DATA SHEET

hitag

HT2DC20S20
HITAG 2 stick transponder

Product specification
Supersedes data of 1998 Mar 01
File under Integrated Circuits, IC11

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Philips
Semiconductors

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HITAG 2 stick transponder HT2DC20S20

FEATURES

- Identification transponder for use in contactless applications
- Operating frequency 125 kHz
- Data transmission and supply energy via RF link, no internal battery
- Reading distance same as writing distance
- Non-volatile memory of 256 bits (128 bits user data, 128 bits control data and secret memory) organized in 8 pages, 4 bytes each
- Ten years non-volatile data retention
- More than 100000 erase/write cycles
- Selective read/write protection of memory content
- Two coding schemes for read operation: biphase and Manchester coding
- Effective communication protocol with outstanding data integrity check
- Mutual authentication function
- Read/write mode allows:
  - Plain data transmission (password check)
  - Encrypted data transmission (crypto mode).
- In read/write mode multi-tag operation possible because of special HALT function
- Emulation of standard industrial read-only transponders:
  - Public mode A (64 bits read-only)
  - Public mode B (according to ISO 11785 for animal identification)
  - Public mode C (PIT compatible mode).
- Special features:
  - User defined write protection
  - Unique 32-bit serial number for each transponder
  - Read-only emulation function
  - Encrypted data transmission possible.

GENERAL DESCRIPTION

The HITAG(1) stick transponder HT2DC20S20 is a high performance transponder for bi-directional transmission in full-duplex between the read and write device and the transponder.

Data is stored in the transponder in a non-volatile memory (EEPROM).

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

The transponder requires no internal power supply; it derives its power from the magnetic component of the RF carrier frequency generated by the reader. Data is transmitted by modulating this carrier.

The HT2DC20S20 is dedicated for use in secure access systems where the transponder and the reader have to identify each other. The choosable use of cryptography enables highest data security. Providing several operating modes (password, crypto and standard read-only modes) the versatile transponder can be used in various applications.

The HALT command can be used after finishing data exchange to reach the halt state. In this state the transponder is muted. This feature can be used to have steady RF field where single transponders are collected one by one. Each transponder is operated and then disabled, so it does not interfere with the next transponder. The HALT state can only be exited by switching off and removing the magnetic field.

The EEPROM has a capacity of 256 bits and is organized in 8 pages of 4 bytes. The 8 pages are split up into 4 pages containing user data and into 4 pages for control of the memory access and for authentication purposes. The pages of the transponder memory can be protected against read and write access by setting corresponding memory flags.

Data transmission from the HT2DC20S20 to the reader uses Manchester or biphase coding and Amplitude Shift Keying (ASK) modulation. Absorption modulation is used to transmit data from the transponder to the reader. The transponder absorbs the magnetic field which hence modulates the current in the reader antenna.

Data transmission from the reader to the HT2DC20S20 uses Binary Pulse Length Modulation (BPLM).

QUICK REFERENCE DATA

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
f_0	resonant frequency	121	125	129	kHz
f_{trans}	data transfer rate				
	transponder to reader	–	4.0	–	kbits/s
	reader to transponder	–	5.2	–	kbits/s
M	memory				
	size	–	256	–	bits
	organization	–	8	–	pages
N	encrypted mutual authentication bits				
	serial number	–	32	–	bits
	secret key	–	48	–	bits
t_{aut}	authentication time	–	36	–	ms

ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
HT2DC20S20	PLLMC	plastic leadless module carrier	SOT385-1

BLOCK DIAGRAM

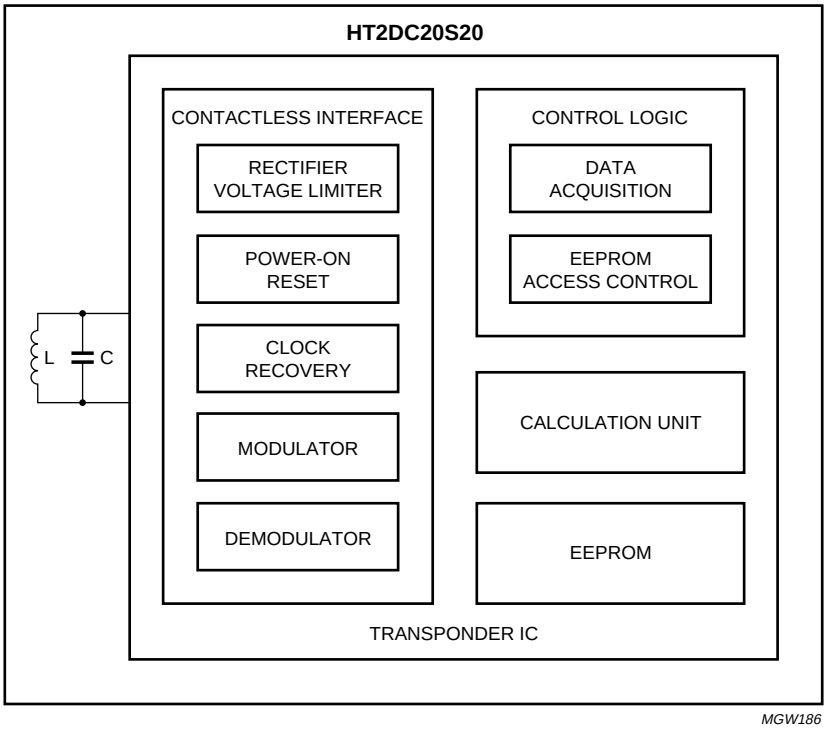


Fig.1 Block diagram.

FUNCTIONAL DESCRIPTION

Memory organization

The memory of the transponder consists of 256 bits EEPROM memory and is organized in 8 pages with 32 bits each.

Depending on the operating mode the EEPROM is organized as described in Table 1.

Table 1 Memory organization

PAGE	CONTENT
Crypto mode	
0	serial number
1	32 LSBs of 48-bit key
2	16 MSBs of 48-bit key; 16 bits reserved
3	8-bit configuration; 24-bit password TAG
4	read/write page
5	read/write page
6	read/write page
7	read/write page
Password mode	
0	serial number
1	password RWD
2	reserved
3	8-bit configuration; 24-bit password TAG
4	read/write page
5	read/write page
6	read/write page
7	read/write page

Operating modes

With the configuration byte, the operating mode and the access rights to the memory can be selected.

During power-up of the transponder the configuration byte is read from the EEPROM of the transponder.

The HT2DC20S20 can operate in several modes:

- Crypto mode

  Mode for writing or reading the transponder with encrypted data transmission.
- Password mode

  Mode for writing or reading the transponder with plain data transmission.
- Public mode A (Manchester)

  Read-only mode. The 64 bits of the user pages 4 and 5 are cyclically transmitted to the read and write device.
- Public mode B (biphase)

  Read-only mode according to ISO standards 11784 and 11785 for animal identification. The 128 bits of the user pages 4 to 7 are cyclically transmitted to the read and write device.
- Public mode C (biphase)

  Read-only mode emulating the read operation of the PCF793X (with a slightly different program mode check). In the public mode C the 128 bits of the user pages 4 to 7 are cyclically transmitted to the read and write device.

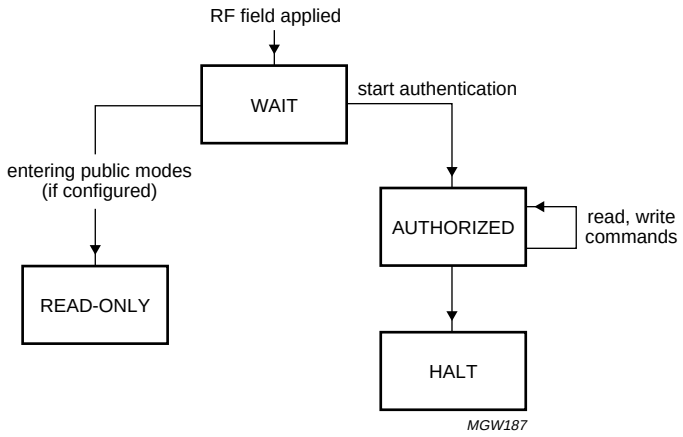


Fig.2 Status flow.

Status flow

After entering the RF field the transponder waits for a command to start the authentication (see Fig.2). After issuing this command the mutual authentication takes place, followed by read and write commands.

In the password mode the data transfer occurs plain and in the crypto mode data are encrypted.

The halt state can be entered for muting a transponder.

If the transponder is configured in one of the public modes, these modes are entered automatically after a certain waiting time and data pages are sent cyclically to the read and write device.

By issuing the command to start the authentication during the waiting time also public mode transponders can be brought into the authorized state.

Configuration

If you change the configuration (keys or passwords) you have to place the transponder directly on the antenna (0-distance)! In order to avoid any errors, do not move the transponder during this write process and be sure that you are in a safe environment without electrical noise.

The configuration byte is represented by the first 8 bits of page 3 of the transponder memory (see Table 2).

Table 2 Format of page 3

PAGE 3										
bit 31							bit 24	bit 23		bit 0
configuration byte (8 bits)								password TAG (24 bits)		
7	6	5	4	3	2	1	0			

Table 3 Bits of the configuration byte

BIT	VALUE	DESCRIPTION	REMARK
0	0	Manchester code	does effect HITAG 2 operation only
	1	biphase code	does effect HITAG 2 operation only
2, 1	00	public mode B	coding biphase; note 1
	01	public mode A	coding Manchester; note 1
	10	public mode C	coding biphase; note 1
	11	HITAG 2	coding depending on bit 0; note 1
3	0	password mode	
	1	crypto mode	
4	0	pages 6 and 7 read/write	
	1	pages 6 and 7 read-only	
5	0	pages 4 and 5 read/write	
	1	pages 4 and 5 read/write	
6	0	page 3 read/write	
	1	page 3 read-only	configuration byte and password TAG fixed; note 2
7	0	pages 1 and 2 read/write	
	1	pages 1 no read and write	note 3
		page 2 read-only	when transponder is in password mode
		page 3 no read and write	when transponder is in crypto mode

Notes

1. The coding in HITAG 2 operation is depending on bit 0.
2. The setting of this bit is One Time Programmable (OTP).
   Do not set bit 6 of the configuration byte to logic 1 before having written the final data into page 3 (including the configuration byte and password TAG) of the transponder.
3. The setting of this bit is One Time Programmable (OTP).
   Do not set bit 7 of the configuration byte to logic 1 before having written the final data into pages 1 and 2 of the transponder.

Table 4 Standard values of the configuration byte

MODE SELECTION	VALUE
Password mode	0x06
Crypto mode	0x0E
Public mode A	0x02
Public mode B	0x00
Public mode C	0x04

Definition of keys and passwords

Keys are cryptographic codes, which determine data encryption during data transfer between the read and write device and the transponder. They are used to select a HT2DC20S20 transponder in the crypto mode. The 16-bit key HIGH and 32-bit key LOW form one 48-bit key which has to be identical on both the transponder and the read and write device.

Passwords are needed to select a HT2DC20S20 transponder in the password mode. There is one pair of passwords (password TAG and password RWD) which has to be identical both on the transponder and the read and write device:

- Password TAG

  Password that the transponder sends to the read and write device and which may be verified by the latter (depending on the configuration of the read and write device).

- Password RWD

  Password that the read and write device sends to the transponder and which is checked for identity by the latter.

It is important that the following values are in accordance with each other, i.e. the respective data on the read and write device and on the transponder have to be identical pairs.

The keys and passwords are predefined by Philips by means of defined transport passwords and a transport key. They can be written to memory, which means that they can be changed (see also Section “Configuration of delivered transponders”).

Remark: keys and passwords only can be changed if their current values are known!

Table 5 Keys and passwords for the read and write device and the transponder

MODE	ON THE READ AND WRITE DEVICE		ON THE TRANSPONDER
Password mode	password RWD	⇔	password RWD
Crypto mode	key LOW	⇔	key LOW
	key HIGH	⇔	key HIGH
–	password TAG; note 1	⇔	password TAG

Note

1. Optional for both password and crypto mode; depending on the configuration of the read and write device.

Configuration of delivered transponders

HT2DC20S20 transponders are delivered with the following configuration.

Table 6 Configuration of delivered transponders

ITEM	NAME	VALUE	DESCRIPTION	REMARK
Unique serial number	serial number	0xXXXX	read-only	fixed
Configuration	configuration byte	0x06	password mode; Manchester code; pages 1 to 7 read/write	can be changed; note 1
Transport passwords and transport keys	password RWD	0x4D494B52	MIKR	
	password TAG	0xAA4854		
	key LOW	0x4D494B52	MIKR	
	key HIGH	0x4F4E	ON	

Note

1. Before delivering transponders to end users, pages 1 to 3 should be locked by setting configuration byte: set bit 6 to logic 1 for page 3 and set bit 7 to logic 1 for pages 1 and 2.

LIMITING VALUES

All values are in accordance with the Absolute Maximum Rating System (IEC 60134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
N	number of erase/write cycles of EEPROM		100000	–	
$t_{D(ret)}$	data retention time of EEPROM	T_{amb} = 55 °C	10	–	years
T_{oper}	operating temperature		–40	+85	°C
T_{stg}	storage temperature		–55	+125	°C
B	magnetic flux density	note 1	–	0.2	T
a_v	vibration acceleration	10 to 2000 Hz; 3 axis; IEC 68-2-6; Test Fc	–	10	g
a_s	shock acceleration	3 axis; IEC 68-2-27; Test Ea	–	1500	g

Note

1. Resistivity against magnetic pulses.

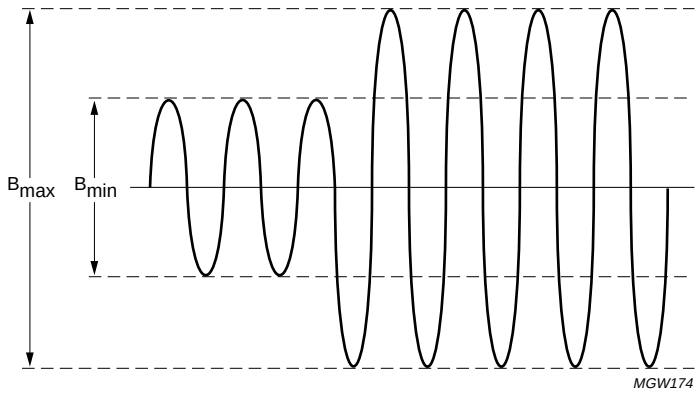
ELECTRICAL CHARACTERISTICS

Period time T_0 = 8 µs (f_0 = 125 kHz); note 1.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
f_0	resonant frequency		121	125	129	kHz
B	bandwidth		2.3	–	–	kHz
$B_{THR(p-p)}$	magnetic flux density for data transmission from transponder (peak-to-peak value)	f_0 = 125 kHz	35	–	400(2)	µT
$B_{PRG(p-p)}$	magnetic flux density for programming the EEPROM (peak-to-peak value)	f_0 = 125 kHz; m = 0.95; $t_{LOW} = 8T_0$	35	–	400(2)	µT
$B_{AUTH(p-p)}$	magnetic flux density for mutual authentication (peak-to-peak value)	f_0 = 125 kHz; m = 0.95; $t_{LOW} = 8T_0$	35	–	400(2)	µT
$B_{READ(p-p)}$	field absorption due to the modulation of the transponder (peak-to-peak value)	f_0 = 125 kHz; B_{field} = 35 µT (p-p)	8	–	–	µT
MI_{PRG}	modulation index (m) of the base station for programming and authentication	f_0 = 125 kHz; B_{field} = 35 µT (p-p); $t_{LOW} = 8T_0$; see Fig.3	95	–	100	%

Notes

1. All parameters are characterized with the SCEMTEC test equipment (STM-1) available from SCEMTEC, Reichshof-Wenrath, Germany. All parameters are guaranteed within the temperature range of T_{amb} = –40 to +85 °C.
2. Maximum available field strength of the test equipment. Transponder limit has not been characterized.



Definitions:

$$m = \frac{B_{max} - B_{min}}{B_{max} + B_{min}}$$

$$m_{read} = |B_{max} - B_{min}|$$

Fig.3 Definition of modulation index.

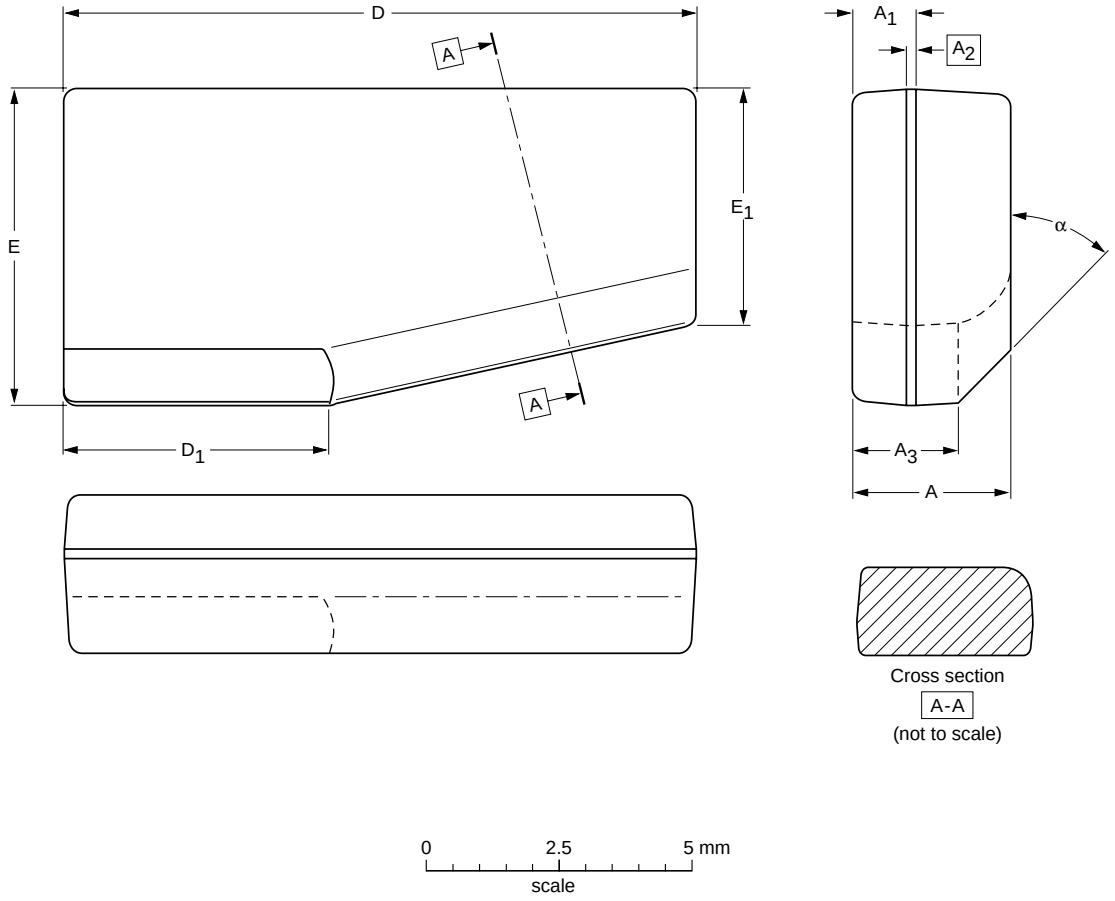
MECHANICAL CHARACTERISTICS

The transponder is sealed in epoxy resin moulding compound. The designation of the package is SOT385-1 (see Chapter “Package outline”).

PARAMETER	VALUE
Mechanical dimensions	$12 \times 6 \times 3$ mm
Protection class	IP67
Casting material	epoxy resin
Transponder IC type	HT2ICS20

PACKAGE OUTLINE

PLLMC: plastic leadless module carrier **SOT385-1**



DIMENSIONS (mm are the original dimensions)

UNIT	A	A_1	A_2	A_3	$D^{(1)}$	$D_1{}^{(1)}$	$E^{(1)}$	$E_1{}^{(1)}$	α
mm	3.05 2.90	1.2 1.1	0.165	2.1 1.9	12.1 11.9	5.1 4.9	6.1 5.9	4.6 4.4	46^o 44^o

Note

1. Plastic protrusions of 0.2 mm per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT385-1						01-06-27

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For additional information please visit **http://www.semiconductors.philips.com**. Fax: **+31 40 27 24825**
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