

Experience with taximeters with a look at the corresponding tables

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Taximeters in EU are subject to regulations

in

Measuring Instruments Directive (MID)

*Directive 2004/22/EC of the European Parliament and of the Council
of 31 March 2004 on measuring instruments*

The Directive applies to the devices and systems with a measuring function defined in the instrument-specific annexes concerning

1. water meters (Annex MI-001),
2. gas meters and volume conversion devices (Annex MI-002),
3. active electrical energy meters (Annex MI-003),
4. heat meters (Annex MI-004),
5. measuring systems for continuous and dynamic measurement of quantities of liquids other than water (Annex MI-005),
6. automatic weighing instruments (Annex MI-006),
- 7. taximeters (Annex MI-007),**
8. material measures (Annex MI-008),
9. dimensional measuring instruments (Annex MI-009)
10. exhaust gas analysers (Annex MI-010).

Examples of EU taximeters approved by the MID







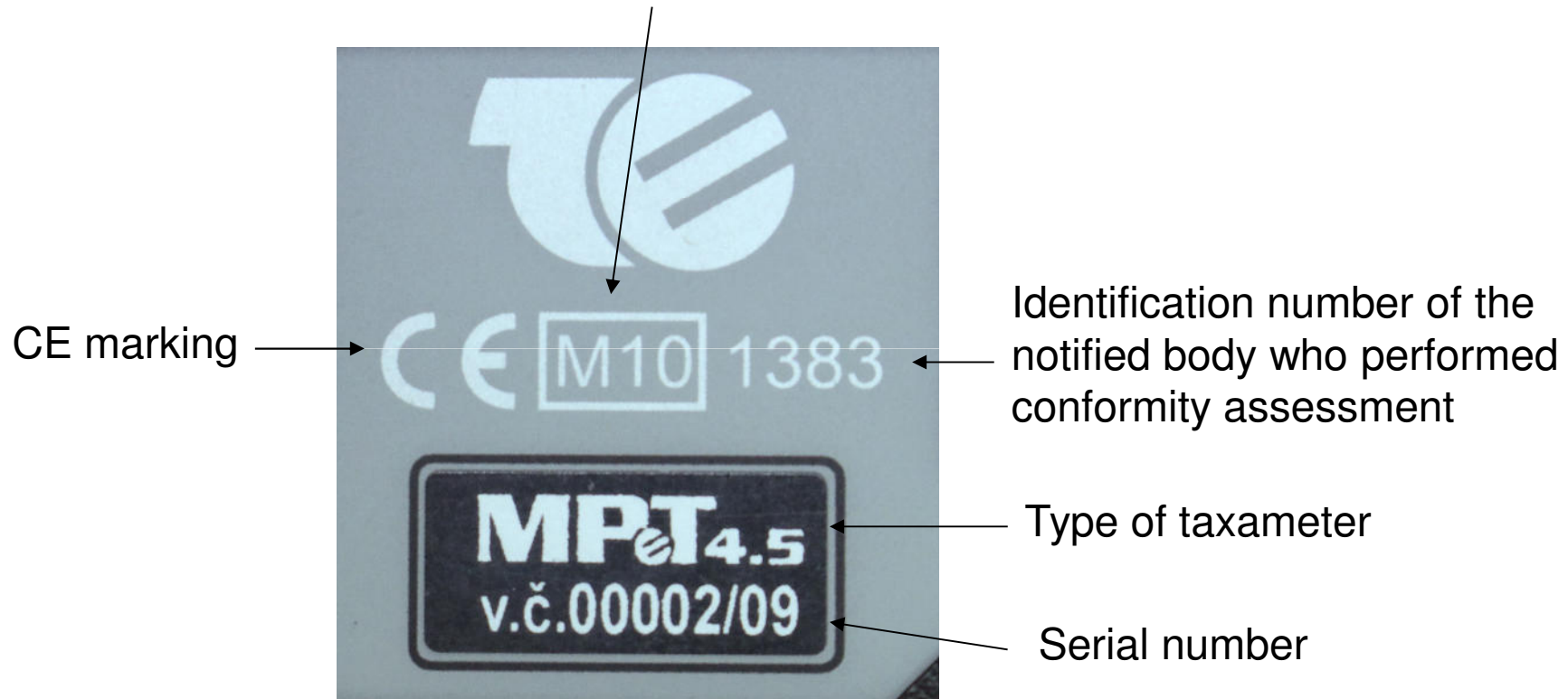






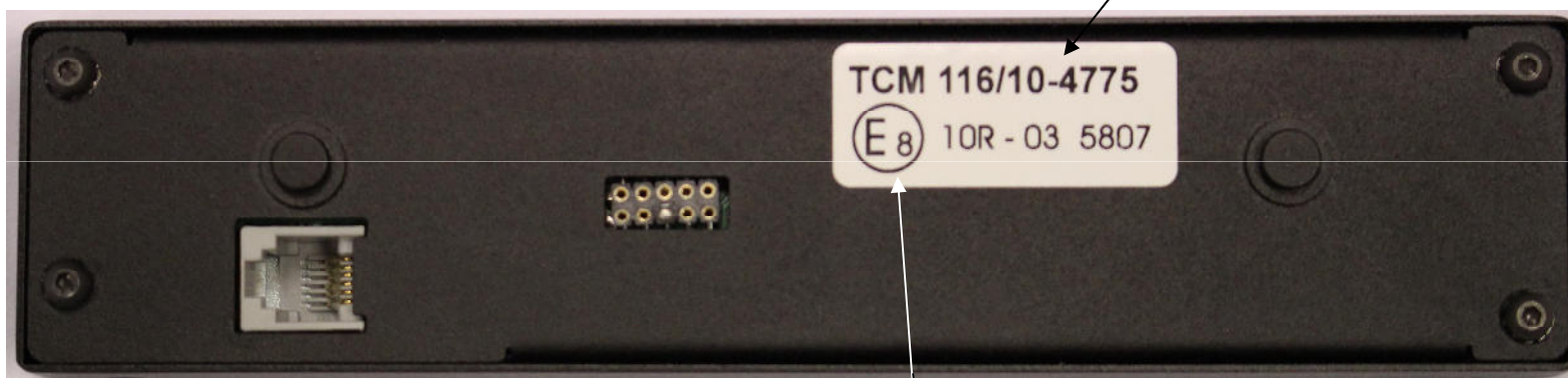
All taximeters approved by MID are marked on the front side with

Capital letter 'M' and the last two digits of the year of its affixing, surrounded by a rectangle



Marking on the rear side of taxameter

Number of EU-type examination certificate



Prefix of the European country where taxameter was examined

8 = Czech Republic

Marking label on the large taximeter



What does it mean?

Since 2004 in the European Union:

- All new type of the taximeter shall meet the requirements of MID, i.e. all shall be approved by **notified body**,
- If the type of taximeter is approved in one EU country according to MID then this certification is valid in **all EU countries**.

Note: It is a pity that the same situation does not apply to police speedometers which are not covered by MID !!!!

DEFINITIONS according MID Annex MI-007

Taximeter

A device that works together with a **signal generator** to make a measuring instrument.

This device measures **duration**, calculates **distance** on the basis of a signal delivered by the **distance signal generator**.

Additionally, it calculates and displays the **fare to be paid** for a trip on the basis of the calculated distance and/or the measured duration of the trip.

What is a distance signal generator ?

It is a transducer which output number of impulses is proportional to the trip length – usually it is connected to the gear box of the taxi engine. Now in the modern taxi cars the information about trip length is taken from CAN bus.

Fare

The total amount of money due for a trip based on a **fixed initial hire fee** and/or the **length** and/or the **duration** of the trip. The fare does not include a supplement charged for extra services.

Cross-over speed

The speed value found by **division** of a **time tariff value** by a **distance tariff value**.

Normal calculation mode S (single application of tariff)

Fare calculation based on application of the **time tariff below** the **cross-over speed** and application of the **distance tariff above** the cross-over speed.

Normal calculation mode D (double application of tariff)

Fare calculation based on **simultaneous application** of time tariff and distance tariff over the whole trip.

Operating position

The different modes in which a taximeter fulfils the different parts of its functioning. The operating positions are distinguished by the following indications:

‘For Hire’: The operating position in which the fare calculation is disabled

‘Hired’: The operating position in which the fare calculation takes place on the basis of a possible initial charge and a tariff for distance travelled and/or time of the trip

‘Stopped’: The operating position in which the fare due for the trip is indicated and at least the fare calculation based on time is disabled.

MAXIMUM PERMISSIBLE ERRORS (MPEs)

The MPE, excluding any errors due to application of the taximeter in a taxi, are:

- For the time elapsed: $\pm 0,1 \%$
minimum value of mpe: 0,2s;
- For the distance travelled: $\pm 0,2 \%$
minimum value of mpe: 4 m;
- For the calculation of the fare: $\pm 0,1 \%$
minimum, including rounding: corresponding to the least significant digit of the fare indication.

For the purpose of testing, the taximeter shall be equipped with the possibility to **test separately** the accuracy of time and distance measurement and the accuracy of the calculation, i.e. each taximeter shall have the **test connector**



CONFORMITY ASSESSMENT

Conformity assessment of a taxameter with the relevant essential requirements in *ANNEX MI-007* shall be allways carried out by **notified body** and by the application, listed in *ANNEX B TYPE EXAMINATION*.

TYPE EXAMINATION

‘Type examination’ is the part of a conformity assessment procedure whereby a notified body examines the technical design of a measuring instrument and ensures and declares that the technical design meets the appropriate requirements of MID.

Notification – Notified body (MID Articles 11 and 12)

Notified body are designated to carry out the tasks pertaining to the conformity assessment modules. The body, its director and staff involved in conformity assessment tasks shall:

- not be the designer, manufacturer, supplier, installer or user of the measuring instruments,
- be free from all pressures and inducements, in particular financial inducements, that might influence their judgement or the results of their conformity assessment,
- shall have at its disposal the necessary staff and shall have access to the necessary facilities for carrying out in a proper manner the technical and administrative tasks entailed in conformity assessment.

Other documents relating to taximeters

- International Recommendation **OIML R21** (Edition 2007)
„Taximeters - Metrological and technical requirements, test procedures and test report format“.
- Guide **WELMEC 8.17** (2008) Issue 1
„Measuring Instruments Directive 2004/22/EC Taximeters Corresponding Tables OIML R21 – MID-007 II“
- Guide **WELMEC 7.2** (2012) Issue 5
„Software Guide MID 2004/22/EC“
- International Document **OIML D 11** (2004)
„General requirements for electronic measuring instruments“

OIML R21 (Edition 2007) Taximeters

„Metrological and technical requirements, test procedures and test report format“.

Very important document which specifies the metrological and technical requirements and test procedures for taximeters that are subject to national metrological control.

This document can be also used in conformity assessment according MID.

It is intended to provide standardized requirements and testing procedures to evaluate the metrological and technical characteristics in a uniform and traceable way.

This document is however not in a stage where it could be used as a normative document

WELMEC 8.17 (2008)

„Measuring Instruments Directive 2004/22/EC Taximeters
Corresponding Tables OIML R21 – MID-007 II“

This document compares the content and the requirements of MID
and OIML R21.

As follows from the Cross Reference Tables MID 2004/22/EC versus
OIML R 21, recommendation R 21 in most cases fully covers the
requirements of MID.

OIML R 21 is however not in a stage where it could be used as a
normative document.

WELMEC 7.2 (2012) Issue 5

„Software Guide Measuring Instruments Directive 2004/22/EC“

The Guide is oriented mainly on instruments included in the regulations of the MID and serves to assessment of Software in software-equipped measuring instruments including taxameters.

All notified bodies accept this Guide as a compliant interpretation of the MID with respect to software.

OIML D 11 (2004)

General requirements for electronic measuring instruments

This International Document specifies the general metrological requirements applicable to measuring instruments and describes tests for verifying the compliance of an instrument with these requirements.

The test procedures of the most common performance tests are specified: electrical (EMC) and environmental.

Conformity assessment procedures of taximeters

1. Assessment of technical documentation conformity and visual inspection of the taximeter
2. Metrological examination under reference conditions in the laboratory
3. EMC and enviromental tests in accredited test labs under supervision of notified body

Assessment of technical documentation conformity and visual inspection of the taximeter

This inspection shall be carried out by comparing the manufacturer's specified characteristics and documentation of the taximeter with the MID requirements.

The inspection shall include dimensional verifications and control of the marking both on taximeter and its interfaces for auxiliary devices.

Sealing and other protection of the taximeter shall be evaluated for adequate effectiveness against unauthorised adjustments and fraud.

Test procedures for taximeters - Examination for type approval

Test	Characteristic under test	Criterion
Static temperatures (dry heat and cold)	influence	MPE
Damp heat (condensing)	disturbance	sf
Supply voltage variations	influence	MPE
Vibration (random or sinusoidal)	influence	MPE
Immunity to electromagnetic fields	disturbance	MPE
Electrostatic discharge	disturbance	MPE
Electrical transient conduction on voltage supply lines or via lines other than supply lines	disturbance	MPE

Note: MPE = maximum permissible error, sf = significant fault

TEST SEQUENCES

Function test

Dry heat

Function control test, visual inspection

Cold

Function control test, visual inspection

Damp Heat (condensing)

Function control test, visual inspection

Vibration

Function control test, visual inspection

Radiated electromagnetic fields /conducted disturbances

Function control test, visual inspection

Electrostatic discharge

Function control test, visual inspection

Voltage supply variations - slow dips below 9V DC

Function control test, visual inspection

Electrical transient conduction slony supply lines

Function control test, visual inspection

Electrical transient conduction via lines other than supply lines

Function test, visual inspection

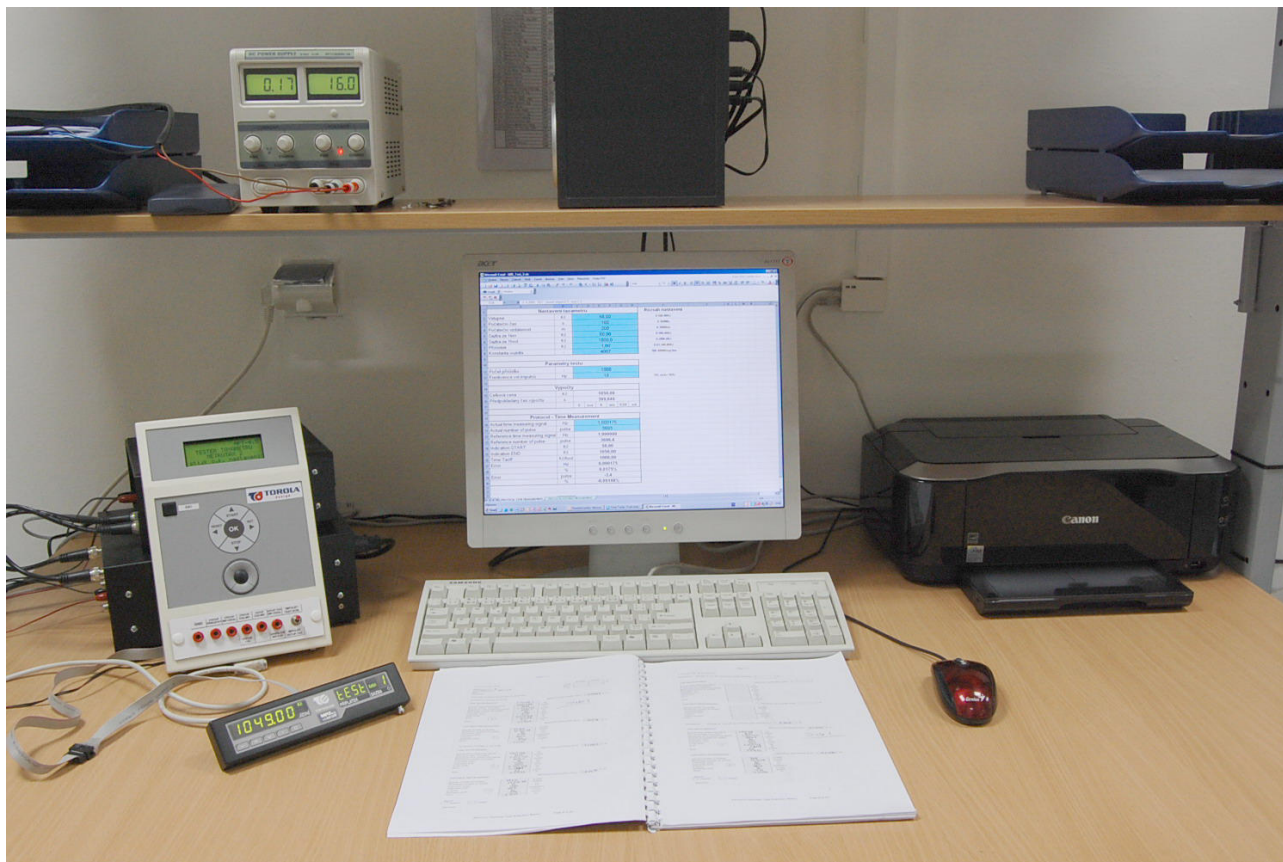
What does it means?

Some tests must be performed in **accredited test labs** under supervision of the **notified body**!

It is not cheap and it takes a long time

Metrological examination under reference conditions in the laboratory

For metrological testing of taxameter is required suitable equipment e.g. generator or simulator.



Manually operated simulator used in CMI



PC controlled simulator used in CMI for automatic calibration of taxameters



Solutions to fulfill point 19 of Annex MI-007

Applicable regulation on taximeters

The MID is applicable for the design and manufacturing of taximeters. The directive includes requirements about the protection of the distance signal. These are the followings:

19. A taximeter and its installation instructions specified by the manufacturer shall be such that, if installed according to the manufacturer's instructions, fraudulent alterations of the measurement signal representing the distance travelled are sufficiently excluded.
20. The general essential requirement dealing with fraudulent use shall be fulfilled in such a way that the interests of the customer, the driver, the driver's employer and the fiscal authorities are protected.

The compliance with these requirements is verified and validated by a notified body during type examination approval. But still the transfer of the measurement signal from generator (=sensor) to taximeter could be fraudulent affected.

Motivation for specific solutions

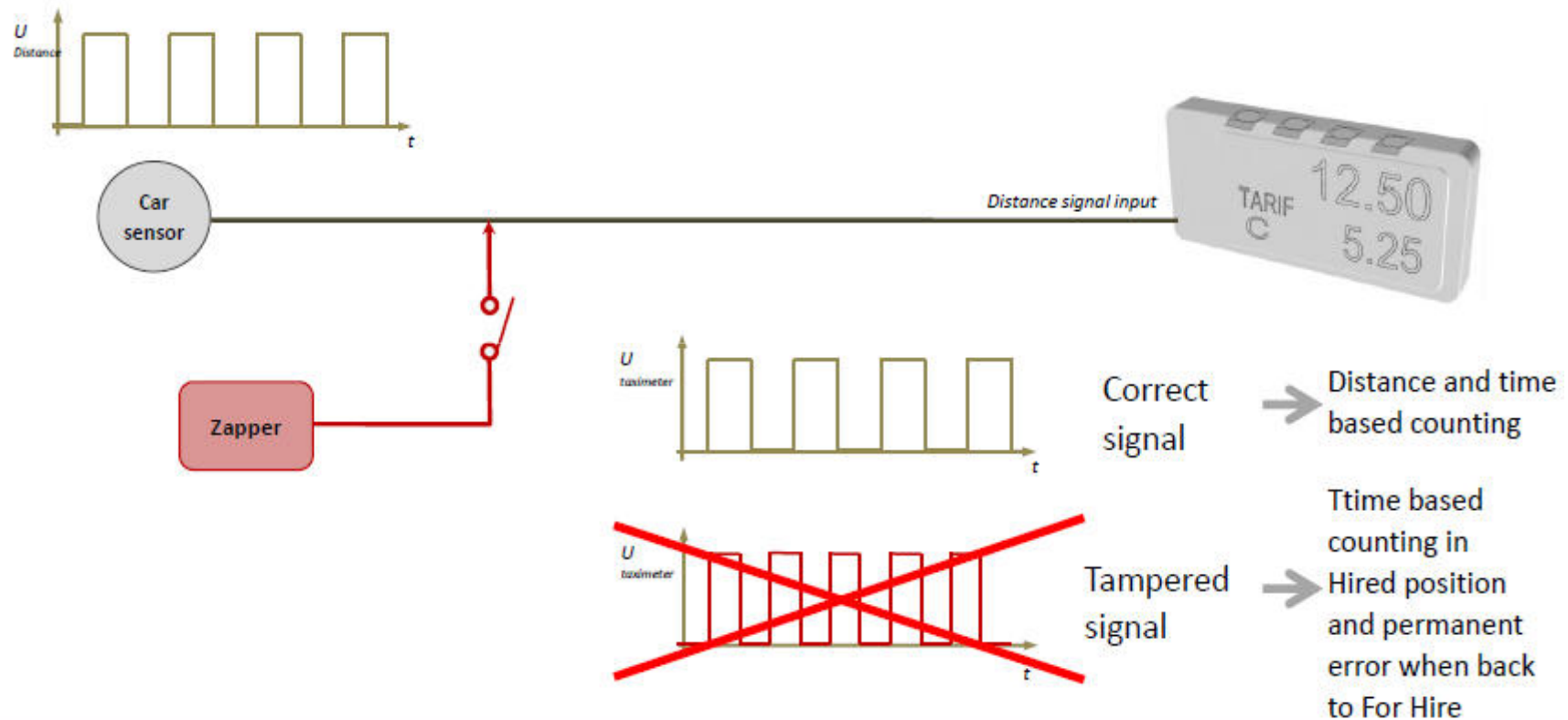
Experience of CMI in type approvals and verification of taximeters makes us state that, since that electronic taximeters had appeared, a non-negligible risk of frauds exists, e.g. it is called TURBO in Czech Republic or zappers in France.

Possible solution

The protection of the measurement signal can be commonly achieved by a solution based on **metallic shielded cables**. But such cables are costly and difficult to install.

ATA from France has developed and implemented solutions with non-shielded cables coupled with an electronic protection system.

The technical solutions used by ATA (1/2)



The technical solutions used by ATA (2/2)

Fraud case 1 : Distance signal disconnected and signal generator zapper



Method of fraud detection:

- electrical characteristics,
- signal stability,
- sensor impedance

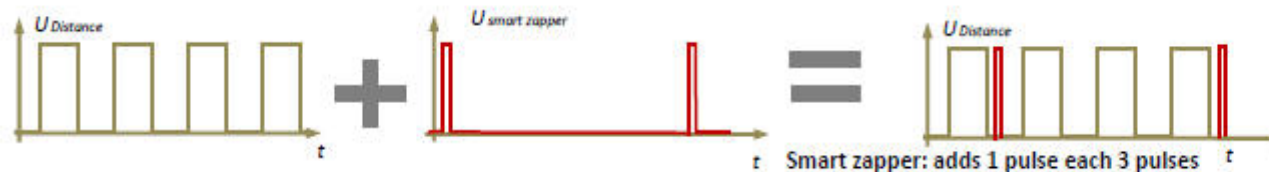
Fraud case 2 : Distance signal tampered by a signal generator zapper



Method of fraud detection:

- voltage levels,
- signal perturbation,
- sensor impedance

Fraud case 3 : Distance signal tampered by a smart zapper

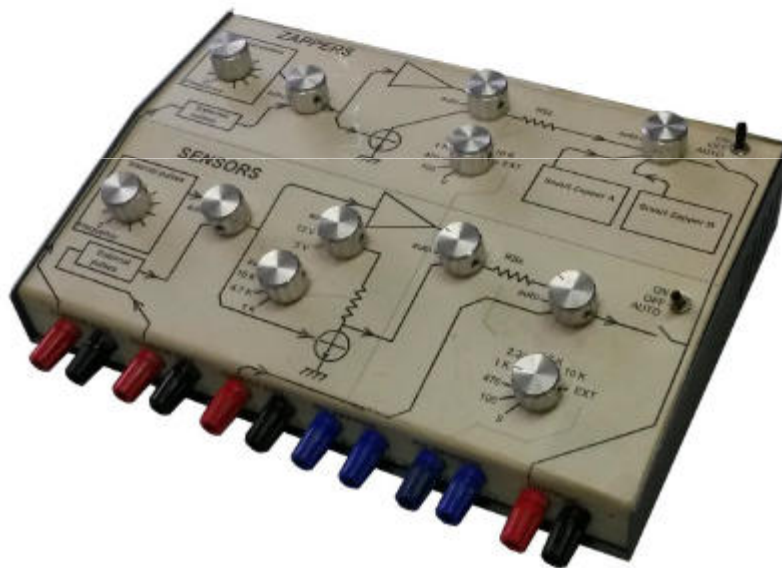


Method of fraud detection:

- abnormal acceleration,
- signal duty ratio,
- sensor impedance

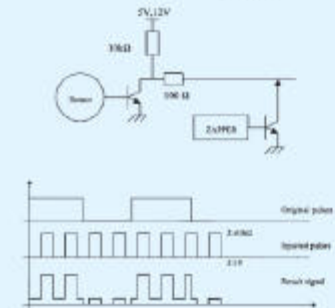
Testability of these solutions (1/2)

Laboratory test case: Distance signal tampered by all possible generators



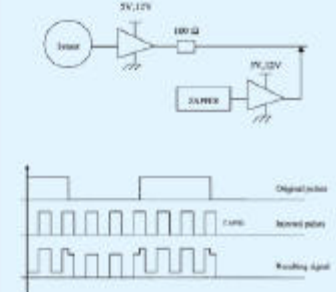
Annex: Examples of sensor line disturbances

HE/OPC sensor versus zipper type 1



- only the high levels of the sensor signal are affected by the zipper;
- the average amplitude is modified; and
- similar phenomena can be observed with sine pulses.

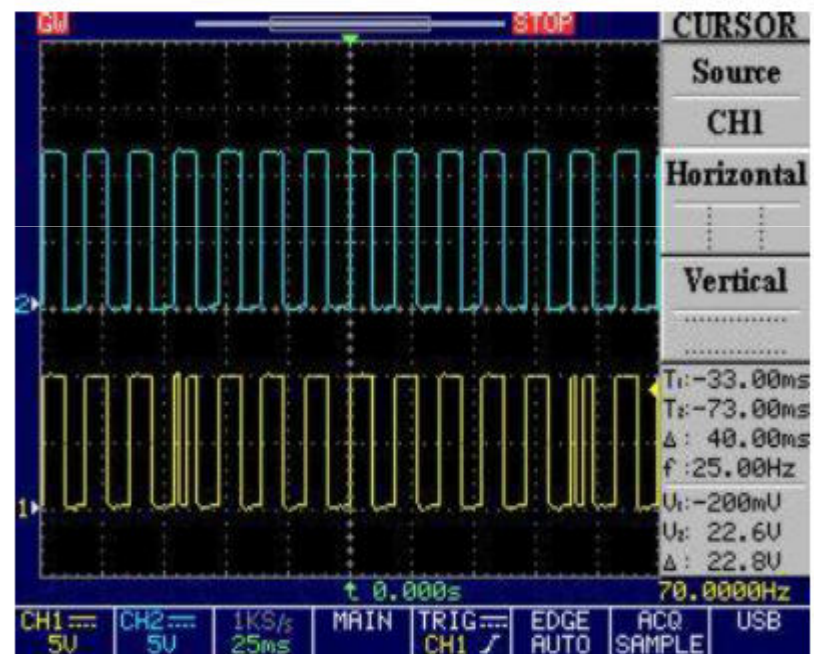
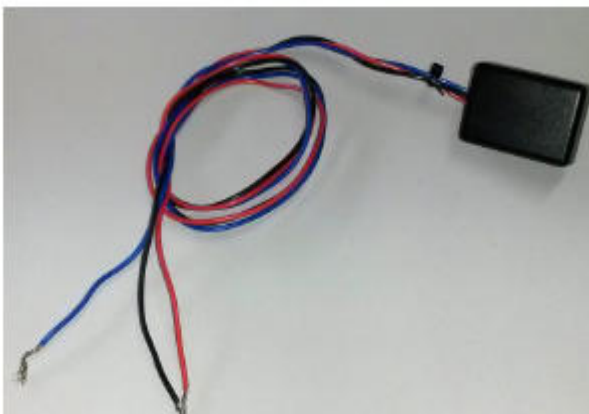
HE/AMP sensor versus zipper type 2 OR 3



- the fraudulent signal is injected through a low impedance. Then the zipper dominates the sensor;
- injection also generates an amplitude modulation; and
- similar phenomena can be observed with sine pulses.

Testability of these solutions (2/2)

Real test case: Distance signal tampered by a smart zapper +10 %



Related topics

- Cross-reference table 2004/22/EC and OIML R21 have limited specifications regarding the requirements on signal protection. It would be useful if more details could be given in these standards.
- Consequently, possible solutions of protection and their validations in type examination depend mainly on the expertise developed by manufacturers and notified bodies.
- An exchange of information about problematic related to manipulations of signal that may be seen in others countries and about others possible solutions to meet the requirement on signal protection would be interesting.

Questions ?

Thanks for your attention



