APPENDIX D. DEFINITIONS AND FILTER CHARACTERISTICS

D.1. DEFINITIONS AND FORMULAE

D.1.1. Basic symbols and notation

T - current time period of the measurement.

T_b - time period after which the results are saved in the buffer (set in the **BUFFER STEP** option of the **MEASURE SETUP** sub-window, the ***INPUT*** window).

T_c - time period of the measurement (set in the **INT. TIME** option of the **MEASURE SETUP** sub-window, the ***INPUT*** window).

T_e - exposure time (time period during which a person is exposed to the action of noise). This parameter can be set in the **EXPOSURE TIME** sub-window of the **DOSEMETER SETUP** in the ***INPUT*** window. The available values are from 1 minute to 8 hours with 1 minute step.

T_{8h} - time period equal to 8 hours (28 800 seconds).

τ - detector time constant (set in the **DETECTOR** option of the **PROFILE x** sub-window of the **PROFILES SETUP** sub-window of the ***INPUT*** window; equal to **IMPULSE**, **FAST** or **SLOW**).

$a_W(t)$ - the temporary value of the measured sound with the weighting filter **W** (equal to **A**, **C** or **LIN**) on the input of the RMS detector.

$p_W(t)$ - the temporary value of the measured sound with the weighting filter **W** (equal to **A**, **C** or **LIN**) on the output of the RMS detector calculated from the equation:

$$p_W(t) = \left(\frac{1}{\tau} \int_{-\infty}^{t} a_W^2(t_x) \exp\left(\frac{t_x - t}{\tau} \right) dt_x \right)^{1/2}$$

where:

t_x - time (variable of the integration).

p_0 - the reference value equal to 20 μPa.

Q - the exchange rate in decibels equal to **2**, **3**, **4** or **5** (set in the **EXCHANGE RATE** sub-window of the **DOSEMETER SETUP** in the ***INPUT*** window). The value of **Q** influences the calculations of dose meter results, namely **DOSE**, **D_8h** and **LAV**. The exposure rate equal to 3 complies with ISO R 1999 "Assessment of Occupational Noise Exposure for Hearing Conservation Purposes", while **Q** equal to 5 complies with the American "Occupational Safety and Health Act" – OSHA. The value of **q** used in the calculations of **DOSE**, **D_8h** and **LAV** is taken from the formula:

$$q = \begin{cases} \dfrac{Q}{\log 2} & \text{for } Q \neq 3 \\ 10 & \text{for } Q = 3 \end{cases}$$

L_T - the threshold sound level set in the **THRESHOLD LEVEL** sub-window of the **DOSEMETER SETUP** in the ***INPUT*** window. The available values are as follows: **None**, **75 dB**, **80 dB**, **85 dB** or **90 dB**.

$\mathbf{L_c}$ - the criterion sound level set in the **CRITERION LEVEL** sub-window of the **DOSEMETER SETUP** in the *INPUT* window. The available values are as follows: **80 dB**, **84 dB**, **85 dB** or **90 dB**.

$\mathbf{L(t)}$ - sound level (a function of time) measured with the selected time constant (**IMPULSE**, **FAST** or **SLOW**) and the weighting filter (equal to **A**, **C** or **LIN**) calculated from the formula:

$$\mathbf{L(t) = 20 \log \frac{p_W(t)}{p_0}}$$

$\mathbf{L_d(t)}$ - sound level (a function of time), depends on the selected threshold level. In the case when the **None** option was selected:

$$\mathbf{L_d(t) = L(t)}$$

In the other cases (when the **THRESHOLD LEVEL** is equal to **75 dB**, **80 dB**, **85 dB** or **90 dB**) this sound level is taken from the formula:

$$\mathbf{L_d(t)} = \begin{cases} \mathbf{L(t)} & \text{for} \quad \mathbf{L(t) \geq L_T} \\ -\infty & \text{for} \quad \mathbf{L(t) < L_T} \end{cases}$$

D.1.2. Definitions of the values, functions and results measured in SLM mode

The PEAK value

The **PEAK** value (Peak Sound Pressure or Peak Sound Level) depends on the weighting filter **W** (equal to **A**, **C** or **LIN**) and is calculated for the given **T** from the formula:

$$\mathbf{PEAK = 20 \log\left(max_T \left| \frac{a_W(t)}{p_0} \right| \right)}$$

In the case of the **PEAK** value saved as the main result $\mathbf{T = T_c}$. When the **PEAK** value is saved in the files of the buffer (time history) - $\mathbf{T = T_b}$.

The SPL function

The **SPL** function (**S**ound **P**ressure **L**evel) - gives an equivalent of the **Sound Level Meter** according to the **IEC 651 Standard** (meeting the requirements for the **Type "1"** instrument). The value of the functions depends on the weighting filter **W** (equal to **A**, **C** or **LIN**) and is calculated from the formula:

$$\mathbf{SPL = 20 \log\left(max_{T_1} \frac{p_W(t)}{p_0} \right)}$$

where:

$\mathbf{T_1}$ - the last second of the measurement.

The MAX result

The **MAX** result means the maximal value on the detector output for the integration time period. The **MAX** result for the time period of 1 second is equal to the value of the **SPL** function. The **MAX** result is calculated according to the formula:

$$\mathbf{MAX} = \mathbf{20\ log}\left(\mathbf{max}_T \frac{\mathbf{p}_W(t)}{\mathbf{p}_0} \right)$$

In the case of the **MAX** value saved as the main result $\mathbf{T} = \mathbf{T_c}$. When the **MAX** value is saved in the files of the buffer (time history) - $\mathbf{T} = \mathbf{T_b}$.

The MIN result

The **MIN** result is calculated according to the formula:

$$\mathbf{MIN} = \mathbf{20\ log}\left(\mathbf{min}_T \frac{\mathbf{p}_W(t)}{\mathbf{p}_0} \right)$$

In the case of the **MIN** value saved as the main result $\mathbf{T} = \mathbf{T_c}$. When the **MIN** value is saved in the files of the buffer (time history) - $\mathbf{T} = \mathbf{T_b}$.

The LEQ function

The **LEQ** function enables the user to calculate the RMS value of sound pressure in the given time period. The instrument operates as the standard **Integrating Sound Level Meter** and conforms to the **IEC 804 Standard** (meeting the requirements for the **Type 1** instrument). The value of the **LEQ** function is calculated, when the **LINEAR** option is selected in the **LEQ INTEGRATION** sub-window of the ***SETUP*** window, according to the formula:

$$\mathbf{LEQ} = \mathbf{20\ log}\left(\frac{\mathbf{1}}{\mathbf{T}} \int_0^T (\mathbf{a}_W(t)/\mathbf{p}_0)^2\, \mathbf{dt} \right)^{1/2}$$

The value of the **LEQ** function is calculated, when the **EXPONENTIAL** option is selected in the **LEQ INTEGRATION** sub-window of the ***SETUP*** window, according to the formula:

$$\mathbf{LEQ} = \mathbf{20\ log}\left(\frac{\mathbf{1}}{\mathbf{T}} \int_0^T (\mathbf{p}_W(t)/\mathbf{p}_0)^2\, \mathbf{dt} \right)^{1/2}$$

In the case the **LEQ** value saved as the main result $\mathbf{T} = \mathbf{T_c}$.

Note: *For* $T = T_b$ *the* ***LEQ*** *values are saved in the files of the buffer (time history) as the* ***RMS*** *results (see below).*

The RMS result

The **RMS** result, saved in the buffer's file, is calculated according to the formula of the **LEQ** function. The value of the **RMS** result is calculated, when the **LINEAR** option is selected in the **LEQ INTEGRATION** sub-window of the ***SETUP*** window, according to the formula:

$$\mathbf{RMS} = \mathbf{20\ log}\left(\frac{\mathbf{1}}{\mathbf{T_b}} \int_0^{T_b} (\mathbf{a_W}(\mathbf{t})/\mathbf{p_0})^2\,\mathbf{dt} \right)^{1/2}$$

The value of the **RMS** result is calculated, when the **EXPONENTIAL** option is selected in the **LEQ INTEGRATION** sub-window of the ***SETUP*** window, according to the formula:

$$\mathbf{RMS} = \mathbf{20\ log}\left(\frac{\mathbf{1}}{\mathbf{T_b}} \int_0^{T_b} (\mathbf{p_W}(\mathbf{t})/\mathbf{p_0})^2\,\mathbf{dt} \right)^{1/2}$$

The SEL result

The **SEL** result (Sound Exposure Level) is essentially the subset of the **LEQ** function. It's value is equal to the **LEQ result referred to the integration time equal to one second** (so, for the **INT. TIME=1 s**, **SEL** is always equal to **LEQ**). The value of the **SEL** function is calculated, when the **LINEAR** option is selected in the **LEQ INTEGRATION** sub-window of the ***SETUP*** window, according to the formula:

$$\mathbf{SEL} = \mathbf{20\ log}\left(\int_0^{T} (\mathbf{a_W}(\mathbf{t})/\mathbf{p_0})^2\,\mathbf{dt} \right)^{1/2} = \mathbf{LEQ} + \mathbf{10} \cdot \mathbf{log}\frac{\mathbf{T}[\mathbf{s}]}{\mathbf{1}[\mathbf{s}]}$$

The value of the **SEL** function is calculated, when the **EXPONENTIAL** option is selected in the **LEQ INTEGRATION** sub-window of the ***SETUP*** window, according to the formula:

$$\mathbf{SEL} = \mathbf{20\ log}\left(\int_0^{T} (\mathbf{p_W}(\mathbf{t})/\mathbf{p_0})^2\,\mathbf{dt} \right)^{1/2} = \mathbf{LEQ} + \mathbf{10} \cdot \mathbf{log}\frac{\mathbf{T}[\mathbf{s}]}{\mathbf{1}[\mathbf{s}]}$$

In the case of the **SEL** value saved as the main result $\mathbf{T} = \mathbf{T_c}$. The **SEL** value is not saved in the files of the buffer (time history).

The Ltm3 and Ltm5 results

The **Ltm3** and **Ltm5** results (Takt-Maximal Levels) are calculated according to the German standard TA Larm.

D.1.1. Definitions of the results measured in DOSE METER mode

The DOSE result

The **DOSE** result is the quantity of noise received by the worker, expressed as the percentage of the whole day acceptable value. This result is calculated from the formula:

$$\mathbf{DOSE} = \frac{\mathbf{100\%}}{\mathbf{T_{8h}}} \int_0^{T} \mathbf{10}^{\frac{L_d(t) - L_c}{q}}\,\mathbf{dt}$$

The D_8h result

The **D_8h** result is the quantity of noise received by the worker during 8 hours. This result is calculated from the formula:

$$D\_8h = \frac{100\%}{T}\int_0^T 10^{\frac{L_d(t)-L_c}{q}}\,dt = \frac{T_{8h}}{T}\cdot DOSE$$

The LAV result

The **LAV** result is the average level of the acoustic pressure for the given time period of the measurement. This result is calculated from the formula:

$$LAV = q\cdot\log\left(\frac{1}{T}\int_0^T 10^{\frac{L_d(t)}{q}}\,dt\right)$$

In the case of **Q** (the exchange rate) equal to 3 the **LAV** result has the same value as **LEQ** (if the **EXPONENTIAL** option is selected in the **LEQ INTEGRATION** sub-window of the ***SETUP*** window).

The SEL8 result

The **SEL8** result is the **SEL result corresponding to the integration time equal to 8 hours**. The **SEL8** result is calculated on the base of the **LEQ** according to the formula:

$$SEL8 = LEQ + 10\cdot\log\frac{T_{8h}[s]}{1[s]}$$

The PSEL result

The **PSEL** result (individual Sound Exposure Level to the noise) is equal to the standing sound level in a measurement time period. The **PSEL** result is calculated on the base of the **LEQ** according to the formula:

$$PSEL = LEQ + 10\cdot\log\frac{T}{T_{8h}}$$

The E result

The **E** result (Exposition) represents the amount of the acoustical energy received by the worker. The **E** value is calculated according to the formula:

$$E = \frac{T[s]}{3600}p_o^2\cdot 10^{\frac{LEQ}{10}}$$

The **E** result is expressed in the linear units (Pa^2h).

The E_8h result

The **E_8h** result (Exposition in 8 hours) represents the amount of the acoustical energy received by the worker during 8 hours. The **E_8h** value is calculated according to the formula:

$$\mathbf{E\_8h} = \mathbf{8[h]} \cdot \mathbf{p_o^2} \cdot \mathbf{10}^{\frac{\mathbf{LEQ}}{\mathbf{10}}}$$

The **E_8h** result is expressed in the linear units (Pa^2h).

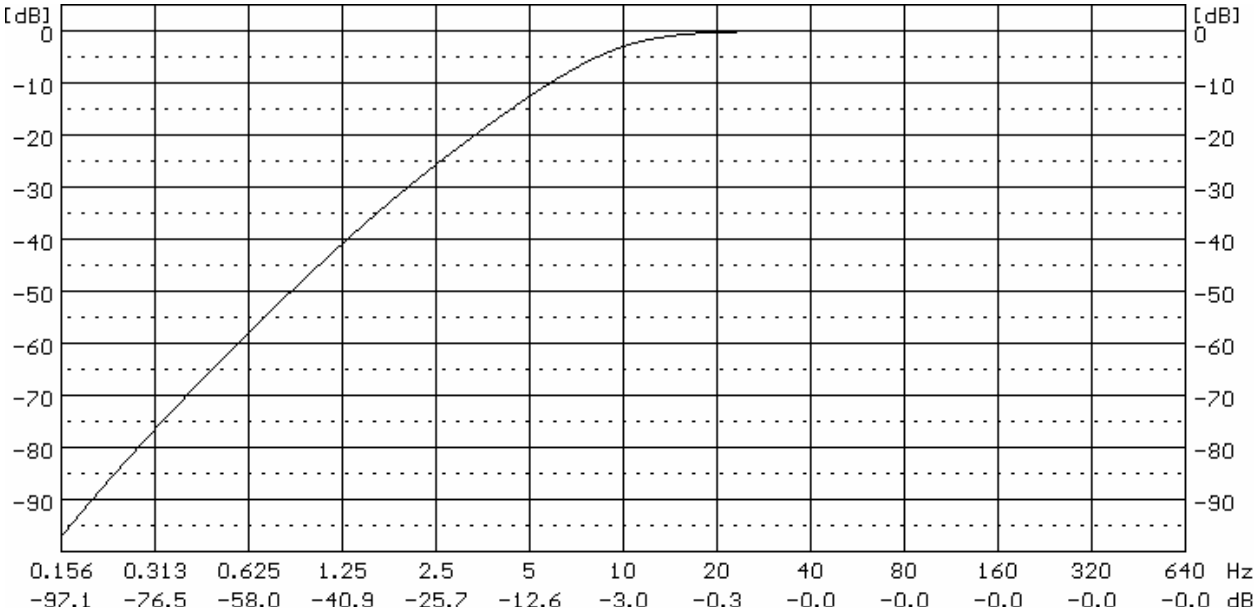
The LEPd result

The **LEPd** result (Exposure level related to 8-hours working day) is calculated on the base of the **LEQ** from the formula:

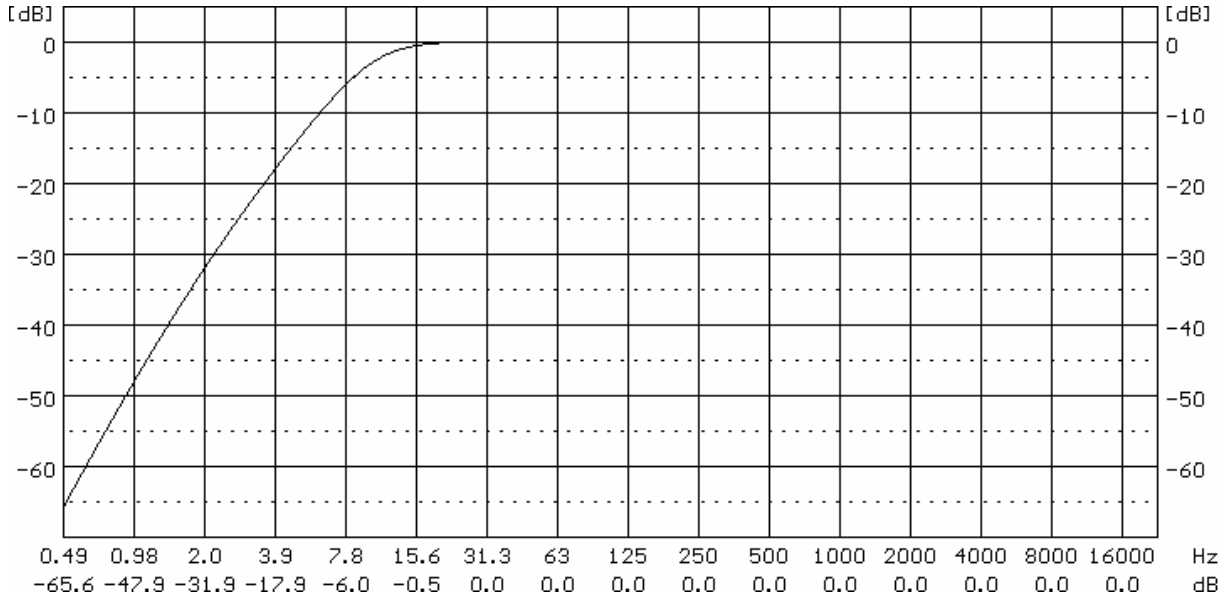
$$\mathbf{LEPd} = \mathbf{LEQ} + \mathbf{10} \cdot \mathbf{log}\frac{\mathbf{T_e}}{\mathbf{T_{8h}}}$$

D.2. FREQUENCY CHARACTERISTICS OF DIGITAL FILTERS IMPLEMENTED IN SVAN 943

LIN: cut-off frequency: 27,0 Hz / -0,1 dB (10,0 Hz / -3,0 dB).

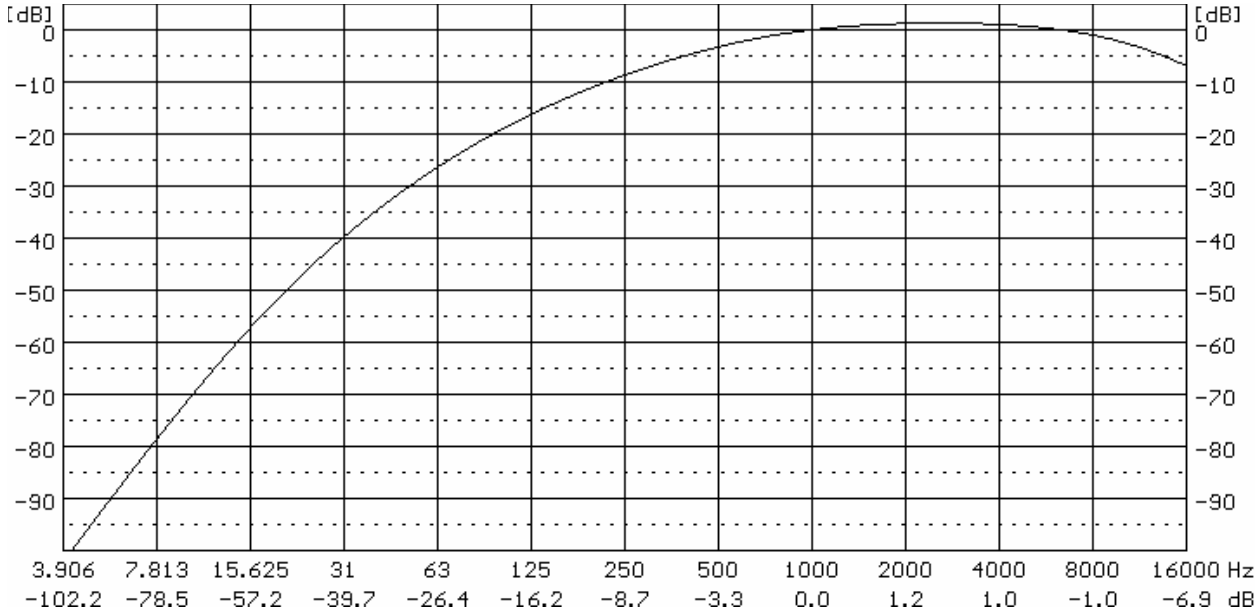


The frequency characteristics of the LIN filter implemented in the instrument in the low frequency band with the emphasis on the acquired attenuation



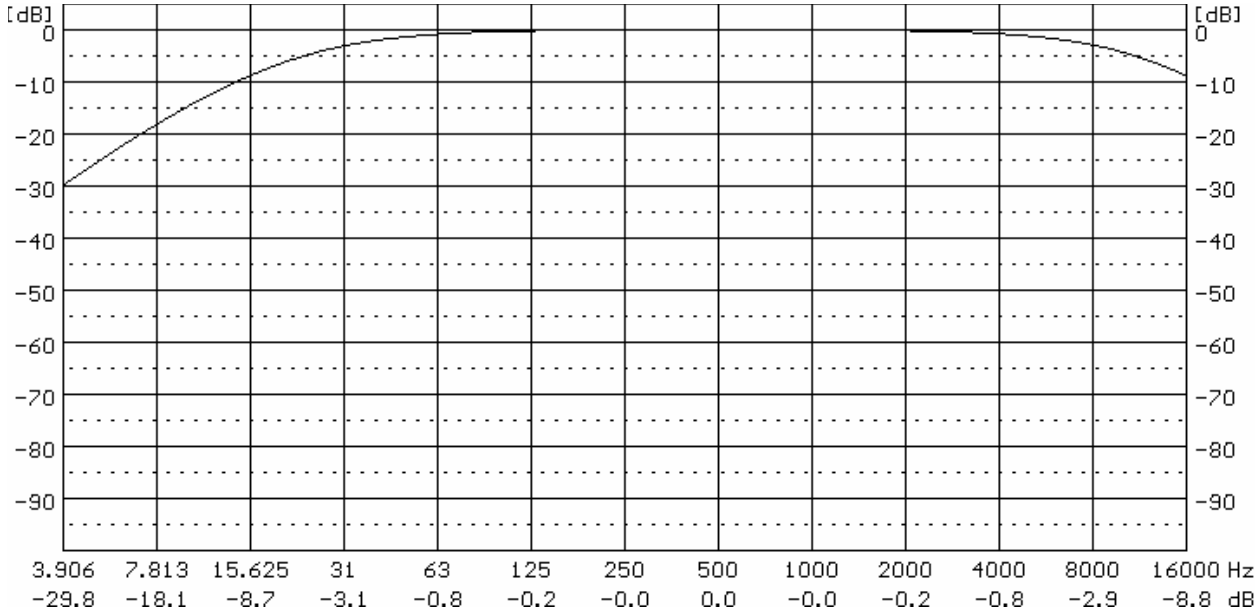
The frequency characteristics of the LIN filter in the full band of the SVAN 943 without the emphasis on the acquired attenuation in the low frequency band

A type 1 according to the **IEC 651** standard.

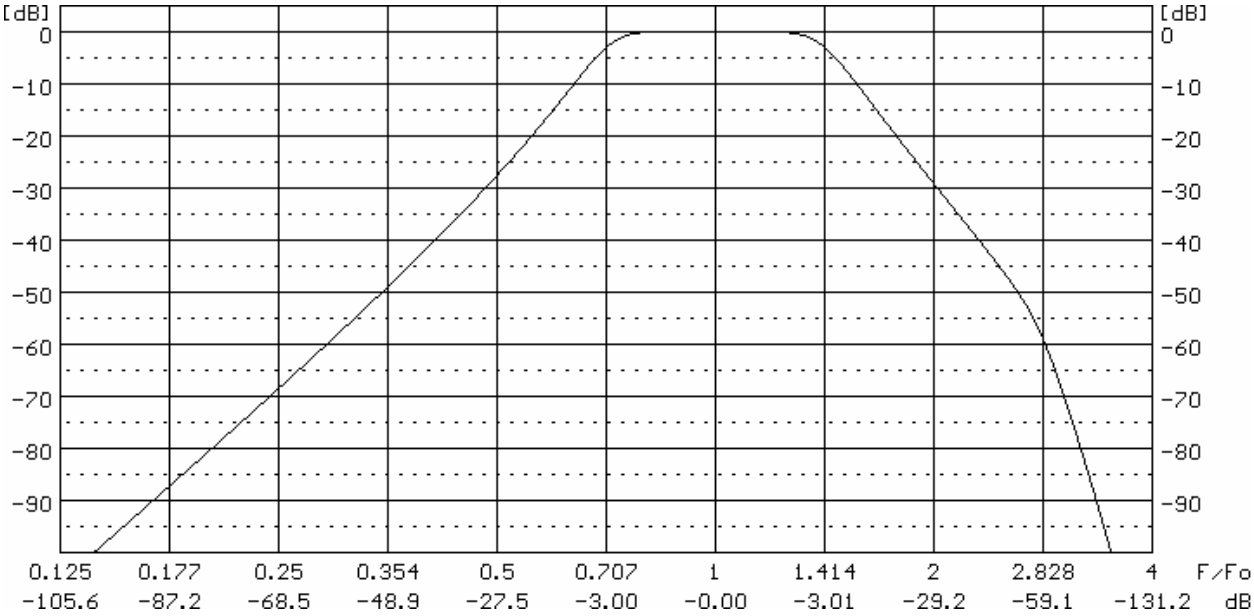


The frequency characteristics of the A filter implemented in the instrument

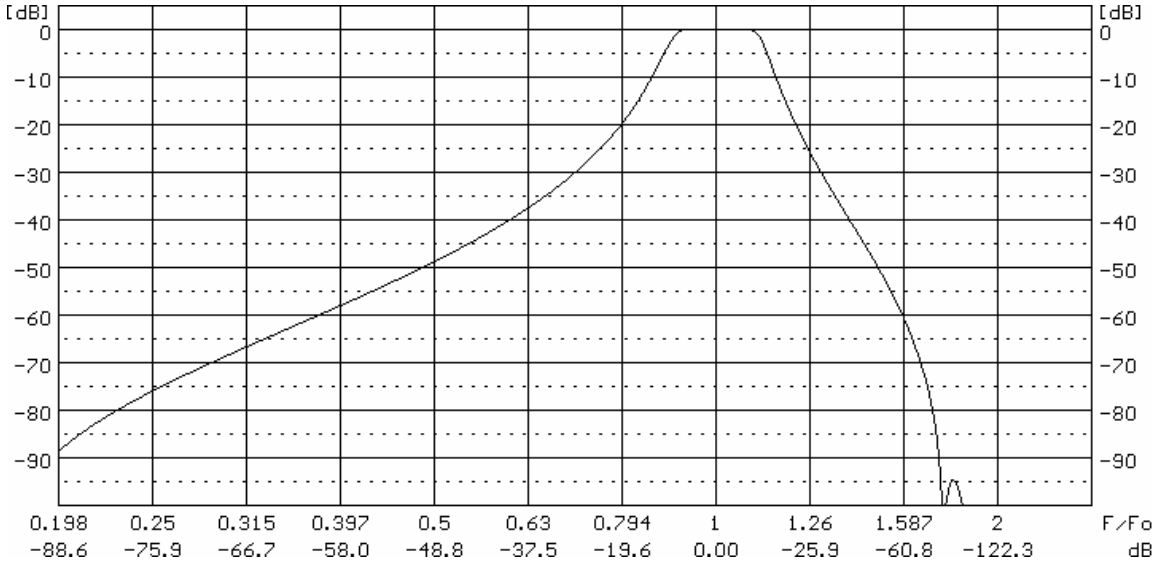
C type 1 according to the **IEC 651** standard.



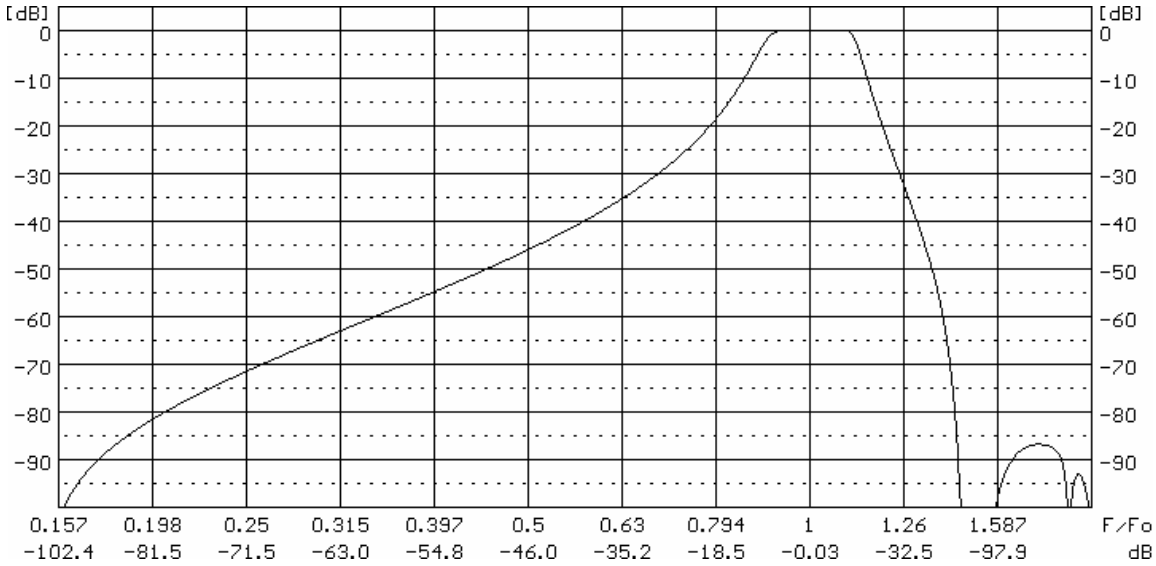
The frequency characteristics of the C filter implemented in the instrument



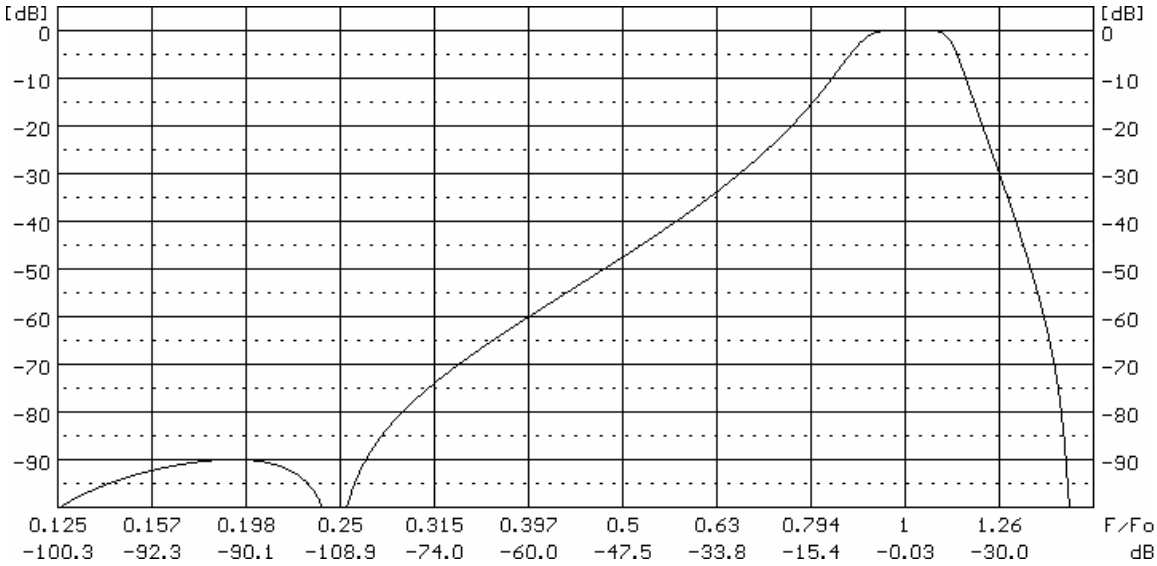
The frequency characteristics of the exemplary 1/1 OCTAVE filter implemented in the instrument



The frequency characteristics of the exemplary lower 1/3 OCTAVE filter implemented in the instrument



The frequency characteristics of the exemplary middle 1/3 OCTAVE filter implemented in the instrument



The frequency characteristics of the exemplary upper 1/3 OCTAVE filter implemented in the instrument