USER MANUAL

SOUND LEVEL METER

PCE-428 / PCE-430 / PCE-432

ENGLISH



User manuals in various languages (français, italiano, español, português, nederlands, türk, polski) can be found via our product search on:
www.pce-instruments.com

SAFETY INFORMATION

Please read this user manual carefully and in its entirety before using the device for the first time. The device may only be operated by properly trained personnel. We assume no liability for damage resulting from failure to follow the instructions in this manual.

- This measuring device must only be used in the manner described in this user manual. Using the measuring device for any other purpose may result in dangerous situations.
- Use the meter only when the ambient conditions (temperature, humidity, etc.) are within the limits specified in the technical specifications. Do not expose the device to extreme temperatures, direct sunlight, extreme humidity, or moisture. The device is not waterproof.
- Do not expose the device to impacts or strong vibrations. Mechanical vibrations can affect the display readings at the lower limit of the measurement range within the sound level meter's frequency range (10 Hz … 20 kHz).
- The device housing may only be opened by qualified personnel from PCE Deutschland GmbH.
- Never use the meter with wet hands.
- No technical modifications may be made to the device.
- The device should only be cleaned with a cloth. Do not use abrasive cleaners or cleaning agents containing solvents.
- The device may only be used with accessories offered by PCE Deutschland GmbH or equivalent replacements.
- Check the housing of the measuring device for visible damage before each use. If visible damage is present, the device must not be used.
- Store the measuring microphone in the supplied box to protect it from external influences. Always handle it with care, as the measuring microphone is extremely sensitive.
- The measuring device must not be used in an explosive atmosphere.
- The measurement range specified in the technical specifications must not be exceeded under any circumstances.
- The sound level meter requires at least 6 hours to acclimate to the environment before being turned on. After that, no further delay is required before measurement.
- Failure to follow the safety instructions may result in damage to the device and injury to the operator.

We assume no liability for typographical errors or inaccuracies in the content of this manual.
Please note that our general warranty terms and conditions, which can be found in our Terms and Conditions, apply.
If you have any questions, please contact PCE Deutschland GmbH. You will find the contact information at the end of this manual.

Safety symbols
Safety-related instructions, failure to follow which may result in damage to the device or injury, are additionally marked with a safety symbol.

Symbol	Label / Description
	**Warning regarding electrostatic charge** Avoid electrostatic charges before operation.

INTRODUCTION

General
The new PCE-428 / PCE-430 / PCE-432 digital sound level meters are equipped with a high-precision 24-bit AD converter and are therefore versatile, e.g., for measuring ambient noise, traffic noise, or industrial noise.
The PCE-430 and PCE-432 are Class 1 devices, while the PCE-428 is a Class 2 device.

Features
» Standards: IEC 61672-1:2013, ANSI S1.4-1983, and ANSI S1.43-1997
» Real-time 1/1 and optional 1/3 octave band analysis according to IEC 61260-1:2014 and ANSI S1.11-2004
» Linearity range: 22 dBA … 136 dBA (PCE-430/432), 25 dBA … 136 dBA (PCE-428)
» Frequency weighting: A/B/C/Z
» Time weighting: fast/slow/impulse
» 3 profiles and 14 user-defined measurements are calculated in parallel with different
» frequency/time weighting
» Calculation of sound pressure level (SPL), weighted average level (LEQ), MAX, MIN, peak, standard deviation (SD), noise exposure level (SEL), noise exposure (E)
» LN statistics and display of the time-history curve
» Custom integral time measurement, integral time up to 24 hours.
» Wide frequency response, high dynamic range, and low noise floor thanks to
» High-speed ARM core with floating-point unit
» 4G MicroSD card (TF card) as mass storage
» RS-232 remote control port
» Internal GPS module (PCE-432), GPS time support

SPECIFICATIONS

Technical Specifications

Model	**PCE-430/432**	**PCE-428**
Accuracy	Class 1 (Group X)	Class 2 (Group X)
Standard	GB/T 3785.1-2010, IEC 60651:1979, IEC 60804:2000, IEC 61672-1:2013, ANSI S1.4-1983, ANSI S1.43-1997	
Octave[1]	Real-time 1/1 octave band: 8 Hz ... 16 kHz Real-time 1/3 octave band (optional): 6.3 Hz … 20 kHz GB/T 3241-2010, IEC 61260-1:2014, ANSI S1.11-2004 Decimal system	Real-time 1/1 octave band: 20 Hz … 8 kHz Real-time 1/3 octave band (optional): 20 Hz … 12.5 kHz GB/T 3241-2010, IEC 61260-1:2014, ANSI S1.11-2004 Decimal system
Integrated microphone	PCE-430/432-MIC: Pre-polarized measurement microphone 1/2”, Class 1 Sensitivity: 40 mV/Pa Frequency range: 3 Hz ... 20 kHz	PCE-428-MIC: Pre-polarized measurement microphone 1/2”, Class 2 Sensitivity: 40 mV/Pa Frequency range: 20 Hz ... 12.5 kHz
Microphone interface	TNC connector with ICCP power supply (4 mA)	
Detector / Filter	Fully digital signal processing with floating-point unit (digital detector and filter)	
Integration period	User-definable integration period 1 s ... 24 h [User] Repetition time: infinite or 1 ... 9999	
Logging interval	0.1 s / 0.2 s / 0.5 s / 1 s ... 24 h	
Measurement functions	$L_{XY(SPL)}$, L_{Xeq}, L_{XYSD}, L_{XSEL}, L_{XE}, L_{XYmax}, L_{XYmin}, L_{XPeak}, L_{XN} Here, X is the frequency weighting: A, B, C, Z; Y is the time weighting: F, S, I; N is the statistical weight: 1 … 99. 3 profiles and 14 user-defined measurements are calculated in parallel with different frequency/time weightings.	
24-hour measurement	Automatic measurement according to user-defined date and time settings and storage of historical data	
Frequency weighting	Parallel A, B, C, Z (applicable to 1/1 and 1/3 octave bands)	
Time weighting	Parallel detection of F, S, I, and Peak	

Model	PCE-430/432	PCE-428
Self-noise[2]	Sound 19 dB(A), 25 dB(C), 31 dB(Z) Electrical data: 13 dB(A), 17 dB(C), 24 dB(Z)	Sound 20 dB(A), 26 dB(C), 31 dB(Z) Electrical data: 14 dB(A), 19 dB(C), 24 dB(Z)
Upper limit[2]	136 dB(A) increases to 154 dB(A) with a microphone rated at 5 mV/Pa	
Frequency response[1]	10 Hz ... 20 kHz	20 Hz ... 12.5 kHz
Linearity range [2/3/4]	22 ... 136 dB(A) Octave: 30 ... 136 dB	25 ... 136 dB(A) Octave: 33 ... 136 dB
Dynamic range [2]	123 dB (13 ... 136 dB(A))	122 dB (14 ... 136 dB(A))
Peak C range[2/3]	47 ... 139 dB	50 ... 139 dB
Electrical input	Maximum input voltage 5 Vrms (7.07 Vpeak) Input impedance of the preamplifier >6 GΩ	
Range setting	Single range to cover the entire dynamic range	
Resolution	24 bits	
Sampling rate	48 kHz (sampling interval LN: 20 ms)	
Time course	Time-domain noise curve display Duration: 1 minute, 2 minutes, 10 minutes	
Display	160 x 160 LCD with white backlight, 14 contrast levels, display refresh rate of one second	
Mass storage	4 GB Micro SD card	
Post-processing	Software for reading, analyzing, and generating reports from the stored data	
Data export	Direct connection to the computer for reading the memory card (USB drive)	
Outputs	AC output (maximum 5 V rms, ±15 mA), DC output (10 mV/dB, max. 15 mA), RS-232 and USB serial interfaces (USB drive mode or modem mode)	
Alarm	User-defined alarm threshold LED to indicate alarm status	
Setup template	5 templates for saving user settings for various applications; templates can be saved to the microSD card.	
Automatic power-on	Automatic power-on and automatic start of measurement when operating voltage is applied, easy integration	
Power supply	4 x 1.5 V alkaline batteries (LR6/AA/AM3) or external DC power source (7 ... 14 V, 500 mA) + USB port (5 V, 1 A)	

Battery life	Approx. 10 hours in continuous operation
Real-time clock	The integrated backup battery was factory-calibrated to an error of <26 s over 30 days (<10 ppm, (25 ±16) °C). The backup battery ensures that the system clock continues to run even when the main batteries are replaced. GPS time function available (PCE-432)
Language	German, English, Portuguese, Spanish, French
Firmware update	Firmware update via USB port
Operating conditions	Temperature: -10 … +50 °C Humidity: 20 … 90% RH
Real-time temperature	is displayed on the main screen
Dimensions (WxHxD)	70 x 300 x 36 mm
Weight (including batteries)	620 g

Notes:

1 - For the PCE-428, ignore results outside the range of 20 Hz … 12.5 kHz due to the microphone frequency response for Class 2 measuring instruments.

2 - The data was measured using a microphone with a sensitivity of 40 mV/Pa.

3 - Measurement performed in accordance with the requirements of standards GB/T3785 and IEC61672.

4 - Measurement in accordance with the requirements of the GB/T 3241 and IEC 61260 standards.

SYSTEM DESCRIPTION

Device
1 - Backlit LCD
2 - Microphone and preamplifier
3 - LED display
4 - Non-slip rubber grip
5 - LR6/AA/AM3 battery
6 - Connection thread
7 - Cover lock
(left: unlock / right: lock)



8 - RS-232 interface
9 - AC output
10 - DC output
11 - Trigger
12 - Charging port
13 - Micro SD
14 - Mini USB



Data and power connection
There are 7 ports on the bottom of the sound pressure meter. Open the rubber cover to view these ports.

Power jack (PWR): Standard DC jack (2.1 mm diameter) for power supply; can be connected to an external power supply rated at 7–14 V, 500 mA.
Note: External voltages exceeding 14 V can damage the sound pressure level meter!

MiniUSB: MiniUSB port for connecting to a computer in USB drive mode or modem mode. The MiniUSB port can also be used as an additional external power supply, but the power supply must be capable of providing 5 V/1 A.

USB drive mode: Files on the MicroSD memory card can be accessed directly in this mode; no driver installation is required.
The computer can recognize the MiniUSB port as a serial port (virtual serial port, driver installation required) and communicate with the sound pressure level meter via the RS-232 protocol.
Note: The power supply must provide a current of at least 1 A, and the cable must be capable of carrying this current (do not use a cable with a ferrite core for the power supply). Select the operating mode after connecting to the computer. Otherwise, the computer will not be able to recognize the USB interface. The MiniUSB port and the RS-232 port cannot be used simultaneously when modem mode is selected.

MicroSD slot: For connecting a MicroSD card to store SWN, OCT, and CSD files. We recommend using the card reader instead of USB drive mode to format the MicroSD card.
MicroSD card: The MicroSD card supplied with the sound pressure meter is already preformatted.
Note: When inserting the MicroSD card, hold the front side (with the scratch protection) facing down.

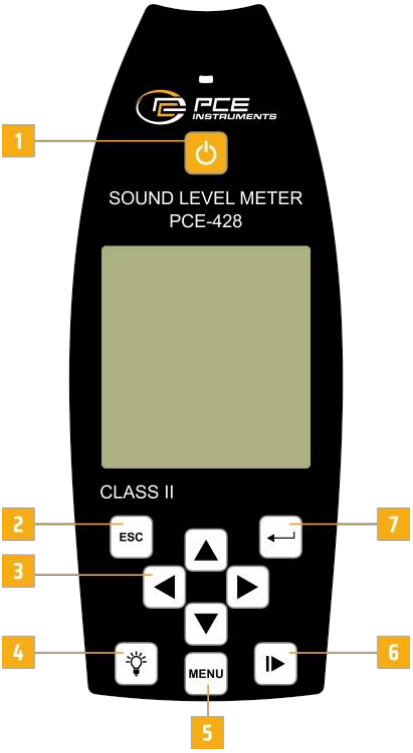
RS-232: The interface can be used as a standard RS-232 interface in remote mode.

TRIGGER: Trigger input with standard 3.5 mm headphone jack.

DC OUT: DC output with standard 3.5 mm headphone jack.

AC OUT: AC output with standard 3.5 mm headphone jack.

Control panel
1 - On/Off button
2 - Cancel button
3 - Arrow keys
4 - Backlight button
5 - Menu button
6 - Stop/Start button
7 - Enter button



On/Off button: Press and hold for 2 seconds to turn the sound level meter on or off.
Note: This is not possible while the meter is currently taking a measurement!
Cancel button: Closes the menu, returns to the previous page, or deletes a curve on the time history page.

Enter button: Opens the next menu; confirms the change; saves the CSD file when the device is stopped.

Backlight button: Turns the LCD backlight on or off. Set the backlight duration in the menu under Settings->Backlight.

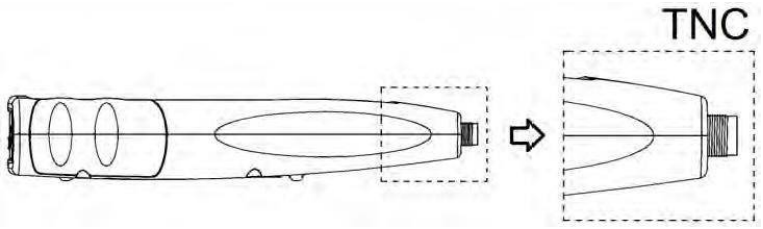
Stop/Start button: Start/stop measurement; start calibration via Calibration > After Measurement.

UP/DOWN/LEFT arrow keys: to select an option or change a value

Right arrow key: Right arrow key, to select an option, change a value, or go to the next page

Menu button: To open the menu

Microphone connector
The TNC connector on the top of the sound pressure meter is used to connect to a microphone and preamplifier (the microphone and preamplifier are typically mounted together in a single housing). The TNC connector is a threaded coaxial connector.



The PCE-430 and PCE-432 sound level meters are equipped with a Class 1 microphone; the PCE-428 sound level meter is equipped with a Class 2 microphone:

PCE-428-MIC: Pre-polarized measurement microphone, 1/2", Class 1, sensitivity: 40 mV/Pa, frequency range: 3 Hz … 20 kHz
Common housing with ICCP preamplifier, power supply 4 mA/24 V.

PCE-430/432-MIC: Pre-polarized measurement microphone 1/2", Class 2, sensitivity: 40 mV/Pa, frequency range: 20 Hz … 12.5 kHz
Shared housing with ICCP preamplifier, power supply 4 mA/24 V.

The microphone and preamplifier are screwed together with a threaded connection. Do not separate the parts except in exceptional cases. The microphone is a precision measurement sensor. Prolonged exposure to high humidity or dusty environments can damage the microphone. When the microphone is not in use, it must be stored in the supplied box.
The microphone has an ICCP power supply. The current technical specifications for the power supply are 4 mA, 24 V. If the voltage exceeds 30 V, the microphone will be damaged. The sound level meter has an internal ICCD power supply to which the microphone can be connected directly.
Connect the microphone to the TNC connector. Then turn the thread until the parts are securely connected.

Windscreen
The sound pressure meter is equipped with a windscreen for use in windy outdoor environments. The windscreen does not need to be used if wind is not expected in the surrounding area (for example, when taking measurements indoors).
Press the windshield firmly onto the microphone until it clicks into place. For more details on adjusting the windshield outdoors, see Adjusting the Windshield Outdoors.

Battery
We recommend using 4 high-quality alkaline batteries (LR6/AA/AM3). Observe the battery polarity (+/-) and the markings in the battery compartment. Do not mix old and new batteries. Remove the batteries when the device is not in use. If the battery remains in the device for a long time, it may leak and damage the device. The total voltage of the 4 battery cells must not exceed 14 V; otherwise, the sound level meter will be damaged.
Field tests show that the 4 alkaline batteries are sufficient for approximately 10 hours of operation (depending on the battery). When using Eneloop BK-3HCCA/4BC rechargeable batteries (rated capacity 2450 mAh), the sound pressure meter can operate continuously for approximately 12 hours. If the battery voltage falls below the sound pressure meter's minimum voltage, the device will automatically shut down. For extended operating times, we recommend using an external power supply or powering the device via USB.

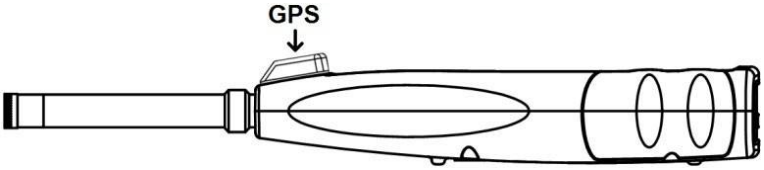
Follow the steps below when inserting or replacing the batteries:

» Slide the cover latch to the left to unlock the battery compartment cover.

» Remove the battery compartment cover.

» Replace the batteries and close and lock the battery compartment cover again.

GPS (PCE-432 only)
The GPS antenna is located on the top of the PCE-432.



GPS performance is influenced by two factors: the satellite ephemerides and the satellite's signal-to-noise ratio.

» **Satellite ephemerides:** Orbit information for GPS satellites. The current location can be determined using the ephemerides, the satellite position signal, and the time. You must download the satellite ephemerides from the GPS satellites; however, the download speed is very slow (about 50 bps) and depends on the satellite's signal strength. The high bit error rate can prolong the download time for the ephemerides or cause the download to fail entirely. The sound pressure meter can store the ephemerides for about 30 minutes after the GPS module is turned off. The ephemerides are valid for only 2 hours.

» **Satellite signal-to-noise ratio:** The strength of the satellite's position signal. On rainy days or indoors, the signal strength is lower.

The GPS has 3 startup modes: cold start, warm start, and hot start

- **Cold start:** Initial position determination; the current ephemerides must be downloaded, so more time is required.
- **Warm start:** The GPS module has the last saved location data but must download new ephemerides because the old ones are out of date. A warm start takes almost as long as a cold start.
- **Hot start:** The GPS module has valid ephemerides and can determine the position in a very short time.

INFORMATION FOR REGULAR TESTS

- Reference sound level: 94.0 dB
- Reference direction of incidence: parallel to the direction of incidence of the microphone
- Microphone reference point: Center of the microphone diaphragm
- Reference direction of incidence: direction perpendicular to the microphone diaphragm
- Reference attenuation of the octave spectra: 0 dB
- Reference input signal level of the octave spectra: 40 mV (94 dB at a sensitivity of 40 mV/Pa)

MEASUREMENT SCREEN

The sound pressure level meter has three measurement modes: level measurement, 1/1-octave measurement, and 1/3-octave measurement. The user can select the measurement mode in the Function menu.

- **The level measurement mode** has 8 screens that you can switch between using the left and right arrow keys. The 8 screens are: Main Screen, 3 Profiles, LN Statistics, Time History, Custom Measurement Page 1, Custom Measurement Page 2, GPS Page 1, and GPS Page 2.
- **The 1/1-octave measurement** has 4–6 screens: Octave histogram, Octave table pages 1–3. PCE-432 only: GPS page 1 and GPS page 2.
- **The 1/3-octave measurement** has 5–7 screens: Octave histogram, Octave table pages 1–4. PCE-432 only: GPS page 1 and GPS page 2.

Meaning of the Screen Display / Symbols
All symbols on the main screen are active; the meaning of each symbol is described below:

Symbol	Meaning
	Start/Stop measurement
	**Range Overrun or Undervoltage** A filled-in arrow indicates that the current status is range overrun or range underrun. An unfilled arrow indicates that the range was undershot or the device was overloaded during the integration period. At the start of the new integration period, the symbol for over- or under-range.
	**ICCP Status** Indicates whether ICCP is disabled
	**Trigger status** Displayed when the trigger is activated
	**Status of the RS-232 interface** Displayed during remote control
	USB status is displayed when a connection to the computer is established
	**Timer status** The 1 icon indicates that the timer is activated and has been started only once. The ∞ icon indicates that the timer is activated and is restarting continuously.
	**MicroSD status** Displayed when data is saved
	**Power status** Icons from left to right: external power supply, battery power supply (with voltage display), and USB power supply
	Calculated parameters
	Filter status
	Detector status
	Range status Single range, Auto display
	Profile number of the current display

114.0 dB	Measured value
	Measured values in the current measurement range as a dynamic bar graph
2010-12-14 17:49:56	Date and time
1 6	Current page number and total number of pages
20.1℃	Internal temperature
05:00:00 00:01:32	Integration period Elapsed time The measurement ends when the elapsed time equals the total measurement time (integral period × repetition).

Only the symbol for the selected parameter is displayed.

SCREEN IN LEVEL MEASUREMENT MODE

Main screen

Display of measurement data, filter, detector, mode, and profile number. The main screen shows only one set of data from the 3 profiles. Press the up and down arrow keys to switch between the 3 profiles.

3 Profiles

Simultaneous display of the data and the corresponding measurement mode, filter, and detector for the profile measurement. The data from the 3 profiles can be saved in an SWN file.

LN Statistics

Displays 10 groups of statistical results. Each data source group (fixed mode for SPL, filter, and detector can be customized) and the percentage value can be set in the menu.

Time History

Displays the current noise level and the time-domain curve. The data sources (one of the 3 profiles) and the time scale (1 minute, 2 minutes, and 10 minutes) can be customized. Press the cancel button to clear the screen and redisplay the curve.

Customizable Measurement Page 1

The user can set the parameters for the 14 measurement sets. The first 7 measurement sets can be displayed on this screen.

Customizable Measurement Page 2

The user can set the parameters for the 14 measurement sets. This screen displays the last 7 measurement sets.

GPS Page 1
Display GPS information: GPS status, GPS date, GPS time, longitude, latitude, altitude, and speed.

GPS Page 2
Display of the number of satellites used for positioning and the signal-to-noise ratio of all visible satellites (0 … 99 dB).
Note: The number of visible satellites may be greater than the number of satellites used for positioning, because some satellites are not available for positioning.

SCREEN IN 1/1-OCTAVE MODE
1/1-Octave Histogram
Displays 12 bands from 8 Hz … 16 kHz and LAeq, LBeq, LCeq, LZeq as a bar graph. Press the up and down arrow keys to view the detailed value for each band. A threshold value can be defined for each band. The LED lights up red if the data exceeds the threshold value.

Octave Table, Page 1
Display of measurement data from 8 Hz to 16 kHz. The LED lights up red and a warning symbol appears if the data exceeds the threshold value.

Octave Table Page 2
Display of measurement data from 1 kHz to 16 kHz. The LED lights up red and a warning symbol appears if the data exceeds the threshold value.

Octave Table Page 3
Display of measurement data for LAeq, LBeq, LCeq, and LZeq. The LED lights up red and a warning symbol appears if the data exceeds the threshold value.

SCREEN IN 1/3-OCTAVE MODE
1/3-Octave Histogram
Displays 36 bands from 6.3 Hz to 20 kHz and LAeq, LBeq, LCeq, LZeq as a bar graph. Press the up and down arrow keys to view the detailed value for each band. A threshold value can be defined for each band. The LED lights up red if the data exceeds the threshold value.

Octave Table Page 1
Display of measurement data from 6.3 Hz … 80 kHz. The LED lights up red and the dB value appears in inverted colors if the data exceeds the threshold value.

Octave Table Page 2
Display of measurement data from 100 Hz to 1.25 kHz. The LED lights up red and the dB value appears in inverted colors if the data exceeds the threshold value.

Octave table, page 3
Display of measurement data from 1.6 … 20 kHz. The LED lights up red and the dB value appears in inverted colors if the data exceeds the threshold value.

Octave table, page 4
Display of measurement data for LAeq, LBeq, LCeq, and LZeq. The LED lights up red and a warning symbol appears if the data exceeds the threshold value.

OPERATION AND MENU SETTINGS

Press the Menu button to access the next menu. All measurement parameters can be set in the menu.

Function

» Select the Function option and press the Enter key to open this menu. You can select from the following 3 measurement modes: **Level measurement, 1/1 octave measurement, and 1/3 octave measurement.**

» Press the up and down arrow keys to select the measurement mode.

» Press the Enter key to save the setting and return to the previous menu. Press the Cancel key to return to the previous menu.

CALIBRATION

» Select the Calibration option and press the Enter key to access this menu.
The microphone's sensitivity is affected by numerous factors, such as temperature, humidity, and air pressure.

» The user must therefore perform at least one calibration before taking a measurement.

» There are two calibration methods: **by measurement and using a calibration factor.**

» For calibration with a sound calibrator, the measurement method should be used.

» The calibration method using a calibration factor allows the user to manually adjust the calibration factor.

Calibration by Measurement
Select the By Measurement option and press the Enter key to open this menu. The calibration level can be adjusted between 0 … 199.9 dB. Press the arrow keys to change the calibration level and the Stop/Start button to begin calibration. Once calibration is complete, the calibration factor is updated. The user can save the result by pressing the Enter key or ignore it by pressing the Cancel key. This menu also displays the calibration history.
Entries ending with an M indicate that the data set was calibrated using the "By Measurement" method.

Calibration with Calibration Factor
Select the "With Calibration Factor" option and press the Enter key to open the menu. The user can manually adjust the calibration factor. Use the left and right arrow keys to select the factor digit, and the up and down arrow keys to adjust the value. Press the Enter key to save, or the Cancel key to return to the previous menu. An entry ending with an F indicates that the data set was calibrated using the With Calibration Factor method.

Conversion of Calibration Factor and Sensitivity
Sensitivity can be calculated using the following formulas. The calibration factor can also be calculated from the sensitivity and entered directly into the sound pressure meter.

Cal.F = 20 x log (Sens / 40) + Offset
Sens = 40 x 10 ((Cal.F-Offset) / 20)

Where:
Cal.F is the calibration factor in decibels (dB);
Sens: the sensitivity of the microphone in mV/Pa;
Offset: the calibration factor in decibels (dB). This value is the calibration result obtained by measuring a 40 mV signal. This offset represents the device's inherent deviation, which varies for each sound level meter.

Performing a calibration by measurement
Calibration by measurement is the recommended calibration method using a sound calibrator. Class 1 and 2 sound calibrators are available from PCE Deutschland GmbH.
Proceed as follows for calibration by measurement:

» Insert the microphone into the cavity of the calibrator as far as it will go. The microphone must be firmly seated.

» Then turn on the calibrator and set a constant sound level (e.g., 94 dB).

» Select the Calibration option from the menu and press the Enter key to open the Calibration by Measurement menu.

» Set the calibration level in the menu, e.g., to 93.8 dB. Calibration begins 5 seconds after pressing the Stop/Start button.

» Once calibration is complete, the sound level meter updates the calibration factor. Press the Enter key to accept the results.

» Return to the main screen and press the Stop/Start button to start the measurement. The current measurement result in this example should be 93.8 dB if the calibrator is functioning properly.

MEASUREMENT
The Measurement menu contains 13 menu options. Use the up and down arrow keys to select options and the Enter key to access the next menu.

Measurement Setup
The Measurement Setup menu is the most important menu for measurement. Here you can set the parameters for delay, integration period, repetition, SW log step, SWN log step, CSD log, and CSD log step. You can select options using the up and down arrow keys.

Delay:
The delay between pressing the Stop/Start button and the start of the measurement. Use the left and right arrow keys to select the delay as follows: Sync 1 min, Sync 15 min, Sync 30 min, Sync 1 h, 1 … 60 s.
The delay time prevents the measurement from being affected by the button press or by vibrations.

Integration period:
The integration period for each individual measurement.
At the start of each integration period, all integration data and time data are reset; the overload or under-range indicator is cleared. Integral data and time data include LEQ, Max, Min, Peak, SD, SEL, E, and LN. Press the left and right arrow keys to select the following option: Infinite, 1 … 59 s, 1 … 59 min, 1 … 24 h.

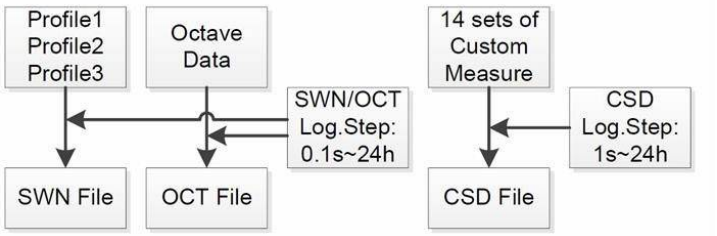
Repeat:
The number of repetitions in a measurement.
Total measurement time = integration period × number of repetitions. Press the left and right arrow keys to select one of the following options: Inf, 1 … 9999.

SWN Log:
Press the left and right arrow keys to switch between options. If you select this option, the sound level meter saves the data in SWN/OCT files. The SWN/OCT files store the time-series data. The data source in level measurement mode is Profile 1–3 (selected in the Save SWN option of the Profile 1–3 menu); the data is saved as an SWN file. In 1/1-octave mode, all octave bands as well as LAeq, LBeq, LCeq, and LZeq are saved as an OCT file.

SWN logging interval:
The logging interval (the time interval) for saving data as an SWN/OCD file.
Press the left and right arrow keys to select one of the following options: 0.1 s, 0.2 s, 0.5 s, 1 … 59 s, 1 … 59 min, 1 … 24 h.
Note: In 1/3-octave mode, the SWN protocol step starts at 0.5 s (0.1 s and 0.2 s are not possible).

CSD Log:
Press the left and right arrow keys to switch modes. When the corresponding option is selected, the sound level meter saves the results in CSD files. CSD files store the instantaneous data. The data source in level measurement mode is the 14 group results of the customizable measurement. These are saved as a CSD file. In 1/1-octave mode,
all octave bands, as well as LAeq, LBeq, LCeq, and LZeq, are saved as a CSD file.
Note: After selecting the appropriate option, press the Enter key on the main screen to manually save the data to the CSD file once the measurement has stopped.

CSD Logging Step:
The logging interval (the time interval) for saving the data as a CSD file.
Press the left and right arrow keys to select one of the following options: 1 s to 59 s, 1 min to 59 min, 1 h to 24 h.
Note: An SWN/OCT file can only store integrated data. The logging interval can be considered an integration period. All data within the logging interval (the integration period) is saved in the SWN/OCT file as a single line. The CSD file saves only instantaneous data without integration. Once the CSD logging interval is reached, the 14 groups of data from the adjustable measurement are saved as a line in the CSD file, like a snapshot.



Measurement Range
The Measurement Range menu displays the linearity range, the dynamic range, and the peak-C range. Thanks to newly developed algorithms, there is only a single measurement range; therefore, the measurement range does not need to be switched. The algorithm meets the requirements for an impulse response up to 0.25 ms with a deviation of only 0.1 dB at 4 kHz. For impulse sequences of 0.125 ms at 4 kHz, the deviation is 0.4 dB.

Linearity range:
The measurement result can only be considered correct if it falls within the linear range. Otherwise, the measurement error exceeds the acceptance limit.
The linearity range is also referred to as the measurement range.

Dynamic range:
The dynamic range is the range between the self-noise and the maximum input signal level. The dynamic range is the maximum range that the sound level meter can display. The measurement result near the self-noise level does not have to be considered linear.

Peak C range:
The Peak C range is the linear range of the Peak C measurement.
The Peak C measurement in this range can be considered accurate.

ICCP POWER SUPPLY
The ICCP menu controls the power supply to all ICCP sensors via the 24 V/4 mA constant current source. Disable the ICCP power supply before connecting another sensor or connecting directly to the signal source. Press the left and right arrow keys to select.

Profiles 1-3
The menu for profiles 1–3 allows you to define the filter, detector, mode, and save options for SWN files. You can select options using the up and down arrow keys.

Filter:
Define the filter for profiles 1–3. Press the left and right arrow keys to select one of the following options: A, B, C, and Z (Z-weighting means no weighting. This weighting is also referred to as flat or linear weighting).

Detector:
Define the detector for profiles 1–3. Press the left and right arrow keys to select one of the following options: Fast, Slow, and Pulse.

Mode:
Defines the integral mode for Profile 1–3. Press the left and right arrow keys to select one of the following options: SPL, PEAK, LEQ, MAX, and MIN.

Save SWN:
This option allows you to specify which data should be saved in the SWN file, since the data source for the SWN file is Profile 1–3. This option has no relation to the screen display. Press the left and right arrow keys to select one of the following options: LEQ, PEAK, MAX, or MIN.

Alarm Threshold
If measurement results from Profiles 1–3 exceed the alarm threshold, the LED above the On/Off button lights up red. The alarm threshold can be set between 20 … 200 dB. Use the up and down arrow keys to increase or decrease the alarm threshold by 1 dB. Use the left and right arrow keys to increase or decrease the setting by 10 dB.

ADVANCED FUNCTION
The Advanced Function allows you to select which screen is displayed.
If the screen is not selected, it will not be displayed. Note that the main menu screen is always displayed.

Statistics
The data source for the statistics is permanently set to SPL. The user cannot change this setting. However, the user can define the filter and detector for SPL, as well as the statistical value, via this menu.

Mode:
The setting is permanently assigned to SPL and cannot be changed.

Filter:
Use the left and right arrow keys to define the filter for the statistical analysis: A, B, C, or Z (linear).

Detector:
Use the left and right arrow keys to set the detector for the statistical analysis: Fast, Slow, or Imp.

LN1 to LN10:
Use the left and right arrow keys to set the percentage for the 10 LN groups from 1 to 99%.
Example: LN1:10 = 80 dB means that, over the integration period, 10% of the measurement data exceeds 80 dB. The LN result depends on the integration period. The result is reset when a new integration period begins.

TIME HISTORY
In the Time History menu, you can use the left and right arrow keys to set the data source and the duration of the time history.

Profile:
Use the left and right arrow keys to set the data source for the time history: Profile 1, Profile 2, Profile 3.

Duration:
Use the left and right arrow keys to set the time scale of the time history: 1 minute, 2 minutes, 10 minutes.

OCTAVE THRESHOLD
In the Octave Threshold menu, you can set the alarm threshold from 31.5 Hz to 16 kHz, as well as LAeq, LBeq, LCeq, and LZeq. If the measurement result exceeds the threshold value, the LED lights up red. Use the left and right arrow keys to set the option between 0.1 dB and 199.9 dB.

CUSTOMIZABLE MEASUREMENTS
There are 14 menu options for Customizable Measurements, where you can define the parameters for 1–14 customizable measurements. Use the left and right arrow keys to select an option and press the Enter key to access the next menu level.
Use the left and right arrow keys to set an option for each group of customizable measurements: Filter, Detector, and Mode.

Filter:
Use the left and right arrow keys to set the filter for custom measurements: A, B, C, and Z (linear).

Detector:
Use the left and right arrow keys to set the detector for customizable measurements: Fast, Slow, or Imp.

Mode:
Use the left and right arrow keys to set the integral mode for customizable measurements: SPL, SD, SEL, E, Max, Min, Peak, LEQ, LN1 through LN10.

TIMER
In the Timer menu, you can set the Start Day, Start Time, and Repeat Interval options for the timer. Press the left and right arrow keys to select. The user can program the measurement to start at 00:00 the next day, run for several minutes, and repeat every hour to achieve an automatic 24-hour measurement.

Timer:
Use the up and down arrow keys to set the timer's operating mode: OFF, One-time, or Loop.

Start Day:
Use the up and down arrow keys to set the trigger date for the timer: Ignore or a fixed day every 30 days. If you select Ignore, the timer ignores the date and uses only the start time to trigger.

Start time:
Use the up and down arrow keys to set the time for the timer: 00:00 … 23:59.

Repeat time:
When the timer is triggered, it will be triggered again after the repeat time has elapsed. Press the left and right arrow keys to select the following option: 1 … 59 min, 1 … 24 h.

Note: The repeat duration must be longer than the total integral time (integral time × repeat) + 5 s, because the timer is set to a fixed delay of 3 s when a measurement is triggered, and an additional 2 seconds are required before the delay begins. Do not change the settings while the timer is running, as this will cause it to malfunction.

24-Hour Measurements with the Timer
The user can use the timer to implement a 24-hour measurement. The following description uses an example to show how to implement the 24-hour measurement.

Example:

- The measurement begins on March 14, 2015, at 12:00 a.m. and measures the first 5 minutes of every hour.
- The measured values are saved to the CSD file when the measurement stops and to the SWN file every second.
- The delay setting is ignored if the measurement is triggered by the timer.
- Set the integration period to 5 minutes and the repetition to 1.
- Enable the SWN log and CSD log.
- Set the SWN logging interval to 1 second and the CSD logging interval to 5 minutes.
- Set the timer to loop mode so that the measurement is triggered repeatedly.
- Set the desired date as the start date.
- Set the start time to 12:00 AM. This is the time when the measurement is triggered for the first time.
- Set the repeat interval to 1 hour so that the measurement is triggered every hour.

SETUP
The Setup menu contains the basic Setup function and condition display. Use the up and down arrow keys to select the option and the Enter key to access the next menu level.

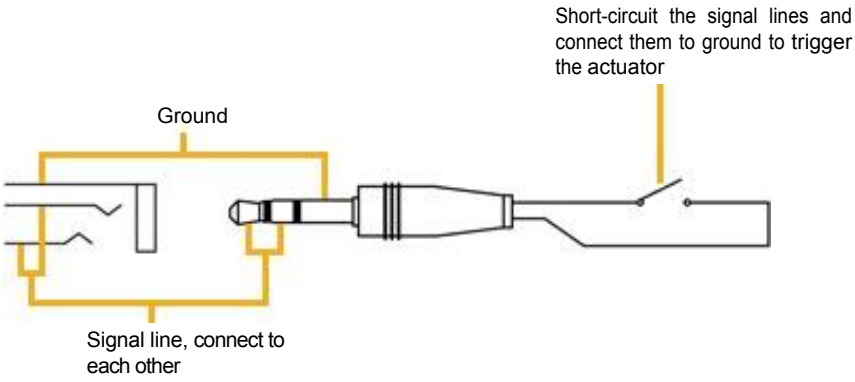
Contrast
In the Contrast menu, you can adjust the contrast of the LCD display in 14 steps. Press the up and down arrow keys to select.

Backlight
The sound pressure level meter automatically turns off the display backlight to reduce power consumption and conserve battery life. In the Backlight menu, you can enable or disable the backlight and change the backlight timeout. Press the up and down arrow keys to make a selection.

Battery
The Battery menu displays the battery status and voltage. The cut-off voltage of a single LR6/AA/AM3 alkaline battery cell is approximately 0.9 V; therefore, the sound level meter automatically shuts off when the total voltage of the 4 alkaline battery cells drops below 3.6 V.

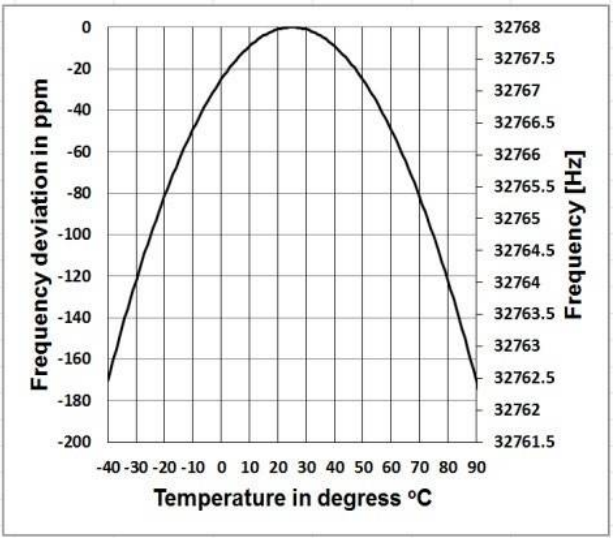
Trigger
In the Trigger menu, you can enable or disable the trigger function. The trigger is an analog input that allows you to start or stop the measurement on the sound level meter via remote control. The trigger input is located on the bottom of the device (3.5 mm headphone jack).

Trigger
In the Trigger menu, you can enable or disable the trigger function. The trigger is an analog input that allows you to start or stop the measurement on the meter via remote control. The trigger input is located on the bottom of the device (3.5 mm headphone jack).



The measurement is started by connecting the signal line to ground and stopped by disconnecting it. Note that when the trigger function is activated, the Start/Stop button is not available.

Date & Time
In the Date & Time menu, you can set the RTC time of the sound level meter. Press the up and down arrow keys to select.
Use the up and down arrow keys to select the date format and change the date. Use the left and right arrow keys to select the year, month, and day, and use the up and down arrow keys to change the numbers. Press the Enter key to save the setting.
Changing the time setting is similar. Use the left and right arrow keys to select the hour, minute, and second, and use the up and down arrow keys to adjust the value.
Press the Enter key to save the setting. An internal backup battery provides power to the RTC. Replace the RTC battery if the device no longer displays the date and time, or if it displays them incorrectly, because the RTC battery voltage is too low. To do this, loosen the 5 screws on the back of the sound level meter so you can remove the cover. The RTC battery is located on the circuit board. The battery is a CR-1220 button cell.
Note: The sound level meter's system clock was calibrated using a reference clock with an average error of 2 ppm (maximum error 3 ppm). The time inaccuracy at room temperature is less than 10 ppm (<26 seconds within 30 days). The maximum time error in internal tests at 25 °C was approximately 5 … 8 seconds.



The accuracy of the system clock may vary depending on the temperature, as no temperature compensation is applied. For the typical temperature curve shown in the figure, the system clock does not change its base frequency. As the temperature rises or falls, the frequency of the system clock changes by approximately -0.04 ppm/°C². Therefore, when the temperature is 0 °C, the system clock value changes by -0.04 x (0-25)² = -25 ppm. This corresponds to a delay of 2.16 seconds per day. If the temperature is 40 °C, the value of the system clock's deviation is -0.04 x (40-25)² = -9 ppm. This corresponds to a delay of 0.78 seconds per day.
The maximum error specified in this user manual (<10 ppm) can be calculated as a difference of approximately 16 °C from the reference temperature of 25 °C. The RTC system clock can therefore keep the error within 26 seconds over a 30-day period between 9 and 41 °C, i.e., at room temperature. The actual RTC error may be greater than the value specified in the user manual if the temperature range is exceeded.

Auto-off
The sound level meter has an automatic shut-off function to reduce power consumption. If the meter remains in the stop status and no button is pressed for a certain period of time, it will shut off according to this setting. The following settings are available for automatic shutdown: 1 minute, 5 minutes, 10 minutes, 30 minutes, Off. Use the left and right arrow keys to select a setting. Press the Enter key to save the setting.

RS-232 Interface
Use the RS-232 Interface menu to configure the options for the serial connection; see 8 RS-232 Data Transmission Protocol.

RS-232 Interface Mode:
RS-232 Options: Remote, Printer. Use the left and right arrow keys to select Remote. The sound level meter can send data and be controlled via the RS-232 port in Remote mode.

ID Setup:
In the ID Setup (for more information, see 8.2.2 Device ID), you can set the ID number to distinguish between multiple sound level meters on the network. You can set an ID between 1 and 255. Press the left and right arrow keys to select.

Baud rate:
The baud rate (for more details, see Section 8.1, Hardware Configuration and Interface Settings) determines the speed of data exchange via the RS-232 interface: 4800 bps, 9600 bps, or 19200 bps. Use the left and right arrow keys to select a setting.

Data Flow Control:
Data flow control allows you to set the data flow mode for remote control. The available options are: Hardware, Software. Press the left and right arrow keys to select.

Response:
For more information, see 8.3 Instructions. Here you can enable or disable the response signal (ACK/NAK). The options are: ON, OFF. Press the left and right arrow keys to select.

FILE MANAGER
The File Manager allows you to manage the stored SWN, OCT, and CSD files. The numeric display on the right side of each line is the file counter for each file type. Use the up and down arrow keys to select an option and the Enter key to access the next menu level.

In the **SWN File** menu, you can use the up and down arrow keys to delete SWN files. Select the file number you want to delete. The full file name is displayed at the bottom of the screen. Select 0000 as the file number if you want to delete the entire SWN file.

In the **OCT File** menu, you can delete the OCT file. The procedure is the same as in the SWN File menu.

In the **CSD File** menu, you can delete or read the CSD file. Use the up and down arrow keys to move the cursor between Select and Option. Deletion works the same way as in the SWN File menu. Select Option in the CSD File menu, then press the left and right arrow keys to select View CSD File. After selecting the file number and action, press the Enter key to view the file's contents. Use the arrow keys to browse the file contents in View mode. Print mode is almost identical to View mode. Press the Enter key to print the currently displayed contents of the CSD file.

In **Boot Mode**, use the up and down arrow keys to select Normal Mode, Power On and Start, or Power On and Auto Measurement.
Note: The hardware mode switch in the battery compartment must be set to match the startup mode.

Switching hardware modes:
The hardware switch for the mode is located in the battery compartment. It is easily accessible after removing the batteries. Use pliers or a pin to slide the switch to the Boot or Normal position.



CAUTION: Avoid static electricity before use, as this area is very sensitive to it.

Normal:
Set the hardware mode switch to Normal. This is the sound level meter's normal operating mode.

Powering On and Starting:
Here, you must set the hardware mode switch to Boot. After selecting this mode, the sound level meter turns on as soon as a suitable power supply is available. The device can be integrated into another system, especially if a power outage is expected. The sound level meter automatically turns back on after a power failure.

Start-up and automatic measurement:
In this case, you must set the hardware switch to "Boot" mode. If you select this mode, the sound level meter not only turns on as soon as power is supplied, but also begins measuring immediately. If the sound level meter is integrated into, it will turn on and start measuring automatically after a power outage.

USB MODE
In the USB Mode menu, you can set the operating mode when you connect the sound level meter to the computer via a USB cable. The options are: Always Ask, USB Drive, and Modem Mode.

Always Ask:
The device always asks which mode to select when the USB cable is connected to the computer. Decide as quickly as possible which option you want to use, otherwise the computer will not recognize the sound level meter due to a timeout.

USB Drive:
The device always runs in USB drive mode without prompting when connected to the computer via the USB cable. The sound level meter can be recognized by the computer without driver installation. The files on the microSD card can be accessed directly using Windows Explorer.

Modem mode:
When connected to a computer via the USB cable without a prompt, the device always runs in modem mode. The sound level meter can be recognized by the computer as a serial port (virtual port) and uses the same protocol as the RS-232 interface (for further details, see 8 Data Transmission Protocol RS-2328)

GPS (PCE-432 only)
In the GPS menu, you can enable or disable the GPS and Automatic Time Synchronization options. If GPS is disabled, the internal GPS module is turned off. The sound level meter's system clock synchronizes with the GPS time when you enable the Automatic Time Synchronization option.

Setup Template
The setup template allows you to save five user group setting parameters of the sound level meter for various applications.
Note: The template does not change the calibration factor. Do not attempt to load the template from the old version into the firmware of the new version, as there may be specific modifications to the template format. Press Enter if there is no template. The template can save a group setting for which the user can define a name consisting of five letters or numbers. Press Enter if a template exists to load or delete it.

About
The About menu displays the type, class, and serial number, version, and HWID (hardware ID) of the sound level meter.

Language
The sound level meter supports six languages: German, English, Chinese, Portuguese, Spanish, and French. Use the up and down arrow keys to select the desired language and press the Enter key to save the setting.

Output
In the Output menu, you can select which measurement data should be output to the DC voltage output. For the level measurement mode and the 1/1-octave measurement, the options are Sound Level Meter DC Voltage Output and 1/1-Octave DC Voltage Output. Press the up and down arrow keys to make your selection.

AC Output
There are two analog outputs on the device: a DC output and an AC output. Connect the DC output or AC output to another device or system using a coaxial cable. The input impedance of the connected device or system should be approximately 5 kΩ. The connection for the AC output is located on the bottom of the sound level meter. It outputs the microphone signal directly without any adjustment options. The maximum output voltage is 5 Vrms (±7 Vpeak), and the maximum output current is ±15 mA. Note: If the input impedance of the receiving device or system is not high enough, you must supplement it with an impedance matching circuit. The AC voltage output can be used for noise recording or monitoring, since the background noise is higher than the lower limit of the sound level meter's linear measurement range.

DC Output
The DC voltage output is used to output the analog DC voltage signal, which is proportional to the measurement result at a ratio of 10 mV/dB. At 93.8 dB, for example, the output is 938 mV. This option is recommended for filtering or averaging the output signal to suppress noise.

The sound level meter's DC output can be set to the signal output for the level measurement mode. Press the arrow keys to select.

» Filter: A, B, C, Z (flat)

» Detector: Fast, Slow, Imp.

» Mode: SPL, LEQ, Peak

The octave DC output defines the output signal in 1/1-octave mode.
The following options are available:

» LAeq

» LBeq

» LCeq

» LZeq

» 31.5 Hz

» 63 Hz

» 125 Hz

» 250 Hz

» 500 Hz

» 1 kHz

» 2 kHz

» 4 kHz

» 8 kHz

» 16 kHz

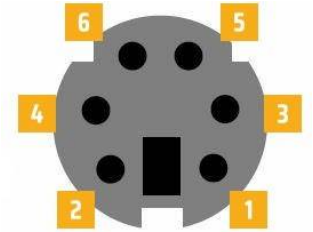
Press the left and right arrow keys to select.

Factory settings
Under Factory Settings, you can reset all parameters that have been changed by users to their factory defaults. The parameters are initialized with the default values. Use the left and right arrow keys to select Y (Yes) or N (No). If you select Y (Yes) and press the Enter key, the parameter is initialized. If you select N (No) or press the Cancel key, the reset is canceled.

RS-232 DATA TRANSMISSION PROTOCOL

The PCE-428 / PCE-430 / PCE-432 sound level meters are equipped with an RS-232 serial interface. The user can modify the sound level meter's configuration via the serial interface, start and stop the sound level meter, query the current measurement parameters, and process the results. Operation via the serial interface does not affect operation via the keyboard.

Hardware Configuration and Interface Settings
The PCE-428 / PCE-430 / PCE-432 sound level meters use a 3-wire serial interface; the physical connector is a 6-pin PS/2 connector. The following is the schematic diagram of the RS-232 interface:



1 - NC
2 - GND
3 - NC
4 - TXD
5 - NC
6 - RXD

RS-232 transmission settings:	
Transmission mode	Full-duplex
Synchronous/asynchronous mode	Asynchronous transmission
Baud rate	4800 bps, 9600 bps, 19200 bps
Data bits	8 bits
Stop bits	1 bit
Parity	None
Data flow control	Note the timing data in the table of nominal parameters.

Note: The housing of the RS-232 connector should be grounded, and we recommend using a protective conductor. Use a high-quality and reliable RS-232-to-RS-485 adapter.

Transmission protocol

The RS-232 interface protocol is based on block-by-block transmission. A typical command block (from the PC) or response block (from the device) consists of a start character, the ID, the attribute character, the command or data, the stop character, the parity character, and the line feed and carriage return characters, as shown in the following table:

<STX>	ID	ATTR	Command or Data	<ETX>	BCC	<CR>	<LF>

Starting and Stopping Block-by-Block Transmission

A command block or response block contains start characters, end characters, and other control characters as shown in the following table:

Name	Hex	Meaning
<STX>	02H	Start character
<ETX>	03H	Stop character
<CR>	0DH	Car returns
<LF>	0AH	Line feed

Device ID

Each command block contains an ID. It is used to distinguish between multiple sound level meters in a network. When the sound level meter receives a command block, it compares the ID in the command block with its own ID. If both IDs match, the corresponding operation is executed. If they do not match, the command is ignored. The response block returned by the sound level meter also contains the ID, which identifies who sent the block.

Note: Ensure that the IDs of the sound level meters on the same network are different; otherwise, operation will be disrupted.

The ID is a byte of the binary address. The range is between 1 and 255; the corresponding hexadecimal value is 01H to FFH. This means that the command is a broadcast command if the ID in the command block is 00H. The sound level meter executes the instruction regardless of its own ID and without returning data if the command is a broadcast command.

Name	Hex	Meaning
ID	01H ... FFH	Device ID
	00H	Broadcast command

ATTR attribute character
The ATTR attribute character specifies the type of command or response.

Name	Hex	Meaning
C	43H	Command block
A	41H	Response block
<ACK>	06H	Normal response
<NAK>	15H	Error response

BCC (Block Check Character)
The block check character bit in the block is calculated by the sender. The receiver then calculates the BCC value of the block and compares it with the BCC value in the sender's block. If both values are identical, this means that the received block is correct. The BCC value is calculated from bytes between <STX> and <ETX> using the XOR operation. If BCC = 00H, the sound level meter does not verify the input and directly executes an authorized instruction. This allows you to simplify the transmission of the instruction block. However, this method is not recommended for long-distance transmissions, as BCC is the only way to guarantee the reliability of data transmission.

Name	Hex	Meaning
BCC	01H ... FFH	XOR checksum
	00H	Ignore checksum

Block Transfer Format
A block transfer of data is possible in four types: as a command block, as a response block, as a normal response block, and as an error response block. The four instruction format types are described below.

Command block: sent by the computer								
<STX>	ID	ATTR	Instruction	Parameter	<ETX>	BCC	<CR>	<LF>
1	1	1	3	N	1	1	1	1 byte

Here, ATTR='C'.
All commands occupy 3 bytes. If more than one parameter is included, all parameters must be separated by spaces.

Response block: Sent by the sound level meter							
<STX>	ID	ATTR	Response	<ETX>	BCC	<CR>	<LF>
1	1	1	4	1	1	1	1 byte

Here, ATTR = 'A'.
If multiple response data are present, the data must be separated by commas.

Normal response: Sent by the sound level meter						
<STX>	ID	ATTR	<ETX>	BCC	<CR>	<LF>
1	1	1	1	1	1	1 byte

Where: ATTR=<ACK>

Error response: Sent by the sound level meter							
<STX>	ID	ATTR	Error code	<ETX>	BCC	<CR>	<LF>
1	1	1	4	1	1	1	1 byte

Here, ATTR=<NAK>.
The error code occupies 4 bytes. All possible error codes are listed in the following table. The meaning of the error codes is described in more detail in the next section.

Error code	Meaning
0001H	Instruction error
0002H	Parameter error
0003H	Not available in current status

RECOVERY AFTER TRANSMISSION ERRORS

Various errors may occur during the transmission of the command block or response block. The following describes how the sound level meter handles errors and restores the output state.

Block transmission not completed

The "Block Transmission Format" section describes the four formats for block transmission. As soon as the sound level meter detects the start of a character block <STX>, it receives the following data until the end-of-block characters <CR>, <LF> are received. When data reception is complete and the parity is correct, the sound level meter performs post-checks. If the character <STX> is received again before <CR>, <LF>, the sound level meter ignores all previously received information and starts receiving a block again.

Validation error

After receiving the data block, the sound level meter checks the data block (except when BCC = 00H). If validation fails, the sound level meter ignores this command.

Command error

The sound level meter may not recognize the received command because the computer is sending an undefined command or an unexpected error occurred during transmission. If either of these errors occurs, the sound level meter returns a NAK block containing error code 0001H.

Parameter errors

Parameters in the command block may also be incorrect because parameters are not separated by a space, exceed the available range, or have an incorrect number of arguments. If a parameter error occurs, the sound level meter returns a NAK block containing error code 0002H.

Not available in current status

The current status may not function properly in the following cases:

- when a request to output octave data in level measurement mode or a request to output level measurement data in octave mode is received,
- if a calibration request is sent while a measurement is still in progress,
- when a change to the measurement parameters or system parameters is requested while a measurement is in progress.

If the above-mentioned error occurs, the sound level meter returns a NAK block containing error code 0003H.

DATA FLOW CONTROL

The sound level meter has a 3-wire serial interface with a 6-pin P/S2 connector, which lacks the pins for hardware flow control. The sound level meter does not support software flow control. Operation in accordance with the requirements of the Specifications section can guarantee the accuracy of the transmitted and received data.

Operation of Multiple Devices
Multiple sound level meters can be connected via the RS-232 interface to form a measurement network. Users can change the settings of all sound level meters on the same network using broadcast commands or access the data and parameters of each individual sound level meter using standard commands. Please note the following:

» Sound level meters in a network must never have the same ID.

» The user must not send a broadcast command that returns arbitrary data.

Nominal parameters				
Name	**Min.**	**Rated value**	**Max.**	**Description**
Response time of the sound level meter	-	-	2 sec	If the value is exceeded, timeout processing should take effect.
Time interval for the command to send to the sound level meter	-	100 ms	-	-
Wait time for the sound level meter after receiving <STX>	-	Unlimited	-	Sound level meter waits indefinitely for the remaining data.
Time interval between each byte that the sound level meter is to receive	-	Unlimited	-	The computer's transmission speed may be very low.

Instructions
There are two types of statements: definition statements and query statements.

» Configuration commands define the measurement parameters and system parameters for a sound level meter.

» Query commands retrieve the parameters and data from the sound level meter.

There are three situations in which commands are sent to the sound level meter:

» Configuration command (without response)

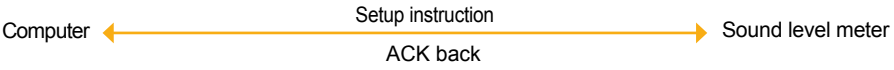
» Configuration commands (with response)

» Query commands.

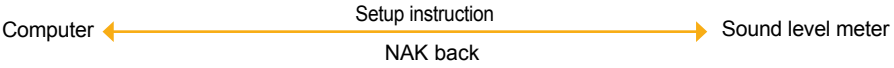
Setup commands (without response):



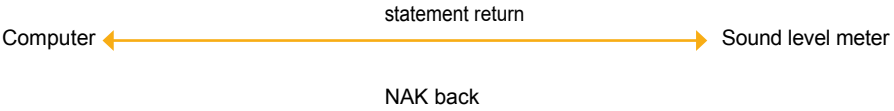
Setup instructions (with response): Normal response



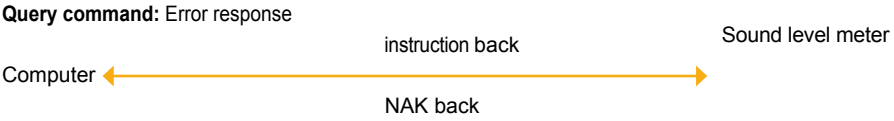
Setup instructions (with response): Error response



Query command: Normal response



Query command: Error response



MAINTENANCE

Troubleshooting

Problem	Possible Cause and Solution
Device cannot be started	» Battery is dead. Replace the battery. » Power supply failure. Replace the power supply. » Power switch not working: Send the device to our repair shop.
Incorrect measurements	Try recalibrating the device.
The measurement data does not change noticeably, even though the sound source changes significantly	» Damaged microphone. Send the microphone to our repair shop. » Poor contact between the microphone and the housing. Send the housing to our repair shop.
Button not working	Button is defective. Send the device to our repair shop.
Slow response during operation	Too many files on the micro SD card: Delete the corrupted files.
The measurement data cannot be saved	» Check the log settings. » Format the memory card with FAT32. » Replace the microSD card with a new memory card with a maximum capacity of 4 GB.

FIRMWARE UPDATE

The firmware can be updated via the USB port. To do this, you will need the following:

» PCE-428 / PCE-430 / PCE-432 sound level meter (HWID P0274 or higher)

» Mini-USB cable (included)

» Power adapter (included)

» Firmware for the update

» CP210x USB driver from Silicon Labs

» Firmware update tool

You can find the firmware update software in the download section of our website.

Installing the USB driver
Unzip and install the driver step by step. Select X86 for a 32-bit operating system and X64 for a 64-bit operating system.
Note: Do not connect the sound level meter to the computer while installing the driver.
Follow the installation instructions, accept the license agreement, and then click Next until the driver installation is complete. After installing the drivers, connect the sound level meter to the computer using a USB cable. In Device Manager, you will see a new device labeled Silicon Labs CP210x USB to UART Bridge (COMx).
Note: Power the sound level meter from an external power source when connecting it to the computer.

Firmware Update Procedure
Follow the step-by-step instructions in the FlashTool Wizard firmware update software. Launch the FlashTool Wizard and select the language.

» Prepare the list for the firmware update.

» Install the driver. Skip this step if you have already installed the driver.

» Connect the sound level meter to your computer as prompted. Note that the sound level meter requires an external power supply. If the driver is working properly, it will automatically select the CP210x port. The default baud rate is 115200 bps, depending on the computer. A higher baud rate can speed up the update.

» First, click the button in the upper right corner to select the firmware, and then click Refresh to start the program. This process takes approximately 3–4 minutes.

» **Note:** Reset the device to its factory settings and perform a calibration at least once after updating the firmware; otherwise, the sound level meter may not function properly. If the message Time Out! keeps appearing, remove the microSD card and try again. There are no restrictions on upgrading or downgrading the firmware. The user can update to any version. However, we always recommend keeping the previous version of the firmware.

GLOSSARY

Frequency weighting[1]
The difference, as a function of frequency, between the level of the frequency-weighted signal on the display device and the corresponding level of a constant sinusoidal input signal. The level difference is expressed in decibels (dB). Frequency weighting typically includes A, B, C, and D weightings, which can simulate the frequency response of human hearing. A- and C-weighting are more commonly used and are defined in the IEC and GB/T standards. The B-weighting is defined only in the ANSI standard. D-weighting refers to an international standard that has already been withdrawn. Only some older devices feature D-weighting. No frequency weighting—i.e., a so-called flat response curve—is always referred to as Z-weighting, a flat response, or a linear response.

Time weighting[1]
An exponential function of time with a specific time constant that weights the square of a sound pressure signal. The weighting of the sound pressure is higher when it corresponds more closely to the current time, and vice versa. The time weightings fast and slow are most commonly used. Impulse should not be used and is listed only for historical reasons.

SPL
The sound pressure level (SPL) calculated by the sound level meter is the highest time-weighted sound pressure level within one second.

LEQ[1]
The time-averaged sound level, or an equivalent continuous sound level. The 10th logarithm (base 10) of the ratio of the square of the average time of a frequency-weighted sound pressure signal during a specified time interval to the square of the reference value LEQ is the current integral value of the sound level for the specified duration. The longer the integration period, the slower LEQ changes. LEQ is frequently used for the overall assessment of noise exposure.

Peak[1]
Peak sound level. The 10-base logarithm of the ratio of the square of a frequency-weighted peak sound pressure signal to the square of the reference value. This value is typically used to evaluate very short sound pulses.

E[1]
Noise exposure. The time integral of the square of a frequency-weighted sound pressure signal over a defined time interval or an event of defined duration. This value is always used to assess the impact of noise on humans.

SEL[1]
Noise exposure. The 10-fold logarithm to base 10 of the ratio of a noise exposure to a reference value; also referred to as the single-event level.

LN
Statistical analysis result. The percentage N% of the measurement duration during which the level was exceeded.

Max[1]
Maximum duration of the weighted sound level within the specified time period

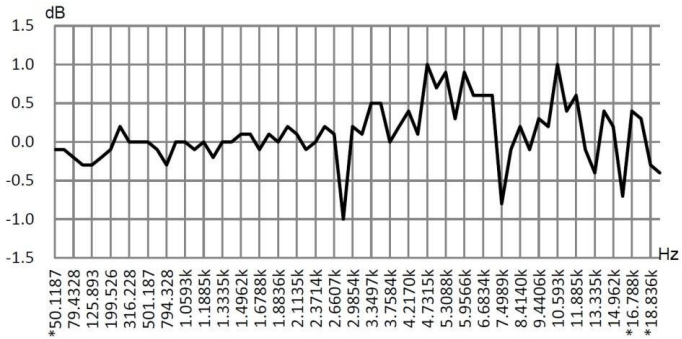
Min
Minimum duration of the weighted sound level within the specified time period

SD
Time-weighted sound level of the standard deviation within the specified duration. SD is used to describe the degree of variation in the sound level

Note 1: For further information, refer to the definition in the standard IEC 61672.1:2013.

CORRECTIONS

Correction for typical reflections from the sound level meter housing and sound scattering around the microphone



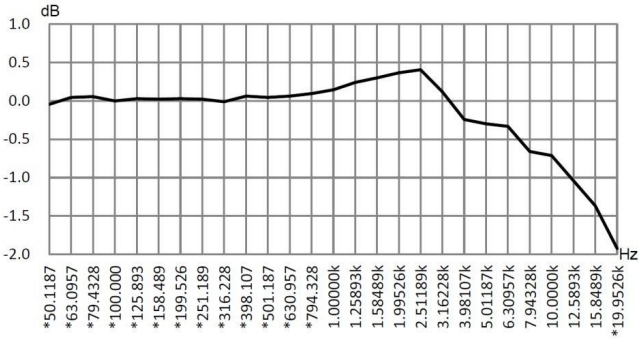
Frequency [Hz]	Value [dB]
*50.119	-0.1
63.096	-0.1
79.433	-0.2
100.00	-0.3
125.89	-0.3
158.49	-0.2
199.53	-0.1
251.19	0.2
316.23	0.0
398.11	0.0
501.19	0.0
630.96	-0.1
794.33	-0.3
1000.0	0.0
1059.3	0.0
1122.0	-0.1
1,188.5	0.0
1,258.9	-0.2
1,333.5	0.0
1,412.5	0.0
1,496.2	0.1

Frequency [Hz]	Value [dB]
1584.9	0.1
1678.8	-1.0
1778.3	0.1
1,883.6	0.0
1995.3	0.2
2,113.5	0.1
2,238.7	-1.0
2,371.4	0.0
2,511.9	0.2
2,660.7	0.1
2,818.4	-1.0
2,985.4	0.2
3,162.3	0.1
3,349.7	0.5
3,548.1	0.5
3,758.4	0.0
3,981.1	0.2
4,217.0	0.4
4,466.8	0.1
4,731.5	1.0
5,011.9	0.7

Frequency [Hz]	Value [dB]
5308.8	0.9
5623.4	0.3
5956.6	0.9
6,200.6	0.6
6,683.4	0.6
7,079.5	0.6
7,498.9	-0.8
7,943.3	-0.1
8,414.0	0.2
8,912.5	-0.1
9,440.6	0.3
10,000	0.2
10,593	1.0
11,220	0.4
11885	0.6
12,589	-0.1
13,335	-0.4
14,125	0.4
14962	0.2
15849	-0.7
*16,788	0.4
*17783	0.3
*18836	-0.3
*19953	-0.4

Expanded uncertainties: U=0.17 (k=2) for <= 4 kHz, U=0.29 (k=2) for >4 kHz
Note: The frequency marked with * is not specified in the standard. The exact frequency can be found in IEC 61672-1.

Corrections for outdoor windscreen



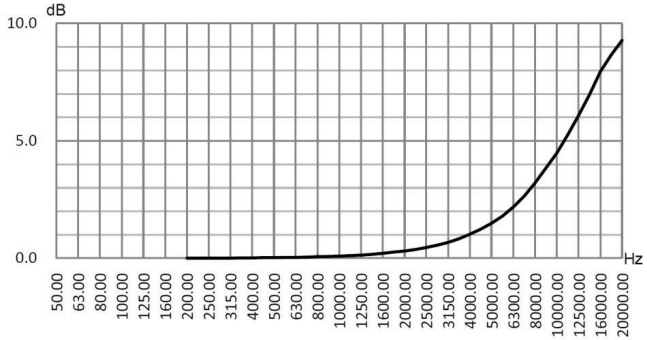
Frequency [Hz]	Value [dB]
*50.119	-0.04
*63.096	0.04
*79.433	0.06
*100.00	0.00
*125.89	0.03
*158.49	0.02
*199.53	0.03
*251.19	0.02
*316.23	-0.01
*398.11	0.06
*501.19	0.04
*630.96	0.06
*794.33	0.09
1,000.0	0.14
1,258.9	0.24
1,584.9	0.30
1,995.3	0.37

Frequency [Hz]	Value [dB]
2511.9	0.41
3162.3	0.12
3981.1	-0.24
5,011.9	-0.30
6,200.6	-0.33
7,943.3	-0.66
10,000	-0.71
12,589	-1.04
15,849	-1.37
*19953	-1.92

Expanded uncertainties: U=0.15 (k=2) for <= 4 kHz, U=0.21 (k=2) for >4 kHz.
Note: The frequency marked with * is not specified in the standard. The exact frequency can be found in IEC 61672-1.

Corrections for the electret microphone

The following corrections are measured by the electret microphone and the power supply.



Frequency [Hz]	Value [dB]
200	0.000
224	0.002
250	0.004
258	0.006
315	0.009
355	0.013
400	0.017
450	0.022
500	0.027
560	0.034
630	0.043
710	0.053
800	0.065
900	0.080
1000	0.096
1120	0.116
1250	0.140

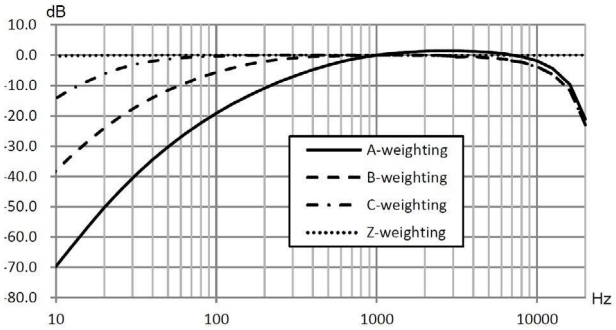
Frequency [Hz]	Value [dB]
1400	0.170
1600	0.213
1800	0.260
2000	0.312
2240	0.378
2500	0.456
2800	0.554
3150	0.678
3550	0.832
4000	1.020
4500	1.245
5000	1,488
5,600	1,798
6,300	2,184
7,100	2,651
8,000	3,204
9,000	3,840

Frequency [Hz]	Value [dB]
10,000	4.488
11,200	5.264
12,500	6,081
14,000	6,960
16,000	7,956
18,000	8,664
20,000	9,272

Expanded uncertainties: U=0.19 (k=2) at <= 4 kHz, U=0.34 (k=2) at 4 … 10 kHz, U=0.39 (k=2) at >= 10 kHz.

TYPICAL FREQUENCY RESPONSE AND CORRESPONDING UPPER LIMIT

Each microphone was carefully tested at the factory prior to shipment. The calibration chart included in the box shows the actual frequency response of the electret microphone and the frequency response in a free-field environment. The typical frequency response with the sound level meter's frequency weighting is shown in the following figure. The typical frequency response and the microphone's frequency response in a free field can be considered the overall characteristic curve of the sound level meter in a free field. The calibration certificate also includes the test results for the frequency response with A-, C-, and Z-weighting.



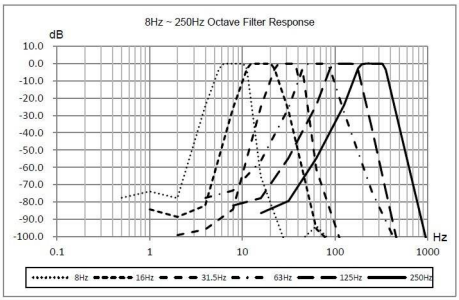
The following table shows the influence of the upper limit of the measurement range for A-, B-, and C-weighting and a typical frequency response as shown in the figure.

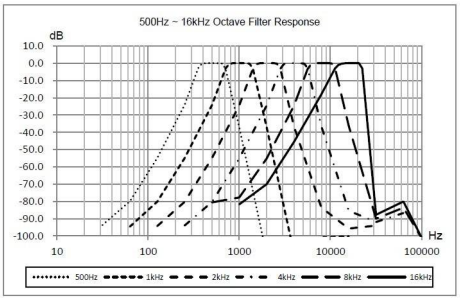
Freq. [Hz]	31.5	63	125	250	500	1 k	2 k	4 k	8 k	16 k*
A-weighting [dB]	-39.5	-26.2	-16.2	-8.7	-3.3	0.0	+1.3	+1.2	-0.5	-9.7
B-weighting [dB]	-17.1	-9.4	-4.3	-1.4	-0.3	0.0	0.0	-0.5	-2.3	-11.6
C-weighting [dB]	-3.0	-0.8	-0.2	0.0	0.0	0.0	-0.1	-0.6	-2.4	-11.7

Note *: Not available for PCE-428.

TECHNICAL SPECIFICATIONS OF THE 1/1 OCTAVE BAND FILTER

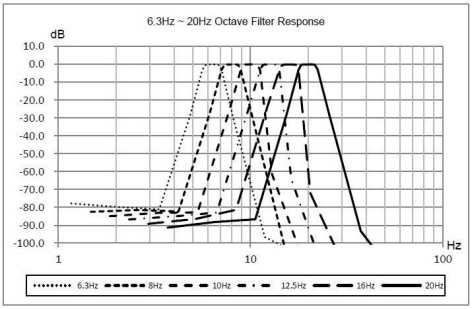
The 1/1-octave band filter was developed from a Butterworth filter with a base of 10. The technical specifications for each filter are shown in the following figures.

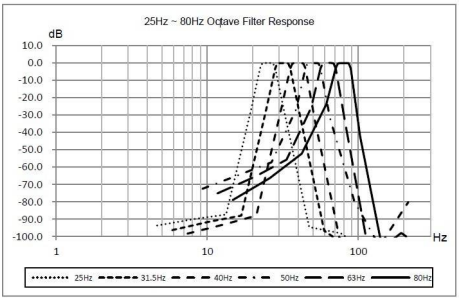


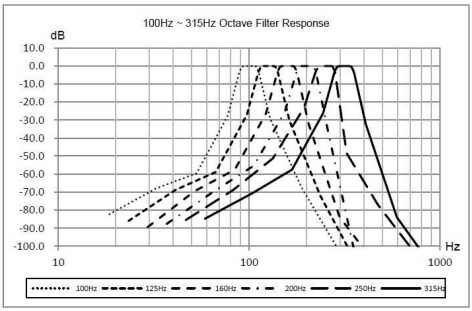


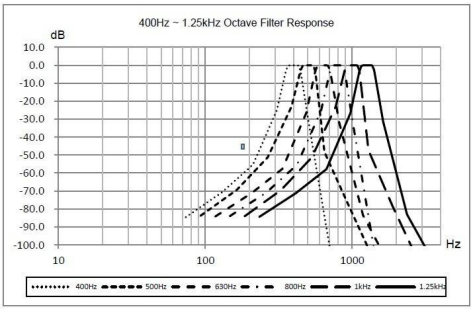
TECHNICAL SPECIFICATIONS OF THE 1/3-OCTAVE BAND FILTER

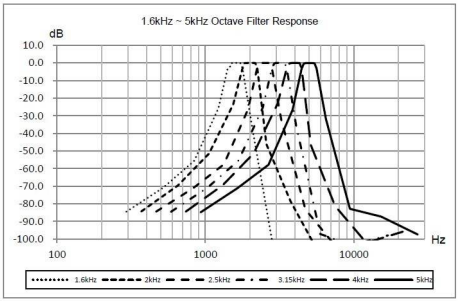
The 1/3-octave filter was developed from a Butterworth filter with a base of 10. The technical specifications for each filter are shown in the following figures.

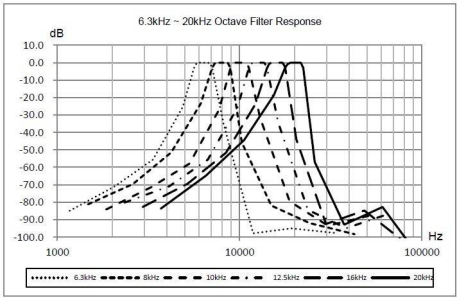












CENTER FREQUENCIES FOR 1/1- AND 1/3-OCTAVE BAND FILTERS

Exact center frequency fm base 10 [Hz]	Nominal Center Frequency [Hz]	1/1 octave band	1/3-octave band
6.3096	6.3	X	X
7.9433	8		X
10,000	10		X
12,589	12.5	X	X
15,849	16		X
19,953	20		X
25,119	25	X	X
31,623	31.5		X
39,811	40		X
50.119	50	X	X
63,096	63		X
79,433	80		X
100.00	100	X	X
125.89	125		X
158.49	160		X
199.53	200	X	X
251.19	250		X
316.23	315		X
398.11	400	X	X
501.19	500		X
630.96	630		X
794.33	800	X	X
1000.0	1000		X
1258.9	1250		X
1584.9	1600	X	X
1,995.3	2000		X
2,511.9	2500		X
3162.3	3150	X	X
3981.1	4000		X
5011.9	5000		X
6309.6	6300	X	X
7,943.3	8000		X
10,000	10,000		X
12,589	12,500	X	X
15,849	16,000		X
19,953	20,000		X

Note: The exact center frequencies were calculated to 5 significant digits.

DISPOSAL

For the disposal of batteries in the EU, the (EU) 2023/1542 directive of the European Parliament applies. Due to the contained pollutants, batteries must not be disposed of as household waste. They must be given to collection points designed for that purpose. In order to comply with the EU directive 2012/19/EU we take our devices back. We either re-use them or give them to a recycling company which disposes of the devices in line with law. For countries outside the EU, batteries and devices should be disposed of in accordance with your local waste regulations. If you have any questions, please contact PCE Instruments.

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