

## Standard Read/Write ID Transponder with Anticollision

### Description

The TK5551 is a complete programmable R/W transponder which implements all important functions for identification systems, including anticollision (e.g. 10 transponders in < 500 ms dependent on the application). 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® \*) e5551 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 TK5551 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. For detailed technical information about functions, configurations etc., please refer to the e5551 data sheet.

### Features

- Anticollision ID transponder in plastic cube for R/W
- Contactless read/write data transmission
- Inductively coupled power supply at 125 kHz
- Basic component: R/W IDIC® e5551
- Anticollision mode by password request
- E.g. 10 transponders read out in < 500 ms (RF/32; maxblock 2) dependent on the application
- 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
- Process control and automation
- Installation and medical equipment
- Asset management

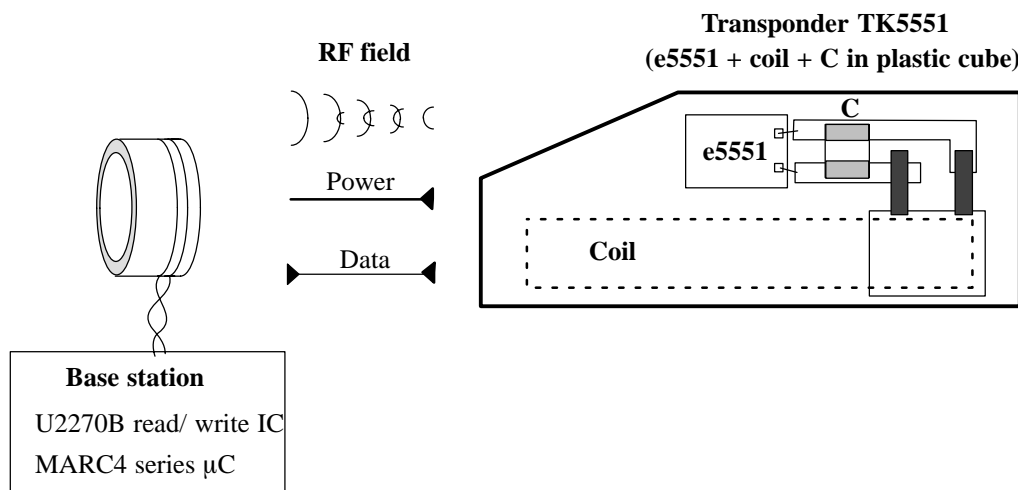


Figure 1. Transponder and base station

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

## Ordering Information

Extended Type Number	Package	Remarks
TK5551A-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/32, MAXBLK = 2

\*) see datasheet e5551

## General

The transponder is the mobile part of the closed coupled identification system (see figure 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 IDIC® e5551.

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

- The transponder antenna, realized as tuned LC-circuit
- Read/ write IDIC® (e5551) 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® e5551

The read/ write IDIC® e5551 is part of the transponder TK5551. 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 of register contents occurs by damping the coil by an internal load. Writing into registers occurs by interrupting the RF field in a specific way. The TK5551 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 e5551 data sheet for more detailed information of IDIC®.

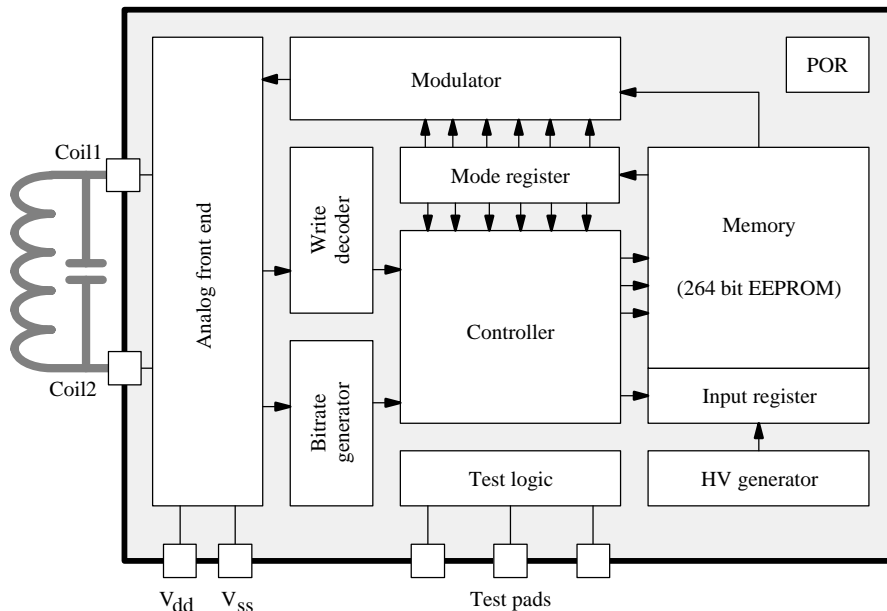


Figure 2. Block diagram e5551

## 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 +125	°C
Maximum assembly temperature, $t < 5$ min.	$T_{ass}$	170	°C
Magnetic field strength at 125 kHz	$H_{pp}$	1000	A/m

### Operating Characteristics Transponder

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

Parameters	Test Conditions	Symbol	Min.	Typ.	Max.	Unit
Inductance		L		3.8		mH
<b>LC circuit, <math>H_{pp} = 20</math> A/m</b>						
Resonance frequency	Room temperature	$f_r$	120	125	130	kHz
Quality factor		$Q_{LC}$		13		

### Magnetic field strength (H)

Parameters	Test Conditions	Symbol	Min.	Typ.	Max.	Unit
Max. field strength where tag does not modulate	No influence to other transponders in the field	$H_{pp\ not}$		4		A/m
<b>Minimum field strength</b>						
Read mode, write mode	$T_{amb} = -40^{\circ}\text{C}$	$H_{pp\ -40}$		30		A/m
	$T_{amb} = 25^{\circ}\text{C}$	$H_{pp\ 25}$		18		A/m
	$T_{amb} = 85^{\circ}\text{C}$	$H_{pp\ 85}$		17		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	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		

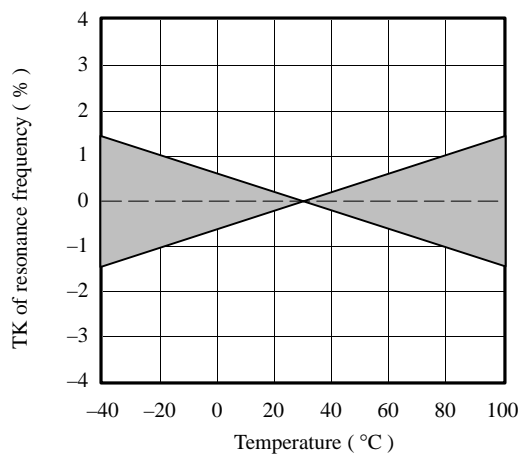


Figure 3. Typical TK-range of resonance frequency

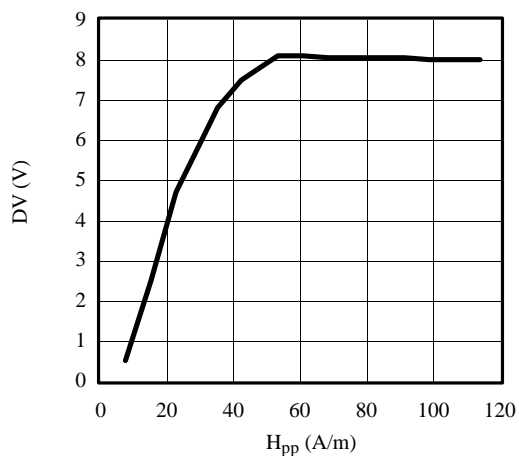
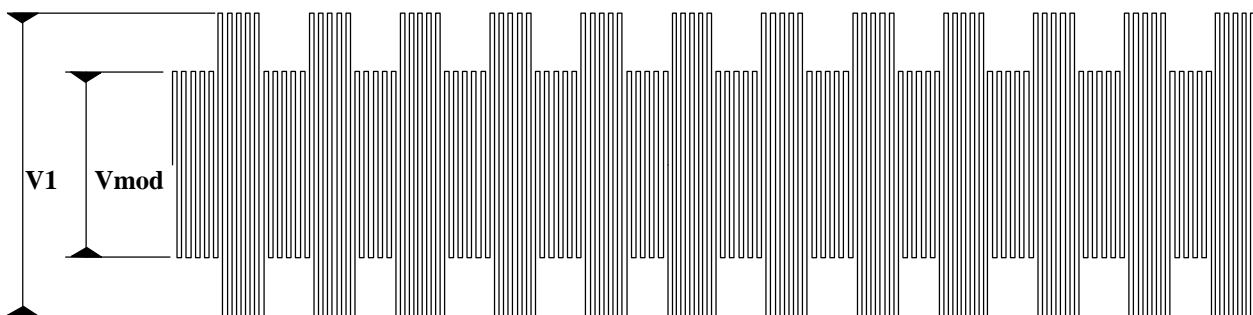


Figure 4. Typical H-DV curve

### Output voltage of the testing application



$$\underline{DV = V1 - Vmod}$$

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.

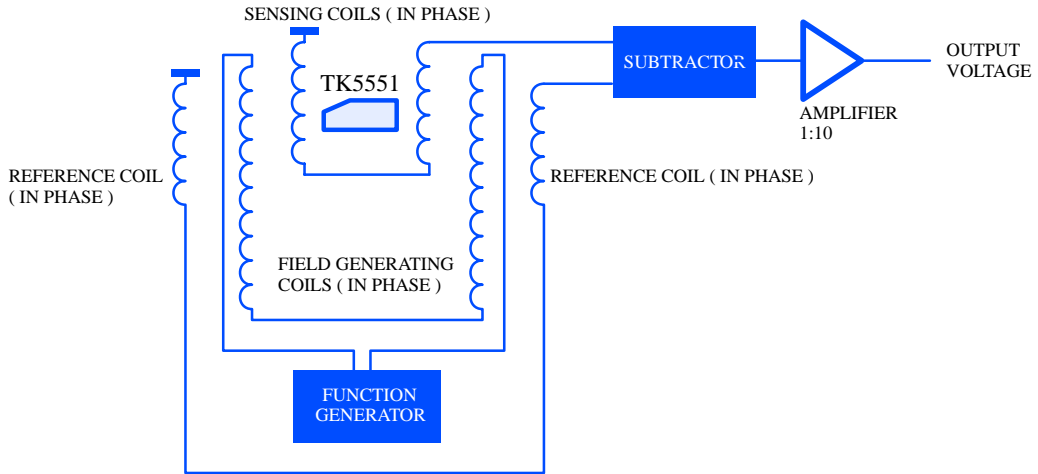


Figure 6. Testing application

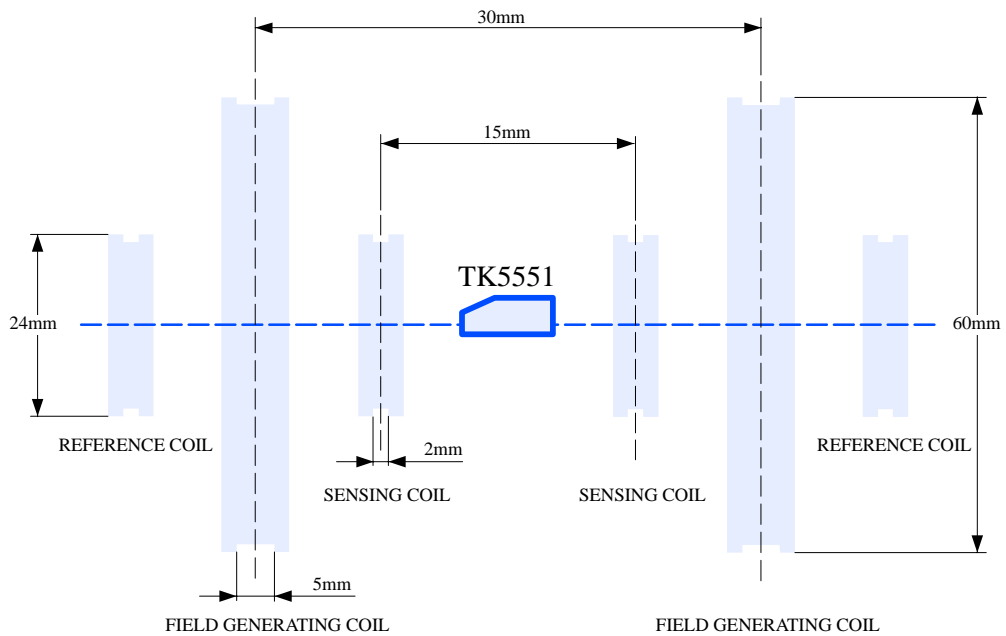


Figure 7. Testing geometry

## Writing Data into the TK5551

The write sequence of the TK5551 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.

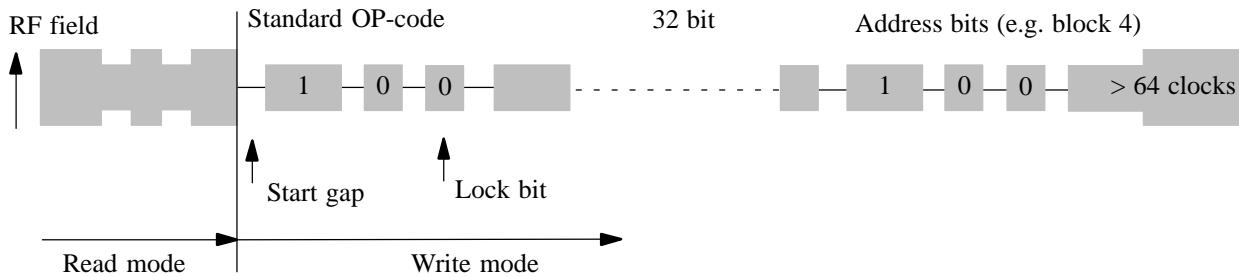
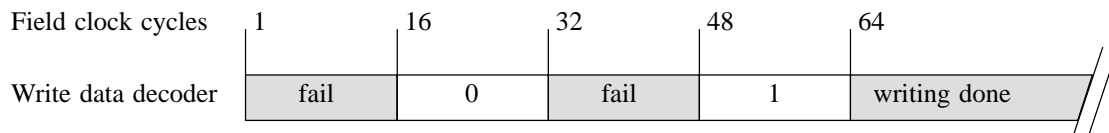


Figure 8. Write protocol

## 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 TK5551 detects a gap if the voltage across the coils decreases below the threshold value of an internal MOS transistor. 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 value of an internal MOS transistor 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.)

Measured write-time frames of the IDIC demokit software are:

$$\begin{aligned} t_0 &= 50 \text{ to } 130 \mu\text{s} \\ t_1 &= 270 \text{ to } 390 \mu\text{s} \\ t_{\text{gap}} &= 180 \text{ to } 400 \mu\text{s} \end{aligned}$$

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

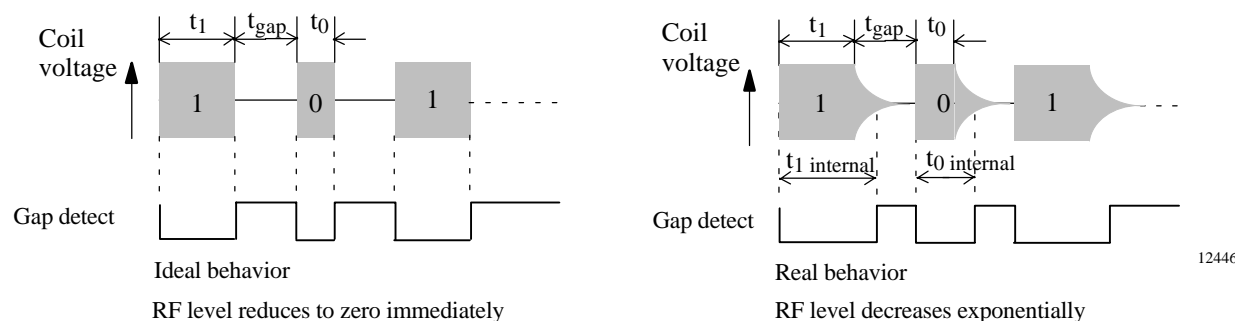


Figure 10. Ideal and real behavior signals

## Operating Distance

The maximum distance between the base station and the TK5551 depends mainly on the base station, the coil geometries and the modulation options chosen (see U2270B Antenna Design Hints and the U2270B data sheet). Under laboratory conditions, a distance of up to

9 cm can be reached. For the optimized distance, please refer to the application note. When using the TEMIC U2270B demo board, the typical distances in the range of 0 to 5 cm can be achieved.

## Anticollision Mode by Password Request (AOR = answer on request)

The AOR mode is an anticollision procedure for transponders to read e.g. 10 transponders in the field during 500 ms (RF/32; maxblock 2). The number of transponders and the time to read out are dependent on the application.

If the AOR mode has been configured by AOR bit at block 0, the transponder remains in sleep mode during putting it into the field. If the specified "AOR wake-up" command is sent, the dedicated transponder generates an internal RESET (see e5551 data sheet: OP-code formats). Due to the RESET the transponder is woken up. That

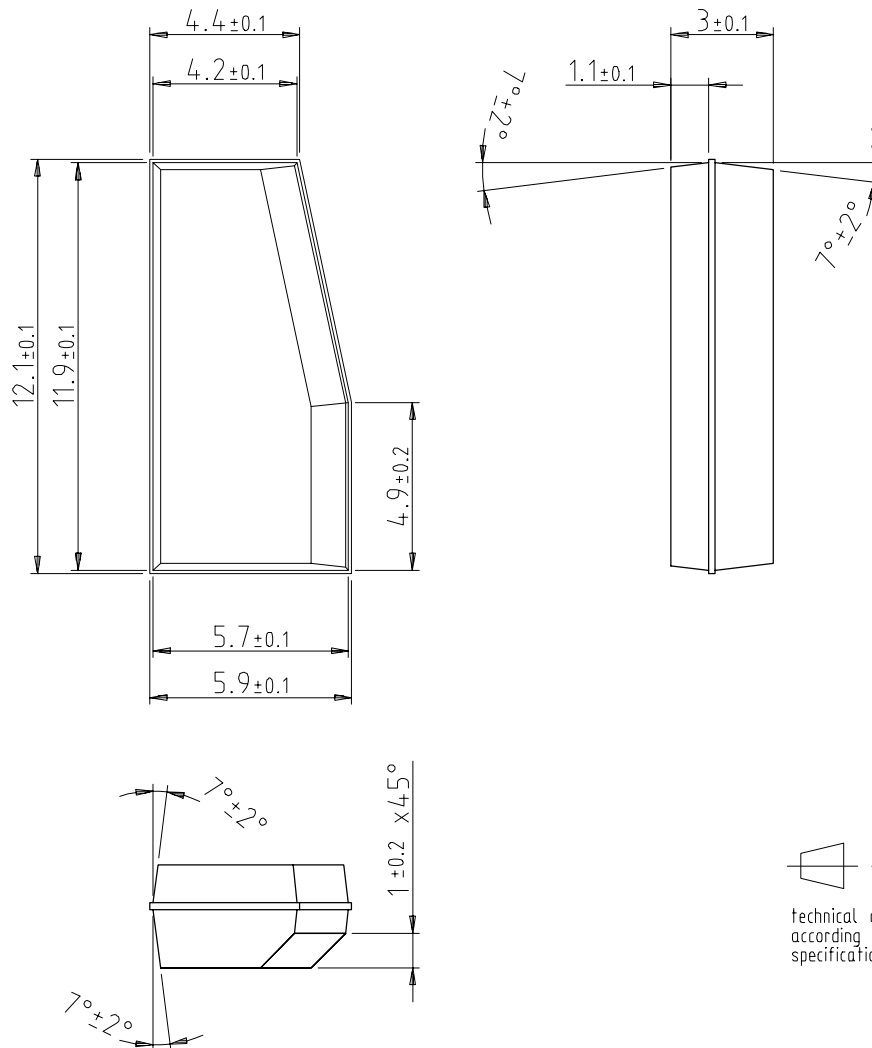
means, the transponder is able to modulate the field (read mode). The "AOR wake-up" command consists of the OP-code and the 32-bit password. The time duration to send the "AOR wake-up" sequence is between 8.7 ms and 27.5 ms according to figure 10. The time duration is dependent on the min./max. values of the measured write-time frames and the content of the password. To select another transponder in the field, it is necessary to send the "stop OP code" to stop the modulation of the transponder.

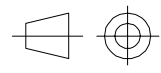




**Package Information**

Dimensions in mm



  
technical drawings  
according to DIN  
specifications

## Ozone Depleting Substances Policy Statement

It is the policy of **TEMIC Semiconductor 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 Semiconductor GmbH** 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 Semiconductor GmbH** can certify that our semiconductors are not manufactured with ozone depleting substances and do not contain such substances.

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