HTSICH56; HTSICH48

HITAG S transponder IC

Rev. 3.1 — 11 December 2014
210331

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 and HITAG 2 transponder IC's. With the new HITAG S family, this existing infrastructure is extended with the next generation of IC’s 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.

One Protocol - two memory options.

The protocol and command structure for HITAG S is based on HITAG 1, including anticollision algorithm.

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

- HITAG S256 with 256 bit Total Memory Read/Write
- HITAG S2048 with 2048 bit Total Memory Read/Write

2. Features and benefits

2.1 Features

- Integrated Circuit for Contactless Identification Transponders and Cards
- Integrated resonance capacitor of 210 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 Anticollision, Manchester and Bi-phase Coding
- Fast Anticollision Protocol for inventory tracking: 100 Tags in 3.2 seconds
- Cyclic Redundancy Check (CRC)
- Optional Transponder Talks First Modes with user defined data length
- Temporary switch from Transponder Talks First into Reader Talks First 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

- Two memory options (256 bit, 2048 bit)
- Up to 100000 erase/write cycles
- 10 years non-volatile data retention
- Secure Memory Lock functionality

2.4 Supported standards

- Full compliant to ISO 11784/85 Animal ID
- Targeted to operated on hardware infrastructure of new upcoming standards
  ISO 14223 (Animal ID with anticollision and read/write functionality)
  ISO 18000-2 (AIDC Techniques-RFID or Item Management)
- Supports German Waste Management Standard and Pigeon Race Standard

2.5 Security features

- 32 bit Unique Identification Number (UID)
- 48 bit secret key based encrypted authentication

2.6 Delivery types

- Sawn, gold - bumped 8” Wafer
- Sawn, gold - megabumped 8” Wafer
- Contactless Chip Card Module MOA4
- HVSON2

3. Applications

- Animal Identification
- Laundry Automation
- Beer keg and gas cylinder logistic
- Pigeon Race Sports
- Brand Protection Applications

4. Quick reference data

Table 1. Quick reference data

Symbol	Parameter	Conditions		Min	Typ[1]	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 IN1 and IN2 HTSICxxxxxEW/x7	[2]	199	210	221	pF

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

[2] Measured with $Q_{coil} = 20$, $L_{coil} = 7.5$ mH, optimal tuned to resonance circuit; $V_{IN1-IN2} = 2$ V (RMS)

5. Ordering information

Table 2. Ordering information

Type number	Package			
	Name	Memory size	Description	Version
HTSICH5601EW/V7	Wafer	256 bit	Au-bumped die on sawn wafer, inkless	-
HTSICH4801EW/V7	Wafer	2048 bit	Au-bumped die on sawn wafer, inkless	-
HTSICC5601EW/C7	Wafer	256 bit	Au-megabumped die on sawn wafer, inkless	-
HTSICC4801EW/C7	Wafer	2048 bit	Au-megabumped die on sawn wafer, inkless	-
HTSMOH5602EV	PLLMC[1]	256 bit	plastic leadless module carrier package; 35 mm wide tape	SOT500-2
HTSMOH4802EV	PLLMC[1]	2048 bit	plastic leadless module carrier package; 35 mm wide tape	SOT500-2
HTSH5601ETK	HVSON2	256 bit	plastic thermal enhanced very thin small outline package; no leads; 2 terminals; body 3 × 2 × 0.85 mm	SOT899-1
HTSH4801ETK	HVSON2	2048 bit	plastic thermal enhanced very thin small outline package; no leads; 2 terminals; body 3 × 2 × 0.85 mm	SOT899-1

[1] This package is also known as MOA4

6. Block diagram

The HITAG S Transponder requires 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 S Transponder, and modulates the magnetic field for data transmission from the HITAG S Transponder to the RWD.

Data are stored in a non-volatile memory (EEPROM). The EEPROM has a capacity up to 2048 bit and is organized in 64 Pages consisting of 4 Bytes each (1 Page = 32 Bits).

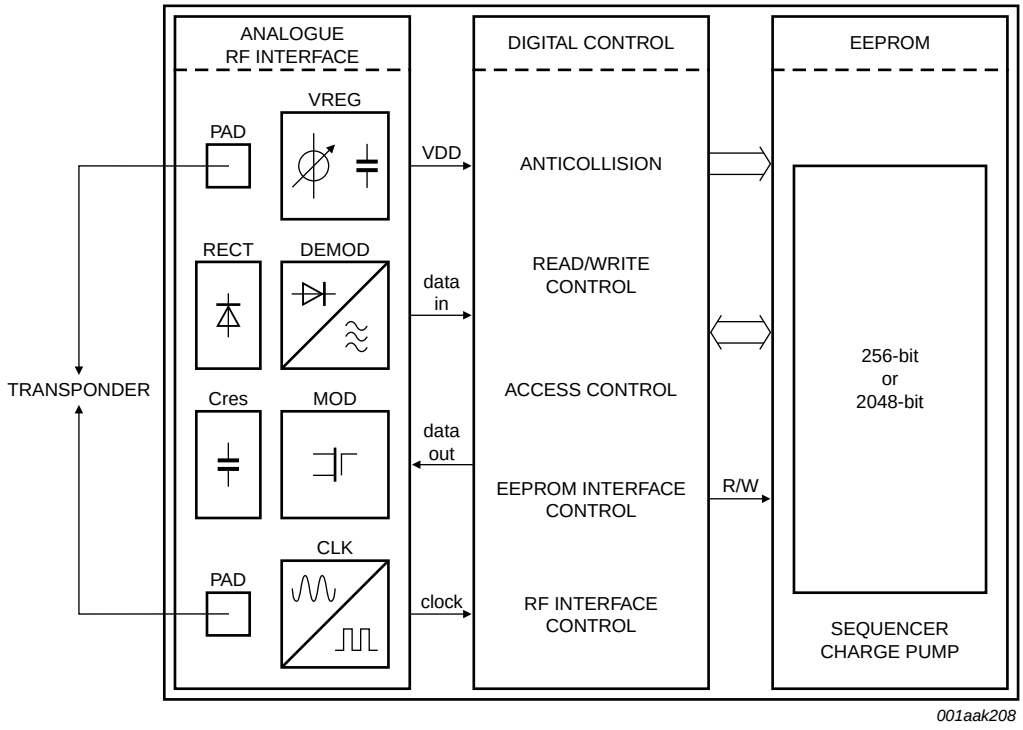

Fig 1. Block diagram

7. Functional description

7.1 Memory organization

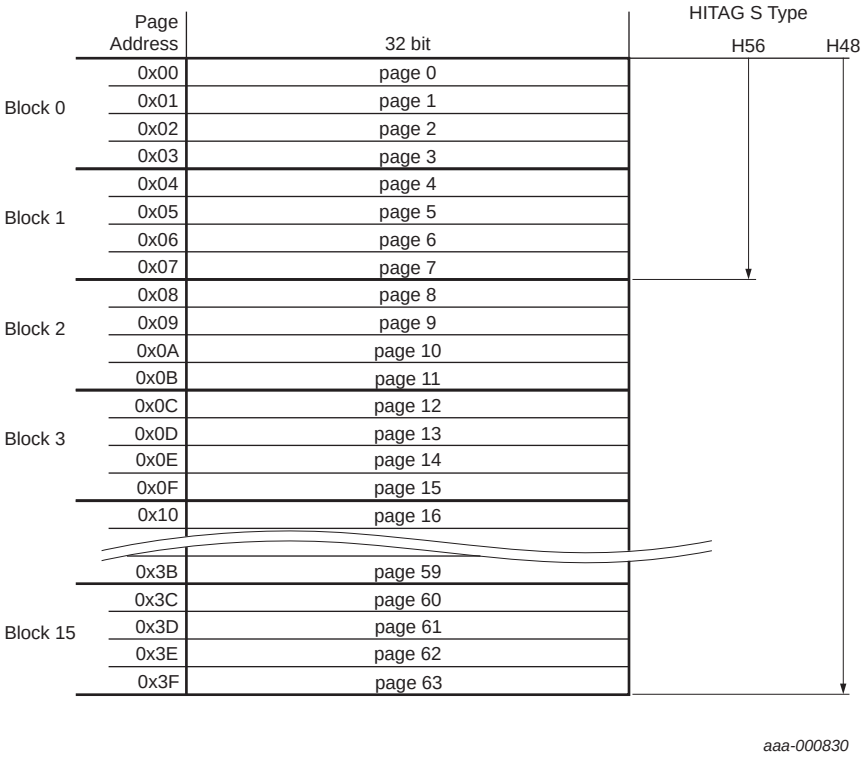

Fig 2. Memory organization

The EEPROM has a capacity up to 2048 bit and is organized in 16 Blocks, consisting of 4 Pages each, for commands with Block access. A Page consists of 4 Bytes each (1 Page = 32 Bits) and is the smallest access unit.

Addressing is done Page by Page (Page 0 to 63) and access is gained either Page by Page or Block by Block entering the respective Page start address. In case of Block Read/Write access, the transponder is processed from the start Page address within one block to the end of the corresponding block.

Two different types of HITAG S IC's with different memory sizes as shown in the figure above are available.

7.2 HITAG S plain mode

Table 3. Memory map for HITAG S in plain mode

	MSByte						**LSByte**	
page address	MSB	LSB	MSB	LSB	MSB	LSB	MSB	LSB
0x00	UID3		UID2		UID1		UID0	
0x01	Reserved		CON2		CON1		CON0	
0x02	Data 3		Data 2		Data 1		Data 0	
0x03	Data 3		Data 2		Data 1		Data 0	

7.3 HITAG S authentication mode

Table 4. Memory map for HITAG S in authentication mode

	MSByte						**LSByte**	
page address	MSB	LSB	MSB	LSB	MSB	LSB	MSB	LSB
0x00	UID3		UID2		UID1		UID0	
0x01	PWDH0		CON2		CON1		CON0	
0x02	KEYH1		KEYH0		PWDL1		PWDL0	
0x03	KEYL3		KEYL2		KEYL1		KEYL0	
0x04	Data 3		Data 2		Data 1		Data 0	
0x05	Data 3		Data 2		Data 1		Data 0	

7.4 State Diagram

7.4.1 General Description of States

Power Off

The powering magnetic field is switched off or the HITAG S Transponder is out of field.

Ready

After start up phase, the HITAG S Transponder is ready to receive the first command.

Init

The HITAG S Transponder enters this State after the first UID REQUEST xx command. In this State the Response Protocol Mode (see Section 7.5) may be changed by further UID REQUEST xx commands. If there are several HITAG S Transponders in the field of the RWD antenna at the same time, the AC SEQUENCE can be started to determine the UID of every HITAG S Transponder.

Authenticate

The HITAG S Transponder enters this State after a valid SELECT (UID) command when configured in Authentication Mode. After an encrypted CHALLENGE Authentication the HITAG S Transponder changes into the Selected State.

Selected

The HITAG S Transponder enters this State after a valid SELECT (UID) command when configured in Plain Mode or a SELECT (UID) and CHALLENGE sequence when configured in Authentication Mode. Only one HITAG S Transponder in the field of the RWD antenna can be Selected at the same time. In this State, Read and Write operations are possible. Data Transmission is not encrypted even if configured in Authentication Mode.

Quiet

The HITAG S Transponder enters this State after a SELECT_QUIET (UID) command in Init State or a QUIET command in Selected State. In this State, the HITAG S Transponder will not answer to any command. Switching off the powering magnetic field or moving the HITAG S Transponder out of field enters it into the Power Off State.

Transponder Talks First (TTF)

The HITAG S Transponder enters this State when configured in TTF Mode if no UID REQUEST xx command is received within the Mode switch window. Once entered this State, the HITAG S Transponder continuously transmits data with configurable data coding, data rate and data length.

7.4.2 HITAG S256 and HITAG S2048

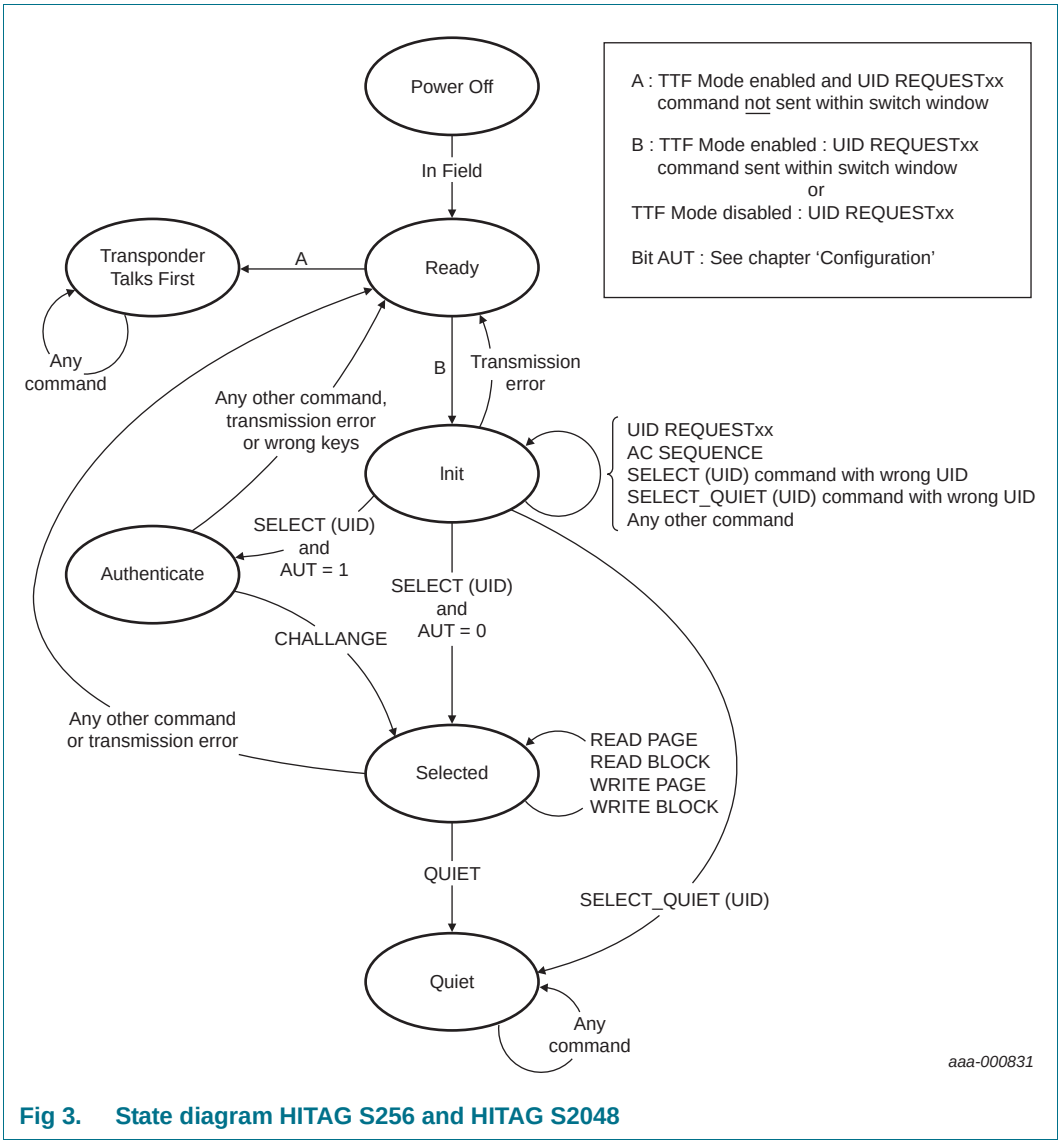

Fig 3. State diagram HITAG S256 and HITAG S2048

Remark: Switching off the powering magnetic field or moving the HITAG S Transponder out of the RWD antenna field enters the HITAG S Transponder into the Power off state independently of its actual state.

7.5 Command set

7.5.1 UID REQUEST xx

Table 5. UID request xx

				LSByte			MSByte
	MSB LSB			**MSB LSB**	**MSB LSB**	**MSB LSB**	**MSB LSB**
RWD:	UID REQUEST xx	EOF					
Transponder:		t_{wresp}	SOF	UID 0	UID 1	UID 2	UID 3
			N=	1.....8	9.....k.....16	17.....24	25.....32

7.5.2 AC SEQUENCE

If more than one HITAG S Transponder is in the field of the antenna a special designed RWD detects the first collision at the Bit position N = k of the UID response. As a result the RWD starts an Anticollision Sequence (AC SEQUENCE).

Table 6. AC sequence

	MSB				**LSB**	**1.....k**	**MSB LSB**			
RWD:	k4	k3	k3	k1	k0	k Bits of UID	CRC 8	EOF		
Transponder:								t_{wresp}	SOF	(32-k) bits to UID
									N=	k+1.....32

After transmitting this command, all HITAG S Transponders which first k Bits of the own UID match with the k received UID Bits, answer with the SOF and the rest of their own UID.

If a collision occurs again the described cycle has to be repeated until one valid UID of the transponders in the field is determined.

The complete response of the HITAG S Transponder is transmitted in Anticollision Coding (AC).

7.5.3 SELECT (UID)

Table 7. Select (UID)

		LSByte								MSByte	
		MSB	LSB	**MSB**	LSB	**MSB**	LSB	**MSB**	LSB	**MSB**	LSB
RWD:	00000	UID 0		UID 1		UID 2		UID 3		CRC 8	EOF

			LSByte						MSByte			
			MSB	LSB	**MSB**	LSB	**MSB**	LSB	**MSB**	LSB	**MSB**	LSB
Transponder:		t_{wresp}	SOF	CON 0		CON 1		CON 2		Reserved		CRC 8

The complete response of the HITAG S Transponder is transmitted in Manchester Coding (MC).

In Plain Mode the MSByte of Page 1 is a Reserved Byte, in Authentication Mode this Byte contains the password high Byte PWDH 0. At the response on a SELECT (UID) command of a HITAG S Transponder configured in Authentication Mode (Bit AUT = 1, keys and password locked), this PWDH 0 Byte is dissolved by ‘1’ Bits.

7.5.4 CHALLENGE

By means of the response of the SELECT (UID) command the RWD detects that the HITAG S Transponder is configured in Authentication Mode (Bit AUT = 1) and starts the encrypted Challenge sequence.

Table 8. Challenge

	MSB LSB	MSB LSB										
RWD:	32 Bit RND	32 Bit Secret Data	EOF									
				MSB	LSB	MSB	LSB	MSB	LSB	MSB	LSB	MSB LSB
Transponder:			t_{wresp}	SOF	CON 2		PWDH 0		PWDL 0		PWDL 1	CRC 8
				32 Bit secret response								

The Read/Write Device sends a 32 bit Random Number (RND) and a 32 bit secret data stream to the transponder. In order to perform the secret data stream, a security co-processor is required on the read/write Device.

If the received secret data stream corresponds with the secret data stream calculated by the HITAG S Transponder, a 32 bit Secret Response (secret data stream encrypting the configuration byte CON 2, password high byte PWDH 0 and password low Bytes PWDL 0 and PWDL 1) is transmitted after the SOF.

The response of the HITAG S Transponder is transmitted in Manchester Coding (MC).

7.5.5 SELECT_QUITE (UID)

With this command a HITAG S Transponder in Init State can be directly entered into the quiet state.

Table 9. Select_quiet(UID)

		LSByte			MSByte			
		MSB LSB	MSB LSB	MSB LSB	MSB LSB		MSB LSB	
RWD:	00000	UID 0	UID 1	UID 2	UID 3	**0**	CRC 8	EOF
	ACK							
Transponder:						t_{wresp}	SOF	0 1

The Start Of Frame (SOF) pattern and the acknowledge (ACK) is transmitted in Manchester Coding.

7.5.6 READ PAGE

After a HITAG S Transponder was selected by the corresponding SELECT (UID) command (or SELECT (UID) and CHALLENGE for Authentication Mode) a read operation of data stored on the EEPROM can be performed. After transmitting the READ PAGE command, the Page address PADR (8 Bits) and the 8 bit Cyclic Redundancy Check (CRC 8), the HITAG S Transponder responds with the SOF and 32 Bits data of the corresponding Page.

Table 10. Read page

		MSB LSB	MSB LSB						
RWD:	1 1 0 0	PADR	CRC 8	EOF					
					LSByte			MSByte	
					MSB LSB	MSB LSB	MSB LSB	MSB LSB	
Transponder:				t_{wresp}	SOF	DATA 0	DATA 1	DATA 2	DATA 3	CRC 8

The highest Page address (PADR) is 0x3F, therefore the two highest Bits must be ‘0’.

7.5.7 READ BLOCK

After transmitting the READ BLOCK command, the Page address PADR (8 Bits) within a block and the 8 bit Cyclic Redundancy Check (CRC 8), the HITAG S Transponder responds with the SOF and 32 up to 128 Bits of data beginning with the addressed Page within a Block to the last Page of the corresponding Block.

Table 11. Read block

		MSB LSB	MSB LSB																
RWD:	1 1 0 1	PADR	CRC 8	EOF															
					LSByte												MSByte		
					MSB LSB		MSB LSB		MSB LSB		MSB LSB		MSB LSB				MSB LSB		MSB LSB
Transponder:				t_{wresp}	SOF	DATA 0		DATA 1		DATA 2		DATA 3		DATA 0			DATA 3		CRC 8

7.5.8 WRITE PAGE

After a HITAG S Transponder was selected by the corresponding SELECT (UID) command (or SELECT (UID) and CHALLENGE for Authentication Mode) a write operation of data onto the memory can be carried out. Least significant Byte is always transmitted first. E.g. in order to change the configuration page the byte CON0 would have to be transmitted first.

After transmitting the WRITE PAGE command, the Page address PADR (8 Bits) and the 8 bit Cyclic Redundancy Check (CRC 8), the HITAG S Transponder responds with the SOF and an acknowledge (ACK) to confirm the reception of a correct WRITE PAGE command. After the waiting time t_{wsc} the RWD transmits the write data with CRC 8. After the programming time t_{prog} the HITAG S Transponder responds with a SOF and an acknowledge to confirm correct programming.

Table 12. Write page

		MSB LSB	**MSB** LSB				
RWD:	1 0 0 0	PADR	CRC 8	EOF			t_{wsc}
							ACK
Transponder:				t_{wresp}	SOF	01	

Table 13. Write page

	LSByte				**MSByte**							
	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB							
RWD:	DATA 0	DATA 1	DATA 2	DATA 3	CRC 8	EOF						
												ACK
Transponder:							t_{prog}	SOF	01			

7.5.9 WRITE BLOCK

After transmitting the WRITE BLOCK command, the Page address PADR (8 Bits) within a Block and the 8 bit Cyclic Redundancy Check (CRC 8), the HITAG S Transponder responds with the SOF and an acknowledge (ACK) to confirm the reception of a correct WRITE BLOCK command. After the waiting time t_{wsc} the RWD transmits the write data with CRC 8 Page by Page (1 to 4 Pages depending on the Page address PADR within the corresponding block). After the programming time t_{prog} the HITAG S Transponder responds with a SOF and an acknowledge to confirm correct programming of each Page.

Table 14. Write block

		MSB LSB	**MSB** LSB			
RWD:	1 0 0 1	PADR	CRC 8	EOF		t_{wsc}
					ACK	
Transponder:				t_{wresp}	SOF	01

Table 15. Write data for page with page address: PADR

	LSByte			**MSByte**			
	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB		
RWD:	DATA 0	DATA 1	DATA 2	DATA 3	CRC 8	EOF	t_{wsc}
						ACK	
Transponder:					t_{prog}	SOF	01

Table 16. Write data for page with page address: PADR + 1

	LSByte			**MSByte**			
	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB		
RWD:	DATA 0	DATA 1	DATA 2	DATA 3	CRC 8	EOF	t_{wsc}
						ACK	
Transponder:					t_{prog}	SOF	01

Table 17. Write data for page with page address: PADR + 2

	LSByte			**MSByte**			
	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB		
RWD:	DATA 0	DATA 1	DATA 2	DATA 3	CRC 8	EOF	t_{wsc}
						ACK	
Transponder:					t_{prog}	SOF	01

Table 18. Write data for page with page address: PADR + 3

	LSByte			**MSByte**			
	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB		
RWD:	DATA 0	DATA 1	DATA 2	DATA 3	CRC 8	EOF	
						ACK	
Transponder:					t_{prog}	SOF	01

7.5.10 QUITE

With this command a Selected HITAG S Transponder can be entered into the Quiet State.

A valid Page address PADR (8 Bits) and Cyclic Redundancy Check (CRC 8) must be sent for command structure reasons only.

Table 19. Quiet

		MSB LSB	**MSB** LSB			
RWD:	0 1 1 1	PADR	CRC 8	EOF		
						ACK
Transponder:				t_{wresp}	SOF	01

8. Limiting values

Table 20. Limiting values[1][2]

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

Symbol	Parameter	Conditions	Min	Max	Unit
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		−25	+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 21. Characteristics

Symbol	Parameter	Conditions	Min	Typ[1]	Max	Unit
f_i	input frequency		100	125	150	kHz
V_I	input voltage	IN1-IN2				
		read	-	±3.5	±4.5	V
		write	-	±6.3	±7.2	V
I_I	input current	IN1-IN2	-	-	±10	mA
Interface characteristics						
C_i	input capacitance	between IN1-IN2 [2] HTSICxxxxxEW/x7	199	210	221	pF
Wafer EEPROM characteristics						
t_{ret}	retention time	$T_{amb} \leq 55$ °C	10	-	-	year
$N_{endu(W)}$	write endurance		100000			cycle

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

[2] Measured with $Q_{coil} = 20$, $L_{coil} = 7.5$ mH, optimal tuned to resonance circuit; $V_{IN1\text{-}IN2} = 2$ V (RMS)

10. Abbreviations

Table 22. 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 23. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
HTSICH56_48_SDS v.3.1	20141211	Product short data sheet	-	HTSICH56_48_SDS v.3.0
Modifications:	• Section 12 “Legal information”: License statement “ICs with HITAG functionality” removed • Section 2.6 “Delivery types”: updated • Section 5 “Ordering information”: updated			
HTSICH56_48_SDS v.3.0	20111012	Product short data sheet	-	-

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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13. Contact information

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