DATA SHEET

HITAG™ Core Module Hardware

Product Specification
Revision 2.1

January 1999

PHILIPS

Table of Contents

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.	

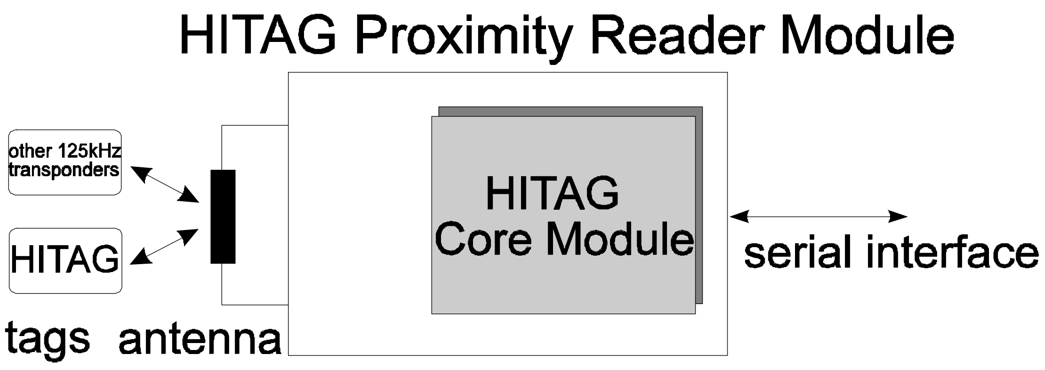
Life support applications

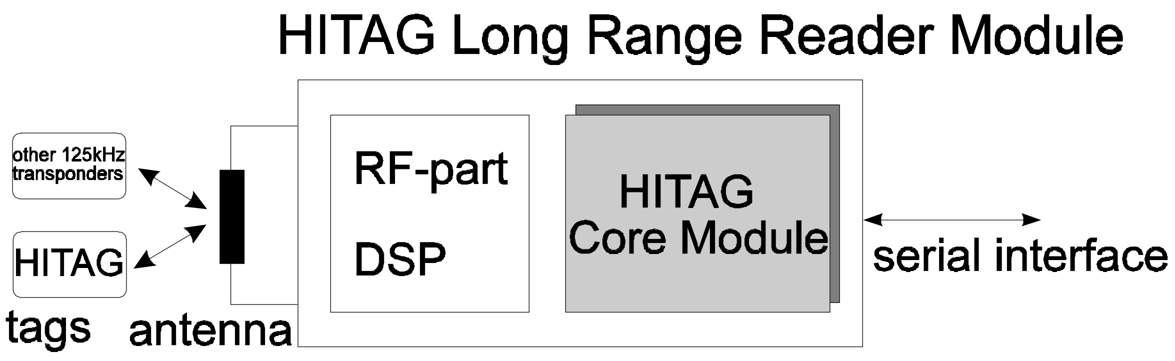
These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Philips customers using or selling these products for use in such applications do so on their own risk and agree to fully indemnify Philips for any damages resulting from such improper use or sale.

1. Introduction

hitag™ - is the name of one of the universal and powerful product lines of our 125 kHz family. The contactless read/write system that works with passive transponders is suitable for various applications. Inductive coupling helps you to achieve operating distances up to 1000 mm and the use of cryptography guarantees highest data security.
Anticollision Mode, which is used only in long range operation, allows you to handle several transponders that are within the communication field of the antenna at the same time, thus achieving highest operating security and permitting to handle several data transfers quickly and simultaneously. In this context anticollision becomes an essential element of applications such as ski-ticketing and long range access control. With applications of that type it will always happen that several transponders arrive in the communication field of the antenna at the same time.
Nevertheless, the proximity application also prevents any type of malfunction even if several transponders arrive in the communication field of the antenna at the same time.

The HITAG product family is used both in the proximity area (operating range up to about 200 mm) and in the long range area (operating range up to about 1000 mm). In both cases the **HITAG Core Module** forms the central part as illustrated by the block diagram below:





The HITAG Core Module provides you with a universal, cost-effective, and small module.
The use of modular architecture guarantees versatile usability and easy integration into bigger systems.
The HITAG Core Module enables communication with HITAG 1 and HITAG 2 transponders.

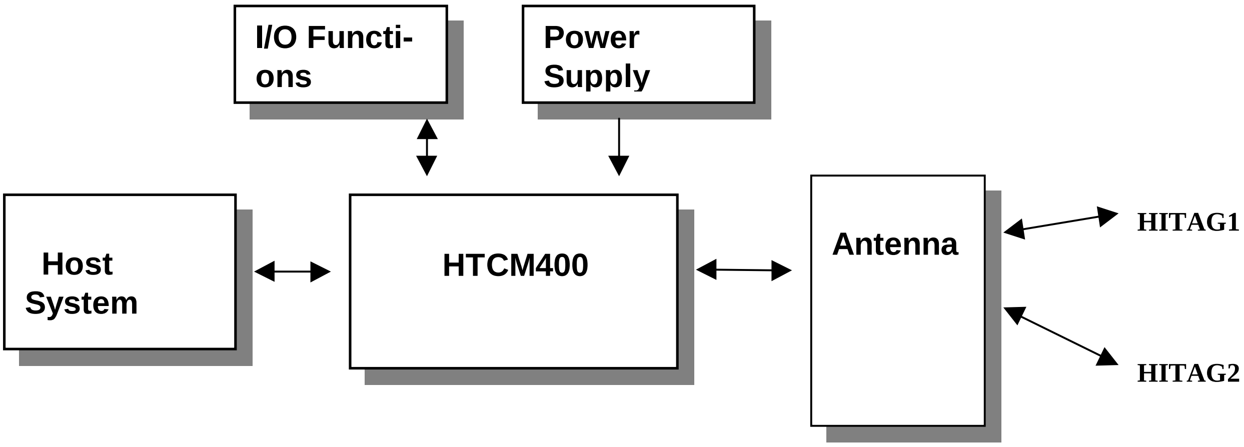
Easy integration and application of the HITAG Core Module is due to:

- small size
- uncomplicated interfaces

Based on the Core Module delivered by Philips and using only a few additional components, every client can build his individually designed Proximity Reader without difficulty.
Moreover, you can obtain an electronic unit of the Long Range Reader (with an additional high frequency component) from Philips, if long range applications are required.

2. System Overview

The HITAG Core Module is a compact module used in read/write devices for the 125 kHz family. With only a few external components (antenna coupling network, interface driver, voltage decoupling) you can use the HITAG Core Module as the central part of a HITAG Proximity Reader Module:



2.1. Transponders

The HITAG Core Module integrated into the read/write device can communicate with Philips HITAG 1 and HITAG 2 transponders.

2.2. Host

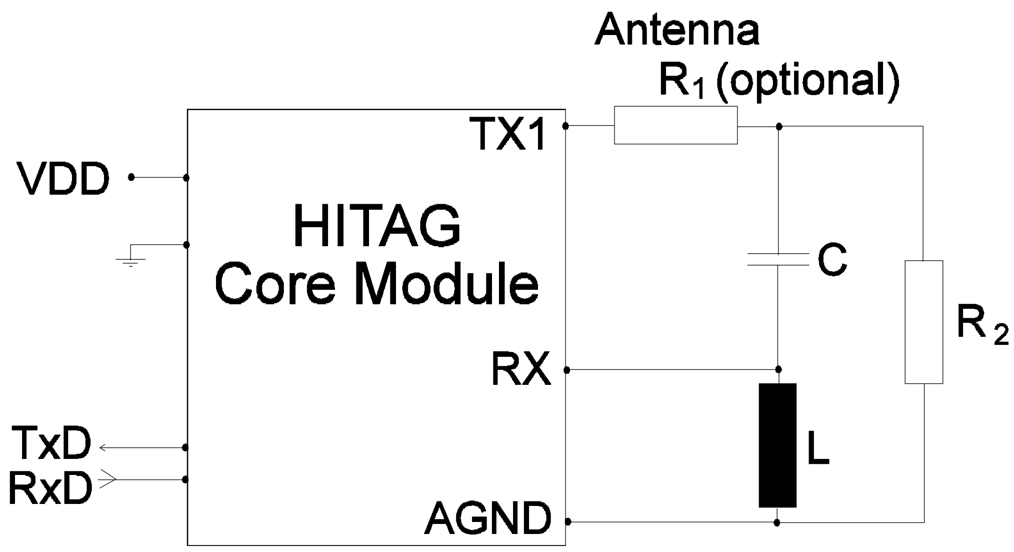
The connection to the host (e.g.: µC or PC) is a serial interface on CMOS level for data transmissions over shorter distances. You can connect an RS232 as well as an RS422 interface component. If you use an additional pin of the HITAG Core Module (Pin 1, TXDEN) as control pin, you can realise an RS485 interface.

2.3. I/O - Functions

The I/O lines form the connection to potential keys and LEDs; two lines are wired as inputs, two as outputs.

2.4. Connecting the Antenna

Connect an antenna as shown in the following illustration:



The resistor R_1 has to be used if the antenna voltage is too high (see Chapter 6.4.7.). With the capacity C the antenna tuning is done, R_2 has only to be used for antenna cable lengths of more than 500 mm and is used for damping.

For more details concerning the design of HITAG Proximity antennas see Chapter 6.4.

2.5. HITAG - Long Range Reader Module

The HITAG Long Range Reader Module supplied by Philips uses some of the module pins as interface to an additional high frequency and Digital Signal Processor (DSP) part.

2.6. Behaviour with Several Transponders

If several HITAG transponders arrive *simultaneously* within the communication field of the antenna of a HITAG Proximity Reader Module, the "stronger" transponder (the nearer one) takes over or - under special circumstances - no communication takes place. If the transponders arrive in the field one after the other, communication is established with the first one, all other transponders are ignored.
Nevertheless it is possible to mute transponders, so that several HITAG transponders can be accessed sequentially.
This ensures that no two (or several) HITAG transponders will ever be processed (above all written to!) accidentally at the same time.
If a HITAG Long Range Reader Module is used, Anticollision Mode is applied, which makes it possible to read and write all the HITAG 1 transponders (theoretical up to 2^{32}) within the communication field of the antenna simultanously. Because of the mutual influence of the transponder coils - they detune each other if there are too many too close to each other - the number of the transponders that can be operated simultaneously is limited.

3. Specifications

3.1. Electrical Specifications

3.1.1. Power Supply and Supply Ripple

Power Supply	Supply Current	Power Consumption
5 VDC ± 5 %	100 mA max.	0.5 W

With the power supply filter described in chapter 5.1 the power supply ripple must be within the following values:

frequency of ripple [kHz]	maximum ripple amplitude [mVss]
$0 \leq f < 10$	5
$10 \leq f < 20$	25
$20 \leq f$	40

3.1.2. Modulation

3.1.2.1. Read/Write Device ⇒ Transponder

Type of Modulation	Modulation Ratio
amplitude shift keying (ASK)	100 %

That means the carrier is periodically blanked completely, the information is located in the intervals between the pauses.

3.1.2.2. Transponder ⇒ Read/Write Device

Type of Modulation	Modulation Ratio
amplitude shift keying (ASK)	depending on the distance between transponder and read/write device

3.1.3. Interfaces

Interfacing to the host is done on CMOS level. You can connect an RS232 interface component or an RS422 interface driver, but you can also implement an RS485 interface using a control pin (Pin 1, TXDEN). For the pin assignment please see Chapter 3.2.3.

3.1.4. Metallic Environment, Interferences

The communication range is impaired by metallic environment and electromagnetic interferences (e.g.: monitors, keyboards). Therefore, you should keep a distance of at least the antenna´s diameter to metallic surfaces or loops as well as to electromagnetic interferences. If this is not possible, you have to take preventive measures such as using ferrites for transponders and antennas or shielding for antennas.

3.1.5. Distance between Two Antennas

In order to be able to operate two systems side by side without negative influence on communication ranges, you must place the antennas at a minimum distance of four times the antenna diameter. If you place them at a closer distance be sure to use suitable shielding or synchronisation.

3.1.6. Temperature Range

-25° C to +85° C (operating)

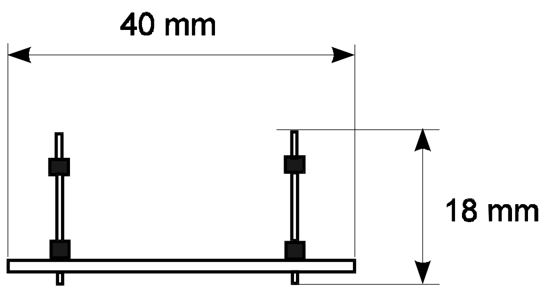
-40° C to +85° C (storage)

3.2. Mechanical Specifications

The module consists of the printed circuit board and one 14- and one 13-pole pin connector that protrudes from the PCB.

3.2.1. Dimensions

The outer dimensions of the PCB are: 86 x 40 x 7 mm.
The module including the pin connectors is about 18 mm high.

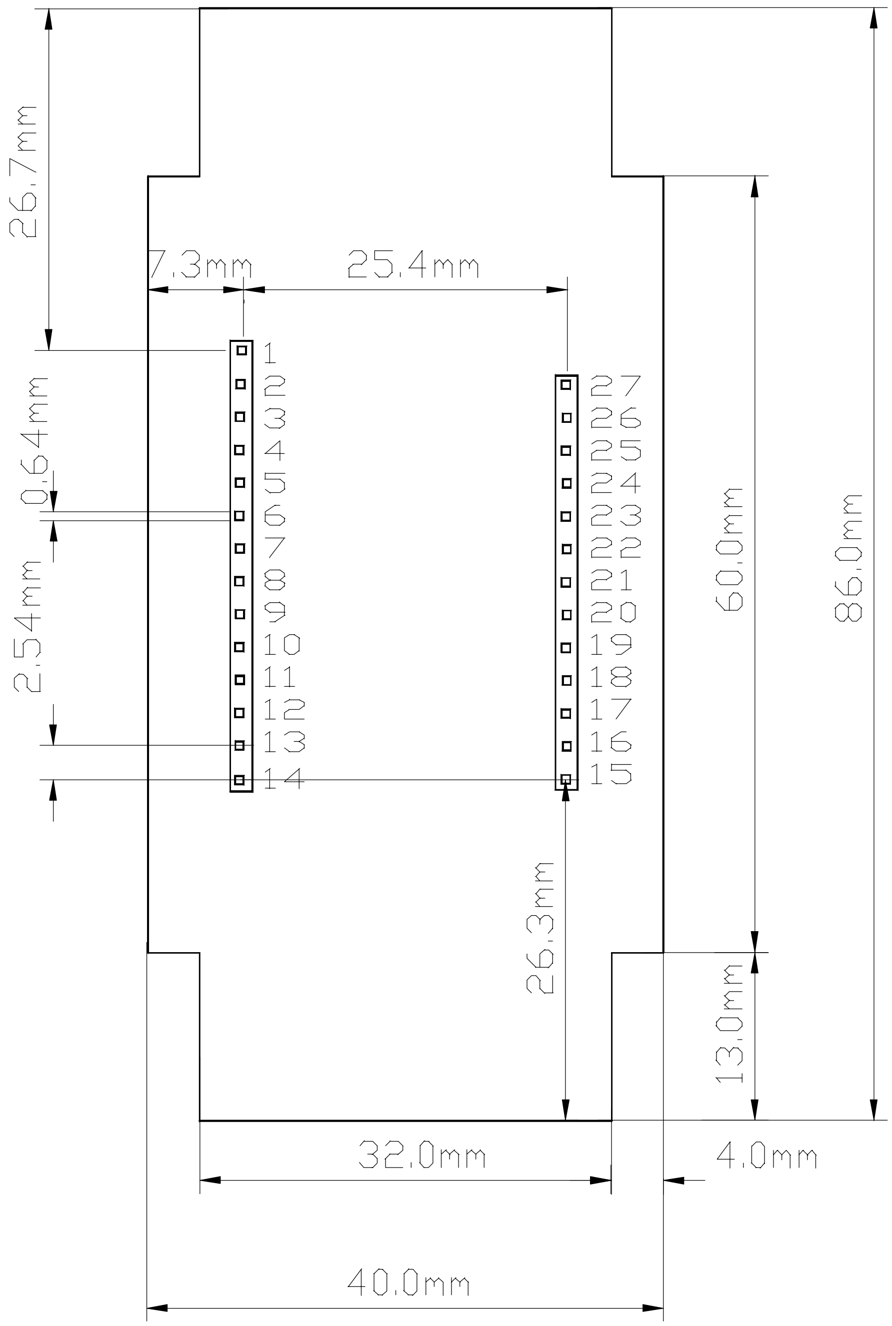


3.2.2. Mounting the Module

You can mount the module onto a base printed circuit board by soldering or plugging.

3.2.3. Pin Assignment

The following illustration shows the module with its pin connectors and pin numbering (seen from below the module, i.e. pins protruding):



The following table shows the pin assignment of the pin connectors:

Pin Number	Pin Name	Type	Function
1	TXDEN	O	control pin providing connection to an RS485 interface
2	RXLOW_DSP	I	interface to the HITAG Long Range board
3	RXHIGH_DSP	I	
4	RXCOL_DSP	I	
5	TXµPL_DSP	O	
6	SCLK_DSP	I	
7	SFFT_DSP	O	
8	IC		internally connected
9	ACNMAN_DSP	O	interface to the HITAG Long Range board
10	HINMIRO_DSP	O	
11	RXD	I	serial interface
12	TXD	O	
13	IC		internally connected
14	IC		
15	OUT1	O	I/O pins
16	OUT2	O	
17	IN1	I	
18	IN2	I	
19	DVDD	PWR	digital voltage supply (5 V)
20	DGND	PWR	
21	NC		not connected
22	AVDD	PWR	analog voltage supply (5 V, GND)
23	AGND	PWR	
24	NRESET	O	reset output
25	NC		not connected
26	TX1	O	antenna interface
27	RX	I	

I input pin

O output pin

PWR power supply pin

3.2.4. Pin Function Description

Pin 1, TXDEN:	This pin is used as control pin if you use an RS485 interface.
Pin 2, RXLOW_DSP:	*)
Pin 3, RXHIGH_DSP:	*)
Pin 4, RXCOL_DSP:	*)
Pin 5, TXµPL_DSP:	*)
Pin 6, SCLK_DSP:	*)
Pin 7, SFFT_DSP:	*)
Pin 8, IC:	internally connected, this pin must not be connected
Pin 9, ACNMAN_DSP:	*)
Pin 10, HINMIRO_DSP:	*)
Pin 11, RXD:	signal to the serial interface from the host
Pin 12, TXD:	signal from the serial interface to the host
Pin 13, IC:	internally connected, this pin must not be connected
Pin 14, IC:	internally connected, this pin must not be connected
Pin 15, OUT1:	output pin of the µC for controlling e. g. a LED (connection of e. g. a BS170 or BSS123 as driver)
Pin 16, OUT2:	output pin of the µC for controlling e. g. a LED (connection of e. g. a BS170 or BSS123 as driver)
Pin 17, IN1:	input for possible switch (must be active low, maximum input voltage: 5 V). Internal pull-up resistores are provided.
Pin 18, IN2:	input for possible switch (must be active low, maximum input voltage: 5 V). Internal pull-up resistores are provided.
Pin 19, DVDD:	digital power supply (5 V)
Pin 20, DGND:	digital power supply (GND)
Pin 21, NC:	not connected
Pin 22, AVDD:	analog power supply (5 V)
Pin 23, AGND:	analog ground
Pin 24, NRESET:	This OC - signal coming from the power-on reset circuit can be used as reset signal. Typ. 10 mA SINK, min. 2 mA SINK.
Pin 25, NC:	not connected
Pin 26, TX1:	antenna input signal
Pin 27, RX:	antenna output signal

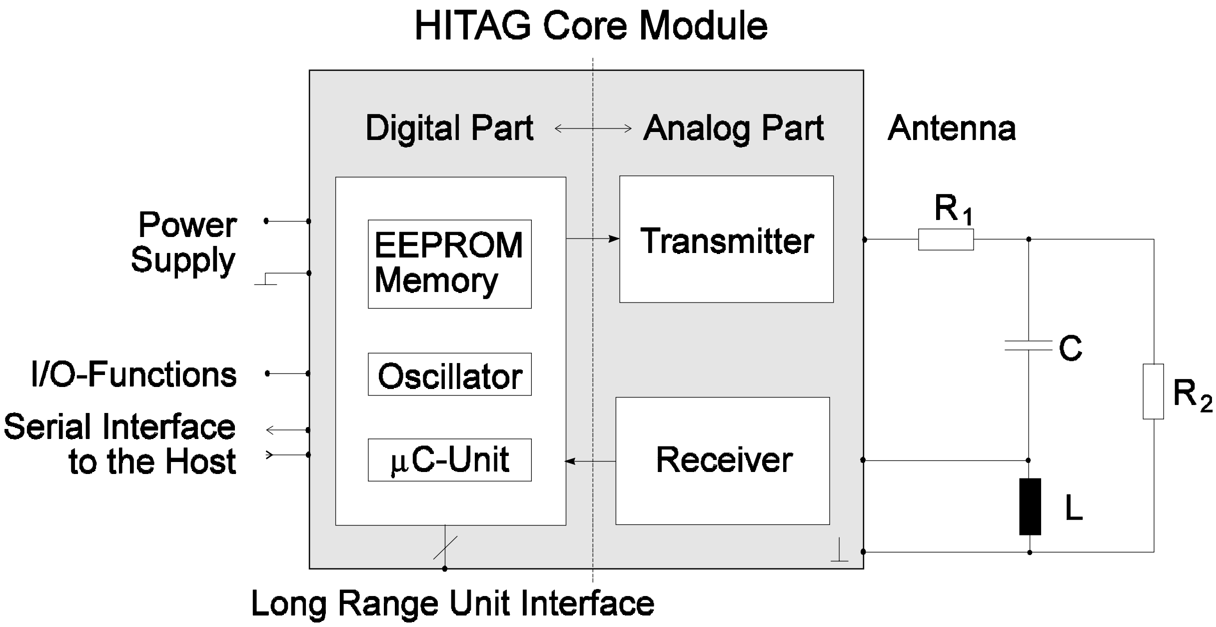
*) interface to the HITAG Long Range board.

Not used pins stay unconnected.

Note: Input, output current on any single of pins 1, 11, 12, 15, 16, 17 and 18: 1.5 mA; Maximum capacitive loading on each single of these pins: 80 pF.

4. Description of the Core Module Functions

4.1. Block Diagram



Note: R_2 has only to be used for antenna cable lengths of more than 500 mm.

4.1.1. EEPROM

The EEPROM is used to store non-volatile data such as personalization data, keys, passwords, configurations and status information.

4.1.2. Micro Controller

The micro controller processes the protocol for the communication between the transponders and the read/write unit. The interface signals are converted so that a HITAG 1 or HITAG 2, transponder is able to process them and the outgoing signals from the transponder are converted into interface-compatible signals.
The second essential micro controller function is its control function. The micro controller activates and deactivates the transmitter and selects the EEPROM.

4.1.2.1. Interface: Micro Controller - HITAG Long Range Board

This interface is not wired with proximity applications (leave pins open).

4.1.2.2. Interface: Micro Controller - HOST

The device communicates with the host (processor, PC, ...) via a serial interface using a baud rate of 9600 baud. Data transfer details are: 1 start bit, 8 data bits, 1 stop bit and no parity bit, the Least Significant Bit is sent first.

An RS232 interface device can be connected to the HITAG Core Module. Optionally an RS422 or an RS485 device is possible.

4.1.3. Transmitter and Receiver

The transmitter receives data from the micro controller and modulates the carrier.

The receiver demodulates the received data and passes them on to the micro controller for further processing.

4.1.4. Antenna

To the design of HITAG Proximity Antennas see Chapter 6.4.

5. Postal Approval

The postal approval can only be granted for final products, not just for components like the HITAG Core Module. But the Core Module is designed in a way that it is possible to get the postal approval for a device including the HITAG Core Module, if you follow the design instructions given by Philips.

Electromagnetic emission comply with the guidelines in FTZ 17 TR 2100 and ETS 300 683, electromagnetic immunity complies with the guidelines in ETS 300 683.

Following circuit diagram shows the basic configuration using the HITAG Core Module used to comply with the standards and some additional circuits which are recommended.

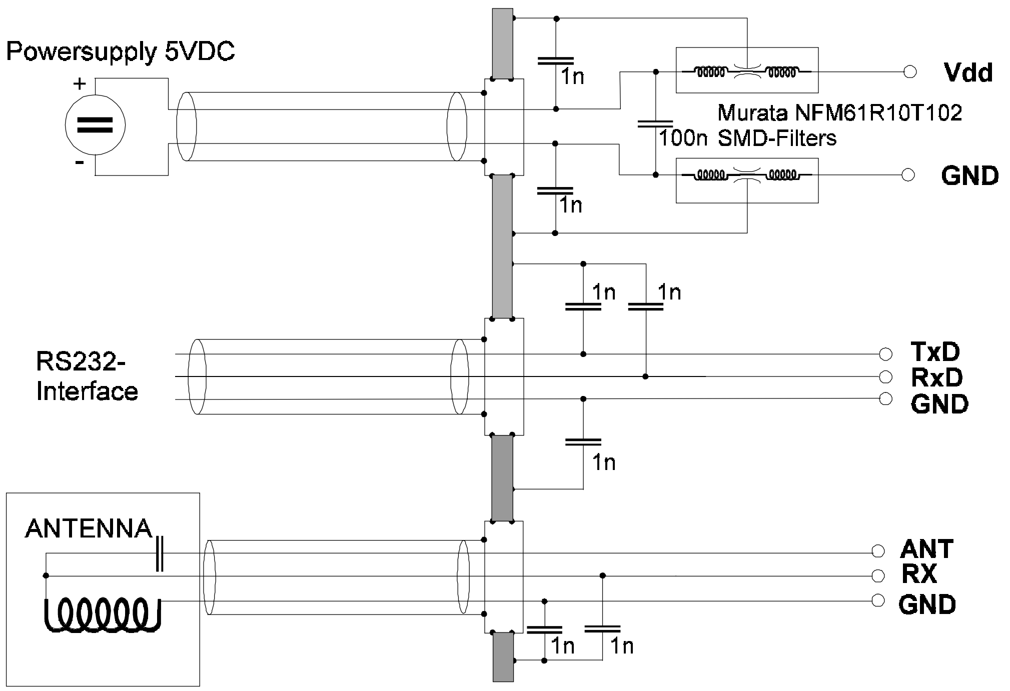


Fig. 1
Common mode filtering

The design consists of a virtual ground layer (drawn grey in the schematic above). All entering wires are blocked by 1nF ceramic capacitors to this layer to prevent common mode disturbances from entering the following circuits. The virtual ground layer is floating, it is not connected to the ground itself.
A recommended metal housing that covers the HITAG Core Module would also be connected to this floating layer.

5.1. Filtering of Power Supply

The transmitter of the HITAG Core Module is supplied via AVDD and GND. Disturbances on these supply pins are amplified and may reduce the performance of the system. For that reason especially the analog supply (AVDD) must be filtered in addition to the commom mode filtering described in Fig. 1.
On the other hand the spurious emissions at the supply connections caused by the digital parts of the module must be limited (DVDD).
A supressor diode protects the core module from ESD to the power supply line.

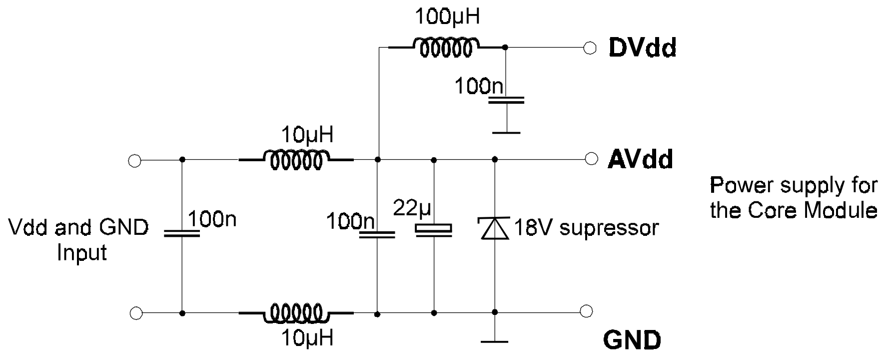


Fig. 2
Power supply filtering

5.2. Filtering of Antenna Circuit

In case of using an external antenna with shielded antenna cable no additional filtering should be necessary. In case of heavy disturbed environment an additional filter circuit is recommended when using external antennas.
Using this filter will reduce the reading performance about 20% !

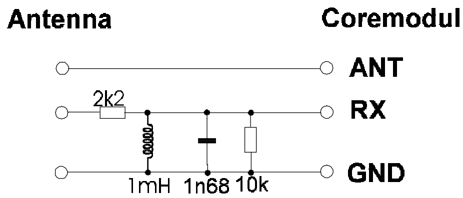


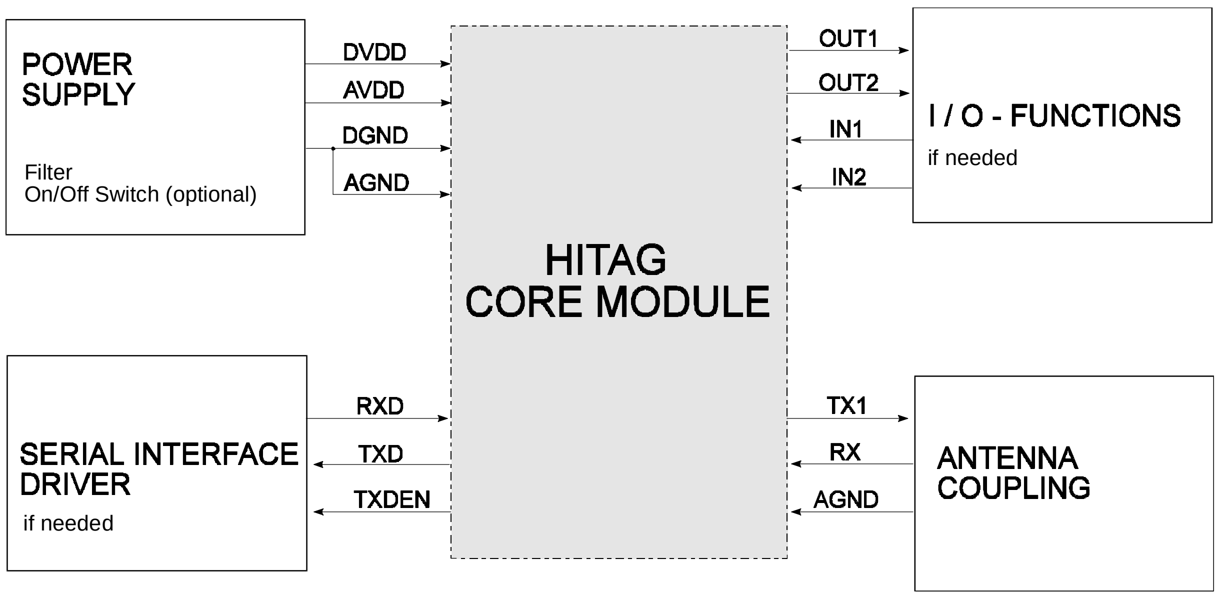
Fig. 3
Filtering of antenna circuit

5.3. ESD Protection

All I/Os should be protected by common circuits consisting of series resistance and suppresser diode.
The transmitter output is already protected by a series resistor and internal diodes of the driving FET´s. To protect the receiver input a 40V bi-directional suppresser diode at the antenna connection is recommended.
If the additional filter shown in Fig. 3 is used, no more protection circuits are needed.

6. Connection of the HITAG Core Module in order to build a proximity read/write device

You need only a few external components to make the HITAG Core Module into a proximity read/write device:



6.1. Power Supply

You have to supply the HITAG Core Module with 5 VDC ± 5 % and it is absolutely necessary to use low resistance (< 0.7 Ω) power supply. Voltage regulation is required and we recommend separate supply for analog and digital parts.

See also chapter 3.1.1 for power supply ripple.

6.2. Interface Driver

Signal transmission for direct connection to the host can be done over the serial CMOS interface. For short distances the transmission can be done over an RS232 interface, longer distances require integration of an RS485 or RS422 interface component. If you use an RS485 interface, Pin 1 (TXDEN) is used as control pin.

6.3. I / O Functions

If necessary you can connect these inputs and outputs to drivers for LEDs and keys.

6.4. Instructions for Building HITAG Proximity Antennas

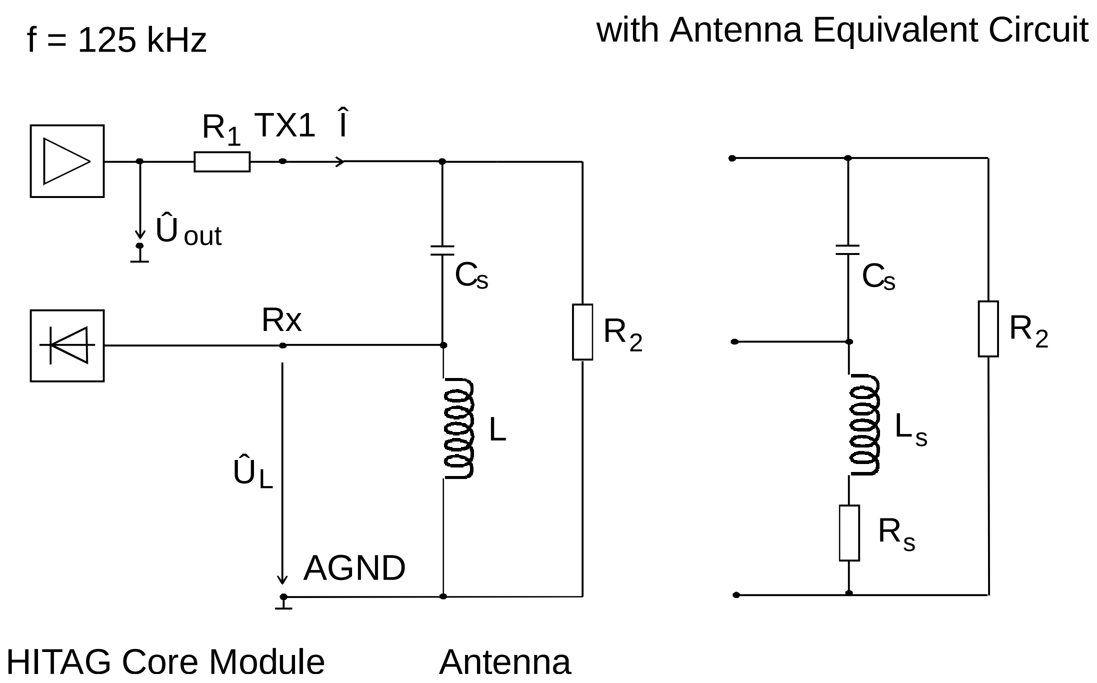
The antenna is an important part in the data transmission process between read/write device and transponder. Therefore, you should be particularly careful when implementing the antenna in order to achieve optimum results.

An essential aspect in dimensioning HITAG proximity antennas is the ratio between the antenna diameter and the diameter of the transponder coil. This ratio should be within the limit values 3 and 1. If the ratio is too big or too small read/write distances can decrease and difficulties during data transmission may occur.

For applications in which the transponders are to be only read, you can also use antennas that diverge from above mentioned instruction.

6.4.1. Basics

The following block diagram shows the general architecture of a HITAG Proximity antenna and its connection to the HITAG Core Module.



When developing an antenna, it is important to take into consideration the read/write device limits, i.e. maximum antenna current and maximum voltage at the receiver input. With an output voltage $\hat{U}_{out}$ of about 2.5 V_p the following limits apply to the HITAG Core Module:

maximum antenna current: 100 mA_p
maximum input voltage (at the receiver ($\hat{U}_L$)): 32 V_p

The resistance R_1 (22 Ohm) in the block diagram is used as current limiter. It protects the output stage in the event of a possible short circuit in the antenna and is already integrated in the HITAG Core Module. R_2 (approx. 600 ... 1000 Ω) has only to be used for antenna cable lengths of more than 50 cm.

6.4.2. Antenna Coil

The inductance of the coil should be between 350 and 500 µH.

The antenna quality factor should be approximately Q = 40.

$$Q = \frac{2 \cdot \pi \cdot f \cdot L}{R_S}$$

Is the Q factor too high it must be reduced with an additional resistor. It is the aim not to need this additional resistor but use a lower wire diameter of the coil.

The following formula describes the approximate calculation of the number of windings for a desired inductance and antenna geometry:

$$L = 2 \cdot a \cdot \ln\left(\frac{a}{D} - K\right) \cdot N^{1.9}$$

The abbreviations read as follows:

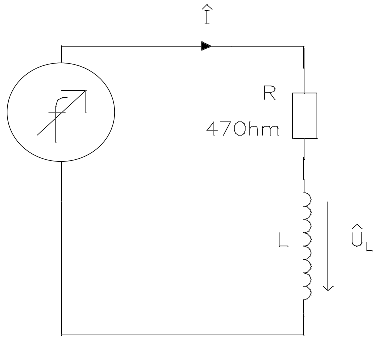
L	...	desired inductance [nH]	
a	...	antenna circumference [cm]	
D	...	wire diameter [cm]	
N	...	number of windings	
K	...	geometrical constant	
		circular antenna :	K=1.01
		square antenna :	K=1.47

Note: The factor K is normally much smaller than a/D and can be therefore left out:

$$N \approx \sqrt[1.9]{\frac{L}{2 \cdot a \cdot \ln(a / D)}}$$

6.4.3. Measuring the Inductance

The inductance of the coil designed following above listed instructions can be measured using the following measuring set-up:



A sinus signal of 125 kHz is fed using a function generator. If you measure the current Î and the antenna voltage $\hat{U}_L$ you can calculate the inductance according to the following formula:

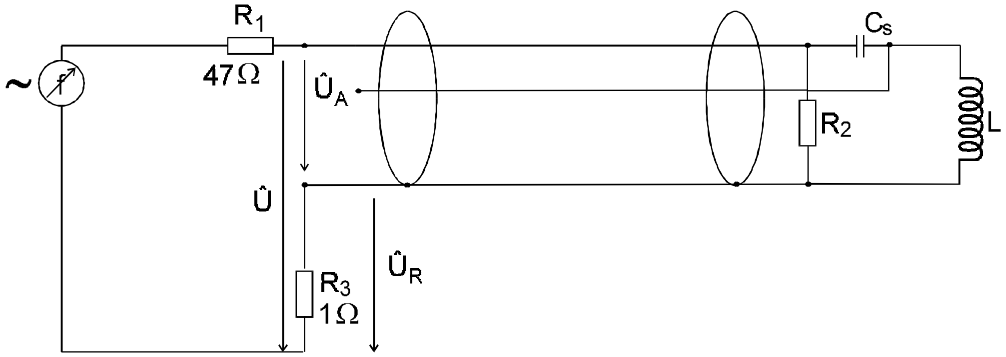
$$L = \frac{\hat{U}_L}{\omega \cdot \hat{I}} \qquad \omega = 2 \times p \times f$$

6.4.4. Antenna Cable Length

For optimal performance the antenna cable length should not exceed 5 m.

6.4.5. Antenna Tuning

You have to tune the antenna in its final form with the connecting cable. You must not make any changes to the antenna coil or the connecting cable after you finished tuning because mechanical changes influence the electrical values and the antenna is detuned again.



A sinus signal of 125 kHz is fed to the antenna using a frequency generator. You measure the voltages Û and $\hat{U}_R$ with an oscilloscope. Then you change the frequency until Û and $\hat{U}_R$ are in phase. If the resonance frequency thus arrived at is too high, you have to increase C_S, if it is too low, you have to decrease C_S.

The aim is to arrive at a resonance frequency of 125 kHz using C_S.

The resonance frequency has to be in the range of 125kHz ± 4kHz.

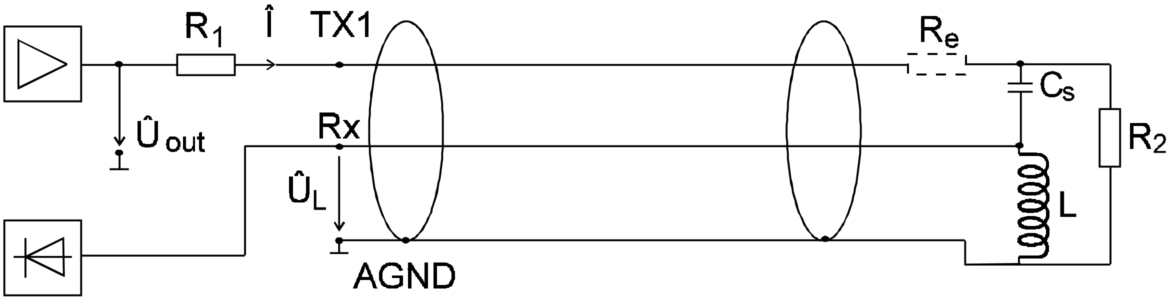
6.4.6. Determining the Serial Resistance of the Antenna

Use an oscilloscope to measure $\hat{U}_A$ and $\hat{U}_R$ at a frequency of 125 kHz.
You can calculate the serial resistance R_S of the antenna with the following formula:

$$\hat{I} = \frac{\hat{U}_R}{R_3} \qquad Þ \qquad R_s = \frac{\hat{U}_A}{\hat{I}}$$

6.4.7. Checking the Antenna Voltage $\hat{U}_L$

Before connecting the antenna to the read/write device as shown in the illustration below, you must carry out a check calculation of the input level of the read/write device according to the formulas further down in order to prevent damage.



$$\hat{I} = \frac{\hat{U}_{out}}{R_1 + R_s + (R_e)}$$

$\hat{U}_{out} \approx 2.5\ V_p$ $\qquad \hat{U}_L = L \cdot \omega \cdot \hat{I}$ $\qquad \omega = 2\pi f$ (f = 125 kHz)

The maximum value for $\hat{U}_L$ reads 32 V_p , safeguarding against damage to the input level of the read/write device.

With $\hat{U}_L < 32\ V_p$ the resistance R_e can be omitted

With $\hat{U}_L > 32\ V_p$ you have to calculate and insert R_e according to the following formula:

$$R_e = L \cdot \omega \cdot \frac{\hat{U}_{out}}{\hat{U}_{L\max}} - R_1 - R_s \qquad Þ \qquad R_e \geq L \cdot \omega \cdot 0{,}078 - 22 - R_s$$

6.4.8. Procedure for Practical Antenna Design

The procedure how to design a HITAG Proximity antenna is described in the previous chapters. The main steps are the following:

1. The desired inductance for the antenna coil can be chosen in a range between 350 and 500 µH, e.g. L = 420 µH).

2. The number of windings N can be calculated with the following formula:

$$N = \sqrt[1.9]{\frac{L\,[nH]}{2 \cdot a \cdot \ln(a / D) - K}}$$

for L = 420 µH:

$$N = \sqrt[1.9]{\frac{420\ 000}{2 \cdot a \cdot \ln(a / D) - K}} = \frac{633}{\sqrt[1.9]{a \cdot \ln(a / D)}}$$

Note: The factor K (see also Chapter 6.4.2.) normally is much smaller than a/D and can be therefore left out.

3. Now the antenna can be built up with the desired dimensions (⇒ circumference a) with the calculated number of turns.

Note: The antenna coil must not be changed afterwards because with the mechanical dimensions the electrical specifications are changing too. That means the number of turns, the shape, arrangement of the coil windings and antenna supply cable must be in their final form.

Note: Metal influences the electrical characteristics of the antenna very much. That is why all future tasks have to be done with the antenna in its final environment if metal will be in the antenna´s neighbourhoud (distance of the metal < maximum antenna diameter).

4. Measurement of the inductance L of the antenna is described in Chapter 6.4.3.

5. Determination of the serial capacitor C_S is described in Chapter 6.4.5.

Note: The capacitance of the antenna supply cable can be measured or found out in the data sheet of the cable (e.g. C_p = 180 pF/m).

6. Now the antenna has to be tuned according to Chapter 6.4.5.
   The tuning is acceptable if the resonance frequency is within a range of 125kHz ± 4kHz.

7. The serial resistance R_S of the antenna is the impedance of the tuned antenna and is an ohmic resistance at the resonance frequency (f = 125 kHz). It can be calculated as shown in Chapter 6.4.6.

8. To get a satisfactory reading distance the quality factor of the antenna **coil** (for non-metal environment) should be about Q = 40. The quality factor of a coil is calculated as follows:

$$Q = \frac{\omega \cdot L}{R_S} = \frac{2 \cdot \pi \cdot f \cdot L}{R_S}$$

9. By knowing R_S and the dropping resistor (R_1 = 22 Ω) it is possible to calculate the current $\hat{I}$ and the antenna voltage $\hat{U}_L$.
   It is very important to calculate the antenna voltage before connecting the antenna to the HITAG Core Module to avoid damage. Is the calculated value of $\hat{U}_L$ higher than $\hat{U}_L$ = 32 V_p a resistor R_e has to be integrated to protect the module output circuit. The resistor has to be placed as shown in Chapter 6.4.7.

10. After checking the antenna voltage as described in point 9. connect your antenna to the HITAG Core Module and measure the read/write distances with your transponders.
    If the read/write distances do not fulfill your expectations, the following points should be considered:

    - The size of the antenna and the size of the transponder have to be in a defined ratio (between 3 and 1).
      That means, if you increase the antenna over a certain size, the maximum read/write distances will decrease by the use of the same transponder.

    - The optimal shape of the antenna coil is a circle. The performance of a square shaped coil is much better than that of a rectangular shaped coil (with the same circumference).

    - To get better read/write distances the quality factor of the antenna **coil** should be increased, but it must not be higher than Q = 40. This can be reached by the following measures:

      - All conducting material has to be removed from the antenna environment.
      - A thicker wire can be used for the coil.
      - Ferrite can be placed behind the antenna coil to concentrate the field.
      - Extension of the antenna area.
      - There can be better results by trying another number of turns.

Attention: All these measures must not differ from the antenna design instructions of Chapter 6.4.

Note: With additional dropping resistor R_1 and resistor R_e the quality factor of the **whole antenna system** is about Q = 15.

6.4.9. Reference Antennas

Designing an antenna in the way described in this chapter you could use the following values:

- ∅ 0.4 mm Cu - laqueur wire
- 35 turns
- Diameter of the turns (internal): 145 mm
- Tuning frequency: 125 kHz
- Tuning Capacity depending on: - length of the antenna cable
  - exact way of winding

This antenna is best suitable for HITAG 1 and HITAG 2 cards. In this performance reading distances of about 150 mm should be achieved.

A further antenna configuration:

- ∅ 0.224 mm Cu - laqueur wire
- 52 turns
- Diameter of the turns (internal): 65 mm
- Tuning frequency: 125 kHz
- Tuning Capacity depending on: - length of the antenna cable
  - exact way of winding

In this case cards and coins can be used and the following approximate communication distances should be achieved:

read distance with HITAG 1 and HITAG 2 card: 120 mm
read distance with HITAG 1 and HITAG 2 coin: 65 mm

The third antenna configuration is the smallest one:

- ∅ 0.224 mm Cu - laqueur wire
- 85 turns
- Diameter of the turns (internal): 35 mm
- Tuning frequency: 125 kHz
- Tuning Capacity depending on: - length of the antenna cable
  - exact way of winding

Using this antenna coins and pills can be operated up to the following approximate distances:

read distance with HITAG 1 coin: 58 mm
read distance with HITAG 1 pill: 28 mm

All distances are given in free air at room temperature.

Specifications subject to change without notice.

6.5. Possible Sources of Errors by Connecting the HITAG Core Module

The following error list should be checked if any error (e.g. read/write distances that do not reach the specified values) occurs:

- Power supply cable not mounted correctly.

- Bad filtering of the power supply.
  Remedial measure: Filtering as described in Chapter 5.1.

- Power supply not in the specified range (U = 5 VDC ± 5 %).

- RS232 interface not connected correctly.

- Interference received by the HITAG Core Module because of the digital part of a possible additional circuit board.
  Remedial measure: Shielding of the additional circuit board.

- Interference received by the HITAG Core Module because of an external noise source.
  Remedial measure: Housing of metal or shielding.

- Interference received by the antenna because of an external noise source (e.g. monitor, keys).
  Remedial measure: Removal of the antenna from the interfering area.

- Connecting cables of the antenna changed by mistake.

- Antenna is mounted in metal environment.
  Remedial measure: Mount a non-metal space keeper between the antenna and the metal.

- Antenna is not designed following the design instructions of Chapter 6.4.

- Inductance of the antenna is too high.

- Quality factor of the antenna is too high (> 40).

- Antenna current is too high.

- Antenna voltage is too high.

7. Security Considerations

Developing the HITAG Core Module special consideration was given to aspects of security. The following items represent the fundamental framework of the security concept:

- cryptography
- mutual authentication
- password verification and
- Cyclic Redundancy Check (CRC)

7.1. Operating Security

The following mechanisms ensure the operation security of the HITAG system.

7.1.1. Anticollision Mode

Anticollision Mode in long range applications permits you to process several HITAG 1 transponders simultaneously. Theoretically up to 2^{32} transponders can be processed simultanously. In practice this number is limited, because of the mutual influence of the transponders - they detune each other, if there are too many too close to each other.

In proximity applications using HITAG 1 or HITAG 2 transponders, only one transponder is handled even if there are several transponders within the communication field of the antenna. In this case either no communication takes place or the "stronger" or closer transponder takes over.
By muting a selected transponder (HALT Mode) another transponder that is to be found in the communication field of the antenna can be recognized.

7.1.2. Monitoring the Supply Voltage

Supply voltage is controlled by a watch dog circuit which triggers a system reset if the supply voltage drops below 4.75 V or if the micro controller fails.

7.1.3. Antenna Rupture, Antenna Short Circuit

The HITAG Core Module does not get permanently damaged in case of an antenna rupture or a brief antenna short circuit.

7.2. Data Reliability

All the commands and data transferred from the HITAG Proximity Reader Module to the transponder are secured by Cyclic Redundancy Check (CRC).

7.2.1. CRC of a Data Stream between Reader Module and Transponder

(This check is carried out in the transponder)
Every data stream sent (commands, addresses, user data) from the HITAG Proximity Reader Module to the transponder is first checked for data errors by a transponder-integrated 8-bit CRC generator and then executed. Normally the transponder responds to each data stream from the HITAG Proximity Reader Module with an acknowledgement signal or with a data block. The CRC is formed over commands and addresses or the plain data respectively and in the case of Encrypted Mode it is also encrypted.
The generator polynomial of the transponder CRC generator reads:

$$u^8 + u^4 + u^3 + u^2 + 1 \text{ ....= } 0x1D$$

and the CRC preassignment is: 0xFF

7.2.2. Checking User Data

(This check is carried out in the HITAG Proximity Reader Module)

Security of the data read from the transponder by the HITAG Proximity Reader Module remains with the user for reasons of flexibility. Therefore, you can choose flexible check sums and store them in the EEPROM together with the data. You can protect sensitive data better than less sensitive data, thus permitting optimised operation times.
Detailed instructions how to use and calculate Cyclic Redundancy Check (CRC) are available in an additional document.

7.3. Data Privacy

The use of cryptography (Stream Cypher), mutual authentication, and password verification prevents monitoring and copying the data channel. Therefore, the area of the transponder that only can be accessed enciphered is called “secret area“.
To make use of cryptography you need secret data: keys and logdata.

> **Keys** are used to **initialise the crypto block**
> and **logdata** are used for **mutual authentication**.

The transponders and the HITAG Proximity Reader Module are provided with identical transport keys and transport logdata so that you can start operating them right away.

The KeyInit Password is set to 0x00000000, HITAG 1 Keys and Logdata are set to 0x00000000, HITAG 2 Key is set to 0x4D494B524F4E, HITAG 2 Password TAG to 0xAA4854 and HITAG 2 Password RWD to 0x4D494B52 by Philips (predefined *transport* values).

In order to offer our OEM clients high flexibility, the configuration of the transponder memory, password, keys and logdata can be changed.
We strictly recommend to rigorously restrict these possibilities for the end customers (by setting the configuration page to read only, setting password, keys and logdata to neither read nor write).

See also Software-Protocol Reader - Host.

8. Ordering Information

Type Name	Description	Ordering Number
HT CM400/EAE	HITAG Core Module	9352 339 00122

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