.

The application software should never read the CR95HF without being sure that the CR95HF is ready to send the response.

The maximum allowed communication speed is 2.2 MHz.

A Control byte is used to specify a communication type and direction:

– 00: Sending command to the CR95HF
– 11: Polling the CR95HF
– 10: Reading data from the CR95HF
– 01: Reset the CR95HF

The $\overline{\text{SPI\_SS}}$ line is used to select a device in common SPI bus. The $\overline{\text{SPI\_SS}}$ active level is LOW.

When the $\overline{\text{SPI\_SS}}$ line is inactive, all data sent by the Master will be ignored and the MISO line will be kept in High impedance.

Figure 7. Sending command to CR95HF

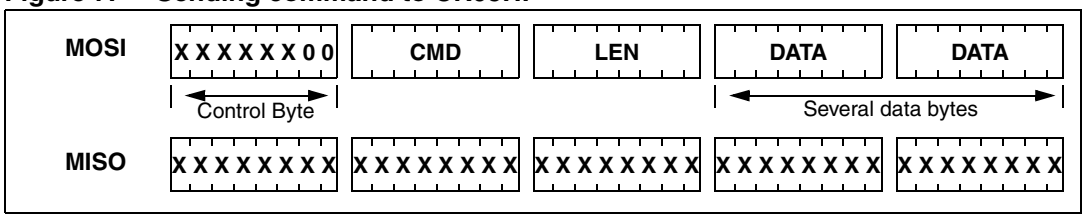


Figure 8. Polling the CR95HF until it is ready

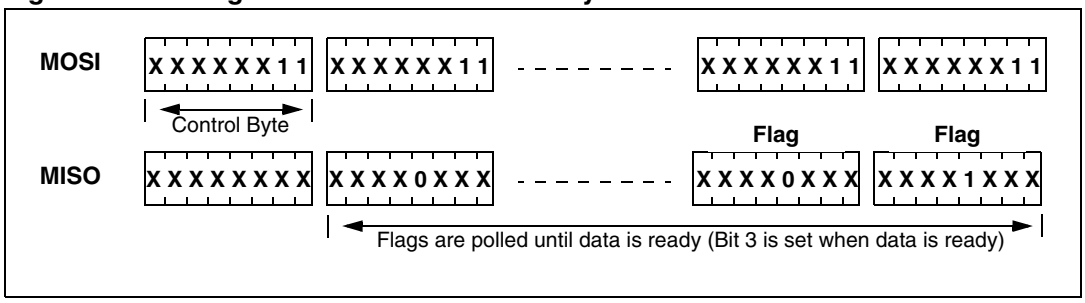
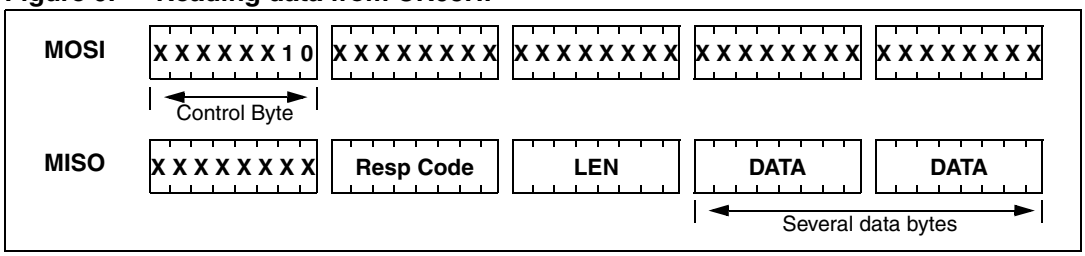


Table 4. Interpretation of flags

Bit	Value (CR95HF point of view)	Meaning (Application point of view)
[7:4]	RFU	
3	SendSize ≠ 0	Data can be read from the CR95HF when set.
2	RecvSize ≠ 0	Data can be sent to the CR95HF when set.
[1:0]	ST Reserved	

Figure 9. Reading data from CR95HF



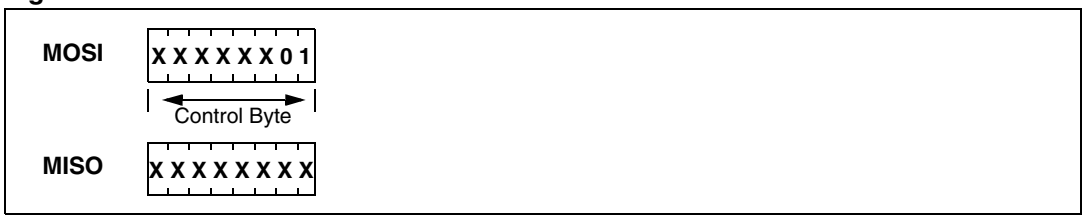
Data must be sampled by the rising edge of the SCK signal.

'Sending', 'Polling' and 'Reading' commands must be separated by a high level of the $\overline{\text{SPI\_SS}}$ line. For example, when the application needs to wait for data from the CR95HF, it asserts the $\overline{\text{SPI\_SS}}$ line low and issues a 'Polling' command. Keeping the $\overline{\text{SPI\_SS}}$ line low, the MCU can read the Flags waiting bit which indicates that the CR95HF can be read. Then, the application has to assert the $\overline{\text{SPI\_SS}}$ line high to finish the polling command. The MCU asserts the $\overline{\text{SPI\_SS}}$ line low and issues a 'Reading' command to read data. When all data is read, the application asserts the $\overline{\text{SPI\_SS}}$ line high.

The application is not obliged to keep reading Flags using the Polling command until the CR95HF is ready in one command. It can issue as many 'Polling' commands as necessary. For example, the application asserts $\overline{\text{SPI\_SS}}$ low, issues 'Polling' commands and reads Flags. If the CR95HF is not ready, the application can assert $\overline{\text{SPI\_SS}}$ high and continue its algorithm (measuring temperature, communication with something else). Then, the application can assert $\overline{\text{SPI\_SS}}$ low again and again issue 'Polling' commands, and so on, as many times as necessary, until the CR95HF is ready.

Note that at the beginning of communication, the application does not need to check flags [2] to start transmission. The CR95HF is assumed to be ready to receive a command from the application.

Figure 10. Reset the CR95HF



Control byte 01 resets the internal controller and the CR95HF enters Idle mode. The CR95HF will wakeup when pin $\overline{\text{IRQ\_IN}}$ goes low.

Caution: SPI communication is MSB first.

4.2.2 IRQ mode

When the CR95HF is ready to send back a response, it sends an Interrupt Request, a low pulse on pin $\overline{\text{IRQ\_OUT}}$. The application can use this request and skip the polling stage.

Caution: SPI communication is MSB first.

5 Commands

5.1 Command format

Fields <Cmd>, <RespCode> and <Len> are always 1 byte long. <Data> can be from 0 to 255 bytes.

- Direction: MCU to CR95HF

  `<CMD><Len><Data>`

- Direction: CR95HF to MCU

  `<RespCode><Len><Data>`

Note: EchoCode is an exception as it has only one byte (0x55).

5.2 List of commands

Table 5 lists the command set available for standard use.

Table 5. List of commands

Code	Command	Description
01	IDN	Requests short information about CR95HF and its firmware version.
02	Protocol Select	Select communication protocol and specify some protocol-related parameters.
04	SendRecv	Sends data using previously selected protocol and receives the tag response.
07	Idle	Switches the CR95HF into TagDetect or Hibernate state and specifies under which condition to exit from these states.
08	RdReg	Reads wakeup flags.
0A	BaudRate	Sets UART baud rate.
55	EchoCode	Performs a serial interface echo.
Other codes		ST Reserved

5.3 Commands

01: IDN

This command gives brief information about the CR95HF and the internal firmware version.

Table 6. IDN command description

Direction	Data	Comments	Example
MCU – CR95HF	01	Command code	0100
	00	Length of data	
CR95HF - MCU	00	Result code	000F4E4643204653324A4153543000 A998 Here 4E4643204653324A4153543000: 'NFC FS2JAST0', #0 A998: CRC of ROM (real CRC can differ from illustrated here)
	<Len>	Length of data	
	<Device ID>	Data in ASCII format	
	<ROM CRC>	CRC calculated for ROM content	

It takes approximately 6 ms to calculate the CRC for an entire ROM. The application must allow sufficient time for waiting for a response for this command.

02: Protocol Select

This command selects the communication protocol and prepares the CR95HF for communication.

Table 7. Protocol Select command description

Direction	Data	Comments	Example
MCU – CR95HF	02	Command code	See *Table 8: Parameter list for different protocols on page 14* for a detailed example.
	<Len>	Length of data	
	<Protocol>	Protocol codes 00: Field OFF 01: ISO-15693 02: ISO-14443-A 03: ISO-14443-B 04: Felica	
	<Parameters>	Each protocol has a different set of parameters. See *Table 8*.	
CR95HF - MCU	00	Result code	0000 Protocol is successfully selected
	00	Length of data	
CR95HF - MCU	82	Error code	8200 Invalid command length
	00	Length of data	
CR95HF - MCU	83	Error code	8300 Invalid protocol
	00	Length of data	

Note that there is no command 'Field ON'. When the application selects a communication protocol, the field turns ON.

When the application selects a protocol, the CR95HF performs all necessary settings: it will choose the appropriate reception and transmission chains, switch field ON or OFF and connect the antenna accordingly.

Different protocols have different sets of parameters. Values for the `<Parameters>` field are listed in *Table 8*.

Table 8. Parameter list for different protocols

Protocol	Code	Parameters			Examples of commands
		Byte	Bit	Function	
Field OFF	00	0	7:0	RFU	02020000
ISO-15693	01	0	7:6	RFU	H 100 S: 02 02 01 01 H 100 D: 02 02 01 03 H 10 S: 02 02 01 05 H 10 D: 02 02 01 07 L 100 S: 02 02 01 21 L 100 D: 02 02 01 23 L 10 S: 02 02 01 25 L 10 D: 02 02 01 27 In these examples, the CRC is automatically appended.
			5:4	00: 26 Kbps (H) 01: 52 Kbps 10: 6 Kbps (L) 11: RFU	
			3	0: Respect 312-µs delay 1: Wait for SOF	
			2	0: 100% modulation (100) 1: 10% modulation (10)	
			1	0: Single subcarrier (S) 1: Dual subcarrier (D)	
			0	Append CRC	
ISO-14443A	02	0	7:6	Transmission data rate 00: 106 Kbps 01: RFU 10: RFU 11: RFU	02020200: ISO-14443-A, 106 Kbps transmission, 106 Kbps reception, Time interval 86/90 Note that commands REQA, WUPA, Select20, Select70 use fixed interval of 86/90 us between request and reply. Other commands use variable interval with fixed granularity. Refer to the standard for more details.
			5:4	Reception data rate 00: 106 Kbps 01: RFU 10: RFU 11: RFU	
			3	RFU	
			2:0	RFU	
		1, 2		AFDT (optional) 2 bytes, LOW part must be sent first	The default AFDT value is 0 (corresponds to FDT 86/90 µs). 1 unit of AFDT corresponds to 8 half-bits. FDT (Frame Delay Time as defined in ISO-14443): (AFDT+1)*(1024*(1/13.56)/1000) ms

Table 8. Parameter list for different protocols (continued)

Protocol	Code	Parameters			Examples of commands
		Byte	Bit	Function	
ISO-14443B	03	0	7:6	Transmission data rate 00: 106 Kbps 01: RFU 10: RFU 11: RFU	02020301: ISO-14443-B, append CRC
			5:4	Reception data rate 00: 106 Kbps 01: RFU 10: RFU 11: RFU	
			3:1	RFU	
			0	Append CRC	
		1, 2		AFDT (optional) 2 bytes, LOW part must be sent first	The default AFDT value is 63 (corresponds to FDT ~4.8 ms, answer to ATTRIB). FDT: (AFDT+1)*(1024*(1/13.56)/1000) ms
Felica	04	0	7:6	RFU	02020411: ISO-18092, 212 Kbps, append CRC Parameter 'Slot counter' is not mandatory. If it is not present, it is assumed that SlotCounter = 00 (1 slot) If slot counter = 0x10, the CR95HF does not respect reply timings, but polls incoming data and searches a valid response during ~8.4 ms.
			5:4	00: RFU 01: 212 Kbps 10: RFU 11: RFU	
			3:1	RFU	
			0	Append CRC	
		1	7:5	RFU	
			4	Disregard slot counter 0: Respect slot counter 1: Search for the reply	
			3:0	Slot counter 0: 1 slot 1: 2 slots … F: 16 slots	

04: SendRecv

This command sends data and receives a reply.

Before sending this command, the application must select a protocol.

Table 9. SendRecv command description

Direction	Data	Comments	Example
MCU – CR95HF	04	Command code	See *Table 10: Data format for transmission on page 17* for a detailed example.
	<Len>	Length of data	
	<Data>	Data to be sent	
CR95HF - MCU	80	Result code	800F5077FE01B3000000000071718EBA00 The tag response is decoded. This is an example of an ISO-14443 ATQB response (Answer to Request Type B)
	<Len>	Length of data	
	<Data>	Data received. Interpretation depends on protocol	
CR95HF - MCU	90	Result code	900401 or 900405 (NAK) 90040A (ACK) Exception for 4-bit frames.
	04	Valid bits	
	ACK or NAK	ISO 14443-A ACK or NAK detection	
CR95HF - MCU	86	Error code	8600 Communication error
	00	Length of data	
CR95HF - MCU	87	Error code	8700 Frame wait time out or no TAG
	00	Length of data	
CR95HF - MCU	88	Error code	8800 Invalid SOF
	00	Length of data	
CR95HF – MCU	89	Error code	8900 Receive buffer overflow (too many bytes received)
	00	Length of data	
CR95HF – MCU	8A	Error code	8A00 Framing error (start bit=0, stop bit=1)
	00	Length of data	
CR95HF – MCU	8B	Error code	8B00 EGT time out (for ISO-14443-B)
	00	Length of data	
CR95HF – MCU	8C	Error code	8C00 Invalid length. Used in Felica, when field Length < 3
	00	Length of data	
CR95HF - MCU	8D	Error code	8D00 CRC error (Used in Felica protocol)
	00	Length of data	
CR95HF - MCU	8E	Error code	8E00 Reception lost without EOF received
	00	Length of data	

If the tag response was received and decoded correctly, the <Data> field can contain additional information which is protocol-specific. This is explained in *Table 10*.

Table 10. Data format for transmission

Protocol	Explanation	Response example	Comments
ISO-15693	Send example Command code Length of entire data field Data	04 03 022000	Example of an Inventory command: H 100 S: 04 03 26 01 00 H 100 D: 04 03 27 01 00 H 10 S: 04 03 26 01 00 H 10 D: 04 03 27 01 00 L 100 S: 04 03 24 01 00 L 100 D: 04 03 25 01 00 L 10 S: 04 03 24 01 00 L 10 D: 04 03 25 01 00 If length of data is Zero, only EOF will be sent. This can be used for anti-collision procedure.
ISO-14443A	Send example Command code Length of entire data field Data Transmission flags: 7: RFU 6: SplitFrame 5: append CRC 4: RFU 3:0: 8 – number of significant bits in last byte	04 07 9370800 F8C8E 28	Example of a Type A request sequence: 04 02 26 07 (REQA) *80 05 44 00 28 00 00 (ATQA)* 04 03 93 20 08 (ANTICOL CL1) *80 08 88 04 A8 D5 F1 28 00 00 (UID CL1)...* Application SW must specify how many bits to send in the last byte. If flag SplitFrame is set, CR95HF will expect 8 – <significant bit count> bits in the 1st byte during reception. Otherwise it expects 8 bits. This command is useful for anti-collision.
ISO-14443B	Send example Command code Length of entire data field Data	04 03 050000	Example of a Type B request sequence: 04 03 05 00 00 (REQB) *80 0F 50 77 FE 01 B3 00 00 00 00 00 71 71 8E BA 00 (ATQB)*
ISO18092 212/424 (Felica)	Send example Command code Length of entire data field Data	04 05 00FFFF0000	Example of a Felica request sequence: 04 05 00 FF FF 00 00 (REQC) *80 12 01 01 01 02 14 8E 0D B4 13 10 0B 4B 42 84 85 D0 FF 00 (ATQC)*

Table 11. Interpretation of <Data> field for different protocols

Protocol	Explanation	Response example	Comments
ISO-15693	Response example Result code Length of entire data field Data received from TAG Original (received) value of CRC 7:2: RFU 1: CRC error if set 0: Collision is detected if set	80 08 0000000000 77CF 00	This is a response on Read Single Block command for Iso15693 TAG. Actual TAG response is **000000000077CF**, other fields are added by the CR95HF
ISO-14443A	Response example Result code Length of entire data field Data received from TAG 7: Collision is detected 6: RFU 5: CRC error 4: parity error 3:0: shows how many significant bits are there in the first byte 7:0: Index of the first byte where collision is detected 7:4: RFU 3:0: Index of the first bit where collision is detected	80 09 80B30B8DB500 00 00 00	ISO-14443-A is bit oriented protocol, so we can receive non-integer amount of bytes. Number of significant bits in the 1st byte is the same as indicated in Send command. To calculate a position of a collision, application has to take index of byte first. Index of bit indicates a position inside this byte. Note that both indexes start from 0 and bit index can be 8, meaning that collision affected parity. Note that collision information is only valid when bit 'Collision is detected' is set.
ISO-14443B	Response example Result code Length of entire data field Data received from TAG Original (received) value of CRC 7:2: RFU 1: CRC error if set 0: RFU	80 0F 5092036A8D000000000071 71 3411 00	

Table 11. Interpretation of <Data> field for different protocols (continued)

Protocol	Explanation	Response example	Comments
Felica	Response example	80 12 01010105017B0...93 FF	801201010105017B06941004014B024F4993FF00
	Result code		
	Length of entire data field		
	Data received from TAG		
	7:2: RFU 1: CRC error if set 0: RFU		

07: Idle

This command switches the CR95HF into low consumption mode and defines the way to return to Standby.

Table 12. Idle command description

Direction	Data	Comments	Example
MCU – CR95HF	07	Command code	Example of switch from Active mode to Hibernate state: 07 0E 01 2200 0400 1800 01 000000000000
	0E	Length of data	
	<WUFlags>	Specifies a wakeup condition	
	EnterCtrlL	Settings to enter Idle mode	Example of switch from Active to Idle mode (wake-up by low pulse on IRQ_IN pin): 07 0E 08 0200 3800 1800 00 000000000000
	EnterCtrlH		
	WUCtrlL	Settings to wake-up from Idle mode	
	WUCtrlH		
	LeaveCtrlL	Settings to leave Idle mode (Default value = 0x1800)	Example of switch from Active to Idle mode (wake-up by low pulse on SPI_SS pin): 07 0E 10 0200 3800 1800 00 000000000000
	LeaveCtrlH		
	<WUPeriod>	Period of time between two tag detections	Example of wake-up by timeout (10 seconds): 07 0E 01 22 00 38 00 18 00 20 60 60 00 00 00 28
	<OscStart>	Wait time for HFO to stabilize (Default value = 0x60)	
	<DacStart>	Wait time for DAC to stabilize (Default value = 0x60)	
	<DacDataL>	Lower compare value for tag detection (1)	Example of switch from Active to Tag Detector mode (wake-up by tag detection or low pulse on IRQ_IN pin) (LFO 32 kHz in activity 250 ms, DAC oscillator 3 ms, Swing 63 pulses of 13.56 MHz): 07 0E 0A 22 00 78 01 18 00 20 60 60 18 20 3F 00 Please contact the ST Sales office for the dedicated application note.
	<DacDataH>	Higher compare value for tag detection (1)	
	<SwingsCnt>	Number of swings HF during tag detection (Default value = 0x3F)	
	<MaxSleep>	Max. number of tag detection trials before timeout (1)	

Table 12. Idle command description (continued)

Direction	Data	Comments	Example
CR95HF - MCU	00	Result code	0000 This response is sent only when CR95HF exits Idle mode.
	00	Length of data	
CR95HF - MCU	82	Error code	8200 Invalid command length
	00	Length of data	

1. An initial calibration is necessary to determine DacDataL and DacDataH values required for leaving Tag Detector state. For more information, contact your ST sales office for the corresponding application note.

08: RdReg

This command is used to read the Wakeup register.

Table 13. Read Wakeup Register command description

Direction	Data	Comments	Example
MCU – CR95HF	08	Command code	08 03 62 01 00 Reads the Wakeup register.
	03	Length of data	
	62	Wakeup register	
	01	Register size	
	00	ST Reserved	
CR95HF - MCU	00	Result code	00 01 01 Wakeup by timer. 00 01 02 Wakeup by tag detector.
	<Len>	Length of data (= RegCount)	
	<RegData>	Registers data	
CR95HF - MCU	82	Error code	82 00 Invalid command length
	00	Length of data	

0A: BaudRate

This command changes the UART baud rate.

Table 14. Set UART baud rate command description

Direction	Data	Comments	Example
MCU – CR95HF	0A	Command code	
	01	Length of data	
	<BaudRate>	New Baud Rate = 13.56 /(2*<BaudRate>+2) Mbps Baud rate 255: 13.56/512 ~26.48 Kbps 254: 13.56/510 ~26.59 Kbps 253: 13.56/508 ~26.7 Kbps . . . 117: 13.56/236 ~57.7 Kbps (Value specified in firmware by default) . . . 2: 13.56/6 ~2.24 Mbps 1: RFU 0: RFU	
CR95HF - MCU	55	Echo code response of 0x55	55 New baud rate is used to reply

Caution: If the Baud Rate command is not correctly executed, the baud rate value will remain unchanged.

55: ECHO

This command verifies the possiblility of communication between an MCU and the CR95HF.

Table 15. ECHO command description

Direction	Data	Comments	Example
MCU – CR95HF	55	Command code	
CR95HF - MCU	55 00	Echo code response	

6 Electrical characteristics

6.1 Absolute maximum ratings

Table 16. Absolute maximum ratings

Symbol	Parameter	Value	Unit
VPS_Main	Supply voltage	3.3	V
VPS_TX	Supply voltage (RF drivers)	3.3	V
V_{IO}	Input or Output voltage relative to Ground	–0.3 to VPS_Main+0.3	
T_A	Ambient operating temperature	–25 to +85	°C
	Ambient operating temperature (RF mode)	–25 to +85	
T_{STG}	Storage temperature (Please also refer to package specification).	–65 to +150	°C
V_{ESD}	Electrostatic discharge voltage according to JESD22-A114, Human Body Model	2000	V
P_{TOT} (1)	Total power dissipation per package	0.5	W

1. Depending on the thermal resistance of package.

Note: Stresses listed above 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 the specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

6.2 Power consumption characteristics

T_A = –25°C to 85°C, unless otherwise specified.

Table 17. Power consumption characteristics (from 2.7V to 3.3V)

Symbol	Parameter	Condition	Typ.	Max.	Unit
I_{CC} (V_{PS}) Hibernate	Supply current in Hibernate state	T_A = 25°C	10		µA
I_{CC} (V_{PS}) Standby	Supply current in Standby	T_A = 25°C	2.5		mA
I_{CC} RF (V_{PS_TX}) Reader ON	Supply current in RF Reader ON ($V_{PS\ TX}$ = 3V)(1)	T_A = 25°C	70		mA
I_{CC} RF (V_{PS_TX}) Reader OFF	Supply current in RF Reader OFF	T_A = 25°C	1		µA
I_{CC} (V_{PS}) Tag Detect	Average supply current in Tag Detection state(2)	T_A = 25°C, 4 RF bursts per second	100		µA
I_{CC} RF (V_{PS_TX}) Tag Detect	Peak current during Burst detection	T_A = 25°C	70		mA

1. Parameter measured using recommended output matching network.
2. Please contact the ST sales office for the corresponding application note.

6.3 SPI characteristics

The CR95HF supports (CPOL = 0, CPHA = 0) and (CPOL = 1, CPHA = 1) modes.

Table 18. SPI interface characteristics

Symbol	Parameter	Condition	Min.	Max.	Unit
f_{SCK} $1/t_{c(SCK)}$	SPI clock frequency			2.0	MHz
$t_{SU(NSS)}$ (1)	NSS setup time		70		ns
$t_{h(NSS)}$ (1)	NSS hold time		0		
$t_{CH(SCKL)}$ (1)	Clock low time			TBD	ns
$t_{CH(SCKH)}$ (1)	Clock high time			TBD	
$t_{SU(SI)}$ (1)	Data slave Input setup time		20		ns
$t_{h(SI)}$ (1)	Data slave Input hold time			80	
$t_{v(SO)}$ (1)	Data slave output valid time			TBD	ns
$t_{h(SO)}$ (1)	Data slave output hold time	After enable edge	280		
$C_{b\_SPI\_IN}$	Capacitive load for input pins NSS, CLK, MOSI			3	pF
$C_{b\_SPI\_OUT}$	Capacitive load for input pins MOSI			20	pF

1. Values based on design simulation and/or characterization results, and not on tested in production.

Figure 11. SPI timing diagram (Slave mode and CPOL = 0, CPHA = 0)

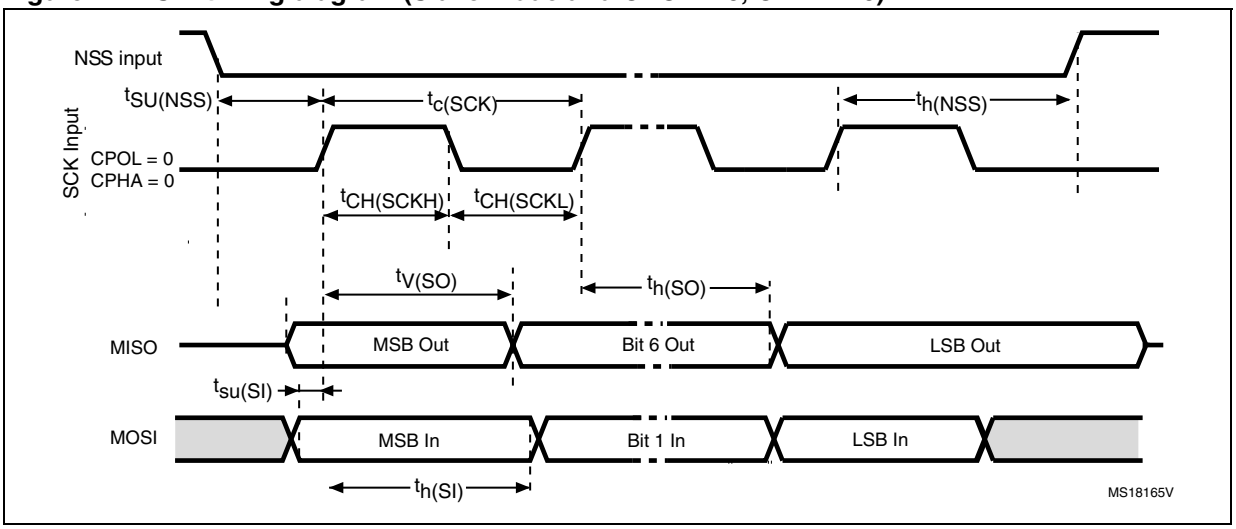
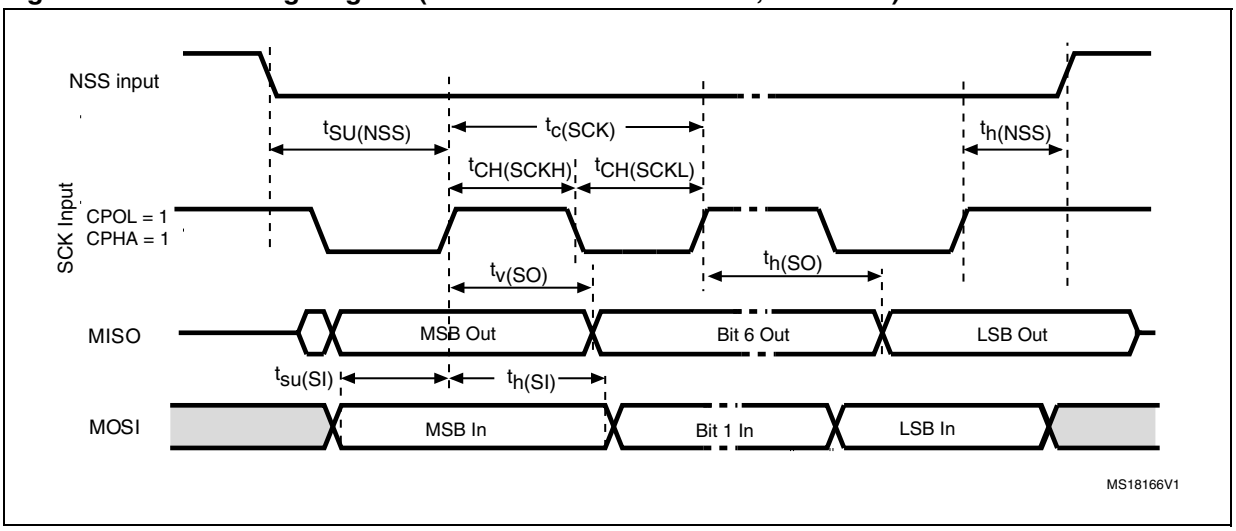


Figure 12. SPI1 timing diagram (Slave mode and CPOL = 1, CPHA = 1)



6.4 RF characteristics

Test conditions are T_A = 0°C to 50°C, unless otherwise specified.

Table 19. Reader characteristics

Symbol	Parameter	Min.	Typ.	Max.	Unit
f_C	Frequency of operating field (carrier frequency)	13.553	13.56	13. 567	MHz
MI Carrier	Carrier modulation index (1) ISO 14443-A			100	%
	ISO 14443-B	8		TBD	
	ISO 15693 (10% modulation)	TBD		TBD	
	ISO 15693 (100% modulation)	80		100	
Transmitter specifications					
	Z_{OUT} differential impedence between TX1 and TX2(1)		32		Ω
	Output power for 3V operation (1)(2)		70		mW
Receiver specifications					
	Small signal differential input resistance (Rx1/Rx2)(1)		80		kΩ
	Small signal differential input capacitance (Cx1/Cx2)(1)		22		pF
	Sensitivity (subcarrier between 420 and 440 kHz)(1)		TBD		mVpp
	Sensitivity (subcarrier at 847 kHz)(1)		TBD		mVpp

1. Values based on design simulation and/or characterization results, and not on tested in production.
2. Parameter measured on samples using recommended output matching network. (Z load is 32 Ohms and 0 degrees.)

6.5 Oscillator characteristics

The external crystal used for this product is a 27.12 MHz crystal with an accuracy of ± 14 kHz.

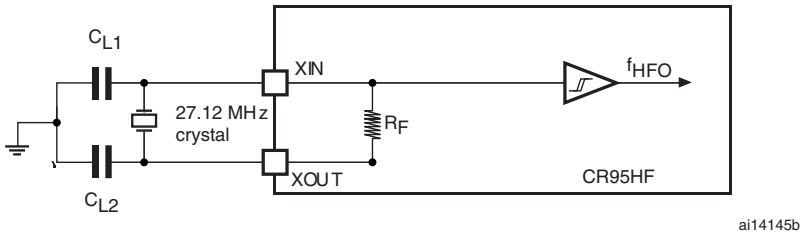
Table 20. HFO 27.12 MHz oscillator characteristics(1) (2)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
f_{XTAL}	Oscillator frequency			27.12		MHz
R_F	Feedback resistor			2		MΩ
C	Recommended load capacitance versus equivalent serial resistance of the crystal (R_S)(3)	R_S = 30 Ω		TBD		pF
i_2	HFO driving current	V_{PS} = 3.3 V with 12 pF load			TBD	mA
g_m	Oscillator transconductance	Startup	TBD			mA/V
$t_{SU(HFO)}$(4)	Startup time	V_{PS} is stabilized		TBD		ms

1. Resonator characteristics given by the crystal/ceramic resonator manufacturer.
2. Based on characterization, not tested in production.
3. The relatively low value of the R_F resistor offers a good protection against issues resulting from use in a humid environment, due to the induced leakage and the bias condition change. However, it is recommended to take this point into account if the MCU is used in tough humidity conditions.
4. $t_{SU(HFO)}$ is the startup time measured from the moment it is enabled (by software) to a stabilized 27.12 MHz oscillation is reached. This value is measured for a standard crystal resonator and it can vary significantly with the crystal manufacturer.

For C_{L1} and C_{L2}, it is recommended to use high-quality external ceramic capacitors in the 10 pF to 20 pF range (typ.), designed for high-frequency applications, and selected to match the requirements of the crystal or resonator (see *Figure 13*). C_{L1} and C_{L2} are usually the same size. The crystal manufacturer typically specifies a load capacitance which is the series combination of C_{L1} and C_{L2}.

Figure 13. Typical application with a 27.12 MHz crystal



Note: For C_{L1} and C_{L2} it is recommended to use high-quality ceramic capacitors in the 10 pF to 20 pF range selected to match the requirements of the crystal or resonator. C_{L1} and C_{L2}, are usually the same size. The crystal manufacturer typically specifies a load capacitance which is the series combination of C_{L1} and C_{L2}.
Load capacitance C_L has the following formula: $C_L = C_{L1} \times C_{L2} / (C_{L1} + C_{L2}) + C_{stray}$ where C_{stray} is the pin capacitance and board or trace PCB-related capacitance. Typically, it is between 2 pF and 7 pF.

7 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: *www.st.com*. ECOPACK® is an ST trademark.

Figure 14. 32-lead VFQFPN (5x5 mm 0.5 mm pitch) package outline

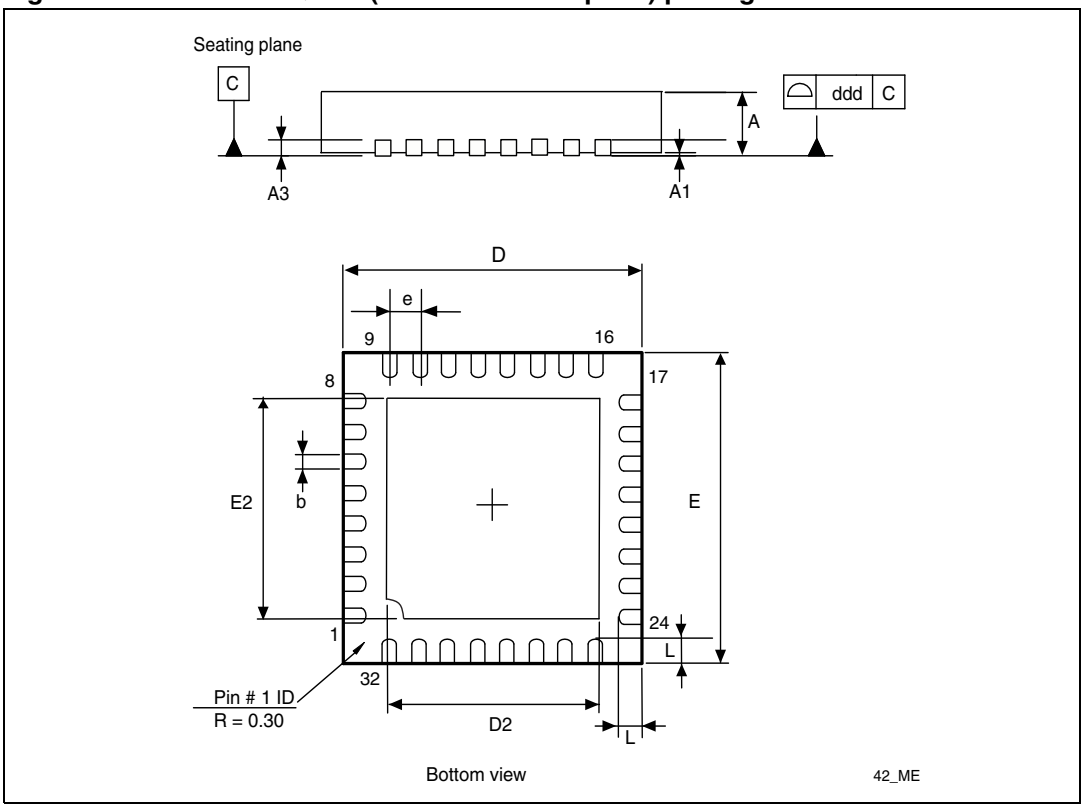


Table 21. 32-pin VFQFPN (5x5 mm 0.5 mm pitch) package mechanical data

Symbol	millimeters			inches[1]			Note
	Min.	Typ.	Max.	Min.	Typ.	Max.	
A	0.800	0.900	1.000	0.0315	0.0354	0.0394	
A1	0.000	0.020	0.050	0.0000	0.0008	0.0020	
A3		0.200			0.0079		
b	0.180	0.250	0.300	0.0071	0.0098	0.0118	
D	4.850	5.000	5.150	0.1909	0.1969	0.2028	
D2 (CAR)	3.200	3.450	3.700	0.1260	0.1358	0.1457	1
D2 (AS)	3.650		3.950	0.1437		0.1555	2
D2 (AMK_A)	2.900	3.100	3.200	0.1142	0.1220	0.1260	3
D2 (AMK_B)	3.500	3.600	3.700	0.1378	0.1417	0.1457	4
E	4.850	5.000	5.150	0.1909	0.1969	0.2028	

Table 21. 32-pin VFQFPN (5x5 mm 0.5 mm pitch) package mechanical data

Symbol	millimeters			inches[1]			Note
	Min.	Typ.	Max.	Min.	Typ.	Max.	
E2 (CAR)	3.200	3.450	3.700	0.1260	0.1358	0.1457	1
E2 (AS)	3.650		3.950	0.1437		0.1555	2
E2 (AMK_A)	2.900	3.100	3.200	0.1142	0.1220	0.1260	3
E2 (AMK_B)	3.500	3.600	3.700	0.1378	0.1417	0.1457	4
e		0.500			0.0197		
L	0.300	0.400	0.500	0.0118	0.0157	0.0197	
ddd (CAR & ASAT)			0.080			0.0031	5
ddd (AMK)			0.050			0.0020	6

1. Values in inches are rounded to 4 decimal digits.

Note: 1 CARSEM SUBCON.
2 ASAT HK SUBCON. Dimensions are not in accordance with JEDEC.
3 AMKOR Variation A. Dimensions are not in accordance with JEDEC.
4 AMKOR Variation B. Dimensions are not in accordance with JEDEC.
5 CARSEM and ASAT.
6 AMKOR.

8 Part numbering

Table 22. Ordering information scheme

Example: CR 95 HF – V MD 5 T

Device type

CR = Contactless reader IC

Wired access

95 = SPI and UART

Frequency band

HF = High frequency (13.56 MHz)

Operating voltage

V = 2.7 to 3.3 V

Package

MD = 32-pin VFQFPN (5 x 5 mm)

Operating temperature

5 = –25° to +85° C

Packaging

T = Tape and Reel

9 Revision history

Table 23. Document revision history

Date	Revision	Changes
30-Mar-2011	1	Initial release.

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