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Steady and transient measurement capabilities, and verification tests

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1. Introduction

Sound signals are normally characterized by high crest factors and large dynamic range. Our ears can handle an impressively large signal range and it is therefore important that a sound level meter can handle similar signals with satisfying accuracy. For this reason a major part of the proposed IEC 1672 standard describes requirements for the response to short duration signals of various levels and durations.

Ideally a sound level meter shall respond to the energy of the signal – no matter whether the signal comes from a short pistol shot or it turns out to be a steady signal like the noise from a fan.

During the period of time the working group has been in operation, it has discussed how to test the response to short test signals. For practical reasons it was early agreed to use electrical test signals. Electrical signals can more easily be controlled with high accuracy. Normally the best way to obtain such test pulses is to extract a known number of periods from a continuous signal. The continuous signal can be measured with a high accuracy using an ordinary voltmeter. The extraction can be done by fast electronic switches. Such features are found as an integral part of modern signal generators with burst capabilities.

Furthermore, the microphone is a nearly linear device which normally performs well for short impulses and thus can be tested using stationary signals. The signal detector which has to square and average the result is usually the most critical part of the sound level meter with respect to the response to short transient signals. This part can equally well be tested by electrical signals.

2. Toneburst response

(IEC 1672:part 5.7)

The IEC 651 have modest requirements only for the response to short pulses, especially for type 1, type 2 or type 3 meters. The requirements are only specified down to 200 ms for F and 500 ms for S response. For type 0 instruments the requirements are for signal durations down to 5 ms. We know that many common measurement signals, such as pistol shots, have much shorter duration. The new requirements are therefore for signals down to 0,25 ms.

The IEC804 standard have, however, more realistic requirements for short duration signals. The requirements are in general specified for signals with duration down to 1 ms.

The working group has lengthily discussed if the testing for signals of different duration should be made with a single period of different frequency or a fixed frequency with a different number of periods. Although the working group could find some situations where a single cycle test at different frequencies enhanced anomalies in some instrument in an effective way, the conclusion was that the test should be performed at a fixed frequency, 4 kHz, and with a different number of periods. The reason was that it was thought that the test was effective enough and that the results from the test were easier to interpret.

IEC 804 defines a linearity range and a pulse range. The proposed standard defines a linear operation range only. The minimum requirements for the span of the ranges and the corresponding tolerances are similar, but the proposed standard require responses for shorter bursts.

3. Response to repeated toneburst

(IEC 1672:part 5.10)

The requirements to the accuracy of indication for a signal with a sequence of burst are quite similar to the requirements for a one-burst signal. The response should follow the energy of the signal. For a multi-burst signal, the accuracy is in general determined from the duration of the single burst.

4. Time weightings

(IEC 1672:part 5.11)

The time weightings F (fast) and S (slow) from IEC 651 have been retained. The requirements are normally divided into a test for charging time and another test for discharging. The test for charging is well covered from the requirements to the response to a short burst of a signal. As mentioned earlier, the requirements have been improved considerably. This is especially true for signals of short duration with requirements to the response down to 0,25 ms. The requirements to the discharge time have been altered to values close to the theoretical response of an ideal sound level meter within a certain tolerance. IEC 651 has only specified maximum times for the level to drop 10 dB when the input signal is suddenly switched off.

IEC 651 describes the time function I (impulse). The working group has had considerable discussions whether this response should be entirely removed from the new standard. The I-response is only used in a few countries. The arguments for the removal were that some markets demand all described functions independent of the actual application – raising the price for an instrument. The argument for keeping the definitions is that the characteristics are referred to in different national standards and that the definition and the specification are not sufficiently

described in any other international standard if IEC 651 is replaced. The compromise was to place the definition of the time-weighting I in an informative annex to the standard.

5. Reset

(IEC 1672:part 5.13)

A reset feature is required to clear the response to earlier applied input signals for values representing an average- or maximum value over some measurement interval. For all practical situations, the requirements are very similar to the requirements in IEC 804.

6. Thresholds

(IEC 1672:part 5.14)

The standard allows the manufacturer to provide user-selectable thresholds for an integrating-averaging or integrating sound level meter. The application of this mode of operation is mainly found in USA. The operation of the threshold is such that if the sound level is below the threshold, no contributions to the averaged value are added – independent of the duration of the signal. The signal is only taken into consideration when the level is above the threshold. The new standard does not describe requirements for how the threshold function operates, but the information has to be described in the instruction manual for instrument.

7. Display of signal level

(IEC 1672:part 5.15)

The normal display on a sound level meter for the measured signal level is assumed to be a digital display with a resolution of 0,1 dB or better. The minimum level range for measurement and display without any range switching is 60 dB. The reading should be updated at regular intervals at least once per second.

The proposed standard also allows an analogue or simulated analogue display. The required range for the displayed value is then reduced to 30 dB or – if autoranging is provided – 20 dB. The requirement from the previous standards that each 1 dB graduation should be at least 1 mm wide, is retained.

The IEC 651 standard requires a display range of 15 dB only, and only 10 dB of that has to be within the primary indication range, independent of the display being analogue or digital.

The increased display range in the proposed standard is a considerable improvement for the users who do not have to change the display range for some dB variation in the signal level.

If the instrument can display more than one measurement quantity, the proposed standard requires that the type of value has to be clearly indicated.

The proposed standard also opens for external display devices. Such devices may be a computer, logging digital values from the sound level meter, or a level recorder plotting the level versus time function. The external display device is then considered to be an integral part of the sound level meter and has to satisfy all functional requirements.

8. AC electrical output

(IEC 1672:part 5.16)

The sound level meter may have an electrical output for the microphone signal, normally called a.c. output. If available, the operation and characteristics have to be described. No loading of such an output, even a short-circuit, should affect the measurement by more than 0,1 dB. This corresponds to the requirements for the best type of instruments in the current standards.

9. Timing facilities

(IEC 1672:part 5.17)

A sound level meter capable of measuring time-averaged sound level or sound exposure level may display the elapsed time since the start of an integration. If provided, the time measurement has to be accurate within 0,1% for a class 1 instrument and within 0,5% for a class 2 instrument, respectively. Due to the high accuracy of even modest priced crystal controlled oscillators, this requirement should cause few problems for the manufacturer.

The requirement for the timing accuracy in the IEC 804 standard is 1%.

10. Power supply

(IEC 1672:part 5.20)

In the proposed standard, every sound level meter has to have a device to check that the power supply is sufficient to operate the instrument. This will apply for battery- as well as mains-operated instruments. It shall be possible to do such a test even during an ongoing measurement without disturbing the operation of the instrument.

When, for a steady input signal, the supply voltage is reduced from the nominal to the minimum value, the indicated level should not change by more than 0,1 or 0,2 dB for a class 1 and a class 2 instrument, respectively.

11. Accuracy of indication at 1 kHz under reference conditions
(IEC 1672:partA.6.2 and B.5.2)

The accuracy of indication at 1 kHz under reference conditions shall, for conformal tests (type approval), be verified when exposed to a known plane progressive wave. If the correspondence between this sensitivity and the sensitivity to an acoustic pressure, as obtained in a sound calibrator, is established, the calibrator may later be used to control the sensitivity in a periodic test.

The sound level meter shall for the tests be set to the reference level range and frequency-weighting A. An electrical input signal is later used to check that the response at 1 kHz is within the required tolerances for different weighting networks and time constants.

12. Tests for toneburst responses
(IEC 1672:part A6.6, A6.7, B.5.5 and B.5.6)

The tests for a single toneburst and a repeated tone burst are in general made at a frequency of 4 kHz. This frequency has been selected because it is in the flat part of both the A- and C-weighted networks. The bursts contain an integer number of periods. The shortest burst consists of a single period which corresponds to a burst duration of 0,25 ms. The longest burst for the test has a duration of 1 second and contains 4000 periods.

The signal for the test is an electrical signal substituted for the microphone signal. Different combinations of levels and durations are prescribed for the test. The bursts are used to test the F- and S-time weighting as well as the integrating-averaging response or integrating response. Toneburst response shall be within the specified tolerance limits as long as the toneburst response is within the linear operating range of the sound level meter. The tolerances apply to test signals giving an indication 10 dB above the lower limit of the linear operating range and for increasing levels until the overload indication turns on. Such tests have to be done both for the conformance test and the periodic tests.

13. Concluding remarks

In general, tighter tolerances have been defined in the proposed IEC 1672 standard compared to the present combination of IEC 651 and IEC 804. However, test of high-quality sound level meters made to the present standards have shown that most instruments respond within the limits set by the proposed standard. In many ways the proposal therefore reflects the specifications of the best, recently developed sound level meters already available in the market.
