DATA SHEET

hitag

HTRM800 family
HITAG long range reader module hardware

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HITAG long range reader module hardware

HTRM800 family

1 FEATURES

- Multi-tag operation (anticollision)
- Read and write distances up to 1000 mm
- Digital signal processor to reduce noise sensitivity
- Communication with all HITAG transponders and various other 125 kHz transponders
- Data encryption and key handling
- Easy system integration
- Three interface options
- Meets all requirements for CE and EMI approval.

2 APPLICATIONS

- Universal and flexible reader module for long range systems.

3 GENERAL DESCRIPTION

HITAG(1) is the name of one of the universal and powerful product lines of our 125 kHz family. The contactless read and write system that works with passive transponders is suitable for various applications.

Inductive coupling helps you to achieve operating ranges 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.

(1) HITAG - is a trademark of Philips Semiconductors Gratkorn GmbH.

4 ORDERING INFORMATION

PART NUMBER	NAME	ORDER CODE (12NC)
HTRM800/AED	HITAG long range reader module RS232	9352 338 40122
HTRM800/CED	HITAG long range reader module RS485	9352 338 50122
HTRM800/EED	HITAG long range reader module CMOS	9352 338 60122

5 BLOCK DIAGRAM

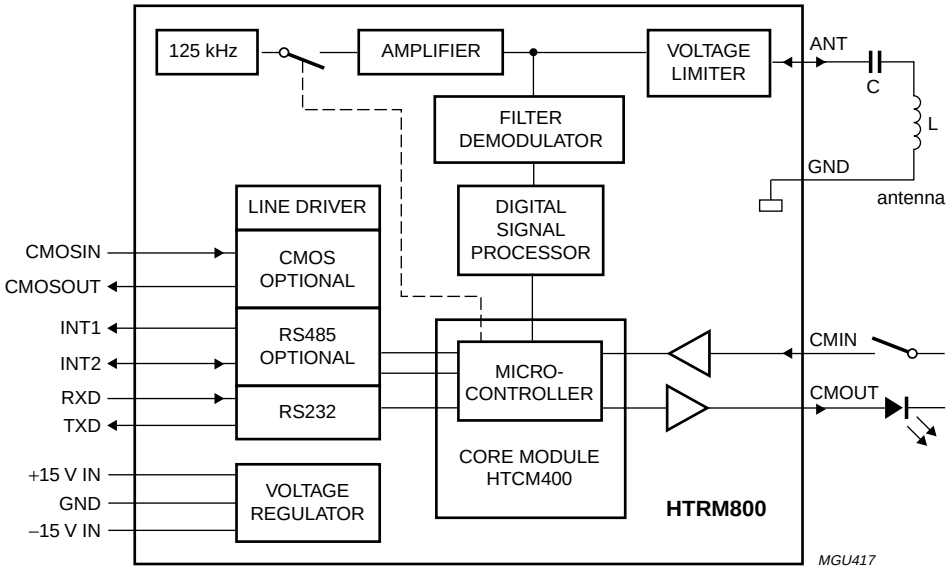


Fig.1 Block diagram.

6 PINNING

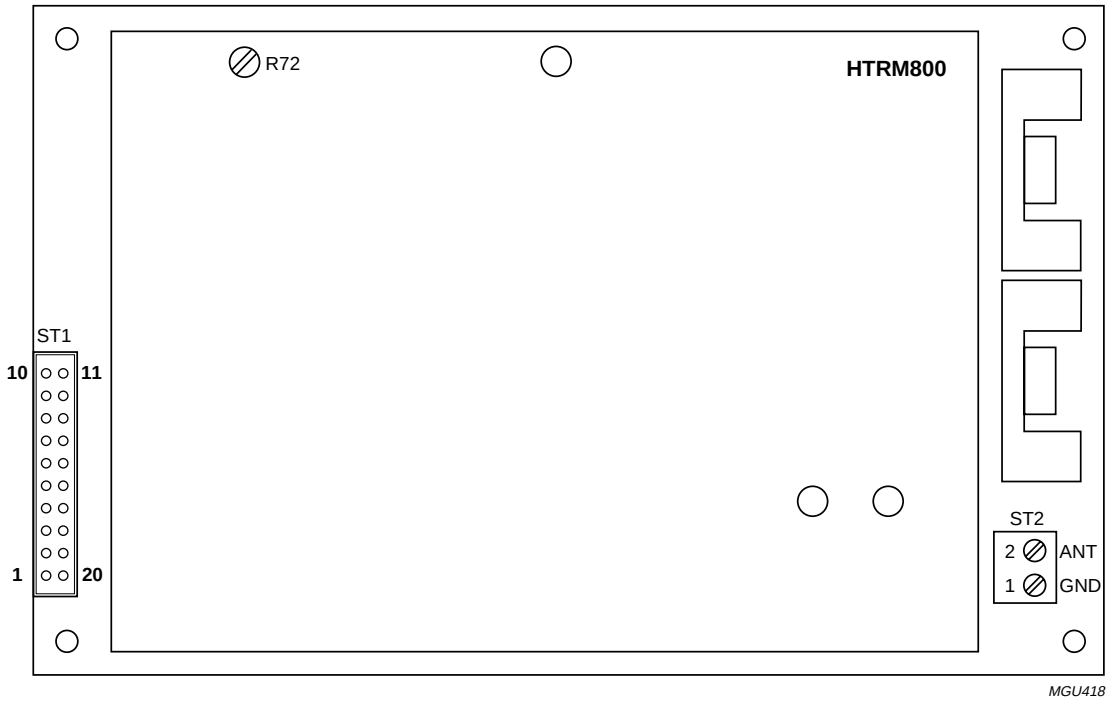


Fig.2 Pin assignment.

6.1 ST1 connector

SYMBOL	PIN	TYPE[1]	DESCRIPTION
–15VIN	1	P	DC supply voltage (–15 V)
GND	2	P	ground
+15VIN	3	P	DC supply voltage (+15 V)
GND	4	P	ground
RXD	5	I	serial interface input; RS232 level
GND	6	P	ground
CMOSIN	7	I	serial interface input; CMOS level (optional)
INT1	8	I/O	serial interface input and output 1; RS485 level (optional)
CMIN	9	I	core module input; general purpose
CMOUT	10	O	core module output; general purpose
GND	11	P	ground
GND	12	P	ground
INT2	13	I/O	serial interface input and output 2; RS485 level (optional)
CMOSOUT	14	O	serial interface output; CMOS level (optional)
GND	15	P	ground
TXD	16	O	serial interface output; RS232 level
GND	17	P	ground
+15VIN	18	P	DC supply voltage (+15 V)
GND	19	P	ground
–15VIN	20	P	DC supply voltage (–15 V)

Note

1. P = power supply, O = output and I = input.

6.2 ST2 connector

SYMBOL	PIN	DESCRIPTION
GND	1	ground
ANT	2	antenna output and input

7 FUNCTIONAL DESCRIPTION

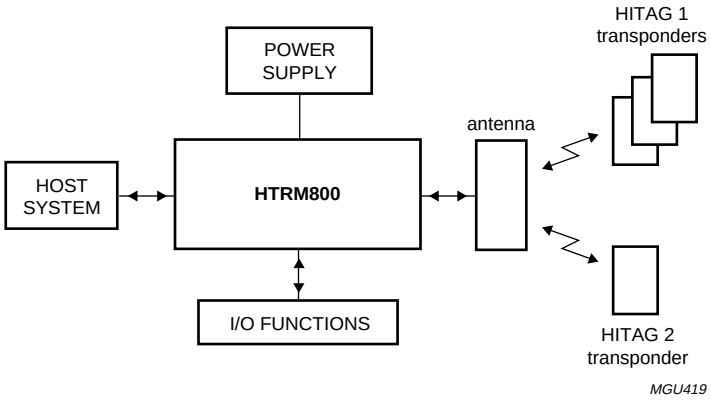


Fig.3 System overview.

7.1 System overview

The HITAG long range reader module (see Fig.3) is a part of a complete Radio Frequency Identification (RFID) system which consists of:

- Transponders
- Antenna
- Host system
- I/O functions
- Power supply.

7.1.1 TRANSPONDERS

The HTRM800 can communicate with transponders based on Philips HITAG 1 and HITAG 2.

7.1.2 ANTENNA

The antenna is an important part of the HITAG long range system. The antenna must provide energy and data transmission between the reader module and transponder.

7.1.3 HOST SYSTEM

The connection to the host system (e.g. microcontroller or PC) is a serial interface on RS232 level for data transmission.

7.1.4 I/O FUNCTIONS

One line of the HTRM800 is wired as input from e.g. a switch and one line as output to drive a LED.

7.1.5 POWER SUPPLY

The HTRM800 must be supplied from an external power supply with +15 V and −15 V (see Section 10.3).

7.2 Reader module software

Software command names mentioned in this data sheet are fully described in document *"HTCM400, HTRM440 Family, HTRM800 Family Interface Protocol Reader - Host"*.

7.3 Reader module hardware

7.3.1 MICROCONTROLLER

The microcontroller is placed on the HITAG core module (see Fig.1) and processes the protocol for the communication between the transponders and the reader module. The interface signals are converted so that the transponders are able to process them and the outgoing signals from the transponders are converted into interface-compatible signals.

The second essential microcontroller function is its control function. The microcontroller activates and deactivates the transmitter and switches the receiver between the modes for the different transponders reception.

Additional functions of the microcontroller are controlling the standby mode of the amplifier, detection of detuned or broken antennas (antenna malfunction) and controlling of the input and output for general purpose.

7.3.2 Interface microcontroller to host

The device communicates with the host system via a serial interface using a baud rate of 9600 baud. Data transfer details are: 1 start bit, 8 data bits, 1 stop bit, no parity bit and the least significant bit is sent first.

Version HTRM800/AED has an integrated RS232 level driver. Version HTRM800/CED is wired with an RS485 level driver and version HTRM800/EED is wired with a CMOS level driver.

7.3.3 Transmitting part

For transmitting power and data to the transponder a 125 kHz sine signal is switched by the microcontroller and amplified. The amplifier is designed as a current source. A voltage limiter is used to clamp the output voltage of the amplifier during the decay and transient phases of the sine signal.

7.3.4 Receiving part

After filtering and demodulation of the amplitude modulated signal received from the transponder, the received data is converted and passed to the Digital Signal Processing (DSP) unit for further processing.

7.3.5 Digital signal processing unit

The receiving part of the reader module includes bandpass filters which attenuate disturbances (3 dB attenuation at 105 and 145 kHz). For disturber frequencies near the 125 kHz (e.g. harmonics of the line frequency of PC monitors, long wave transmitters) a fourier transformation is used to recognize harmonic disturbers and to eliminate their influence. The DSP is also responsible for separating the responses of different transponders during anticollison cycles (multiple transponder operation).

7.3.6 Periodic disturbers

There are a couple of possible sources for disturbances for a 125 kHz system like HITAG. The HTRM800 is designed to handle this problem and achieve optimal performance under worst conditions.

Long wave transmitters, other 125 kHz systems and PC monitors are examples for periodic disturbers which can be relevant for 125 kHz systems. To eliminate these disturbers the digital signal processing unit is used.

After the command StartFFT is sent to the reader module a Fast Fourier Transformation (FFT) is started to locate periodic disturbers. After about 110 ms this calculation is finished and for the following communication between reader module and transponder the located disturbers are eliminated. The command StartFFT should be executed as often as the application allows.

Remarks:

1. The DSP is able to suppress up to two harmonic electromagnetic disturbances
2. During FFT is running (about 110 ms) communication with a transponder is not possible.

7.3.7 Voltage regulating unit

The reader module contains some filtering circuits which supply all parts of the reader module with the required voltages. Nevertheless some requirements are to be fulfilled by the external power supply. This means the maximum ripple of the supply voltages must not exceed the values specified in Chapter 8.

7.3.8 Standby mode

The HTRM800 offers a software controlled standby mode. This mode can be activated and deactivated by the host system. During the standby mode the amplifier is turned off and the power consumption decreases drastically.

7.3.9 Behaviour with HITAG 1 transponders

If several HITAG 1 transponders arrive simultaneously within the communication field of the antenna of a HTRM800, all the transponders (theoretically up to 2^{32}) within the communication field of the antenna can be read and written simultaneously. 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.

7.3.10 Behaviour with HITAG 2 transponders

If several HITAG 2 transponders arrive simultaneously within the communication field of the antenna of a HTRM800, 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 the other transponders are ignored. This ensures that no two (or several) HITAG 2 transponders will ever be processed (above all written to!) accidentally at the same time. By muting a selected HITAG 2 transponder (HALT mode) another HITAG 2 transponder that is to be found in the communication field of the antenna can be recognized.

7.4 Postal approval

The postal approval can only be granted for final products, not just for components like the HTRM800. But this reader module is designed in a way that it is possible to get the postal approval for a system including the HTRM800.

Electromagnetic emissions comply with the guidelines in FTZ 17 TR 2100, ETS 300 330 and ETS 300 683. Electromagnetic immunity complies with the guidelines in ETS 300 683.

The following configuration is in compliance with the European telecommunication standards:

- Reader module HTRM800
- Power supply according to the recommendations (transformer type)
- Antenna: 50 × 70 cm, number of turns N = 26 and inductivity L = 1.2 mH.

A survey of the passed measurements is given in Table 1.

Table 1 Survey of measurements

ITEM	MEASUREMENT	STANDARD	REQUIREMENTS
EMI	electromagnetic emission	ETS 300 330, Sep 1994	FTZ 17 TR 2100
RFI emission	limit class	EN 55022, 1987	
Immunity	RF electromagnetic field	ENV 50140	80 to 1000 MHz: 3 V/m, AM 80%, 1 kHz
	electrostatic discharge	IEC 801-2, 1991	contact discharge: 4 kV; air discharge: 8 kV
	electrical fast transient (burst)	IEC 801-4, 1988	signal ports: 0.5 kV; DC power ports: 1 kV; AC power ports 2 kV
	RF common mode	ENV 50141	current clamp injection 150 kHz to 80 MHz: 3 V (rms), AM 80%, 1 kHz
	voltage dips and interruptions	IEC 1000-4-11	reduction of 30% of UN for 10 ms, of 60% of UN for 100 ms, voltage interruption for 5 s
	surges, common and differential mode	IEC 1000-4-5	AC power input ports: 1 kV (lines-to-ground), 0.5 V (line-to-line)

7.5 Operating security

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

- Anticollission mode
- Monitoring the supply voltage
- Antenna rupture and short circuit.

7.5.1 Anticollision mode

Anticollision mode in long range applications permits you to process several HITAG 1 transponders simultaneously. Theoretically up to 2^{32} HITAG 1 transponders can be processed simultaneously. 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 long range applications using 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.

7.5.2 Monitoring the supply voltage

The supply voltage is controlled by a watch dog circuit which triggers a system reset if the supply voltage of the core module drops below 4.75 V or if the microcontroller fails.

7.5.3 Antenna rupture and antenna short-circuit

The HTRM800 does not get permanently damaged in case of an antenna rupture or a brief antenna short-circuit. The detection of detuned or broken antennas (antenna malfunction) is possible.

7.6 Security considerations

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

- Cryptography
- Mutual authentication
- Password verification
- Cyclic Redundancy Check (CRC).

7.6.1 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 for HITAG 1 transponders you need:

- Keys to be used for initializing of the crypto block
- Logdata to be used for mutual authentication.

To make use of cryptography for HITAG 2 transponders you need:

- A key which is used to initialize the crypto block using HITAG 2 in crypto mode
- Passwords which are used for authentication for HITAG 2 in password mode.

The transponders and the HTRM800 are provided with identical transport keys and transport logdata so that you can start operating them right away (see Table 2).

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).

Table 2 Transport values predefined by Philips.

SYSTEM	PARAMETER	VALUE
HITAG 1	keyinit password	0x00000000
	keys	0x00000000
	logdata	0x00000000
HITAG 2	keyinit password	0x00000000
	key	0x4D494B524F4E
	password TAG	0xAA4854
	password RWD	0x4D494B52

8 ELECTRICAL SPECIFICATIONS

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Power supply						
V_{P1}	positive supply voltage		–	15	–	V
I_{P1}	positive supply current	operating mode	–	400	550	mA
		standby mode	–	200	–	mA
V_{P2}	negative supply voltage		–	–15	–	V
I_{P2}	negative supply current	operating mode	–	–300	–400	mA
		standby mode	–	–100	–	mA
$V_{ripple(rms)}$	maximum amplitude of ripple on supply voltage (RMS value)	f_{ripple} < 0.5 kHz	–	48	–	mV
		f_{ripple} = 0.5 to 20 kHz	–	7	–	mV
		f_{ripple} = 20 to 120 kHz	–	36	–	mV
		f_{ripple} = 120 to 130 kHz	–	12	–	mV
		f_{ripple} > 130 kHz	–	48	–	mV
Modulation						
m_{TX}	modulation ratio of reader module to transponder	note 1	–	100	–	%
m_{RX}	modulation ratio of transponder to reader module	note 2	–	–	–	%
Interface to host						
f_t	transmission speed		–	9600	–	baud
Temperature						
T_{oper}	operating temperature		–25	–	+70	°C
T_{stg}	storage temperature		–40	–	+85	°C

Notes

1. Modulation type is Amplitude Shift Keying (ASK). A modulation ratio of 100% means the carrier is blanked completely, the information is located in the intervals between the pauses.
2. Modulation type is Amplitude Shift Keying (ASK). The modulation ratio depends on the distance between transponder and reader module.

9 MECHANICAL SPECIFICATIONS

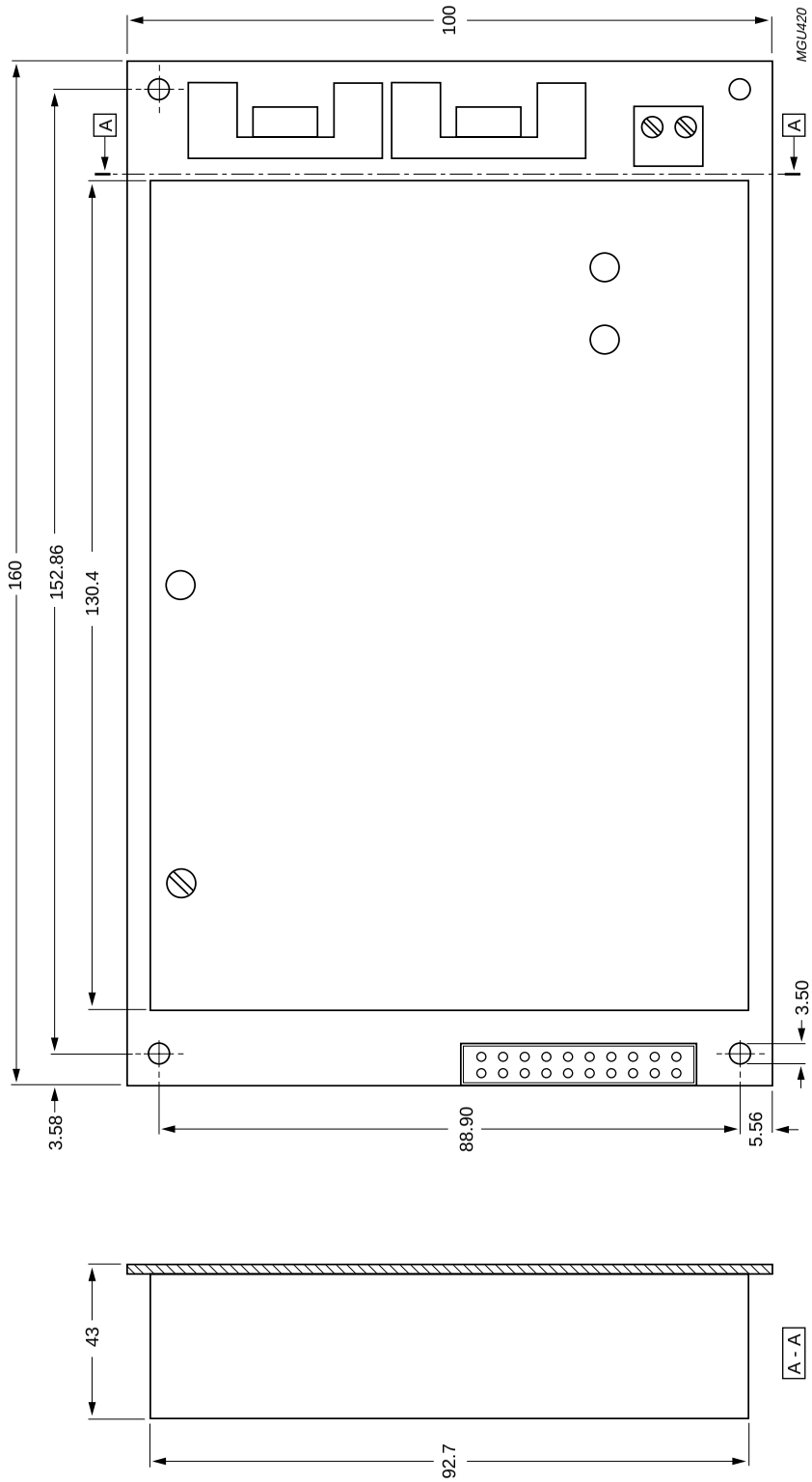


Fig.4 HTRM800 long range reader module.

Dimensions in mm.

10 APPLICATION INFORMATION

10.1 Metallic environment and interferences

The communication range is impaired by metallic environment and electromagnetic interferences (e.g. monitors and keyboards). Therefore, you should keep a distance of at least one time the antenna 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 or shielding for transponder and antenna.

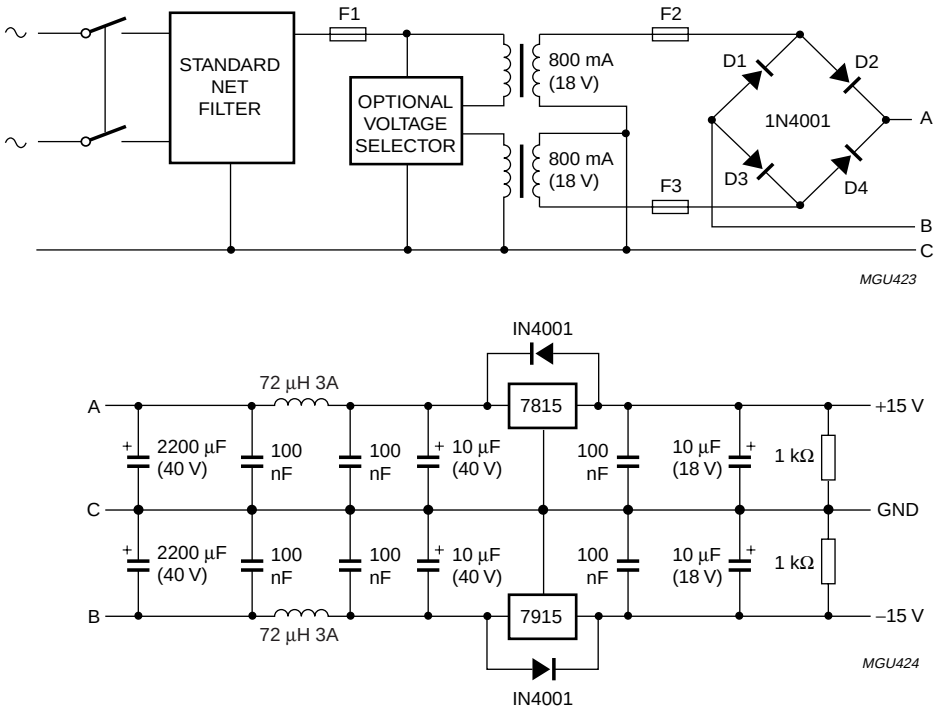
The HTRM800 is able to suppress up to two harmonic electromagnetic disturbances.

10.2 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. To keep this distance low, magnetic shielding must be realized. This topic is handled in detail in application note *"Antenna Design for the HITAG Long Range System"*.

10.3 External power supply

Instead of a transformer type supply unit (see Fig.5), a switching frequency power supply unit can be used alternatively. The switching frequency must be in the range from 165 to 210 kHz (overtemperature, load and production).



F1 = depends on the type of transformer.
F2 = 800 mA delayed.
F3 = 800 mA delayed.
D1 = D2 = D3 = D4 = 4 x 1N4001.

Fig.5 Transformer type power supply.

10.4 Possible sources of errors by connecting the HTRM800

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

- Power supply cable not mounted correctly
- Power supply voltage not in the specified range
- Serial interface not connected correctly
- Interference received by the antenna because of an external noise source (e.g. monitor, keyboards); the remedial measure is to remove the antenna from the interfering area and use the command StartFFT
- Connecting cables of the antenna changed by mistake
- Antenna is mounted in metal environment; the remedial measure is to mount a non-metal space keeper between the antenna and the metal
- Antenna is not designed following the antenna design instructions
- Inductance of the antenna is not in the specified range
- Quality factor of the antenna is not in the specified range.

10.5 Building HITAG long range antennas

10.5.1 BASICS

The exact way how to design a HITAG long range antenna is described in application note *"Antenna Design for the HITAG Long Range System"*.

The antenna is an important part of the HITAG long range system. The antenna must provide energy and data transmission between the reader module and transponder. Therefore, you should be particularly careful when implementing the antenna in order to achieve optimum results.

The equivalent circuit of the antenna is shown in Fig.6.

The requirements of the antenna coil are:

- Quality factor: Q = 30 to 60

$$Q = \frac{X_s}{R_s} \text{ where}$$

X_s = effective series reactance

R_s = effective series resistance

- Inductance: L = 400 to 1200 μH.

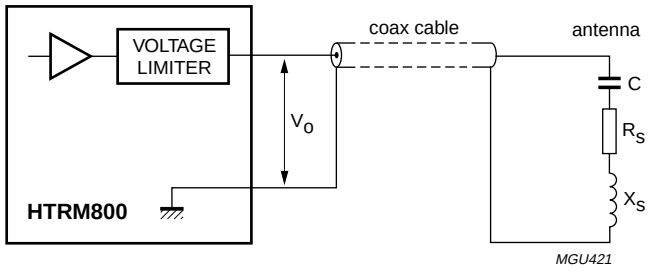


Fig.6 Basics of the long range antenna.

10.5.2 Recommended antenna cable and length

The length of the antenna cable should be limited with five meters. In case of longer cables a type with low capacitance and resistance must be used. For standard applications a 50 Ω coaxial cable is recommended and a 75 or 95 Ω coaxial cable for special applications.

10.5.3 Tuning of the antenna current

Potentiometer R72 (see Fig.2) is used to tune the current driven through the antenna. The default setting is 200 mA. It is not customary to change this value. However, if you want to change the current for a special application, it should be noted that $V_{o(peak)} < 10$ V.

10.5.4 Tuning of the antenna phase

The signal from a transponder is delayed by the decay time of the antenna. To achieve optimal performance this signal and the digital signal processing unit of the reader module must be synchronous. Thus it is necessary to store a phase information called Bit Clock Delay (BCD), which is a function of the quality factor and the inductance (reactance) of the antenna.

The default setting is 7 which is suitable in most of the cases. Apart from that, the user is able to change the BCD value. The reader module includes a non volatile memory (EEPROM) to store the bit clock delay. To load the BCD value to the reader module the command SetBCD is used.

10.5.5 HITAG antenna tuning device

Especially for the HITAG product line the HITAG antenna tuning device HTOT840 was designed. This tuning device can be used for tuning long range and proximity antennas.

10.5.6 Antenna malfunction indication

If the antenna is broken or badly detuned, the antenna overload bit is set. This bit can be read by the host system via the serial interface by using the command ReadLRStatus.

10.5.7 Additional remarks

The following list is a summary about HITAG long range antennas:

- Philips lays high emphasis on the research of antenna development
- The choice of various antenna shapes (the electrical parameters) is characteristic to 125 kHz systems
- The knowledge is transferred to Philips customers, in order to enable them to design and build antennas which fit best for the particular applications (antenna training)
- Solutions can be found for almost every environmental scene (metal, periodic disturbers, special antenna shapes, etc.).

10.6 Antenna arrangements

Various arrangements are suitable for different applications (see Fig.6):

- The single loop antenna is used for standard arrangements
- The gate antenna is used for typical access control applications such as access control during passing through the gate
- The double gate antenna is similar to the gate using two rows
- The antenna multiplex system is a cost efficient application, because one reader module drives many antennas and the number of multiplexed antennas is only limited by timing restrictions.

By changing the arrangement of the antenna, the total system performance and reliability can be significantly improved. As an example: building gate antennas with opposite magnetic orientation leads to a very reliable system.

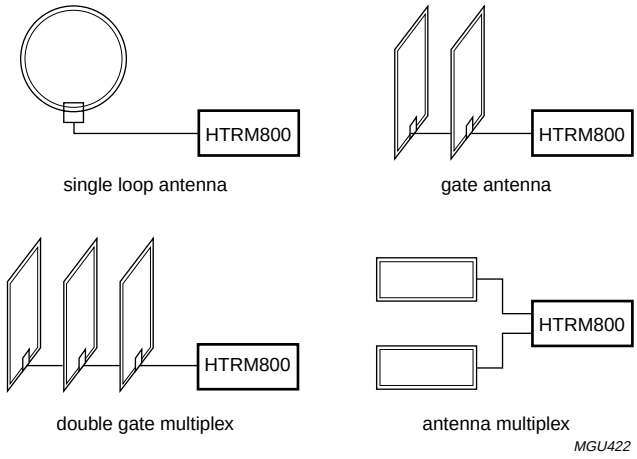


Fig.6 Possible arrangements of antennas.

11 SURVEY OF REFERENCED DOCUMENTS

CATEGORY	TITLE
Data sheet	*"HTCM400, HTRM440 Family, HTRM800 Family HITAG Interface Protocol Reader - Host"*
Application note	*"Antenna Design for the HITAG Long Range System"*

12 DATA SHEET STATUS

DATA SHEET STATUS(1)	PRODUCT STATUS(2)	DEFINITIONS
Objective data	Development	This data sheet contains data from the objective specification for product development. Philips Semiconductors reserves the right to change the specification in any manner without notice.
Preliminary data	Qualification	This data sheet contains data from the preliminary specification. Supplementary data will be published at a later date. Philips Semiconductors reserves the right to change the specification without notice, in order to improve the design and supply the best possible product.
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Notes

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2. The product status of the device(s) described in this data sheet may have changed since this data sheet was published. The latest information is available on the Interned at URL tap://www.semiconductors.philips.com.

13 DEFINITIONS

Short-form specification — The data in a short-form specification is extracted from a full data sheet with the same type number and title. For detailed information see the relevant data sheet or data handbook.

Limiting values definition — Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 60134). 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 sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.

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