Read/Write Crypto Transponder

Description

The TK5560 is a complete transponder, which implements all important functions for immobilizer and identification systems. It consists of a plastic cube which accomodates the crypto IDIC® *) e5560 and the antenna realized as tuned LC-circuit. The TK5560 is a R/W crypto transponder for applications, which demand higher security levels than those which standard R/W transponders can fulfil. For this reason, the TK5560 has an additional encryption algorithm block which enables a base station to authenticate the transponder. Any attempt to fake the base station with a wrong transponder will be recognized immediately. For authentication, the base station transmits a challenge to the TK5560. This challenge is encrypted by both IC and base station. Both should posses the same secret key. Only then the result be expected to be equal.

Features

- Identification transponder in plastic cube
- Contactless read/write data transmission
- High security authentication with crypto algorithm
- Inductive coupled power supply at 125 kHz
- Basic component R/W e5560 IDIC
- Built in coil and capacitor for circuit antenna
- Starts with cyclical data read out
- Self adapting resonance frequency optionally
- 128 bit EEPROM user programmable
- Typical < 50 ms to write and verify a block
- Encryption time < 35 ms
- Read/write protection by lock bits
- Options set by EEPROM
  Bitrate (bit/s): Rf/32; Rf/64
  Modulaton: Manchester; Biphase

Application

- Car immobilizers with higher security level
- High security identification systems

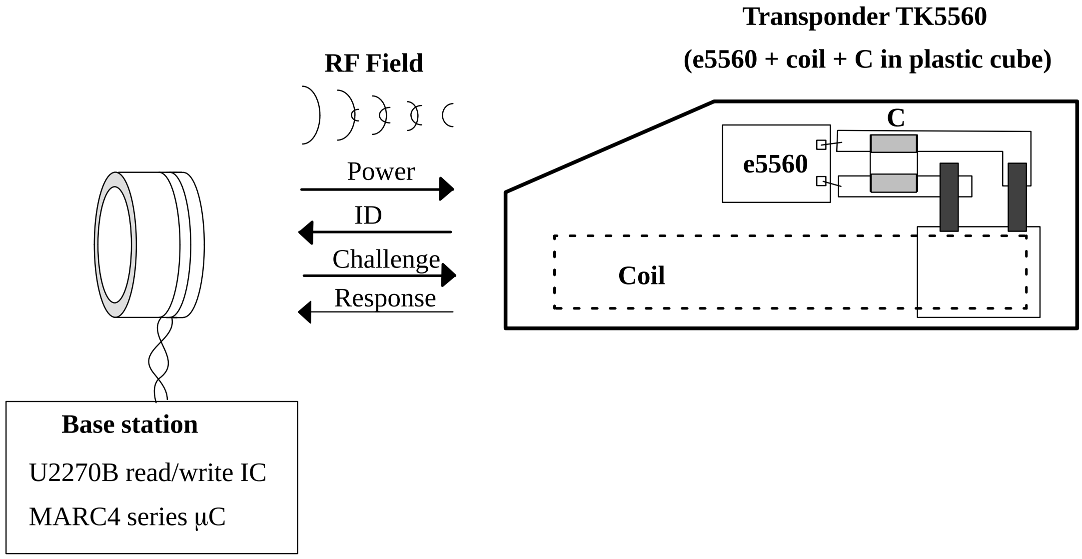


Figure 1. Transponder and base station

*) IDIC® stands for **ID**entification **I**ntegrated **C**ircuit and is a trademark of TEMIC.

General

The transponder is the mobile part of the closed coupled identification system (see figure 1 on page 1), whereas the read/ write base station is basing on the U2270B or on discrete solutions, and the read/ write transponder is basing on the e5560 IDIC®.

The transponder is a plastic-cube device consisting of following parts:

- The transponder antenna, realized as tuned LC-circuit
- Read/ write IDIC® (e5560) with EEPROM

The Transponder Antenna

The antenna consists of a coil and a capacitor for tuning the circuit to the nominal carrier frequency of 125 kHz. The coil has a ferrite core for improving the distance of read, write and programming operations.

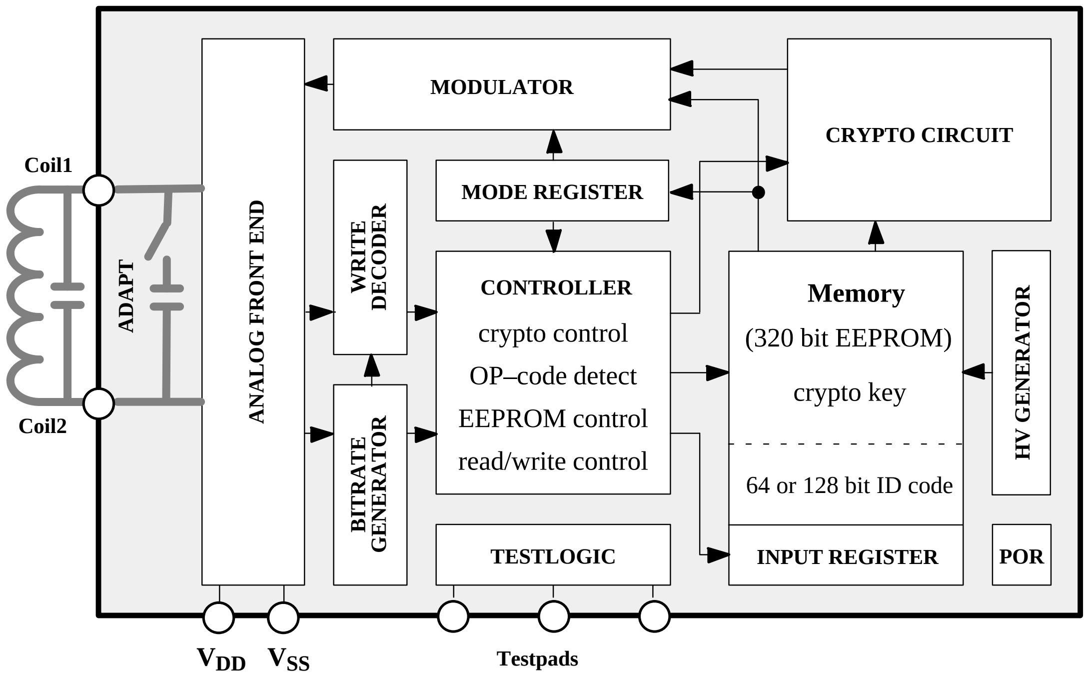


Figure 2. Block diagram

Read-Write Crypto Identification

The e5560 is a member of the TEMIC contactless **ID**entification **IC** (IDIC)® family, which are used in applications where information has to be transmitted without contacts. The IDIC® is connected to a tuned LC circuit for power supply and bidirectional data communication (**R**ead/**W**rite) to a base station.

The on chip non volatile memory of 320 bit EEPROM (10 blocks 32 bits each) can be read and written blockwise by a read/write base station, e.g. basing on the U2270B. Up to four blocks consists of the ID code user programmable, the crypto key and configurations are stored in six blocks. The crypto key and the ID code can be individually protected against overwriting.

To ensure that the TK5560 is not be used from unauthorized users for copying and faking read only IDIC®'s, the supplier can program and lock 8 bits of the ID code with a customer specific header.

The typical operational frequency of the TK5560 is 125 kHz. Two data bit rates are programmable: Rf/32 and Rf/64. During the reading operation the incoming RF field is damped bit wise by an on-chip load. This AM-modulation is detected by the field generating base station unit. Data transmission starts after power – up with the transmission of the ID code and continues as long as the TK5560 is powered.

Writing is done with TEMIC writing method (patent pending). To transmit data to the TK5560 the read/ write base station has to interrupt the RF field for a short time to create a field gap. The information is encoded in the number of clock cycles between two subsequent gaps.

See e5560 data sheet for detailed information of IDIC®.

Electrical Characteristics

Absolute Maximum Ratings

Parameters	Symbol	Value	Unit
Operating temperature range	T_{amb}	–40 to +85	°C
Storage temperature range	T_{stg}	–40 to +100	°C
Magnetic field strength	H_{pp}	1000	A/m
Maximum assembly temperature, t < 5 min.	T_{ass}	150	°C

Operating Characteristics Transponder

T_{amb} = 25°C, f = 125 kHz if not otherwise noted

Parameters	Test Conditions / Pins	Symbol	Min.	Typ.	Max.	Unit
Temperature stability		T_{stab}			180	°C
Inductance		L		3.8		mH
DC resistance		R		85		Ω
Resonance capacitor						
Capacitance		C_r		390		pF
LC circuit, H_{PP} = 20 A/m						
Resonance frequency	Room temperature	f_r	121		129	kHz
Quality factor		Q_{LC}		13		

Magnetic field strength (H)

Parameters	Test Conditions / Pins	Symbol	Min.	Typ.	Max.	Unit
Max. field strength where tag does not modulate	No influence to other tags in the field	$H_{pp\ not}$		5		A/m
Minimum field strength						
Read mode	T_{amb} = –40°C	$H_{pp\ -40}$		30		A/m
	T_{amb} = 25°C	$H_{pp\ 25}$		15		A/m
	T_{amb} = 85°C	$H_{pp\ 85}$		20		A/m
Programming mode	T_{amb} = 25°C	H_{pp}		50		A/m
Data retention EEPROM	T = 25°C	$t_{retention}$	10			Years
Programming cycles EEPROM			100,000			
Programming time / block	RF = 125 kHz	t_p		16		ms
Maximum field strength		$H_{pp\ max}$			600	A/m

Modulation range (see also H–DV curve)

Parameters	Test Conditions / Pins	Symbol	Min.	Typ.	Max.	Unit
Modulation range	H_{pp} = 20 A/m H_{pp} = 30 A/m H_{pp} = 50 A/m H_{pp} = 100 A/m	DV		4.0 6.0 8.0 8.0		V

Preliminary Information

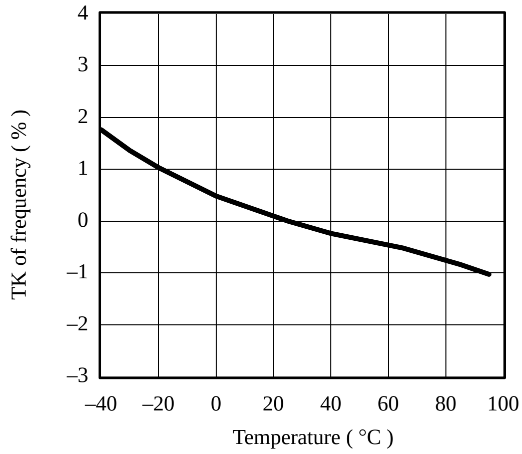


Figure 3. Typical T_K of the frequency

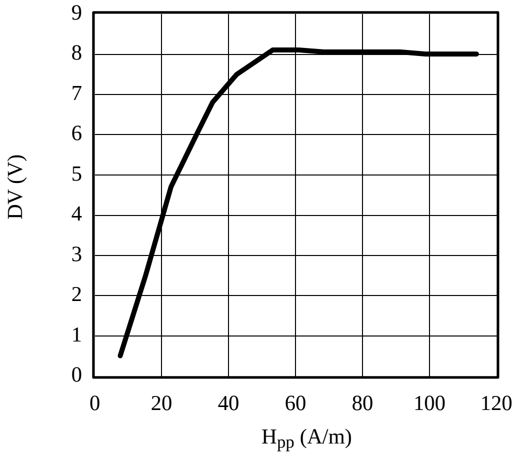


Figure 4. Typical H–DV curve

Output voltage of the testing application

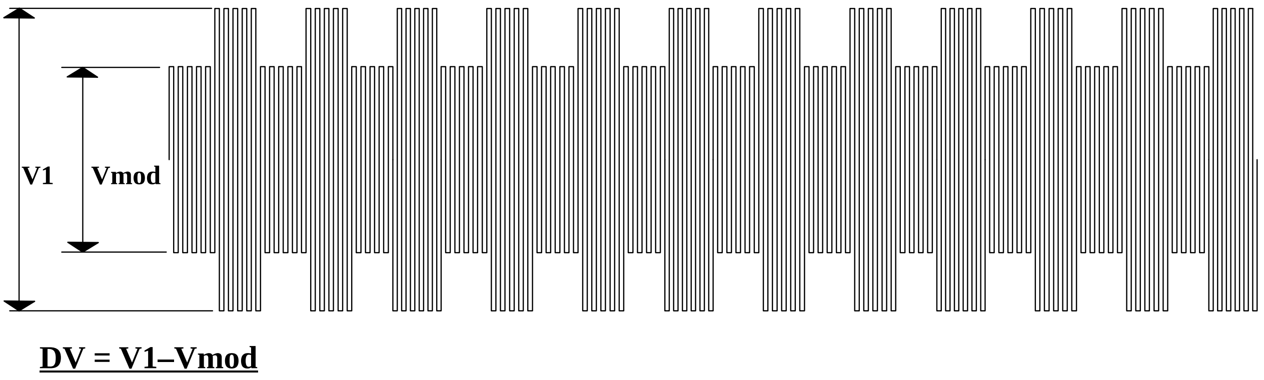


Figure 5. Measurement of the modulation range DV

Measurement Assembly

All parameters are measured in a Helmholtz-arrangement, which generates a homogenous magnetic field (see figure 6 and 7). A function generator drives the field generating coils, so the magnetic field can be varied in frequency and field strength.

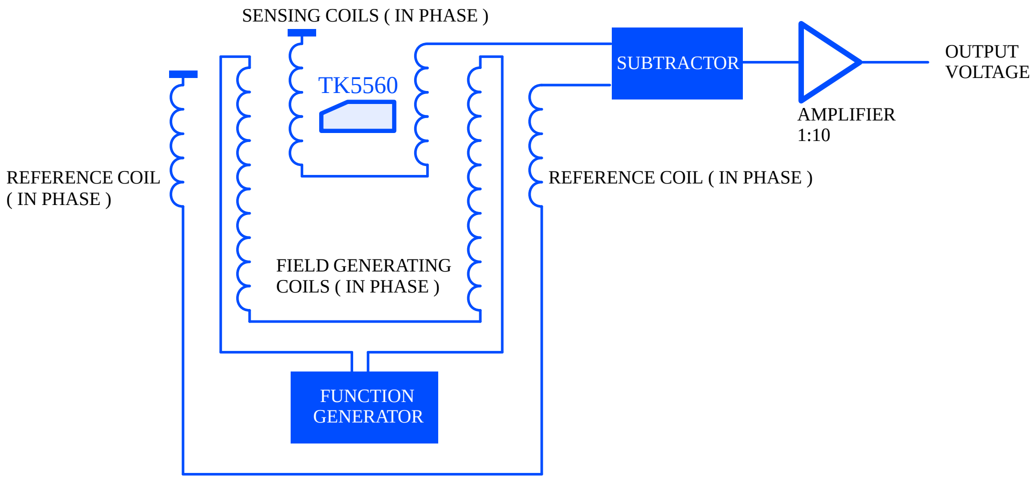


Figure 6. Testing application

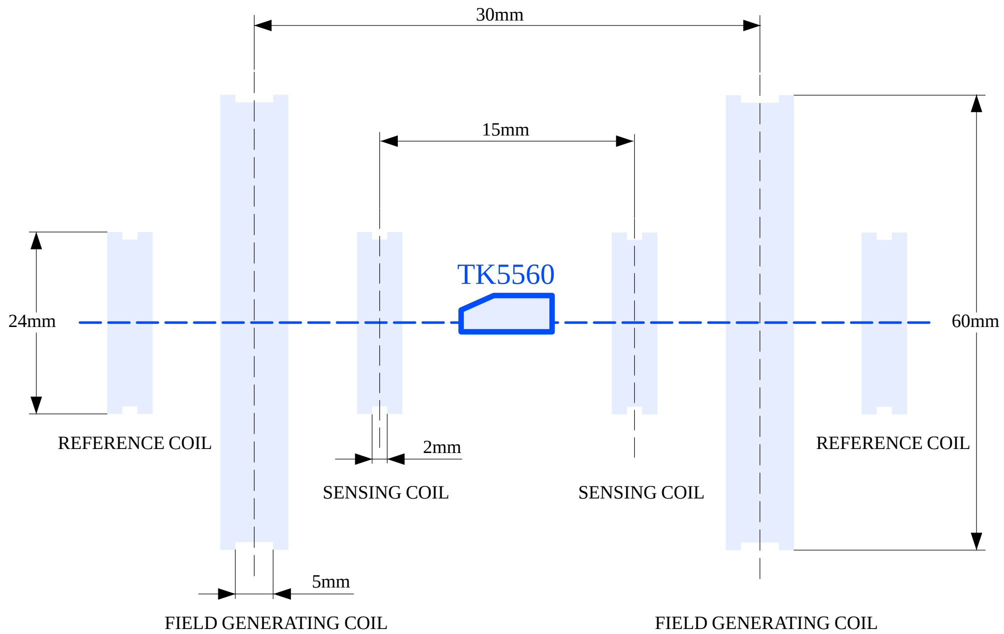


Figure 7. Testing geometry

Writing Data into the TK5560

A write sequence of the TK5560 is shown below. Writing data into the transponder occurs by interrupting the RF field with short gaps. After the start gap the write op-code (10) is transmitted. The next 32 bits contain the actual data. The last 4 bits denote the destination block address. If the correct number of bits have been received, the actual data is programmed into the specified memory block.

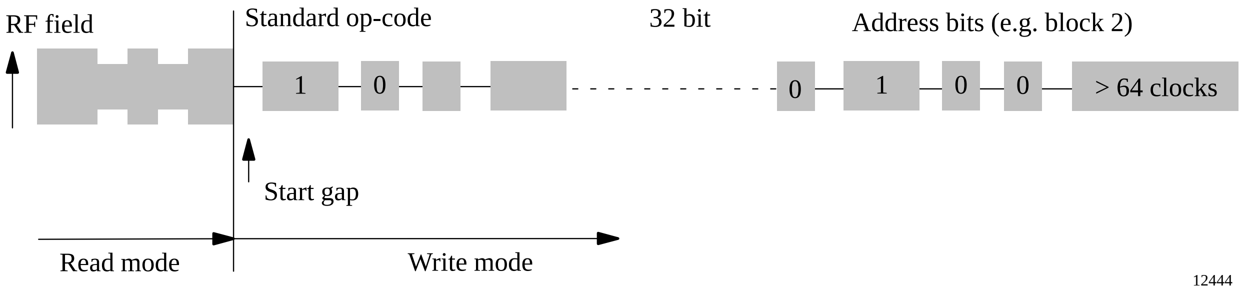


Figure 8. Write protocol to program the EEPROM

Write Data Decoding

The time elapsing between two detected gaps is used to encode the information. As soon as a gap is detected, a counter starts counting the number of field clock cycles until the next gap will be detected. Depending on how many field clocks elapse, the data is regarded as ’0’ or ’1’. The required number of field clocks is shown in figure 9.

A valid ’0’ is assumed if the number of counted clock periods is between 16 and 32, for a valid ’1’ it is 48 or 64 respectively. Any other value being detected results in an error and the device exits write mode and returns to read mode.

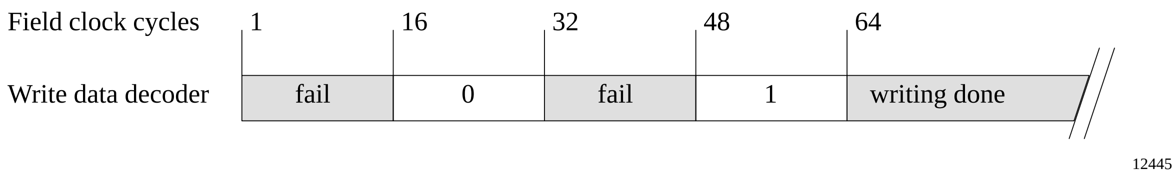


Figure 9. Write data decoding scheme

Behavior of the Real Device

The TK5560 detects a gap if the voltage across the coils decreases below a peak-to-peak value of 800 mV. Until then, the clock pulses are counted. The number given for a valid ’0’ or ’1’ (see figure 9), refer to the actual clock pulses counted by the device. However, there are always more clock pulses being counted than where applied by the base station. The reason for this is the fact, that a RF field cannot be switched off immediately. The coil voltage decreases exponentially. So although the RF field coming from the base station is switched off, it takes some time until the voltage across the coils reaches the threshold peak-to-peak value of 800 mV and the device detects the gap.

Referring to the following diagram (figure 10) this means that the device uses the times $t_{0\ internal}$ and $t_{1\ internal}$. The exact times for t_0 and t_1 are dependent on the application (e.g., field strength, etc.)

Typical time frames are:

t_0 = 70 to 165 µs
t_1 = 330 to 425 µs
t_{gap} = 150 to 400 µs

Antennas with a high Q-factor require longer times for t_{gap} and shorter time values for t_0 and t_1.

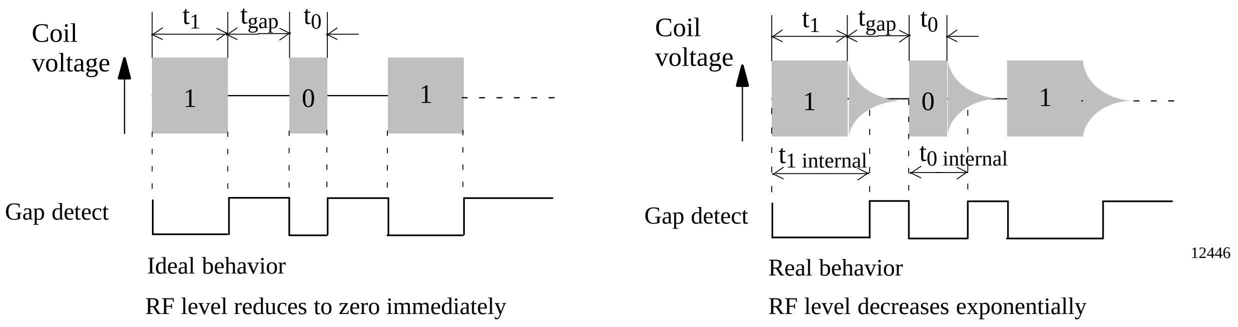


Figure 10. Ideal and real behavior signals

Operating Distance

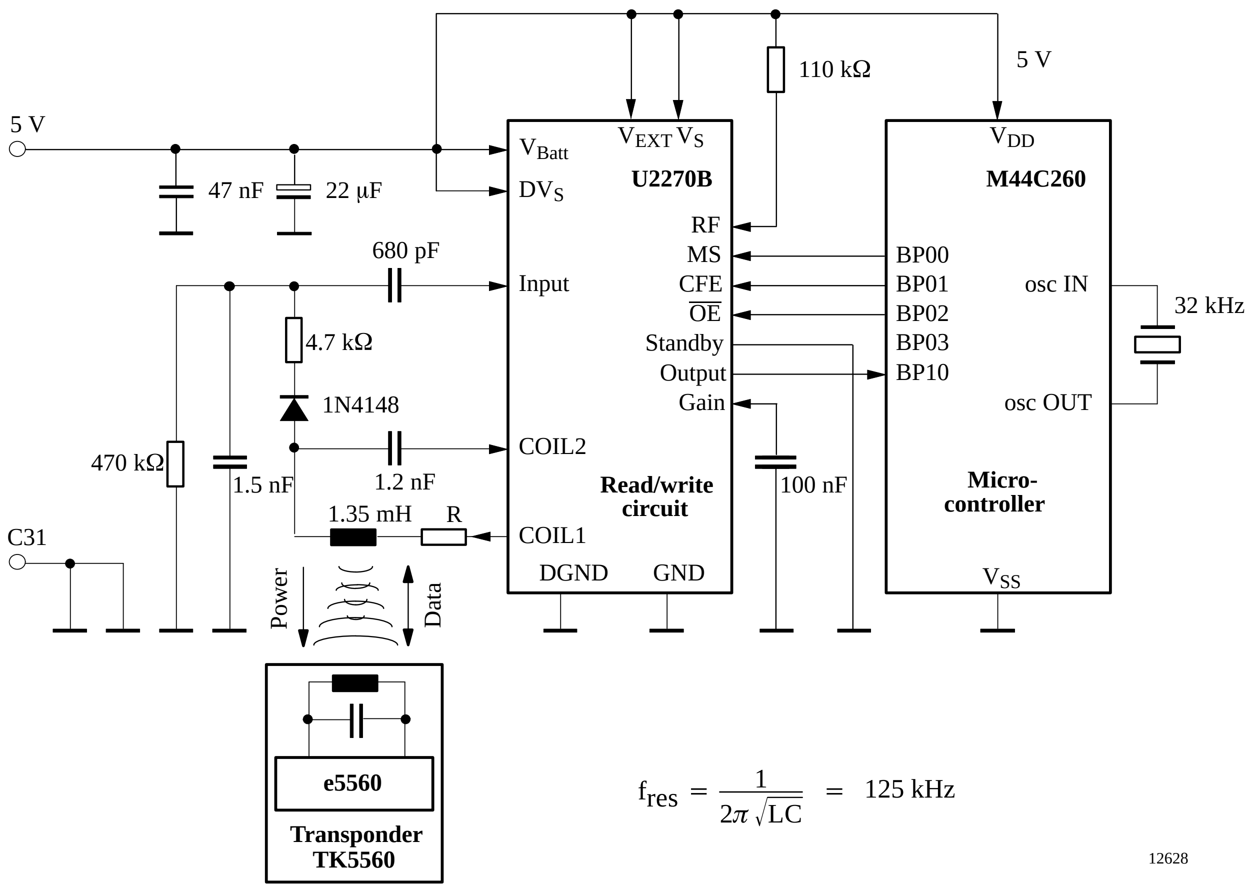
The maximum distance between the base-station and the TK5560 depends mainly on the base-station, the coil geometries and the chosen modulation options. Typical distances are 0 to 3 cm. A general maximum distance value can not be given. A convenient way is to measure the TK5560 within its environment. Rules for a correct base-station design can provided on request (see Antenna Design Guide).

Ordering Information

TK5560x-PP

Version of e5560 IDIC®

Application



$$f_{res} = \frac{1}{2\pi\sqrt{LC}} = 125\ \text{kHz}$$

Figure 11. Complete transponder system with the read/write IC U2270B

Mechanical Specification

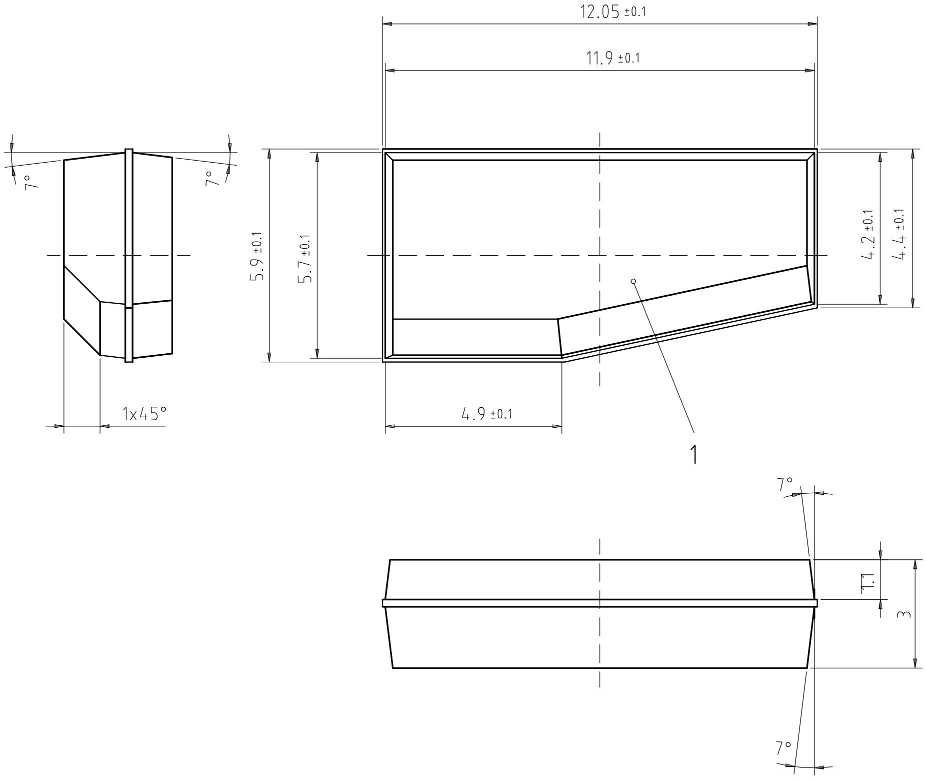


Figure 12. Mechanical drawing of transponder

Ozone Depleting Substances Policy Statement

It is the policy of **TEMIC TELEFUNKEN microelectronic GmbH** to

1. Meet all present and future national and international statutory requirements.

2. Regularly and continuously improve the performance of our products, processes, distribution and operating systems with respect to their impact on the health and safety of our employees and the public, as well as their impact on the environment.

It is particular concern to control or eliminate releases of those substances into the atmosphere which are known as ozone depleting substances (ODSs).

The Montreal Protocol (1987) and its London Amendments (1990) intend to severely restrict the use of ODSs and forbid their use within the next ten years. Various national and international initiatives are pressing for an earlier ban on these substances.

TEMIC TELEFUNKEN microelectronic GmbH semiconductor division has been able to use its policy of continuous improvements to eliminate the use of ODSs listed in the following documents.

1. Annex A, B and list of transitional substances of the Montreal Protocol and the London Amendments respectively

2. Class I and II ozone depleting substances in the Clean Air Act Amendments of 1990 by the Environmental Protection Agency (EPA) in the USA

3. Council Decision 88/540/EEC and 91/690/EEC Annex A, B and C (transitional substances) respectively.

TEMIC can certify that our semiconductors are not manufactured with ozone depleting substances and do not contain such substances.

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