DATA SHEET

HT2 MOA3 S20

HITAG™2 Chip Module

Preliminary Specification
Revision 1.1

August 1997

PHILIPS

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1 Definitions

1.1 Objective of the Specifications

This specification lists the parameters to be fulfilled by the HITAG 2 chip module HT2 MOA3 S20 for contactless smart cards or similar transponders (as e.g. discs).

1.2 Definition of the Chip Module

A chip module is an electronically packaged chip covered with a globe top cap. The HT2 MOA3 S20 is above all used as card module, i.e. for further lamination into contactless smart cards according to ISO 10536.1.

So the HITAG 2 chip module HT2 MOA3 S20 is best suited for customers that do not want to spend time with micro assembly and therefore start - e.g. ISO card production - with the HITAG 2 chip module.

1.3 Use of the Modules

The HITAG 2 modules are designed to be connected to a coil and then to be further processed by packaging into a transponder (e.g. lamination into an ISO smart card). Specific processing information for the coil-module connection and packaging is given in the specification.

For production of contactless chip cards it is recommended to prepunch card foils to create a recess for the chip module in the card body.

2 Specifications

2.1 Mechanical Properties

Width (Proposed Punching Outline)	7.55 mm	see also drawing in chapter 3
Length (Proposed Punching Outline)	11.75 mm	
Overall Thickness	0.45 mm ± 0.03 mm	
Film Thickness	0.16 mm ± 0.005 mm	
Bondpad Size for Transponder Coil / Module Interconnection	1.9 x 3.5 mm	Suitable for Welding/Soldering/ Conductive Gluing

2.2 Materials

Tape	110 µm	Glass epoxy
Copper Plating	35 µm	ED copper
Bond Plating	Ni / Au	Suitable for Al and Au wire bonding
Backside Plating	Ni / Au	
Glob Top	Filled Epoxy	Thermal curing

2.3 Temperature Range

Operating	-25°C to +85°C	For packed transponder, depending on type of package
Processing	150°C for 30 minutes	at a standard lamination pressure for contactless smart card plastic materials (e.g. PVC, PET, ...)
Welding Parameters	max. 25 ms @ 500 °C	on bond pads
Soldering Parameters	max. 3 s @ 390 °C	on bond pads

2.4 Storage Conditions

Temperature	15 - 30 °C	
Relative Humidity	40 - 70 %	
Duration	1 year	

2.5 Delivery Conditions

Delivery Identification	Date of ready for shipment, reel numbers, total quantity of good modules with the detail of good modules per reel, order number, product type, no supplier identification on reels, bags and boxes.	
Types of Delivery	Chip modules on reel single chip modules (bulk goods)	approx. 15.000 to 20.000 pcs. per reel, tape width super 35 mm, pitch 9,5 mm, 2 rows 500 pcs . per bag
Packing and Transport	According to documentation "Packing Method Modules (reel)" "Packing Method Modules (singulated)"	Order-No. 3322 845 04881
Bad Module Marking	All bad modules (mechanical and electrical faults) must be punched by reject hole for customer Bad positions (reel): <20%	see drawings chapter 3
Splicing Specifications	Tape material: adhes. tape 15,5 +/- 0,7 mm, thermal resistance at <190°C by < 100 cN tractive power and < 30 sec. duration.	see drawings chapter 3
Labeling	Identification label on the reel and on carton bag: - Product type - Number of the reel - Total number of positions - Number of good positions - Date of sealing (to be checked) - Two batches per reel only - Batch number indication (only coded, to be checked)	

2.6 Electrical Specifications

	Symbol	min	typ	max	Comment / Conditions
Absolute Maximum Ratings					
Junction Temperature	T_J	-55°C		140°C	
Input Peak Current	I_{INpeak}			30 mA	
Latch up Current		100 mA			MIL-STD 883D, Method 3023
ESD		2 kV			MIL-STD 883D, Method 3015.7, Human Body
Operating Range					
Temperature	T_A	-40°C		85°C	$R_{ThJunctionAmbient} \leq 30$ K/W @ $I_{INpeak} = 30$ mA
Input Read Only Threshold Voltage [1) 3)]	$V_{IN,RO}$		2,8 V_p	3,9 V_p	start modulation in read only modes
Input Threshold Voltage [1) 3)]	$V_{IN,TH}$		3,1 V_p	4,2 V_p	start modulation after SETCC
Input Read Voltage [1) 3)]	$V_{IN,RD}$		3,5 V_p	4,5 V_p	read E²PROM
Input Write Voltage [1) 3)]	$V_{IN,WR}$		3,7 V_p	4,7 V_p	write E²PROM
Demodulator					
Range [3)]	V_{DEM_R}	2,0 V_p		4,0 V_p	V_{INHigh} - V_{INLow} @ V_{INHigh} = 5,0 V_p T_0=8 µs, T_{MOD}=6*T_0 [2)]
Modulator					
R_MOD linear [3)]	R_{MODL}			4,5 kΩ	$V_{INLow} \leq 2,0$ V_p
R_MOD nonlinear [3)]	R_{MODNL}			3,6 kΩ	$V_{INLow} \geq 2,0$ V_p
Resonance Capacitor [3)]					
	$C_{ResInit}$	189 pF	210 pF	231 pF	V_{IN} = 4,0 V_p

EEPROM					
Write Current [4)]	I_W			25 µA	V_{DD} = 2,8 V
Read Current [4)]	I_R			9 µA	V_{DD} = 2,8 V
Data Retention	Years	10			@ 55°C
Write Endurance	Cycles	100.000			

1) $|V_{IN}| = |V_{IN1} - V_{IN2}|$ ... voltage between connection pads

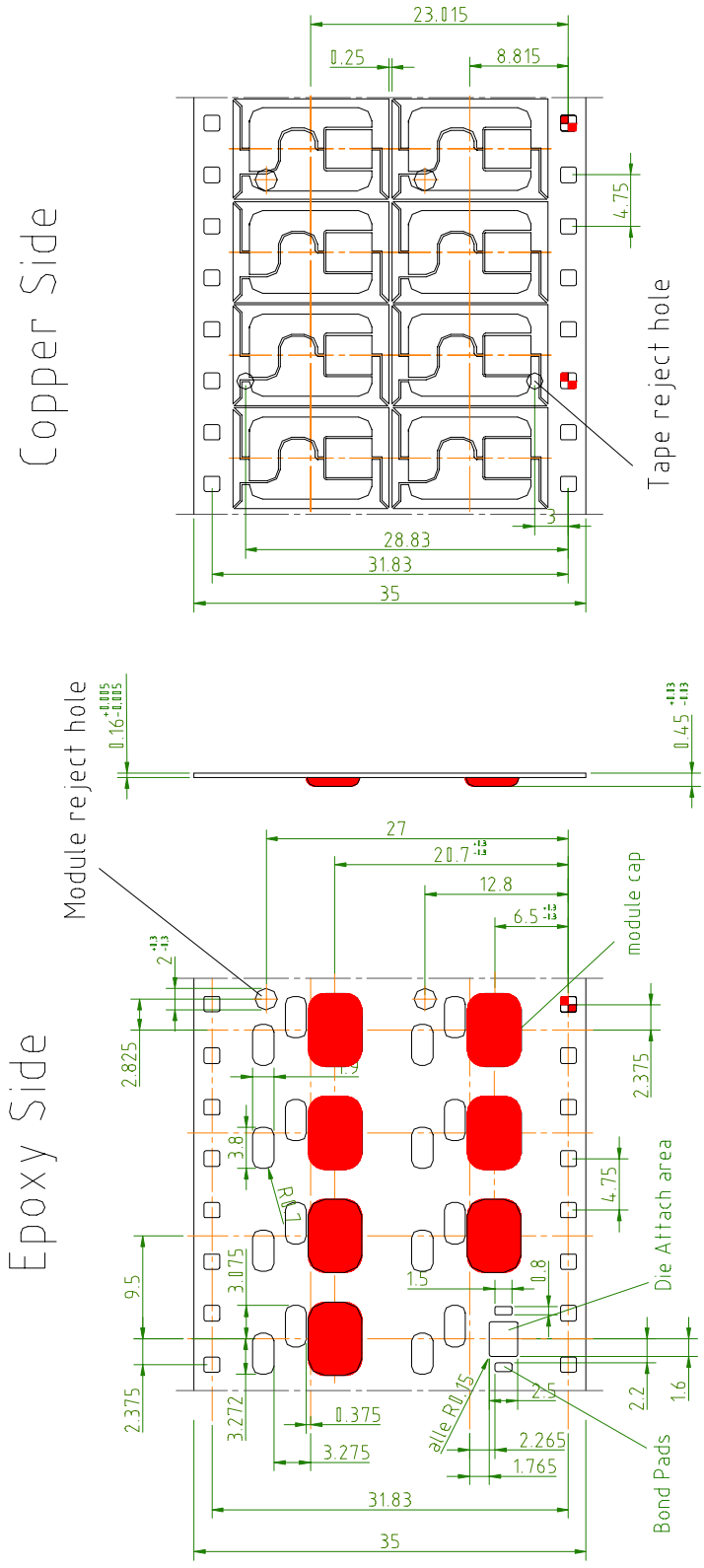
2) V_{INHigh} input voltage before modulation
V_{INLow} input voltage during modulation
T_{MOD} duration of the modulation

3) @ $R_i = 10$ kΩ resistance of measurement equipment

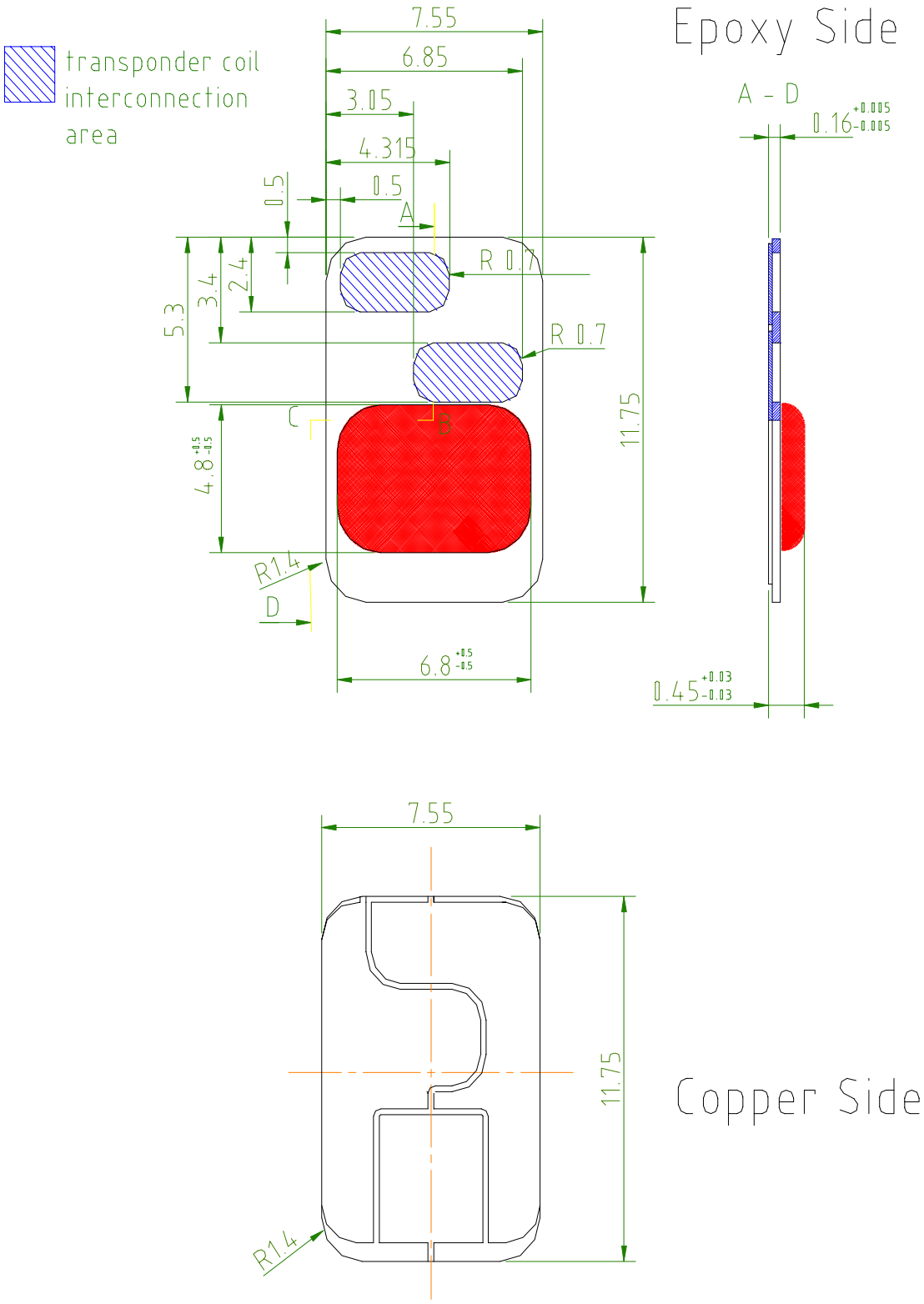
4) tested on silicon level

3 Drawing of the Chip Module HT2 MOA3 S20

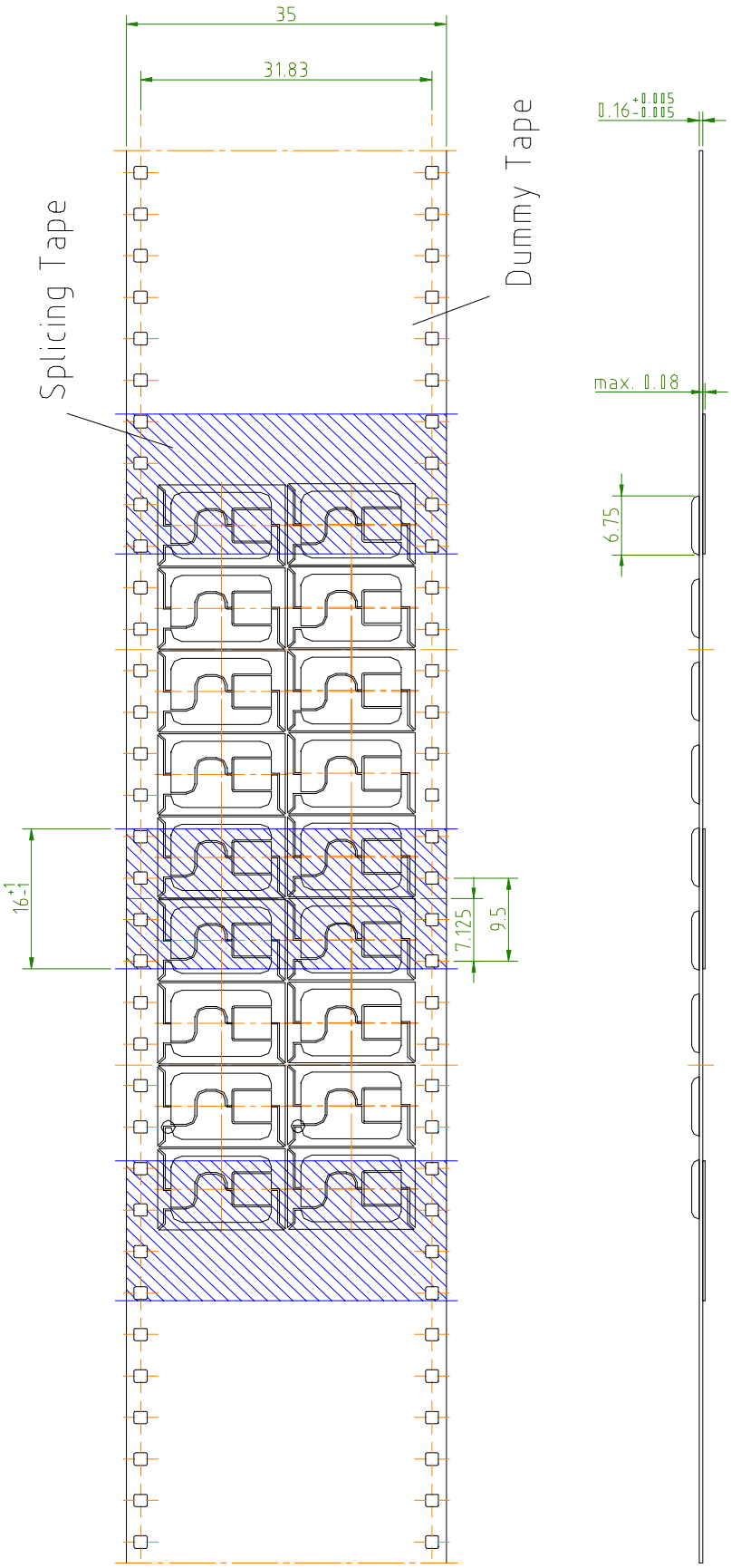
3.1 Drawing of the Reel



3.2 Module outline suggestion



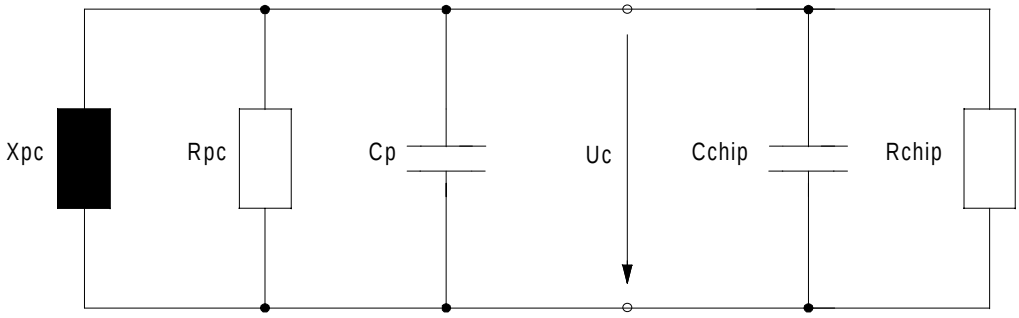
3.3 Splicing Specification



4 Coil Specifications

The HITAG 2 chip module has to be connected to a coil whose parameters are briefly described in the following.

Equivalent circuit of the transponder



U_c	...	voltage at the connection pads
f_{res}	...	resonant frequency of the transponder
X_{pc}	...	parallel reactance of the coil (f = 125 kHz)
R_{pc}	...	parallel resistance of the coil (f = 125 kHz)
C_p	...	parasitic capacitance of the package
C_{chip}	...	capacitance of the chip (U_c > 4 Vpp)
R_{chip}	...	resistance of the chip
f_{resc}	...	self resonant frequency of the coil
L_{pc}	=	$X_{pc}/2\pi f$ (f = 125 kHz)
L_{pc}	=	7.72 mH ± x % (C_p = 0, x depends on the coil production process)
C_{chip}	=	210 pF ± 10 %
R_{pc}	>	45 kΩ
f_{resc}	>	750 kHz

Note: The parasitic capacitance of the package (C_p) must be considered.

$$f_{res} = \frac{1}{2\pi\sqrt{(C_{chip} + C_p).L_{pc}}} = 125\ \text{kHz} \Rightarrow L_{pc} = \frac{1}{(2\pi f_{res})^2 (C_{chip} + C_p)}$$

Typical values for C_p
hot laminated cards: C_p = 1.5 pF
moulded tags: C_p = 6.0 pF

For a rough estimation (± 10 %) of the number of coil windings following formula can be used. It is assumed that the winding is done in circular form.

$$N = \sqrt[1,85]{\frac{L}{2\,U\,\ln(\frac{u}{d})}}$$

N ... number of windings
L ... inductance [nH]
U ... average coil circumference [cm]
d ... copper diameter [mm]
u ... average coil circumference [mm]

For fine tuning a measurement of the inductance and an according adjustment of the number of windings is necessary. This process always needs some iterations.

5 Functional Description of HITAG 2

5.1 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 operation mode the EEPROM is organized as described in the following.

Crypto Mode:

Page	Content
0	Serial Number
1	32 bit "KEY LOW"
2	16 bit " KEY HIGH", 16 bit 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:

Page	Content
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

5.2 Operation Modes and Configuration

With the Configuration Byte the operation mode and the access rights to the memory can be selected. During Power-Up of the transponder the Configuration Byte is read from the transponder's EEPROM.

If you change the configuration, keys or passwords, you have to place the transponder directly on the antenna or hold it directly to it (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.

5.2.1 Modes of Operation

The HITAG 2 can be operated 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.
A password check is performed.

Public Mode A (Manchester):

Read only mode emulating Philips Semiconductors´ MIRO transponders resp. µEM H400x transponders.
The 64 bits of the user Pages 4 and 5 are cyclically transmitted to the read/write device.

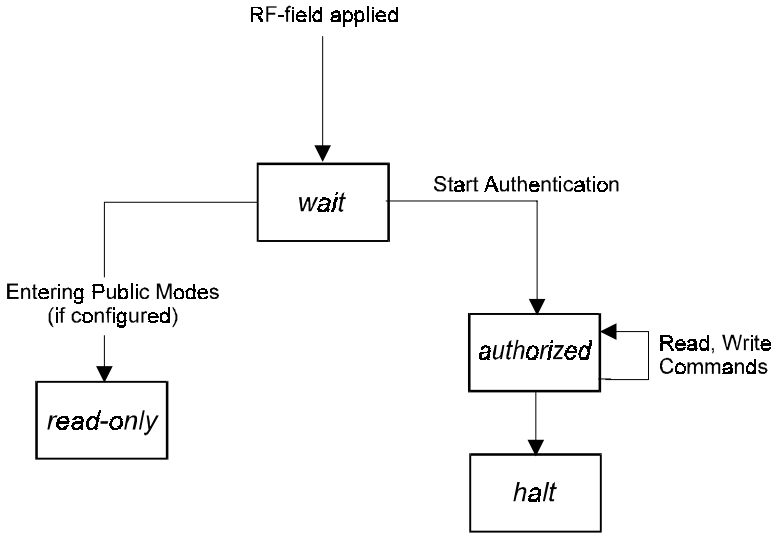
Public Mode B (Biphase):

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/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/write device.

5.2.2 Status Flow



After entering the RF-field the transponder waits for a command to start the authentication.

After issuing this command the mutual authentication takes place, followed by read- and write commands.
In password mode the data transfer occurs plain, in crypto mode data are encrypted.

The halt mode can be entered for muting a transponder.

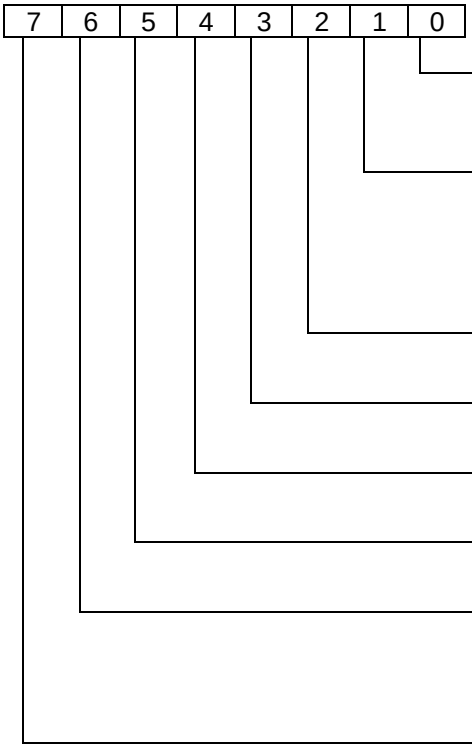
If the transponder is configured in one of the public modes, these modes are entered automatically after a certain waiting time and data pages are sent cyclically to the read/write device.

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

5.2.3 Configuration

The Configuration Byte is represented by the first 8 bits of Page 3 of the transponder memory.

Configuration Byte:



0: Manchester Code
1: Biphase Code

Bit 2	Bit 1	Version	Coding	Coding in HITAG 2-Operation
0	0	Public Mode B	biphase	depending on bit 0
0	1	Public Mode A	manchester	depending on bit 0
1	0	Public Mode C	biphase	depending on bit 0
1	1	HITAG 2	depending on bit 0	depending on bit 0

0: password mode
1: crypto mode

0: PAGE 6 and 7 read/write
1: PAGE 6 and 7 read only

0: PAGE 4 and 5 read/write
1: PAGE 4 and 5 read only

THE SETTING OF THIS BIT IS **OTP !**
0: PAGE 3 read/write
1: PAGE 3 read only; Configuration Byte and Password TAG **fixed**

THE SETTING OF THIS BIT IS **OTP !**
0: PAGE 1 and 2 read/write
1: PAGE 1 no read/no write
PAGE 2 read only (when transponder is in password mode)
PAGE 2 no read/no write (when transponder is in crypto mode)

Configuration Byte / Bit 6:

Bit 6 = ‘0’: Page 3 is read/write.
Bit 6 = ‘1’: Page 3 can only be read. This process is irreversible !

ATTENTION: Do not set Bit 6 of the Configuration Byte to ‘1’ before having written the final data into Page 3 (including the Configuration Byte and Password TAG) of the transponder.

Configuration Byte / Bit 7:

Bit 7 = ‘0’: Pages 1 and 2 are read/write.
Bit 7 = ‘1’: Pages 1 and 2 are locked against writing. This process is irreversible !

ATTENTION: Do not set Bit 7 of the Configuration Byte to ‘1’ before having written the final data into Pages 1 and 2 of the transponder.

Standard values for the Configuration Byte:

Password Mode:	0x06
Crypto Mode:	0x0E
Public Mode A:	0x02
Public Mode B:	0x00
Public Mode C:	0x04

5.3 Configuration of Delivered HITAG 2 Transponders

HITAG 2 transponders are delivered with the following configuration by Philips Semiconductors:

Unique Serial Number:

Serial Number:	Read Only	-	fixed

Configuration Byte:

0x06:	Password Mode (Manchester Code)	-	can be changed
	Page 6 and 7 read/write	-	can be changed
	Page 4 and 5 read/write	-	can be changed
	Page 3 read/write	-	can be changed
	Page 1 and 2 read/write	-	can be changed

Values for Transport Passwords, Transport Keys:

Password RWD:	0x4D494B52	(= ″MIKR″)
Password TAG:	0xAA4854	
Key Low:	0x4D494B52	(= ″MIKR″)
Key High:	0x4F4E	(= ″ON″)

RECOMMENDATION:
Before delivering transponders to end users, Pages 1 to 3 should be locked (set Configuration Byte / Bit 6 to ‘1’ for Page 3 and set Configuration Byte / Bit 7 to ‘1’ for Pages 1 and 2).

5.4 Definition of Passwords and Keys

Keys are cryptographic codes, which determine data encryption during data transfer between read/write device and transponder. They are used to select a HITAG 2 transponder in 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/write device.

Passwords are needed to select a HITAG 2 transponder in Password Mode. There is one pair of passwords (Password TAG, Password RWD) which has to be identical both on the transponder and the read/write device.

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

Password RWD: Password that the read/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/write device and on the transponder have to be identical pairs.

HITAG 2 in Password mode:

on the read/write device		**on the transponder**
Password RWD	⇔	Password RWD

as an option (depending on the configuration of the read/write device):

Password TAG	⇔	Password TAG

HITAG 2 in Crypto mode:

on the read/write device		**on the transponder**
KEY LOW	⇔	KEY LOW
KEY HIGH	⇔	KEY HIGH

as an option (depending on the configuration of the read/write device):

Password TAG	⇔	Password TAG

The passwords and keys are predefined by Philips Semiconductors by means of defined Transport Passwords and a Transport Key. They can be written to, which means that they can be changed (see also Chapter “Configuration of Delivered HITAG 2 Transponders“).

ATTENTION: Passwords and Keys only can be changed if their current values are known!

6 Quality Inspection

Quality inspection is performed with statistical quality control according to ISO 2859 part 1, with AQL1.0.

Optical Properties	scratches, encapsulation failures, gold discolouration, delamination	according to the reference sample catalogue
Geometrical Properies	width	measured with gauge
	length	measured with gauge
	overall thickness	measured with micrometer at the center of the transfer mould cap
Electrical Properties	operation	basic read/write operations
Shipment Quantity		
Packing and Labeling		

7 Characterisation and Test of the Final Transponder

7.1 Characterisation of the Transponder

The parameters recommended to be characterised for the transponder are:

Parameter		Comment
Resonant frequency	f_{res}	Transponder does not modulate Resonant frequency @ T_{amb} = 22°C, @ B_{TH}
Threshold value	B_{TH}	Start of modulation
Threshold value for READ	B_{RD}	Command READ_PAGE OK
Threshold value for WRITE	B_{WR}	Command WRITE_PAGE OK

For the measurement of these parameters we recommend to use the test equipment available from **SCEMTEC, Marienheide-Rodt, Germany (Transponder Measurement System STM-1).** This device also supports functional testing (besides parameter testing). Therefore it can also be used as production test equipment for the final transponder test. For further information please contact Scemtec GmbH.

7.2 Final Test of the Transponder

In addition to the equipment described in the previous chapter Philips Semiconductors offers a device for a final functional test of transponders, the HITAG™ Test System HT OT490. Parameter tests are not supportet by this device.

Basic flow for production and test:

1. Assembly of transponders
2. Functional test and final test of the EEPROM

Since the Keys and Logdata are changed during final test the Configuration and personalization must take place after the final test. The final test is disabled (not reversible) by setting the Tag-test mode bit to 0.

For the final test of transponders we recommend to use the HITAG™ Test System HT OT490 of Philips Semiconductors or the Transponder Measurement System STM-1 of Scemtec.

8 Ordering Information

Type Name	Description	Ordering Number
HT2 MOA3 S20/E/3	HITAG 2 S20 Chip Module, reel	9352 600 62118
HT2 MOA3 S20/E/1	HITAG 2 S20 Chip Module, bulk	9352 602 19122

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 Semiconductors´ customers using or selling these products for use in such applications do so on their own risk and agree to fully indemnify Philips Semiconductors for any damages resulting from such improper use or sale.

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