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*



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# Contents

Page

Foreword ..... iv
1 Scope ..... 1
2 Normative references ..... 1
3 Terms and definitions ..... 1
4 CPOD resonator components ..... 2
5 Coil requirements ..... 2
6 Electrical properties ..... 3
6.1 Digital resonator protocol ..... 3
6.2 Subcarrier bitstream ..... 5
6.3 Modulation ..... 7
6.4 Modulation parameters ..... 16
7 Resonator timing ..... 18
7.1 General ..... 18
7.2 Power-up ..... 18
7.3 Reset ..... 18
7.4 Relevant timing and reset parameters ..... 19
8 Electrical and environmental parameters ..... 20
8.1 Absolute maximum ratings ..... 20
8.2 Operating ranges ..... 21
8.3 Storage conditions ..... 21
9 CPOD resonator compatibility test ..... 21
10 Resonator environmental qualification ..... 22
10.1 Application profile ..... 22
10.2 Common test parameters ..... 23
10.3 Operating states ..... 24
10.4 Parametrical test and parameter checking ..... 24
10.5 Qualification tests ..... 25
10.6 Electromagnetic compatibility (EMC) test ..... 38
10.7 Electrostatic discharge (ESD) test ..... 47
10.8 Magnetic field stress test ..... 50
10.9 Qualification flow chart ..... 51
Annex A (normative) CPOD resonator compatibility test set-up ..... 52
Annex B (normative) CPOD resonator compatibility test parameters ..... 58
Annex C (normative) Continuous parameter check ..... 61
Annex D (normative) CPOD reference resonator ..... 63

## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

In other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of document:

— an ISO Publicly Available Specification (ISO/PAS) represents an agreement between technical experts in an ISO working group and is accepted for publication if it is approved by more than 50 % of the members of the parent committee casting a vote;

— an ISO Technical Specification (ISO/TS) represents an agreement between the members of a technical committee and is accepted for publication if it is approved by 2/3 of the members of the committee casting a vote.



An ISO/PAS or ISO/TS is reviewed after three years in order to decide whether it will be confirmed for a further three years, revised to become an International Standard, or withdrawn. If the ISO/PAS or ISO/TS is confirmed, it is reviewed again after a further three years, at which time it must either be transformed into an International Standard or be withdrawn.

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*

# 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*

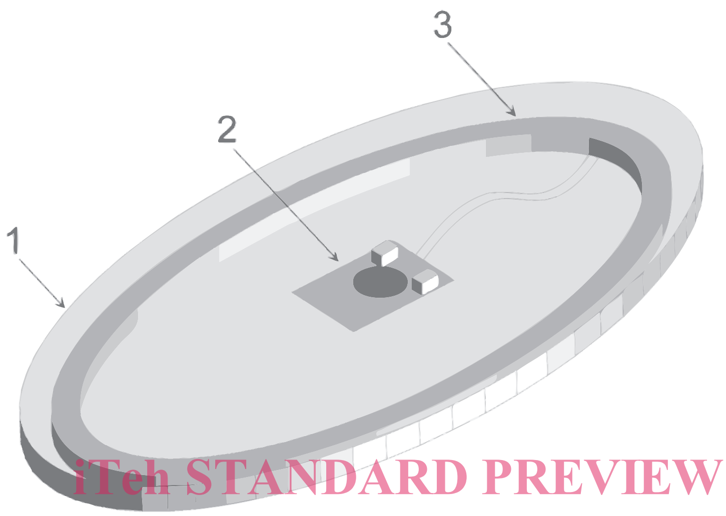
IEC 60068-2-60, *Environmental testing — Part 2: Tests — Test Ke: Flowing mixed gas corrosion test*

## 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

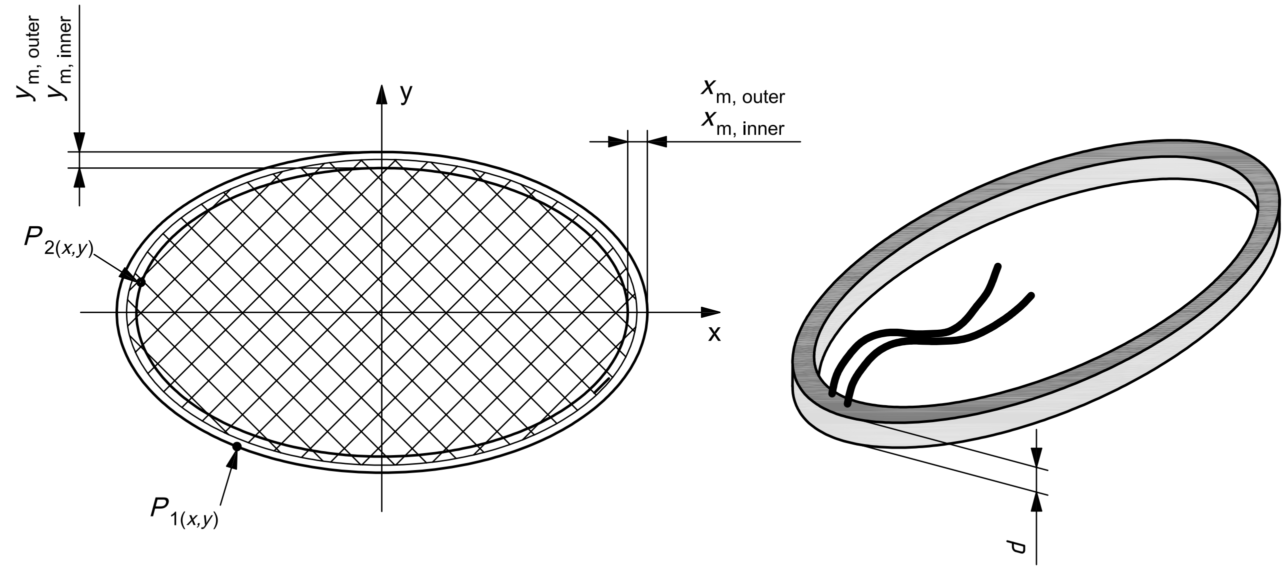
2 electronics

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**

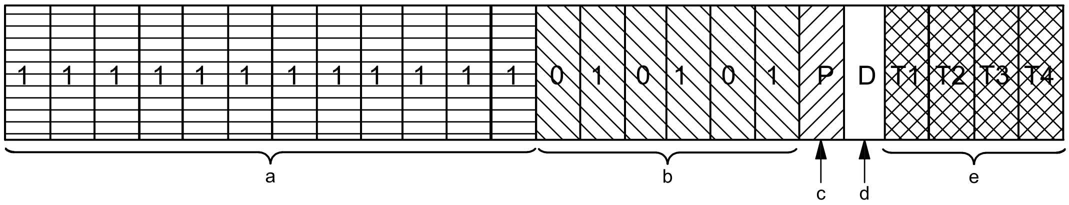
Dimensions in millimetres

| 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.

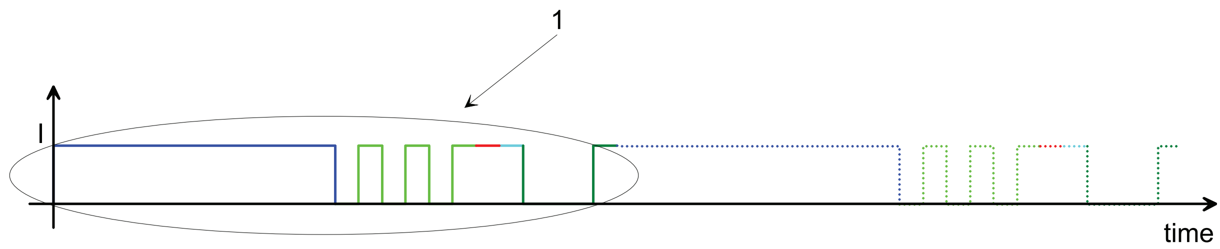
**Table 2 — Child seat type classification**



| 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.

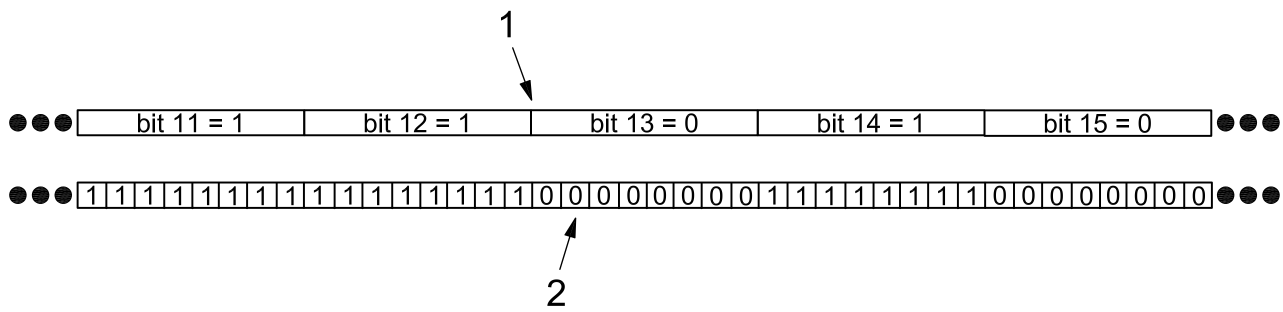
**Table 3 — Data protocol bit frequency**

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



## 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**

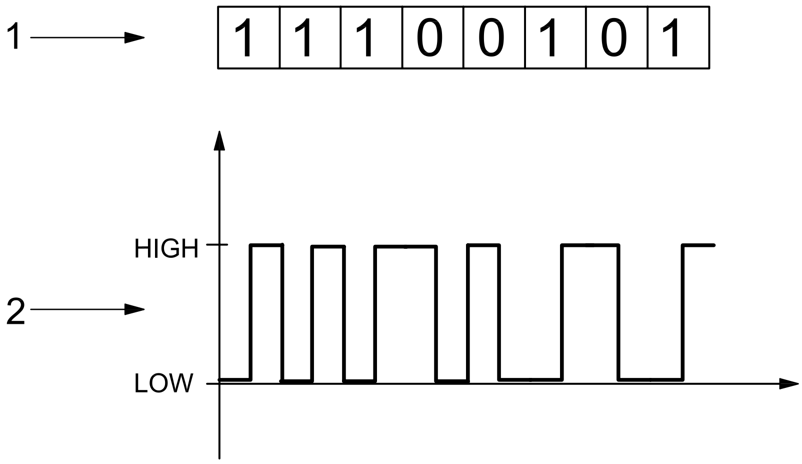
1 resonator data protocol

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, $f_{subcarrier}$**

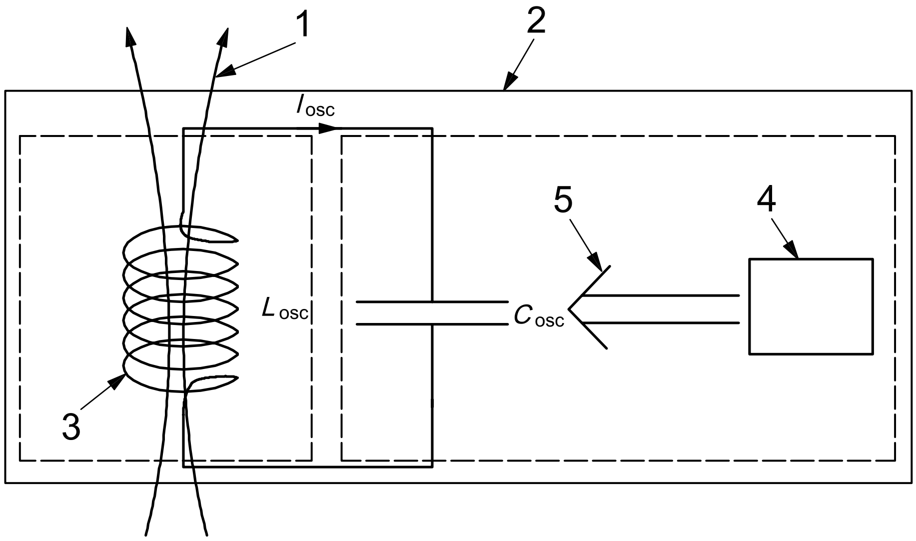
| Resonator type | Parameter | Data protocol frequency |
|---|---|---|
| left | $f_{subcarrier}$ | $f_{TX}/40$ |
| right | $f_{subcarrier}$ | $f_{TX}/56$ |



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.

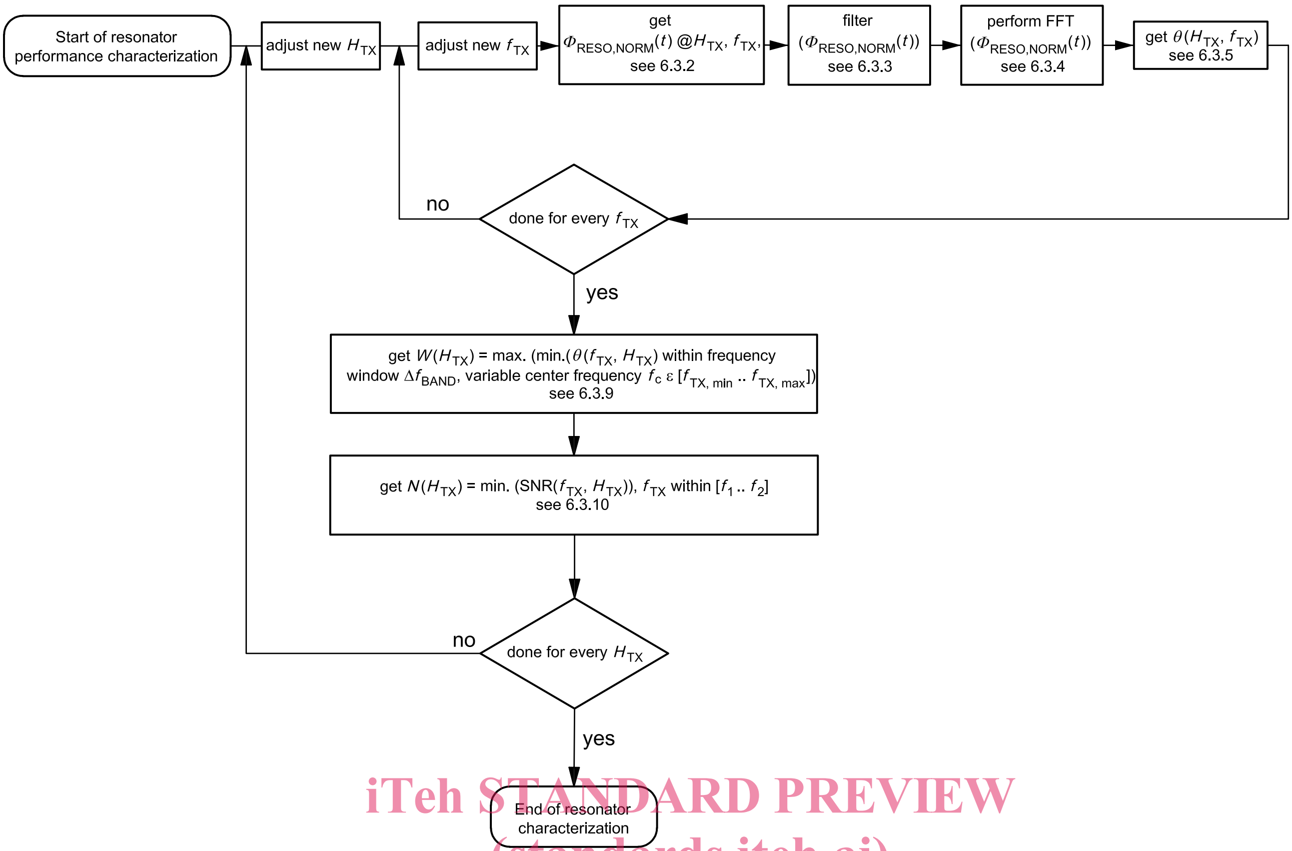


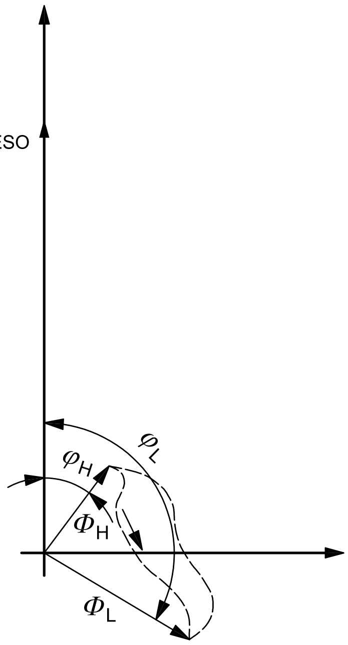



**Figure 8 — Procedure to derive $W(H_{TX})$ and $N(H_{TX})$ for magnetic field strength $H_{TX}$**



### 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**

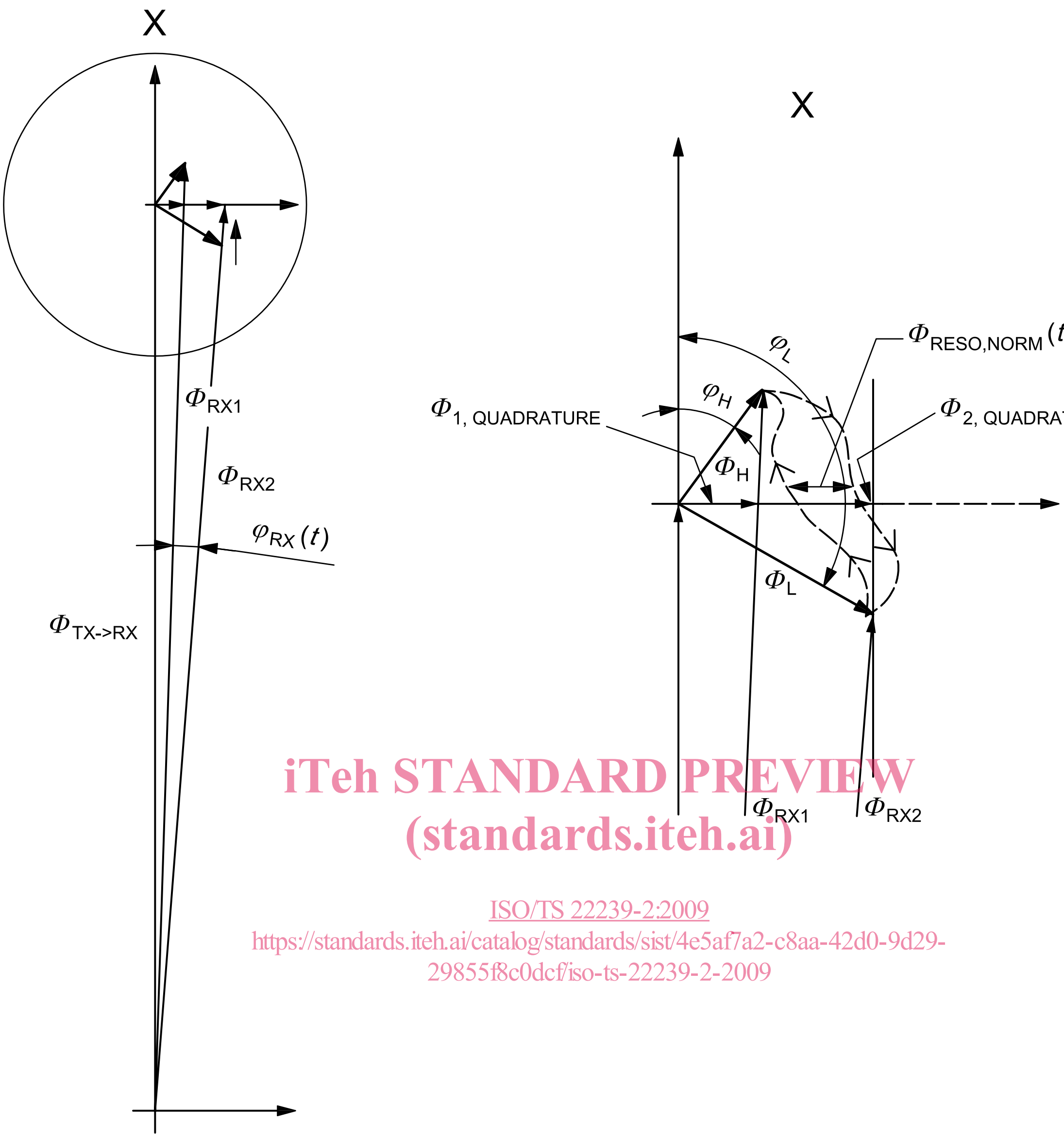
$\Phi_{TX \to RESO}$ transmitter magnetic flux component supplying resonator
$\varphi_H$ phase angle between resonator field and resonator magnetic flux, high state of modulation
$\Phi_H$ amplitude of resonator magnetic flux, high state of modulation
$\varphi_L$ phase angle between transmitter field and resonator magnetic flux, low state of modulation
$\Phi_L$ 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 $\Phi_{RX}$ 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 |
| $\varphi_H$ | phase angle between transmitter field and transponder magnetic flux, high state of modulation |
| $\Phi_H$ | amplitude of resonator magnetic flux flooding receiving antenna high state of modulation |
| $\varphi_L$ | phase angle between transmitter field and transponder magnetic flux, low state of modulation |
| $\Phi_L$ | 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 $\Phi_{\mathrm{RESO,NORM}}(t)$ is defined by Equation (2):

$$\Phi_{\mathrm{RESO,NORM}}(t) = \mathrm{abs}[\underline{\Phi}_{\mathrm{RESO}}(t)] \times \sin\{\arg[\underline{\Phi}_{\mathrm{RESO}}(t)]\}) = \mathrm{abs}(\underline{\Phi}_{\mathrm{RESO}}(t)) \times \sin[\varphi(t)] \quad (2)$$

where

$\underline{\Phi}_{\mathrm{RESO}}(t)$ is the complex amplitude of $\Phi_{\mathrm{RESO}}$ over time;

$\arg[\underline{\Phi}_{\mathrm{RESO}}(t)]$ is the phase difference between $\Phi_{\mathrm{TX}}$ and $\underline{\Phi}_{\mathrm{RESO}}(t)$ (see Figure 10).

### 6.3.3 Lowpass filtering

Before performing the Fast Fourier transform (FFT) on $\Phi_{\mathrm{RESO,NORM}}(t)$, 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 9$^{\mathrm{th}}$ harmonic. Table 5 specifies the lowpass filter to be used.

**Table 5 — Definition of lowpass filter**

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



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

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 $\Phi_{\mathrm{RESO,NORM}}(t)$ as a function of time.