APPENDIX D. DEFINITIONS AND FILTER CHARACTERISTICS

D.1. DEFINITIONS AND FORMULAE

Basic definitions

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** position of the **MEASURE SETUP** sub-list, the *INPUT* list).

τ - the r.m.s. detector time constant set in the **DETECTOR** position of the **PROFILE X** sub-list (in the case of vibration equal to **100 ms**, **125 ms**, **200 ms**, **500 ms**, **1 s**, **2 s**, **5 s** or **10 s**; in the case of sound equal to **IMPULSE**, **FAST** or **SLOW**).

$a_W(t)$ - the value of the measured sound or vibration with the **W** weighting filter (**A**, **C** or **LIN** in the case of sound and **HP1**, **HP3**, **HP10** in the case of vibration and **W–Bxy**, **W–Bz**, **H–A**, **W–Bc**, **KB**, **Wk**, **Wd**, **Wc** or **Wj** in the case of vibration and Human Vibration Option available) on the input of the r.m.s. detector.

$p_W(t)$ - the temporary value of the measured sound or vibration with the **W** weighting filter (**A**, **C** or **LIN** in the case of sound and **HP1**, **HP3**, **HP10** in the case of vibration and **W–Bxy**, **W–Bz**, **H–A**, **W–Bc**, **KB**, **Wk**, **Wd**, **Wc** or **Wj** in the case of vibration and Human Vibration Option available) on the output of the r.m.s. 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 - the time (variable of the integration).

$$r_W(t) = \begin{cases} a_W(t) & \text{for } \textbf{LINEAR LEQ} \text{ (or } \textbf{RMS}\text{) integration} \\ p_W(t) & \text{for } \textbf{EXPONENTIAL LEQ} \text{ (or } \textbf{RMS}\text{) integration} \end{cases}$$

p_0 - the value to which the measurement is related, equal to 20 μPa (for SLM only).

D.1.1 Definitions of the results available in the SLM mode of the SVAN 949

The PEAK result

The **PEAK** result (Peak Sound Pressure or Peak Sound Level) is calculated for the given **T** from the formula:

$$PEAK = 20 \log\left(max_T \left| a_W(t)/p_0 \right| \right)$$

For the **PEAK** result saved in the files of the buffer (time history) $T = T_b$.

The SPL result

The **SPL** result (**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 **SPL** result is calculated from the formula:

$$\mathbf{SPL} = \mathbf{20\,log}\left(\mathbf{max}_{T_1}\left(\mathbf{p_W}(\mathbf{t})/\mathbf{p_0}\right)\right)$$

where:

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:

$$\mathbf{MAX} = \mathbf{20\,log}\left(\mathbf{max}_{T}\left(\mathbf{p_W}(\mathbf{t})/\mathbf{p_0}\right)\right)$$

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

The MIN result

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

$$\mathbf{MIN} = \mathbf{20\,log}\left(\mathbf{min}_{T}\left(\mathbf{p_W}(\mathbf{t})/\mathbf{p_0}\right)\right)$$

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

The LEQ result

The **LEQ** result means 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** result is calculated from the formula:

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

The RMS result

The **RMS** result, saved in the buffer’s file, is calculated according to the formula of the **LEQ**. The value of the **RMS** result is calculated from the formula:

$$\mathbf{RMS} = \mathbf{20\,log}\left(\frac{\mathbf{1}}{\mathbf{T_b}}\int_0^{\mathbf{T_b}}\left(\mathbf{r_W}(\mathbf{t})/\mathbf{p}_0\right)^2\mathbf{dt}\right)^{1/2}$$

The SEL result

The **SEL** result (Sound Exposure Level) is essentially the subset of the **LEQ** result. 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** is calculated from the formula:

$$SEL = 20\log\left(\int_0^T (r_w(t)/p_0)^2\,dt\right)^{1/2}$$

The Ltm3 and Ltm5 results

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

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

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

- the day-time (denoted as $\mathbf{T_d}$) starts from 7 am and ends at 7 pm,
- the evening-time (denoted as $\mathbf{T_e}$) starts from 7 pm and ends at 11 pm,
- the night-time (denoted as $\mathbf{T_n}$) starts at 11 pm and ends at 7 am.

The mentioned above results are calculated from the following expressions:

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

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

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

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

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

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

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

D.1.2 Definitions of the results available in the VLM mode of the SVAN 949

The PEAK result

The **PEAK** result is calculated from the formula:

$$\mathbf{PEAK} = \mathbf{max}_T \left|\mathbf{a}_W(\mathbf{t})\right|$$

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

The P-P value

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

$$\mathbf{P} - \mathbf{P} = \mathbf{max}_T(\mathbf{0}, \mathbf{a}_W(\mathbf{t})) - \mathbf{min}_T(\mathbf{0}, \mathbf{a}_W(\mathbf{t}))$$

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

The MAX result

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

$$\mathbf{MAX} = \mathbf{max}_{T_b}(\mathbf{p}_W(\mathbf{t}))$$

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

$$\mathbf{MAX} = \mathbf{max}_T(\mathbf{p}_W(\mathbf{t})) \quad \text{for } \boldsymbol{\tau} \neq \mathbf{1}\,\text{sec}$$

The 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:

$$\mathbf{MTVV} = \mathbf{max}_T(\mathbf{p}_W(\mathbf{t})) \quad \text{for } \boldsymbol{\tau} = \mathbf{1}\,\text{sec}$$

The RMS result

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

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

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

The VDV result

The fourth power 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:

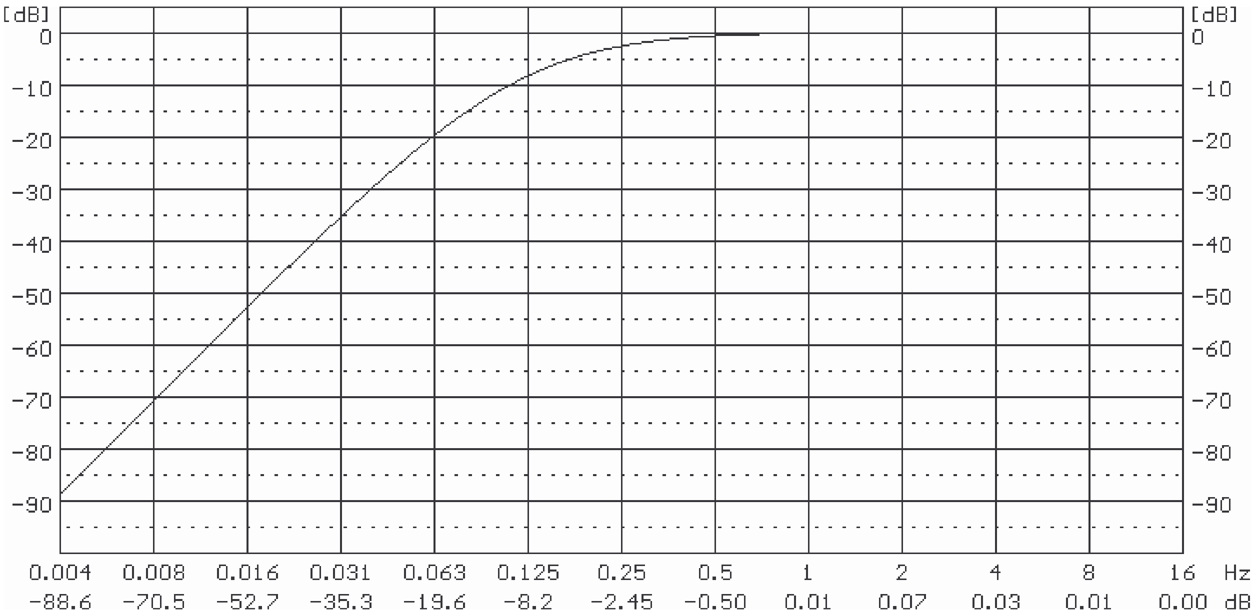
$$\mathbf{VDV} = \left(\int_0^T \mathbf{r}_W^4(\mathbf{t})\,\mathbf{dt}\right)^{1/4}$$

This result is calculated in the case when the Human Vibration Option is available.

D.2. CHARACTERISTICS OF DIGITAL FILTERS IMPLEMENTED IN SVAN 949

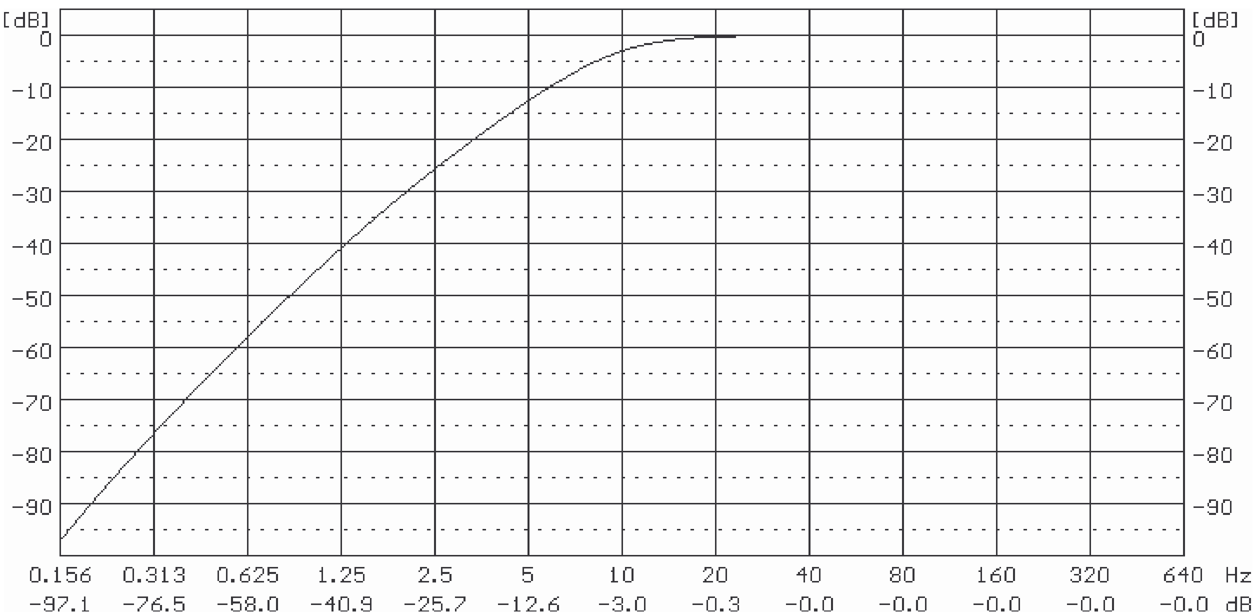
The digital weighting filters implemented in the SLM mode

HP: cut-off frequency: 0,770 Hz / -0,1 dB (0,225 Hz / -3,0 dB).



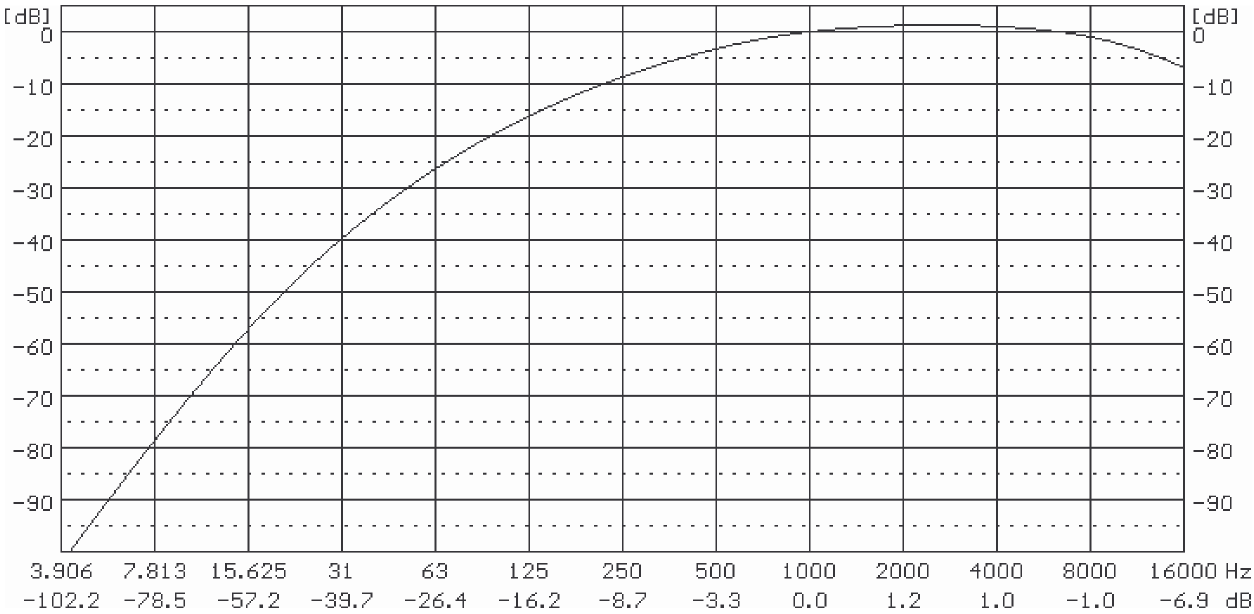
Characteristics of the HP filter implemented in the SVAN 949 instrument in the SLM mode

LIN: cut-off frequency: 27.0 Hz / -0.1 dB (10.0 Hz / -3.0 dB).



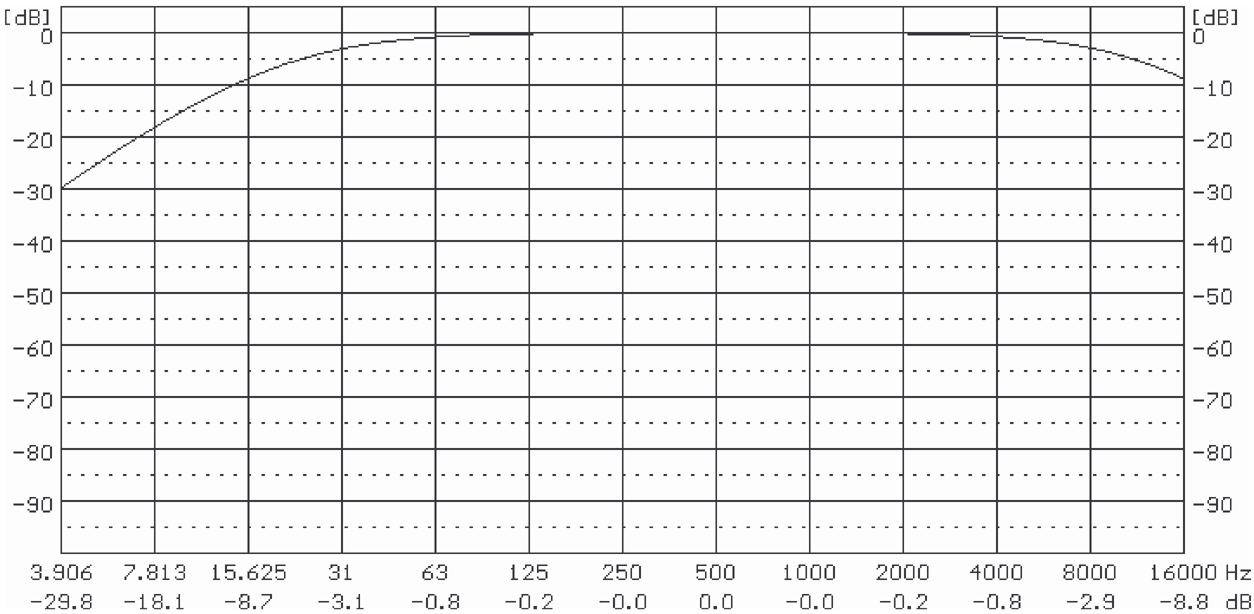
Characteristics of the LIN filter implemented in the SVAN 949 instrument in the SLM mode

A type 1 according to IEC 651 standard.



Characteristics of the A filter implemented in the SVAN 949 instrument in the SLM mode

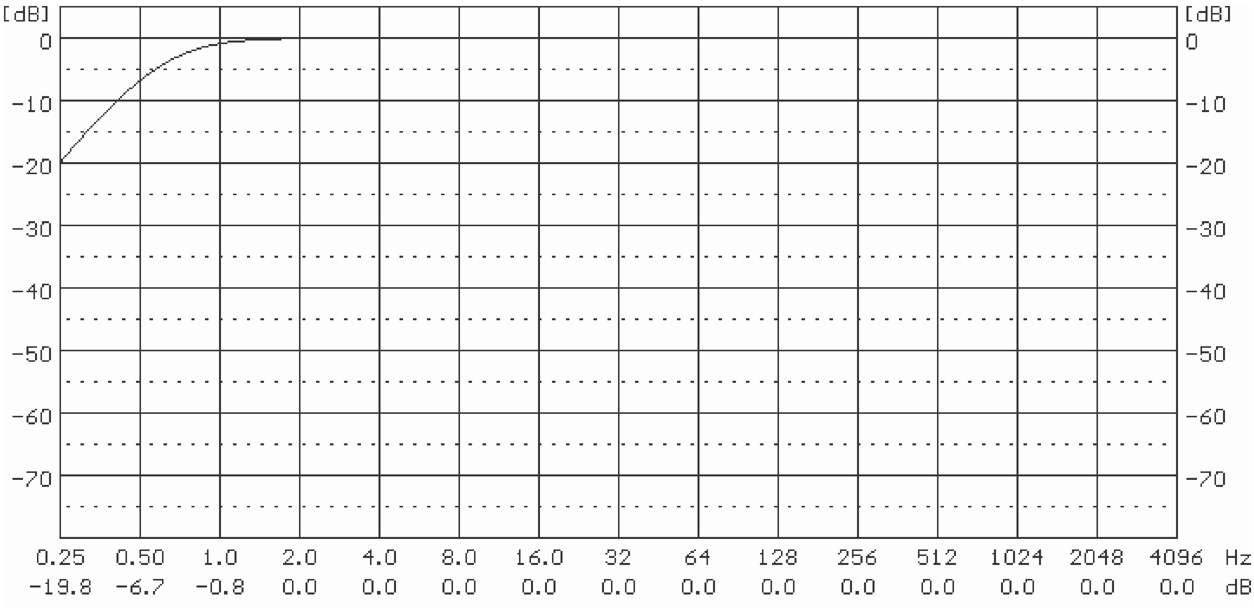
C type 1 according to IEC 651 standard.



Characteristics of the C filter implemented in the SVAN 949 instrument in the SLM mode

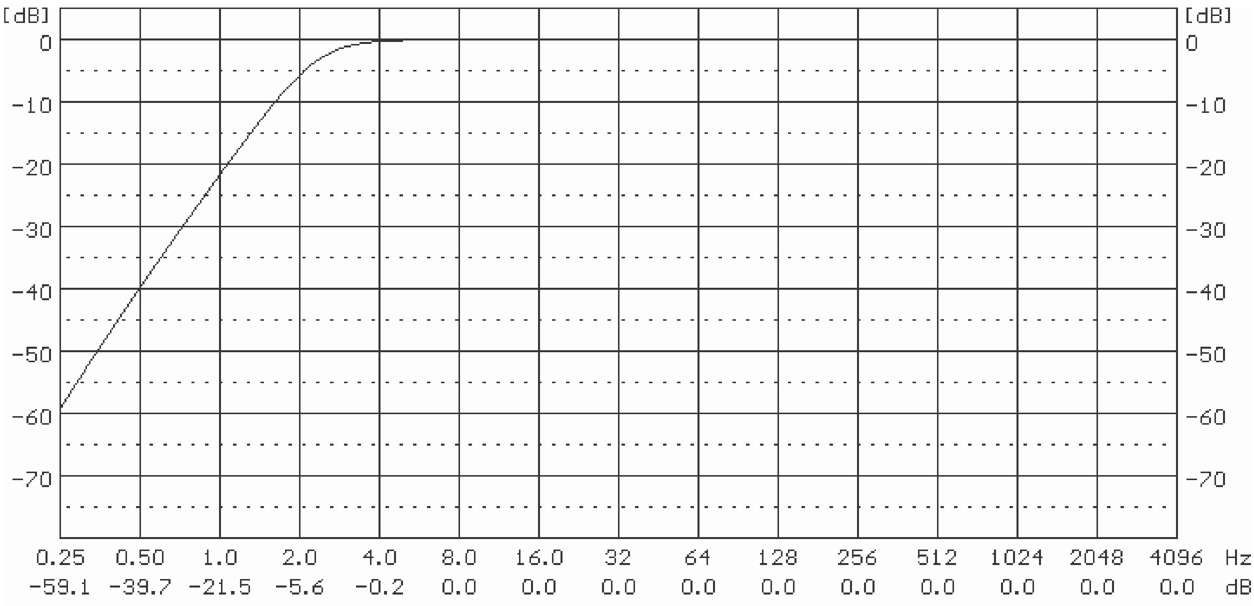
The digital weighting filters implemented in the VLM mode

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



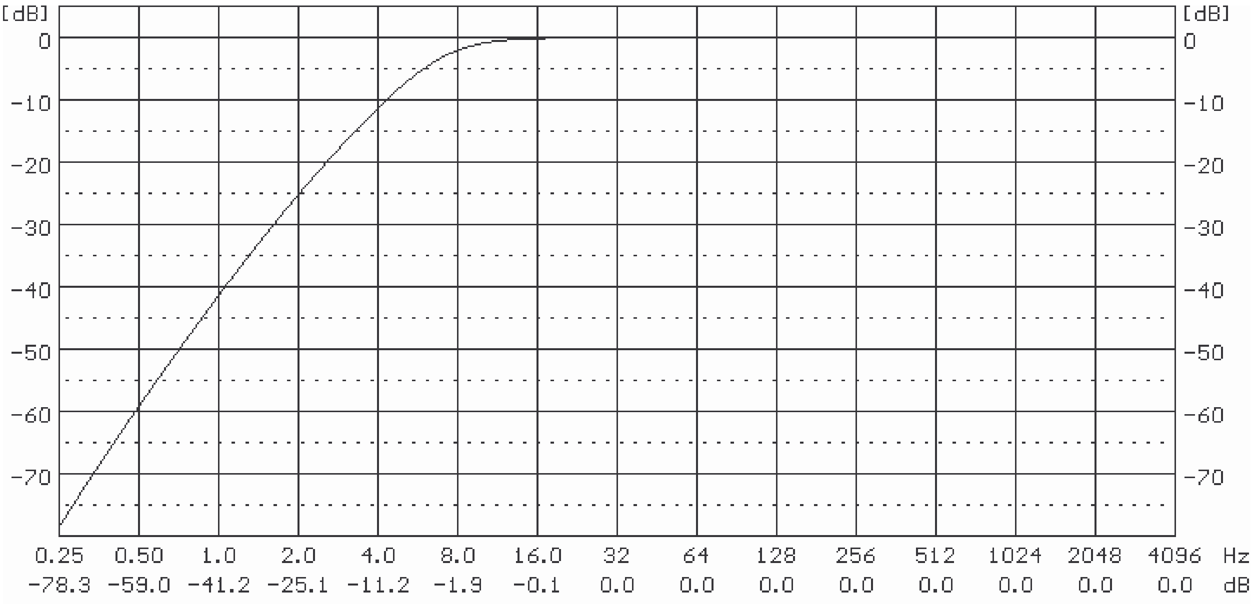
Characteristics of the HP1 digital filter implemented in the SVAN 949 instrument in the VLM mode for the acceleration measurements

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



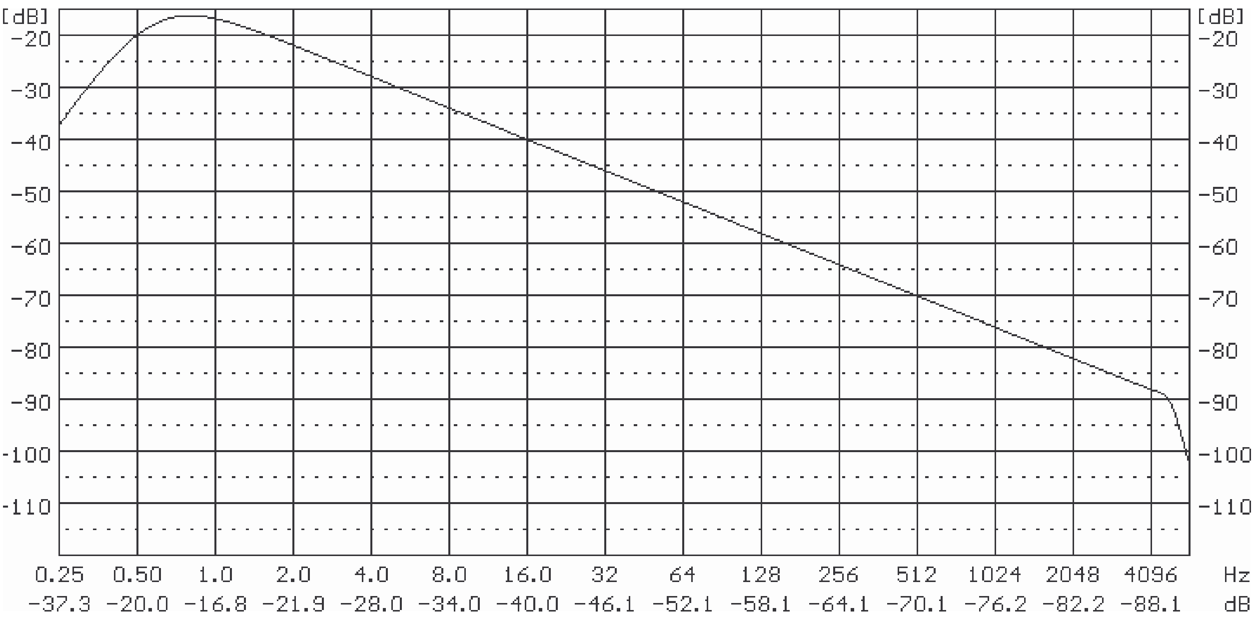
The characteristics of the HP3 digital filter implemented in the SVAN 949 instrument in the VLM mode for the acceleration measurements

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

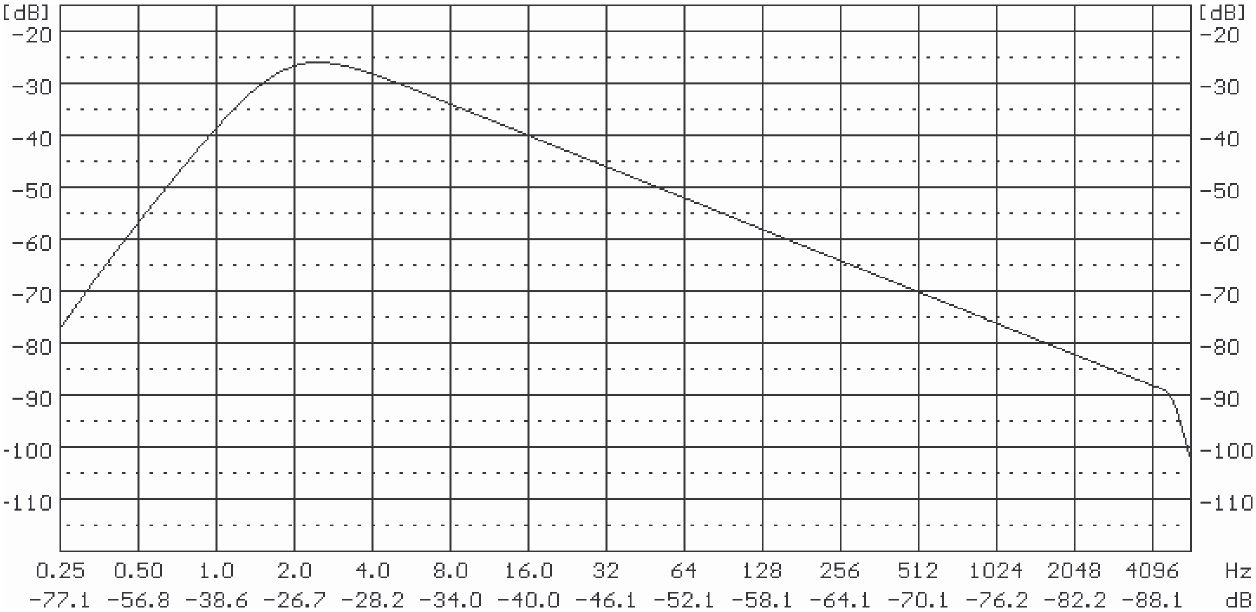


The characteristics of the HP10 digital filter implemented in the SVAN 949 instrument in the VLM mode for the acceleration measurements

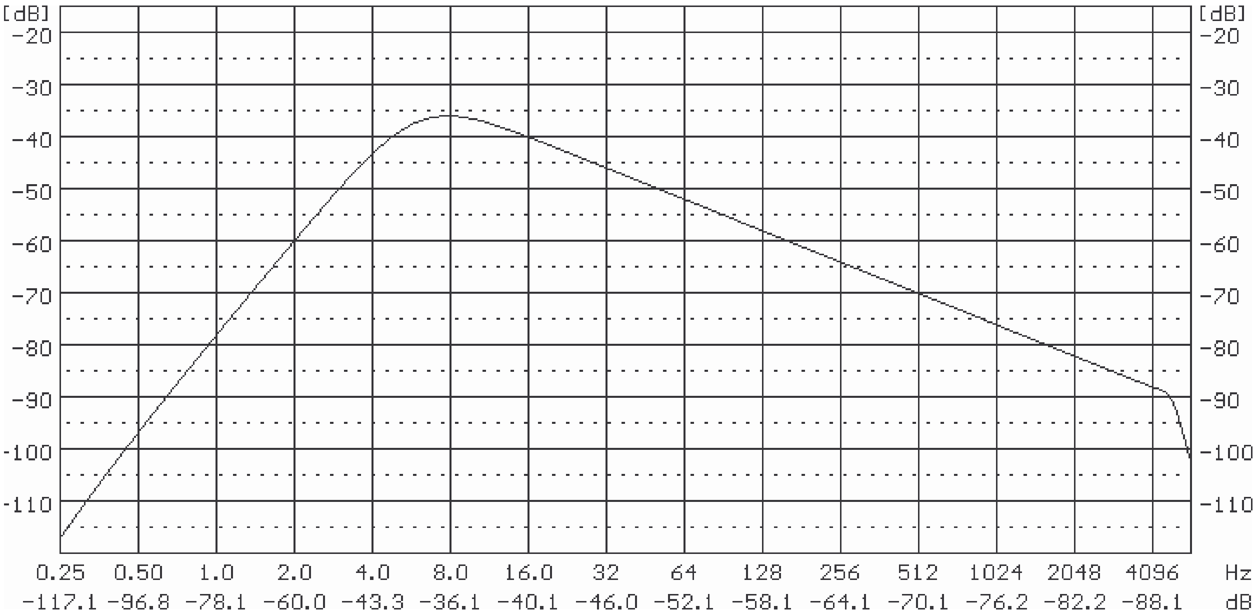
The digital filters implemented in the vibration level meter (VLM) mode for the velocity measurements



The characteristics of the Vel1 digital filter implemented in the SVAN 949 instrument in the VLM mode for the velocity measurements

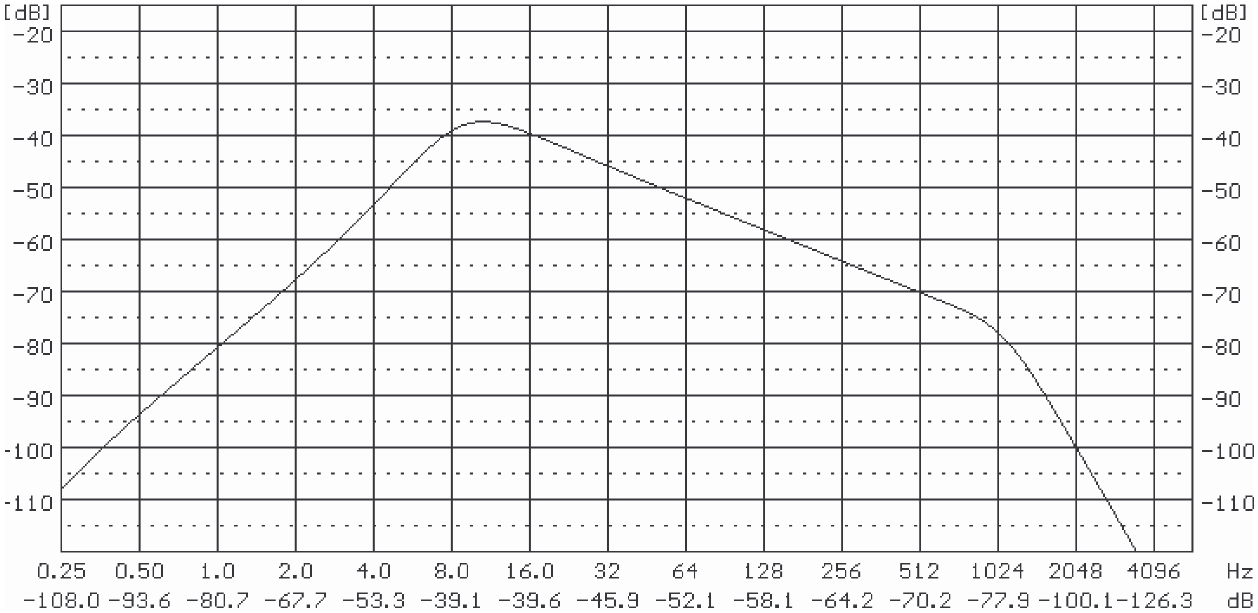


The characteristics of the Vel3 digital filter implemented in the SVAN 949 instrument in the VLM mode for the velocity measurements



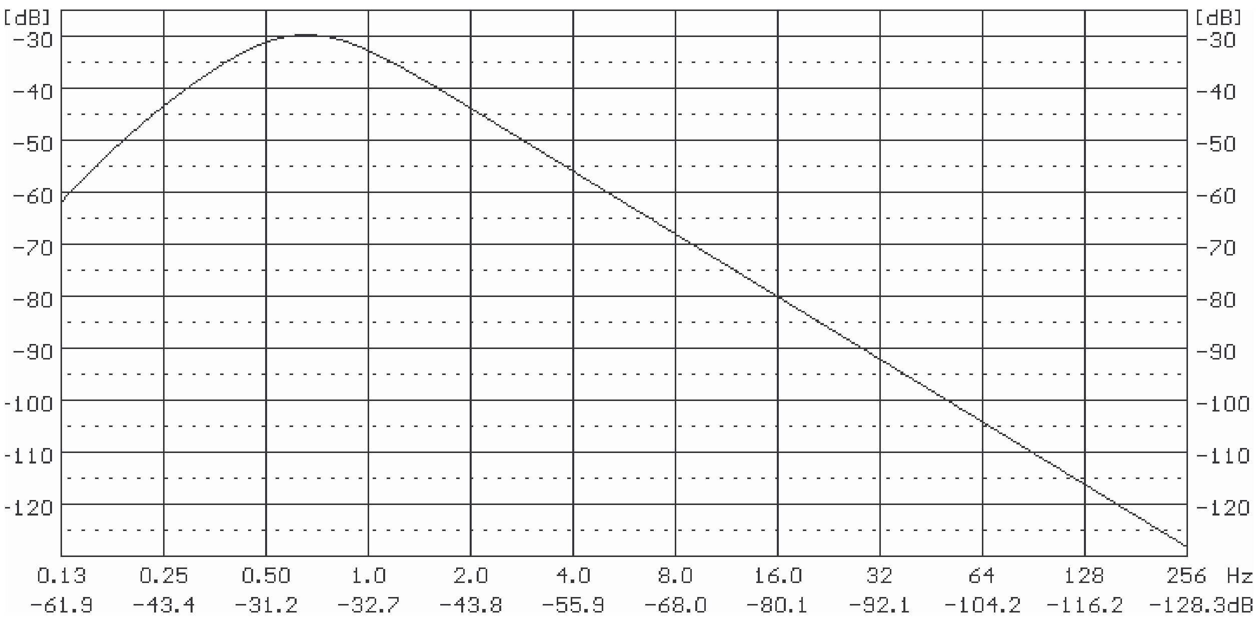
The characteristics of the Vel10 digital filter implemented in the SVAN 949 instrument in the VLM mode for the velocity measurements

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.

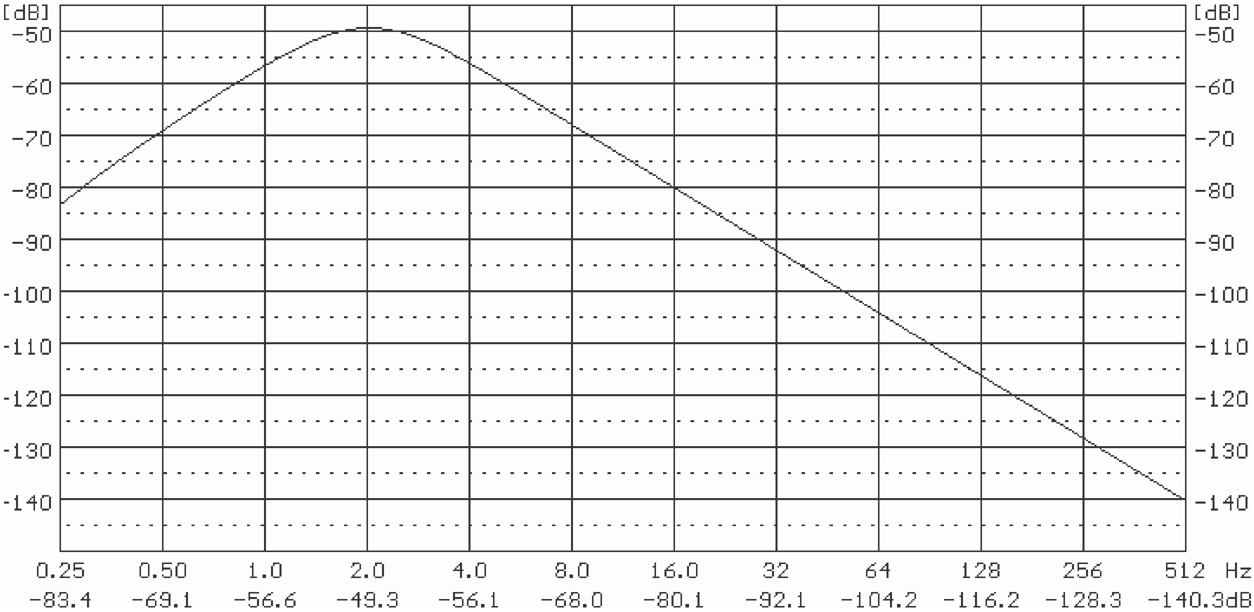


The characteristics of the VelMF digital filter implemented in the SVAN 949 instrument in the VLM mode for the velocity measurements

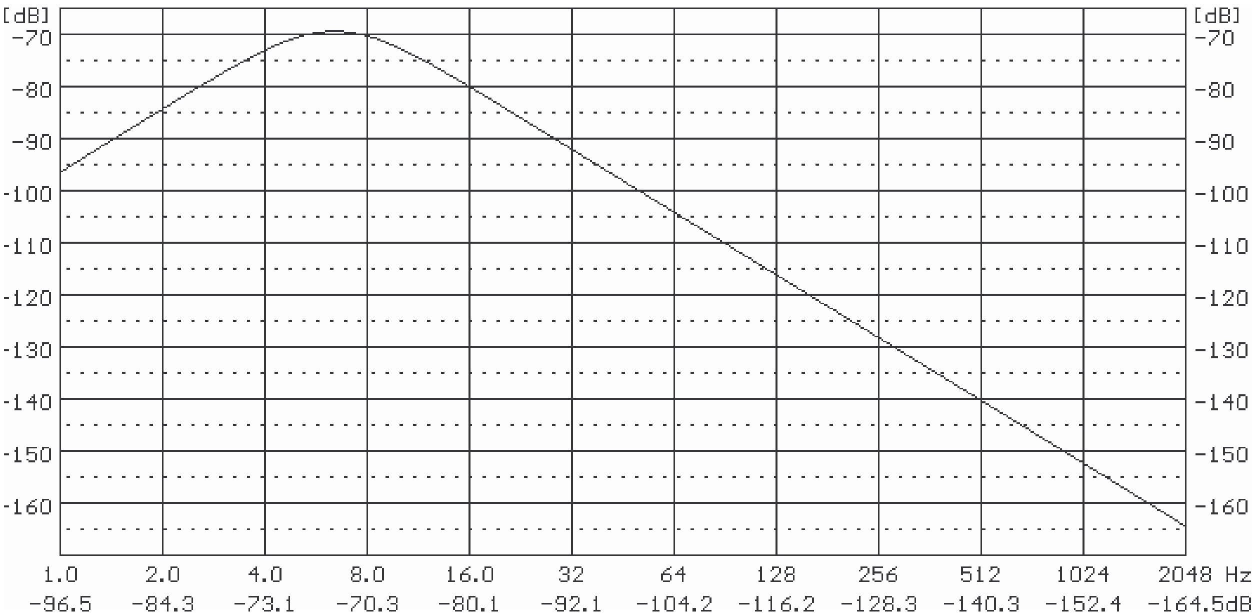
The digital filters implemented in the vibration level meter (VLM) mode for the displacement measurements



The characteristics of the Dil1 digital filter implemented in the SVAN 949 instrument in the VLM mode for the displacement measurements



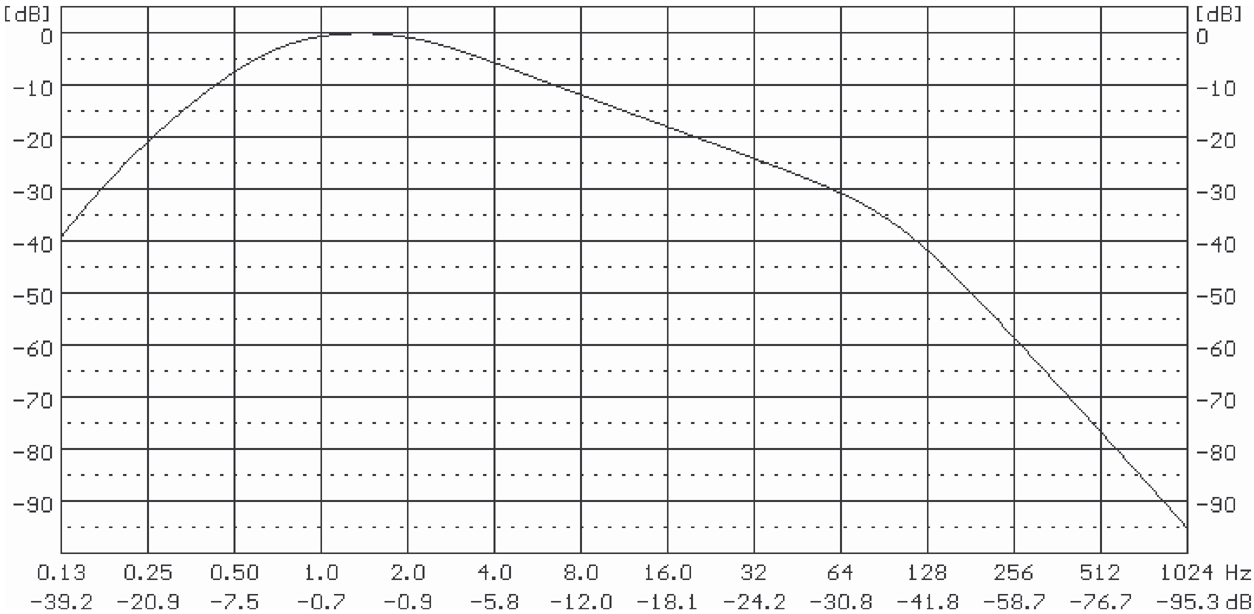
The characteristics of the Dil3 digital filter implemented in the SVAN 949 instrument in the VLM mode for the displacement measurements



The characteristics of the Dil10 digital filter implemented in the SVAN 949 instrument in the VLM mode for the displacement measurements

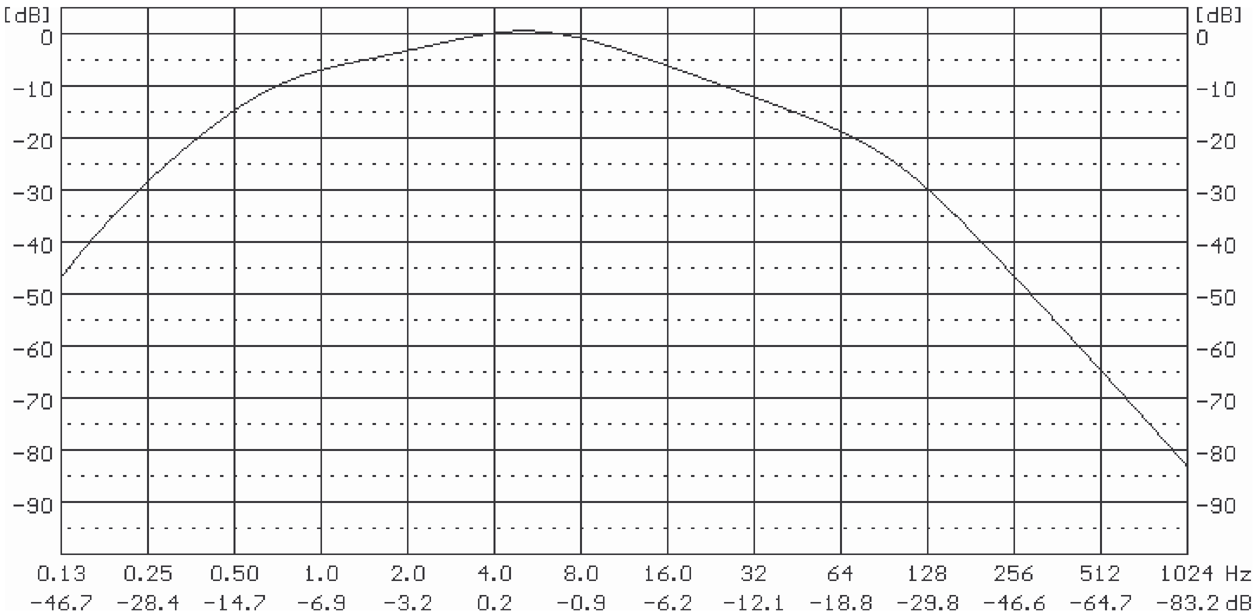
The digital filters included in the HUMAN VIBRATION OPTION

The **W–Bxy** filter is used for the assessment of the influence of the vibration signal on the human body in the horizontal direction. It conforms to the ISO 2631 and ISO 8041 (version dated as 1990-07-15) standards.



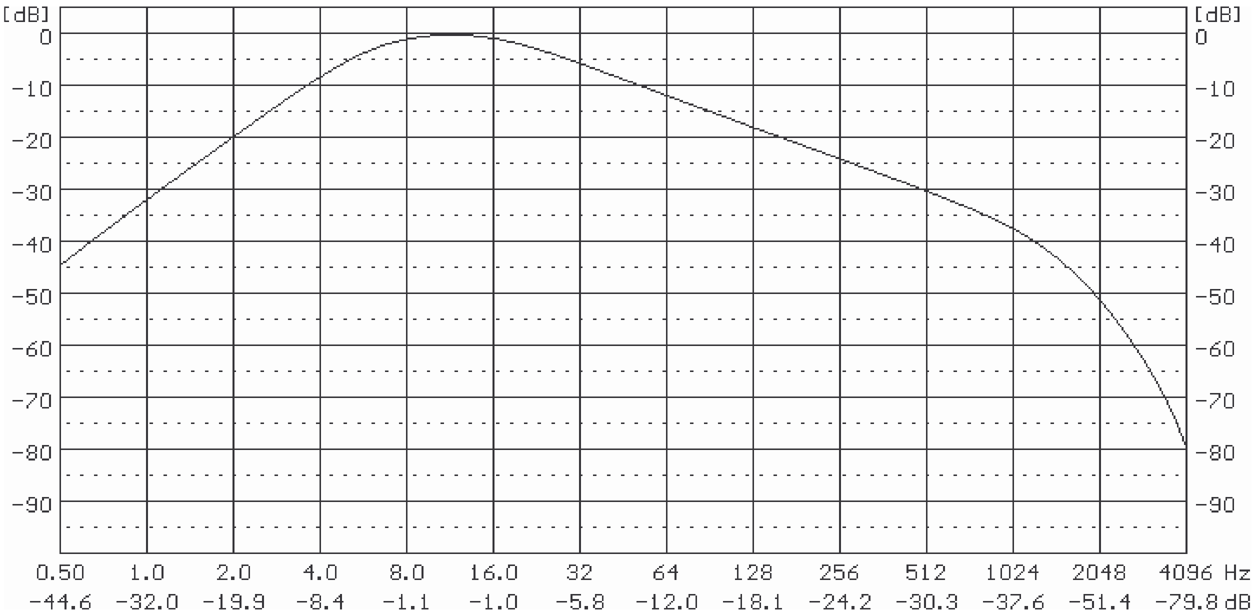
The characteristics of the W-Bxy digital filter implemented in the SVAN 949 instrument in the VLM mode

The **W–Bz** filter is used for the assessment of the influence of the vibration signal on the human body in the vertical direction. It conforms to the ISO 2631 and ISO 8041 (version dated as 1990-07-15) standards.



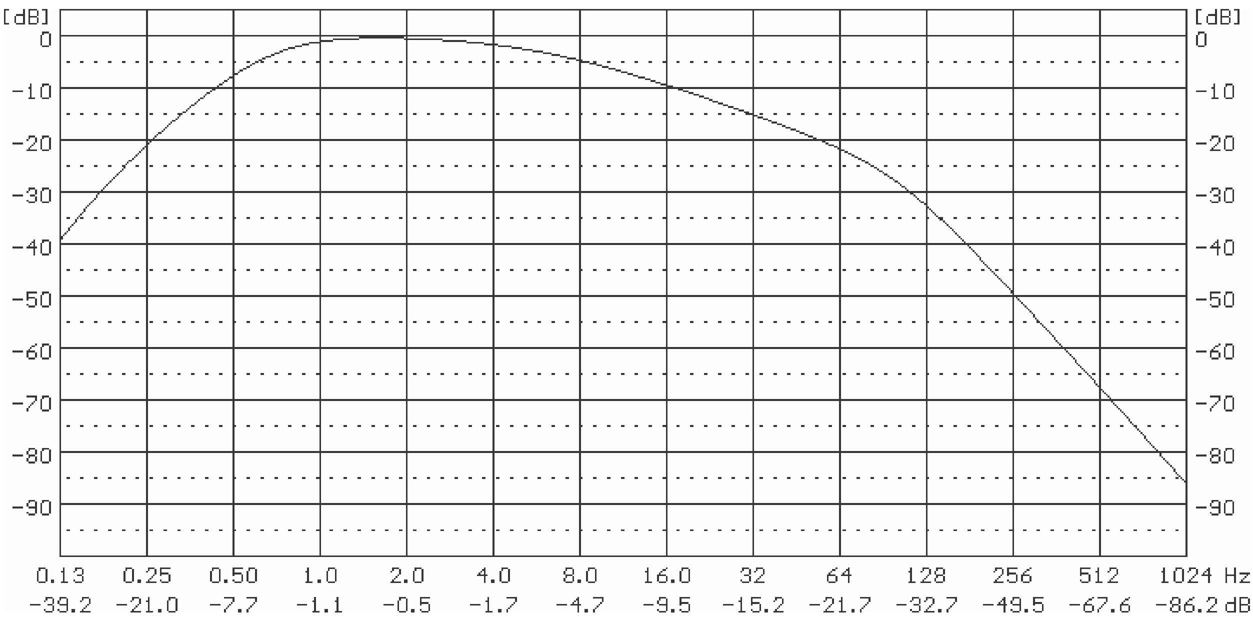
The characteristics of the W-Bz digital filter implemented in the SVAN 949 instrument in the VLM mode

The **H–A** filter is used for the assessment of the influence of the local vibration signal on the human body. It conforms to the ISO 2631 and ISO 8041 (version dated as 1990-07-15) standards.



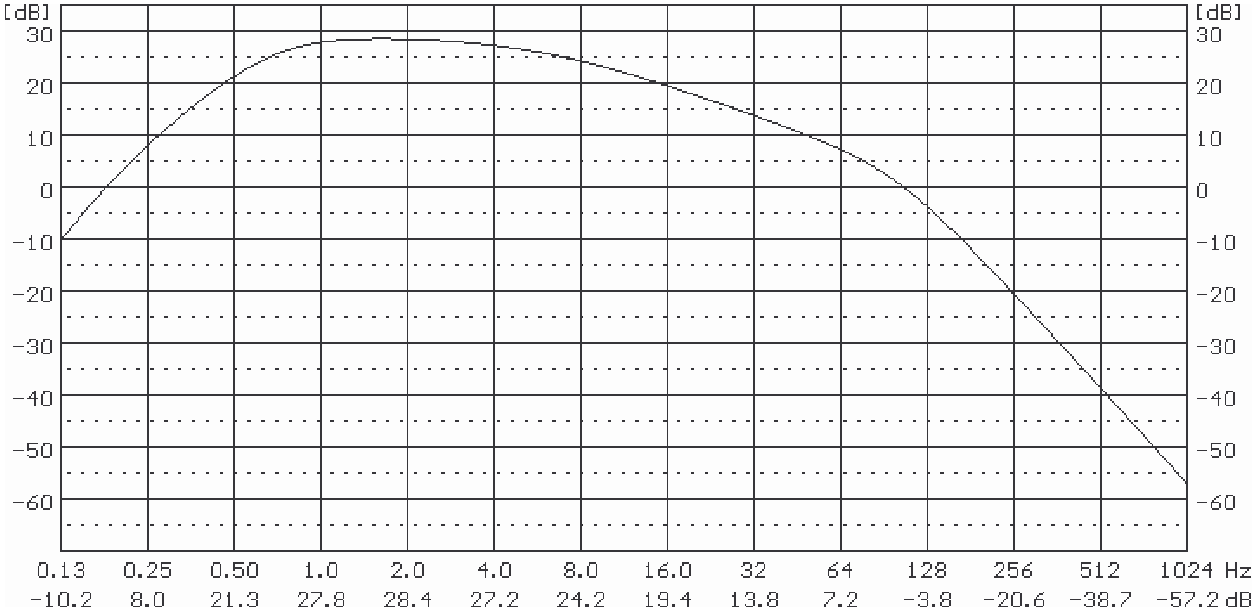
The characteristics of the H-A digital filter implemented in the SVAN 949 instrument in the VLM mode

The **W–Bc** 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 (version dated as 1990-07-15) standards.



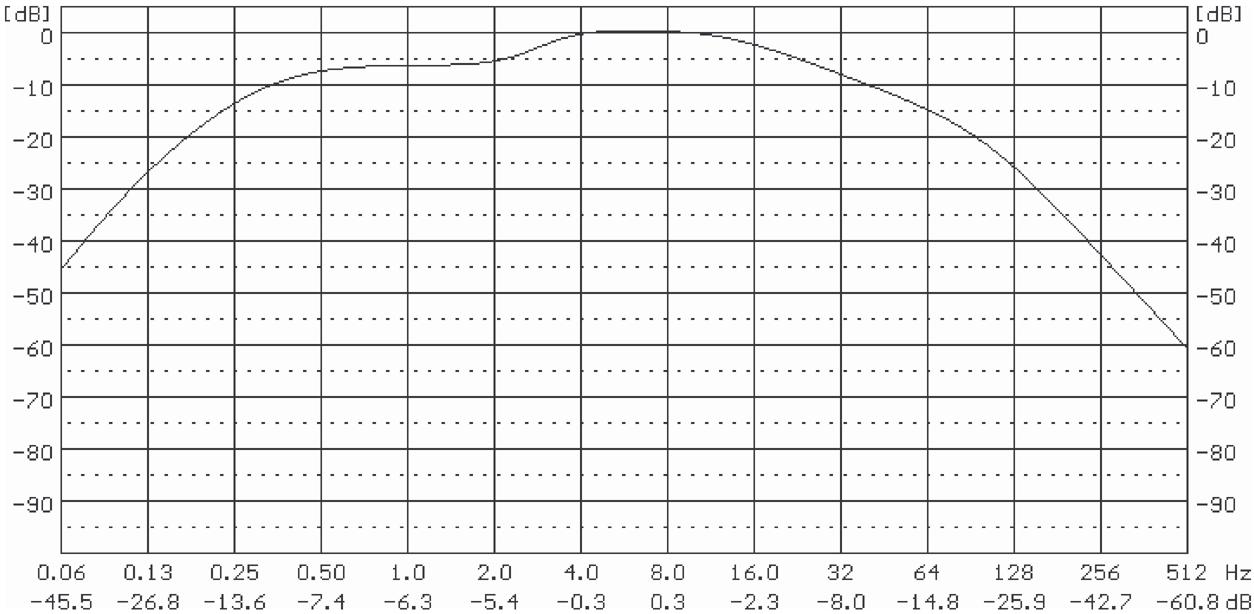
The characteristics of the W-Bc digital filter implemented in the SVAN 949 instrument in the VLM mode

The **KB** filter is used for the vibration measurements on ships. Its characteristics, presented below, is taken from the formulae: **KB** = **W–Bc** +28.9 dB.



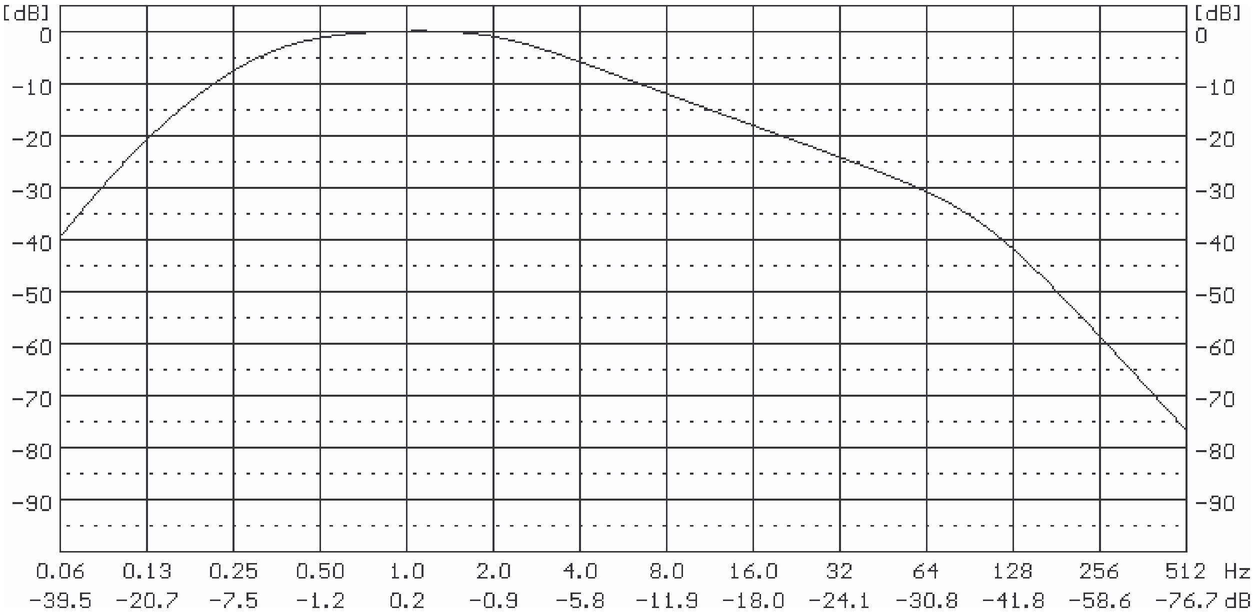
The characteristics of the KB digital filter implemented in the SVAN 949 instrument in the VLM mode

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 2631-1-97 and ISO 8041 (version dated as 1999-11-01) standards.



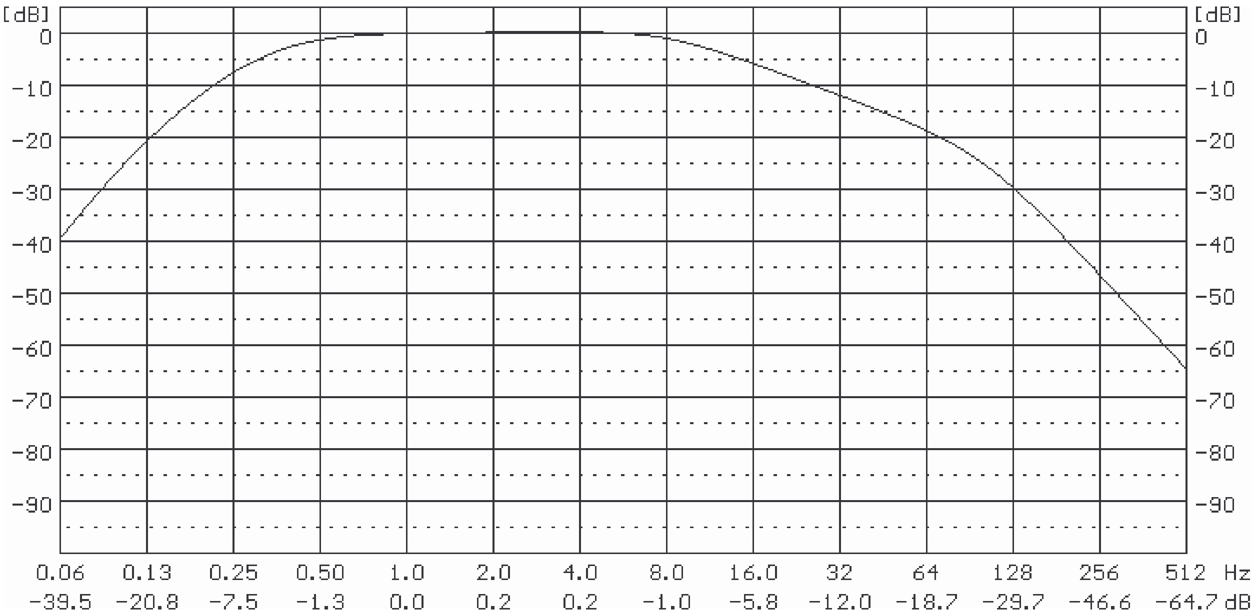
The characteristics of the Wk digital filter implemented in the SVAN 949 instrument in the VLM mode

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 2631-1-97 and ISO 8041 (version dated as 1999-11-01) standards.



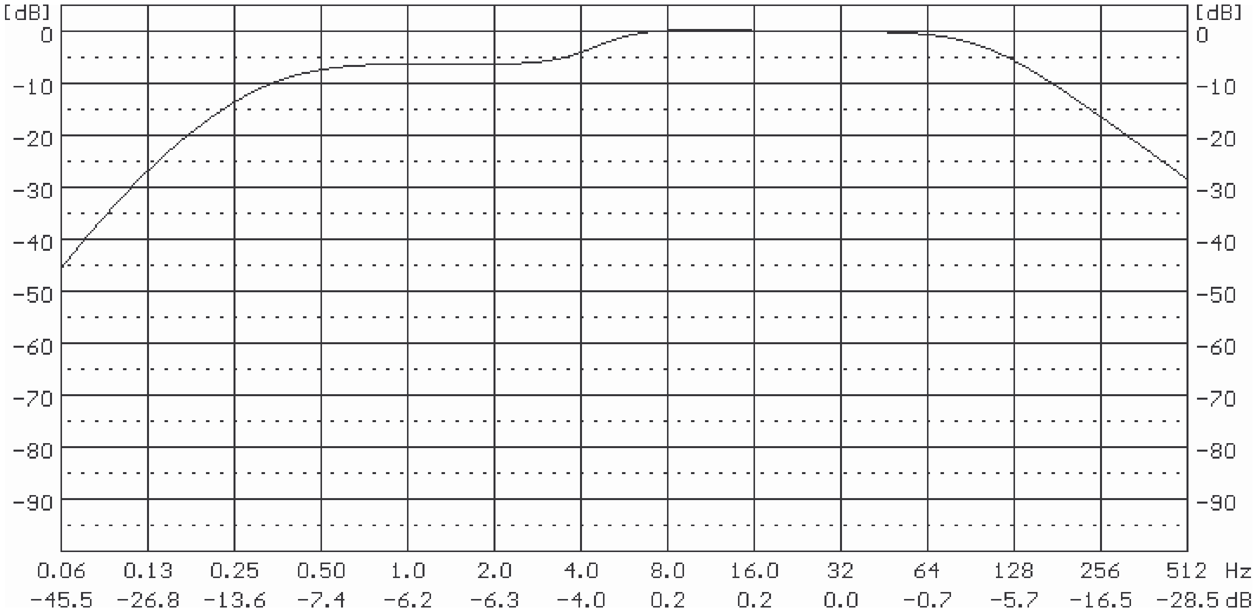
The characteristics of the Wd digital filter implemented in the SVAN 949 instrument in the VLM mode

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 2631-1-97 and ISO 8041 (version dated as 1999-11-01) standards.



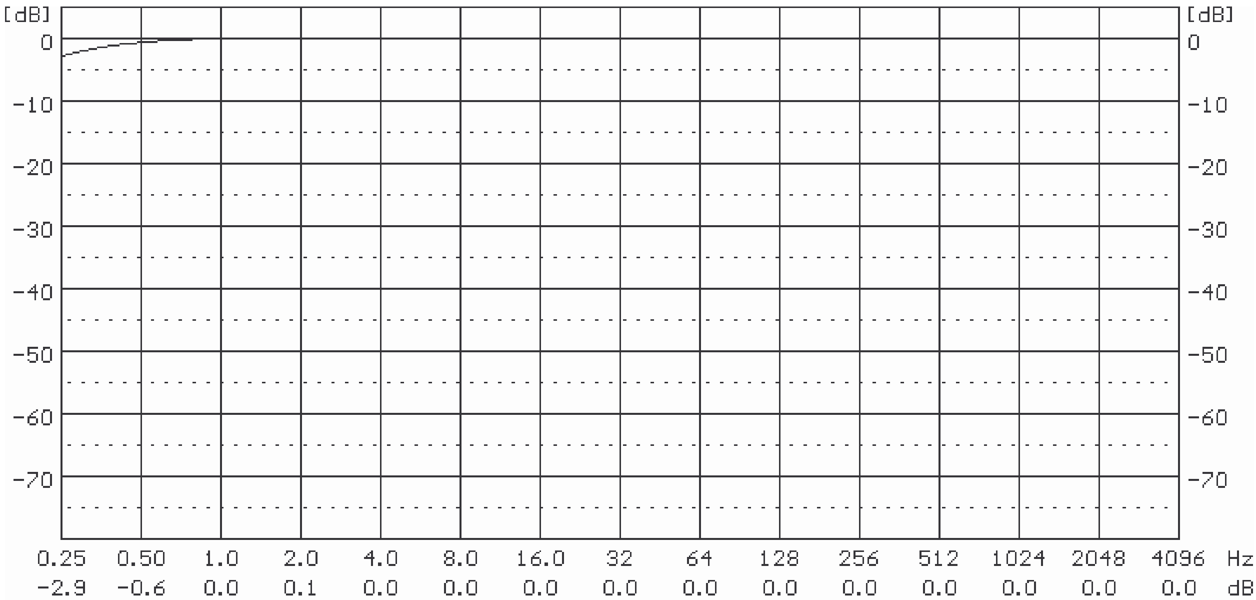
The characteristics of the Wc digital filter implemented in the SVAN 949 instrument in the VLM mode

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 2631-1-97 and ISO 8041 (version dated as 1999-11-01) standards.



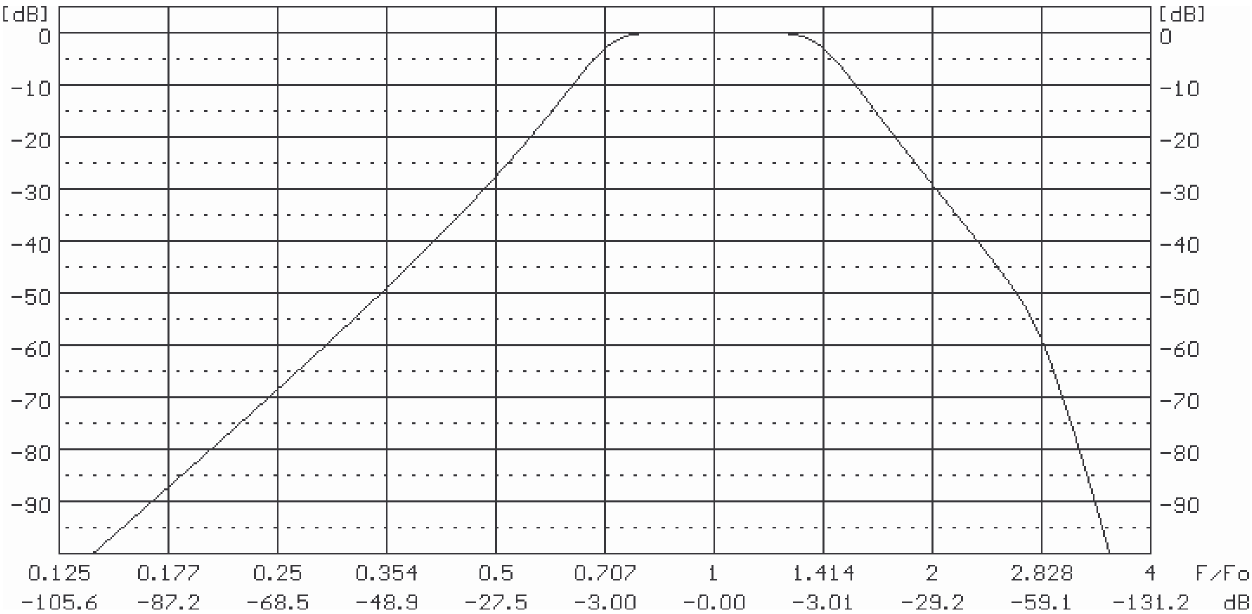
The characteristics of the Wj digital filter implemented in the SVAN 949 instrument in the VLM mode

The digital HP filter implemented in 1/1 OCTAVE, 1/3 OCTAVE and FFT analysis in the SVAN 949 instrument

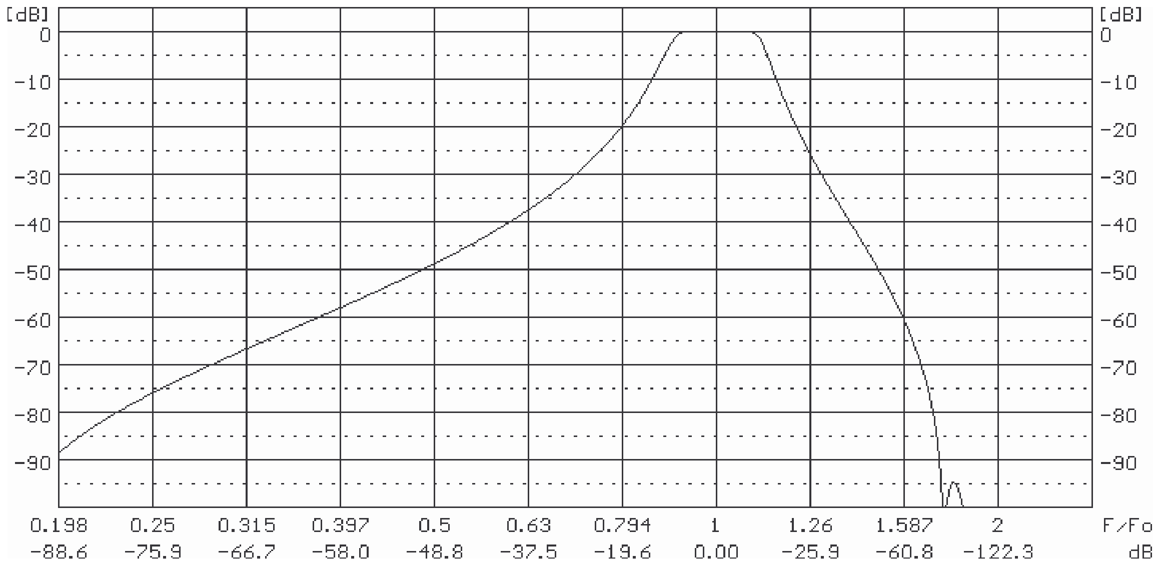


The characteristics of the HP digital filter implemented in the SVAN 949 instrument in 1/1 OCTAVE, 1/3 OCTAVE and FFT analysis

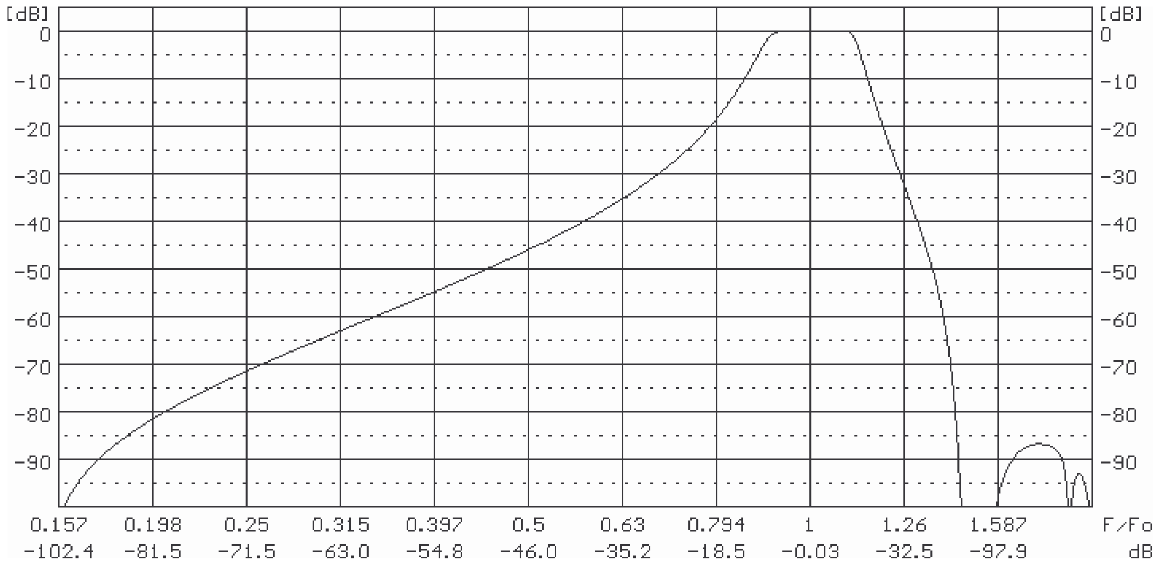
The digital 1/1 OCTAVE and 1/3 OCTAVE filters implemented in the SVAN 949 instrument



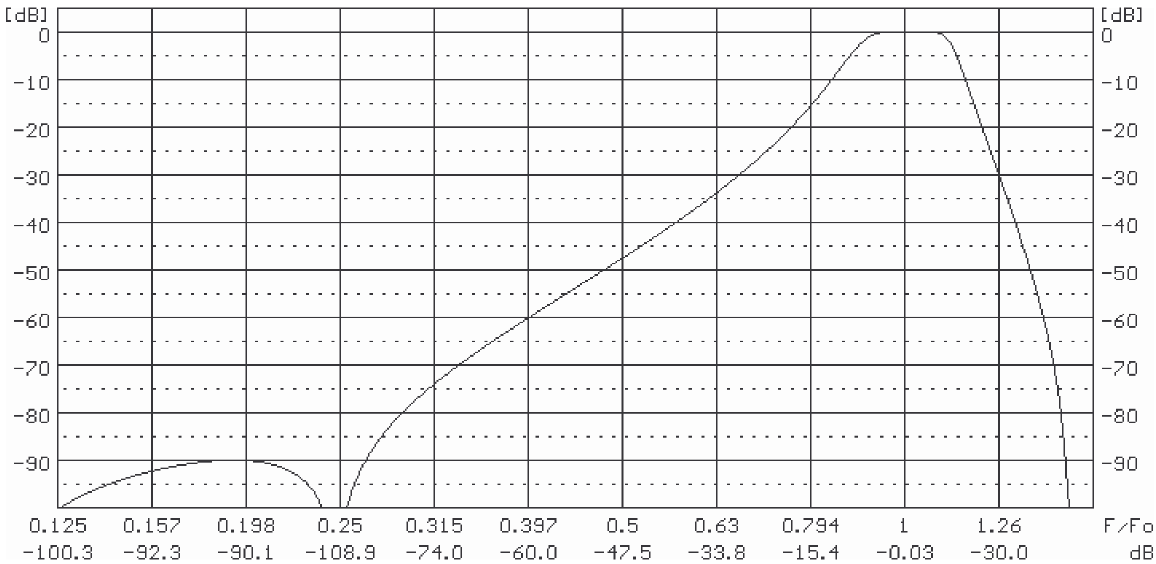
The characteristics of the exemplary digital 1/1 octave filter implemented in the SVAN 949 instrument



The characteristics of the exemplary lower digital 1/3 octave filter implemented in the SVAN 949 instrument



The characteristics of the exemplary middle digital 1/3 octave filter implemented in the SVAN 949 instrument



The characteristics of the exemplary upper digital 1/3 octave filter implemented in the SVAN 949 instrument