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ELECTROMAGNETIC COMPATIBILITY - THE REQUIREMENTS OF IEC 1672

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1. INTRODUCTION

IEC 1672 will be the first International Standard for Sound Level Meters to include a full set of requirements and tests for Electromagnetic Compatibility. Although mindful of the European Union's Directive 89/336/EEC which came into force on the 1st January 1996, the requirements are not identical to those presently tested to affix the CE mark to products intended for sale in Europe, but are specifically designed to obtain a defined level of confidence in the ability of all sound level meters to meet a common baseline of Electromagnetic Compatibility anywhere in the world. The current absence of any Product Standard for Electromagnetic Compatibility for sound level meters world-wide is being addressed by the addition of Addenda to the existing IEC 651 (1) and IEC 804 (2) standards for sound level meters and integrating-averaging sound level meters respectively, and the requirements contained therein have formed the basis of the tests now included in IEC 1672.

By making product-specific requirements for sound level meters in the new Standard, it becomes mandatory for all manufacturers to test at least to the level defined therein, and will establish for the first time a baseline by which meters from different sources can be compared. Provision is made for manufacturers wishing to extend the testing to more demanding levels than are insisted upon in the Standard, but these claims will be verified when the instrument is submitted for a Conformance test, sometimes referred to as a pattern evaluation test.

The requirements apply equally to all types of sound level meter, although the magnitude of the effects permitted are generally larger for class 2 meters. Full testing is required if an instrument is submitted for Conformance testing, but is not included as part of the periodic tests as it was considered that the design is responsible for the Electromagnetic performance, and this would not have altered since the Conformance test was completed.

2. WHY THE NEED FOR ELECTROMAGNETIC COMPATIBILITY?

The effects of electromagnetic radiation can be almost anything. Devices that emit large radio frequency (RF) fields can disturb other more sensitive equipment operating nearby, often with no immediately obvious effects. The most telling source of RF today is rapidly becoming the mobile telephone. By their very nature, they must emit RF, so operating a telephone in a steady sound field with a sound level meter just 0.5m away from the phone's aerial (about the distance of a phone in use while the user is also holding a sound level meter) can be an interesting test. If the sound level meter is susceptible (i.e. not immune to

the RF), readings could easily change ±10 to 20 dB. By adding a preamplifier extension cable to the sound level meter, these numbers might reach ±30 or 40 dB.

Conversely, with today's powerful data logging, real-time frequency-analysing sound level meters, the likelihood of them interfering with other sensitive logging and measuring equipment being used nearby has also increased tremendously. The one aspect of Electromagnetic Compatibility that has usually been taken seriously in the past is electrostatic discharge. Few instruments experience problems in this area because these effects were usually obvious to the user and would cause complaints to the manufacturers if observed. With these problems and requirements in mind, the need to define the performance of a sound level meter in known electromagnetic environments seems essential. This Standard now defines the minimum performance expected.

3. THE APPROACH TO ELECTROMAGNETIC COMPATIBILITY IN IEC 1672

The sound level meter comes in many different forms and guises. In an attempt to cover this wide variety with as few variations in testing as possible, it was decided to define three groups that the product could fit into, and then to make the tests hierarchical. Section 5.1.2 of the Standard defines these groups, which can be summarised as:-

Group X	battery operated complete meters.
Group Y	mains operated complete meters.
Group Z	meters that require two or more items connected together, mains or battery powered, to form a complete meter.

The testing required starts with the tests for Group X, and then adds additional tests for Groups Y and Z.

3.1 Requirements

These fall into three categories. Those for emissions from the meter are defined in section 5.19. The requirements are the same as the EU Generic standard EN 50081 (3), as these levels seem to be gaining wide acceptance as reasonable expectations from most equipment. There seems no case for specifying higher emissions, but equally no case for insisting on lower levels. Manufacturers therefore have a common test for compliance with IEC 1672 and CE marking for Europe.

The same applies to electrostatic discharge requirements in section 6.5. These are the same as the EU Generic Standard EN 50082 (4), and derive the same commonality benefits.

The requirements for a.c.power-frequency and radio-frequency fields form the third part of the electromagnetic compatibility requirements and are found in section 6.6. These are peculiar to the product being tested and it has been the lack of any specific Standards in

this area that has made the testing for CE marking in Europe so variable. Here the requirements of the new Standard have been developed from those in the proposed Addenda to IEC's 651 and 804 mentioned in the Introduction. Because the presence of RF fields is usually unknown to the person measuring with the sound level meter, it was felt that the level of RF fields specified should be higher than those required for CE marking, (although these are under consideration to be increased) and the range of RF frequencies covered should be wider.

The field strength of the RF field has caused much debate within many Committees. In the USA, ANSI started from their own Standard which defines the maximum supposed safe level of RF fields for exposure to humans (63 V/m) and wanted to use this as the test level for all instruments, from the standpoint that if a human can hold the meter and be legally exposed to this level, then the meter should be able to withstand the same field. This is a very high field strength and very few laboratories could test at anything like this magnitude at all frequencies expected. Because of the largely unknown effects of RF fields on equipment, the EU adopted a more cautious approach and started with 3 V/m.

It is now recognised that this level is often too low for testing equipment likely to be near RF fields such as mobile telephones, and with the knowledge gained from many test houses engaged in the testing of products for CE compliance, has started reviewing their requirements.

IEC 1672 requires a field strength of 10 V/m, which also looks likely to become a level favoured by the EU. At present, these requirements exceed those for the EU, but are practical for most manufacturers and test authorities to generate to verify compliance with this Standard. They also match a grade of Compliance with the revised draft of the ANSI standard. In the fullness of time, it could be that the proposed tests here would also ensure direct compliance with all EU and ANSI standards without the need for different testing. It is believed that, when published, IEC 1672 would be considered a Product Standard by the EU and as such will take precedence over the existing generic EU requirements. Any manufacturer requiring CE marking would therefore have to have the product tested according to the requirements of IEC 1672 first and pass. It is unclear whether tests at the existing lower field strengths would also have to be carried out using similar conditions, in order to correctly affix the CE mark.

4. REQUIREMENTS AND TESTS FOR EMISSIONS FROM THE METER

These requirements are specified in section 5.19 and the tests in section A 6.13. All sound level meters are required to emit not more than 30 dB (re 1 μV/m) at a distance of 10 m from 30 to 230 MHz, and not more than 37 dB above 230 MHz up to 1 GHz. The Instruction Manual is required to state the operating mode or modes in which the instrument produces the greatest emissions of RF energy (section 9.3.12).

For meters in Groups Y or Z powered from the mains, additional tests are required to check on the level of interference generated by the sound level meter that is present on the mains supply cable. Some complex limits on this are found in table 5.

Testing of the meter uses a specific type of RF receiver defined in section A.6.13.1. The layout and orientation of the meter can effect the emissions measured, so definitions of methods for positioning the meter and the cables are included in A 6.13.3. This involves attempting to keep all cables within 250mm of the meter, whilst not reducing the emissions measured by the receiving apparatus. The tests are required to be performed in the reference orientation defined in section 3.41, (and which must be stated in the handbook as required by section 9.3.11), and in two other planes, approximately orthogonal to the reference orientation. Any cables which could be connected to the meter are to be included when testing, and left unterminated unless forming part of a sound level meter system. If several cables may be used, the Instruction Manual is required to state (section 9.3.12) which configuration is likely to produce the greatest emissions. The organisation performing Conformance testing should attempt to verify that the claims in the handbook are correct and may test any other configuration at their discretion.

The tests on disturbances on the mains supply cable have already been well defined for other types of equipment and need no special features for sound level meters.

5. REQUIREMENTS AND TESTS FOR ELECTROSTATIC DISCHARGES

These requirements are specified in section 6.5 and the tests in A 7.6. They require a sound level meter to withstand discharges of ±4 kVolts in direct contact with any part of the meter, and up to ±8 kVolts with an air discharge. No degradation in performance or loss of functionality is permitted unless this is specified in the Instruction Manual (section 9.2.46), and this is not allowed to include reduced operational capability, change of operating state, change of configuration and corruption or loss of any stored data.

Testing is performed using standard equipment specified in A 7.6.1. Any cables that may be connected to the meter other than those necessary for a Group Z meter are not allowed to be plugged in, so exposing any sockets and connection points to the possibility of a direct discharge, but the equipment used for performing these tests is not required or expected to touch connectors with recessed pins or any other connections that are below the surface of the meter. Discharges are applied 10 times for both contact and air discharges to any point the tester deems accessible to personnel during normal usage, which will include the battery compartment and connections for a battery operated instrument. Testing starts at ±2 kVolts and is increased up to the maximum required to determine any threshold of failure, and each discharge must be at least 1 second after the previous one. Conformance with the requirements and the statements (if any) in the Instruction Manual must be verified.

6. REQUIREMENTS AND TESTS FOR THE INFLUENCE OF A.C. POWER-FREQUENCY AND RADIO-FREQUENCY FIELDS

The requirements are in section 6.6 and the tests in A 7.7. This section is thought likely to be the most demanding for existing designs of sound level meters to comply with, and will need to be seriously considered when new designs are under development. The requirements for a.c. power-frequency effects use the same field strength (80 A/m at 50 or 60 Hz) as did IEC's 651 and 804, (which is higher than required for CE marking), but whereas the older Standards merely required a statement of what happened when subjected to this field, exact limits have now been laid down. The limits are the same as for RF fields and some explanation of these is necessary.

6.1 Conditions for specifying immunity

In order to assess the effect of the power or RF field on the meter, the meter must be measuring something. For the minimum level of testing, a sound level of 74 dB ±1 dB has been chosen as a reasonable level that can be generated and into which the sound level meter can be placed whilst being tested.

The generation of this sound must not interfere in any way with the ability of the meter to receive the radiation being applied, so sound ducted to the microphone by plastic pipes or noise generated by a means known to be immune to the fields applied must be used. In order to avoid discrete frequencies that may cause beating effects with the applied fields, a band of pink noise centred on 1 kHz, with roll-off rates of at least 12 dB/octave below 700 Hz and above 1400 Hz is specified.

The meter is set to read A frequency-weighted and F time-weighted sound level or A frequency-weighted time-average sound level, whichever is available, and set to a measurement range that has the lower boundary of the linear operating range as close to, but not greater than, 70 dB. This is to ensure that the measurements are made towards the lower end of the dynamic range of the meter, where signals from the microphone are usually small and where any effects due to the applied fields could have greatest impact. If a meter is sufficiently immune at this point in its measurement range, it is likely that readings greater than 74 dB up to the top of the measurement range will be equally, or more immune to the applied fields.. It is also likely that readings greater than 74 dB, up to the maximum capability of the meter, will also be equally immune. If a manufacturer so wishes, the sound level of 74 dB can be reduced to any level specified by them, to the nearest whole dB, but the meter will be tested on all measurement ranges that can display the level claimed.

The requirements in the Standard allow the initial reading of the pink noise to vary by ±1 dB for a Class 1 instrument, and ±2 dB for a Class 2 instrument when in the presence of both power- and radio-frequency fields. The RF fields required are of two types. Firstly an amplitude modulated carrier at all frequencies from 25 MHz to 1 GHz (a range wider than currently required for CE marking) at an electric field strength of 10 V/m without modulation,

as measured at the meter under test, is used. Modulation at 1 kHz to a depth of 80% is added, and the reading of the meter must not change by more than the limits prescribed. In addition, no change of operating state, configuration or corruption or loss of any stored data is permitted for any applied field. The second field is with a carrier of 900 MHz and the same field strength of 10 V/m unmodulated. A square wave at 200 Hz repetition rate and 50% duty cycle is added and again the same limits on change apply. This field is used as a representation of that expected from some mobile telephones.

All these requirements apply to all Groups of sound level meters. For Groups Y and Z meters, additional tests where interference is injected onto the mains power supply cables in the frequency range 0.15 to 80 MHz are also required, as well as tests for immunity to voltage dips, voltage interruptions, voltage fluctuations and low-frequency harmonics. These tests are the same as those required by the Generic EU standard EN 50082 but are also required to be carried out with the 74 dB sound source specified and to the same limits on change as for the radiated fields.

For a Group Z meter, there are even more tests that must be carried out by injecting interference in the range 0.15 to 80 MHz if any of the interconnecting cables are longer than 3m, injecting fast transients onto the mains supply cable and for hand-held meters a test with an artificial hand placed around the meter for immunity to common-mode interference.

6.2 Testing

Testing of the immunity of a sound level meter can be a lengthy task. If the meter does not read instantaneous sound levels, then each frequency must be tested separately. To this end, A.7.7.9 allows the carrier frequency to be stepped in 2% increments from 25 MHz to 1 GHz and each frequency integrated for at least 10 seconds to establish the reading. The meter must then be reset before the next stepped frequency is measured. These steps are wider than recommended by IEC Standards and those used at present for CE testing, but are considered adequate for sound level meters. The meter, however, must comply at any frequency, and those used for testing are at the tester's discretion.

Testing a.c.power-frequency fields is performed at the orientation required to be specified as producing maximum response in the Instruction Manual (section 9.3.13).

Testing with RF fields is performed at the same reference orientation as for testing the emissions, and at two other planes, approximately orthogonal to the principal plane of this orientation. If the meter has external connection facilities, all cables are included and remain unterminated unless part of the sound level meter system as for the tests of emissions. The Instruction Manual is required to state the operating mode and configuration that has the minimum immunity (section 9.3.13).

The additional tests for Groups Y and Z meters are common to many other instruments covered by the IEC 1000 series of standards and are cross referenced in IEC 1672.

If a manufacturer wishes to claim electromagnetic immunity for the sound level meter at sound levels lower than 74 dB, the meter must first be tested and pass at 74 dB. The meter must then be retested in reducing steps of not more than 5 dB until the claimed level is reached. These lower levels must be tested on every measurement range whose linear operating range includes the level under test. Both power- and radio-frequency tests must be carried out using the same band-limited pink noise source at reduced amplitudes and with the meter in the same configuration. This applies to the additional tests for Groups Y and Z as well.

Figures are included in Annex A for the maximum uncertainties in setting the field strengths and of the indicated signals.

7. CONCLUSION

The requirements and tests now specified represent a significant change to sound level meter standards. With the increasing use of electronics in all walks of life, the need for a guarantee of sound level meter reading integrity has never been greater, and the difficulty of electromagnetic fields is the inability of a sound level meter operator to be aware of their existence. The requirements in this Standard will not guarantee that all meters will be totally immune to these effects, but will give a common baseline of performance that can be expected from all meters claiming compliance with this Standard, and which should ensure a level of performance which, in the majority of circumstances currently experienced, will give accurate and reliable data from the sound level meter being used.

8. REFERENCES

(1) IEC 651 Now renumbered as EN 60651:1994. Sound Level Meters.
(2) IEC 804 Now renumbered as EN 60804:1994. Integrating-Averaging Sound Level Meters.
(3) EN 50081-1:1992 & EN 50081-2:1993. European Standard - Electromagnetic compatibility - Generic emission standard.
(4) EN 50082-1:1992 & EN 50082-2:1995. European Standard - Electromagnetic compatibility - Generic Immunity standard.