D. DEFINITIONS AND FILTER CHARACTERISTICS

D.1. Definitions and formulae

D.1.1. Basic symbols and notation

T - current period of the measurement.

$\mathbf{T_b}$ - period after which the results are saved in the logger, set in the **LOGGER STEP** (*path: MENU / INPUT / MEASUREMENT SETUP / LOGGER STEP*).

$\mathbf{T_c}$ - period of the measurement, set in the **INT. PERIOD** (*path: MENU / INPUT / MEASUREMENT SETUP / INT. PERIOD*).

$\mathbf{T_e}$ - exposure time (period during which a person is exposed to the action of noise). This parameter can be set in the **EXPOSURE TIME** (*path: MENU / INPUT / AUXILIARY SETUP / HAV/WBV DOSE SETUP / EXPOSURE TIME*). The available values are from 1 minute to 8 hours with 1-minute step.

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

τ - detector time constant, set in the **DETECTOR** (equal to **IMPULSE**, **FAST** or **SLOW** in the case of sound mode and equal to **100 ms**, **125 ms**, **200 ms**, **500 ms**, **1 s**, **2 s**, **5 s** or **10 s** in the case of vibration mode; *path: MENU / INPUT / CHANNELS SETUP / CHANNEL x / (CH x PROFILE y - in the case of sound mode) / DETECTOR*).

$\mathbf{a_W(t)}$ - the temporary value of the measured sound or vibration with the weighting filter **W** (equal to **A**, **C**, **LIN** or **G** in the case of sound mode and equal to **HP1**, **HP3**, **HP10**, **KB**, **Wk**, **Wd**, **Wc**, **Wj**, **Wm**, **Wh**, **Wg**, **Wb** in the case of vibration mode; *path: MENU / INPUT / CHANNELS SETUP / CHANNEL x / (CH x PROFILE y - in the case of sound mode) / FILTER*) on the input of the RMS detector.

$\mathbf{p_W(t)}$ - the temporary value of the measured sound or vibration with the weighting filter **W** (equal to **A**, **C**, **LIN** or **G** in the case of sound mode and equal to **HP1**, **HP3**, **HP10**, **KB**, **Wk**, **Wd**, **Wc**, **Wj**, **Wm**, **Wh**, **Wg**, **Wb** in the case of vibration mode; *path: MENU / INPUT / CHANNELS SETUP / CHANNEL x / (CH x PROFILE y - in the case of sound) / FILTER*) 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:

$\mathbf{t_x}$ - time (variable of the integration).

$$r_W(t) = \begin{cases} a_W(t) & \textit{path : MENU / SETUP / RMS INTEGRATION / LINEAR} \\ p_W(t) & \textit{path : MENU / SETUP / RMS INTEGRATION / EXPONENTIAL} \end{cases}$$

$\mathbf{p_0}$ - the reference value equal to 20 μPa (only in the case of sound measurements).

Q - the exchange rate in decibels equal to **2**, **3**, **4** or **5**, set in the **EXCHANGE RATE** (*path: MENU / INPUT / DOSIMETER SETUP / EXCHANGE RATE*). The value of **Q** influences the calculations of acoustic dosimeter 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:

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

L_T - the threshold sound level, set in the **THRESHOLD LEVEL** (*path: MENU / INPUT / DOSIMETER SETUP / THRESHOLD LEVEL*). The available values are as follows: **None**, **75 dB**, **80 dB**, **85 dB** or **90 dB**.

L_c - the criterion sound level, set in the **CRITERION LEVEL** (*path: MENU / INPUT / DOSIMETER SETUP / CRITERION LEVEL*). The available values are as follows: **80 dB**, **84 dB**, **85 dB** or **90 dB**.

$L(t)$ - sound level (a function of time) measured with the selected time constant (**IMPULSE**, **FAST** or **SLOW**; *path: MENU / INPUT / CHANNELS SETUP / CHANNEL x - MODE: SOUND / CH x PROFILE y / FILTER*) and the weighting filter (equal to **A**, **C**, **LIN** or **G**) calculated from the formula:

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

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

$$L_d(t) = L(t)$$

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

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

D.1.2. Definitions of the quantities measured in sound mode

PEAK value

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

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

In the case of the **PEAK** value saved as the main result **- T** = T_c. When the **PEAK** value is saved in the files of the logger (time-history) **- T** = T_b.

SPL function

The **SPL** function (**S**ound **P**ressure **L**evel) - gives an equivalent of the **Sound Level Meter** according to the **IEC 61672** standard (meeting the requirements for the **Type "1"** instrument). The value of the function depends on the weighting filter **W** (equal to **A**, **C**, **LIN** or **G**; *path: MENU / INPUT / CHANNELS SETUP / CHANNEL x - MODE: SOUND / CH x PROFILE y / FILTER*) and is calculated from the formula:

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

where:

T_1 - the last second of the measurement.

MAX result

The **MAX** result means the maximal value on the detector output for the integration period. The **MAX** result for the 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 logger (time-history) - $\mathbf{T} = \mathbf{T_b}$.

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 logger (time-history) - $\mathbf{T} = \mathbf{T_b}$.

LEQ function

The **LEQ** function enables the user to calculate the RMS value of sound pressure in the given 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 according to the formula:

$$\mathbf{LEQ} = \mathbf{20\ log}\left(\frac{\mathbf{1}}{\mathbf{T}}\int_{\mathbf{0}}^{\mathbf{T}}\left(\mathbf{r_W(t)}/\mathbf{p_0}\right)^{\mathbf{2}}\mathbf{dt}\right)^{\mathbf{1/2}}$$

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

Note: *For* $\mathbf{T} = \mathbf{T_b}$ *the* ***LEQ*** *values are saved in the files of the logger (time-history) as the* ***RMS*** *results (see below).*

RMS result

The **RMS** result, saved in the logger's file, is calculated according to the formula of the **LEQ** function. The value of the **RMS** result is calculated according to the formula:

$$\mathbf{RMS} = \mathbf{20\ log}\left(\frac{\mathbf{1}}{\mathbf{T_b}}\int_{\mathbf{0}}^{\mathbf{T_b}}\left(\mathbf{r_W(t)}/\mathbf{p_0}\right)^{\mathbf{2}}\mathbf{dt}\right)^{\mathbf{1/2}}$$

SEL result

The **SEL** result (Sound Exposure Level) is essentially the subset of the **LEQ** function. Its 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 according to the formula:

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

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 logger (time-history).

Ltm3 and Ltm5 results

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

Ld, **Le**, **Ln**, **Lde**, **Len**, **Lnd** and **Lden results**

Only one from the mentioned above results is contextually available in the instrument. It depends on the day and nighttime in which the measurement was performed. It is assumed that:

- the day-time (denoted as $\mathbf{T_d}$) starts at 6 am and ends at 6 pm or starts at 7 am and ends at 7 pm,
- the evening-time (denoted as $\mathbf{T_{ev}}$) starts at 6 pm and ends at 10 pm or starts at 7 pm and ends at 11 pm,
- the night-time (denoted as $\mathbf{T_n}$) starts at 10 pm and ends at 6 am or starts at 11 pm and ends at 7 am.

The mentioned above results are calculated from the following formulae:

$$\mathbf{Ld} = \mathbf{20\ log}\left(\frac{1}{T_d}\int_{T_d} (r_W(t)/p_0)^2 dt\right)^{1/2} \qquad (\mathbf{T_d} \neq 0,\ \mathbf{T_{ev}} = 0,\ \mathbf{T_n} = 0),$$

$$\mathbf{Le} = \mathbf{5\ dB} + \mathbf{20\ log}\left(\frac{1}{T_{ev}}\int_{T_{ev}} (r_W(t)/p_0)^2 dt\right)^{1/2} \qquad (\mathbf{T_d} = 0,\ \mathbf{T_{ev}} \neq 0,\ \mathbf{T_n} = 0),$$

$$\mathbf{Ln} = \mathbf{10\ dB} + \mathbf{20\ log}\left(\frac{1}{T_n}\int_{T_n} (r_W(t)/p_0)^2 dt\right)^{1/2} \qquad (\mathbf{T_d} = 0,\ \mathbf{T_{ev}} = 0,\ \mathbf{T_n} \neq 0),$$

$$\mathbf{Lde} = \mathbf{10\ log}\left[\frac{1}{12+4}\left(12\cdot 10^{Ld/10} + 4\cdot 10^{Le/10}\right)\right] \qquad (\mathbf{T_d} \neq 0,\ \mathbf{T_{ev}} \neq 0,\ \mathbf{T_n} = 0),$$

$$\mathbf{Len} = \mathbf{10\ log}\left[\frac{1}{4+8}\left(4\cdot 10^{Le/10} + 8\cdot 10^{Ln/10}\right)\right] \qquad (\mathbf{T_d} = 0,\ \mathbf{T_{ev}} \neq 0,\ \mathbf{T_n} \neq 0),$$

$$\mathbf{Lnd} = \mathbf{10\ log}\left[\frac{1}{8+12}\left(8\cdot 10^{Ln/10} + 12\cdot 10^{Ld/10}\right)\right] \qquad (\mathbf{T_d} \neq 0,\ \mathbf{T_{ev}} = 0,\ \mathbf{T_n} \neq 0),$$

$$\mathbf{Lden} = \mathbf{10\ log}\left[\frac{1}{12+8+4}\left(12\cdot 10^{Ld/10} + 4\cdot 10^{Le/10} + 8\cdot 10^{Ln/10}\right)\right] \qquad (\mathbf{T_d} \neq 0,\ \mathbf{T_{ev}} \neq 0,\ \mathbf{T_n} \neq 0).$$

LEPd result

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

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

OVL result

The **OVL** result (Overload) presents the percentage of the overloaded input signal, which occurred during the selected $\mathbf{T_c}$ - measurement time set in the **INT. PERIOD** (*path: MENU / INPUT / MEASUREMENT SETUP / INT. PERIOD*).

Statistical Levels Ln

The noise level **L(t)** is the continuous random variable. The probability that the temporary noise level **L(t)** belongs to the interval $\langle L_k, L_k + \Delta L \rangle$ is called the class density and it can be expressed by the equation:

$$P_k[L_k \le L(t) \le L_k + \Delta L] = \sum_{i=1}^{n} \Delta t_i \Big/ P$$

where:

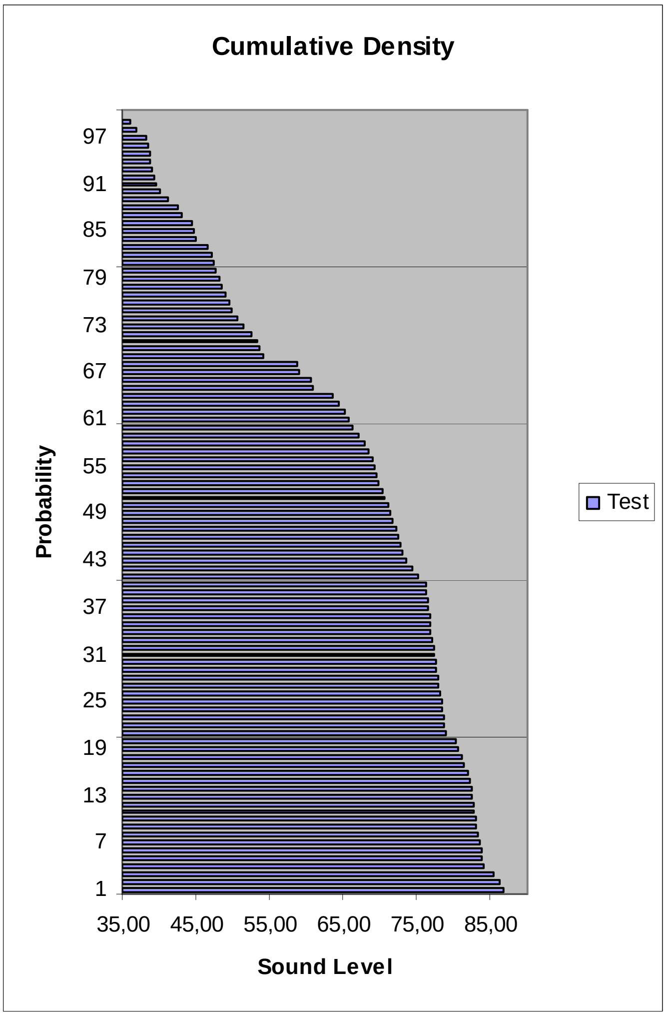
Δt_i - time intervals, in which the noise level $L(t) \in \langle L_k, L_k + \Delta L \rangle$ occurs,

ΔL - so-called class interval or distribution class of the series,

P - total observation period.

In the case when the class interval approaches infinity, the probability of **L(t)** tends to the probability of L_k. In practice, ΔL value is strictly determined and it depends mainly on the dynamics of the measurements performed in the instrument. In the SVAN 95x instrument, there are 120 classes and the width of each class is equal to 1 dB.

The histogram is the set of the class-density values calculated for all classes. In the SVAN 95x instrument the histogram is saved in the result files if the **SAVE STATISTICS** (*path: MENU / FILE / SAVE OPTIONS / SAVE STATISTICS*) is activated (cf. the detailed description of the relevant table in App. B).



The statistical distribution function, which determines the probability (expressed in %) of the noise occurrence on the level equal or less than $L_k + \Delta L$ is given by the formulae:

$$P[L(t) \le L_j] = \sum_{k=1}^{j} P_k(L)$$

The cumulative density function, expressed by the equation:

$$P[L(t) > L_j] = 1 - P[L(t) \le L_j]$$

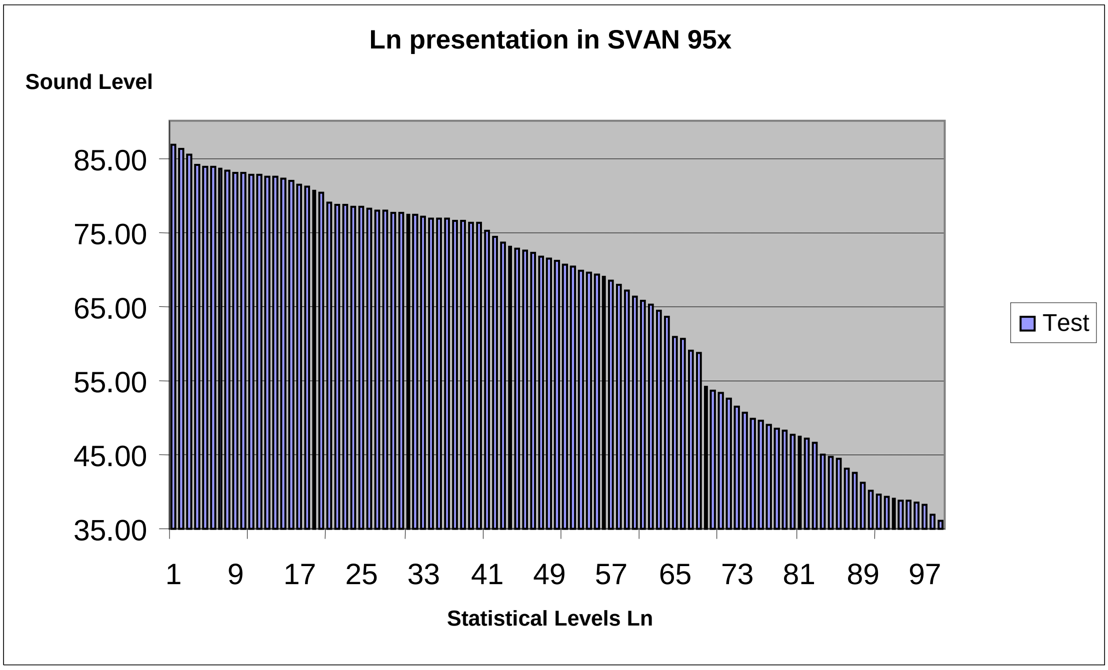
is directly used to determine so-called statistical levels **Ln** or position parameters of the distribution.

The **Ln** is the certain boundary level surpassed by the temporary noise level values in not more than **n%** of the observation period.

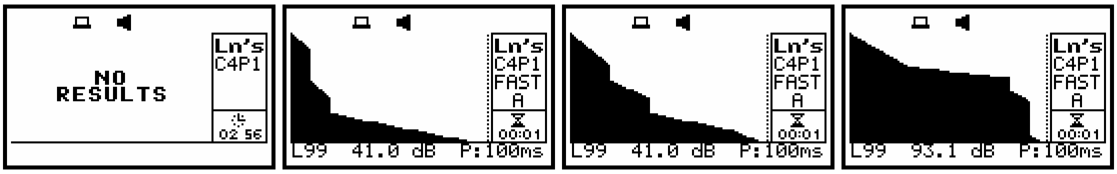
Example: Let us assume that **L35** is equal to 76.8 dB. It means that during the measurements the noise level 76.8 dB was exceeded in not more than 35% of the observation period.

The cumulative density function for the exemplary data is presented in Figure on the right side. In order to determine the **Ln** level one has to draw the horizontal cursor and find out the crossing point between the cumulative density function and the cursor. In the SVAN 95x instruments the user can determine 99 statistical levels - from **L01** to **L99** (1% step of observation period).

The display in the SVAN 95x instrument has only 64 pixels on the vertical axis and 128 on the horizontal one. It is obvious that the change of the axes is more suitable for the presentation of 99 statistical levels. In this case, the user has to draw the vertical cursor and the value on it gives the required statistical level (the value of the noise level, which happened during the performed measurements in not more than selected percentage of the observation period).

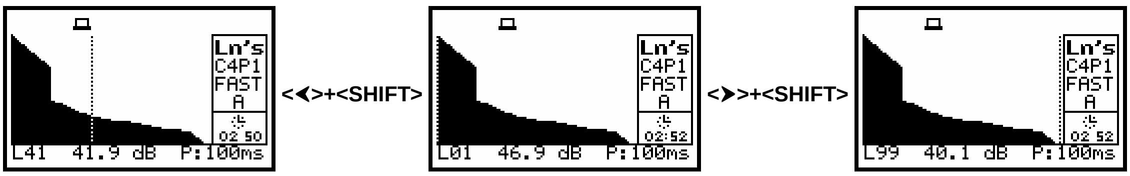


The statistical levels are available in the SVAN 958 instrument after the selection of the statistics presentation mode made by pressing **<˅>** push-button from the main results presentation mode. The **Ln** values, selected by the cursor, are displayed in the bottom line together with its value and units (dB). The P value indicating the observation period equal to 100 ms (it means that the statistical results are updated every 100 ms) is placed at the end of the bottom line. The channel's number and profile's number the statistics are taken from (CxPy - in the SVAN 958 statistics are taken always from the first profile/profiles), the RMS detector (**Lin.** or **Exp.**: **Fast**, **Slow** or **Imp**.), the filter's name (**A**, **C**, **LIN** or **G**) and real-time clock are displayed on the right side of the display. The selection of the channel is made by pressing the **<Shift>** and **<˄>** or the **<Shift>** and **<˅>** push-buttons.



Results presented in the statistics presentation mode

The selection of the **Ln** to be displayed is done by pressing the **<❮>**, **<❯>** push-buttons. The statistics **L01** is immediately available after pressing the **<Shift>** and **<❮>** while the **L99** - after pressing the **<Shift>** and **<❯>** push-buttons.



Results presented in the statistics presentation mode; the selection of the statistical level

D.1.3. Definitions of the results measured in dosimeter mode

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:

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

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:

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

LAV result

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

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

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 **RMS INTEGRATION** - *path: MENU / SETUP / RMS INTEGRATION*).

TLAV result

The **TLAV** result is the average level of the acoustic pressure of the measurement. This result is calculated from the formula:

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

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:

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

PSEL result

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

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

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:

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

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

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).

D.1.4. Definitions of the quantities measured in vibration mode

PEAK value

The **PEAK** value is calculated for the given **T** from the formula:

$$\mathbf{PEAK} = \mathbf{max_T} |\mathbf{a_W(t)}|$$

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

P–P value

The **P–P** result, saved in the logger’s file, is calculated according to the formula:

$$\mathbf{P - P} = \mathbf{max_T(0, a_W(t))} - \mathbf{min_T(0, a_W(t))}$$

For the **P–P** result saved in the files of the logger (time-history) **-** $\mathbf{T} = \mathbf{T_b}$**.**

MAX result

The **MAX** result, saved in the logger’s file, is calculated according to the formula:

$$\mathbf{MAX} = \mathbf{max_{T_b}(p_W(t))}$$

The **MAX** main result is calculated according to the formula:

$$\mathbf{MAX} = \mathbf{max_T(p_W(t))} \quad \text{for } \boldsymbol{\tau} \neq \mathbf{1} \text{ second}$$

MTVV result

The **M**aximum **T**ransient **V**ibration **V**alue **- MTVV**, saved as the main result, is defined (according to the **ISO 8041** standard) as:

$$\mathbf{MTVV} = \mathbf{max_T(p_W(t))} \quad \text{for } \boldsymbol{\tau} = \mathbf{1} \text{ second}$$

RMS result

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

$$\mathbf{RMS} = \left(\frac{1}{T} \int_0^T r_W^2(t)\, dt \right)^{1/2}$$

For the **RMS** result saved in the files of the logger (time-history) - **T** = $\mathbf{T_b}$.

VDV result

The fourth power of the vibration dose value (**VDV**) expressed in meters per second taken to the power of 1.75 ($m/s^{1.75}$) is calculated from the formula:

$$\mathbf{VDV} = \left(\int_0^T r_W^4(t)\, dt \right)^{1/4}$$

D.1.4.1 Definitions of the Hand-Arm vibration results available in the vibration mode

Symbol definitions

$$\mathbf{AEQ} = \sqrt{RMS_x^2 + RMS_y^2 + RMS_z^2}$$

T_0 - Reference duration of 28 800 seconds (8 hours)
T_E - Exposure time
T - Measurement time
EAV - **E**xposure **A**ction **V**alue
ELV - **E**xposure **L**imit **V**alue

Current Exposure result

The **Current Exposure** result is calculated according to the formula:

$$\mathbf{CExp} = \mathbf{AEQ}\sqrt{\frac{T}{T_0}}$$

Daily Exposure result

The **Daily Exposure** result is calculated according to the formula:

$$\mathbf{A(8)} = \mathbf{AEQ}\sqrt{\frac{T_E}{T_0}}$$

EAV Total Time result

The **EAV Total Time** result is calculated according to the formula:

$$\mathbf{EAV_{TT}} = T_0\left(\frac{EAV}{AEQ}\right)^2$$

EAV Time Left Result

The **EAV Time Left** result is calculated according to the formula:

$$EAV_{TL} = EAV_{TT} - T$$

ELV Total Time result

The **ELV Total Time** result is calculated according to the formula:

$$ELV_{TT} = T_0 \left(\frac{ELV}{AEQ} \right)^2$$

ELV Time Left Result

The **ELV Time Left** result is calculated according to the formula:

$$ELV_{TL} = ELV_{TT} - T$$

D.1.4.2 Definitions of the Whole-Body vibration results available in the vibration mode

Symbol definitions

$$VDV_{WB} = \max\{1.4VDV_x, 1.4VDV_y, VDV_z\}$$

$$RMS_{WB} = \max\{1.4RMS_x, 1.4RMS_y, RMS_z\}$$

T_0 - Reference duration of 28 800 seconds (8 hours)
T_E - Exposure time
T - Measurement time
EAV_A - **E**xposure **A**ction **V**alue expressed in $\frac{m}{s^2}$
ELV_A - **E**xposure **L**imit **V**alue expressed in $\frac{m}{s^2}$
EAV_V - **E**xposure **A**ction **V**alue expressed in $\frac{m}{s^{1.75}}$
ELV_V - **E**xposure **L**imit **V**alue expressed in $\frac{m}{s^{1.75}}$

Current Exposure result

The **Current Exposure** result is calculated according to the formula:

$$CExp = RMS_{WB} \sqrt{\frac{T}{T_0}}$$

Daily Exposure result

The **Daily Exposure** result is calculated according to the formula:

$$A(8) = RMS_{WB} \sqrt{\frac{T_E}{T_0}}$$

Current Dose result

The **Current Dose** result is calculated according to the formula:

$$\mathbf{CDose} = \mathbf{VDV_{WB}}$$

Daily Dose result

The **Daily Dose** result is calculated according to the formula:

$$\mathbf{DDose} = \mathbf{VDV_{WB}}\sqrt[4]{\frac{\mathbf{T_E}}{\mathbf{T}}}$$

EAV Total Time result

The **EAV Total Time** result is calculated according to the formula:

$$\mathbf{EAV_{TTA}} = \mathbf{T_0}\left(\frac{\mathbf{EAV_A}}{\mathbf{RMS_{WB}}}\right)^2$$

$$\mathbf{EAV_{TTV}} = \mathbf{T}\left(\frac{\mathbf{EAV_V}}{\mathbf{VDV_{WB}}}\right)^4$$

$$\mathbf{EAV_{TT}} = \begin{cases} \mathbf{EAV_{TTA}} \ \textbf{if EAV limit is in } \dfrac{\mathbf{m}}{\mathbf{s^2}} \\ \mathbf{EAV_{TTV}} \ \textbf{if EAV limit is in } \dfrac{\mathbf{m}}{\mathbf{s^{1.75}}} \end{cases}$$

EAV Time Left Result

The **EAV Time Left** result is calculated according to the formula:

$$\mathbf{EAV_{TL}} = \mathbf{EAV_{TT}} - \mathbf{T}$$

ELV Total Time result

The **ELV Total Time** result is calculated according to the formula:

$$\mathbf{ELV_{TTA}} = \mathbf{T_0}\left(\frac{\mathbf{ELV_A}}{\mathbf{RMS_{WB}}}\right)^2$$

$$\mathbf{ELV_{TTV}} = \mathbf{T}\left(\frac{\mathbf{ELV_V}}{\mathbf{VDV_{WB}}}\right)^4$$

$$\mathbf{ELV_{TT}} = \begin{cases} \mathbf{ELV_{TTA}} \ \textbf{if ELV limit is in } \dfrac{\mathbf{m}}{\mathbf{s^2}} \\ \mathbf{ELV_{TTV}} \ \textbf{if ELV limit is in } \dfrac{\mathbf{m}}{\mathbf{s^{1.75}}} \end{cases}$$

ELV Time Left Result

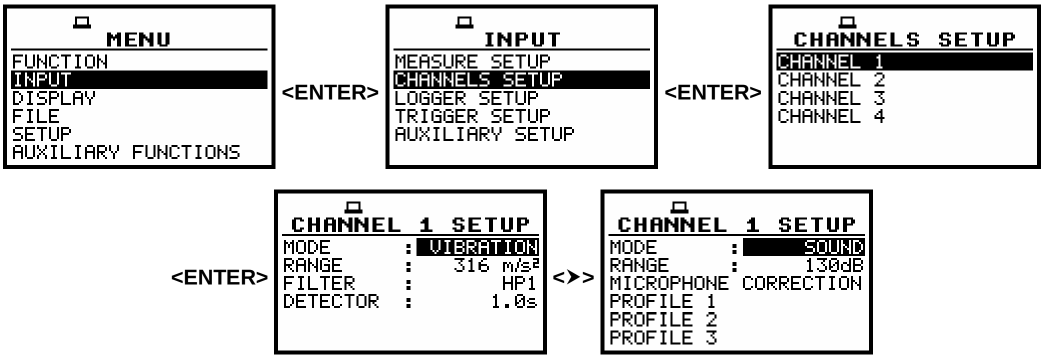
The **ELV Time Left** result is calculated according to the formula:

$$\mathbf{ELV_{TL}} = \mathbf{ELV_{TT}} - \mathbf{T}$$

D.2. Digital filters implemented in the SVAN 958 instrument

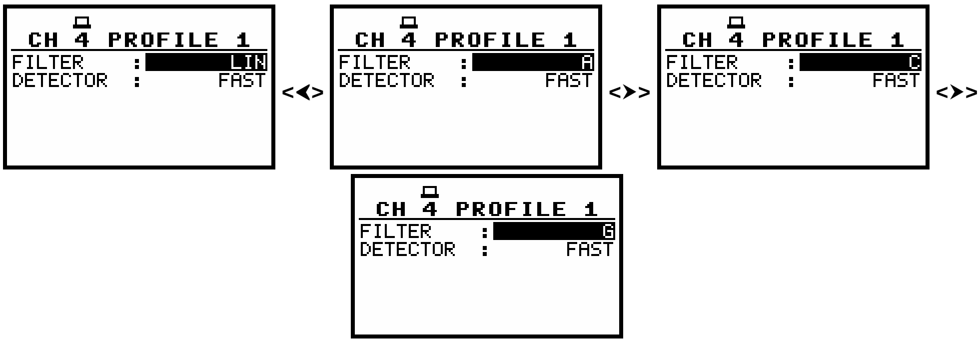
D.2.1. Digital weighting filters implemented in sound mode

The sound mode is selected in the *MENU / INPUT / CHANNELS SETUP / CHANNEL x* window (***MODE: SOUND***). Default setting of the fourth channel is **SOUND** mode.



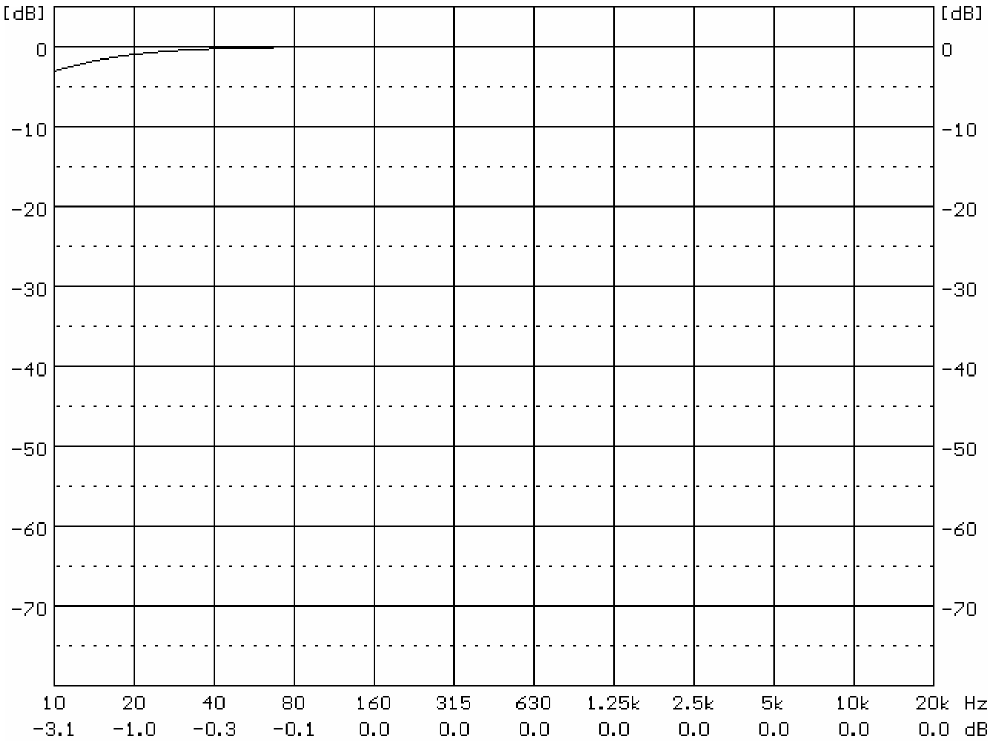
MENU, INPUT and CHANNEL 1 SETUP windows; sound mode selection

The weighting filters, which are available in the sound mode (**LIN**, **A**, **C** and special filter **G** dedicated for infrasound) are selected in the *MENU / INPUT / CHANNEL x / CH x PROFILE y* windows.

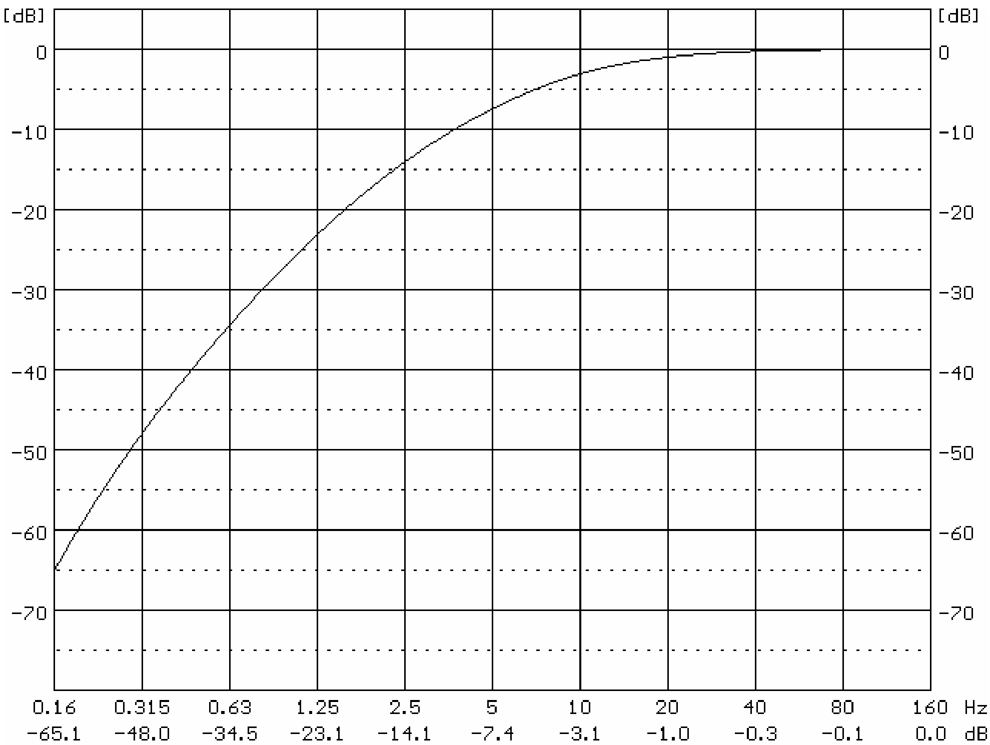


CH 4 PROFILE 1 windows; weighting filter selection

LIN: cut-off frequency: 10.0 Hz / -3.0 dB

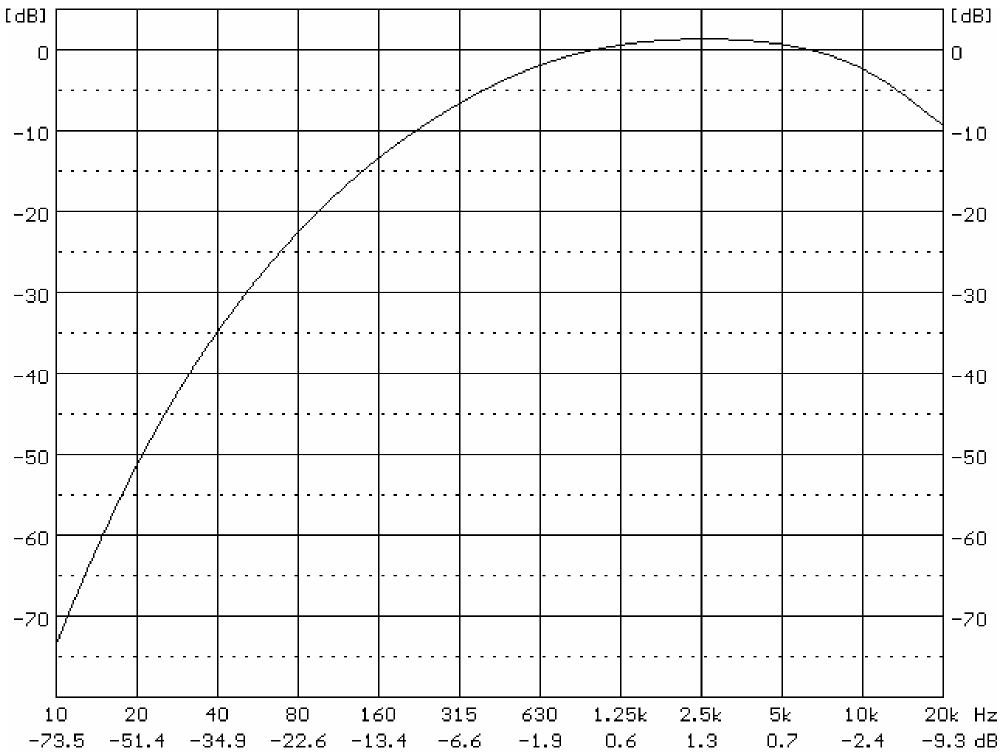


Full band frequency characteristics of the LIN filter implemented in the instrument



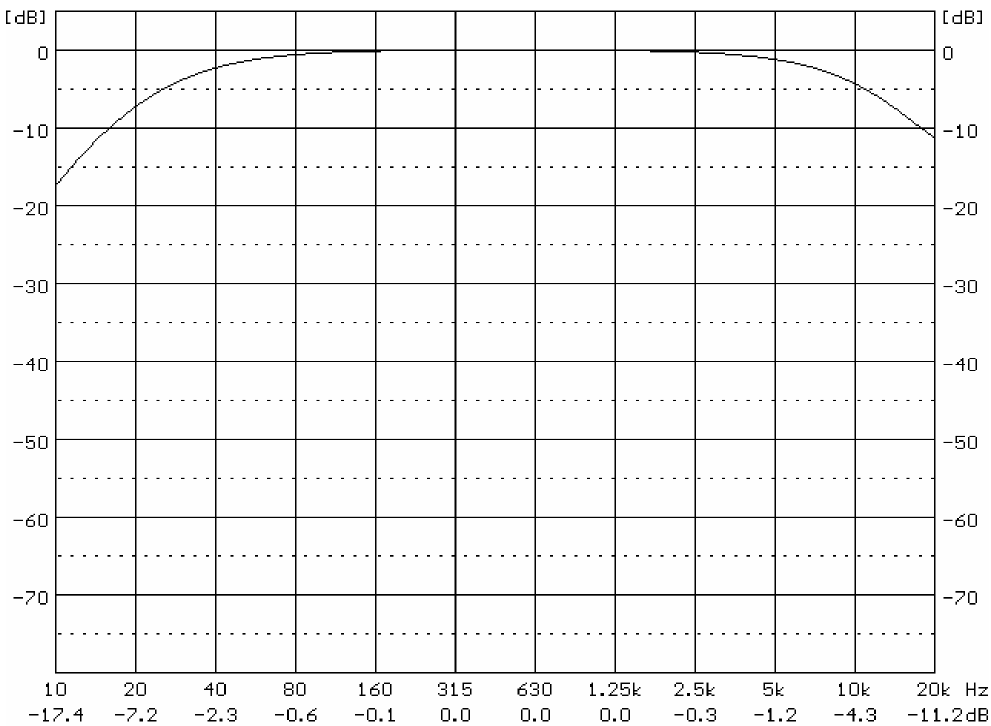
Low band frequency characteristics of the LIN filter implemented in the instrument

A type 1 according to the IEC 61672:2002 standard.



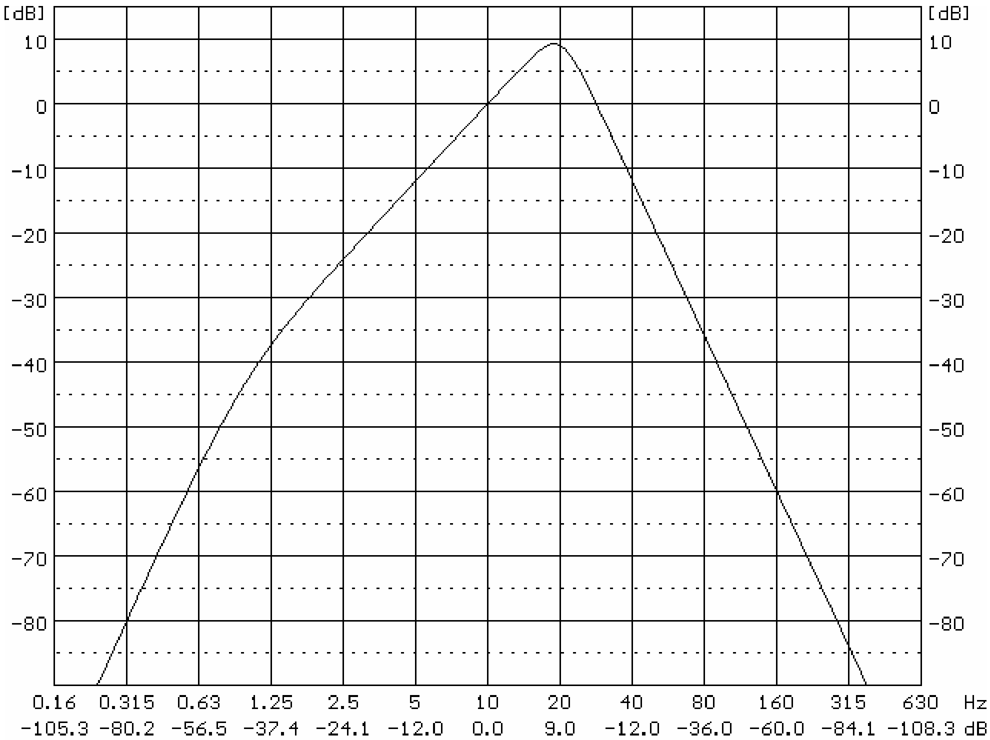
Frequency characteristics of the A filter implemented in the instrument

C type 1 according to the IEC 61672:2002 standard.



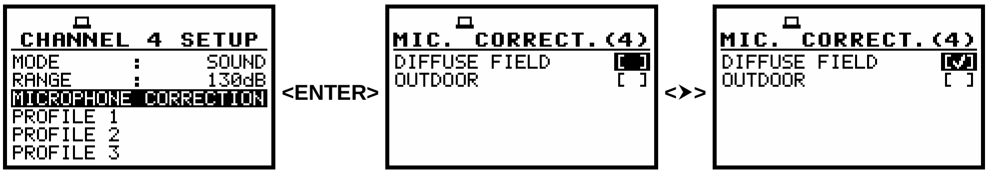
Frequency characteristics of the C filter implemented in the instrument

G type 1 according to the ISO 7196:1995 standard.

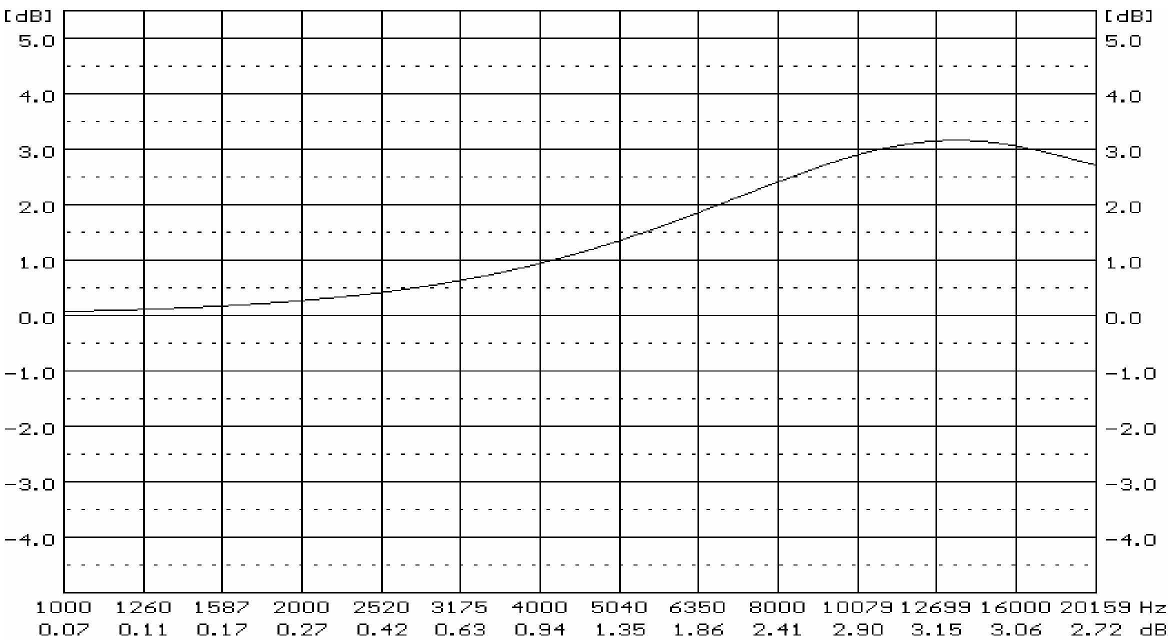


Frequency characteristics of G filter implemented in the instrument

The **DIFFUSE FIELD** filter is switched on in the *MENU / INPUT / CHANNELS SETUP / CHANNEL x / MICROPHONE CORRECTION / DIFFUSE FIELD*.

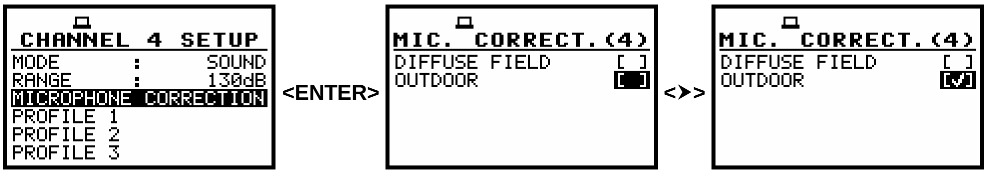


CHANNEL 4 SETUP and MIC. CORRECT. windows; the activation of DIFFUSE FIELD filter

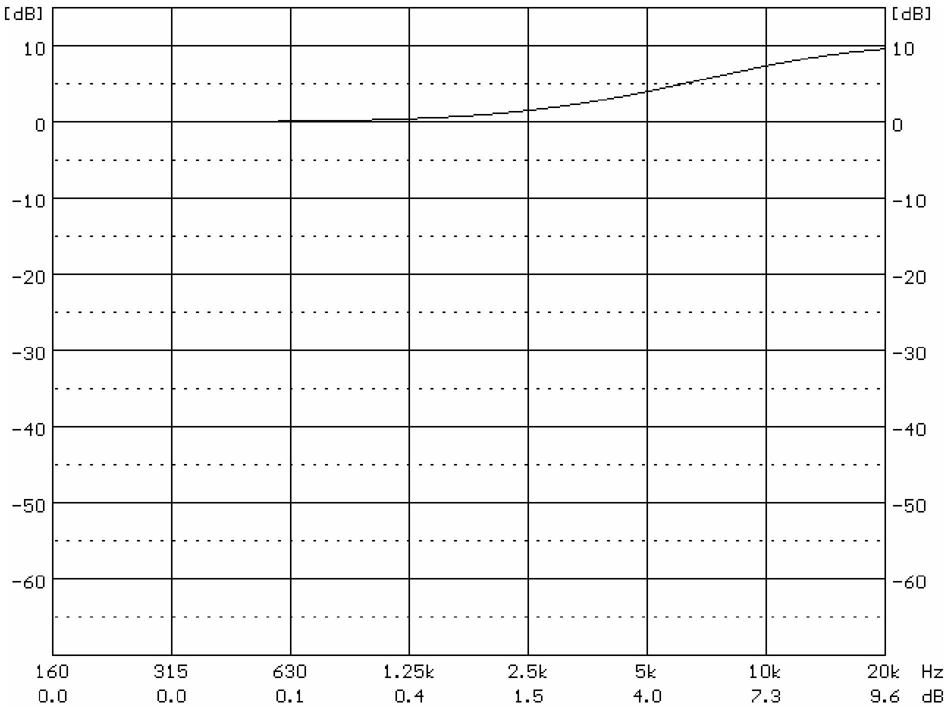


Frequency characteristics of the DIFFUSE FIELD filter implemented in the instrument

The **OUTDOOR** filter is switched on in the *MENU / INPUT / CHANNELS SETUP / CHANNEL x / MICROPHONE CORRECTION / OUTDOOR*.



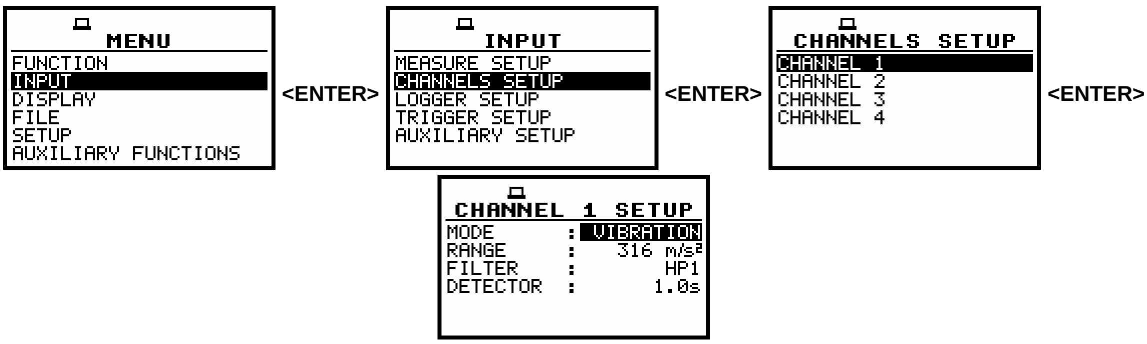
CHANNEL 4 SETUP and MIC. CORRECT. windows; the activation of OUTDOOR filter



Frequency characteristics of the OUTDOOR (ENVIRONMENTAL) filter implemented in the instrument

D.2.2. Digital weighting filters implemented in vibration mode

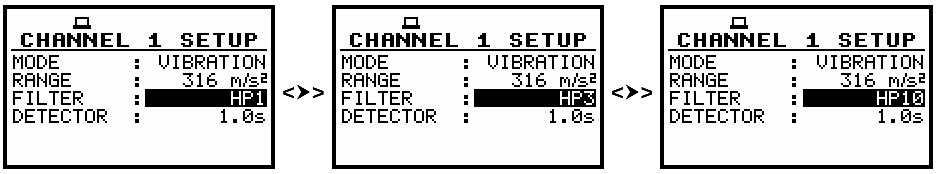
The vibration mode of the **SVAN 958** instrument is selected in the *MENU / INPUT / CHANNEL x (**MODE: VIBRATION**)*.



MENU, INPUT and CHANNEL 1 SETUP windows; vibration mode selection

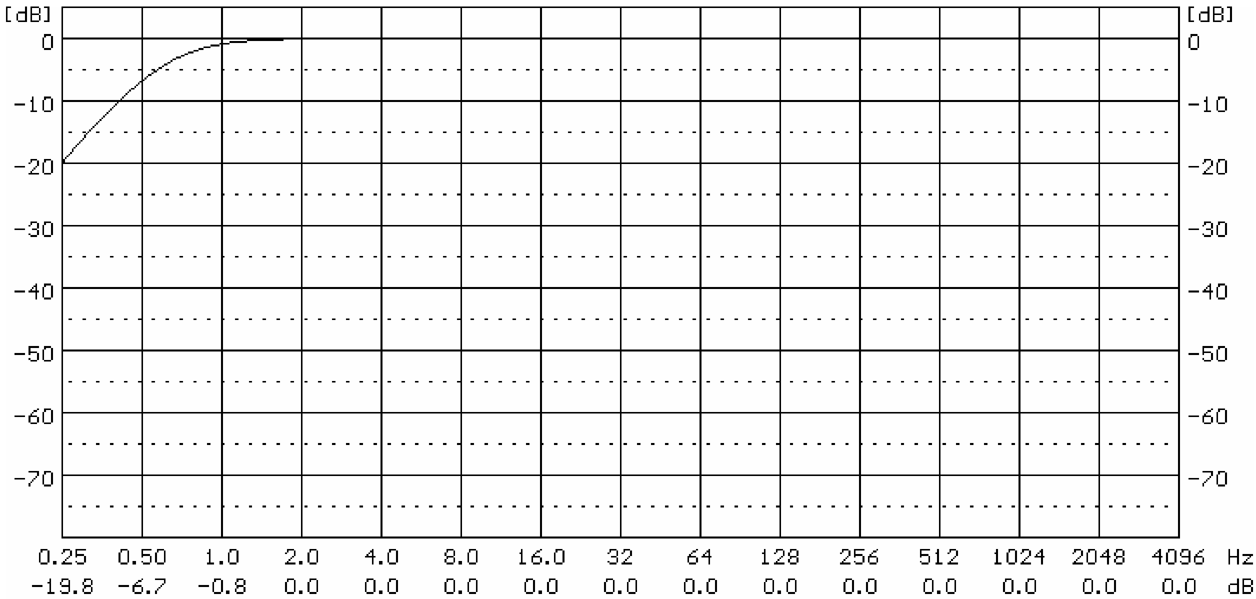
D.2.2.1. Digital filters implemented in vibration mode for acceleration measurements

The weighting filters, which are available in vibration mode, are selected in the *MENU / INPUT / CHANNEL x* windows. The first three of them (**HP1**, **HP3**, and **HP10**) are dedicated for the acceleration measurements of the vibration signal in the different frequency ranges.



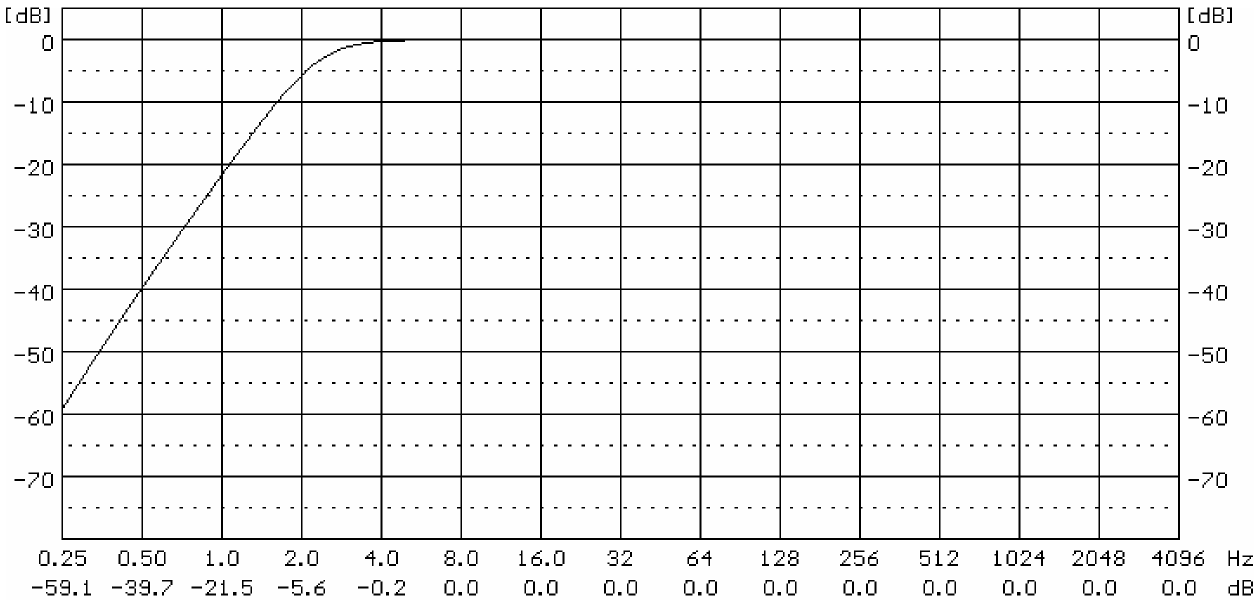
CHANNEL 1 SETUP windows; high-pass filter selection in acceleration measurements

The **HP1** filter is used for the acceleration measurements (the vibration signal) in the frequency range from 1 Hz to 20 kHz.



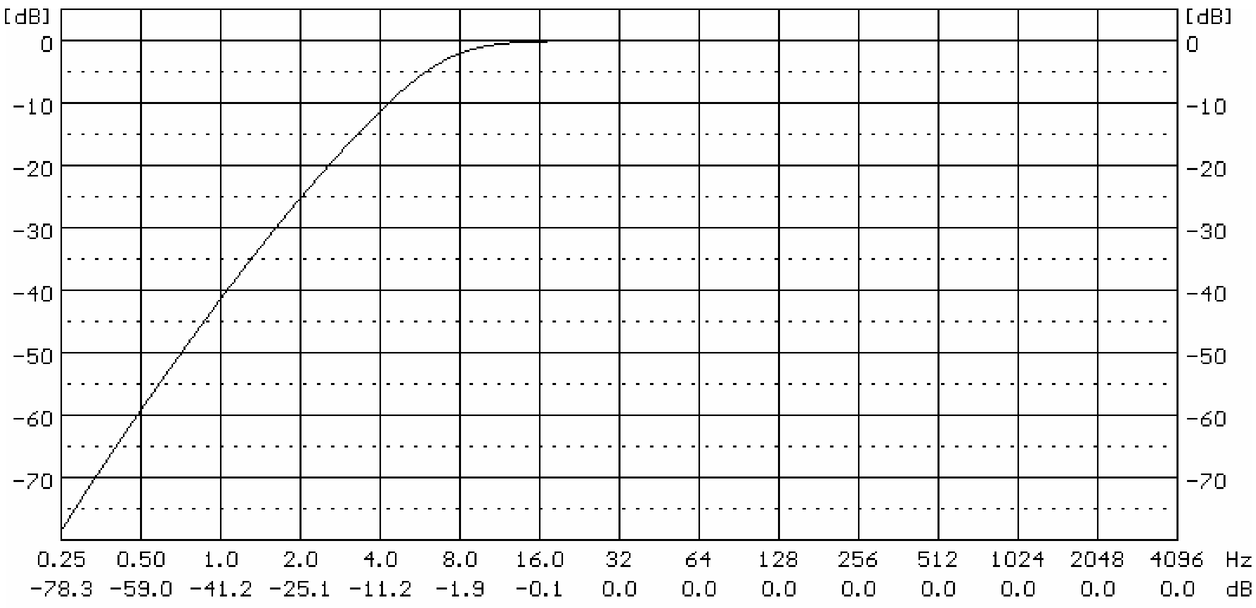
Characteristics of the HP1 digital filter implemented for the acceleration measurements in the VM

The **HP3** filter is used for the acceleration measurements (the vibration signal) in the frequency range from 3.5 Hz to 20 kHz.



Characteristics of the HP3 digital filter implemented for the acceleration measurements in the VM

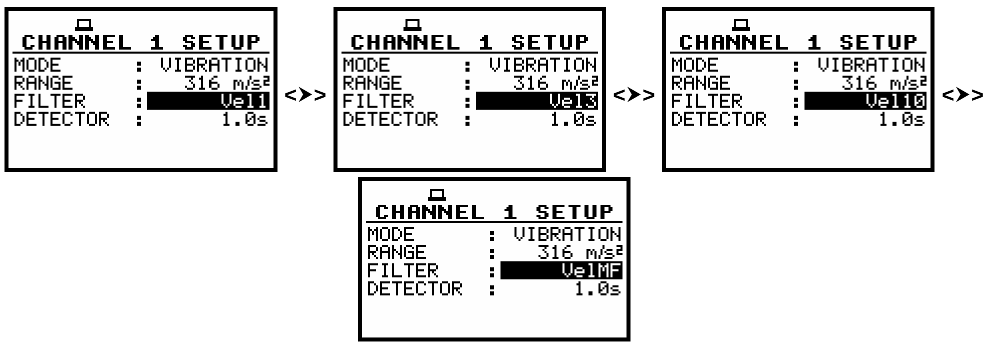
The **HP10** filter is used for the acceleration measurements (the vibration signal) in the frequency range from 10 Hz to 20 kHz.



Characteristics of the HP10 digital filter implemented for the acceleration measurements in the VM

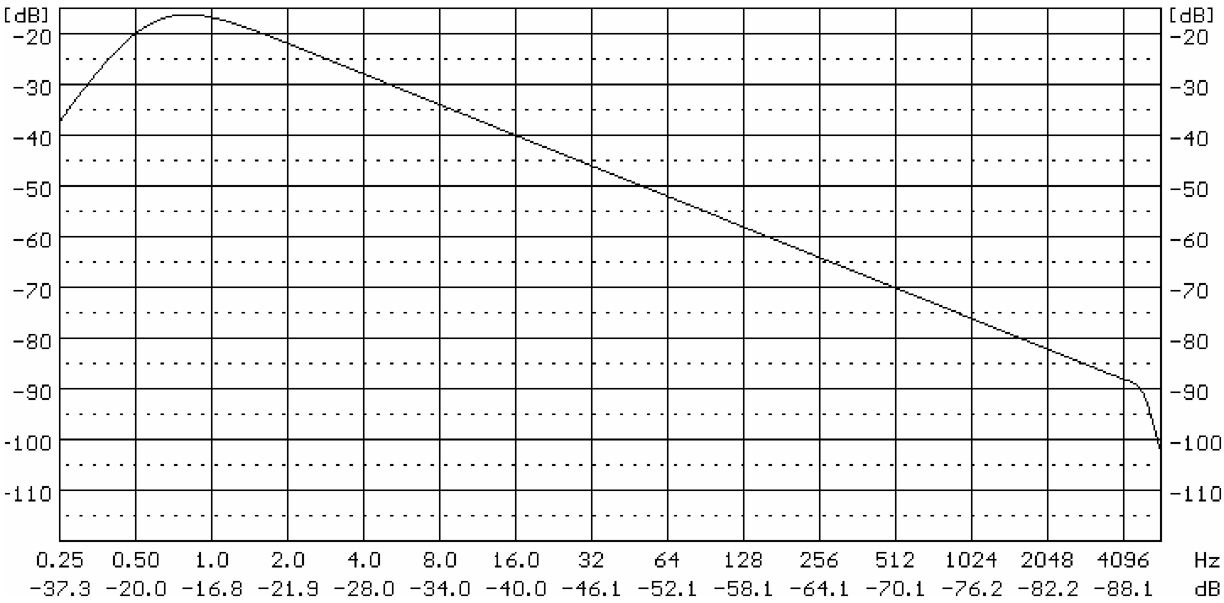
D.2.2.2. Digital filters implemented in vibration mode for velocity measurements

The following four filters (**Vel1**, **Vel3**, **Vel10** and **VelMF**) are dedicated for the velocity measurements of the vibration signal in the different frequency ranges.



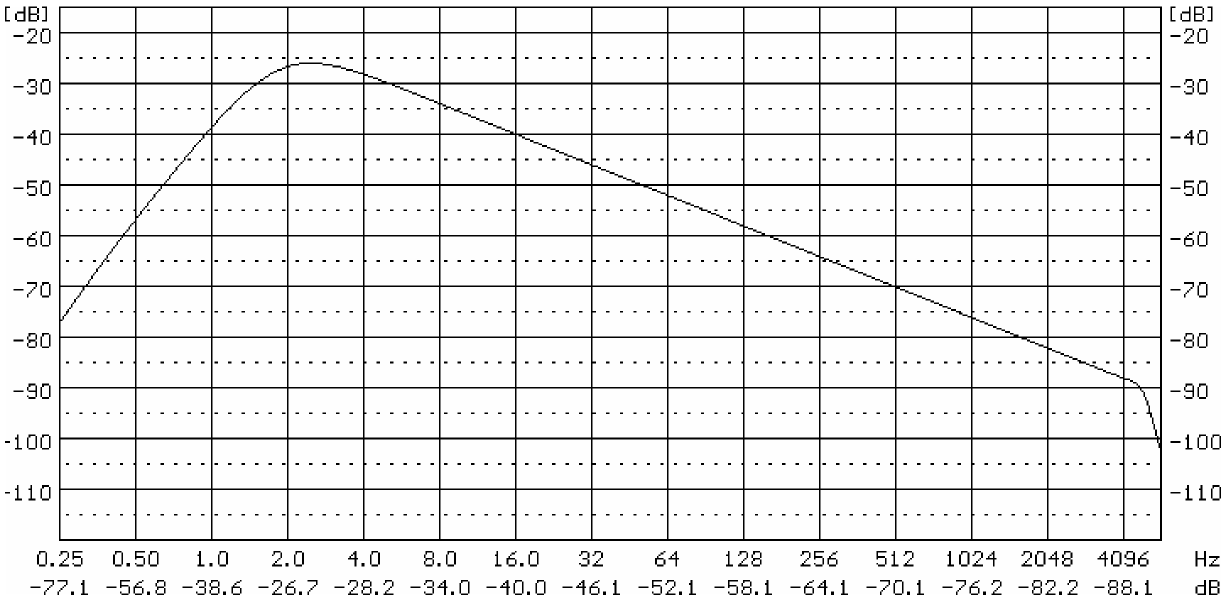
CHANNEL 1 SETUP windows; weighting filters in velocity measurements

The **Vel1** filter is used for the velocity measurements (the vibration signal) in the frequency range from 1 Hz to 20 kHz.



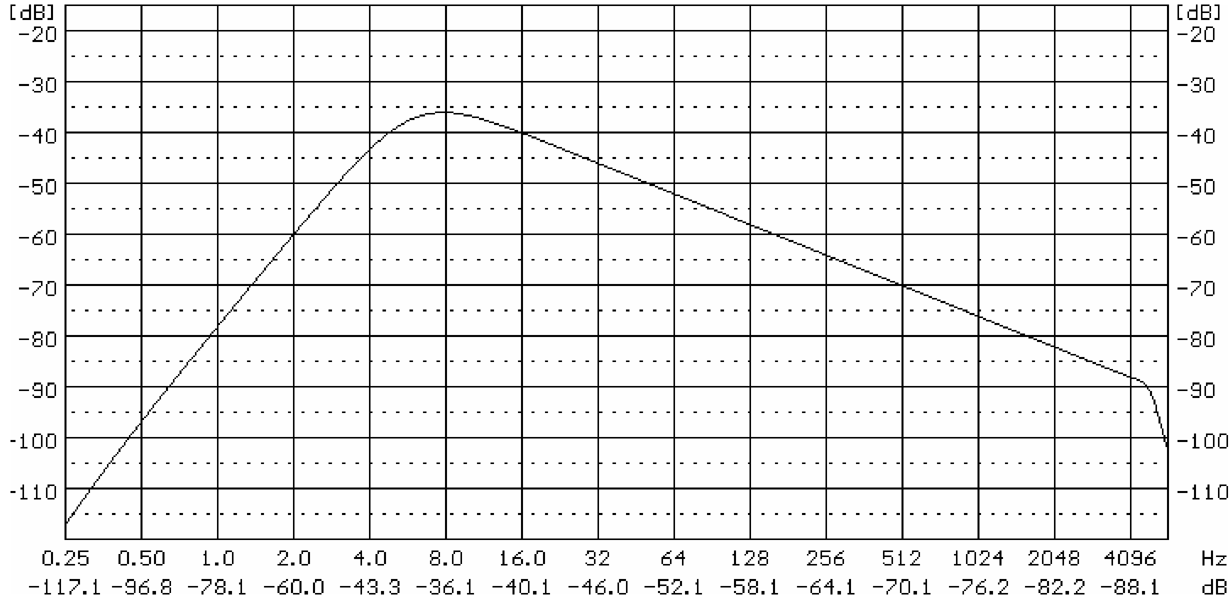
Characteristics of the Vel1 digital filter implemented for the velocity measurements in the VM

The **Vel3** filter is used for the velocity measurements in the frequency range from 1 Hz to 20 kHz.



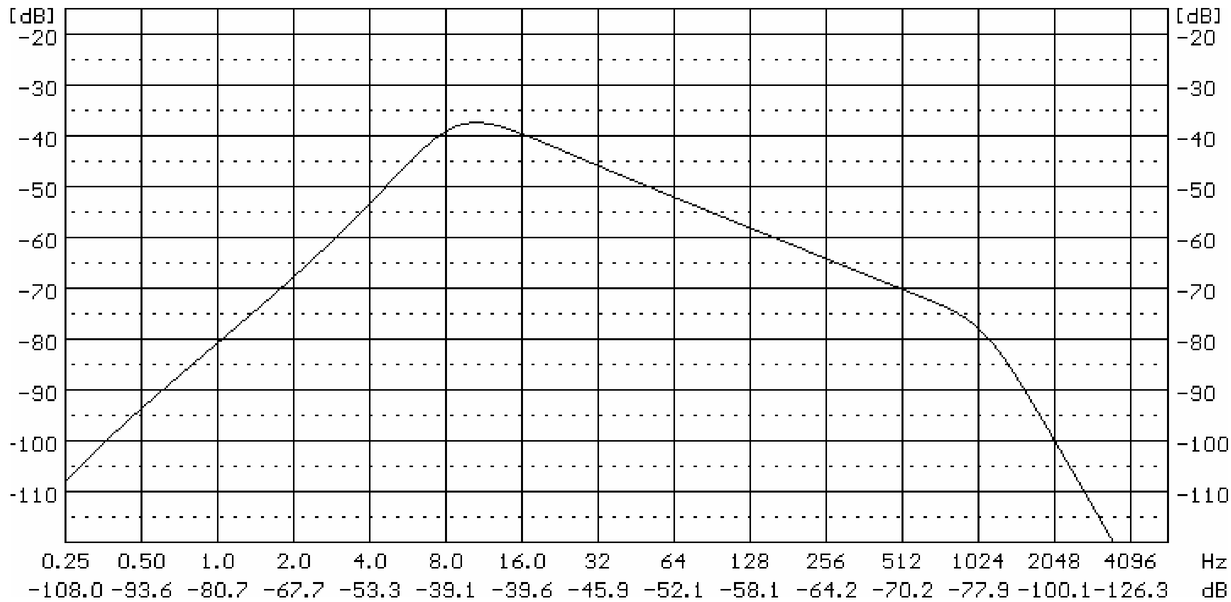
Characteristics of the Vel3 digital filter implemented for the velocity measurements in the VM

The **Vel10** filter is used for the velocity measurements in the frequency range from 1 Hz to 20 kHz.



Characteristics of the Vel10 digital filter implemented for the velocity measurements in the VM

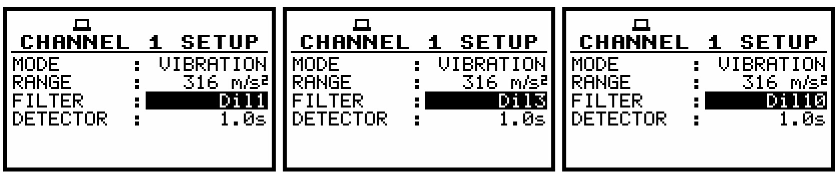
The **VelMF** filter is used for the evaluation of the state of the machines. This filter is used for the measurements in the frequency range from 10 Hz to 1000 Hz and conforms to the ISO 10816 standard.



Characteristics of the VelMF digital filter implemented for the velocity measurements in the VM

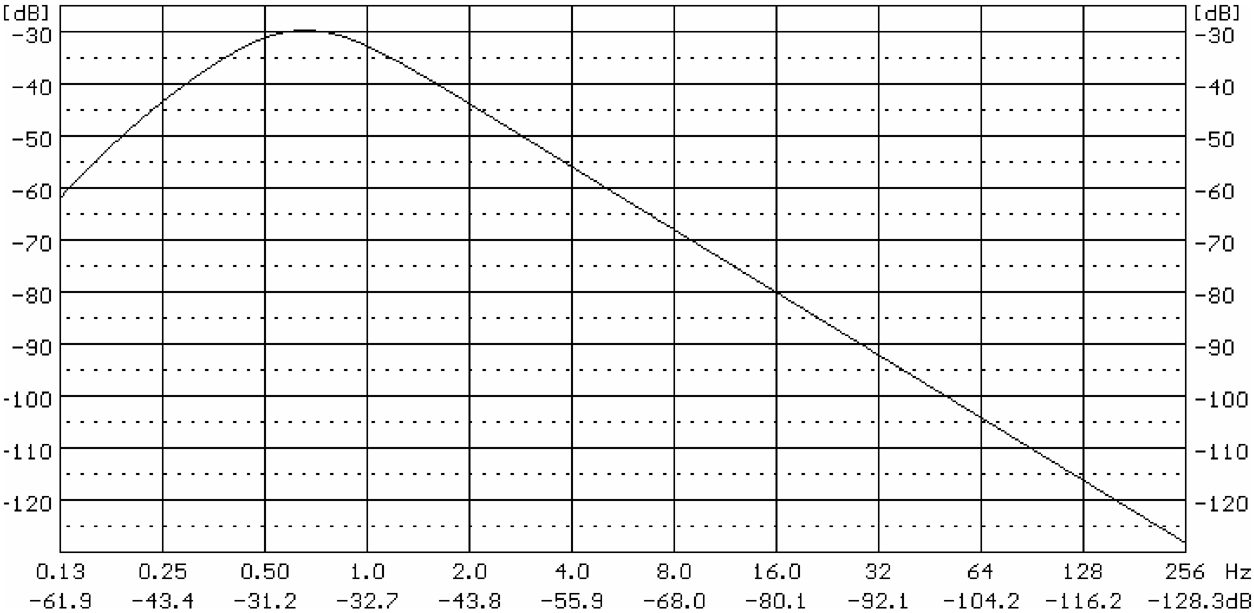
D.2.2.3. Digital filters implemented in vibration mode for displacement measurements

The following three filters (**Dil1**, **Dil3** and **Dil10**) are dedicated for the displacement measurements of the vibration signal in the different frequency ranges.



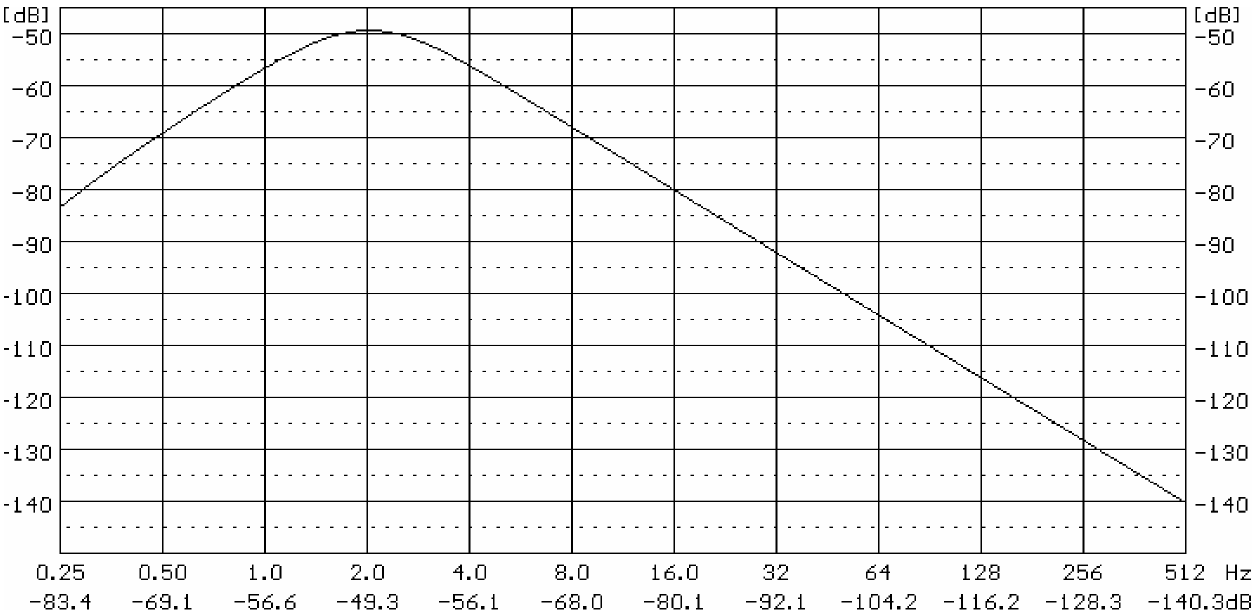
PROFILE(1) windows; the selection of the weighting filter in displacement measurements

The **Dil1** filter is used for the displacement measurements in the frequency range [1 Hz to 20 kHz].



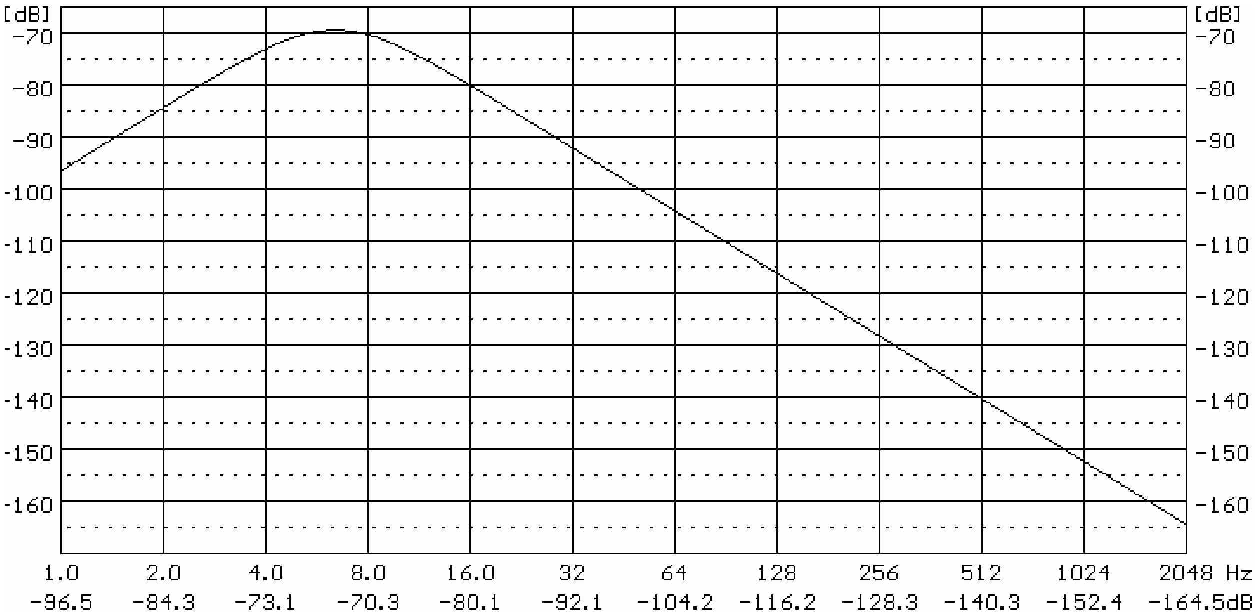
Characteristics of the Dil1 digital filter implemented for the displacement measurements in the VM

The **Dil3** filter is used for the displacement measurements in the frequency range [1 Hz to 20 kHz].



Characteristics of the Dil3 digital filter implemented for the displacement measurements in the VM

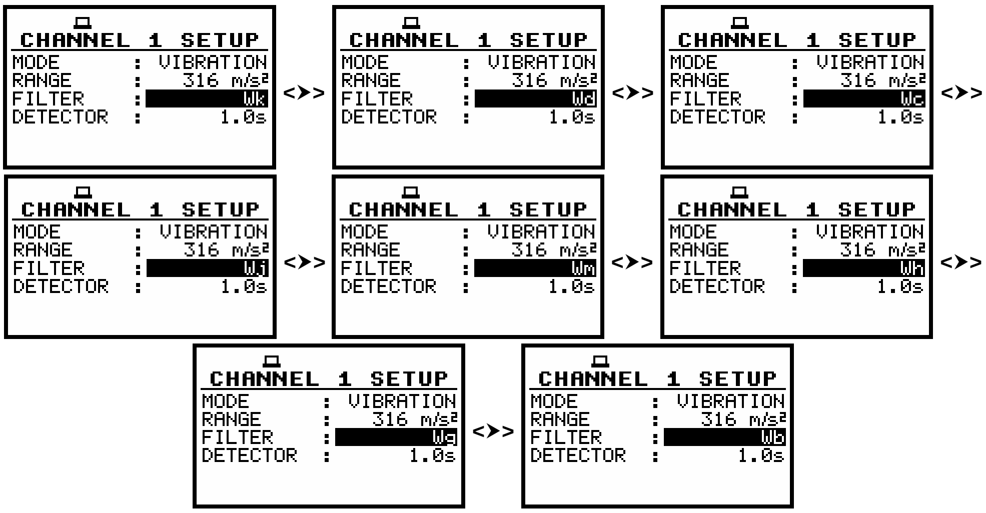
The **Dil10** filter is used for the displacement measurements in the frequency range [1 Hz to 20 kHz].



Characteristics of the Dil10 digital filter implemented for the displacement measurements in the VM

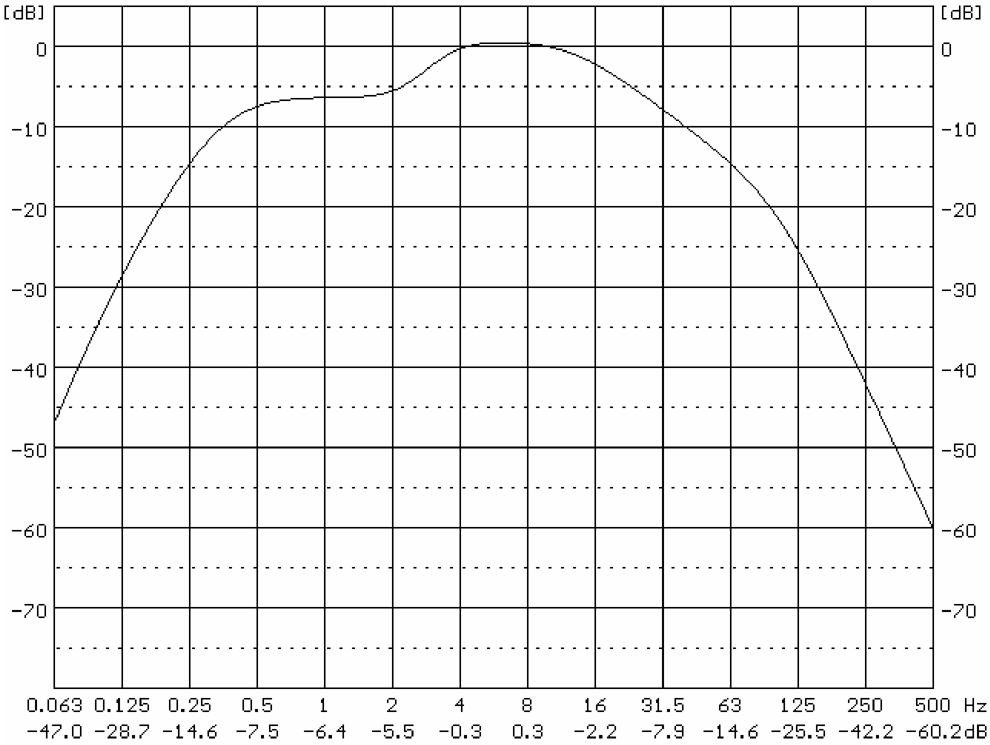
D.2.2.4. Digital filters used in HUMAN VIBRATION investigations

The **HUMAN VIBRATION FILTERS** (**Wk**, **Wd**, **Wc**, **Wj**, **Wm**, **Wh**, **Wg** and **Wb**). are in the standard set of the **SVAN 958**. The filters conform to ISO 8041:2005 standard They are currently used in many countries for the assessment of the influence of the vibration signal on the human body.



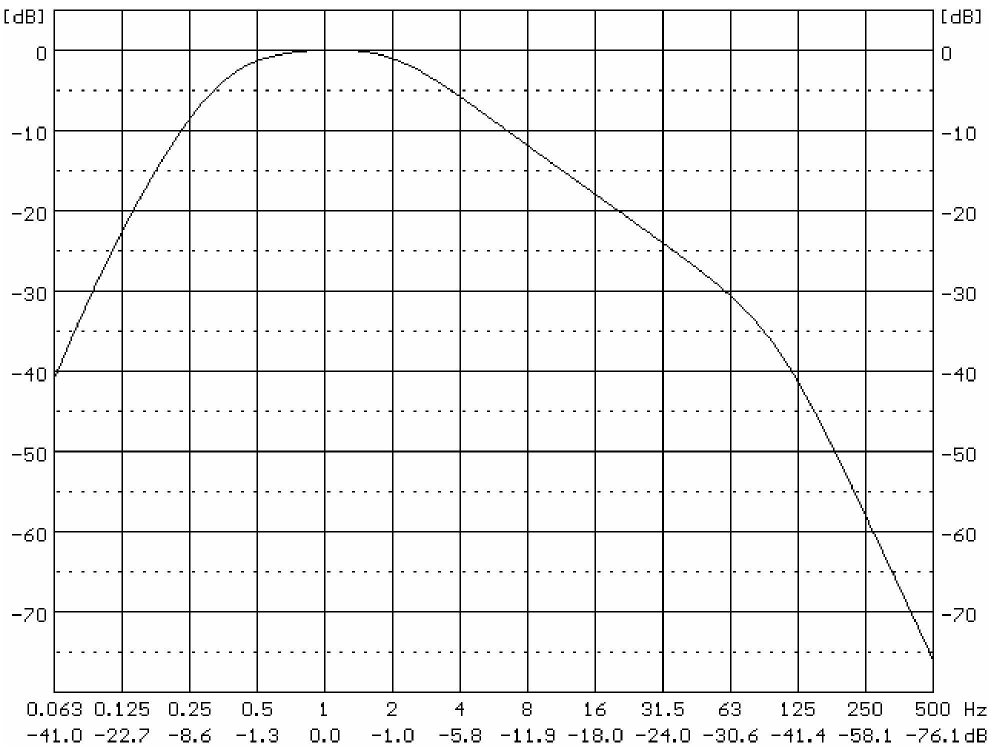
CHANNEL 1 SETUP windows; weighting filters for human vibration measurements

The mentioned above filters can be set in the same manner as other filters, in the **CHANNEL x** windows.The **Wk** filter is used for the assessment of the influence of the vibration signal on the human body in the ***z*** direction and for vertical recumbent direction. It conforms to the ISO 8041:2005 standard.



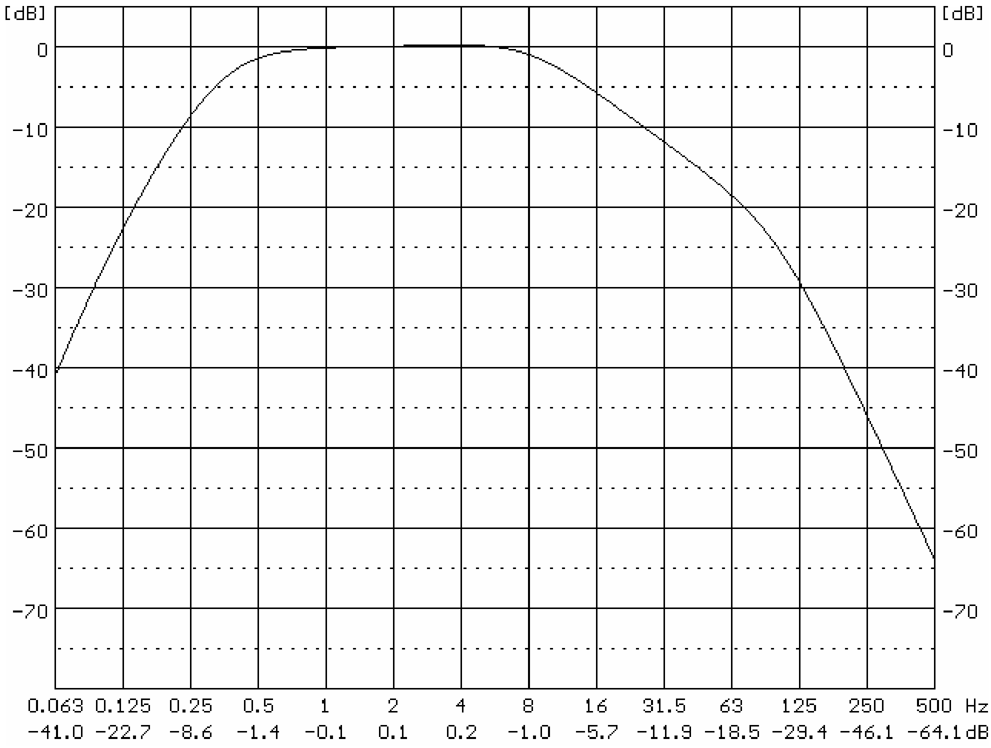
Characteristics of the Wk digital filter implemented in the instrument for human vibration measurements

The **Wd** filter is used for the assessment of the influence of the vibration signal on the human body in the x and y directions and for horizontal recumbent direction. It conforms to the ISO 2631 and ISO 8041:2005 standard.



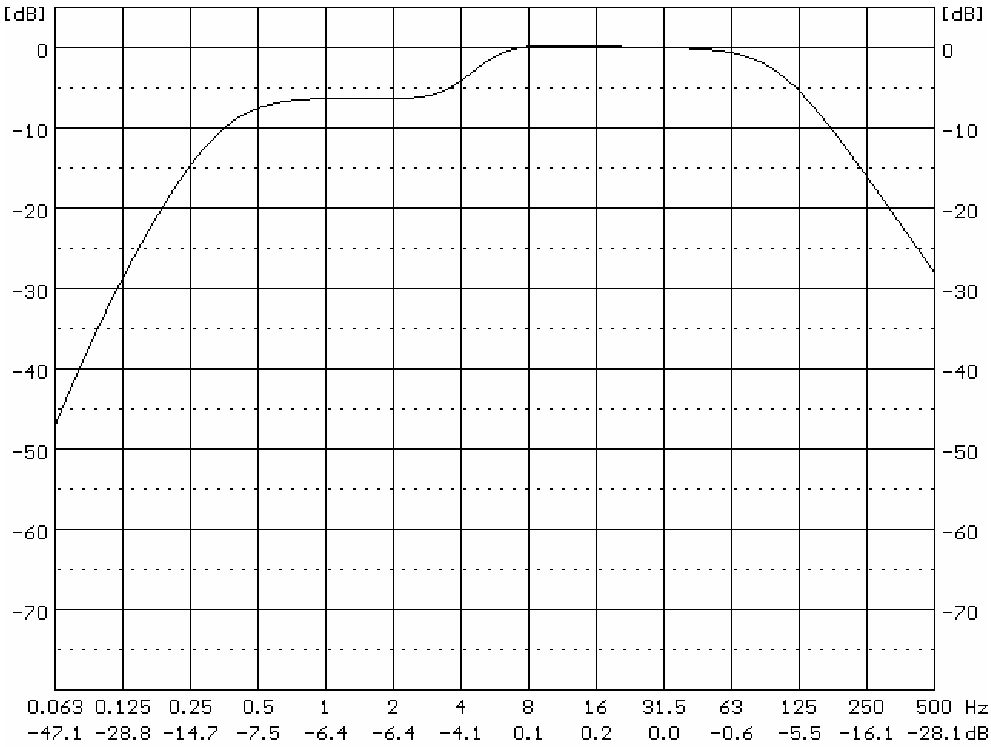
Characteristics of the Wd digital filter implemented in the instrument for human vibration measurements

The **Wc** filter is used for the assessment of the influence of the vibration signal on the human body during the seat-back measurements. It conforms to the ISO 2631 and ISO 8041:2005 standards.



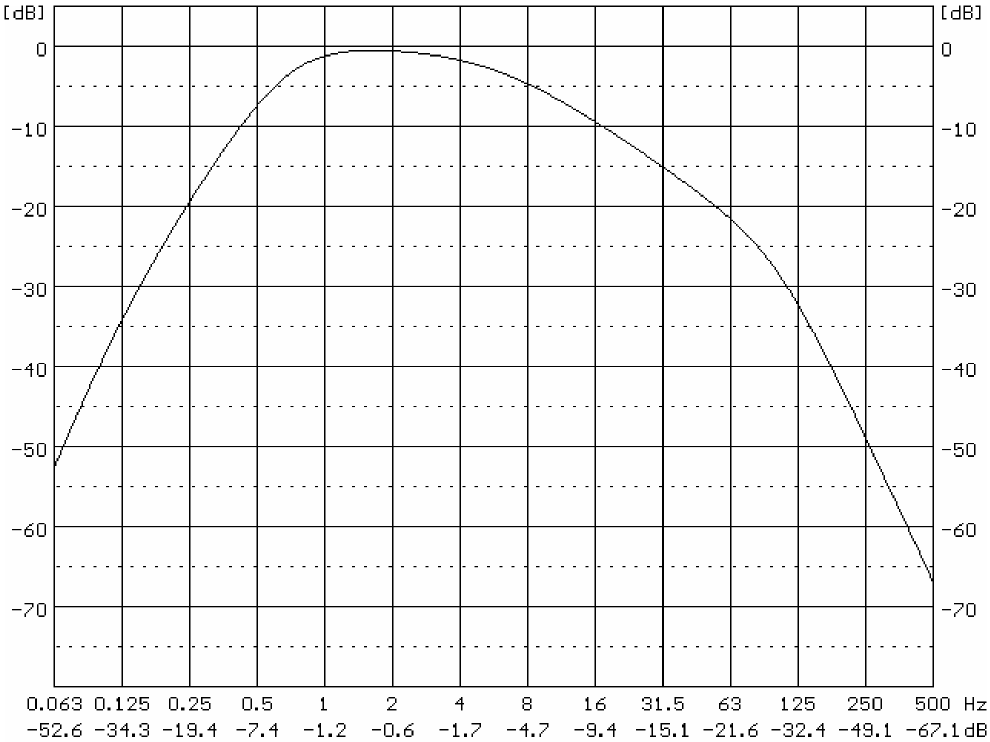
Characteristics of the Wc digital filter implemented in the instrument for human vibration measurements

The **Wj** filter is used for the assessment of the influence of the vibration signal under the head of the recumbent person. It conforms to the ISO 2631 and ISO 8041:2005 standards.



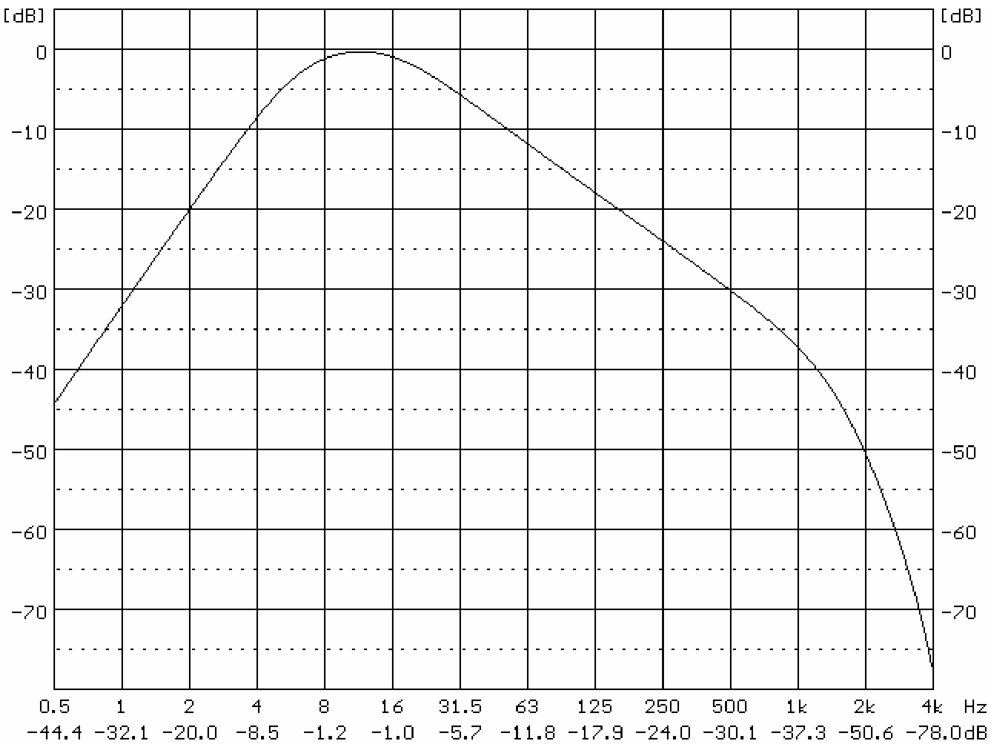
Characteristics of the Wj digital filter implemented in the instrument for human vibration measurements

The **Wm** filter is used for the assessment of the influence of the vibration signal on the human body. It conforms to the ISO 2631 and ISO 8041:2005 standards.



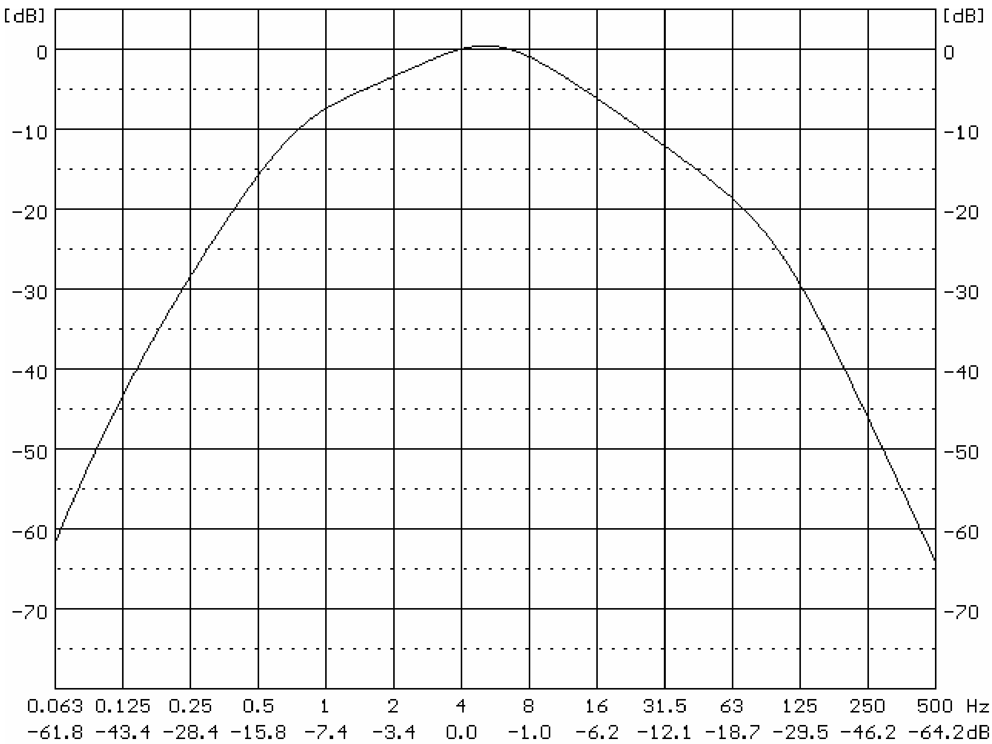
Characteristics of the Wm digital filter implemented in the instrument for human vibration measurements

The **Wh** filter is used for the assessment of the influence of the vibration signal on the human body. It conforms to the ISO 5349 and ISO 8041:2005 standards.



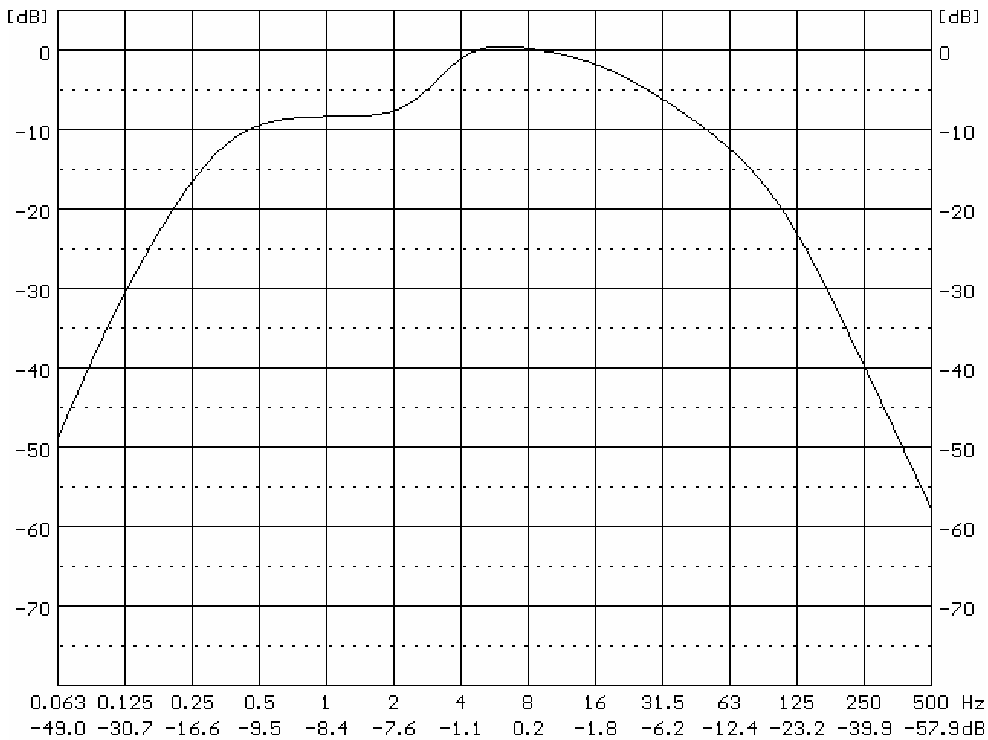
Characteristics of the Wh digital filter implemented in the instrument for human vibration measurements

The **Wg** filter is used for the assessment of the influence of the vibration signal on the human body. It conforms to the ISO 8041:2005 and BS 6841:1987 standards.



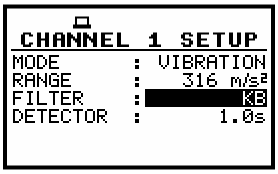
Characteristics of the Wg digital filter implemented in the instrument for human vibration measurements

The **Wb** filter is used for the assessment of the influence of the vibration signal on the human body. It conforms to the ISO 2631 and ISO 8041:2005 standards.



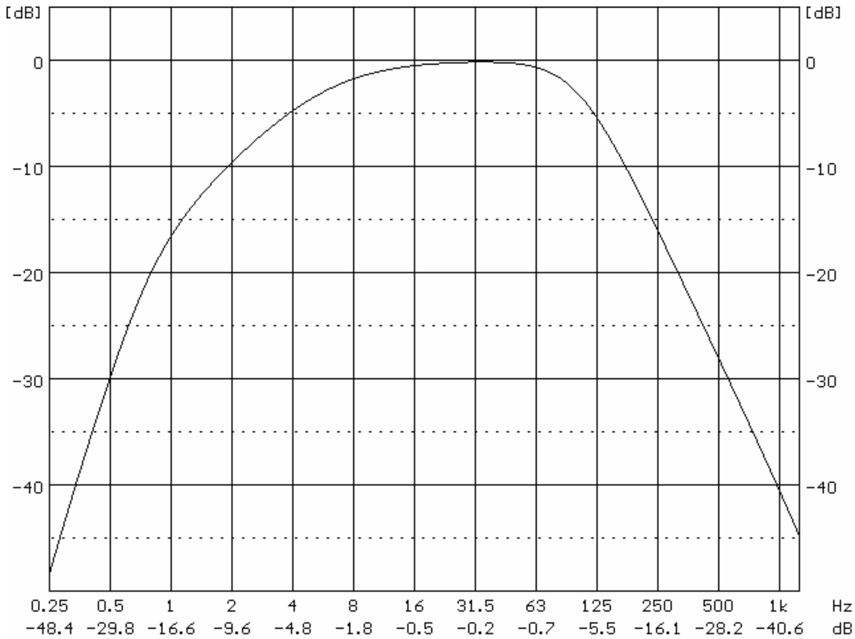
Characteristics of the Wb digital filter implemented in the instrument for human vibration measurements

D.2.2.4 Digital filter used for building vibration measurements



CHANNEL 1 SETUP window; the selection of KB filter

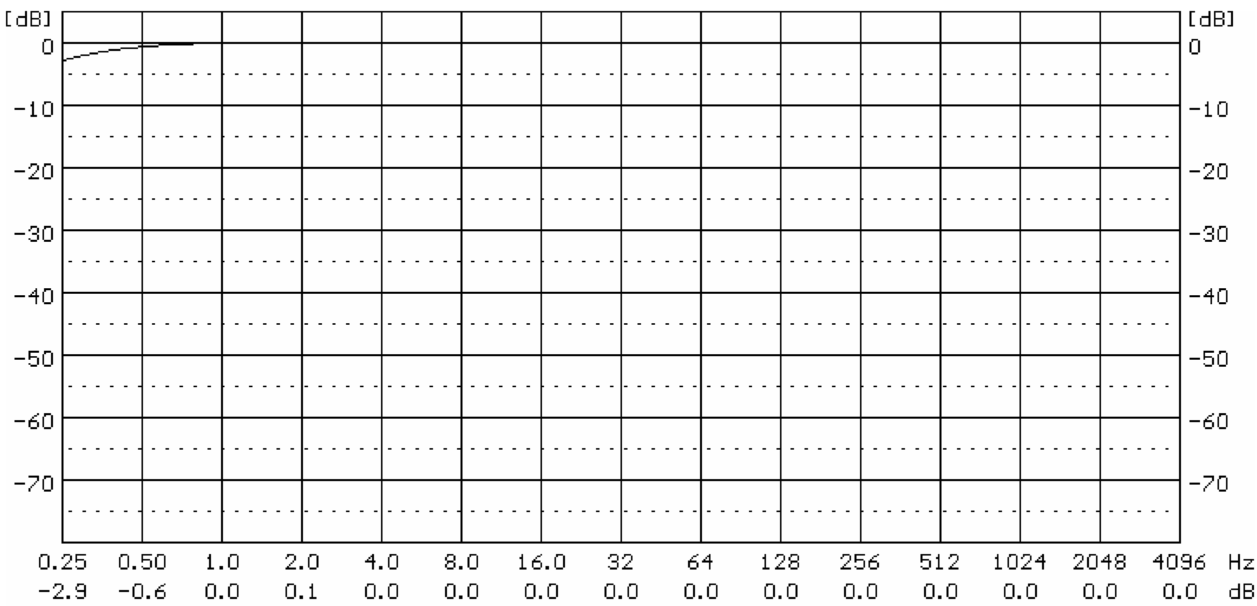
The **KB** filter is used for building vibration measurements meeting DIN 45669-1 standard.



Characteristics of the KB digital filter implemented in the instrument

D.2.3. Digital HP filter implemented in 1/1 & 1/3 OCTAVE and FFT analysis

In **1/1 OCTAVE**, **1/3 OCTAVE** and **FFT** analysis the special high-pass filter is switched on automatically. It can not be switched off.

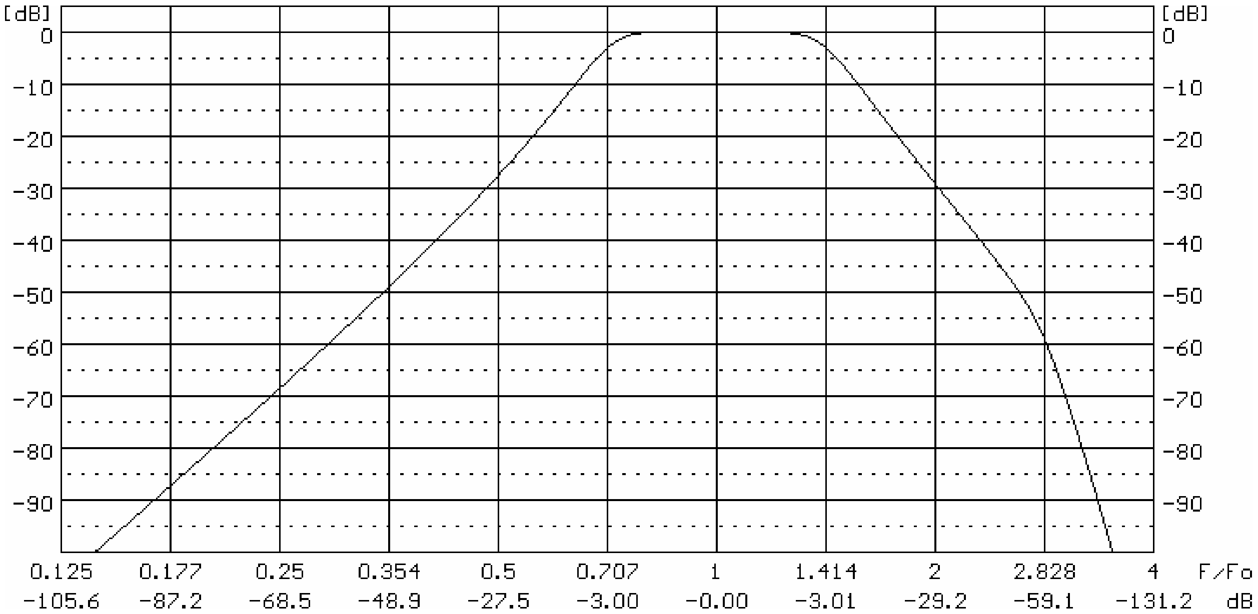


Characteristics of the HP digital filter implemented in the instrument in 1/1 OCTAVE, 1/3 OCTAVE and FFT analysis

D.2.4. Digital 1/1 OCTAVE and 1/3 OCTAVE filters implemented in the SVAN 958

In **1/1 OCTAVE** analysis 15 digital pass-band filters are implemented with centre frequencies from 1 Hz to 16 kHz (base 2), meeting IEC 61260:1995 standard. The filters are switched on after the selection of the function.

In **1/3 OCTAVE** analysis 45 digital pass-band filters are implemented with centre frequencies from 0.8 Hz to 20 kHz (base 2), meeting IEC 61260:1995 standard. The filters are switched on after the selection of the function.



Characteristics of the exemplary digital 1/1 OCTAVE filter implemented in the instrument