TCO´99 – Mandatory and recommended requirements for System Units and Graphic Adapters concerning:

- Visual ergonomics (for Graphic Adapters)
- Emissions
- Energy saving
- Electrical safety
- Acoustic noise

Introduction

The TCO'99 labelling scheme also covers CRT-type VDUs, Flat panel VDUs as stand alone units and as parts of Laptop and Notebook computers and Keyboards. Separate reports for these items are already available or will be issued later.

The characteristics included in the TCO'99 scheme originate from TCO´95, ISO, IEC and EN-standards and also from such national specifications as the Swedish MPR 1990:8 (MPRII) and TCO Screen Facts 1991.

References

EN 60 950 (IEC 60 950), Safety of information technology equipment, including electrical business equipment.

ISO 7779, Acoustics – measurement of airborne noise emitted by computer and business equipment.

ISO 9296, Acoustics – declared noise emission values of computer and business equipment.

MPR 1990:8, Test methods for Visual Display Units.

TCO, Screen Facts, 1991.

TCO´95, Third edition, 1996.

Mandatory and recommended requirements

		Mandatory requirement	Recommended requirement
1 Visual ergonomics – for Graphic Adapters			
1.1	Luminance level	X	R
1.2	Luminance contrast	X	R
1.3	Periodic luminance variation	X	R
2 Emissions and energy saving			
2.1	Alternating electric fields	X	-
2.2	Alternating magnetic fields	X	-
2.3	Energy saving	X	R
3 Electrical safety			
3.1	Electrical safety	X	-
4 Acoustic noise			
4.1	Acoustic noise	XM	R

Definitions

X = characteristics required for certification that shall be verified by accredited or other laboratories accepted by TCO

XM are characteristics which can be verified by accredited or other laboratories accepted by TCO or by the suppliers' own test reports or declarations.

R = characteristics that are not required for certification at present, or characteristics that might be required in the future

Requirements for System Units and Graphic Adapters included in System Units

1 Visual ergonomics – for Graphic Adapters

1.1 Luminance level

Definition:	Luminance characterises the physical amount of projected light. Luminance can be defined for a point on a surface of a light source, in a light beam or on a lit surface. For screen and character luminance an average is taken over an area corresponding to one degree.
Reason:	It shall be possible to set a sufficiently high luminance level with respect to the ambient lighting in order to avoid eye strain.
Method:	See test method section.
Mandate:	$\geq$ 100 cd/m^2
Recommendation:	$\geq$ 125 cd/m^2

1.2 Luminance contrast

Definition:	The minimum contrast for a character and its surrounding areas that has a bearing on legibility. Contrast is the relationship between the luminance of the test object and the luminances of adjacent areas.
Reason:	The luminance contrast is important for legibility and for the capability to distinguish one character from another. The electronic performance of a graphic adapter has an important impact on the contrast of visual display units.
Method:	See test method section.
Mandate:	C_m □ 0.5
Recommendation:	C_m □ 0.7

1.3 Periodic luminance variation

Definition:	Time-dependent unintended variations in character or background luminance.
Reason:	Noticeable flickering, i.e. rapid changes in brightness can cause visual tiredness and eye strain, with possible headaches. Flicker may also distract the user.
Applicability:	Flicker is primarily experienced with graphic adapters for CRT-type visual display units which use the principle of repetitive refreshment of the image information. Flicker may also occur with graphic adapters for other types of visual display units where similar sequential exposure is used.
Method:	See test method section.
Mandate:	≥ 85 Hz
Recommendation:	≥ 100 Hz

2 Emissions and energy saving

2.1 Alternating electric fields

Definition: Alternating electric fields arise between objects with different electrical potentials. The strength of the field depends on both distance and on the actual electrical potential involved.

Reason: Some computer users are concerned about the possible danger to health of alternating electric fields in the vicinity of the equipment.

The mandatory requirement is based on the ambition of reducing the alternating electric fields to as low a level as it is technically possible to achieve, so as not to burden the working environment with unnecessary factors. The mandatory requirement shall however not be taken as representing hygienic limit values.

Note: The VDU that is connected to the system unit shall display a screen with positive polarity – See also the test method section.

Screened mains power supply cord may not be used in order to comply with the mandatory requirement. If, however, such a non-detachable cord is supplied with the product it will be used for the test.

Method: See test method section.

Mandate: Band I: 5 Hz to 2 kHz, ≤ 10.0 V/m, measured at 30 cm and at 50 cm in front of the system unit.
Band II: 2 kHz to 400 kHz, ≤ 1.0 V/m, measured at 50 cm around the system unit and at 30 cm in front of it.

Recommendation: –

2.2 Alternating magnetic fields

Definition: System units, like other electrical apparatus, are surrounded by magnetic fields. These magnetic fields are generated by various parts in the equipment, such as power supply units and other internal circuits.

Reason: Some computer users are concerned about the possible danger to health from magnetic fields in the vicinity of the equipment.

The mandatory requirement is based on the ambition of reducing the magnetic fields to as low a level as it is technically possible to achieve, so as not to burden the working environment with unnecessary factors. The mandatory requirement shall however not be taken as representing hygienic limit values.

Note: The VDU that is connected to the system unit shall display a screen with positive polarity – See also the test method section.

Method: See test method section.

Mandate: Band I: 5 Hz to 2 kHz, ≤ 200 nT, measured at 50 cm around the system unit and at 30 cm in front of it.
Band II: 2 kHz to 400 kHz, ≤ 25 nT measured at 50 cm around the system unit.

Recommendation: –

2.3 Energy saving

Definition: The electrical energy consumed by a system unit can be considered as being completely converted into heat energy, that warms up the room in which it is placed. Apart from the conversion in this way of electric energy to heat energy, high power consumption wastes electricity.

Reason: If the additional heat is more than can be handled by the capacity of the normal room ventilation, an undesired increase of room temperature may result. Also, taking into account the general desire to reduce electrical energy consumption, it is important for all electrical equipment, the cooling system included, to consume as little energy as possible.

Method: See test method section.

Mandate: The system unit shall automatically enter an energy saving mode with less than or equal to 30 Watts.

The maximum “wake-up-time” is 5 seconds.

The applicant shall submit an energy declaration showing power consumption in normal use and for the energy saving mode. There shall also be a complete description, from the users’ point of view, of how the system unit is brought into the energy saving mode. This description shall always be available in English.

Recommendation: The mandatory requirements apply but a maximum “wake-up-time” of 3 seconds is required.

3 Electrical safety

3.1 Electrical safety

Definition: Electrical safety concerns the electrical design of apparatus with respect to its electrical insulation and other arrangements that are intended to prevent accidents resulting from contact with live components, and the risk of fire or explosion as a result of electrical flash-over due to inadequate or faulty electrical insulation.

Reason: To prevent personal injury and/or fire.

Application: All system units.

References: EN 60 950 (IEC 60 950). Safety of information technology equipment including business equipment.

Mandate: The system unit shall be certified according to EN 60 950 (IEC 60 950).

4 Acoustic noise

4.1 Acoustic noise

Definition: A measure of the total amount of sound power emitted by a machine (sound source) when it is operating. The A-weighted sound power level for a sound source is given in bels, B (1 B = 10 dB). The reference sound power is 1 pW.

A measure of the total amount of sound emitted by a machine (sound source) when it is operating. The A-weighted sound pressure level for a sound source is given in decibels, dB. The reference sound pressure is 20 μPa.

Reason: Noise from fans, hard disks etc. can be annoying. To prevent such annoyance, the aim is to have as little unintentional sound generation as possible from system units and personal computers where they are used.

References: ISO 7779, Acoustics - Measurement of airborne noise emitted by computer and business equipment and ISO 9296, Acoustics - Declared noise emission values of computer and business equipment.

Method:

See ISO 7779 and ISO 9296. The measurements shall be performed according to ISO 7779 with the addition that sound power measurements only have to be performed in six microphone positions. The measurements can also be performed according to another standardized method with equal or higher precision.

Mandate:

Sound pressure level

The declared A-weighted sound pressure level at the operator position shall be reported for the following modes of operation:

Idling and operating with, respectively: hard disk, diskette drive, CD drive, DVD drive etc. (if applicable).

It should also be reported if the equipment emits broad band noise or if there are any significant discrete frequency components. If so, these frequencies shall be reported.

Sound power level

The declared A-weighted sound power level in bel (1 B = 10 dB) shall be reported and shall not exceed:

	Operating*	Idling*
Unit with fan	5.5	4.8

* with the component in operation which gives the highest sound pressure level at the operator position.

Additional information:

For the sound pressure level measurements the sound source shall be placed on top of a standard test table according to ISO 7779, with the exception of large floor standing tower models intended to be placed under the table.

The sound pressure level obtained in practice will depend on the conditions of the room and the location of the sound source.

Recommendation:

It is recommended that the declared A-weighted sound power level in bel does not exceed:

	Operating*	Idling*
Unit with fan	5.5	4.8

* See text above.

Test methods for System Units and Graphic Adapters

General test conditions for visual ergonomics

See relevant parts in the TCO´99 Report for CRT-type VDUs.

The testing of the Graphic Adapter shall be made with a VDU that complies with TCO´99 connected.

1 Visual ergonomics – for Graphic Adapter

1.1 Luminance level

Method:

The brightness and contrast controls of the VDU that is connected to the Graphic Adapter are set to maximum.

Test image for maximum luminance

An image with an image loading of 80 ± 5 % (80 % white/20 % black) shall be used when measuring the maximum luminance of the VDU. In the centre of the screen a white area, 4 by 4 cm, is created. The maximum luminance is measured in the centre of this white area.

Test luminance setting

Using the same image as described for maximum luminance, the brightness control is first used to reduce the luminance to the test luminance level of 100 cd/m^2. If necessary, the contrast control may in addition be used to achieve 100 cd/m^2.

These brightness and contrast settings shall be used for all the remaining visual ergonomic testing.

Uncertainty: ≤ ± 10 % of the measured luminance.

1.2 Luminance contrast

Method:

The image details that are to be seen as separated shall be used to measure luminance contrast. Two characters shall be used and each shall be measured in the centre of the VDU screen.

The characters (Arial 12 points is recommended) are the lower case “e” (for contrast between vertically adjacent character features) and “m” (for contrast between horizontally adjacent character features).

The contrast is determined in both horizontal and vertical directions. The most unfavourable value is reported. The integration in the scanning direction shall be made over a distance corresponding to one minute of arc (= 0.15 mm at a viewing distance of 500 mm).

The relationship between the higher (L_{max}) and lower (L_{min}) luminances that define the test pattern to be detected, expressed as contrast modulation defined as

$$C_m = \frac{(L_{max} - L_{min})}{(L_{max} + L_{min})}$$

Measurements shall be performed for the resolutions that are requested by the client (minimum 85 Hz vertical frequency is required for compliance).

Uncertainty: $\leq \pm$ 10 % of the measured luminance.

1.3 Periodic luminance variation

Method:

The horizontal frequency must be $\geq$ 85 Hz.

General test conditions for emissions

For the test methods for emissions described in this document the following conditions apply:

The test results are valid only for the presentation form(s) and configuration(s) tested.

1 Extra measurement distances for TCO'99 emission characteristics

In order to comply with the mandates, additional measurements must be made for alternating electric fields and magnetic fields in front of the system unit at 30 cm distance. This is not required for magnetic fields in band II.

2 Conditions and set up for the test object

- The tests shall be performed with a TCO´99 compliant CRT-type VDU connected to the system unit.
- When the system unit is connected via a detachable cable the measurement shall be performed with a non-shielded grounded cable of normal type.
- The supply voltage and frequency used during the test shall be stated in the test report.
- The VDU control settings shall be the same as for visual ergonomics. This means that 100 cd/m^2 at an image loading of 80 $\pm$ 5 % (80 % white and 20 % black) shall be used for the emission testing of alternating electric and magnetic fields.
- Positive polarity shall be used, meaning dark or black characters on a white background.
- The mode(s) (i. e. horizontal and vertical scan frequency and resolution) used during the test shall be stated in the test report.

3 Positioning of the VDU that is connected to the system unit

- The VDU shall be positioned so far away from the system unit that it does not influence the test results.

2 Emissions and energy saving

2.1 Alternating electric field

Method:

The true RMS-value of the amplitude of the electric field strength, at the surface of the measuring probe, is measured in front of the test object in band I and in four azimuths in band II. The frequency ranges are selected by means of filters in the measuring equipment.

The system unit shall be positioned such that the bottom plane is parallel to the horizontal plane. The largest horizontal distance between the front and the back of the system unit is called L. The origin of the co-ordinate system is chosen to be situated at a distance L/2 behind the front of the system (see figure below). An angle (ϑ) is positive in the counter-clockwise direction. Measurements shall be made at all points with co-ordinates according to:

A = L/2 + 50 (In the front also L/2+30 cm)
ϑ = 0 for band I
ϑ = 0, 90, 180 and 270 for band II

Distances are given in centimetres and angles in degrees. The co-ordinates are given for the centre of the measuring probe. The surface of the probe shall be perpendicular, within ± 5 degrees, to the horizontal plane.

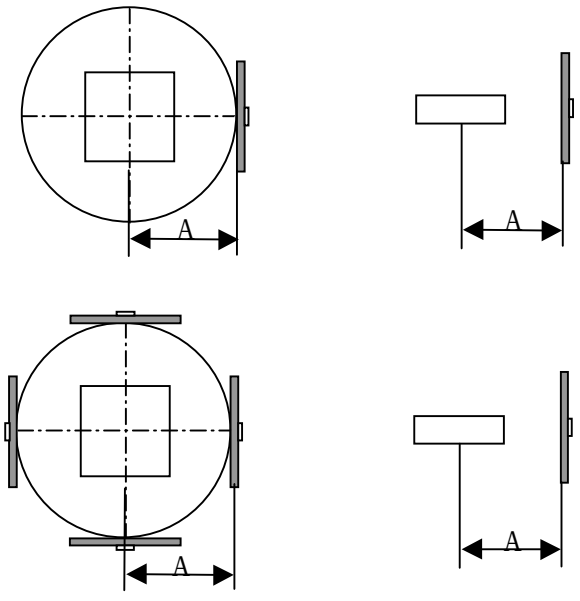

Figure: Measurement geometry for band I (top) and band II (bottom). A is the measurement distance 50 cm. In front of the test sample the testing must be made also at 30 cm distance.

The system unit under test and the measuring probe shall be positioned at least 1 m from all significant metallic structures and objects.

Additional units and connecting cables necessary for the operation of the system unit, but which are not part of the test, shall be placed so far away from the measuring set-up that the fields they emit do not influence the measurement. Shielding may be added to these units and cables, as long as the 1 m clearance is maintained.

The measuring probe shall be connected to ground.

The VDU that is connected to the system unit shall display a full screen of capital “H” pattern in dark/black letters on a white background.

For VDU luminance settings – see General test conditions for emission.

Background electric field strengths in the test laboratory, including disturbances transmitted by power lines and internally generated noise in the measuring system, shall together not exceed 2.0 V/m in band I and 0.20 V/m in band II.

The mains voltage of the system unit under test shall be within $\pm$ 3 % of its nominal value. The nominal value of the main voltage used shall be specified in the test report.

The power cable of the test object shall be connected to the phase and the neutral conductors of the mains power supply. If the mains power supply plug permits an interchange of the live and neutral conductors, measurements shall be taken with the connection that gives the highest reading in band I.

The system unit under test shall be connected to the mains power supply via a cable that shall be laid horizontally 10 cm out from the test object, measured from the rear surface, and then vertically downwards for at least 1 m.

Equipment:

The alternating electrical field emission from the system unit under test shall be determined by measuring the displacement current passing a given surface of the measuring probe. The probe consists of a disc of double sided printed circuit board laminate with a diameter of 300 mm. On the front of the board the copper layer is removed in the annulus between radii 50 and 52 mm, see figure below. The copper foil surrounded by the annulus is the active measuring surface. It is connected to one input terminal of an operational amplifier, with capacitive feedback. The other input terminal of the operational amplifier, the copper ring outside the active surface, and the back of the board is connected to ground. The output voltage (U) from the probe (active surface with area (A)) is related to the incident electrical field, E, averaged over the active surface according to $U = \varepsilon \cdot E \cdot A/C$ where C is the capacitance in the feedback loop of the operational amplifier and ε is the permittivity for a vacuum.

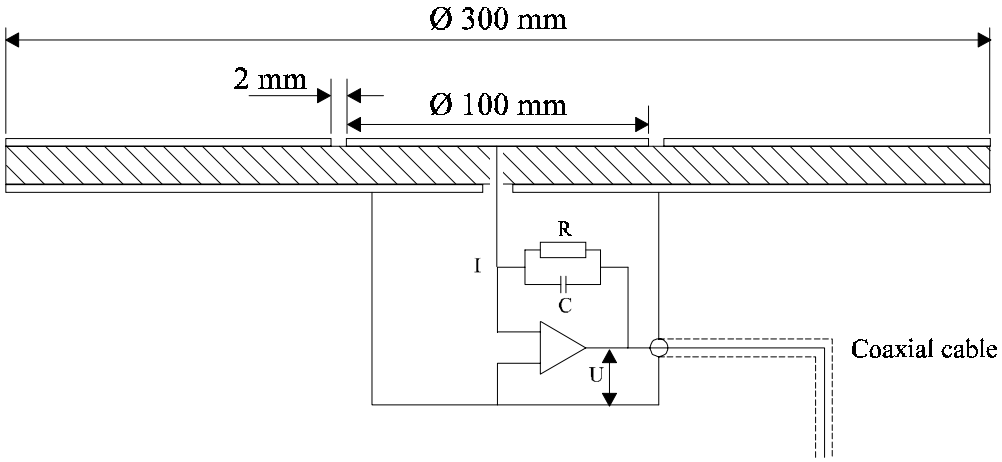

Figure: Sketch and circuit principle of the measuring probe for alternating electrical field measurements. The feedback circuit of the operational amplifier is a capacitance C in parallel with a high value resistor R to ensure that there is no DC voltage across the plates of the capacitor C.

The specifications for the frequency response of the measuring probe are given by the calibration procedure. The signals from the probe shall be filtered by high-pass and low-pass filters. The specification of the filters is given in Table A.

Table A. Filter specifications

Frequency band I

Frequency	< 5 Hz	5 Hz	100 Hz	2 kHz	> 2 kHz
Attenuation	> 80 dB/decade	3 dB	0 dB	3 dB	> 40 dB/decade

Frequency band II

Frequency	< 2 kHz	2 kHz	30 kHz	400	> 400 kHz
Attenuation	> 80 dB/decade	3 dB	0 dB	3 dB	> 40 dB/decade

After amplification and filtering the output voltage of the measuring probe shall be used to determine the RMS-value of the electric field strength in both frequency bands.

The measuring time shall be sufficiently long to enable measurements with an accuracy of ± 5 % at 50/60 Hz.

The measuring system shall be capable of measuring 2.0 V/m in band I and 0.20 V/m in band II.

The measuring probe shall be calibrated using a parallel plate capacitor (air dielectric) consisting of the measuring probe and a metal plate of at least 300 mm diameter. The distance between the surface of the probe and the plate shall not exceed 30 mm.

The calibration shall be performed with sinusoidal fields at the amplitudes and frequencies specified in Table B.

Table B Calibration frequencies and amplitudes

	Frequencies	Amplitudes
Band I	50, 100, 500, 1000 Hz	25, 250 V/m
Band II	15, 30, 60, 120 kHz	2.5, 10, 25 V/m

Recorded values at these calibration points shall be within ± 5% of the nominal value. Due to the nature of the specified filters the deviation shall be calculated at 1 kHz from 22.5 and 225 V/m and at 120 kHz from 2.4, 9.5 and 24 V/m

Results:

Results shall be presented as RMS-values of the alternating electric field expressed in volts per meter (V/m). For band I, results shall be presented as the measured values at 30 cm and 50 cm for normal operation. For band II, the measured values in front of the system unit and the maximum value at rotation shall be presented for normal operation.

If the measured values are less than 10.0 V/m in band I or less than 1.0 V/m in band II the result shall be reported as "≤ 10.0 V/m" or "≤ 1.0 V/m", respectively.

Measurement uncertainty:

The test shall be performed in such a way that the total uncertainty in the test result will be better than ± (10 % of reading + 1. 5 V/m) for band I and ± (10 % of reading + 0. 1 V/m) for band II.

2.2 Alternating magnetic fields

Method:

Test laboratory
Background magnetic fields in the test laboratory, including disturbances transmitted along the power line and internally generated noise in the measuring system, shall together not exceed 40 nT in band I and 5 nT in band II.

The true RMS value of the amplitude of the magnetic flux density vector is measured at 48 points on a cylindrical surface around the test object in the two frequency ranges, band I and band II. The frequency ranges are selected by specified filters in the measuring equipment.

The measuring geometry is illustrated in figure below and the measurement points are mathematically defined in the following way.

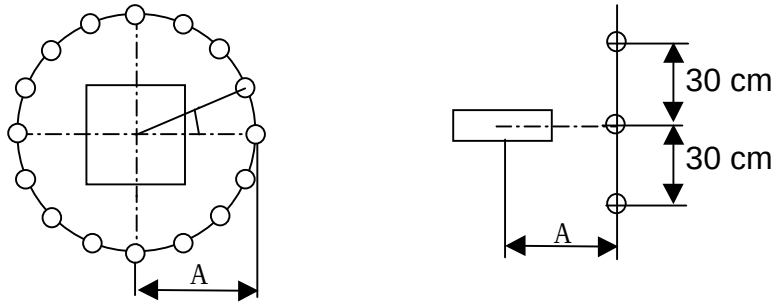

Figure: Measurement geometry for the test object.

The system unit shall be positioned such that the bottom plane is parallel to the horizontal plane. The largest horizontal distance between the front and the back of the system unit is called L. The origin of the cylindrical co-ordinate system is chosen to be situated at a distance L/2 behind the front of the system (see figure below). An angle (ϑ) is positive in the counter-clockwise direction. Measurements shall be made at all points with co-ordinates according to:

The z-axis is to be at right angles to the horizontal plane. An angle (ϑ) is positive in the counter-clockwise direction. Measurements shall be made at all points which have a minimum clearance of 25 cm to the outer surface of the system unit and with co-ordinates according to:

z = - 30 cm, z = 0 and z = + 30 cm
A = L/2 + 50 cm (In the front also L/2 + 30 cm)
ϑ = p • 22.5 where p represents all integers in the range $0 \leq p \leq 15$.

Distances are given in centimetres and angles in degrees.

The measuring coils shall be stationary during the measurements.

The VDU that is connected to the system unit shall display a full screen of capital “H” pattern in dark/black letters on a white background.

For VDU luminance settings – see General test conditions for emission.

The power cable of the test object shall be connected to the phase and the neutral conductors of the mains power supply. If the mains power supply plug permits an interchange of the live and neutral conductors, measurements shall be taken with that connection which gives the highest reading in band I.

Equipment:

The magnetic field shall be measured with two coil systems, one covering band I and the other band II. Each coil system shall consist of three mutually perpendicular concentric circular coils each with an area of 0.01 m^2. The coils may depart from a circular shape where they intersect. The minimum inner diameter shall be 110 mm and the maximum outer diameter 116 mm. The measuring coils shall not be sensitive to electric fields.

The resonance frequency of each coil appropriately connected to cables and amplifiers shall be greater than 12 kHz for band I and greater than 2.5 MHz for band II. The resonances shall be suppressed by resistive loading of each coil.

Amplifiers and integrating networks to make the output voltage proportional to the magnetic flux density and independent of frequency shall follow each coil. The specifications in respect of the frequency response are given in the calibration procedure.

High-pass and low-pass filters shall filter the signals from the coil systems. The specifications of the filters are given in Table A.

Table A. Filter specifications

Frequency band I

Frequency	< 5 Hz	5 Hz	100 Hz	2 kHz	> 2 kHz
Attenuation	> 80 dB/decade	3 dB	0 dB	3 dB	> 40 dB/decade

Frequency band II

Frequency	< 2 kHz	2 kHz	30 kHz	400	> 400 kHz
Attenuation	> 80 dB/decade	3 dB	0 dB	3 dB	> 40 dB/decade

After amplification, integration and filtering, the signals from the three coils in each coil set shall be used as input values for calculating the RMS-values of the amplitudes of the magnetic flux density vectors in both frequency bands. It is permissible to calculate the RMS-value for each of the coil signals and use the root of the squared sum of those RMS-values as the test result.

The measuring time shall be sufficiently long to enable measurement with an accuracy of $\pm$ 5 % at 50/60 Hz.

The measuring system shall be capable of measuring 40 nT in band I and 5.0 nT in band II.

The measuring system shall be calibrated using a Helmholtz-type calibration coil as shown in the figure on the next page. Calibration shall be performed with sinusoidal fields at the amplitudes and frequencies specified in Table B.

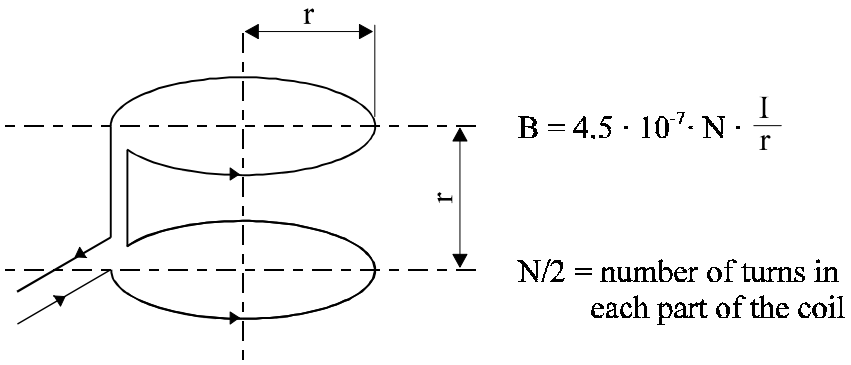

Figure: Calibration set-up.

Table B Calibration frequencies and amplitudes

	Frequencies	**Amplitudes**
Band I	60, 100, 500, 1000 Hz	200, 2000 nT
Band II	15, 30, 60, 120 kHz	25, 250 nT

Recorded values for these calibrations shall not deviate more than ± 5 % from the nominal value. Due to the nature of the specified filters the deviation at 1 kHz shall be calculated from 180 nT and 1800 nT and at 120 kHz from 24 nT and 240 nT.

The calibration shall be performed for each of the three individual coils separately exposed, and for one situation where approximately the same flux density passes through all three coils.

Results:

Results shall be presented as RMS-values of the magnetic flux density expressed in nanotesla (nT) for the two frequency bands. The values in front of the system unit and the maximum value and its position shall be given for normal operation. If measured values are less than 200 nT in band I or less than 10.0 nT in band II the result shall be reported as "≤ 200 nT" and "≤ 10.0 nT" respectively.

Measurement uncertainty:

The test shall be performed in such a way that the total uncertainty in the test result will be better than ± (10 % of reading + 30 nT) for band I and ± (10 % of reading + 1.5 nT) for band II.

Note: The uncertainties given are worst case limits. In many cases it will be possible to obtain better accuracy, especially in band II.

2.3 Energy saving

Energy saving mode

The system unit shall enter the energy saving mode after an adjustable time interval following the last use of the keyboard, a mouse operation or a message received. Readable screen shall occur not more than 5 seconds from the moment when the keyboard or mouse is touched again or when a message comes to the computer.

It is recommended to allow at least 5 minutes to elapse before the recovery time is tested.

Energy declaration

The energy declaration shall specify the power consumption under the following conditions:

- Normal operation (maximum)
- Energy saving mode

The energy declaration shall also include an instruction to the user to switch off the system unit when leaving it for long periods.

Special testing conditions for energy saving

- Line impedance	≤ 0.25 ohm
- Total harmonic distortion (voltage)	≤ 5 %
- AC mains voltage *1	230 VAC RMS tolerance ≤ 1 %
- AC mains frequency *1	50 Hz tolerance ≤ 2 %

*1 – or other voltage and frequency combination specified by the client.

3 Electrical safety

3.1 Electrical safety

Method: The certification shall be made by a recognised testing laboratory within the CB scheme.

4 Acoustic noise

4.1 Acoustic noise

Method: See the standards mentioned on page 8-9.

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