TECHNICAL SPECIFICATION

ISO/TS 22239-2

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Road vehicles — Child seat presence and orientation detection system (CPOD) —

Part 2:
Resonator specification

Véhicules routiers — Système de détection de la présence d'un siège enfant et de son orientation (CPOD) —

Partie 2: Spécifications relatives aux résonateurs

Reference number
ISO/TS 22239-2:2009(E)

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Foreword

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Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TS 22239-2 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 12, *Passive safety crash protection systems*.

ISO/TS 22239 consists of the following parts, under the general title *Road vehicles — Child seat presence and orientation detection system (CPOD)*:

- *Part 1: Specifications and test methods*
- *Part 2: Resonator specification*
- *Part 3: Labelling*

TECHNICAL SPECIFICATION **ISO/TS 22239-2:2009(E)**

Road vehicles — Child seat presence and orientation detection system (CPOD) —

Part 2:
Resonator specification

1 Scope

This part of ISO/TS 22239 specifies the child seat presence and orientation detection (CPOD) resonator as part of the CPOD system. It defines the electrical and environmental requirements to be met by the resonators as a condition for CPOD compatibility.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 10605:2008, *Road vehicles — Test methods for electrical disturbances from electrostatic discharge*

ISO 11452-1, *Road vehicles — Component test methods for electrical disturbances from narrowband radiated electromagnetic energy — Part 1: General principles and terminology*

ISO 11452-2, *Road vehicles — Component test methods for electrical disturbances from narrowband radiated electromagnetic energy — Part 2: Absorber-lined shielded enclosure*

ISO 11452-3, *Road vehicles — Component test methods for electrical disturbances from narrowband radiated electromagnetic energy — Part 3: Transverse electromagnetic mode (TEM) cell*

ISO 20653, *Road vehicles — Degrees of protection (IP-Code) — Protection of electrical equipment against foreign objects, water and access*

ISO/TS 22239-1:2009, *Road vehicles — Child seat presence and orientation detection system (CPOD) — Part 1: Specifications and test methods*

ISO 22241-1, *Diesel engines — NOx reduction agent AUS 32 — Part 1: Quality requirements*

IEC 60068-2-11, *Environmental testing — Part 2: Tests. Test Ka: Salt mist*

IEC 60068-2-38, *Environmental testing — Part 2: Tests. Test Z/AD: Composite temperature/humidity cyclic test*

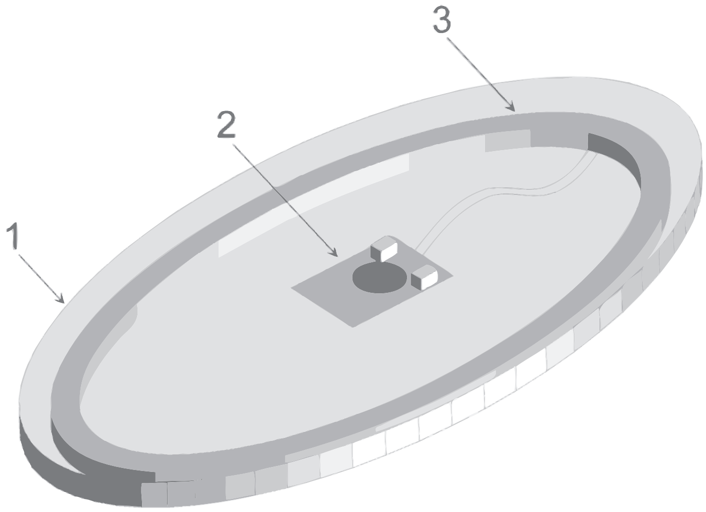
IEC 60068-2-60, *Environmental testing — Part 2: Tests — Test Ke: Flowing mixed gas corrosion test*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/TS 22239-1 apply.

4 CPOD resonator components

The CPOD resonator shall consist of a coil and of electronics. It might be encapsulated by a housing as indicated in Figure 1. In order to pass the resonator compatibility test successfully, the different components shall meet the requirements defined. The transponders shall be passive, i.e. they shall take their energy out of the magnetic field produced by the CPOD sensor.



Key

1 encapsulation/housing

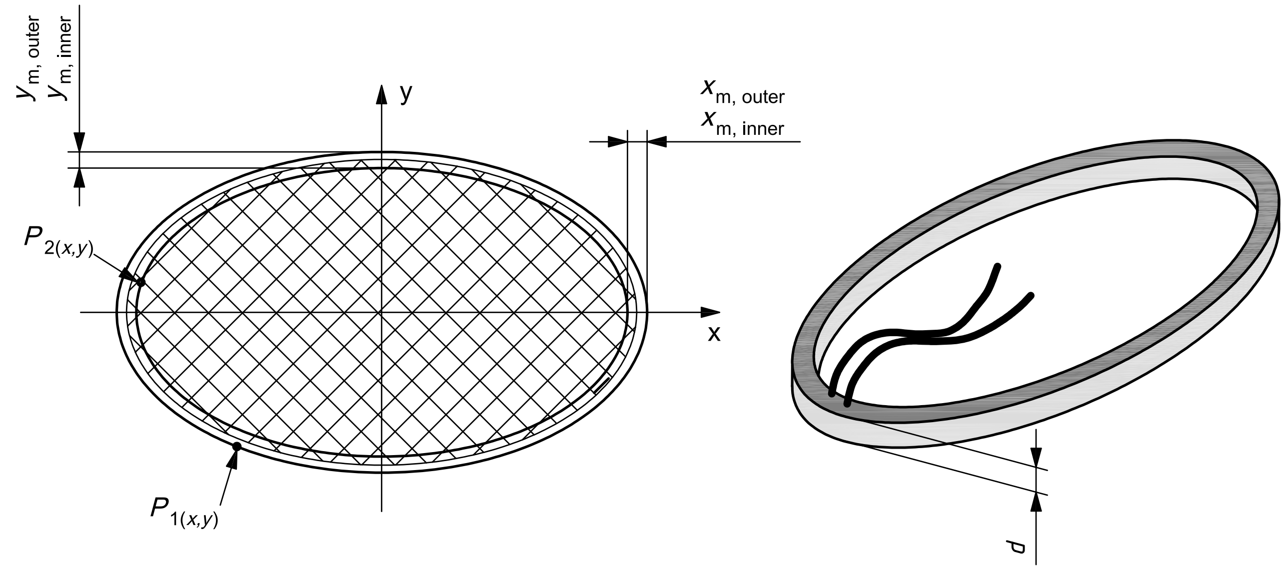
2 electronics

3 coil

Figure 1 — CPOD resonator components

5 Coil requirements

The CPOD resonator coil shall be an air coil with an elliptical shape. The geometry of the resonator probe coil is defined as indicated in Figure 2.



Key

$P_{1(x,y)}$, $P_{2(x,y)}$ position vectors determined by Equation (1)

Figure 2 — Resonator coil geometry

The position vectors of the inner and outer shape of the coil are described by Equation (1) with parameters as specified in Table 1.

$$P_{(x,y)} = \left(\frac{x}{x_{\mathrm{m}}}\right)^2 + \left(\frac{y}{y_{\mathrm{m}}}\right)^2 = 1 \qquad (1)$$

Table 1 — Coil geometry parameters

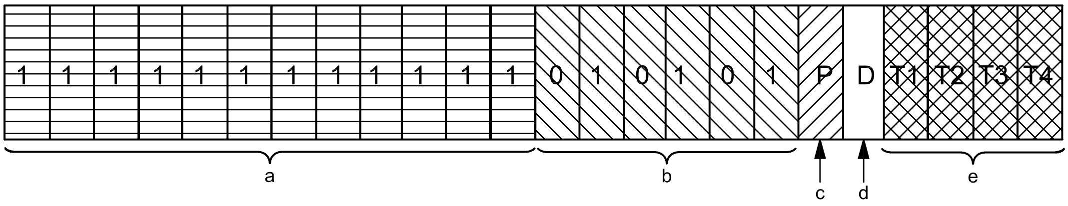
Dimensions in millimetres

Parameter	min.	max.
$x_{\mathrm{m,outer}}$	—	60
$y_{\mathrm{m,outer}}$	—	35
$x_{\mathrm{m,inner}}$	53	—
$y_{\mathrm{m,inner}}$	28	—
d	—	8

6 Electrical properties

6.1 Digital resonator protocol

By generating a modulated magnetic field that is detected in the receiving antennae of the CPOD sensor in the seat, the resonator shall transmit a digital data protocol which is built up as indicated in Figure 3.



[a]	Header:	Sequence of 12 bits with logical bit value = 1.
[b]	Synchronization sequence:	Sequence of three logical 0/1 transitions.
[c]	Parity bit:	Odd parity for T1-, T4-bit.
[d]	Divider bit:	Subcarrier divider bit: 1 → divider by 40, left resonator; 0 → divider by 56, right resonator.
[e]	Child seat type:	T1 ... T4.

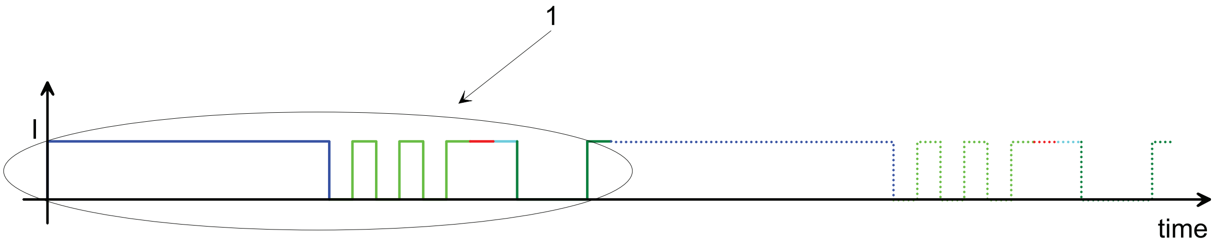
Figure 3 — CPOD resonator protocol

Additional information about the child seat is provided via the child seat type bits as defined in Table 2.

Table 2 — Child seat type classification

Type	T4	T3	T2	T1	Description
0	0	0	0	0	not allowed
1	0	0	0	1	rear-facing child seat
2	0	0	1	0	forward-facing child seat
3	0	0	1	1	convertible child seat, resonators in stiff connection with child seat
4	0	1	0	0	convertible child seat, resonators not connected with child seat
5	0	1	0	1	booster cushion
6	0	1	1	0	carry-cots
7	0	1	1	1	not yet defined
8	1	0	0	0	not yet defined
9	1	0	0	1	not yet defined
10	1	0	1	0	not yet defined
11	1	0	1	1	not yet defined
12	1	1	0	0	not yet defined
13	1	1	0	1	not yet defined
14	1	1	1	0	not yet defined
15	1	1	1	1	not yet defined

The protocol shall be repeated cyclically if the exiting magnetic field is still present. Thus, after the T4 bit, the next bit shall again be the first bit of the header part of the data protocol (see Figure 4).



Key

1 resonator protocol

Figure 4 — Cyclical sending of the resonator protocol

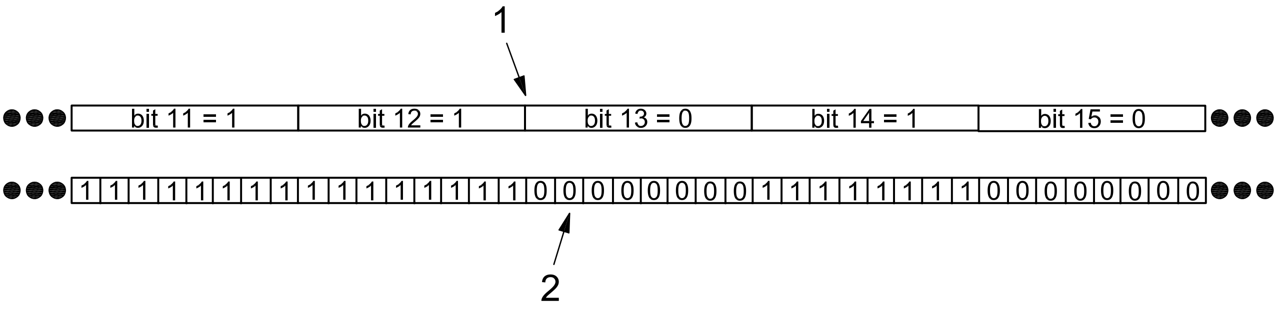
Depending on whether it is a left or a right resonator, the bit frequency of the data protocol varies as shown in Table 3.

Table 3 — Data protocol bit frequency

Resonator type	Parameter	Data protocol frequency
left	$f_{\text{data,left}}$	$f_{\text{TX}}/40/8 = f_{\text{TX}}/320$
right	$f_{\text{data,right}}$	$f_{\text{TX}}/56/8 = f_{\text{TX}}/448$

6.2 Subcarrier bitstream

Every resonator protocol bit value in accordance with Figure 3 logically summarizes eight consecutive bits of the same logical value (hereafter defined as subcarrier bits) with another, higher bit frequency (hereafter defined as subcarrier frequency). The relation between data protocol bits and subcarrier bits is indicated in Figure 5.



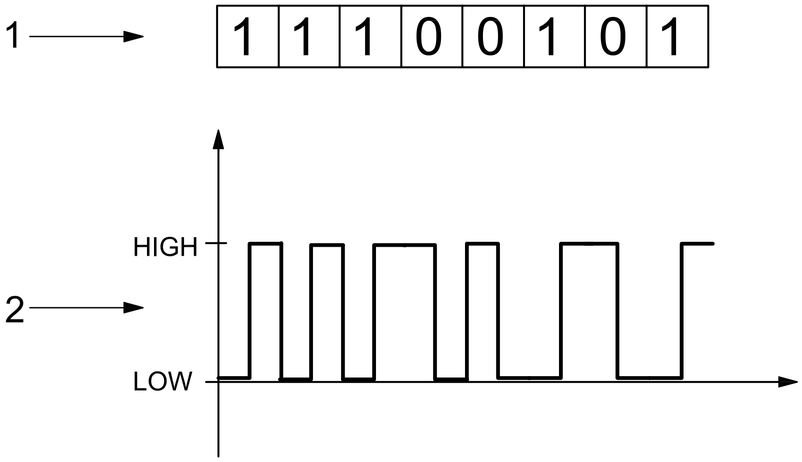
Key

1 resonator data protocol

2 subcarrier bitstream

Figure 5 — Difference between original and resonator Manchester coding

In order to prepare the subcarrier bits for transmission, every subcarrier bit value shall be Manchester coded, as indicated in Figure 6.



Key

1 subcarrier bit values

2 resulting Manchester code

Figure 6 — Manchester coding of subcarrier bit values

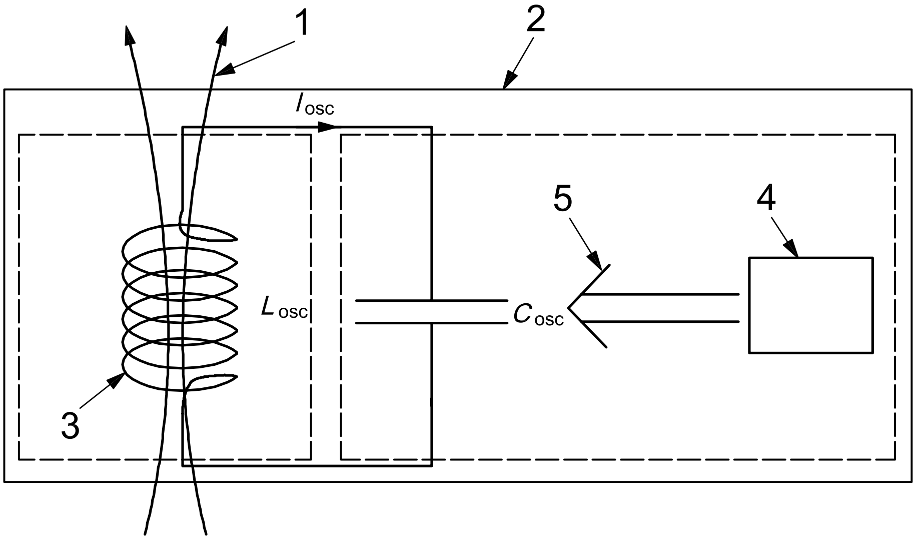
A subcarrier bit value of 1 shall cause a LOW to HIGH transition in the Manchester code pattern. A subcarrier bit value of 0 shall cause a HIGH to LOW transition on the Manchester pattern.

Table 4 — Subcarrier bit frequency, $f_{\text{subcarrier}}$

Resonator type	Parameter	Data protocol frequency
left	$f_{\text{subcarrier}}$	$f_{\text{TX}}/40$
right	$f_{\text{subcarrier}}$	$f_{\text{TX}}/56$

If there is a 0 to 1 transition or a 1 to 0 transition in the resonator data protocol, the resulting Manchester code shows a ±180° phase shift (phase shift keying, PSK).

The frequency of the subcarrier bitstream, as well as the phase angle of the concerned Manchester code, shall be used to modulate the magnetic field generated by the resonator, e.g. Figure 7 shows the main structure of the analogue front end of a resonator. The impedance of the LC oscillator is controlled by the Manchester code derived by the subcarrier bitstream, e.g. a HIGH level in the Manchester code leads to state one of the oscillators impedance (HIGH state); a low level in the Manchester Code leads to state two (LOW state) of the oscillator's impedance.



Key

1 magnetic field

2 resonator

3 resonator coil

4 control logic

5 impedance variation of LC oscillator

Figure 7 — Exemplified electrical structure of resonator analogue front end

6.3 Modulation

6.3.1 General

The resonators shall produce a phase modulation in the receiving antenna which is demodulated by the CPOD electronic control unit (ECU). Depending on the magnetic field supplying the resonators with energy, these shall produce a corresponding magnetic field that assures compatibility with all CPOD-compatible systems. The Manchester code of the bitstream specified in 6.2 shall be used to control physically the state of modulation.

The ability of a CPOD resonator to generate a phase modulation in the receiving antenna, which can be evaluated by the CPOD sensor, is characterized by two parameters: the parameter W determines the ability of the resonator to produce sufficient receiving amplitude in a CPOD-compatible sensor after demodulation; the parameter N specifies a maximum noise power at the demodulator's output.

Both parameters are derived using the following procedure, whose blocks are explained in 6.3.2 to 6.3.10.

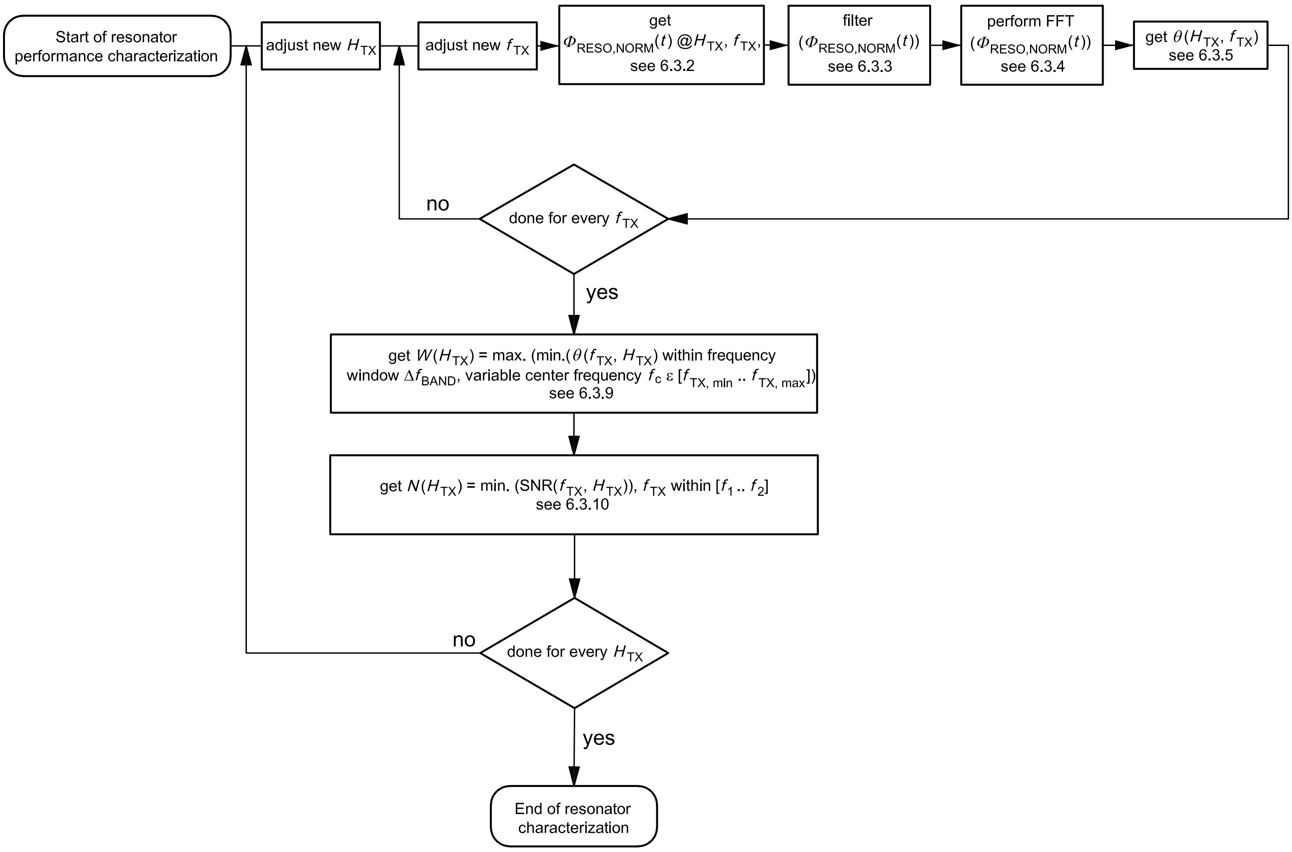
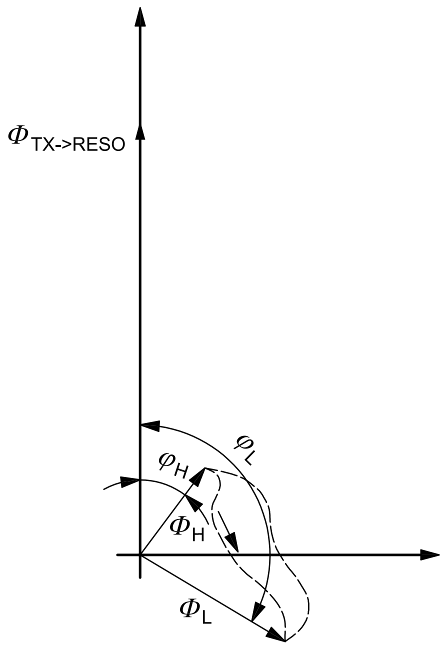


Figure 8 — Procedure to derive $W(H_{TX})$ and $N(H_{TX})$ for magnetic field strength H_{TX}

6.3.2 Useful resonator signal $\Phi_{RESO,NORM}(t)$

Since CPOD sensors usually have a high magnetic coupling between transmitting and receiving antennae, the useful resonator signal in the resonator magnetic field reduces to the component being perpendicular to the exiting magnetic transmitter field, which is also flooding the receiving antennae. The amplitude phase diagram in Figure 9 shows the relation between exciting magnetic field and resulting resonator magnetic flux.

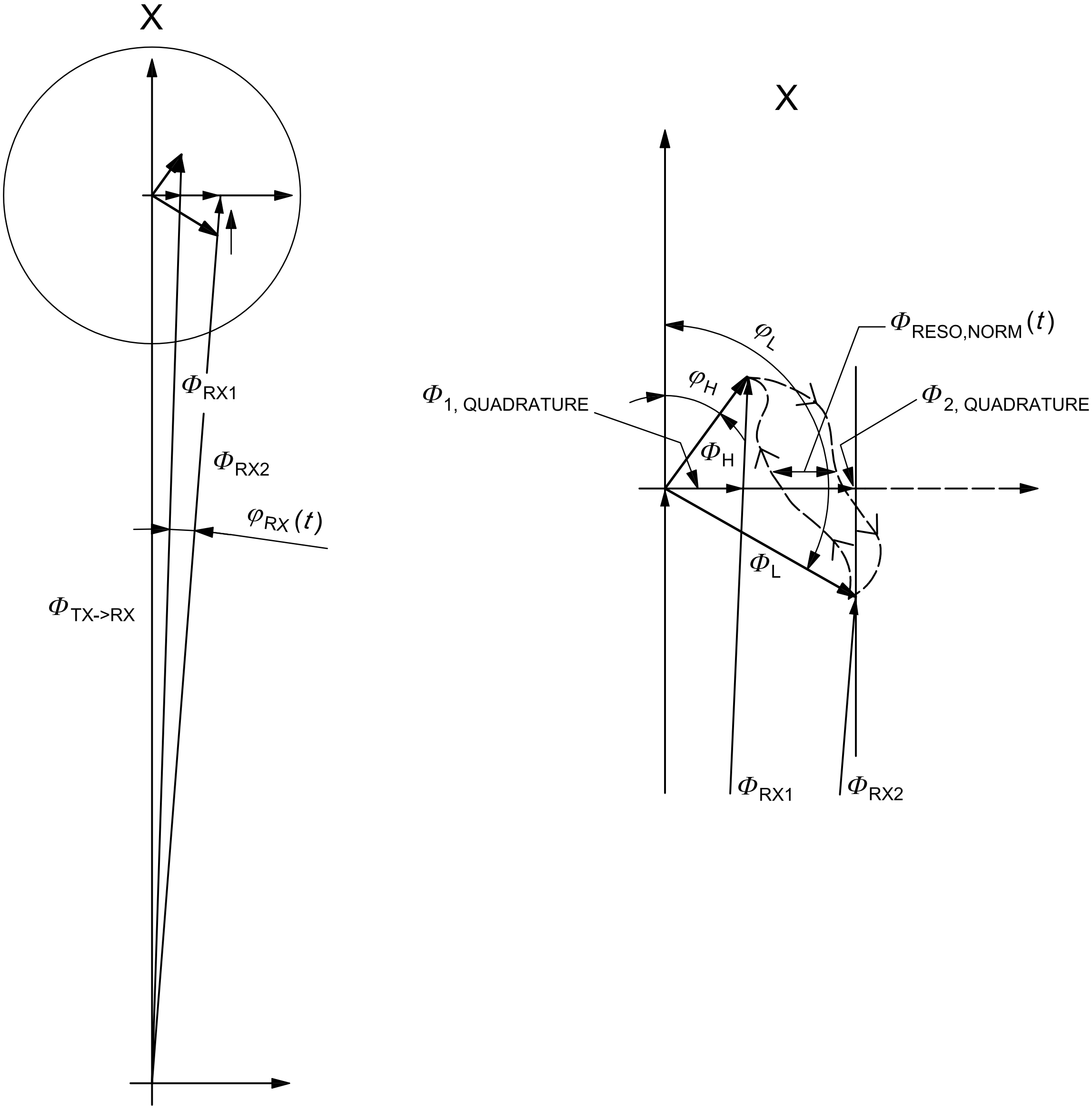


Key

$\Phi_{TX\rightarrow RESO}$	transmitter magnetic flux component supplying resonator
φ_H	phase angle between resonator field and resonator magnetic flux, high state of modulation
Φ_H	amplitude of resonator magnetic flux, high state of modulation
φ_L	phase angle between transmitter field and resonator magnetic flux, low state of modulation
Φ_L	amplitude of resonator magnetic flux, low state of modulation

Figure 9 — Resonator amplitude phase diagram

The magnetic flux generated by the resonator, which is flooding the receiving antenna, superposes to the part of the magnetic flux generated by the transmitting antenna, which also floods the receiving antenna. The resulting magnetic flux Φ_{RX} in the receiving antenna is indicated in Figure 10.



Key

$\varphi_{RX}(t)$	phase angle modulation in receiving antenna
$\Phi_{TX\rightarrow RX}$	transmitter field component flooding receiving antenna
φ_H	phase angle between transmitter field and transponder magnetic flux, high state of modulation
Φ_H	amplitude of resonator magnetic flux flooding receiving antenna high state of modulation
φ_L	phase angle between transmitter field and transponder magnetic flux, low state of modulation
Φ_L	amplitude of resonator magnetic flux flooding receiving antenna, low state of modulation

Figure 10 — Resulting magnetic flux in receiving antenna

Only the quadrature part of the magnetic flux generated by the resonator underlies CPOD compatibility requirements (depending on the physical realization of the resonator, the part of the magnetic flux being in phase with the supplying transmitter field may vary drastically).

The useful signal $\Phi_{\text{RESO,NORM}}(t)$ is defined by Equation (2):

$$\Phi_{\text{RESO,NORM}}(t) = \text{abs}[\underline{\Phi}_{\text{RESO}}(t)] \times \sin\left\{\text{arg}[\underline{\Phi}_{\text{RESO}}(t)]\right\}) = \text{abs}(\underline{\Phi}_{\text{RESO}}(t)) \times \sin[\varphi(t)] \tag{2}$$

where

$\underline{\Phi}_{\text{RESO}}(t)$	is the complex amplitude of Φ_{RESO} over time;
$\text{arg}[\underline{\Phi}_{\text{RESO}}(t)]$	is the phase difference between Φ_{TX} and $\underline{\Phi}_{\text{RESO}}(t)$ (see Figure 10).

6.3.3 Lowpass filtering

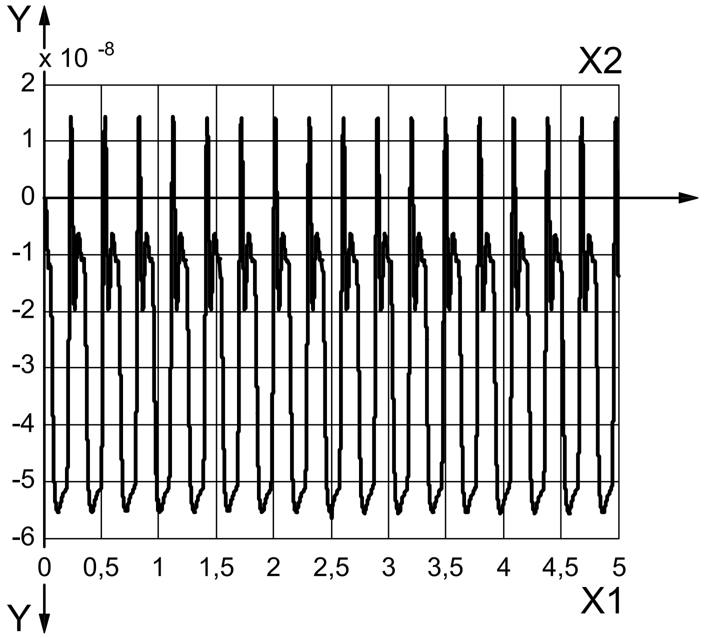
Before performing the Fast Fourier transform (FFT) on $\Phi_{\text{RESO,NORM}}(t)$, the signal shall be filtered by a third order lowpass filter since, usually, the influence of the harmonics on the demodulator output of the CPOD sensor can be neglected for frequency components above the 9th harmonic. Table 5 specifies the lowpass filter to be used.

Table 5 — Definition of lowpass filter

Parameter	min.	max.
End of pass band $W_{\text{p\_low}}$ kHz	20	20
Beginning of stop band $W_{\text{s\_low}}$ kHz	100	100
Attenuation in pass band $R_{\text{p\_low}}$ dB	0	1
Attenuation in stop band $R_{\text{s\_low}}$ dB	60	—

6.3.4 Spectral contents of $\Phi_{\text{RESO,NORM}}(t)$

Although Manchester coded bitstream explained in 6.2 contains only two discrete states (HIGH and LOW), the transition in the magnetic flux generated by the resonator takes a certain transition time, as indicated by the dotted lines in Figure 10. Figure 11 shows an example for the $\Phi_{\text{RESO,NORM}}(t)$ as a function of time.



Key

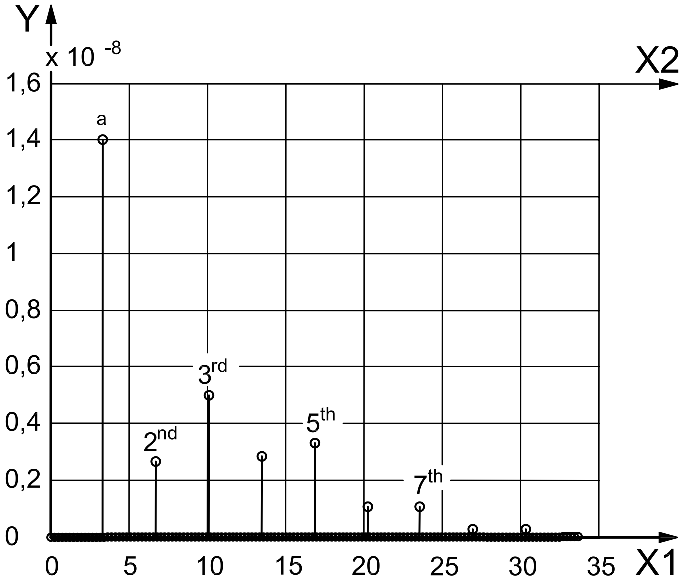
X1 time (ms)

X2 $\Phi_{\text{RESO,NORM}}(t)$ vs time

Y resonator magnetic flux (V·s)

Figure 11 — Transitions during modulation (exemplified)

Obviously, the spectral content of the magnetic flux contains the fundamental with subcarrier bitstream frequency, several harmonics, as shown in Figure 12.



Key

X1 f (kHz)

X2 spectral contents of $\Phi_{\text{RESO,NORM}}(t)$

Y magnetic flux amplitude (V·s)

[a] Fundamental.

Figure 12 — Spectral contents of $\Phi_{\text{RESO,NORM}}(t)$ (exemplified)

The spectral contents of $\Phi_{\mathrm{RESO,NORM}}(t)$ depends on the frequency f_{TX} and the magnetic field strength H_{TX} supplying the resonator.

6.3.5 The useful signal $\Theta(f_{\mathrm{TX}},H_{\mathrm{TX}})$

The spectral contents of $\Phi_{\mathrm{RX}}(t)$ (see Figure 12 for example) shows the subcarrier bit frequency (fundamental) of the phase modulation $\Phi_{\mathrm{RX}}(t)$. The even harmonics (2nd, 4th, 6th, etc.) usually do not have any influence on the performance. Therefore, they are not addressed in this part of ISO/TS 22239 and may have, as well as their phase angle relation with respect to the fundamental, arbitrary values.

Only the odd harmonics (fundamental, 3rd, 5th, etc.) are taken to define and to calculate the useful signal $\Theta(f_{\mathrm{TX}},H_{\mathrm{TX}})$, as follows:

$\Theta(f_{\mathrm{TX}},H_{\mathrm{TX}})$ = fundamental – 1/3*3rd harmonic – 1/5*5th harmonic – 1/7*7th harmonic – 1/9*9th harmonic, etc.

Getting the values for $\Theta(f_{\mathrm{TX}},H_{\mathrm{TX}})$ over the complete f_{TX} frequency range qualitatively leads to the curve shown in Figure 13.

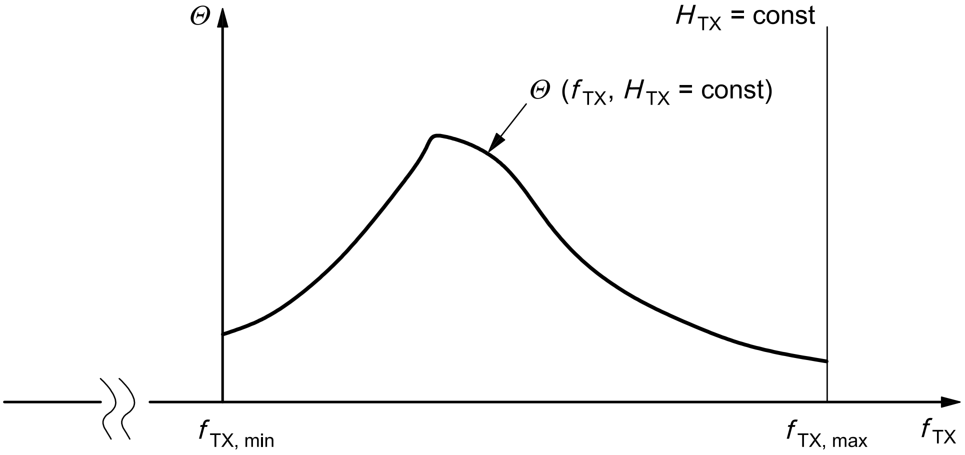


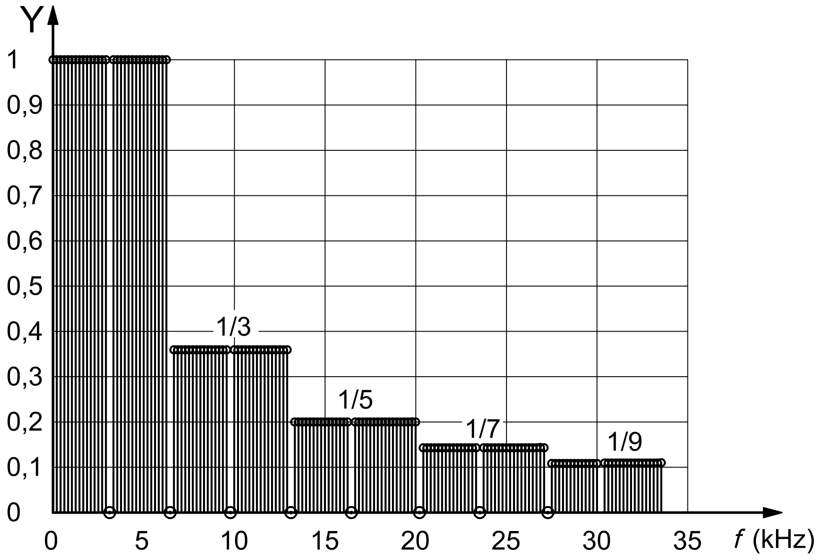
Figure 13 — Qualitative curve of $\Theta(f_{\mathrm{TX}},H_{\mathrm{TX}})$ for H_{TX} = const

6.3.6 The useful signal power $P_{\Theta}(f_{\mathrm{TX}},H_{\mathrm{TX}})$

The useful signal power $P_{\Theta}(f_{\mathrm{TX}},H_{\mathrm{TX}})$ is defined as $P_{\Theta}(f_{\mathrm{TX}},H_{\mathrm{TX}}) = \Theta(f_{\mathrm{TX}},H_{\mathrm{TX}})^2$.

6.3.7 Noise power $P_{\mathrm{NOISE}}(f_{\mathrm{TX}},H_{\mathrm{TX}})$

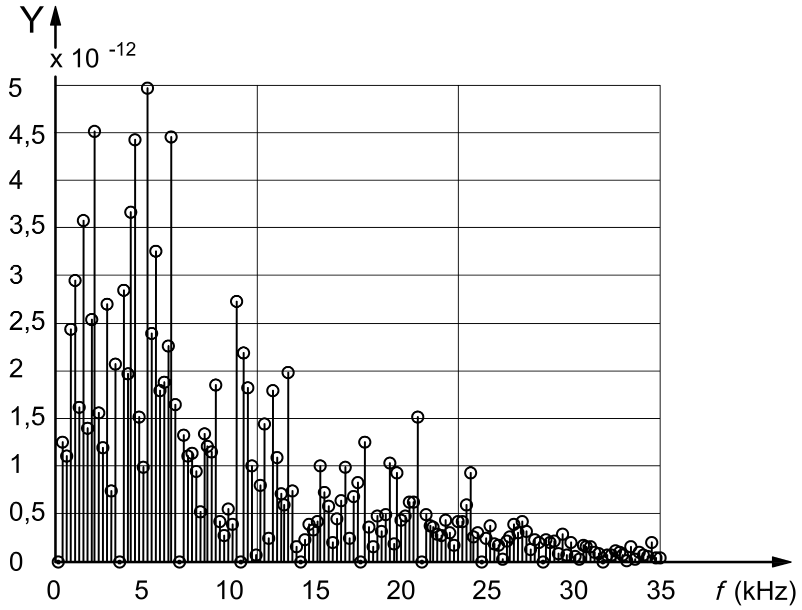
In order to derive the power, $P_{\mathrm{NOISE}}(f_{\mathrm{TX}},H_{\mathrm{TX}})$, the spectral contents of $\Phi_{\mathrm{RESO,NORM}}(t)$ (see Figure 12) shall be taken into account without the d.c. part, fundamental (odd and even) and its harmonics (set to 0). The remaining part shall be weighted over frequency. The weighting is performed by multiplying the resulting spectrum with the weighting function (see Figure 14). The resulting noise spectral content is shown in Figure 15.



Key

Y weighting function

Figure 14 — Weighting function and resulting noise spectral contents of $\varphi_{RX}(t)$



Key

Y noise amplitude (V)

Figure 15 — Resulting noise spectral contents of $\varphi_{NORM}(t)$

The noise power is defined as:

$$P_{NOISE}(f_{TX}, H_{TX}) = \int_f \text{noise\_spectrum}^2 \qquad (3)$$

The noise power depends on the frequency f_{TX} and the magnetic field strength H_{TX} supplying the resonator.

6.3.8 The signal-to-noise ratio (SNR)

In order to generate the signal-to-noise ratio (SNR), the useful signal's power as well as the noise power shall be calculated. The SNR is defined by Equation (4):

$$SNR(f_{\mathrm{TX}}, H_{\mathrm{TX}}) = \frac{P_{\Theta}(f_{\mathrm{TX}}, H_{\mathrm{TX}})}{P_{\mathrm{NOISE}}(f_{\mathrm{TX}}, H_{\mathrm{TX}})} \tag{4}$$

In order to characterize the performance of the resonator, SNR shall be recorded over frequency and magnetic field strength.

6.3.9 Definition of $W(H_{\mathrm{TX}})$

Due to the fact that there are only discrete frequency settings that the CPOD transmitter can use, the function $\Theta(f_{\mathrm{TX}}, H_{\mathrm{TX}})$ (see 6.3.5) shall be evaluated within a frequency window whose centre frequency is variable and which has a defined width of Δf_{BAND} (see Figure 16). This is because the transmitting frequency may vary between CPOD sensors.

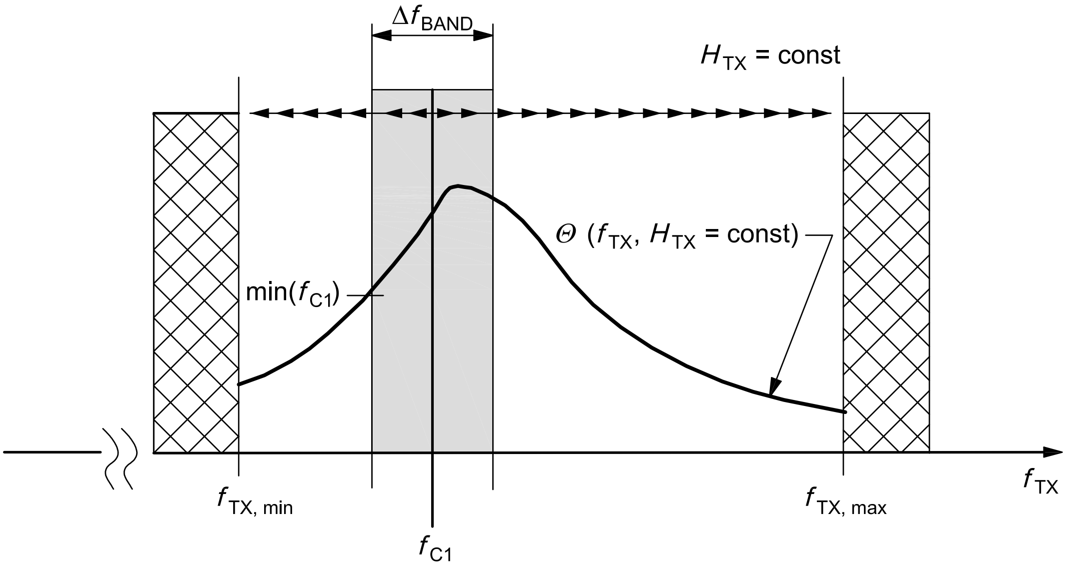


Figure 16 — Evaluation of $W(H_{\mathrm{TX}})$ at a given transmitter field strength

$W(H_{\mathrm{TX}})$ is defined as

$$W\left(H_{\mathrm{TX}}\right) = \max\left(\min\left\{\Theta\left[f_{\mathrm{TX}}\varepsilon\left(f_{\mathrm{C}} - \Delta f_{\mathrm{BAND}}/2 \ldots f_{\mathrm{C}} + \Delta f_{\mathrm{BAND}}/2\right), H_{\mathrm{TX}}\right]\right\}\right) \tag{5}$$

with $f_{\mathrm{C}}\varepsilon\left(f_{\mathrm{TX,min}} \cdots f_{\mathrm{TX,max}}\right)$.

When shifting the frequency window over $\Theta(f_{\mathrm{TX}}, H_{\mathrm{TX}})$ with $f_{\mathrm{C}} = f_{\mathrm{TX,min}} \cdots f_{\mathrm{TX,max}}$, the following shall be recorded:

$$W\left(H = H_{\mathrm{TX}}\right) = \max\left(\min\left\{\Theta\left[f_{\mathrm{C}}\varepsilon\left(f_{\mathrm{C}} - \Delta f_{\mathrm{BAND}}/2 \ldots f_{\mathrm{C}} + \Delta f_{\mathrm{BAND}}/2\right), H_{\mathrm{TX}}\right]\right\}\right) \tag{6}$$

This shall be done for all $H_{\mathrm{TX}}\varepsilon\left(H_{\mathrm{OP,min}} \cdots H_{\mathrm{OP,max}}\right)$.

6.3.10 Definition of $N(H_{TX})$

$N(H_{TX})$ specifies the minimum SNR in the f_{TX} frequency range where $\Theta(f_{TX}, H_{TX}) \geqslant W(H_{TX})$ (see Figure 17 for explanation). In mathematical terms,

$$N\left(H_{TX}\right) = \min\left\{\mathrm{SNR}\left[f_{TX} \varepsilon \left(f_1 ... f_2\right), H_{TX}\right]\right\} \tag{7}$$

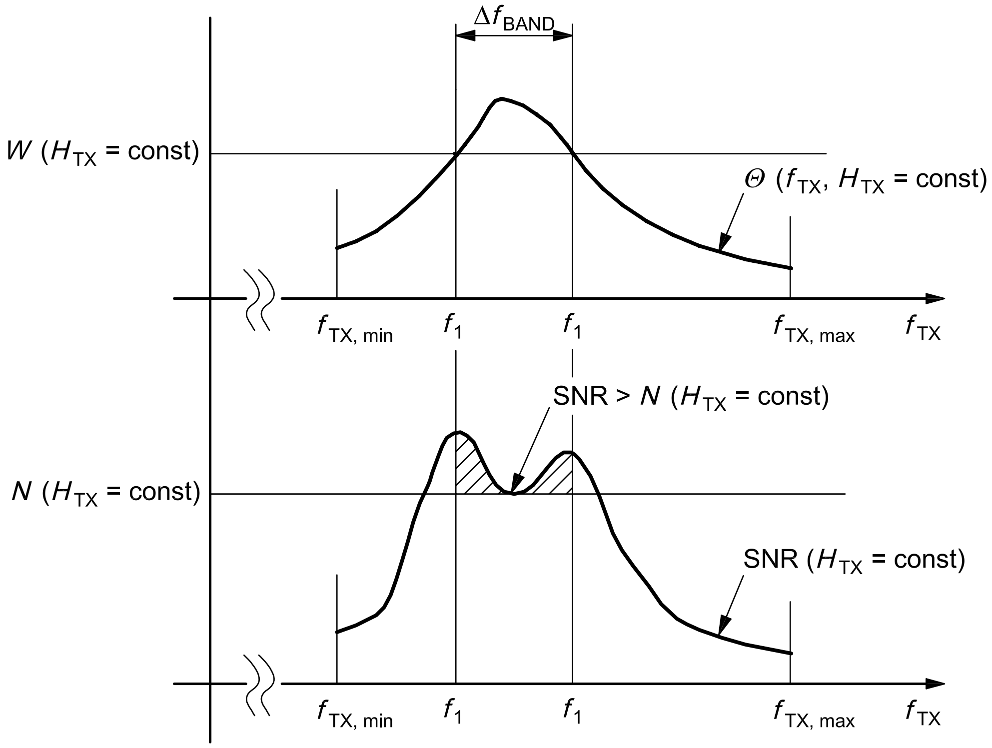


Figure 17 — Example for interpretation of $W(H_{TX})$

6.4 Modulation parameters

$W(H_{TX})$ and $N(H_{TX})$ shall meet the requirements specified in Table 6.

Table 6 — $W(H_{TX})$, $N(H_{TX})$ specification

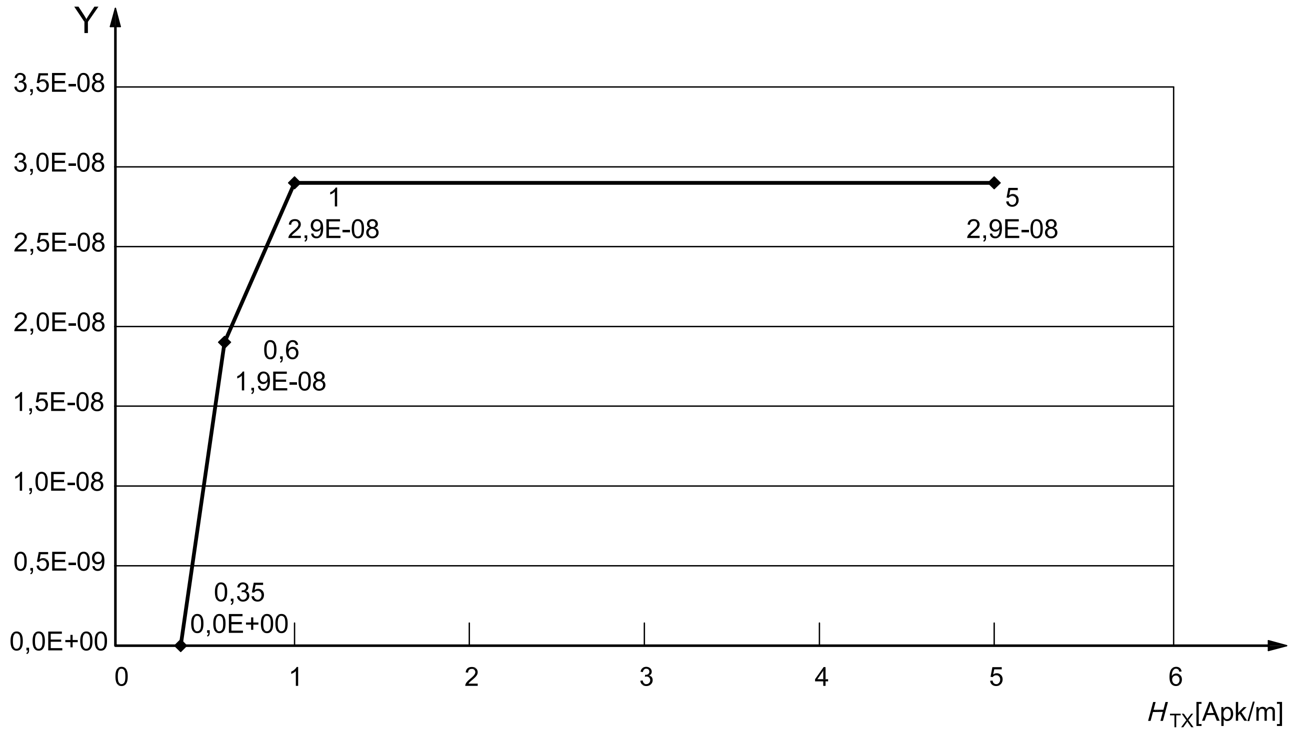
Parameter	Definition	min.	max.
W_{synch} [a] Vspk	Δf_{BAND} = 2 185 kHz, measured in accordance with 6.3.9; measurement starts $T_{STARTUP}$ after reset field gap	as defined in Figure 18	—
N_{synch} [a] dB	Δf_{BAND} = 2 185 kHz, measured in accordance with 6.3.10; measurement starts $T_{STARTUP}$ after reset field gap	as defined in Figure 19	—
W_{asynch} [b] Vspk	Δf_{BAND} = 2 185 kHz, measured in accordance with 6.3.9; measurement starts after T_{DELAY}, no reset field gap generated	as defined in Figure 18	—
N_{asynch} [b] dB	Δf_{BAND} = 2 185 kHz, measured in accordance with 6.3.10; measurement starts after T_{DELAY}, no reset field gap generated	as defined in Figure 19	—

NOTE 1 pk = peak value.

NOTE 2 $N[\mathrm{dB}] = 10 * \log_{10}[N(H_{TX})]$.

[a] Resonator protocol generation timing is **synch**ronized with reader timing, since resonator was reset before.

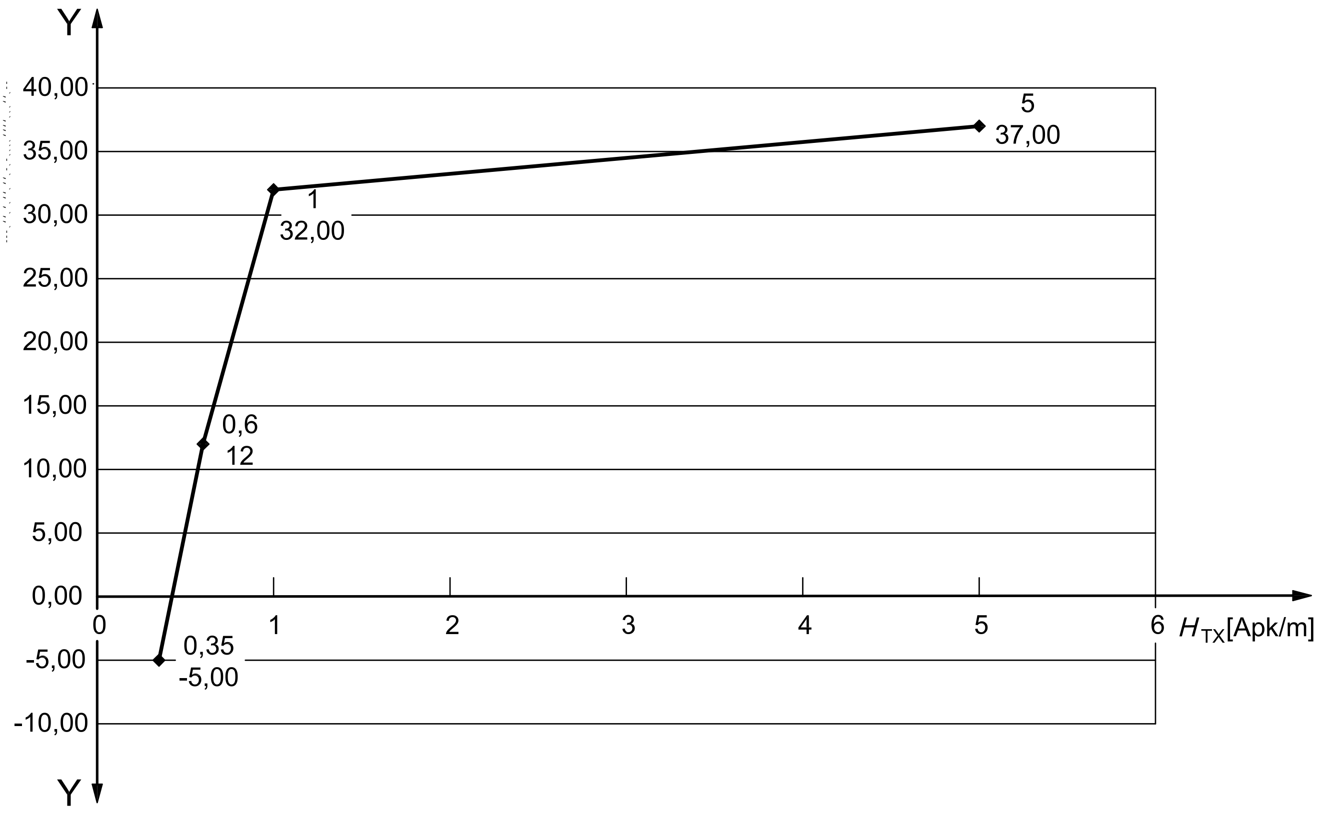
[b] Resonator protocol generation timing is **asynch**ronous with reader timing, since resonator was **not** reset before.



Key

Y $W_{\text{synch,asynch}}$ [Vspk]

Figure 18 — $W_{\text{synch,asynch}}$ versus magnetic field strength, H_{TX}



Key

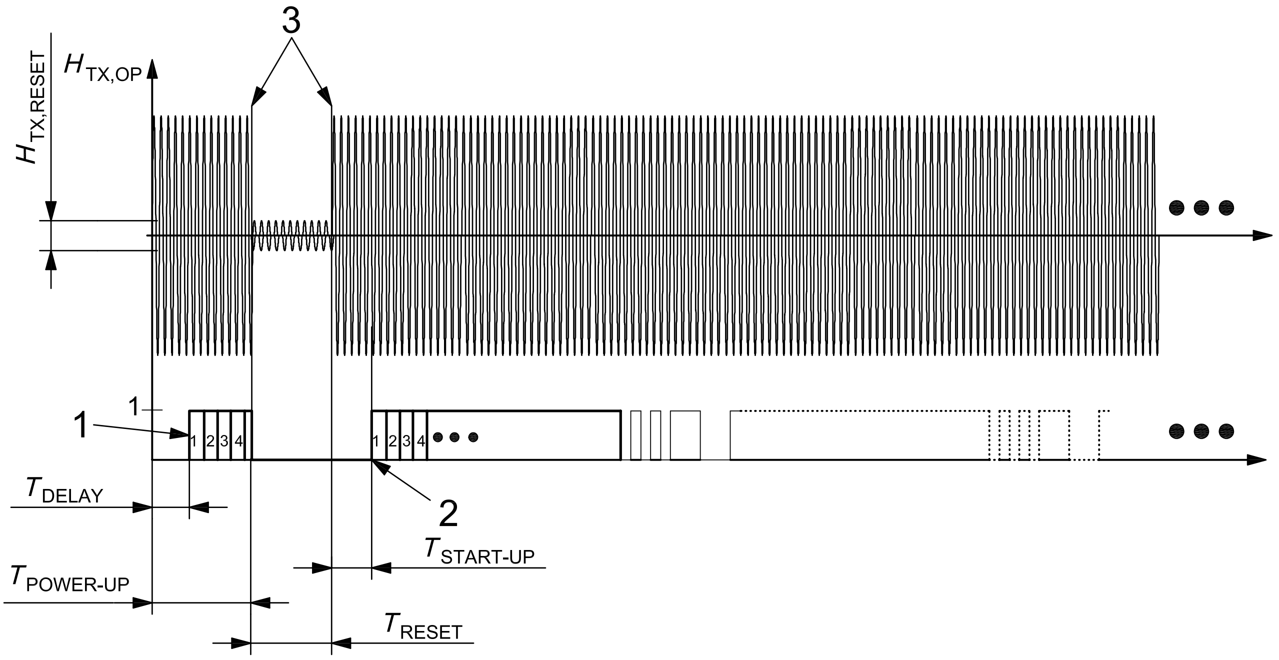
Y $N_{\text{synch,asynch}}$ [dB]

Figure 19 — $N_{\text{synch,asynch}}$ versus magnetic field strength, H_{TX}

7 Resonator timing

7.1 General

The resonator shall meet timing requirements in order to be CPOD compliant. Figure 20 shows the relevant parameters.



Key

1 start of modulation

2 start of modulation after reset field gap

3 reset field gap ($H_{TX,RESET} < H_{TX,RESET,max}$)

Figure 20 — Resonator timing and reset field strength, $H_{TX,RESET}$

7.2 Power-up

For the duration of resonator power-up, $T_{POWER-UP}$, the transmitter is switched on to enable the resonator to charge its energy storages, in order to pass a possible following reset gap in a biased state (see Figure 20). During $T_{POWERUP}$, at the latest after T_{DELAY}, the resonator shall begin to transmit its digital protocol, starting with bit one.

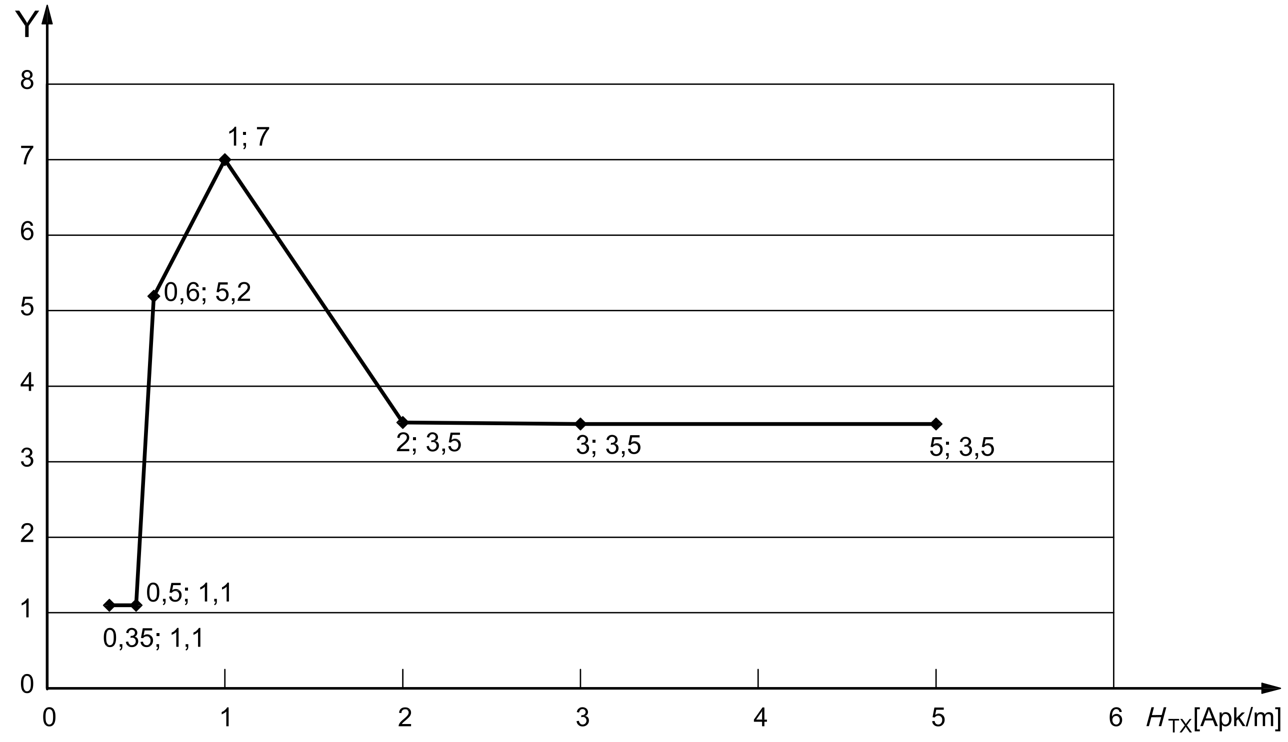
7.3 Reset

In order to reset the protocol transmission, the transmitter switches off the transmitting field for a duration of T_{RESET}. Once the transmitting field is up from reset and within its operating range again, the resonator, after $T_{STARTUP}$, shall resume the transmission from the beginning of its digital data protocol (bit one).

7.4 Relevant timing and reset parameters

Table 7 — Relevant timing and reset parameters

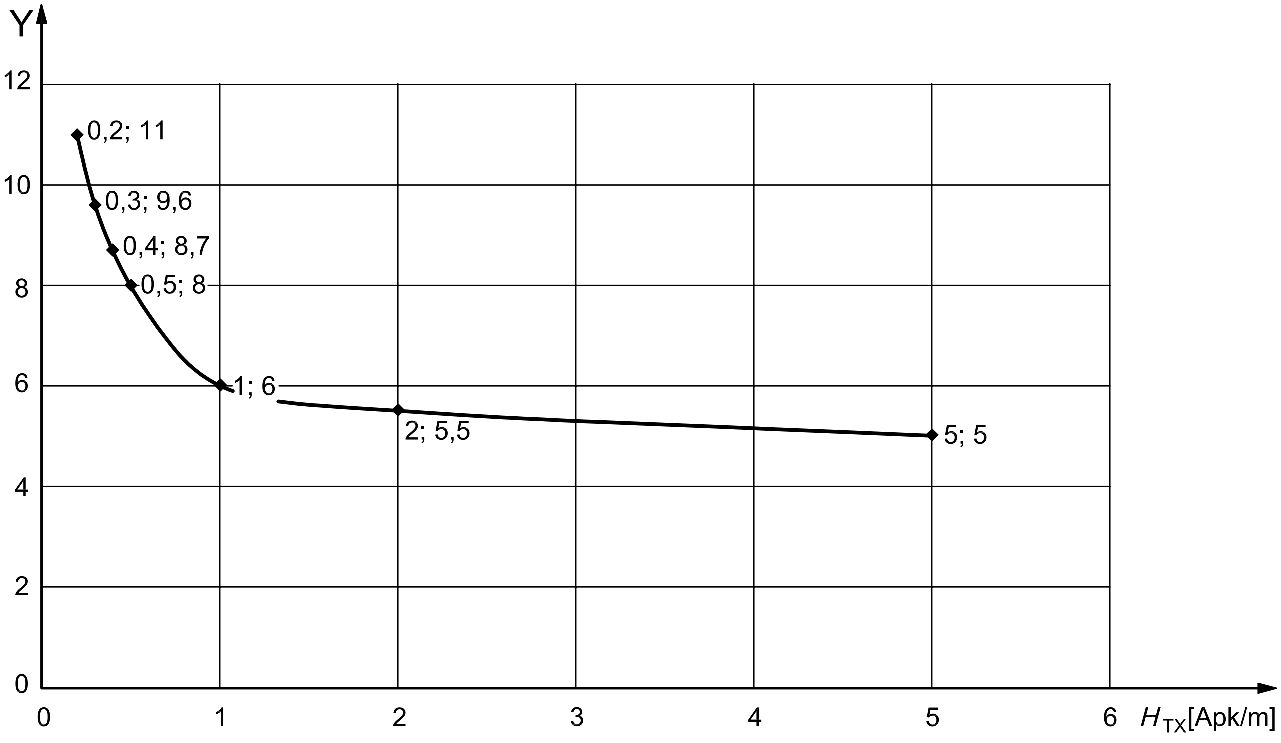
Parameter	Definition	min.	max.
$T_{\text{POWER-UP}}$ ms	Duration for resonator power-up, H_{TX} within operating range	10	—
T_{RESET} ms	Duration of reset field gap, $H_{\text{TX}} \leqslant H_{\text{RESET,MAX}}$	2,5	3,5
$T_{\text{START-UP}}$ ms	Time between end of reset field gap ($H_{\text{TX}} \geqslant H_{\text{OP,MIN}}$) and start of resonator modulation	0	1
T_{DELAY} ms	Time between $H_{\text{TX}} \geqslant H_{\text{OP,MIN}}$ and start of resonator protocol transmission, except after reset field gap	—	see Figure 21
H_{RESET} mApk/m	Magnetic field strength to cause resonator reset at the latest after T_{RESET}, $f = f_{\text{TX}}$, measured in accordance with ISO/TS 22239-1:2009, Annex G	see Figure 21	—



Key

Y $H_{\text{reset\_target}}$ [mApk/m]

Figure 21 — H_{RESET} versus magnetic field strength, H_{TX}



Key

Y T_{delay} (ms)

Figure 22 — T_{DELAY} versus magnetic field strength, H_{TX}

8 Electrical and environmental parameters

8.1 Absolute maximum ratings

Correct functionality of the transponder is not required when it is exposed to the absolute maximum ratings mentioned in this clause, but the transponder shall not be damaged during and after exposure to these conditions. When it is back in operating condition, it shall work again in accordance with this part of ISO/TS 22239.

Table 8 — Absolute maximum ratings

Parameter	Definition	min.	max.
$H_{MAX,SEQ}$	Maximum magnetic field strength at $f = f_{TX}$, for transmitting sequence[a], measured in accordance with ISO/TS 22239-1:2009, Annex G	—	30 A/m rms
$H_{MAX,CONT}$	Maximum magnetic field strength at $f = f_{TX}$, stressed unlimited, measured in accordance with ISO/TS 22239-1:2009, Annex G	—	20 A/m rms
T_{ABS}	Temperature range to which to be exposed	–40 °C	+95 °C

[a] There is a worst case timing given for the maximum magnetic field stress (see Figure 23).

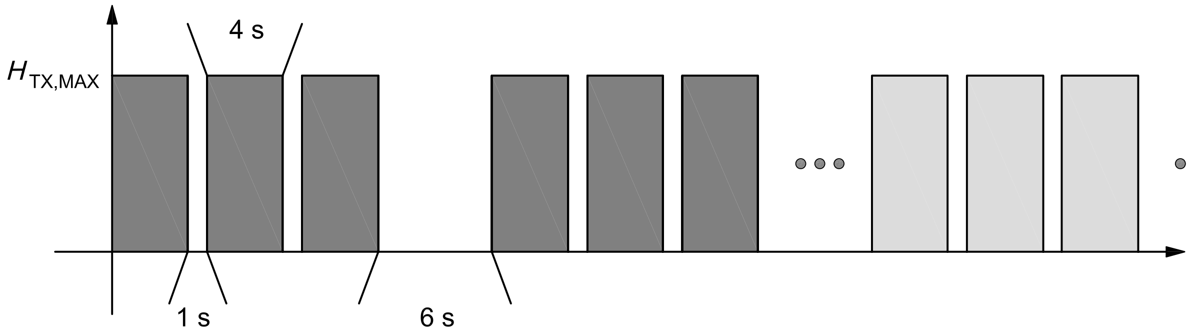


Figure 23 — Timing for maximum magnetic field stress

8.2 Operating ranges

When exposed to the conditions specified in Table 9, the resonator shall feature its full functionality.

Table 9 — Operating ranges

Parameter	Definition	min.	max.
f_{TX}	Magnetic field frequency	124 kHz	133 kHz
H_{OP}	Operating magnetic field strength, measured in accordance with ISO/TS 22239-1:2009, Annex G	0,3 Apk/m	5 Apk/m
T_{AMB}	Ambient temperature	–40 °C	+85 °C
NOTE pk = peak value.			

8.3 Storage conditions

The storage conditions are specified in Table 10.

Table 10 — Storage conditions

Parameter	min.	max.
Storage temperature T_{STOR} °C	–40	+95

9 CPOD resonator compatibility test

In order to be CPOD compliant, a resonator shall pass the CPOD compatibility test. The CPOD resonator compatibility test set-up in accordance with Annex A shall be used. The test parameters and the testing procedure are described in Annex B. In addition, the resonator shall pass successfully the environmental qualification programme described in Clause 10.

10 Resonator environmental qualification

10.1 Application profile

The application profile defined in Tables 11 to 14 summarizes the mechanical, climatic and chemical influences on the CPOD resonator during its lifetime.

Table 11 — Lifetime and operating time

Parameter	Requirement
Resonator lifetime	15 years
Active operating time (resonator supplied by magnetic field)	6 000 h
Passive operating time (resonator not supplied by magnetic field)	119 000 h

Table 12 — Mechanical exposure

Parameter		Requirement
Vibration	periodic excitation	passenger compartment vibration profile
	static excitation	
Acceleration	mechanical shock	acceleration up to 500 m/s^2
	free fall	1 m fall height, concrete floor

Table 13 — Chemical exposure

Parameter	Requirement
Protection class	IP5K4
Environmental influences	salt fog atmosphere
Purifying agents	chemicals in accordance with Table 31
Corrosive gases	industrial climate (H_2S, NO_2, Cl_2, SO_2)

Table 14 — Climatic exposure (temperature/humidity)

Operating state	Parameter	Requirement	
During operation in child seat/car	temperature profile	temperature °C	distribution %
		–40	6
		+23	65
		+60	20
		+80	8
		+85	1
	temperature class	passenger compartment, maximum temperature 85 °C	
	humidity	relative humidity up to 100 % condensation and freezing	
In child seat/car, non-operating	temperature	minimum temperature: –40 °C maximum temperature: +85 °C typical temperature: +23 °C	
	humidity	relative humidity up to 100 % condensation and freezing 60 % relative humidity on average	
Transport	temperature	minimum temperature: –40 °C maximum temperature: +95 °C	
	transport duration	max. 24 h continuously at minimum temperature max. 48 h continuously at maximum temperature	
Storage	temperature	minimum temperature: –10 °C maximum temperature: +55 °C	
	storage duration	5 years	
	humidity	max. 85 % relative humidity	
Long term storage (spare part supply)	temperature	minimum temperature: +10 °C maximum temperature: +40 °C	
	storage duration	15 years	
	humidity	max. 80 % relative humidity	
Temperature cycles	quantity	5 500 over 15 years	
	temperature swing	average: 34 °C	

10.2 Common test parameters

Table 15 specifies the common test parameters.

Table 15 — Common test parameters

Parameter	Definition	Requirement
T_{min}	Minimum ambient temperature possible at the place of installation of the component; the component shall not show any functional degradation	−40 °C
T_{R}	Room temperature	(23 ± 5) °C
T_{max}	Maximum ambient temperature possible at the place of installation of the component; the component shall not show any functional degradation	+85 °C
$H_{\mathrm{T,min}}$	Minimum magnetic field strength applied during test, measured in accordance with ISO/TS 22239-1:2009, Annex G	0,3 [Apk/m]
$H_{\mathrm{T,typ}}$	Typical magnetic field strength applied during test, measured in accordance with ISO/TS 22239-1:2009, Annex G	0,5 [Apk/m]
$H_{\mathrm{T,max}}$	Maximum magnetic field strength applied during test, measured in accordance with ISO/TS 22239-1:2009, Annex G	5 [Apk/m]
NOTE pk = peak value.		

10.3 Operating states

10.3.1 General

In general, the CPOD resonators are driven under different conditions during their lifetime. These conditions shall be simulated during the component test/environmental qualification.

10.3.2 Operating state A (transport and storage)

Operating state A describes the situation during transport and storage of the resonator (no magnetic field is applied). The resonator is boxed in its original package (transportation package).

10.3.3 Operating state B (non-functional state)

Operating state B describes the situation where the resonator-equipped child seat is located in a car on the passenger seat or on the back seat of a parked car. No magnetic field is applied.

10.3.4 Operating state C (functional state)

Operating state C describes the situation where the resonator-equipped child seat is located on the passenger seat of a car with the ignition on. An exciting magnetic field is applied periodically.

10.3.5 Operating state D (intermitting functional state)

Operating state D describes the situation where the resonator-equipped child seat is located on the passenger seat of a car. The ignition state periodically varies between on and off and, therefore, the resonator operating state changes periodically between operating state B and operating state C.

10.4 Parametrical test and parameter checking

10.4.1 Parametrical test before/after every single test

Before and after every single test listed in 10.5, a parametrical test shall be performed. The parametrical test shall be performed at T_{min}, T_{R} and T_{max}. A parametrical test consists of the CPOD resonator compatibility test described in Clause 9.

10.4.2 Continuous parameter check

For the tests mentioned in 10.5 where a continuous parameter check is required, the parameters tested during the parametrical test shall be tested for only one typical magnetic field strength in order to increase the testing frequency (see Clause 9 and Annex C). A computer-based data acquisition shall be used.

10.5 Qualification tests

10.5.1 General

By passing the following qualification tests (described in 10.5.2 to 10.5.17), the CPOD resonator proves its basic automotive suitability. The qualification plan indicating the test order over time can be found in 10.9.

10.5.2 Acceptance criteria

Functional performance shall be verified by parametric measurements in accordance with 10.4.1 before the start and after completion of the test. Measured parameters shall meet the limits of this part of ISO/TS 22239.

If a continuous parameter check in accordance with 10.4.2 is required during testing, the measured parameters during every check shall meet the limits of this part of ISO/TS 22239.

10.5.3 Temperature storage (transport and storage)

10.5.3.1 Test parameters

Table 16 — Test parameters

Parameter	Requirement
Duration	164 h
Minimum test temperature	–40 °C
Maximum test temperature	+95 °C
Temperature gradient	0,6 °C/min
Number of parts	5
Operating state	operating state A during high and low temperature; operating state C at T_{R}
Parameter check	parameter test before/after the test in accordance with 10.4.1

10.5.3.2 Test procedure

The test procedure is as described below.

a) Place component in a temperature chamber and ramp down the chamber temperature to –40 °C within 2 h. Keep component at –40 °C for next 24 h.

b) Ramp up the chamber temperature to T_{R} over a period of 2 h and operate component at T_{R} for 1 h with continuous monitoring.

c) Ramp up the chamber temperature to +95 °C within 2 h. Keep component at +95 °C for the next 48 h.

d) Ramp down the chamber temperature to T_{R} over a period of 2 h and operate component at T_{R} for 1 h with continuous monitoring.

e) Repeat steps a) to d) one more time (total two cycles).

10.5.4 Low temperature durability test

10.5.4.1 Test parameters

Table 17 — Test parameters

Parameter	Requirement
Duration	120 h
Temperature	T_{min}
Number of parts	5
Operating state	operating state C, with continuous parameter check in accordance with 10.4.2
Parameter check	parameter test before/after the test in accordance with 10.4.1

10.5.4.2 Test procedure

The test procedure is as follows:

a) place component in a climatic chamber and ramp down the chamber temperature to T_{min};

b) operate component at T_{min} for 120 h with continuous monitoring.

10.5.5 High temperature operating endurance test

10.5.5.1 Test parameters

Table 18 — Test parameters

Parameter	Requirement
Duration	1 036 h
Temperature	T_{max}
Number of parts	5
Operating state	operating state C, with continuous parameter check in accordance with 10.4.2
Parameter check	parameter test before/after the test in accordance with 10.4.1

10.5.5.2 Test procedure

The test procedure is as follows:

a) place component in a temperature chamber and ramp up the chamber temperature to T_{max};

b) operate component at T_{max} for the specified test duration with continuous monitoring.

10.5.6 Power thermal cycle endurance (PTCE)

10.5.6.1 Test parameters

Table 19 — Test parameters

Parameter	Requirement
Number of test cycles	400
Minimum test temperature	T_{min}
Maximum test temperature	T_{max}
Temperature gradient	4 °C/min If a gradient of 4 °C/min is not achievable, it can be reduced to 2 °C/min
Soak time	20 min It shall be verified at least once that the resonator reaches T_{min} and T_{max} with a tolerance of ± 2 °C during the soak time; if not, the soak time shall be extended accordingly.
Test duration (informative)	The test duration depends on the soak time and the temperature gradient. Based on a temperature gradient of 4 °C/min and a soak time of 20 min, the test duration can be calculated to 685 h
Number of samples	5
Operating state	operating state D, with the following timing: — 1 min operating state C; — 9 min operating state B; operating state C, with continuous parameter check in accordance with 10.4.2
Parameter check	parameter test before/after the test in accordance with 10.4.1

10.5.6.2 Test procedure

Refer to Figure 24 as applicable to the resonator.

a) Place component in a temperature chamber, operate component (intermittent operation 1) with continuous monitoring and ramp down the chamber temperature to T_{min} with the specified temperature change rate (t_1 to t_2 in Figure 24).

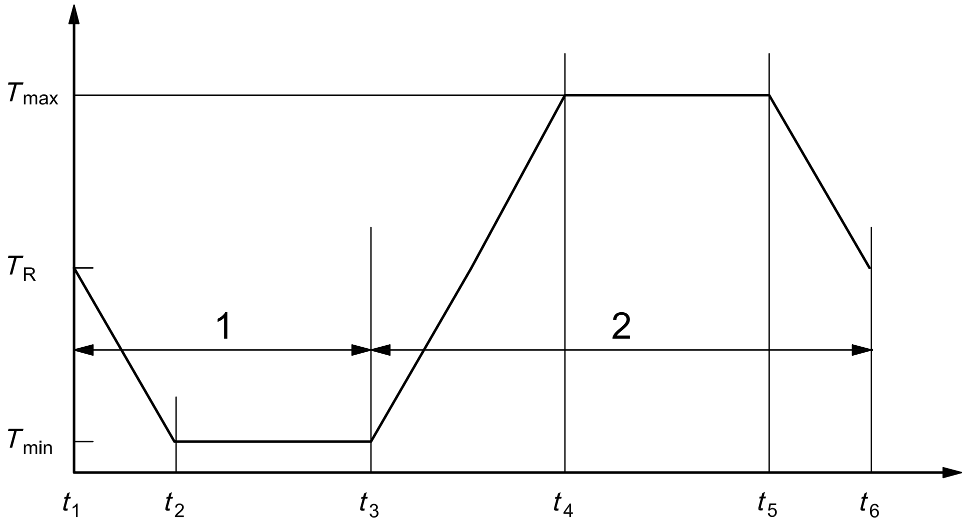
b) Keep component at T_{min} for the specified component soak time (t_2 to t_3).

c) Change operating status to intermittent operation 2 with continuous monitoring. Ramp up chamber temperature from T_{min} to T_{max} with the specified temperature change rate (t_3 to t_4).

d) Keep component at T_{max} for the specified component soak time (t_4 to t_5).

e) Ramp-down the chamber temperature from T_{max} to T_{R} with the specified temperature change rate (t_5 to t_6).

f) Repeat powered thermal cycle [steps a) to e)] for the specified number of cycles.



Key

1 intermittent operation 1

2 intermittent operation 2

Figure 24 — PTCE timing

10.5.7 Thermal shock test

10.5.7.1 Test parameters

Table 20 — Test parameters

Parameter	Requirement
Number of test cycles	100
Minimum test temperature	T_{min}
Maximum test temperature	T_{max}
Soak time	20 min It shall be verified at least once that the resonator reaches T_{min} and T_{max} with a tolerance of ±2 °C during the soak time; if not, the soak time shall be extended accordingly
Rearrangement duration	< 30 s
Number of samples	5
Operating state	operating state B
Parameter check	parameter test before/after the test in accordance with 10.4.1

10.5.7.2 Test procedure

The test procedure is as described below.

a) Place component in a chamber with dual temperature zone capability and adjust the temperature zones to T_{max} and T_{min}, respectively. If a chamber with dual temperature zone capability is not available, use two chambers in close proximity and maintain one chamber at T_{max} and another at T_{min}.

b) Maintain component at T_{min} for specified component soak time.

c) Transfer component from T_{min} zone to T_{max} zone within 30 s.

d) Keep component at T_{max} for the specified component-specific soak time.

e) Transfer component from T_{max} zone to T_{min} zone within 30 s.

f) Repeat the thermal cycles [steps b) to e)] for the specified number of test cycles.

g) Allow the component to return to room temperature within 2 h before removing it from the test chamber.

10.5.8 Temperature cycling test, constant humidity

10.5.8.1 Test parameters

Table 21 — Test parameters

Parameter	Requirement
Test duration	240 h
Temperature and humidity profile	In accordance with IEC 60068-2-38 The first five temperature cycles shall be performed with low temperature phases, the following four cycles without low temperature phases (see IEC 60068-2-38)
Minimum test temperature	−10 °C
Maximum test temperature	+65 °C
Relative humidity	93 %, with the exception of those intervals defined in IEC 60068-2-38 where there is no humidity control
Number of samples	5
Operating state	operating state D, with the following timing: — 50 min operating state C; — 50 min operating state B; operating state C, with continuous parameter check in accordance with 10.4.2
Parameter check	parameter test before/after the test in accordance with 10.4.1

10.5.8.2 Test procedure

The test procedure is as follows:

a) place component in a climatic chamber.

b) operate component with continuous monitoring while running a temperature and humidity profile in accordance with IEC 60068-2-38.

10.5.9 High temperature and humidity endurance (HTHE)

10.5.9.1 Test parameters

Table 22 — Test parameters

Parameter	Requirement
Test duration	1 048 h
Temperature	T_{max}
Humidity	85 % relative humidity
Number of samples	5
Operating state	operating state D, with the following timing: — 1 h operating state C; — 47 h operating state B; operating state C, with continuous parameter check in accordance with 10.4.2
Parameter check	parameter test before/after the test in accordance with 10.4.1

10.5.9.2 Test procedure

The test procedure is as described below.

a) Place component in a test chamber and maintain chamber temperature at 85 °C for 1 h.

b) Introduce humidity to the chamber and maintain the relative humidity inside the chamber at 85 % RH.

c) Operate component (1 h operational followed by 47 h non-operational, alternating) with continuous monitoring for the specified test duration. Interrupt test after predefined intervals to perform parametric measurements in accordance with 10.4.1. Condensation shall be prevented when replacing the (cold) component into the climatic chamber by heating the component to 85 °C first without humidity and introducing humidity only after the component has reached 85 °C.

10.5.10 Vibration test

10.5.10.1 Test parameters

Table 23 — Test parameters

Parameter	Requirement	
Vibration class	I	
Test duration per co-ordinate axis	30 h (8 h with superposed temperature profile; 22 h at T_R)	
Temperature gradient of temperature profile	1 °C/min to 1,5 °C/min	
Minimum temperature	T_min	
Maximum temperature	T_max	
Vibration profile broad band noise	frequency Hz	acceleration density [a] (m/s^2)^2/Hz
	5	0,884
	10	20,0
	55	6,5
	180	0,25
	300	0,25
	360	0,14
	1 000	0,14
	2 000	0,14
	RMS	30,8 m/s^2
Number of samples	5	
Operating state	operating state C, with continuous parameter check in accordance with 10.4.2 where operation is indicated; otherwise, operating state B	
Parameter check	parameter test before/after the test in accordance with 10.4.1	

[a] PSD (power spectral density).

10.5.10.2 Test procedure (vibration class I)

The test procedure is as described below.

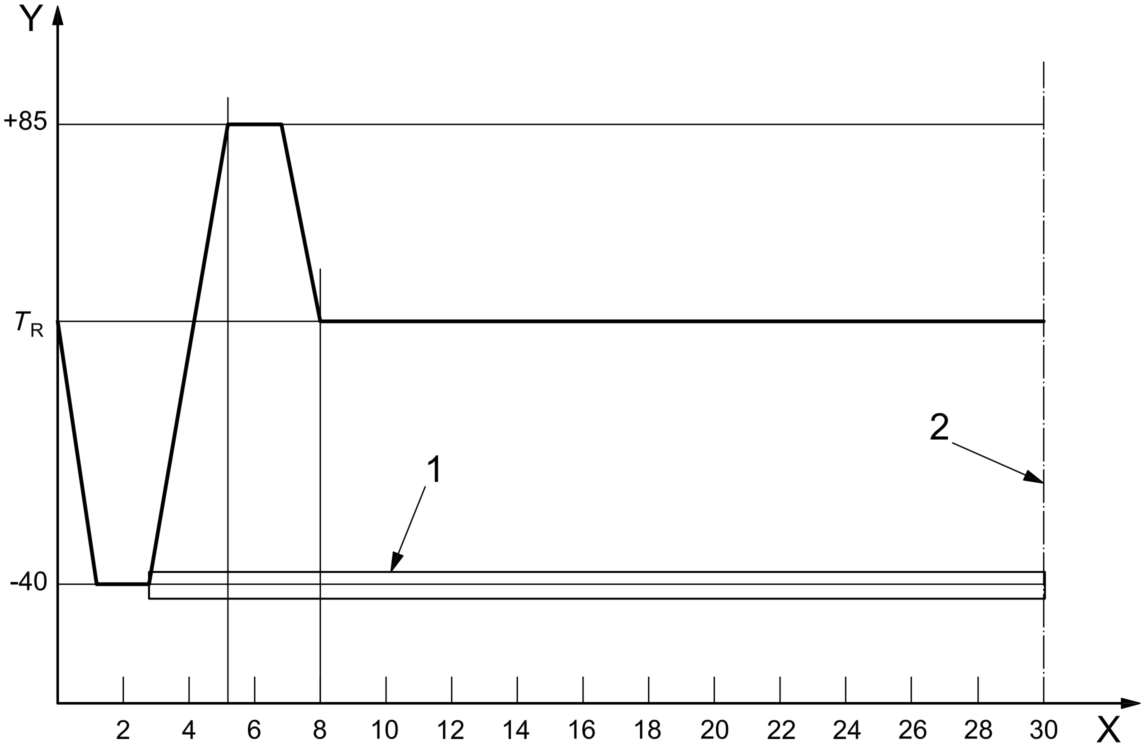
a) Program the vibration shaker for the random vibration profile given in Table 23.

b) Program the temperature chamber for the temperatures, ramp rates and duration shown in Figure 25 and given in Table 23.

c) Place the component on the vibration shaker inside the temperature chamber. Mount the component on one of the axes using a released bracket or mounting hardware, connector and wiring harness.

d) Start, vibration and temperature sequence and operate the component with continuous monitoring for the specified test duration per axis.

e) At the end of the test cycle for one axis, repeat steps c) and d) for the remaining two axes.



Key

1 operating state C during this time
2 test duration per axis
X time [hours]
Y temperature [°C]

Figure 25 — Temperature profile for vibration class I

10.5.11 Mechanical shock test

10.5.11.1 Test parameters

Table 24 — Test parameters

Parameter	Requirement
Number of shocks per space co-ordinate (±x, ±y, ±z)	10 (60 shocks altogether)
Acceleration	500 m/s^2
Duration of shock	11 ms
Test temperature	T_R
Number of samples	5
Operating state	operating state B
Parameter check	parameter test before/after the test in accordance with 10.4.1

10.5.11.2 Test procedure

The test procedure is as described below.

a) Define the component's in-vehicle mounting co-ordinates relative to the vehicle co-ordinates x (longitudinal), y (transverse), and z (vertical). Mount the component on the shock test equipment to simulate the in-vehicle co-ordinates.

b) Apply half-sine pulse 10 times in each direction of ±x, ±y, and ±z at room temperature. The total number of shocks shall be 60.

10.5.12 Fall test, not packed

10.5.12.1 Test parameters

Table 25 — Test parameters

Parameter	Requirement
Number of falls per sample	1 [a]
Fall height	1 m
Number of samples	6
Operating state	operating state B
Parameter check	parameter test before/after the test in accordance with 10.4.1

[a] Every sample shall fall on one of its six sides (±x, ±y, ±z).

10.5.12.2 Test procedure

Drop the component from a height of 1 m onto a concrete surface. The component shall be oriented prior to the release so that each component is released only once in one of the positive and negative directions of its primary ±x, ±y and ±z axes.

10.5.12.3 Additional acceptance criteria

Apart from the general acceptance criteria defined in 10.5.2, the component shall be visually inspected with the naked eye for any obvious damage. The component shall not show any obvious damage.

10.5.13 Protection against intrusion of hard bodies

10.5.13.1 Test parameters

Table 26 — Test parameters

Parameter	Requirement
Protection class	IP5K4
Test method	ISO 20653
Dust specification	ISO 20653
Dust concentration	ISO 20653
Type of dust exposure	ISO 20653
Number of samples	5
Operating state	operating state B
Parameter check	parameter test before/after the test in accordance with 10.4.1

10.5.13.2 Test procedure

Follow ISO 20653 for testing protection class IP5K4.

10.5.14 Protection against intrusion of fluids

10.5.14.1 Test parameters

Table 27 — Test parameters

Parameter	Requirement
Protection class	IP5K4
Test method	ISO 20653
Number of samples	5
Operating state	operating state D with the following timing: — 1 min operating state C; — 1 min operating state B; operating state C, with continuous parameter check in accordance with 10.4.2.
Parameter check	parameter test before/after the test in accordance with 10.4.1

10.5.14.2 Test procedure

Follow ISO 20653.

10.5.15 Corrosion Test with gutting corrosion gas

10.5.15.1 Test parameters

Table 28 — Test parameters

Parameter	Requirement
Test duration	14 days
Test method	IEC 60068-2-60, method 4
Corrosion gas concentration	H_2S: 10 ppb
	SO_2: 200 ppb
	Cl_2: 10 ppb
	NO_2: 200 ppb
Relative humidity	75 %
Test temperature	T_R
Number of samples	5
Operating state class	operating state B
Parameter check	parameter test before/after the test in accordance with 10.4.1

NOTE Gas concentration in ppb = parts per billion (1 in 10^9) volume per volume (vol/vol) in air.

10.5.15.2 Test procedure

The test procedure is as follows:

a) place component with mating connector in a test chamber and subject it to a mixed flowing gas environment in accordance with IEC 60068-2-60;

b) terminate testing after the specified test duration.

10.5.16 Salt spray test

10.5.16.1 Test parameters

Table 29 — Test parameters

Parameter	Requirement
Test duration	24 h
Test method	IEC 60068-2-11
Test temperature	35 °C
Salt concentration	(5 ± 1) weight %
Number of samples	5
Operating state	operating state D, with the following timing: — 55 min operating state C; — 55 min operating state B; operating state C, with continuous parameter check in accordance with 10.4.2.
Parameter check	parameter test before/after the test in accordance with 10.4.1

10.5.16.2 Test procedure

The test procedure is as follows:

a) place component in the test chamber;

b) subject component to salt fog atmosphere in accordance with IEC 60068-2-11 while operating the component with continuous monitoring for the specified test duration.

10.5.17 Resistance to chemical substances

10.5.17.1 Test parameters

Table 30 — Test parameters

Parameter	Requirement
Test duration	24 h per fluid application
Amount of test fluid/chemical	100 ml Cleaning fluids shall be applied by spraying; bulk liquids shall be applied by pouring/spilling
Storage temperature	70 °C
Dwell time at storage temperature	(4 + 12) h = 16 h per cycle (see Figure 26)
Number of samples	5
Operating state	operating state B
Parameter check	parameter test before/after the test in accordance with 10.4.1

Table 31 — Collection of chemicals/fluids

Name of fluid/chemical	Description	Sample No.				
		1	2	3	4	5
Interior cleaning fluid – cockpit spray	(e.g. Caramba Chemie [a])	X		X		
Interior cleaning fluid	(e.g. Armorall Protectant [b])	X		X		
Solvent – stain remover	(e.g. Caramba Chemie [a])	X		X		
Leather care foam	(e.g. Caramba Chemie [a])				X	X
Plastic and vinyl cleaner	(e.g. Caramba Chemie [a])		X			X
Glass cleaner	(e.g. Caramba Chemie [a])					X
Soapy water	5 % soap concentration		X		X	
Hot beverages	100 ml coffee with cream (6 ml) and sugar (6 ml)	X	X			
Cold beverages	Regular (non-diet) cola			X	X	
Ammonia solution	aqueous urea solution AUS 32 in accordance with ISO 22241-1	X				

[a] Caramba Chemie GmbH & Co.KG, Wanheimerstr. 334/336, D-47055 Duisburg, supplies suitable products available commercially. This information is given for the convenience of users of this part of ISO/TS 22239 and does not constitute an endorsement by ISO of these products. Equivalent products may be used if they can be shown to lead to the same results.

[b] Armorall Protectant is an example of a suitable product available commercially. This information is given for the convenience of users of this part of ISO/TS 22239 and does not constitute an endorsement by ISO of this product. Equivalent products may be used if they can be shown to lead to the same results.

10.5.17.2 Test procedure

The test procedure is as described below (see Figure 26).

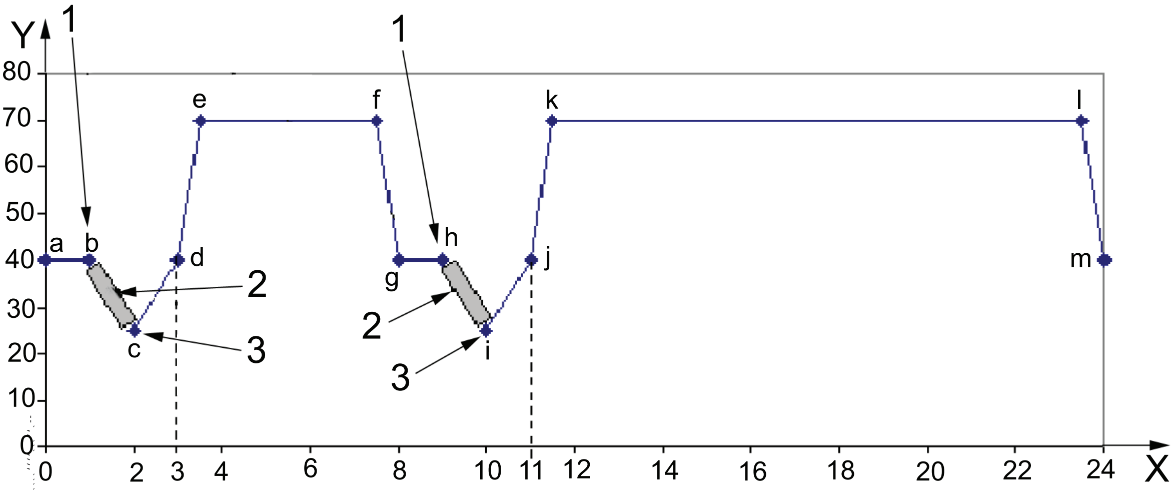
a) Place the component in a temperature chamber maintained at 40 °C.

b) Keep the component at 40 °C for 1 h (see a to b in Figure 26). Remove the component from the chamber and apply 100 ml of test fluid/chemical by either spraying or pouring to cover all faces of the component. Store the component at ambient temperature (T_R) for 1 h (see b to c in Figure 26).

c) Replace the component in the chamber and keep it at 40 °C for one hour (see c to d in Figure 26). Then ramp up the chamber temperature to 70 °C within 30 min (see d to e in Figure 26) and keep the component at 70 °C for 4 h (dwell time, see e to f in Figure 26). Ramp down the chamber temperature to 40 °C within 30 min (see f to g in Figure 26).

d) Repeat steps b) and c) for the same fluid, but prolong dwell time from 4 h to 12 h at high temperature (see k to l in Figure 26).

e) Repeat steps b), c) and d) for the next fluid in the set. Continue the process up to a maximum of three fluids per component.



Key

X time, hours

Y temperature, °C

1 remove resonator from chamber and apply test fluid immediately

2 resonator stored at T_R outside chamber

3 replace resonator in chamber

Figure 26 — Temperature profile (fluid exposure tests)

10.6 Electromagnetic compatibility (EMC) test

10.6.1 General

The electromagnetic compatibility of the CPOD resonators shall be tested using a CPOD compatible passenger seat on which the resonators are positioned in a defined position during the EMC test.

The EMC test shall be performed in accordance with ISO 11452.

Table 32 — Test conditions — General information

Parameter	Requirement
Number of samples	2 resonator pairs
Temperature	(23 ± 5) °C
Humidity	20 % to 80 %
Ground plane	In accordance with ISO 11452-1

10.6.2 Functional status qualification

During EMC test, the detection status of the CPOD sensor shall be monitored as an indication of the functional status of the resonators under test. By the selection of the CPOD passenger seat, it shall be ensured that only the resonators can be the cause for functional degradation during testing, if such degradation is monitored, i.e. only CPOD passenger seats that remain fully functional under the tested conditions can be used for the resonator EMC test.

ISO 11452 classifies possible functional statuses of the device under test (DUT). For the resonator EMC test, class A shall be met during testing (see Table 33).

Table 33 — Functional status classification

Class	Description for DUT
A	The resonators shall operate **as designed** during and after exposure to a disturbance

10.6.3 Acceptance criteria

During EMC testing, the resonator pair itself and its forward-facing orientation shall be detected correctly throughout the complete test duration by the CPOD passenger seat. In addition, the received CRS type (see Table 2) shall comply with the information intended to be sent by the resonators.

10.6.4 Community

10.6.4.1 General

Community shall be in accordance with ISO 11452-1.

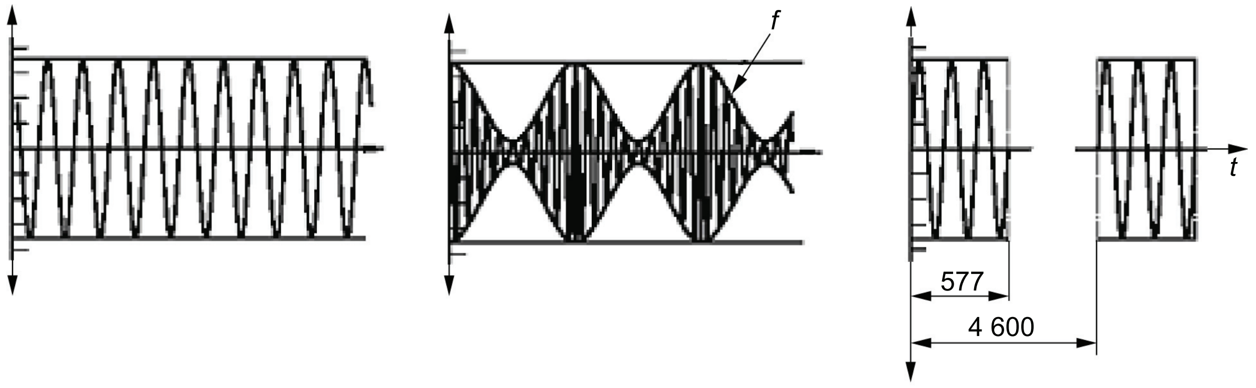
10.6.4.2 Modulation

Figure 27 illustrates different types of modulation:

a) continuous wave (CW): no modulation;

b) amplitude modulation (AM): 1 kHz sine wave at 80 %, peak CW = peak AM;

c) pulse modulation (PM): GSM-Modulation with PulseDuration = 577 µs; PulseReptitationTime = 4 600 µs.



a) CW signal

b) AM signal

c) PM signal

Figure 27 — Different types of modulation

10.6.4.3 RI 01: Immunity with antenna

10.6.4.3.1 General

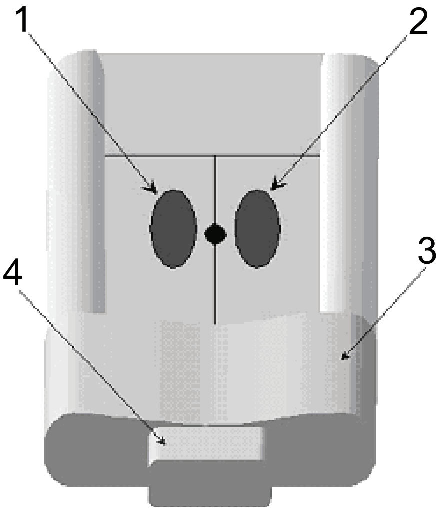
The DUT shall be subjected to radiated immunity testing using an antenna for field generation in accordance with ISO 11452-2 (with ground plane), with changes as defined in this part of ISO/TS 22239 (substitution method).

10.6.4.3.2 Test location

In accordance with ISO 11452-2, the test location shall be an absorber-lined shielded enclosure.

10.6.4.3.3 Test set-up

In accordance with ISO 11452-2, only a resonator pair can be tested for CPOD compatibility. The resonator pair shall meet the requirements of ISO/TS 22239-1:2009, Annex B. It shall be positioned on the CPOD passenger seat in forward-facing orientation (right resonator on passenger seat’s right side, left resonator on passenger seat’s left side, see Figure 28).



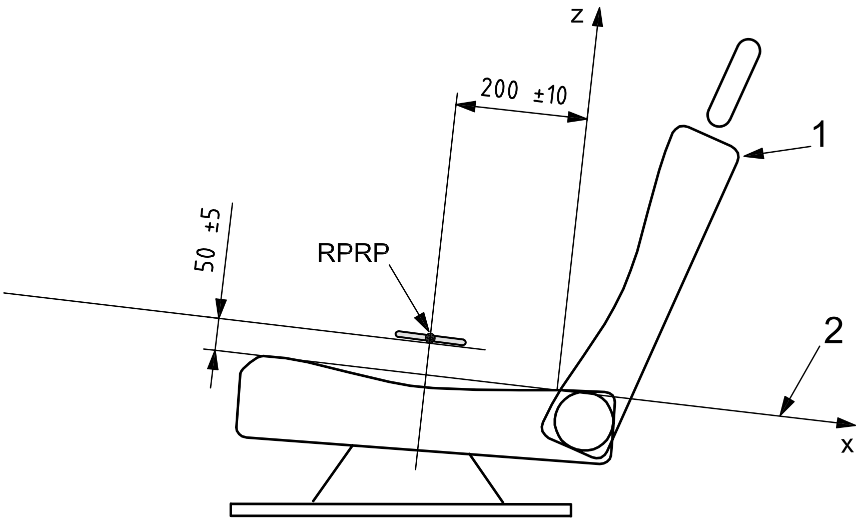
Key

1 left resonator
2 right resonator
3 backrest
4 headrest

Figure 28 — Resonator positioning on passenger seat (top view)

In addition, the location of the RPRP shall be equal to (x, y, z) = [(–200 ± 10) mm, (0 ± 5) mm, (50 ± 5) mm] within the passenger seat’s reference co-ordinate system (see ISO/TS 22239-1 for reference co-ordinate system definition). The bottom of the resonators shall be in parallel to the reference co-ordinate system's x-y plane (see Figure 29). The torso angle shall be adjusted to (27 ± 5)°.

Dimensions in millimetres



Key

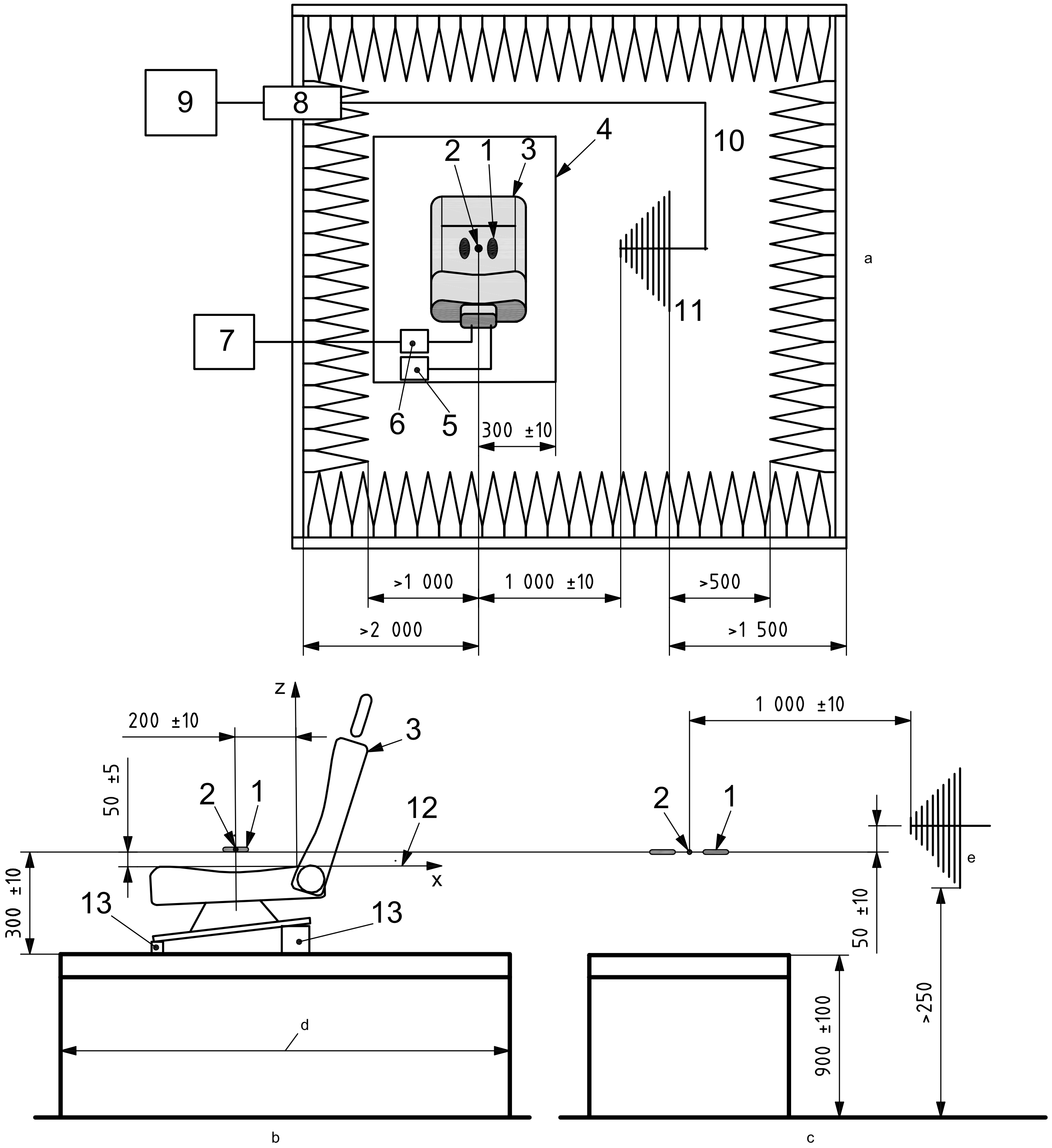
1 CPOD passenger seat

2 reference co-ordinate system

Figure 29 — Resonator positioning on passenger seat (side view)

Figures 30 and 31 show different examples of the complete test set-up.

Dimensions in millimetres



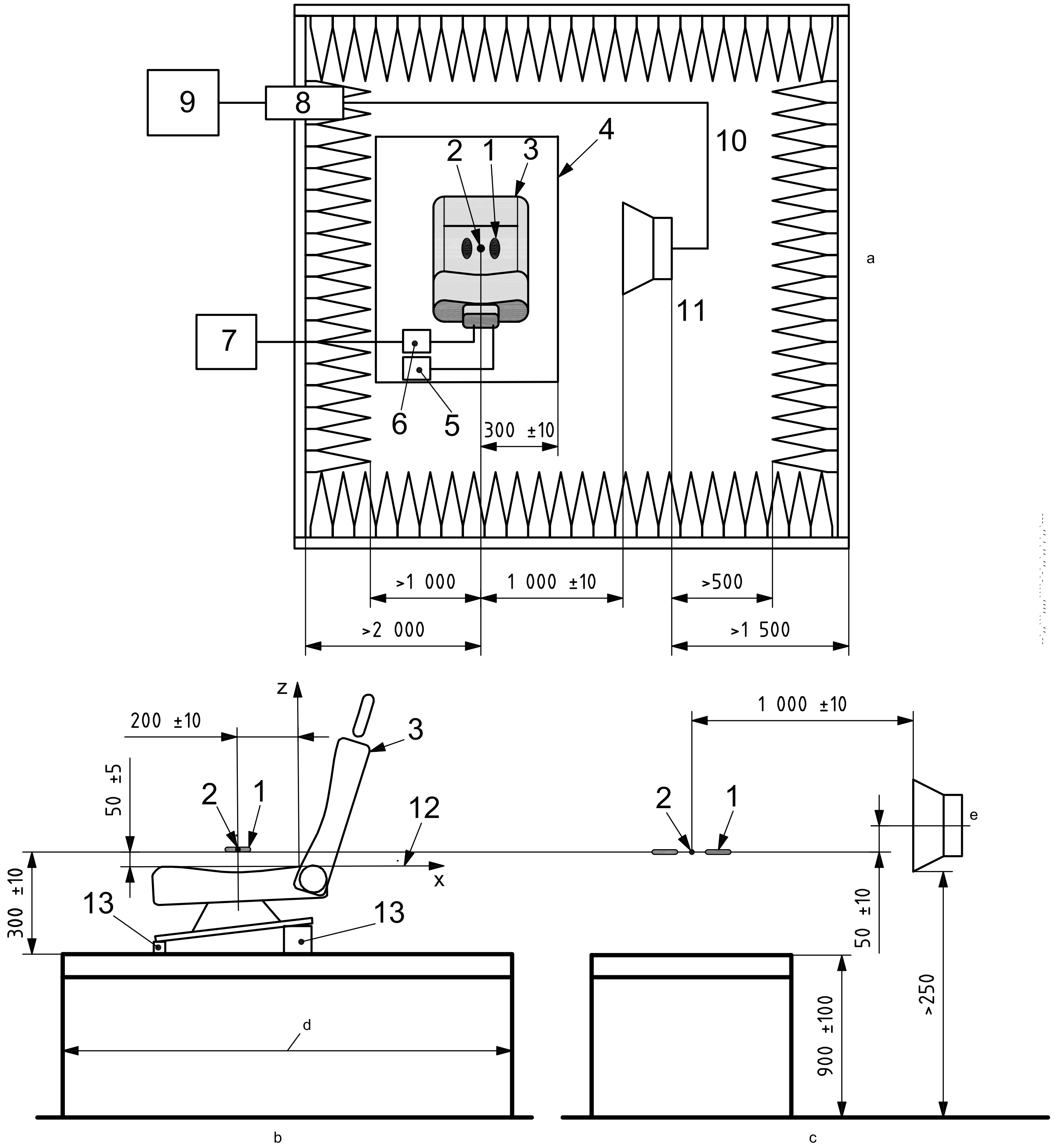
Key

1 resonator pair under test
2 RPRP
3 CPOD-compatible passenger seat
4 ground plane (bonded to shielded enclosure)
5 power supply, typical voltage
6 converter, e.g. K-line to optical
7 monitoring system
8 bulkhead connector
9 RF signal generator and amplifier
10 high quality double shielded coaxial cable (50 Ω)
11 log-periodic antenna
12 passenger seat reference co-ordinate system
13 support

[a] Upper view (horizontal polarized).
[b] Side view.
[c] Front view.
[d] See ISO 11452-2.
[e] Vertical polarized.

Figure 30 — Antenna set-up < 1 GHz

Dimensions in millimetres



Key

1	resonator pair under test
2	RPRP
3	CPOD-compatible passenger seat
4	ground plane (bonded to shielded enclosure)
5	power supply, typical voltage
6	converter, e.g. K-line to optical
7	monitoring system
8	bulkhead connector
9	RF signal generator and amplifier
10	high quality double shielded coaxial cable (50 Ω)
11	horn antenna
12	passenger seat reference co-ordinate system
13	support

[a] Upper view (horizontal polarized).

[b] Side view.

[c] Front view.

[d] See ISO 11452-2.

[e] Vertical polarized.

Figure 31 — Antenna set-up > 1 GHz

Deviating from ISO 11452-2, the phase centre of the antennae shall be in line with the DUT for the complete frequency range.

The detection state delivered by the CPOD passenger seat shall be monitored outside the shielded enclosure. Thus, the optical converter to be used depends upon the data interface featured by the CPOD passenger seat (e.g. K-Line to optical, LIN to optical).

10.6.4.3.4 Test parameters

Use the appropriate antenna for each frequency range and mention it in the test report.

Minimum dwell time is determined by the maximum duration that might be needed by the sensor in the CPOD passenger seat to indicate a change in the detected state. This duration shall be determined before testing and shall include qualification times (if qualification cannot be switched off), etc.:

- continuous wave (CW): no modulation;
- amplitude modulation (AM): 1 kHz sine wave at 80 %, peak CW = peak AM;
- pulse modulation (PM): GSM-Modulation

10.6.4.3.5 Requirements and test levels

Table 34 — Antenna settings

Range MHz	**Log. step** %	**Level** V/m	**Modulation**	**Class**
Vertical polarization				
200 to 520	1	150	CW, AM	A
520 to 800	1	70	CW, AM	A
800 to 1 000	1	70	CW, PM	A
1 000 to 1 200	0,5	70	CW, PM	A
1 200 to 1 400	0,5	150	CW, PM	A
1 400 to 2 700	0,5	70	CW, PM	A
2 700 to 3 200	0,5	150	CW, PM	A
Horizontal polarization				
400 to 520	1	150	CW, AM	A
520 to 800	1	70	CW, AM	A
800 to 1 000	1	70	CW, PM	A
1 000 to 1 200	0,5	70	CW, PM	A
1 200 to 1 400	0,5	150	CW, PM	A
1 400 to 2 700	0,5	70	CW, PM	A
2 700 to 3 200	0,5	150	CW, PM	A

10.6.4.4 RI 02: Immunity with TEM cell

10.6.4.4.1 General

The DUT shall be subjected to radiated immunity testing using a transverse electromagnetic (TEM) cell in accordance with ISO 11452-3, for testing over the frequency range of 1 MHz to 200 MHz.

10.6.4.4.2 TEM cell

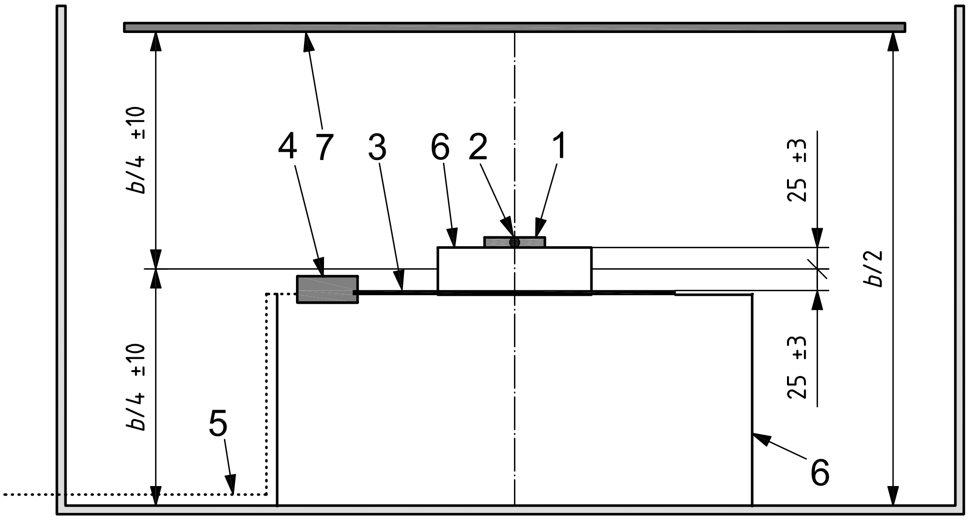
A TEM cell in accordance with ISO 11452-3 shall be used, with dimensions $b \geqslant 56$ cm, $l \geqslant 60$ cm and $w \geqslant 60$ cm.

10.6.4.4.3 Test set-up

The test set-up shall be in accordance with ISO 11452-3.

Due to the limited space, instead of using a complete CPOD passenger seat, only a CPOD-compatible sensor shall be positioned in the TEM cell together with resonators to be tested. Figures 32 and 33 show the test set-up which applies.

Dimensions in millimetres

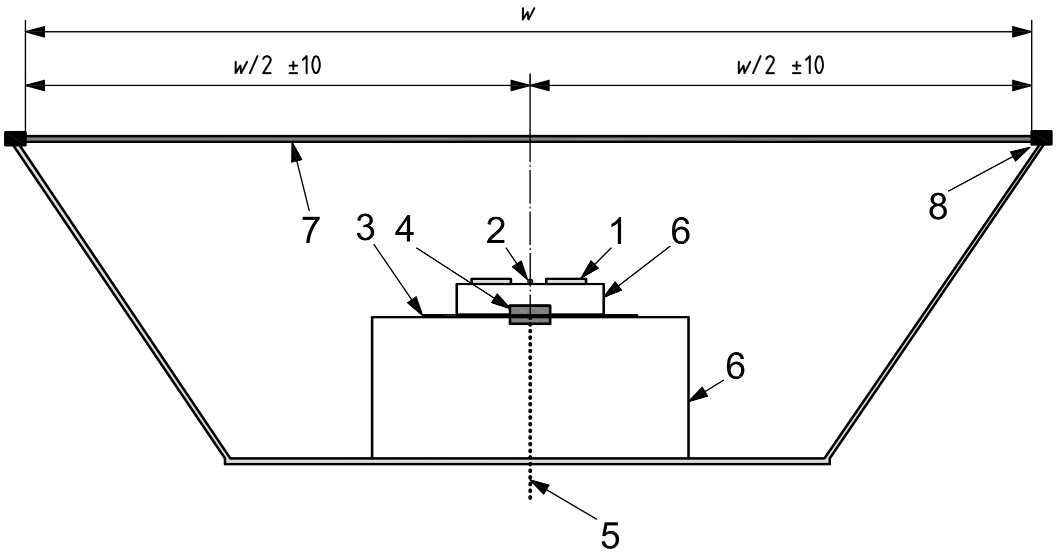


Key

1 resonator pair under test
2 RPRP
3 CPOD sensor (antennae)
4 CPOD sensor (electronics)
5 CPOD sensor cable harness
6 dielectric support (relative permittivity $\varepsilon_r \leqslant 1,4$)
7 septum
b height of TEM cell

Figure 32 — TEM cell set-up (longitudinal view)

Dimensions in millimetres



Key

1	resonator pair under test
2	RPRP
3	CPOD sensor (antennae)
4	CPOD sensor (electronics)
5	CPOD sensor cable harness
6	dielectric support (relative permittivity $\varepsilon_r \leqslant 1,4$)
7	septum
8	coaxial connectors
w	length of TEM cell

Figure 33 — TEM cell set-up (side view)

The CPOD sensor shall be positioned in such a manner that the centre of the antenna structure is located right below RPRP, while the position of RPRP follows the specifications in Figures 32 and 33.

10.6.4.4.4 Test parameters

Minimum dwell time is determined by the maximum duration that might be needed by the CPOD sensor to indicate a change in the detected state. This duration shall be determined before testing and shall include qualification times (if qualification cannot be switched off), etc.:

- continuous wave (CW): no modulation;
- amplitude modulation (AM): 1 kHz sine wave at 80 %, peak CW = peak AM.

10.6.4.4.5 Requirements and test levels

Table 35 — TEM cell settings

Range MHz	Log. step %	Level V/m	Modulation	Class
1 to 30	1	150	CW, AM	A
30 to 54	1	150	CW, AM	A
54 to 65	1	70	CW, AM	A
65 to 88	1	150	CW, AM	A
88 to140	1	70	CW, AM	A
140 to180	1	150	CW, AM	A
180 to 200	1	70	CW, AM	A

10.7 Electrostatic discharge (ESD) test

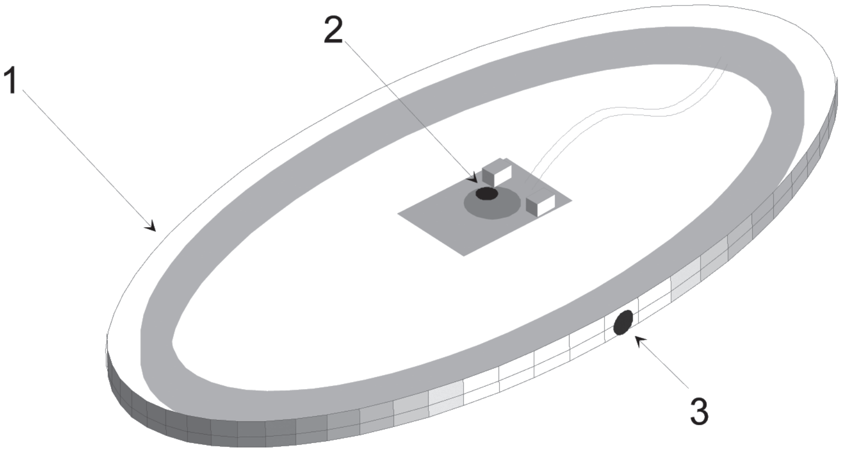
10.7.1 Test parameters

Table 36 — Test parameters

Parameter	Requirement
Test method	in accordance with ISO 10605
Number of samples	6 (3 “left” resonators; 3 “right” resonators)
Number of discharge locations	5
Test temperature	(23 ± 5) °C
Relative humidity	30 % to 60 %
Human body model	–330 pF/2 kΩ (powered-up test) –150 pF/2 kΩ (unpowered test)
Discharge voltage (contact)	see ISO 10605 (severity level IV)
Discharge voltage (air)	see ISO 10605 (severity level IV)
Functional state	Class C in accordance with ISO 10605

10.7.2 Discharge locations

At least five different discharge locations shall be defined for the resonators and documented in the test plan. The discharge location selection shall focus on points where discharges on the resonator electronics or on the coil could be possible and where discharges would be most critical (see examples in Figure 34).



Key

1 encapsulation/housing

2 location above electronics

3 possible access to coil for discharge

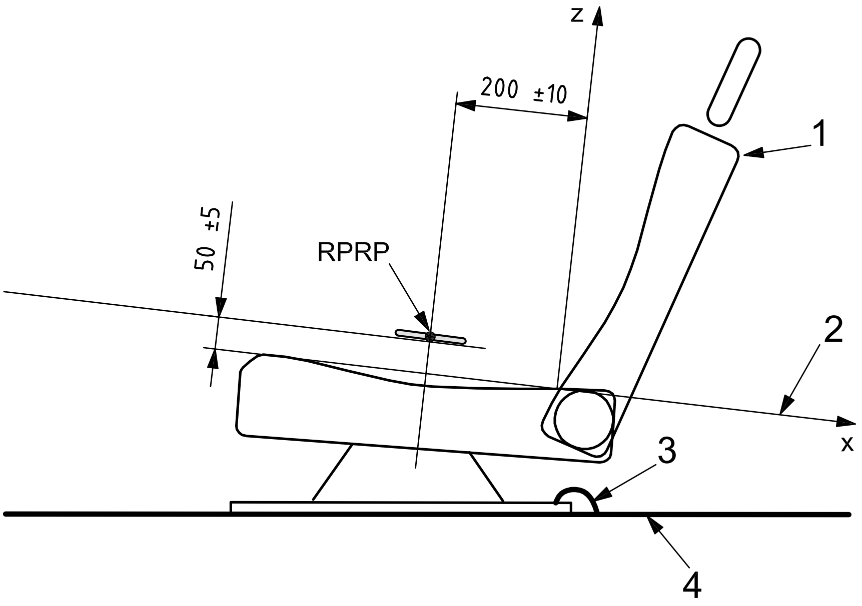
Figure 34 — Example of selection of discharge locations

10.7.3 Powered-up test

The powered-up ESD test shall be performed in accordance with ISO 10605 with the following deviations and definitions:

The resonator pair shall be placed on a CPOD-compatible passenger seat as indicated in Figure 35. The location of the RPRP shall be equal to (x, y, z) = [(–200 ± 10) mm, (0 ± 5) mm, (50 ± 5) mm] within the passenger seat's reference co-ordinate system (see ISO/TS 22239-1 for reference co-ordinate system definition). The bottom of the resonators shall be parallel to the reference co-ordinate system's x-y plane (see Figure 35). The torso angle of the passenger seat shall be adjusted to (27 ± 5)°. The seat's metallic structure shall be electrically connected to the ground plane.

Dimensions in millimetres



Key

1 CPOD passenger seat
2 reference co-ordinate system
3 electrical connection
4 ground plane

Figure 35 — Resonator positioning on passenger seat (side view)

For the powered-up ESD test, the 330 pF/2 kΩ capacitor probe shall be used. The resonator under test shall be tested at each voltage specified in Table 37.

Table 37 — Powered-up ESD test parameters

Type of discharge	Discharge voltage kV				Minimum number of discharges per voltage and polarity [a]
contact discharge	±4	±6	±7	±8	3
air discharge	±4	±8	±14	±15	3

[a] The minimum time duration between two successive discharges is 5 s.

Since functional class C is required, the resonator under test shall return to normal operation immediately after a discharge. The functional state of the resonators shall be determined by evaluating the data delivered by the CPOD sensor in the seat. It shall be ensured that functional degradation of a resonator during testing is detected instantaneously (e.g. by deactivating qualification state).

10.7.4 Packaging and handling test (unpowered test)

Follow ISO 10605:2008, Clause 9. The thickness of the static dissipative material is specified as (25 ± 2,5) mm. For the unpowered ESD test, the 150 pF/2 kΩ capacitor probe shall be used. The resonator under test shall be step-stressed in accordance with the voltages specified in Table 38.

Table 38 — Unpowered ESD test parameters

Type of discharge	Discharge voltage kV			Minimum number of discharges per voltage and polarity[a]
contact discharge	±4	±6	±8	3
air discharge	±4	±15	±25	3

[a] The minimum time duration between two successive discharges is 5 s.

Functional performance shall be verified by parametric measurements in accordance with 10.4.1 before the start and after completion of the test. Measured parameters shall meet the limits of this part of ISO/TS 22239.

10.8 Magnetic field stress test

10.8.1 Test parameters

Table 39 — Test parameters

Parameter	Requirement
Number of samples	4 (2 “left” resonators; 2 “right” resonators)
Test temperature	(23 ± 5) °C
Continuous stress duration	1 min
Continuous stress field strength	$H_{\mathrm{MAX,CONT}}$
Pulsed stress duration	2 min
Pulsed stress field strength	$H_{\mathrm{MAX,PULSED}}$
Transmitting frequency	max_freq($H_{\mathrm{OP,MAX}}$); see following test procedure
Operational state	B
Parameter check	parameter test before/after the test in accordance with 10.4.1

10.8.2 Test procedure

Perform the resonator compatibility test in accordance with Clause 9. Push the button “Pulsed Stress” and wait for the end of the pulsed stress test. Push the button ‘Constant Stress’ and wait for the end of the constant stress test.

10.8.3 Acceptance criteria

Functional performance shall be verified by parametric measurements before the start and after completion of the test. Measured parameters shall meet the limits of this part of ISO/TS 22239.

10.9 Qualification flow chart

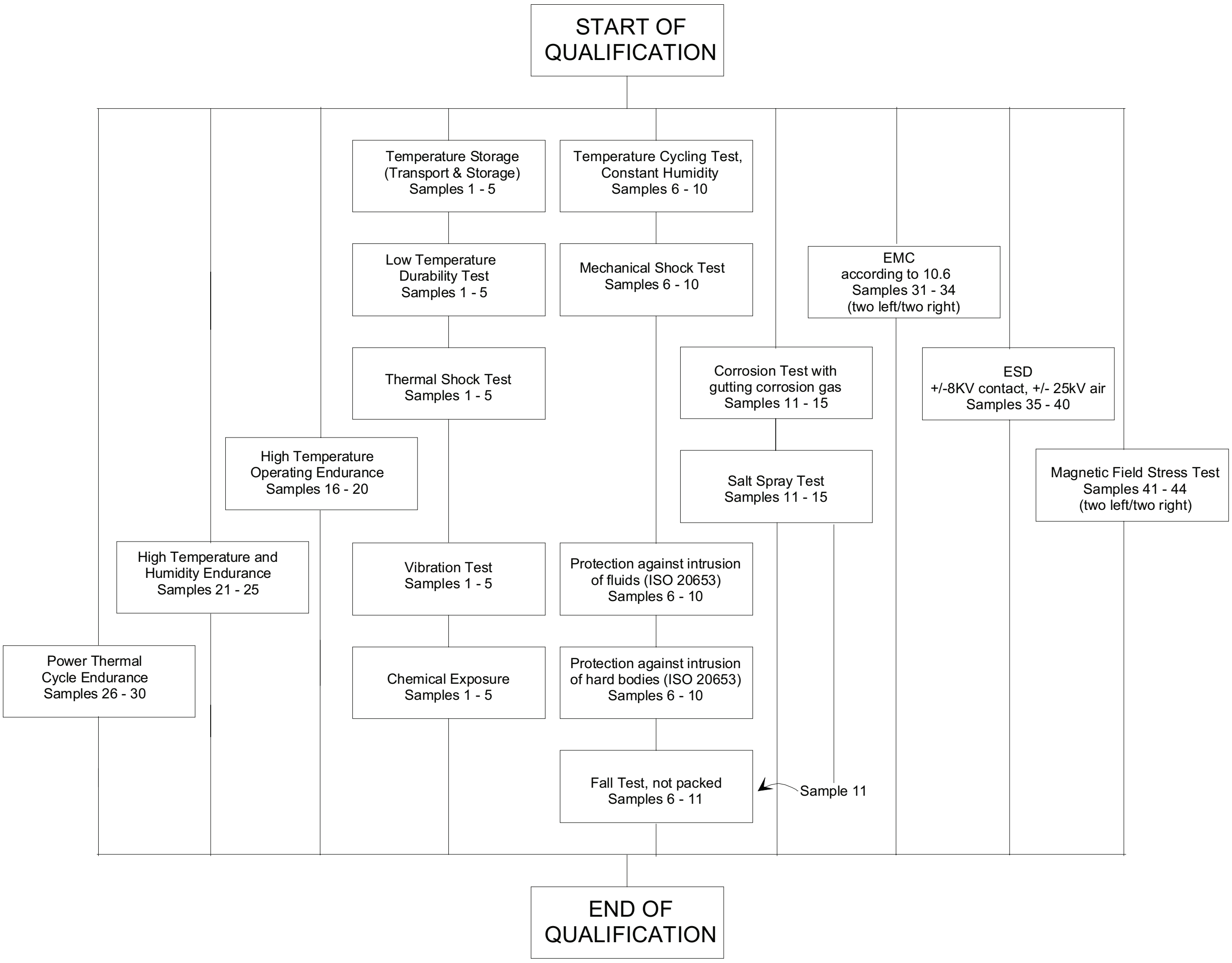


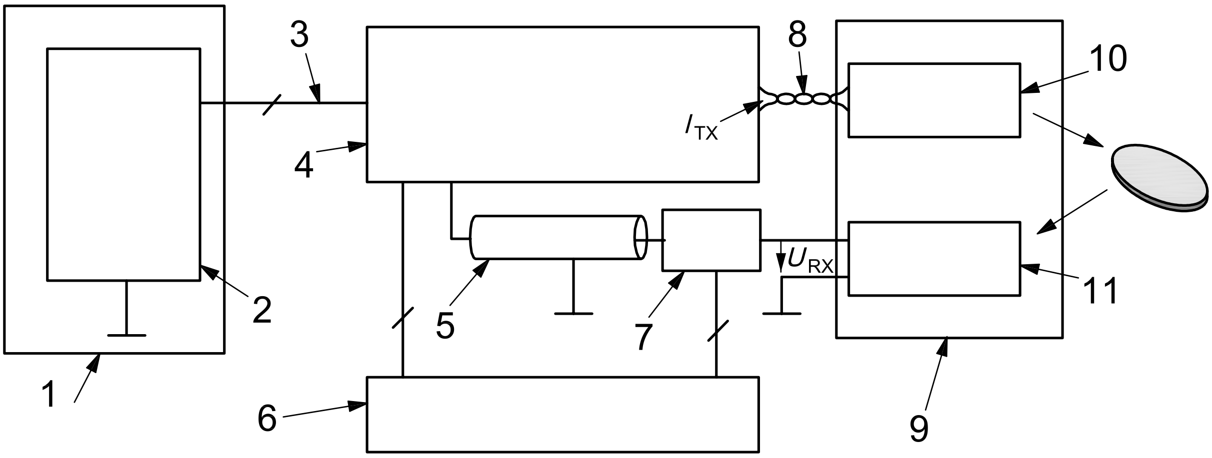
Figure 36 — Qualification flow chart

Annex A
(normative)

CPOD resonator compatibility test set-up

A.1 Structure

The CPOD resonator compatibility test set-up consists of different components, as indicated in Figure A.1.



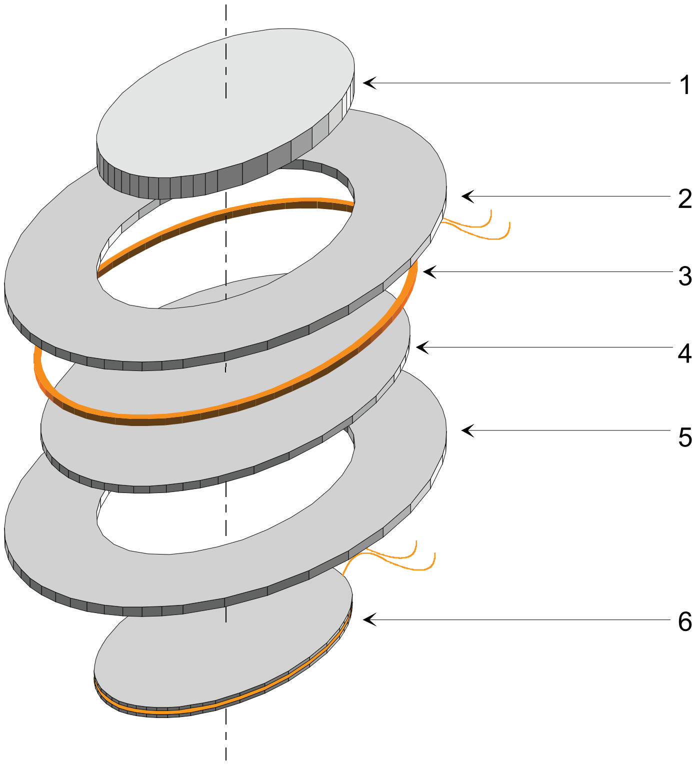
Key

1	PC
2	PC card NI PCI-6115
3	connection cable SH68-68-EP (NI)
4	interface electronics
5	coax < 1 m (RG174 or equivalent)
6	power supply
7	buffer
8	twisted pair (< 1 m)
9	antenna structure
10	transmitting antenna
11	receiving antenna

Figure A.1 — Different components of resonator compatibility test set-up

Transmitting and receiving antennae are combined in one defined structure, as indicated by the “exploded” drawing in Figure A.2.

The NI PCI-6115 (National Instruments) PC card shall be used to control the current source, to measure the transmitting current and to measure the voltage induced in the resonator probe as part of the antenna structure. A Windows-based PC (Windows2000, XP, or younger) shall be used. For the connection between interface electronics and PC cards, National Instruments’ shielded cable SH68-68-EP shall be used.

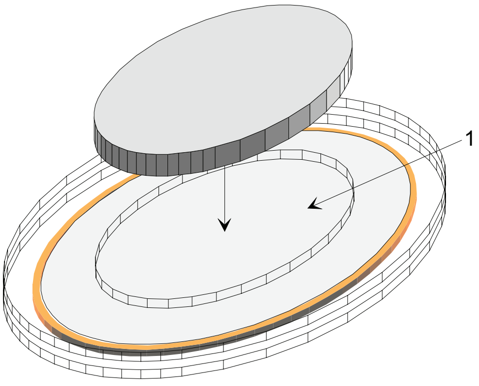


Key

1 resonator
2 upper transmitting antenna cover
3 transmitting antenna
4 spacer
5 lower transmitting antenna cover
6 resonator probe

Figure A.2 — Exploded drawing of resonator compatibility test set-up antenna structure

Figure A.3 shows the top view of the antenna structure.



Key

1 resonator box-out

Figure A.3 — Resonator compatibility test set-up antenna structure (top view)

Figure A.4 shows the bottom view of the antenna structure.

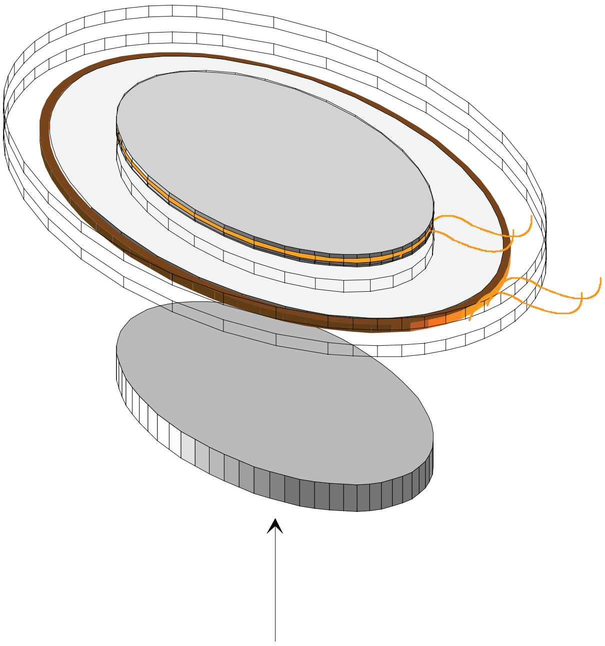
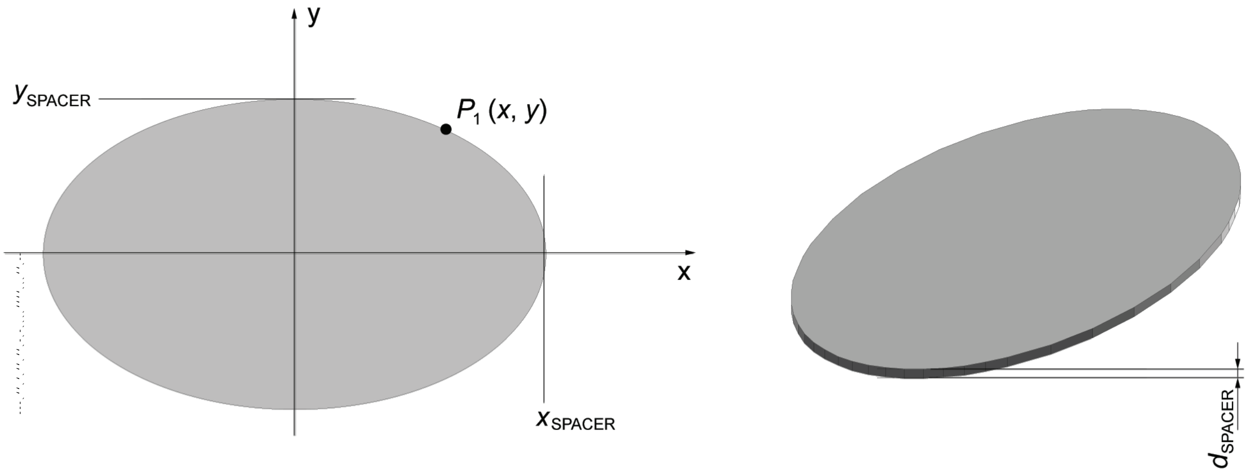


Figure A.4 — Resonator compatibility test set-up antenna structure (bottom view)

A.2 Dimensions

A.2.1 Spacer

The spacer serves as a mechanical carrier for the transmitting antenna and realizes the necessary gap between both transmitting antenna covers.



Key

$P_1(x,y)$ position vector [determined according to Equation (A.1)]

Figure A.5 — Resonator compatibility test set-up antenna structure (top view)

The position vectors of the outer shape of the spacer are described by Equation (A.1):

$$P(x,y) = \left(\frac{x}{x_{\text{SPACER}}}\right)^2 + \left(\frac{y}{y_{\text{SPACER}}}\right)^2 = 1 \qquad \text{(A.1)}$$

A.2.2 Transmitting antenna

The transmitting antenna shall be realized as an air coil. An adequate copper wire diameter shall be chosen to meet the geometrical dimensions as well as the number of turns, N, and the inductance, all mentioned in Table A.1. The transmitting antenna shall be wound around the spacer.

Table A.1 — Spacer parameters

Dimensions in millimetres

Parameter	min.	max.
x_{SPACER}	79,9	80,1
y_{SPACER}	54,9	55,1
d_{SPACER}	1,95	2,05

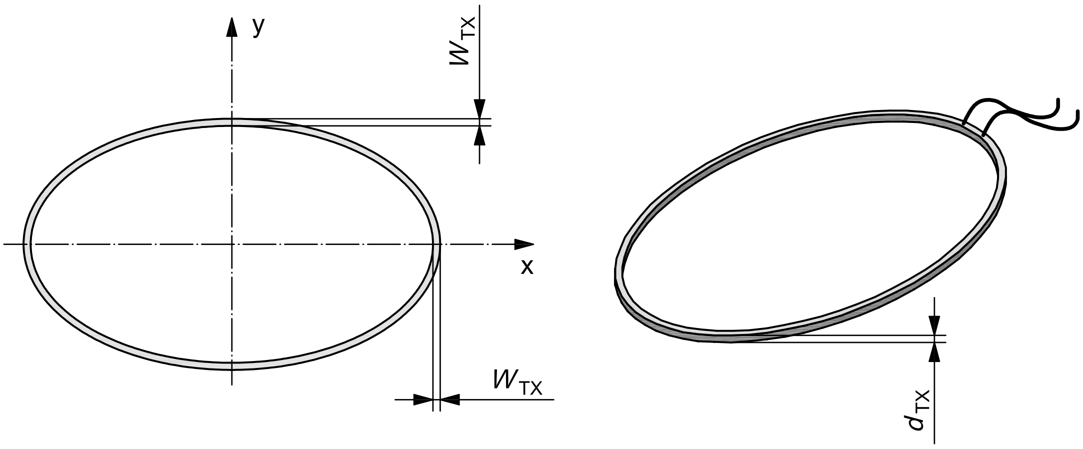


Figure A.6 — Resonator compatibility test set-up transmitting antenna

The position vectors of the inner and outer shape of the coil are described by Equation (A.2):

$$P(x,y) = \left(\frac{x}{x_{\text{TX,outer/inner}}}\right)^2 + \left(\frac{y}{y_{\text{TX,outer/inner}}}\right)^2 = 1 \qquad \text{(A.2)}$$

with parameters defined in Table A.2.

Table A.2 — Transmitting antenna parameters

Parameter	min.	max.
W_{TX} mm	1	1,5
d_{TX} mm	1,95	2,05
Number of turns N_{TX}	31	31
Inductance of transmitting antenna L_{TX} uH	380	420

A.2.3 Transmitting antenna cover

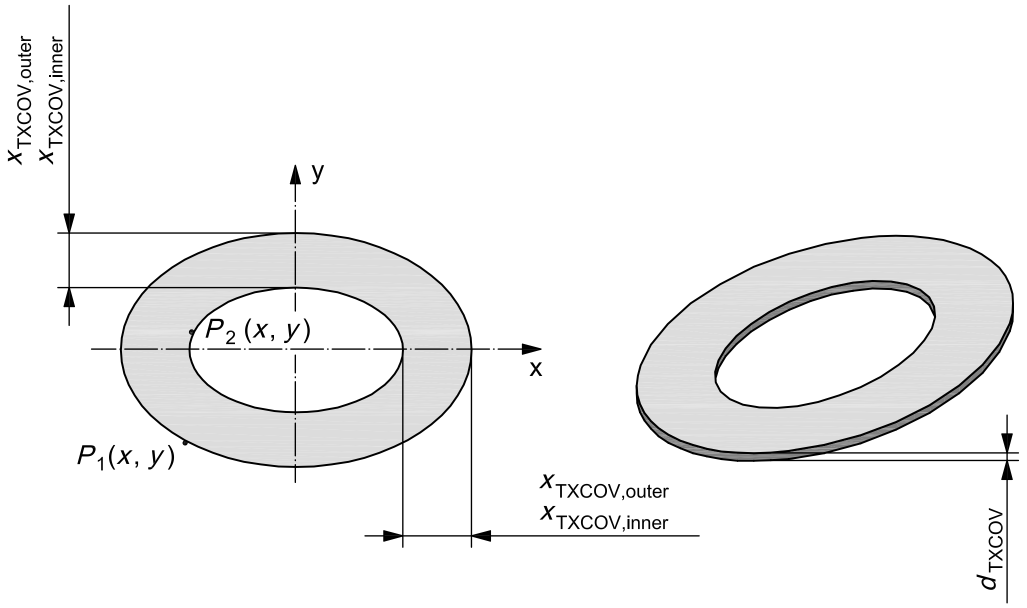


Figure A.7 — Transmitting antenna cover

The position vectors of the inner and outer shape of the transmitting antenna cover are described by Equation (A.3):

$$P(x,y)=\left(\frac{x}{x_{\text{TXCOV,outer/inner}}}\right)^2+\left(\frac{y}{y_{\text{TXCOV,outer/inner}}}\right)^2=1 \qquad \text{(A.3)}$$

with parameters defined in Table A.3.

Table A.3 — Transmitting antenna cover parameters

Dimensions in millimetres

Parameter	min.	max.
$x_{\text{TXCOV,outer}}$	89,9	90,1
$y_{\text{TXCOV,outer}}$	64,9	65,1
$x_{\text{TXCOV,inner}}$	60,7	60,8
$y_{\text{TXCOV,inner}}$	35,7	35,8
d_{TXCOV}	3,95	4,05

A.2.4 Resonator probe

See ISO/TS 22239-1:2009, Annex F.

Annex B
(normative)

CPOD resonator compatibility test parameters

B.1 Test procedure

The test procedure is as follows:

- connect the power supply to the power net;
- connect the PC card with the interface electronics using shielded cable SH68-68-EP;
- start the application “CPODResCompTest.exe”;
- press the “CALIBRATE” button and wait for successful calibration of the test set-up;
- place the resonator to be tested in the box-out of the upper transmitting antenna cover;
- press the “START TEST” button;
- monitor the result of the test.

B.2 Test parameters

B.2.1 General

The CPOD resonator compatibility test consists of an analogue part and a digital part.

B.2.2 Analogue part

The parameters specified in Table B.1 are measured during the analogue part of the compatibility test.

Table B.1 — Set of analogue parameters to be measured during compatibility test

Parameter	Measurement condition	Acceptance criteria
W_{synch}	— measured after $T_{\text{STARTUP,MAX}}$ — magnetic field strength array $H_{\text{TX\_ARR}}$ = [0,2; 0,3; 0,4; 0,5; 1; 2; 5] Apk/m, — transmitting frequency array $f_{\text{TX\_ARR}}$ = [124; 125; 126; 127; 128; 129; 130; 131; 132; 133] kHz — linear interpolation between $\Theta(f_{\text{TX}}\,\varepsilon\,f_{\text{TX\_ARR}}, H_{\text{TX}} = \text{const})$ to get W	Minimum values for W shall be exceeded (see Figure 18).
N_{synch}	— measured after $T_{\text{STARTUP,MAX}}$ — magnetic field strength array $H_{\text{TX\_ARR}}$ = [0,2; 0,3; 0,4; 0,5; 1; 2; 5] Apk/m — transmitting frequency array $f_{\text{TX\_ARR}}$ = [124; 125; 126; 127; 128; 129; 130; 131; 132; 133] kHz — linear interpolation between $SNR(f_{\text{TX}}\,\varepsilon\,f_{\text{TX\_ARR}}, H_{\text{TX}} = \text{const})$ to get N	Minimum values for N shall be exceeded (see Figure 19)
W_{asynch}	— measured after $T_{\text{DELAY}}(H_{\text{TX\_ARR}})$ — magnetic field strength array $H_{\text{TX\_ARR}}$ = [0,2; 0,3; 0,4; 0,5; 1; 2; 5] Apk/m, — transmitting frequency array $f_{\text{TX\_ARR}}$ = [124; 125; 126; 127; 128; 129; 130; 131; 132; 133] kHz — linear interpolation between $\Theta(f_{\text{TX}}\,\varepsilon\,f_{\text{TX\_ARR}}, H_{\text{TX}} = \text{const})$ to get W	Minimum values for W shall be exceeded (see Figure 18).
N_{asynch}	— measured after $T_{\text{DELAY}}(H_{\text{TX\_ARR}})$ — magnetic field strength array $H_{\text{TX\_ARR}}$ = [0,2; 0,3; 0,4; 0,5; 1; 2; 5] Apk/m — transmitting frequency array $f_{\text{TX\_ARR}}$ = [124; 125; 126; 127; 128; 129; 130; 131; 132; 133] kHz — linear interpolation between $SNR(f_{\text{TX}}\,\varepsilon\,f_{\text{TX\_ARR}}, H_{\text{TX}} = \text{const})$ to get N	Minimum values for N shall be exceeded (see Figure 19).
H_{RESET}	— $T_{\text{POWERUP}} = T_{\text{POWERUP,MIN}}$ — $T_{\text{RESET}} = T_{\text{RESET,MIN}}$ — $f_{\text{TX}} = f\,\varepsilon\,f_{\text{TX\_ARR}}$ where maximum of $\Theta(H_{\text{TX}} = \text{const})$ was measured — magnetic field strength array $H_{\text{TX\_ARR}}$ = [0,2; 0,3; 0,4; 0,5; 1; 2; 5] Apk/m — criteria for detected reset: protocol timing shall not deviate from specification — EXAMPLE f_{TX} = 125 kHz, subcarrier frequency = 125 kHz/40 = 3 125 Hz --> bit 13 of protocol shall start after t ms after end of reset field gap, $t\,\varepsilon$ [30,72 ms ... 31,72 ms (since $T_{\text{STARTUP,MAX}}$ = 1 ms)]. — H_{RESET} to be determined with a tolerance of 1mA/m	Maximum value for H_{RESET} shall be exceeded (see Table 7).

B.2.3 Digital part

The parameters specified in Table B.2 are measured during the digital part of the compatibility test.

Table B.2 — Digital part

Parameter	Measurement condition	Acceptance criteria
Protocol logical bit values, bit timing to be correct	— $T_{\text{POWERUP}} = T_{\text{POWERUP,MIN}}$ — $T_{\text{RESET}} = T_{\text{RESET,MAX}}$ — magnetic field strength array $H_{\text{TX\_ARR}}$ = [0,2; 0,3; 0,4; 0,5; 1; 2; 5] Apk/m, — transmitting frequency array $f_{\text{TX\_ARR}} = f_{\text{C}}(H_{\text{TX\_ARR}})$, see Figure 16, f_{C} = centre frequency of frequency window as function of H_{TX}, leading to value for $W(H_{\text{TX}} = \text{const})$. — bit timing shall not deviate from specification — EXAMPLE f_{TX} = 125 kHz, subcarrier frequency = 125 kHz/40 = 3 125 Hz --> bit 13 of protocol shall start after t ms after end of reset field gap, t ε [30,72 ms ... 31,72 ms (since $T_{\text{STARTUP,MAX}}$ = 1 ms)].	— protocol logical values definition in accordance with 6.1 shall be met — timing in accordance with 6.2 shall be met

Annex C
(normative)

Continuous parameter check

C.1 Test parameters

Tables C.1 and C.2 describe the resonator parameters to be tested during a continuous parameter check.

C.2 Analogue part

The parameters specified in Table C.1 are measured during the analogue part of the compatibility test.

Table C.1 — Set of analogue parameters to be measured during compatibility test

Parameter	Measurement condition	Acceptance criteria
W_{synch}	— measured after $T_{\text{STARTUP,MAX}}$ — magnetic field strength array $H_{\text{TX}} = 0{,}5$ Apk/m, — transmitting frequency array $f_{\text{TX\_ARR}} = [124; 125; 126; 127; 128; 129; 130; 131; 132; 133]$ kHz — linear interpolation between $\Theta(f_{\text{TX}}\,\varepsilon\, f_{\text{TX\_ARR}}, H_{\text{TX}} = \text{const})$ to get W	Minimum values for W (0,5 A/m) shall be exceeded (see Figure 18).
N_{synch}	— measured after $T_{\text{STARTUP,MAX}}$ — magnetic field strength array $H_{\text{TX}} = 0{,}5$ Apk/m, — transmitting frequency array $f_{\text{TX\_ARR}} = [124; 125; 126; 127; 128; 129; 130; 131; 132; 133]$ kHz — linear interpolation between $SNR(f_{\text{TX}}\,\varepsilon\, f_{\text{TX\_ARR}}, H_{\text{TX}} = \text{const})$ to get N	Minimum values for N (0,5 A/m) shall be exceeded (see Figure 19).
W_{asynch}	— measured after $T_{\text{DELAY}}(H_{\text{TX\_ARR}})$ — magnetic field strength array $H_{\text{TX}} = 0{,}5$ Apk/m, — transmitting frequency array $f_{\text{TX\_ARR}} = [124; 125; 126; 127; 128; 129; 130; 131; 132; 133]$ kHz — linear interpolation between $\Theta(f_{\text{TX}}\,\varepsilon\, f_{\text{TX\_ARR}}, H_{\text{TX}} = \text{const})$ to get W	Minimum values for W (0,5 A/m) shall be exceeded (see Figure 18).
N_{asynch}	— measured after $T_{\text{DELAY}}(H_{\text{TX\_ARR}})$ — magnetic field strength array $H_{\text{TX}} = 0{,}5$ Apk/m, — transmitting frequency array $f_{\text{TX\_ARR}} = [124; 125; 126; 127; 128; 129; 130; 131; 132; 133]$ kHz — linear interpolation between $SNR(f_{\text{TX}}\,\varepsilon\, f_{\text{TX\_ARR}}, H_{\text{TX}} = \text{const})$ to get N	Minimum values for N (0,5 A/m) shall be exceeded (see Figure 19).

Table C.1 (*continued*)

Parameter	Measurement condition	Acceptance criteria
H_{RESET}	— $T_{\mathrm{POWERUP}} = T_{\mathrm{POWERUP,MIN}}$ — $T_{\mathrm{RESET}} = T_{\mathrm{RESET,MIN}}$ — $f_{\mathrm{TX}} = f \, \varepsilon \, f_{\mathrm{TX\_ARR}}$ where maximum of $\Theta(H_{\mathrm{TX}} = \mathrm{const})$ was measured — magnetic field strength array $H_{\mathrm{TX}} = 0{,}5$ Apk/m — criteria for detected reset: protocol timing shall not deviate from specification — EXAMPLE f_{TX} = 125 kHz, subcarrier frequency = 125 kHz/40 = 3 125 Hz --> bit 13 of protocol shall start after t ms after end of reset field gap, $t \, \varepsilon$ [30,72 ms ... 31,72 ms (since $T_{\mathrm{STARTUP,MAX}}$ = 1 ms)]. — H_{RESET} to be determined with a tolerance of 1 mA/m	Maximum value for H_{RESET} shall be exceeded (see Table 7).

C.3 Digital part

The parameters specified in Table C.2 are measured during the digital part of the compatibility test.

Table C.2 — Digital part

Parameter	Measurement condition	Acceptance criteria
Protocol logical bit values, bit timing to be correct	— $T_{\mathrm{POWERUP}} = T_{\mathrm{POWERUP,MIN}}$ — $T_{\mathrm{RESET}} = T_{\mathrm{RESET,TYP}}$ — magnetic field strength array $H_{\mathrm{TX}} = 0{,}5$ Apk/m, — transmitting frequency array $f_{\mathrm{TX}} = f_{\mathrm{C}}(0{,}5$ Apk/m), see Figure 16, f_{C} = centre frequency of frequency window as function of H_{TX}, leading to value for $W(H_{\mathrm{TX}} = \mathrm{const})$. — bit timing shall not deviate from specification — EXAMPLE f_{TX} = 125 kHz, subcarrier frequency = 125 kHz/40 = 3 125 Hz --> bit 13 of protocol shall start after t ms after end of reset field gap, $t \, \varepsilon$ [30,72 ms ... 31,72 ms (since $T_{\mathrm{STARTUP,MAX}}$ = 1 ms)].	protocol logical values definition in accordance with 6.1 shall be met timing in accordance with 6.2 shall be met

Annex D
(normative)

CPOD reference resonator

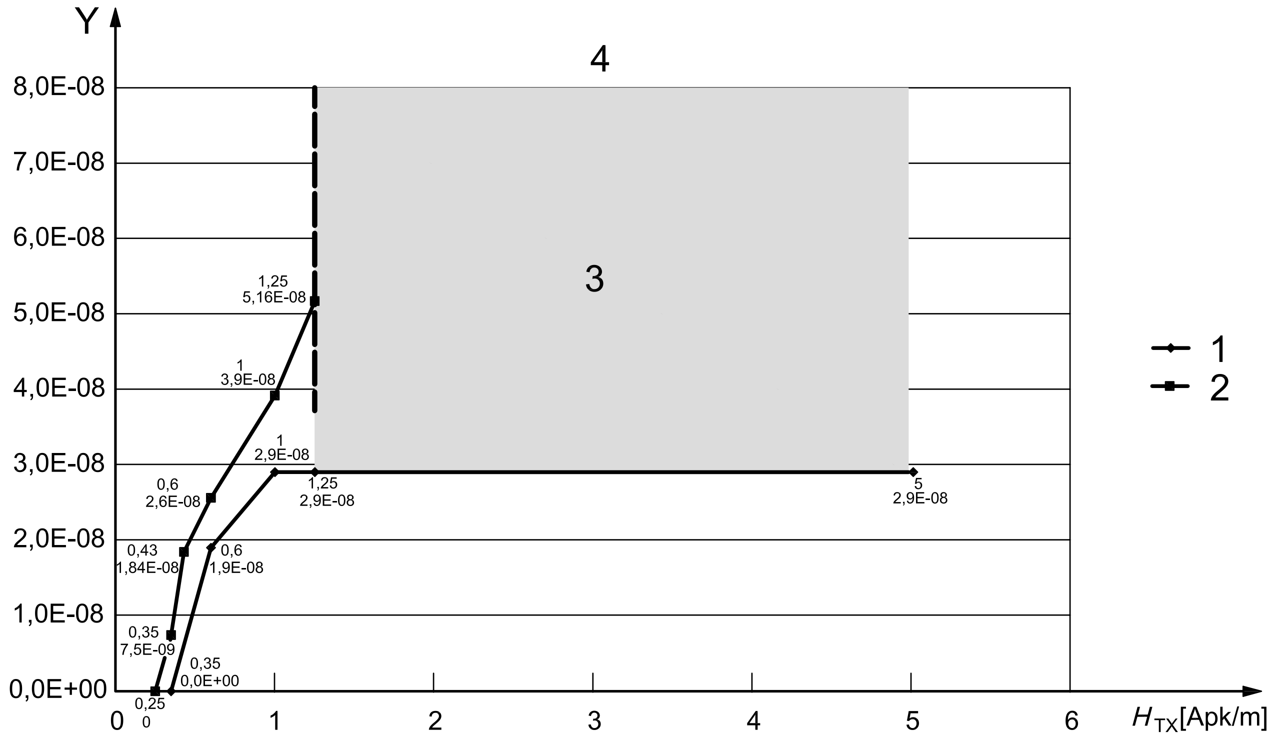
D.1 Reference performance

The CPOD reference resonator shall be used to perform the CPOD passenger seat compatibility tests described in ISO/TS 22239-1.

The CPOD reference resonator features the performance described in this annex with the following restrictions.

D.2 Restrictions on W_{synch}, W_{asynch}

A reference resonator's W_{synch}, W_{asynch} curve shall stay within the limits defined by Figure D.1.



Key

1 W(RefReso),min

2 W(RefReso),max

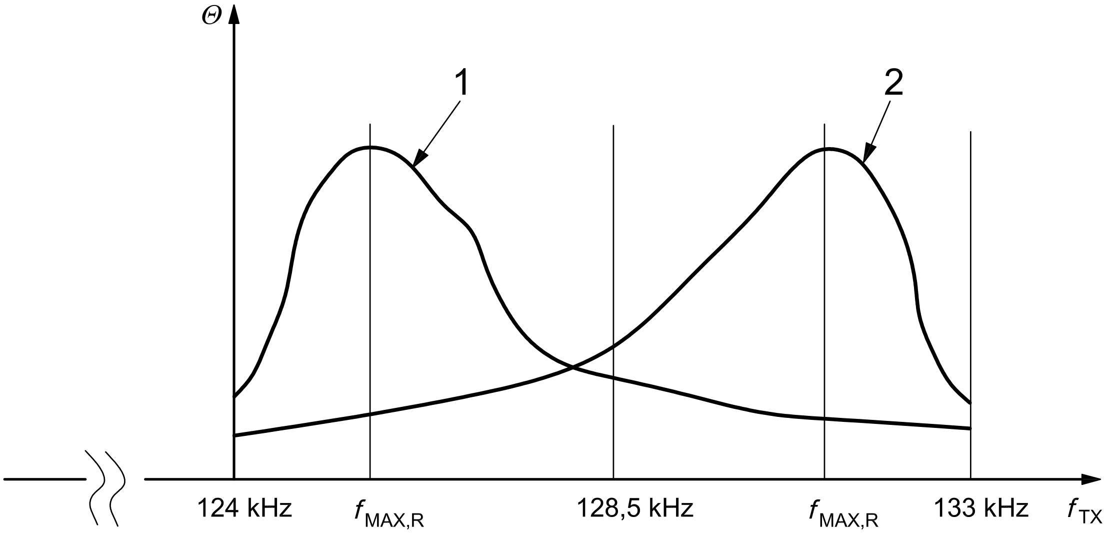
3 reference resonator's $W_{\text{synch,}}$ W_{asynch} only limited by W(RefReso),min

4 reference resonator W_{synch}, W_{asynch} definition

Y $W_{\text{synch,asynch}}$ [Vspk]

Figure D.1 — Reference resonator W_{synch} limitation

In addition, the frequencies of the supplying magnetic field which cause the absolute maximum values for Θ in accordance with 6.3.5 and Figure D.2 shall meet the limits defined in Table D.1.



Key

1 $\theta_{RIGHT\_REF\_RESONATOR}$

2 $\theta_{LEFT\_REF\_RESONATOR}$

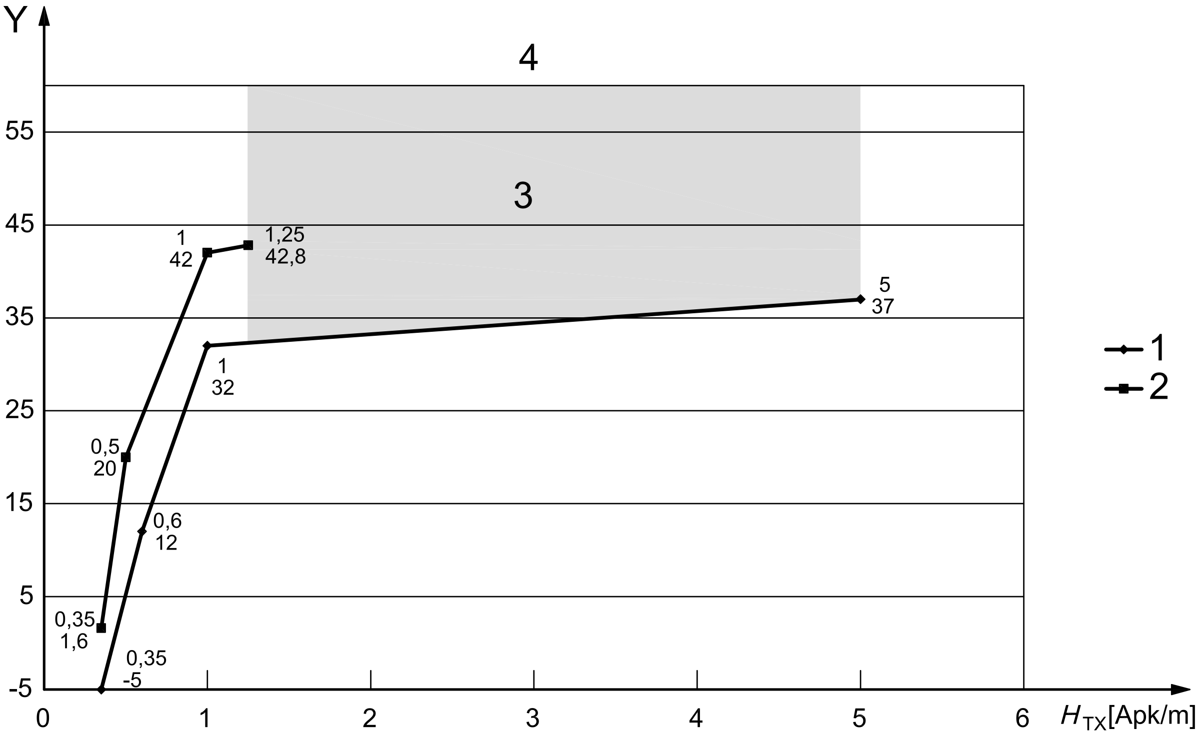
Figure D.2 — Reference resonator frequency ranges

Table D.1 — Definition of $f_{MAX,R}/f_{MAX,L}$

Parameter	min.	max.
Frequency at maximum value for Θ, right reference resonator, measured with a tolerance of ±500 Hz $f_{MAX,R}$ kHz	124	128,5
Frequency at maximum value for Θ, left reference resonator, measured with a tolerance of ±500 Hz $f_{MAX,L}$ kHz	128,5	133

D.3 Restrictions on N_{synch}, N_{asynch}

A reference resonator's N_{synch}, N_{asynch} curve shall stay within the limits defined by Figure D.3.



Key

1 N(RefReso),min

2 N(RefReso),max

3 reference resonator's $N_{synch,}N_{asynch}$ only limited by N(RefReso),min

4 reference resonator $N_{synch, asynch}$ definition

Y $N_{synch,asynch}$ (dB)

Figure D.3 — Reference resonator N_{synch}, N_{asynch} limitation

D.4 Reference resonator CRS type

The CPOD reference resonator shall feature the following CRS type, see Table D.2.

Table D.2 — Definition of reference resonator type

Parameter	Explanation	Value
$TYPE_{REFRES}$	CRS type of reference resonator	1

ICS 43.040.80

Price based on 65 pages