HTMS1x01;HTMS8x01

HITAG μ transponder IC

Rev. 3.0 — 28 September 2011
193330

Product short data sheet
COMPANY PUBLIC

1. General description

The HITAG product line is well known and established in the contactless identification market.

Due to the open marketing strategy of NXP Semiconductors there are various manufacturers well established for both the transponders/cards as well as the read/write devices. All of them supporting HITAG 1, HITAG 2 and HITAG S transponder ICs.

With the new HITAG μ family, this existing infrastructure is extended with the next generation of ICs being substantially smaller in mechanical size, lower in cost, offering more operation distance and speed, but still being operated with the same reader infrastructure and transponder manufacturing equipment.

The protocol and command structure for HITAG μ is design to support Reader Talks First (RTF) operation, including anti-collision algorithm.

Different memory sizes are offered and can be operated using exactly the same protocol.

2. Features and benefits

2.1 Features

- Integrated circuit for contactless identification transponders and cards
- Integrated resonance capacitor of 210 pF with ±3 % tolerance or 280 pF with ±5 % tolerance over full production
- Frequency range 100 kHz to 150 kHz

2.2 Protocol

- Modulation read/write device → transponder: 100 % ASK and binary pulse length coding
- Modulation transponder → read/write device: Strong ASK modulation with anti-collision, Manchester and Biphase coding
- Fast anti-collision protocol
- Cyclic Redundancy Check (CRC)
- Transponder Talks First (TTF) mode
- Temporary switch from Transponder Talks First into Reader Talks First (RTF) Mode
- Data rate read/write device to transponder: 5.2 kbit/s
- Data rates transponder to read/write device: 2 kbit/s, 4 kbit/s, 8 kbit/s

2.3 Memory

- Different memory options
- Up to 10000 erase/write cycles
- 10 years non-volatile data retention
- Memory Lock functionality
- 32-bit password feature

2.4 Supported standards

- Full compliant to ISO 11784 and ISO 11785 Animal ID
- Designed to support ISO/IEC 14223 Animal ID with anticollision and read/write functionality

2.5 Security features

- 48-bit Unique Identification Number (UID)

2.6 Delivery types

- Sawn, gold-bumped 8” wafer
- HVSON2
- SOT-1122

3. Applications

- Animal identification
- Laundry automation
- Beer keg and gas cylinder logistic
- Brand protection

4. Quick reference data

Table 1. Quick reference data

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
Wafer EEPROM characteristics							
t_{ret}	retention time	$T_{amb} \leq 55$ °C		10	-	-	year
$N_{endu(W)}$	write endurance			100000	-	-	cycle
Interface characteristics							
C_i	input capacitance	between LA and LB					
		HTMS1x01	[1][2]	203.7	210	216.3	pF
		HTMS8x01	[1][3]	266	280	294	pF

[1] Measured with an HP4285A LCR meter at 125 kHz/room temperature (25 °C); $V_{IN1\text{-}IN2}$ = 0.5 V (RMS)

[2] Integrated Resonance Capacitor: 210 pF ± 3 %

[3] Integrated Resonance Capacitor: 280 pF ± 5 %

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5. Ordering information

Table 2. Ordering information

Type number	Package			
	Name	Description	Type	Version
HTMS1001FUG/AM	Wafer	sawn, megabumped wafer, 150 µm, 8 inch, UV	HITAG µ, 210 pF	-
HTMS1101FUG/AM	Wafer	sawn, megabumped wafer, 150 µm, 8 inch, UV	HITAG µ Advanced, 210 pF	-
HTMS1201FUG/AM	Wafer	sawn, megabumped wafer, 150 µm, 8 inch, UV	HITAG µ Advanced+, 210 pF	-
HTMS8001FUG/AM	Wafer	sawn, megabumped wafer, 150 µm, 8 inch, UV	HITAG µ, 280pF	-
HTMS8101FUG/AM	Wafer	sawn, megabumped wafer, 150 µm, 8 inch, UV	HITAG µ Advanced, 280 pF	-
HTMS8201FUG/AM	Wafer	sawn, megabumped wafer, 150 µm, 8 inch, UV	HITAG µ Advanced+, 280 pF	-
HTMS1001FTB/AF	XSON3	plastic extremely thin small outline package; no leads; 4 terminals; body 1 × 1.45 × 0.5 mm	HITAG µ, 210 pF	SOT1122
HTMS1101FTB/AF	XSON3	plastic extremely thin small outline package; no leads; 4 terminals; body 1 × 1.45 × 0.5 mm	HITAG µ Advanced, 210 pF	SOT1122
HTMS1201FTB/AF	XSON3	plastic extremely thin small outline package; no leads; 4 terminals; body 1 × 1.45 × 0.5 mm	HITAG µ Advanced+, 210 pF	SOT1122
HTMS8001FTB/AF	XSON3	plastic extremely thin small outline package; no leads; 4 terminals; body 1 × 1.45 × 0.5 mm	HITAG µ, 280 pF	SOT1122
HTMS8101FTB/AF	XSON3	plastic extremely thin small outline package; no leads; 4 terminals; body 1 × 1.45 × 0.5 mm	HITAG µ Advanced, 280 pF	SOT1122
HTMS8201FTB/AF	XSON3	plastic extremely thin small outline package; no leads; 4 terminals; body 1 × 1.45 × 0.5 mm	HITAG µ Advanced+, 280 pF	SOT1122
HTMS1001FTK/AF	HVSON2	plastic thermal enhanced very thin small outline package; no leads; 2 terminals; body 3 × 2 × 0.85 mm	HITAG µ, 210 pF	SOT899-1
HTMS1101FTK/AF	HVSON2	plastic thermal enhanced very thin small outline package; no leads; 2 terminals; body 3 × 2 × 0.85 mm	HITAG µ Advanced, 210 pF	SOT899-1
HTMS1201FTK/AF	HVSON2	plastic thermal enhanced very thin small outline package; no leads; 2 terminals; body 3 × 2 × 0.85 mm	HITAG µ Advanced+, 210 pF	SOT899-1
HTMS8001FTK/AF	HVSON2	plastic thermal enhanced very thin small outline package; no leads; 2 terminals; body 3 × 2 × 0.85 mm	HITAG µ, 280 pF	SOT899-1
HTMS8101FTK/AF	HVSON2	plastic thermal enhanced very thin small outline package; no leads; 2 terminals; body 3 × 2 × 0.85 mm	HITAG µ Advanced, 280 pF	SOT899-1
HTMS8201FTK/AF	HVSON2	plastic thermal enhanced very thin small outline package; no leads; 2 terminals; body 3 × 2 × 0.85 mm	HITAG µ Advanced+, 280 pF	SOT899-1

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6. Block diagram

The HITAG µ transponder ICs require no external power supply. The contactless interface generates the power supply and the system clock via the resonant circuitry by inductive coupling to the Read/Write Device (RWD). The interface also demodulates data transmitted from the RWD to the HITAG µ transponder IC, and modulates the magnetic field for data transmission from the HITAG µ transponder IC to the RWD.

Data are stored in a non-volatile memory (EEPROM). The EEPROM has a capacity of up to 1760 bit and is organized in blocks.

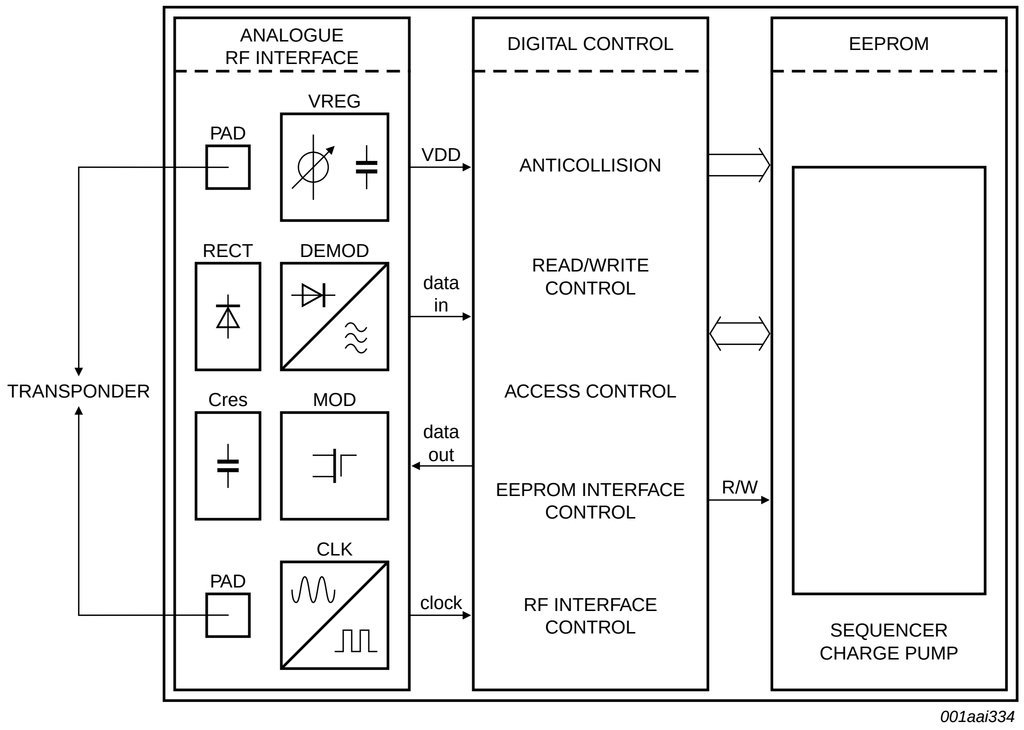

Fig 1. Block diagram of HITAG µ transponder IC

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7. Functional description

7.1 Memory organization

The EEPROM has a capacity of up to 1760 bit and is organized in blocks of 4 bytes each (1 block = 32 bits). A block is the smallest access unit.

The HITAG µ transponder IC is available with different memory sizes as shown in Table 3 “Memory organization HITAG m (128-bit)”, Table 4 “Memory organization HITAG m Advanced (512 bit)” and Table 5 “Memory organization HITAG m Advanced+ (1760 bit)”.

For permanent lock of blocks please refer to Section 7.4.8 “LOCK BLOCK”.

7.1.1 Memory organization HITAG µ transponder ICs

Table 3. Memory organization HITAG µ (128-bit)

Block address	Content	Password Access
FFh	User Config	bit 3 = 0 R/W[2] bit 3 = 1 RO[1]
FEh	PWD	
03h	ISO 11784/ISO 11785 128 bit TTF data	
02h		
01h		
00h		

[1] RO: Read without password, write with password

[2] R/W: Read and write without password

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7.1.2 Memory organization HITAG µ Advanced

Table 4. Memory organization HITAG µ Advanced (512 bit)

Block address	Content	Password Access
FFh	User Config	
FEh	PWD	
0Fh	User Memory	bit 4 = 0 R/W[2] bit 4 = 1 RO[1]
0Eh		
0Dh		
0Ch		
0Bh		
0Ah		
09h		
08h		
07h		
06h		
05h		
04h		
03h	ISO 11784/ISO 11785 128-bit TTF data	bit 3 = 0 R/W[2] bit 3 = 1 RO[1]
02h		
01h		
00h		

[1] RO: Read without password, write with password

[2] R/W: Read and write without password

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7.1.3 Memory organization HITAG µ Advanced +

Table 5. Memory organization HITAG µ Advanced+ (1760 bit)

Block address	Content	Password Access
FFh	User Config	
FEh	PWD	
36h	User Memory	bit 6 = 0; bit 5 = 0 R/W[2] bit 6 = 0; bit 5 = 1 RO[1] bit 6 = 1; bit 5 = 0 R/W(P)[3] bit 6 = 1; bit 5 =1 R/W(P)[3]
35h		
...		
14h		
13h		
12h		
11h		
10h		
0Fh	User Memory	bit 4 = 0 R/W[2] bit 4 = 1 RO[1]
0Eh		
0Dh		
0Ch		
0Bh		
0Ah		
09h		
08h		
07h		
06h		
05h		
04h		
03h	ISO 11784/ISO 11785 128-bit TTF data	bit 3 = 0 R/W[2] bit 3 = 1 RO[1]
02h		
01h		
00h		

[1] RO: Read without password, write with password

[2] R/W: Read and write without password

[3] R/W(P): Read and write with password

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7.2 State diagram

7.2.1 General description of states

RF Off

The powering magnetic field is switched off or the HITAG µ transponder IC is out of the field.

WAIT

After start up phase, the HITAG µ transponder IC is ready to receive the first command.

READY

The HITAG µ transponder IC enters this state after a valid command, except of the STAY QUIET, SELECT or WRITE-ISO 11785 command. If there are several HITAG µ transponder ICs at the same time in the field of the RWD antenna, the anticollision sequence can be started to determine the UID of every HITAG µ transponder IC.

SELECTED

The HITAG µ transponder IC enters the Selected state after receiving the SELECT command with a matching UID. In the Selected state the respective commands with SEL = 1 are valid only for selected transponder.

Only one HITAG µ transponder IC can be selected at one time. If one transponder is selected and a second transponder receives the SELECT Command, the first transponder will automatically change to Quiet state.

QUIET

The HITAG µ transponder IC enters this state after receiving a STAY QUIET command or when he was in selected state and receives a SELECT command addressed to another transponder.

In this state, the HITAG µ transponder IC reacts to any request commandos where the ADR flag is set.

ISO 11785 STATE

In this state the HITAG µ transponder IC replies according to the ISO 11785 protocol.

Remark:

In case of an invalid command the transponder will remain in his actual state.

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7.2.2 State diagram HITAG µ advanced/advanced+

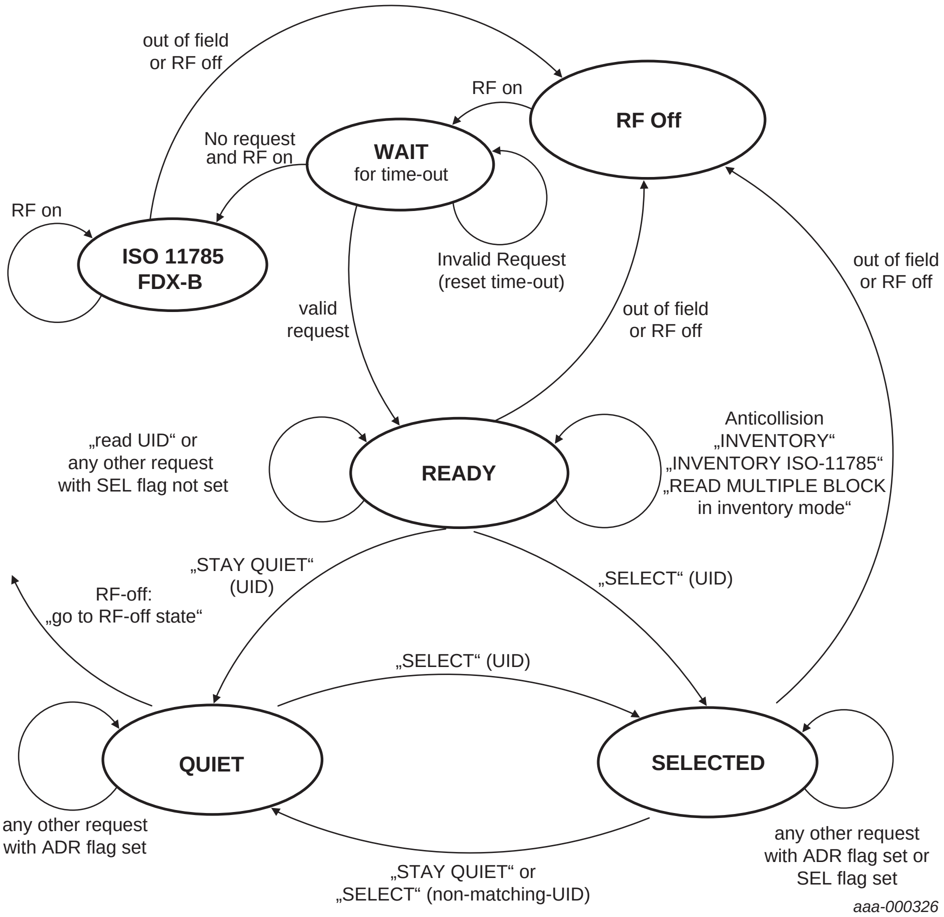

Fig 2. State diagram of HITAG µ Advanced/Advanced+ transponder ICs

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7.2.3 State diagram HITAG µ

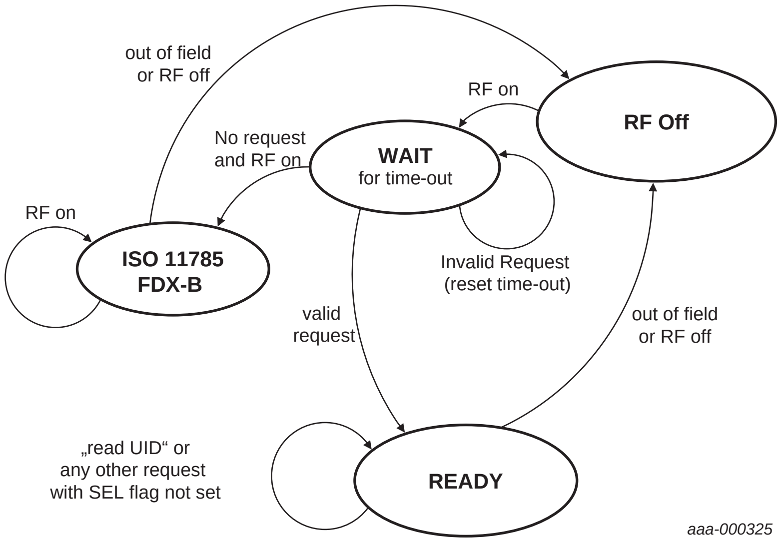

Fig 3. State diagram of HITAG µ transponder IC

7.3 Modes

7.3.1 ISO 11785 Mode

This mode is also named Transponder Talks First (TTF).

Every time a transponder IC is activated by the field it starts executing this mode. After waiting the maximum listening window time the transponder IC sends continuously its TTF data (128-bit).

The TTF data stored in the memory will be not checked for ISO compliance, therefore data will be sent as stored in the EEPROM.

Receiving a valid command or a switch command within the listening window sets the transponder IC into Reader Talks First (RTF) mode.

7.3.2 RTF Mode

In this mode the transponder IC reacts only to RWD request commands as presented in Section 7.4. A valid request consists of a command sent to the transponder IC being in matching state.

7.3.3 Anticollision

The RWD is the master of the communication with one or multiple transponder ICs. It starts the anticollision sequence by issuing the inventory request (see Section 7.4.1). Within the RWD command the NOS flag must be set to the desired setting (1 or 16 slots) and add the mask length and the mask value after the command field.

The mask length n indicates the number of significant bits of the mask value. It can have any value between 0 and 44 when 16 slots are used and any value between 0 and 48 when 1 slot is used.

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The next two subsections summarize the actions done by the transponder IC during an inventory round.

7.3.3.1 Anticollision with 1 slot

The transponder IC will receive one ore more inventory commands with NOS = '1'. Every time the transponder ICs fractional or whole UID matches the mask value of RWD's request it responses with remaining UID without mask value.

Transponder ICs responses are modulated by dual pattern data coding as described in the full data sheet.

7.3.3.2 Anticollision with 16 slots

The transponder IC will receive several inventory commands with NOS = '0' defining an amount of 16 slots. Within the request there is the mask specified by length and value (sent LSB first).

In case of mask length = '0' the four least significant bits of transponder ICs UID become the starting value of transponder IC's slot counter.

In case of mask length ≠ '0' the received fractional mask is compared to transponder IC's UID. If it matches the starting value for transponder IC's slot number will be calculated. Starting at last significant bit of the sent mask the next four less significant bits of UID are used for this value. At the same time transponder IC's slot counter is reset to '0'.

Now the RWD begins its anticollision algorithm. Every time the transponder IC receives an EOF it increments slot-counter. Now if mask value and slot-counter value are matching the transponder IC responses with the remaining UID without mask value but with slot number

In case of collision within one slot the RWD changes the mask value and starts again running its algorithm.

7.4 Command set

7.4.1 INVENTORY

[Advanced, Advanced+]

Upon reception of this command without error, all transponder ICs in the ready state shall perform the anticollision sequence. The inventory (INV) flag shall be set to '1'. The NOS flag determines whether 1 or 16 slots are used.

If a transponder IC detects any error, it shall remain silent.

7.4.2 INVENTORY ISO 11785

[Advanced, Advanced+]

Upon reception of this command without error, all transponder ICs in the ready state are performing the anticollision sequence. The inventory (INV) flag is set to '1'. The NOS flag determines whether 1 or 16 slots are used.

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In contrast to INVENTORY command the transponder IC (holding requested slot) sends the 64-bit ISO 11785 number in addition to remaining UID. The 64-bit number is taken from a fixed area of EEPROM. It will not be checked on ISO 11785 compliance before sending.

If a transponder IC detects any error, it remains silent.

7.4.3 STAY QUIET

[Advanced, Advanced+]

Upon reception of this command without error, a transponder IC in either ready state or selected state enters the quiet state and shall not send back a response.

The STAY QUIET command with both SEL and ADR flag set to '0' or both set to '1' is not allowed.

There is no response to the STAY QUIET request, even if the transponder detects an error

7.4.4 READ UID

[µ, Advanced, Advanced+]

Upon reception of this command without error all transponder ICs in the ready state are sending their UID.

The ADdRessed (ADR), the SELect (SEL), the INVentory (INV) and the Protocol EXTension (PEXT) flag are set to '0'.

7.4.5 READ MULTIPLE BLOCK

[µ, Advanced, Advanced+]

Upon reception of this command without error, the transponder reads the requested block(s) and sends back their value in the response. The blocks are numbered from 0 to 255.

The number of blocks in the request is one less than the number of blocks that the transponder returns in its response i.e. a value of '6' in the 'Number of blocks' field requests to read 7 blocks. A value '0' requests to read a single block.

7.4.6 READ MULTIPLE BLOCKS in INVENTORY mode

[Advanced, Advanced+]

The READ MULTIPLE BLOCK command can also be sent in inventory mode (which is marked by INV flag = '1' within the request).

If the transponder detects an error during the inventory sequence, it shall remain silent.

7.4.7 WRITE SINGLE BLOCK

[µ, Advanced, Advanced+]

Upon reception of this command without error, the transponder IC writes 32-bit of data into the requested user memory block and report the success of the operation in the response.

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7.4.8 LOCK BLOCK

[µ, Advanced, Advanced+]

Upon reception of this command without error, the transponder IC is write locking the requested block (block size = 32-bit) permanently. Blocks within the block address range from 00h to 18h as well as FEh and FFh can be locked individually. For HITAG µ advanced+ transponder IC a LOCK BLOCK command with a block number value between 19h to 36h will lock all blocks within the block address range 19h to 36h.

In case a password is applied to the memory a lock is only possible after a successful login.

7.4.9 SELECT

[Advanced, Advanced+]

The SELECT command is always be executed with SEL flag set to '0' and ADR flag set to '1'. There are several possibilities upon reception of this command without error:

- If the UID, received by the transponder IC, is equal to its own UID, the transponder IC enters the Selected state and shall send a response.
- If the received UID is different there are two possibilities
  - A transponder IC in a non-selected state (QUIET or READY) is keeping its state and not sending a response.
  - The transponder IC in the Selected state enters the Quiet state and does not send a response.

7.4.10 WRITE ISO 11785 (custom command)

[µ, Advanced, Advanced+]

Upon reception of this command without error, the transponder IC (in Ready state) writes 128-bit of ISO 11785 TTF data into suitable reserved memory block and report the success of the operation in the response. The user does not have to attend whether the data is compliant to ISO 11785 or not. The command data block is sent exactly the same way as it is sent by the transponder IC in TTF mode (Header, 64-bit ID, CRC…) after entering the field again.

There are two different command codes one for locking the TTF area after successful write command and one without locking.

The command must be completed by a reset of the IC. After entering the RF field the ISO 11785 data is sent when the transponder is in ISO 11785 state.

7.4.11 GET SYSTEM INFORMATION

[Advanced, Advanced+]

Upon reception of this command without error, the transponder IC reads the requested system memory block(s) and sends back their values in the response.

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7.4.12 LOGIN

[µ, Advanced, Advanced+]

Upon reception of this command without error, the transponder IC compares received password with PWD in memory block (FEh) and if correct it permits write (opt. read) access to the protected memory area (defined in User config, see full data sheet) and reports the success of the operation in the response. In case a wrong password is issued in a further login request no access to protected memory blocks will be granted.
Default password: FFFFFFFFh

7.5 Data integrity/calculation of CRC

The following explanations show the features of the HITAG µ protocol to protect read and write access to transponders from undetected errors. The CRC is an 16-bit CRC according to ISO 11785.

7.5.1 Data transmission: RWD to HITAG µ transponder IC

Data stream transmitted by the RWD to the HITAG µ transponder may include an optional 16-bit Cyclic Redundancy Check (CRC-16).

The data stream is first verified for data errors by the HITAG µ transponder IC and then executed.

The generator polynomial for the CRC-16 is:

$u^{16} + u^{12} + u^{5} + 1 = 1021h$

The CRC pre set value is: 0000h

7.5.2 Data transmission: HITAG µ transponder IC to RWD

The HITAG µ transponder calculates the CRC on all received bits of the request. Whether the HITAG µ transponder IC calculated CRC is appended to the response depends on the setting of the CRCT flag.

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8. Limiting values

Table 6. Limiting values[1][2]

In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit
T_{stg}	storage temperature		–55	+125	°C
V_{ESD}	electrostatic discharge voltage	JEDEC JESD 22-A114-AB Human Body Model	±2	-	kV
$I_{i(max)}$	maximum input current	IN1-IN2	-	±20	mA
T_j	junction temperature		–40	+85	°C

[1] Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any conditions other than those described in the Operating Conditions and Electrical Characteristics section of this specification is not implied.

[2] This product includes circuitry specifically designed for the protection of its internal devices from the damaging effects of excessive static charge. Nonetheless, it is suggested that conventional precautions should be taken to avoid applying values greater than the rated maxima

9. Characteristics

Table 7. Characteristics[1]

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
f_i	input frequency			100	125	150	kHz
V_I	input voltage	IN1-IN2		4	5	6	V
I_I	input current	IN1-IN2		-	-	±10	mA
C_i	input capacitance	between IN1-IN2					
		HTMS1x01	[2][3]	203.7	210	216.3	pF
		HTMS8x01	[2][4]	266	280	294	pF

[1] Typical ratings are not guaranteed. Values are at 25 °C.

[2] Measured with an HP4285A LCR meter at 125 kHz/room temperature (25 °C); $V_{IN1\text{-}IN2}$ = 0.5 V (RMS)

[3] Integrated Resonance Capacitor: 210 pF ± 3 %

[4] Integrated Resonance Capacitor: 280 pF ± 5 %

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10. Abbreviations

Table 8. Abbreviations

Acronym	Description
ASK	Amplitude Shift Keying
CRC	Cyclic Redundancy Check
EEPROM	Electrically Erasable Programmable Read-Only Memory
IC	Integrated Circuit
RF	Radio Frequency
RTF	Reader Talks First
RWD	Read Write Device
TTF	Transponder Talks First
UID	Unique Identification Number

11. Revision history

Table 9: Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
HTMS1X01_8X01_SDS v.3.0	20110928	Product short data sheet	-	-

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12. Legal information

12.1 Data sheet status

Document status[1][2]	Product status[3]	Definition
Objective [short] data sheet	Development	This document contains data from the objective specification for product development.
Preliminary [short] data sheet	Qualification	This document contains data from the preliminary specification.
Product [short] data sheet	Production	This document contains the product specification.

[1] Please consult the most recently issued document before initiating or completing a design.

[2] The term 'short data sheet' is explained in section "Definitions".

[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL http://www.nxp.com.

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ICs with HITAG functionality
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13. Contact information

For more information, please visit: **http://www.nxp.com**

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14. Contents

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