

Short Form Specification

mifare[®]

MF RC500

Highly Integrated ISO 14443A Reader IC

Short Form Specification

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Highly Integrated ISO 14443A Reader IC**MF RC500**

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Highly Integrated ISO 14443A Reader IC

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1 INTRODUCTION

1.1 Scope

The MF RC500 is member of a new family of highly integrated reader ICs for contactless communication on 13,56MHz. This new reader IC family utilises an outstanding modulation and demodulation concept completely integrated for all major kinds of passive contactless communication methods and protocols on 13,56MHz.

The MF RC500 supports all layers of ISO14443A.

The internal transmitter part is able to drive a proximity antenna (up to 100mm) directly without additional active circuitry.

The receiver part provides a robust and efficient implementation of a demodulation and decoding circuitry for signals of ISO14443A compatible transponders.

The digital part handles ISO 14443A framing and error detection (Parity & CRC). Additionally it supports the fast CRYPTO 1 stream cipher to authenticate MIFARE[®] Classic (MIFARE[®] Standard, MIFARE[®] Light) products.

A comfortable parallel interface which can be directly connected to any 8-bit μ Controller gives high flexibility for Reader / Terminal design.

1.2 Features

- Highly integrated analog circuitry to decode card response
- Buffered output drivers to connect an antenna with minimum number of external components
- Proximity operating distance (up to 100 mm)
- Fast internal oscillator buffer to connect 13.56 MHz quartz
- Clock frequency monitoring
- Hard reset with low power functions
- Power down mode per software
- Parallel μ Controller interface with internal address latch and IRQ line
- Automatic detection of parallel μ C interface type
- Comfortable send and receive FIFO buffer
- Anti-collision procedure support
- Bit- and byte-oriented framing
- Unique serial number
- Onboard timer circuit
- Supports MIFARE[®] PRO and ISO 14443A (transparent mode and T="CL")
- Supports MIFARE[®] Classic
- Crypto1 and secure non-volatile internal key memory
- Supports MIFARE[®] active antenna concept.
- Suitable for high security terminals with SAM's based on e.g. triple DES, RSA, elliptic curves

1.3 Applications

The MF RC500 is tailored to fit the requirements of various applications using contactless communication based on ISO/IEC 14443A standard where cost-effectiveness, small size, high performance with a single voltage supply are important.

- Public transport terminals
- Handheld terminals
- On board units
- Contactless PC terminals
- Metering
- Contactless public phones

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2 BLOCK DIAGRAM

The block diagram shows the main internal parts of the MF RC500.

The parallel μ Controller interface automatically detects the kind of 8 bit parallel interface connected to it. It includes a comfortable bi-directional FIFO buffer and a configurable interrupt output. This gives the flexibility to connect a variety of μ C, even low cost devices, still meeting the requirements of high-speed contactless transactions.

The Data processing part performs parallel serial conversion of the data. It supports framing including CRC and parity generation / checking. It operates in full transparent mode thus supporting all layers of ISO 14443A.

The status and control part allows configuration of the device to adapt to environmental influences and to adjust to operate with best performance.

For communication with MIFARE[®] Classic products like MIFARE[®] Standard or MIFARE[®] Light a high speed CRYPTO 1 stream cipher unit and a secure non-volatile key memory is implemented.

The analog circuit includes a transmitting part with a very low impedance bridge driver output. This allows an operating distance up to 100mm. The receiver is able to detect and decode even very weak responses. Due to a highly sophisticated implementation the receiver is no longer a limiting factor for the operating distance.

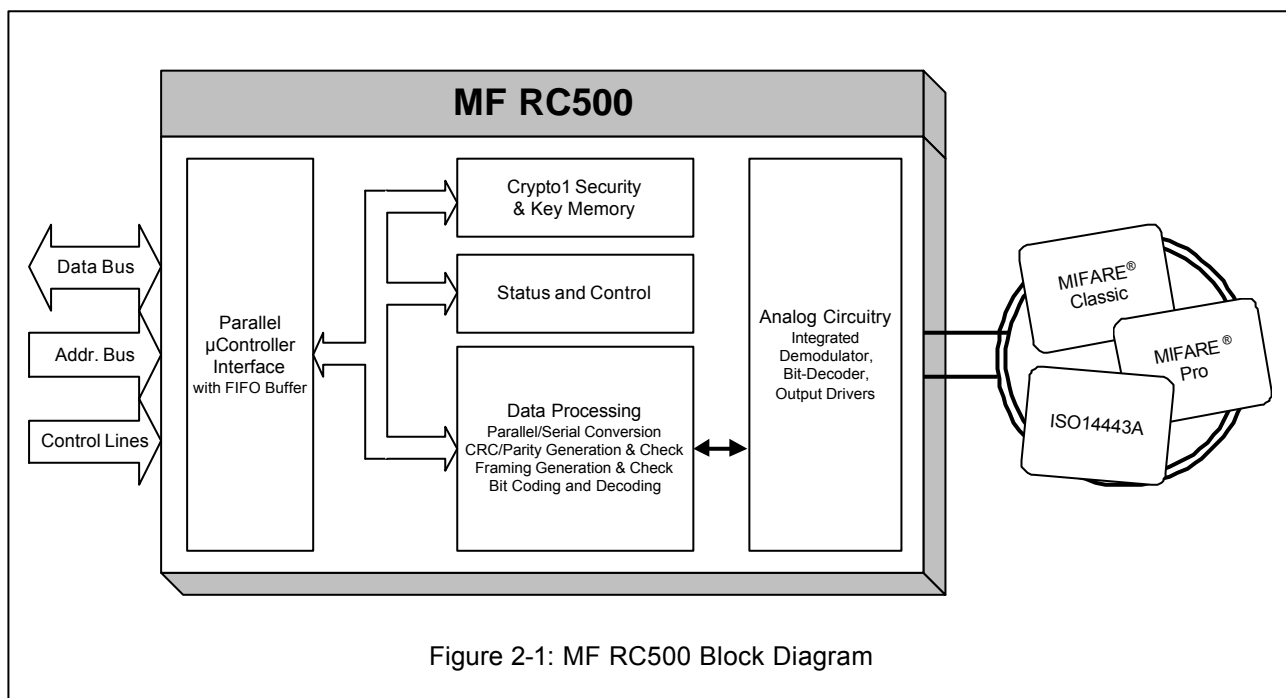


Figure 2-1: MF RC500 Block Diagram

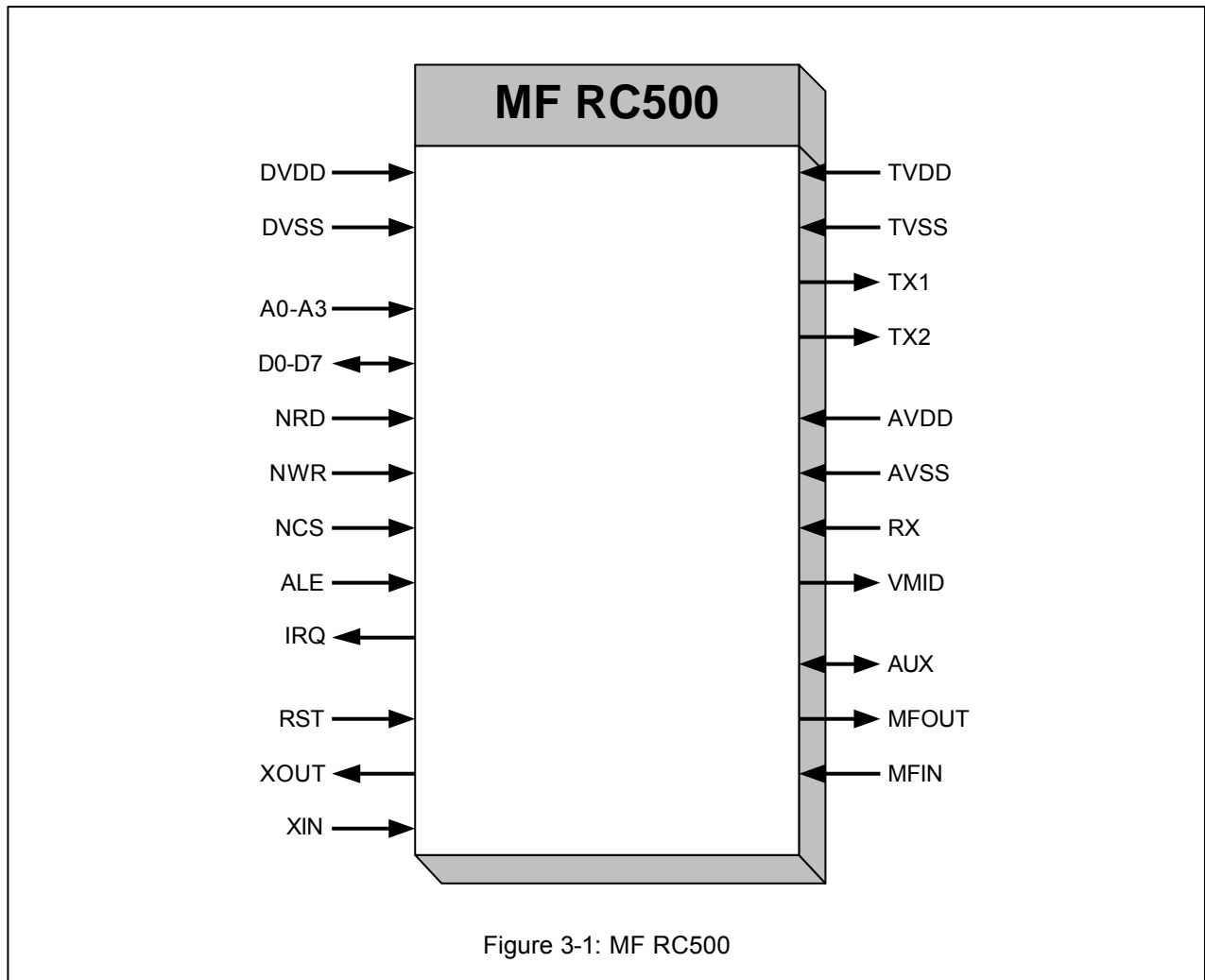
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3 MF RC500 PINNING

3.1 Pinning Diagram

The device is packaged in a 32 pin SO-package.



The device operates with 3 individual power supplies for best performance in terms of EMC behaviour and signal de-coupling. This gives outstanding RF performance and also maximum flexibility to adapt to different operating voltages of digital and analog part.

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3.2 Pin Description

3.2.1 ANTENNA INTERFACE

The contactless antenna interface basically uses four pins:

| Name | Type | Function |
|----------|------------|----------------------|
| TX1, TX2 | O Buffered | Antenna Drivers |
| VMID | Analog | Reference Voltage |
| RX | I Analog | Antenna Input Signal |

To drive the antenna the MF RC500 provides the energy carrier of 13.56 MHz through TX1 and TX2. This signal is modulated by the transmitting data according the register settings.

The card responds with load modulation of the RF field. The resulting signal picked up by the antenna is coupled out from the antenna matching circuit and forwarded to the RX-pin. Inside the MF RC500 the receiver senses and demodulates the signal and processes it according to the register settings. Data is passed further on to the parallel interface where it is accessible by the μ -Controller.

The MF RC500 uses a separate power supply for the driver stage.

| Name | Type | Function |
|------|-------|----------------------------|
| TVDD | Power | Transmitter Supply Voltage |
| TGND | Power | Transmitter Supply Ground |

3.2.2 ANALOG SUPPLY

For best performance the MF RC500 analog part has a separate supply. It powers the oscillator, the analog demodulator and decoder circuitry.

| Name | Type | Function |
|------|-------|--------------------------------|
| AVDD | Power | Analog Positive Supply Voltage |
| AGND | Power | Analog Supply Ground |

3.2.3 DIGITAL SUPPLY

The MF RC500 uses a separate digital supply.

| Name | Type | Function |
|------|-------|---------------------------------|
| DVDD | Power | Digital Positive Supply Voltage |
| DGND | Power | Digital Supply Ground |

3.2.4 AUXILLARY PIN

Internal signals may be selected to drive this pin. It is used for design-in support and test purpose.

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3.2.5 RESET PIN

The reset pin disables internal current sources and clocks and detaches the MF RC500 virtually from the μC bus. If RST is released, the MF RC500 executes the power up sequence.

3.2.6 OSCILLATOR

| Name | Type | Function |
|------|------|--------------------------|
| XIN | I | Oscillator Buffer Input |
| XOUT | O | Oscillator Buffer Output |

The very fast on-chip oscillator buffer operates with a 13.56 MHz crystal connected to XIN and XOUT. If the device shall operate with an external clock it may be applied to pin XIN.

3.2.7 MIFARE[®] INTERFACE

The MF RC500 supports the active antenna concept of MIFARE[®]. It may handles the base-band signals NPAUSE and KOMP of MIFARE[®] Core Modules (MF CMxxx) at the pins MFIN and MFOUT.

| Name | Type | Function |
|-------|------------------------|--------------------------------------|
| MFIN | I with Schmitt Trigger | MIFARE [®] Interface Input |
| MFOUT | O | MIFARE [®] Interface Output |

The MIFARE[®] interface may be used to communicate with either the analog or the digital part of the MF RC500 separately in the following ways:

- The analog circuit may be used stand-alone via the MIFARE[®] interface. In that case MFIN will be connected to the externally generated NPAUSE signal. The MFOUT pin provides the KOMP signal.
- The digital circuit may be used to drive an external analog circuit via the MIFARE[®] interface. In that case the MFOUT pin provides the internally generated NPAUSE signal and MFIN will be connected to the KOMP signal from the outside.

3.2.8 PARALLEL INTERFACE

16 pins control the parallel interface:

| Name | Type | Function |
|-----------|--------------------------|----------------------------|
| D0 ... D7 | I/O with Schmitt Trigger | Bi-directional Data Bus |
| A0 ... A2 | I/O with Schmitt Trigger | Address Lines |
| NWR / RNW | I/O with Schmitt Trigger | Not Write / Read Not Write |
| NRD / NDS | I/O with Schmitt Trigger | Not Read / Not Data Strobe |
| NCS | I/O with Schmitt Trigger | Not Chip Select |
| ALE | I/O with Schmitt Trigger | Address Latch Enable |
| IRQ | O | Interrupt Request |

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3.3 Applications

3.3.1 CONNECTING DIFFERENT μ CONTROLLER'S

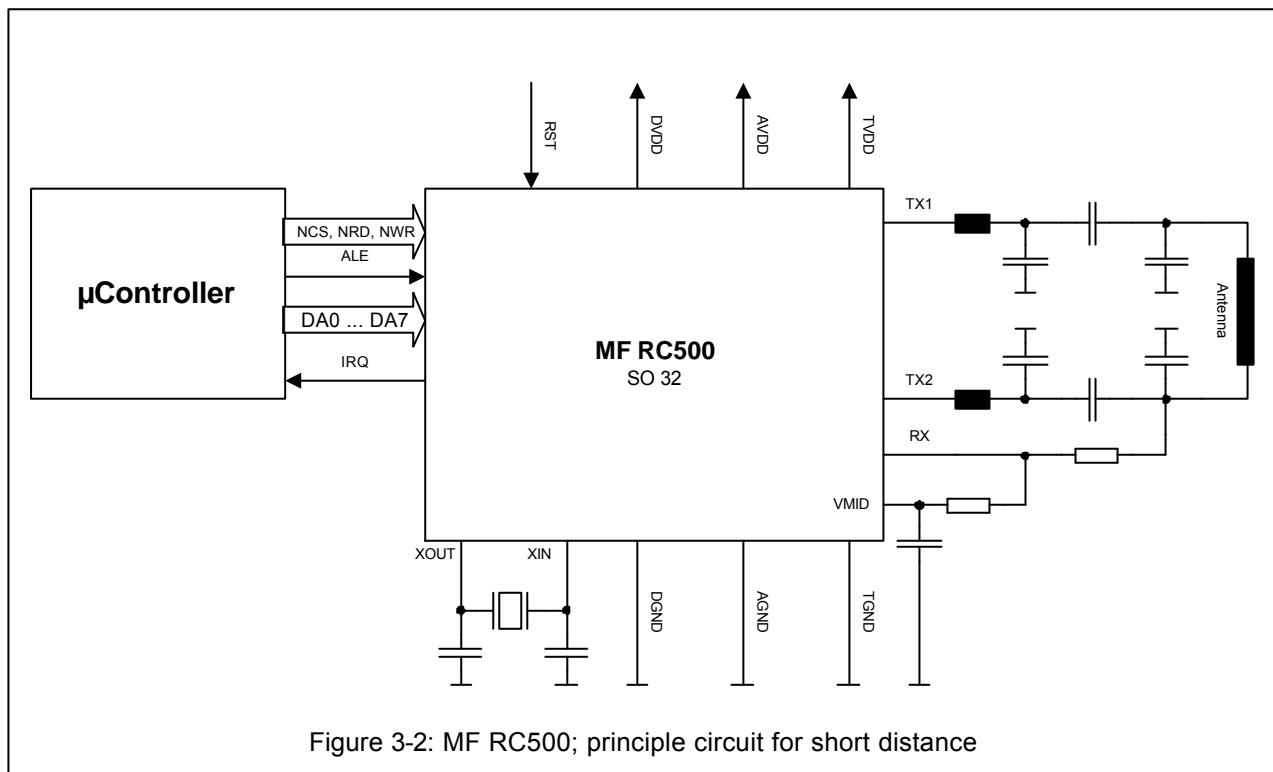
The MF RC500 supports different parallel μ C interfaces. An intelligent auto-detection logic automatically adapts the parallel interface to the respective bus system. Selection of the device is performed with signal NCS.

To connect μ -Controllers using separated address and data bus pin ALE has to be connected to DVDD.

To connect μ -Controllers using multiplexed address and data bus pin ALE has to be connected to the signal ALE of the μ -Controller

To connect μ -Controllers using RNW and NDS (instead of NWR and NRD) the μ -Controller's RNW has to be connected to pin NWR and NDS to pin NRD.

3.3.2 APPLICATION EXAMPLE



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4 MIFARE® CLASSIC RELATED ITEMS**4.1 CRYPTO I: Card Authentication**

For correct authentication of MIFARE® Classic products the fast CRYPTO 1 stream cipher is available. The corresponding keys have to be programmed into the secure non-volatile key memory of the MF RC500.

Only two commands need to be sent by application software to turn on CRYPTO 1 secured communication.

4.1.1 INITIATING CARD AUTHENTICATION

The correct key for the authentication has to be selected from the secure internal non-volatile key memory and loaded into the internal CRYPTO1 register. Next the authentication command is transmitted to the card.

After receiving the first message token from the card, the μ -Controller has to check the

communication status flags. If communication so far has been successful the second part of the authentication procedure can be started.

4.1.2 SECOND PART OF CARD AUTHENTICATION

Data to be transmitted to the card in this phase are generated automatically by the internal CRYPTO 1 unit inside the MF RC500. To request this action the according command has to be triggered.

The card will respond with the second message token. Then the communication status flags have to be checked by the μ -Controller. If authentication has been successful further communication with a MIFARE® Classic card continues CRYPTO 1 enciphered.

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5 ELECTRICAL SPECIFICATION

5.1 DC Characteristics

| SYMBOL | PARAMETER | CONDITIONS | MIN | TYP | MAX | UNIT |
|--------|-----------|------------|-----|-----|-----|------|
|--------|-----------|------------|-----|-----|-----|------|

Voltage Supply

| | | | | | | |
|------|----------------------------|--|-----|-----|-----|---|
| DVDD | Digital Supply Voltage | | 4.5 | 5.0 | 5.5 | V |
| AVDD | Analog Supply Voltage | | 4.5 | 5.0 | 5.5 | V |
| TVDD | Transmitter Supply Voltage | | 3.3 | 5.0 | 5.5 | V |

Current Consumption

| | | | | | | |
|------------|--|-----------------|--|----|-----|----|
| I_{DVDD} | Operating Digital Supply Current | | | 6 | | mA |
| I_{AVDD} | Operating Analog Supply Current | | | 25 | | mA |
| I_{TVDD} | Operating Buffered Antenna Driver Supply Current | continuous wave | | | 150 | mA |

5.2 Start up Characteristics

| Mode | CONDITIONS | Current | UNIT | Time | UNIT |
|------|------------|---------|------|------|------|
|------|------------|---------|------|------|------|

Startup times and current consumption

| | | | | | |
|---------------------------------|--|---|---------|--------|---------|
| Power on | | - | - | < 1000 | μ s |
| Hard Reset via Reset Pin | | 1 | μ A | < 1000 | μ s |
| Soft Reset via Register Setting | | 1 | μ A | < 1000 | μ s |

Definitions

| Data sheet status | |
|--|---|
| Objective specification | This data sheet contains target or goal specifications for product development. |
| Preliminary specification | This data sheet contains preliminary data; supplementary data may be published later. |
| Product specification | This data sheet contains final product specifications. |
| Limiting values | |
| Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics section of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability. | |
| Application information | |
| Where application information is given, it is advisory and does not form part of the specification. | |

Life support applications

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