

Read/Write Transponder

Description

The TK5550 is a complete programmable R/W transponder, which implements all important functions for identification systems. It allows the contactless reading and writing of data, which are transmitted bidirectionally between a read/write base station and the transponder. It is a plastic-cube device, which accommodates the IDIC[®] e5550 and also the antenna realized as an LC-circuit. No additional external power supply is necessary for the transponder, because it receives power from the RF field generated by the base

station. Data are transmitted by modulating the amplitude of the RF field. The TK5550 can be used to adjust and modify the ID-code or any other stored data, e.g. rolling code systems. The on-chip 264-Bit EEPROM (8 blocks, 33 bits per block) can be read and written blockwise from the base station. The blocks can be protected against overwriting. One block is reserved for setting the operation modes of the IC. Another block can obtain a password to prevent unauthorized writing.

Features

- Identification transponder in plastic cube
- Contactless read/write data transmission
- Inductive coupled power supply at 125 kHz
- Basic component: R/W e5550 IDIC[®]
- Built-in coil and capacitor for circuit antenna
- Starts with cyclical data read out
- 224 bit EEPROM user programmable in 32-bit blocks
- Typical < 50 ms to write and verify a block
- Write protection by lock bits

- Malprogramming protection
- Options set by EEPROM:
 Bitrate [bit/s]: RF/8, RF/16, RF/32, RF/40,
 RF/50, RF/64, RF/100, RF/128
 Modulation: BIN, FSK, PSK, Manchester,
 Biphase

Application

- Access control
- Rechargeable cash card
- Process control and automation
- Other identification systems

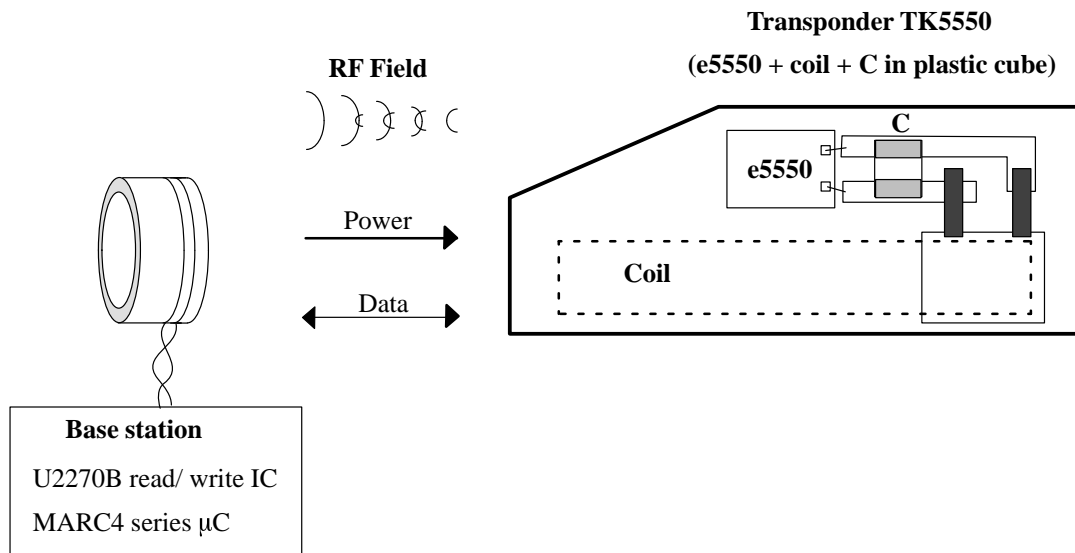


Figure 1. Transponder and base station

*) IDIC[®] stands for IDentification Integrated Circuit and is a trademark of TEMIC.

Ordering Information

Extended Type Number	Package	Remarks
TK5550F-PP	Plastic cube	All kind of modulation; RF/8, RF/16, RF/32, RF/40, RF/50, RF/64, RF/100 and RF/128 *) Default programmed: Manchester Modulation, RF/64, MAXBLK = 7

*) see datasheet e5550 page 4

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 e5550 IDIC®.

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

- The transponder antenna, realized as tuned LC-circuit
- Read/ write IDIC® (e5550) 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.

The Read/ Write IDIC® e5550

The read/ write IDIC® e5550 is part of the transponder TK5550. The data are transmitted bidirectionally between the base station and the transponder. The transponder receives power via a single coil from the RF signal generated by the base station. The single coil is connected to the chip and also serves as the IC's bidirectional communication interface.

Data are transmitted by modulating the amplitude of the RF signal. Reading occurs by damping the coil by an internal load. Writing occurs by interrupting the RF field in a specific way. The TK5550 transponder operates at a nominal frequency of 125 kHz. There are different bit rates and encoding schemes.

The on-chip 264-bit EEPROM (8 block, 33 bits each) can be read and written blockwise from the base station. The blocks can be protected against overwriting by using lock bits. One block is reserved for setting the operation modes of the IC. Another block contains a password to prevent unauthorized writing.

See e5550 data sheet for more detailed information of IDIC®.

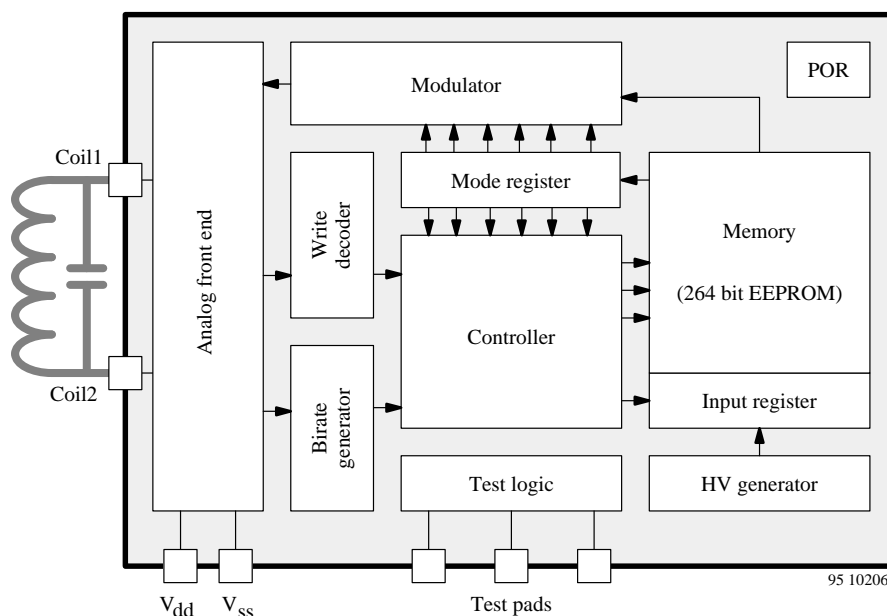


Figure 2. Block diagram e5550

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

$T_{amb} = 25^{\circ}\text{C}$, $f = 125$ kHz if not otherwise noted

Parameters	Test Conditions / Pins	Symbol	Min.	Typ.	Max.	Unit
Temperature stability		T_{stab}			180	°C
Inductance		L		3.85		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	$T_{amb} = -40^{\circ}\text{C}$	$H_{pp\ -40}$		30		A/m
	$T_{amb} = 25^{\circ}\text{C}$	$H_{pp\ 25}$		15		A/m
	$T_{amb} = 85^{\circ}\text{C}$	$H_{pp\ 85}$		20		A/m
Programming mode	$T_{amb} = 25^{\circ}\text{C}$	H_{pp}		50		A/m
Data retention EEPROM	$T = 25^{\circ}\text{C}$	$t_{retention}$	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	DV		4.0		V
	$H_{pp} = 30$ A/m			6.0		
	$H_{pp} = 50$ A/m			8.0		
	$H_{pp} = 100$ A/m			8.0		

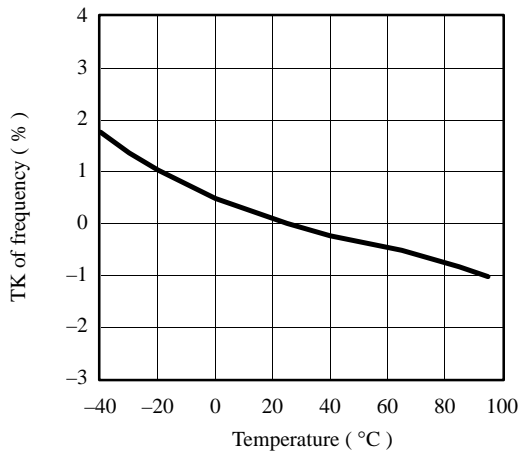


Figure 3. Typical T_K of the frequency

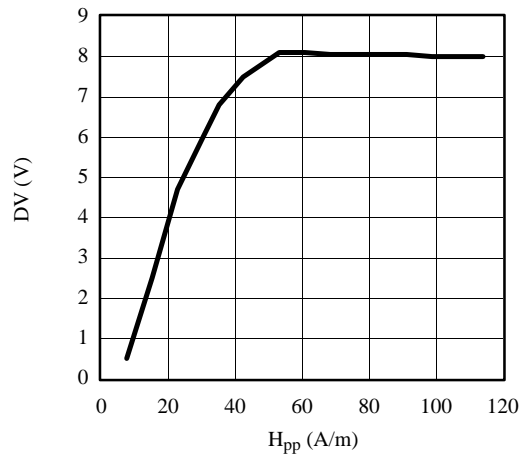


Figure 4. Typical H-DV curve

Output voltage of the testing application

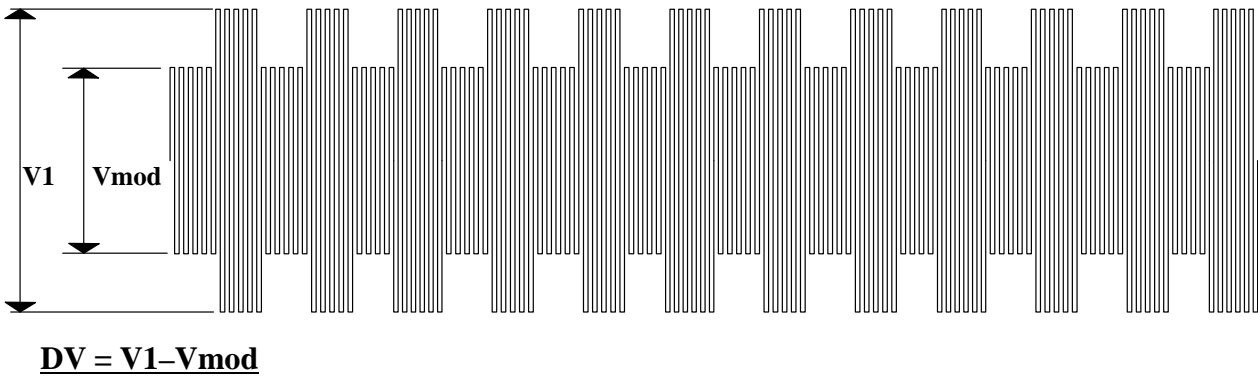


Figure 5. Measurement of the modulation range DV

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.

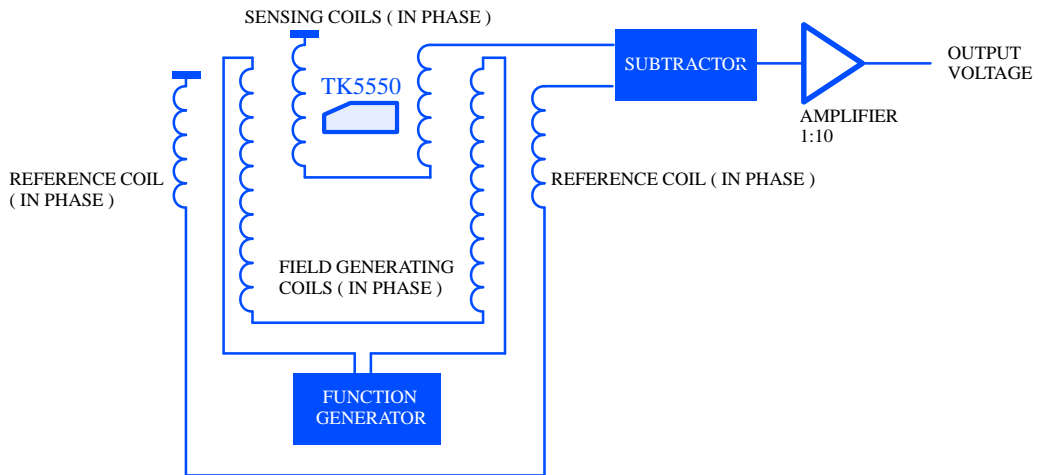


Figure 6. Testing application

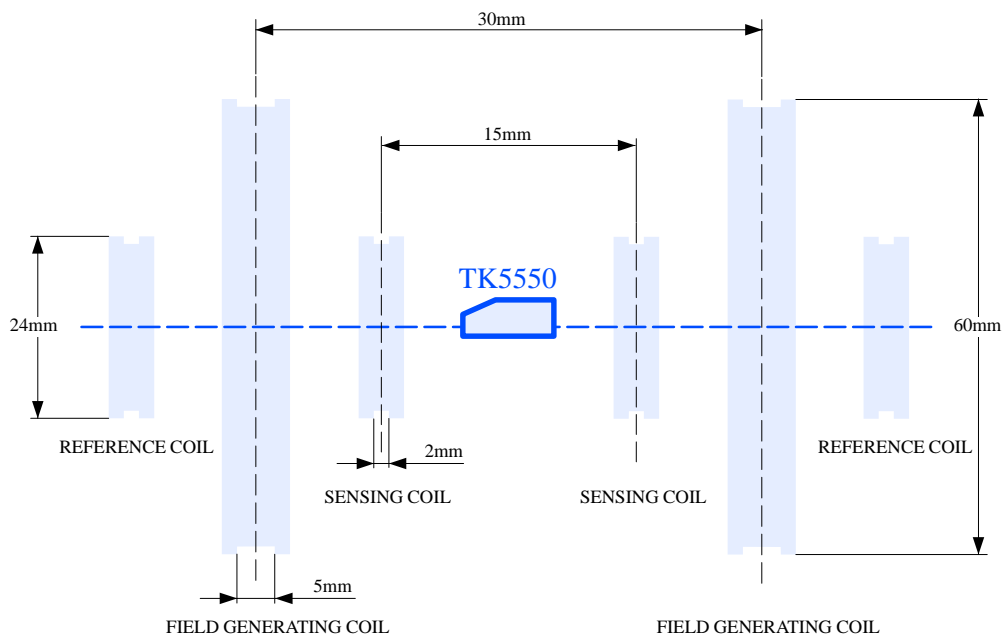
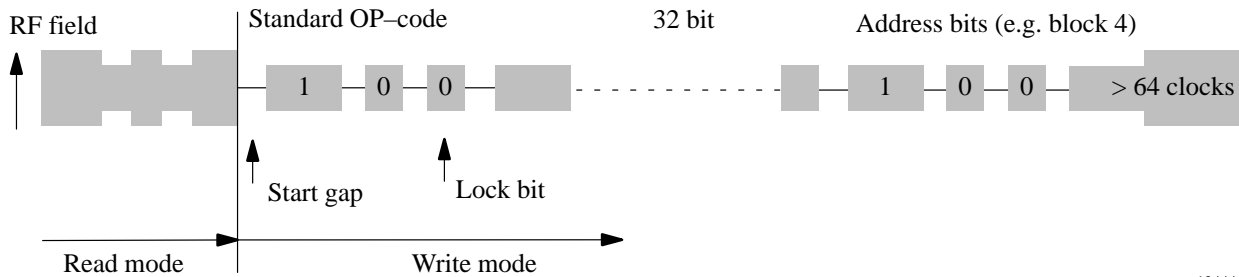


Figure 7. Testing geometry

Writing Data into the TK5550

The write sequence of the TK5550 is shown below. Writing data into the transponder occurs by interrupting the RF field with short gaps. After the start gap the standard write OP-code (10) is followed by the lockbit.

The next 32 bits contain the actual data. The last 3 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.



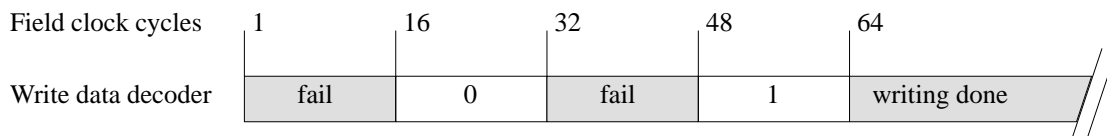
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Figure 8. Write protocol

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.



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Figure 9. Write data decoding scheme

Behavior of the Real Device

The TK5550 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 $t_{0\text{ internal}}$ and $t_{1\text{ internal}}$. The exact times for t_0 and t_1 are dependent on the application (e.g., field strength, etc.)

Typical time frames are:

- $t_0 = 70 \text{ to } 165 \mu\text{s}$
- $t_1 = 330 \text{ to } 425 \mu\text{s}$
- $t_{\text{gap}} = 150 \text{ to } 400 \mu\text{s}$

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

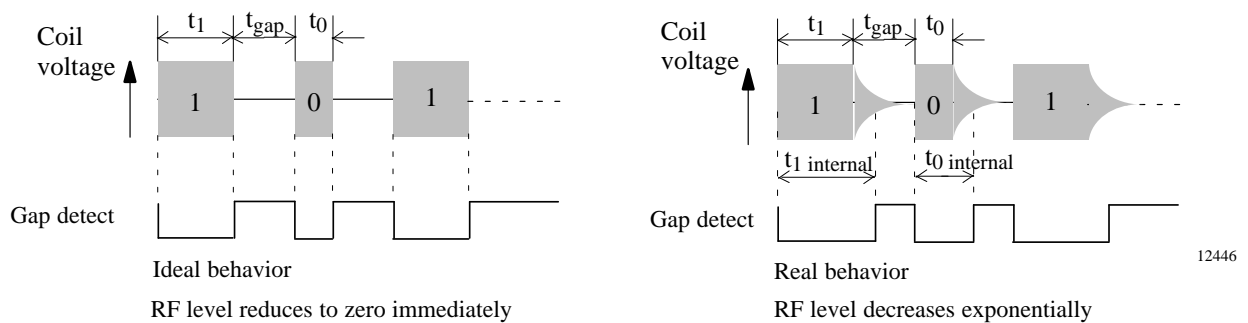


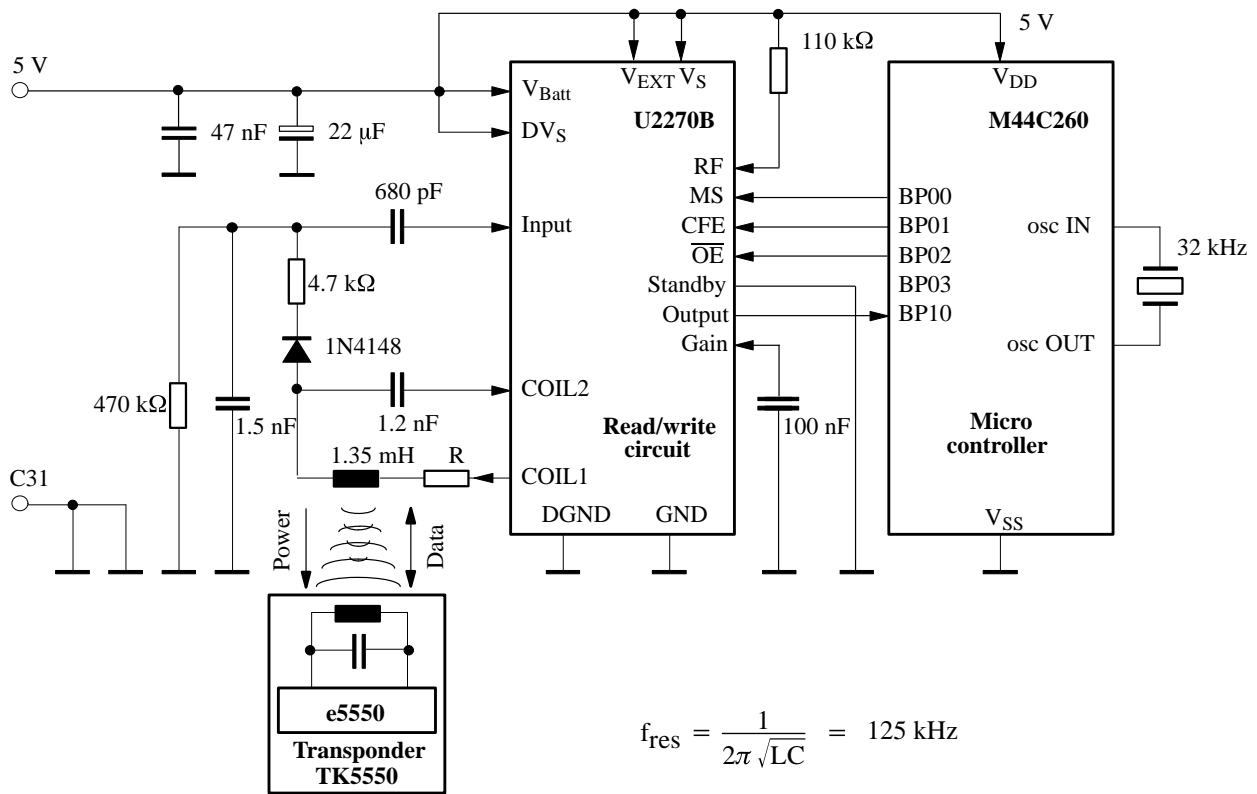
Figure 10. Ideal and real behavior signals

Operating Distance

The maximum distance between the base-station and the TK5550 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 TK5550 within its environment. Rules for a correct base-station design can provided on request (see Antenna Design Guide).

Application



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

Mechanical Specification

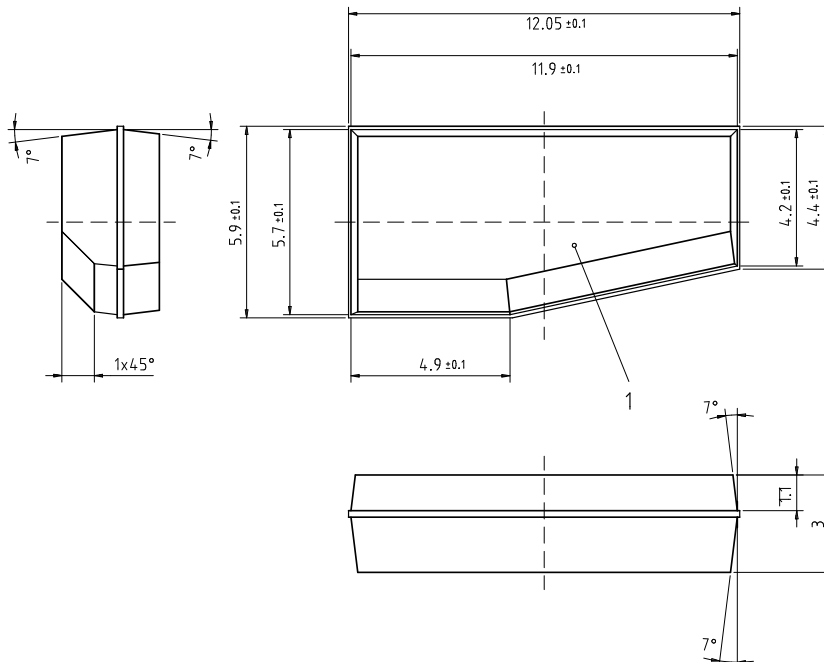


Figure 12. Mechanical drawing of transponder

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.

We reserve the right to make changes to improve technical design and may do so without further notice.

Parameters can vary in different applications. All operating parameters must be validated for each customer application by the customer. Should the buyer use TEMIC products for any unintended or unauthorized application, the buyer shall indemnify TEMIC against all claims, costs, damages, and expenses, arising out of, directly or indirectly, any claim of personal damage, injury or death associated with such unintended or unauthorized use.

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