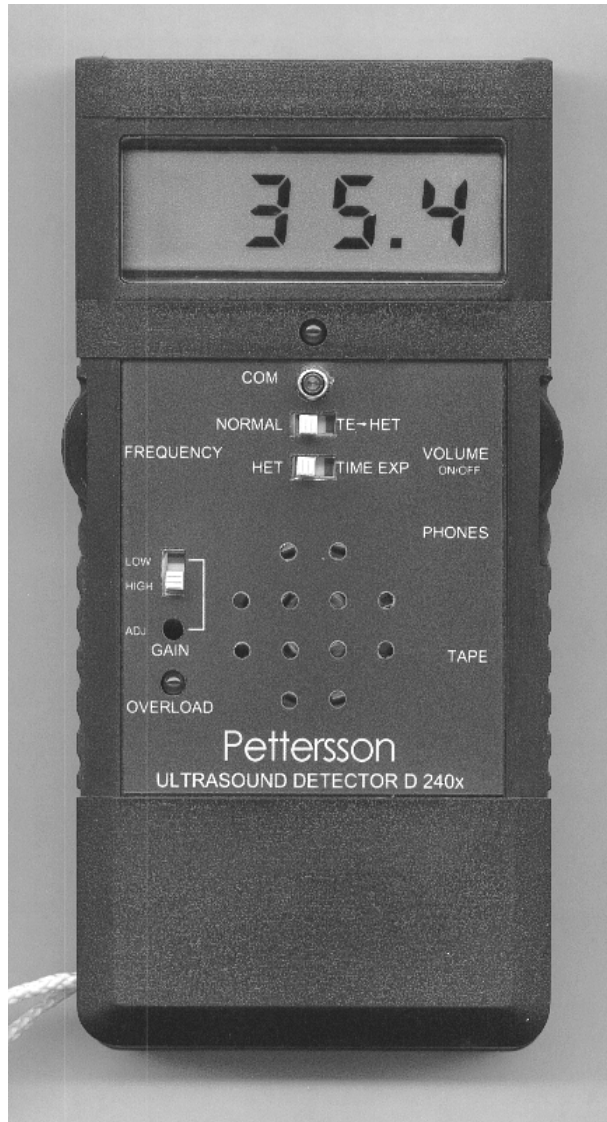


# ULTRASOUND DETECTOR D240x OPERATING INSTRUCTIONS



## INTRODUCTION

The ultrasound detector D240x is an easy-to-handle and very powerful instrument for conversion of ultrasound to audible sound. It is primarily intended for studying bats and other animals emitting ultrasound. The detector has two independent ultrasound conversion systems; a heterodyne system and a time expansion system. The detector is equipped with a digital display to provide very accurate readings of the tuned frequency.

Before using the detector, please read the following information carefully! Further information on the identification of different bat species using ultrasound detectors may be found in the literature (e.g. *Barataud: The inaudible world* available from Pettersson).

The D240x transforms ultrasound in the range 10 - 120 kHz into the audible frequency range. Although the main application for the D240x is studying bioacoustic ultrasound (bats, rodents, bush crickets etc.), the detector can be used in many other situations where detection of ultrasound is involved (ultrasonic intruder systems, leaks in pressurized systems, corona discharges etc.).

The transformed sounds are monitored either through the built-in loudspeaker or through headphones connected to the PHONES jack. A tape recorder or other recording device may be connected to the TAPE jack to make recordings of the transformed sounds or the direct microphone signal (if the COMMENT button is pressed, the microphone signal is directly connected to the TAPE output to enable the recording of spoken comments on the tape).

## GETTING STARTED

The detector is powered from one 9 V battery. An alkaline battery will last for appr. 15 hours.

Remove the battery compartment lid and insert a new battery. Observe the polarity! Then turn the VOLUME control/ON-OFF switch clockwise to switch the detector on. The LCD display now shows the tuned frequency (heterodyne system only!) and the LCD backlight is turned on. The LCD backlight also serves as a battery condition indicator, so if the backlight is too weak to read the display in darkness, it is time to replace the battery! To test the detector, perform the following steps.

Set the HET/TIME EXP switch to the HETERodyne position and the NORMAL/TE→HET switch to the NORMAL position. Adjust the VOLUME control so that a weak noise is heard in the loudspeaker. Then turn the FREQUENCY control to give a display reading of approximately 20 kHz and gently snap your fingers near the microphone (at the front of the detector). A scraping sound should then be heard in the loudspeaker. Another good ultrasound source is a jingling bunch of keys.

The frequency control works in the following way. The display shows the center of the frequency range (approximately 10 kHz wide), to be transformed. If the control is set to 30 kHz, you can listen to ultrasonic frequencies between approximately 25 and 35 kHz.

Next, let's have a look at the time expansion system. First, set the HET/TIME EXP switch to the TIME EXP position. Set the TRIG switch to the MANUAL position and the MEMORY SIZE switch to the 1.7 sec position (both switches are located on the time expansion control panel on the under side of the D240x).

Hold the detector in your left hand and push the MANUAL START/STOP button on the time expansion control panel with your pointing finger to make the red LED light up (indicating "SAMPLING"). Produce some ultrasound (e.g. as described above) and then push the button again to stop the sampling. The detector then replays the sounds immediately before (i.e. 1.7 seconds before) the button was pushed the second time, at a rate ten times lower than the original rate. Replaying the stored sequence takes about 17 seconds (34 seconds with time expansion factor 20). After replaying

the sequence once, it is replayed repeatedly until the push-button is pushed again. The frequency control and the displayed frequency does not have any effect on the time expansion system.

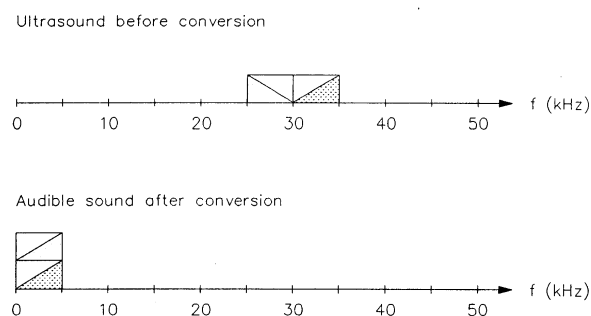
The time expansion system also has several advanced operation modes, which are described below.

If the volume control is turned up too high, acoustic feedback (a howling sound) may occur when the detector is working in the heterodyne mode. To avoid this, simply turn down the volume control or use headphones instead.

The D240X comes with a soft carrying case. For protection of the detector we recommend you keep it in this case when not in use. The detector should be placed with the display upwards in the case.

## THE HETERODYNE SYSTEM

There are several different principles to convert ultrasound into audible sound. As mentioned above, one of the systems in the D240x is based on the heterodyne principle. This technique means that a limited frequency range is selected for conversion into the audible range. If the frequency control is set to 30 kHz, the range from appr. 25 to 35 kHz will be transformed. This is illustrated in the figure below.



Let's assume an ultrasonic signal with constant frequency is emitted. When the frequency control of the D240x is turned from low frequencies to higher, a high-pitched tone will be heard in the loudspeaker when the frequency setting is appr. 5 kHz lower than the frequency of the ultrasound source. The closer the tuned frequency comes to the ultrasound's frequency, the lower the frequency of the loudspeaker tone gets. When both frequencies are identical the resulting output frequency becomes zero, i.e. nothing is heard in the loudspeaker. If you continue to turn the frequency control towards higher frequencies, a tone will again be heard in the loudspeaker, however this time the frequency will increase as the tuned frequency increases. By tuning the frequency control up and down it is possible to locate the frequency resulting in a zero Hz output frequency (the tuned frequency then equals the frequency of the ultrasound).

NOTE: The example above is only intended to illustrate the heterodyne principle. Constant frequency sounds are very rare in practice, so in most cases you will only be able to get an approximate measure of the signal frequency.

## **THE TIME EXPANSION SYSTEM**

This technique is similar to recording a sound on a tape recorder and then replaying the tape at a reduced speed. However, in the D240x the signal is not stored on a magnetic tape but in a digital memory. The time expansion principle is unique in the sense that it is the only ultrasound conversion system that retains virtually all characteristics of the original signal, so time expanded signals are well suited for many forms of advanced signal analysis (e.g. with our sound analysis software package BatSound). A time expansion factor of either 10 or 20 can be selected with the switch located immediately to the left of the relay output connector. The switch is accessible through the opening for the relay connector. Using a small screwdriver or similar object is required to alter the switch setting. The switch was given this sheltered position on purpose, to avoid inadvertently changing its setting. The factory default setting is 10 (switch pointing towards the microphone).

There are two basic operation modes of the time expansion system, manual and automatic. The operation mode is selected with the TRIG switch. In the manual mode, the MANUAL START/STOP switch is used to start and stop storing the signal, while in the automatic mode, the detector captures the signal itself when it exceeds an adjustable threshold level.

The maximum storage time in the time expansion system is 3.4 seconds. The actual memory size is selected with the MEMory SIZE switch. The alternatives are: 3.4 sec, 1.7 sec and "MIN". The default factory value for "MIN" is 0.1 sec. On request, it is however also possible to obtain a "MIN" storage time of 0.05 sec or 0.8 sec.

In order to obtain the highest sound quality on time expanded sounds, headphones should be used to monitor the sounds. Listening to the heterodyne system through the speaker, while sampling a signal to the time expansion system will cause the high frequency parts of the speaker sound to enter the microphone and to be mixed with the desired ultrasonic signal.

When the D240X is switched on, the memory of the detector is filled with a random signal which may sound like white noise. After switching the detector on, please allow at least the chosen memory time (e.g. 3.4 seconds) to elapse before you interrupt the recording by pressing the MANUAL START/STOP button (or, in the AUTO mode, the recording is interrupted by an incoming sound) and this random signal will be replaced with a "real" signal. If you change the memory time, please first make a new recording and allow the entire memory to be filled, as described above.

### ***The manual triggering mode***

To select the manual triggering mode, set the TRIG switch to the MAN position.

The MANUAL START/STOP switch is used to start and stop the sampling into the digital memory of the time expansion system in the manual operation mode. The red LED below the frequency display indicates the recording status (light on = "recording", light off = "replaying"). When the detector is in the "record" mode, samples are continuously stored into the memory (when the memory is full the samples that were first stored are overwritten, so at each time, the memory contains the last 3.4/1.7/0.1 seconds of the signal). Pushing the push-button to switch to the "replay" mode, will cause the content of the memory to be replayed in an endless loop fashion. This is done at 1/10 (1/20) of the original rate, so one sequence lasts for 34/17/1 (68/34/2) seconds.

### ***The automatic triggering mode***

To select the automatic triggering mode, set the TRIG switch to the AUTO position. In this mode, the detector will capture the signal itself and store it in the time expansion memory.

In the absence of sound, the detector is continuously recording into the memory. When a sound exceeding the chosen trigger level is detected, the detector interrupts the recording and automatically replays the stored signal once. A 50% pretrigger function is applied, which means that the detector stores the signal starting from a time “50%” prior to the triggering instant. 50% relates to the chosen memory size. E.g. with a memory size of 3.4 seconds, the pretrigger time is 1.7 seconds. That way the onset of the pulse that triggered the detector, will not be cut off.

The trigger level can be continuously varied with the LEVEL ADJ control. You need a small screwdriver or similar to change the LEVEL ADJ control. Turning the control clockwise increases the threshold level. Setting the control maximum counter-clockwise will cause the detector to trigger all the time, since the noise in the input amplifier then will exceed the threshold level. There is also a switch (TRIGGER LEVEL) to enable quickly changing the threshold. The LOW position will trigger the time expansion system at a low signal level, i.e. the detector will capture weaker signals. Changing the LEVEL ADJ will affect the sensitivity in both the LOW and HIGH positions.

Normally, all sounds exceeding the threshold level within the frequency range of the detector will trigger the time expansion system. It is, however, also possible to activate the frequency selective triggering mode. This is done by setting the TRIGGER SOURCE switch to the HETerodyne position, and the output from the heterodyne system will be used as trigger signal instead. That way the setting of the heterodyne frequency control (the frequency shown on the display) will determine which frequencies the time expansion triggering system will respond to. Setting the heterodyne control to 30 kHz will capture signals between approximately 25 and 35 kHz. This is useful to reduce the influence from background noise or to make the detector capture only certain species. It should be noted that even if the detector has its highest sensitivity near the tuned heterodyne frequency, strong signals outside of this range can also trigger the system. In particular, if the detector’s input amplifier is overloaded, harmonics will be created, which may cause the triggering system to trigger although the fundamental frequency is not within the tuned (heterodyne) frequency range.

### ***Heterodyne analysis of the stored signal***

The signal stored in the time expansion memory is normally replayed at one tenth of its original rate. It is, however, also possible to play it through the heterodyne system at its original rate. That way the user can analyze the stored sequence carefully, e.g. checking for max and min frequencies etc. This mode is also useful to demonstrate the heterodyne principle to an audience.

To feed the stored signal through the heterodyne system, the NORMAL/ TE→HET switch should be in the TE→HET position and the HET/TIME EXP switch in the HET position.

This mode is intended for use in the manual triggering mode. If you wish to use it in the automatic triggering mode, you should change the TRIG switch to MAN immediately after the signal you want to study has been captured, or the detector will start recording again after replaying the sequence once.

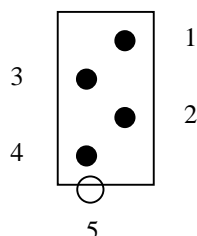
### ***Using the relay output***

In some situations, you may want to automatically dump the time expanded calls onto a tape recorder or other recording device. The easiest way to achieve this it to use a voice activated recording device. However, the D240x also has an output which can be used to control a relay or other device, which in turn can activate a recording device. This is for advanced users only.

The relay control output should be used only in the automatic triggering mode. It will be activated when a signal exceeds the triggering threshold level, and remains activated while the sequence is replayed once.

## ***High-speed replay***

When the NORMAL/TE→HET switch is in the TE→HET position, the signal in the time expansion memory will be replayed at its original rate, as described above. The signal from the time expansion system is also available at the RELAY OUTPUT connector. As opposed to the TE signal at the TAPE jack, this output is not lowpass filtered. So, if you have access to an ultrasonic transducer (“loudspeaker”), you can use this output to replay the captured sequence in its original shape. The impedance of any device connected to this output should be at least 500 ohms.



The “Relay Output” Connector (top view)

- 1 and 2 – relay output (if polarized, 1 = positive, 2 = negative)
- 3 and 4 – signal output (3 = signal, 4 = ground)
- 5 – polarizing hole for the connector

NOTE: If you wish to connect equipment other than Pettersson’s to this connector, please first contact us for instructions. Please also be careful not to let metal objects enter the case of the detector through the relay output connector opening, since this may damage the detector.

## **INPUT GAIN CONTROL**

In order to avoid overloading the input amplifier, the D240x has an overload indicator and an adjustable input gain control. If the signal is overloaded, spurious harmonics will be created. Such a signal should of course not be used for analysis. If the OVERLOAD indicator flashes frequently, you should set the GAIN switch to LOW. The actual gain in the LOW position is determined by the setting of the GAIN control. To adjust this, use a small screwdriver or similar (the control is located about 5 mm below the front panel). Usually, this is not necessary to do very often, you will probably find a suitable setting and you will then only use the switch to change the input sensitivity when required.

## **OUTPUTS**

The two 3.5 mm sockets are used to connect a set of headphones or a tape recorder/recording device. The TAPE output is not affected by the setting of the volume control or the HET/TIME EXP switch. When the COM switch is pressed, the time expansion output signal is temporarily replaced by the amplified microphone signal, enabling the recording of spoken comments with the recording device.

If the input impedance of the recording device is very low (lower than 5 kohms), the signal levels in the detector will be decreased, resulting in a weaker output to the loudspeaker or headphones. In order to record both the heterodyne and time expansion signals, a stereo cable and a stereo recording device is required. Using a mono cable and/or mono recording device will result in recording only one of the channels (usually the heterodyne channel) or mixing of both channels. Any equipment connected to the TAPE output should be battery powered. The maximum length of any connected cable is 1 meter.

The PHONES socket is used to connect a set of stereo headphones with a 3.5 mm plug. Connecting a set of headphones will automatically turn off the internal loudspeaker. For both output sockets, the heterodyne signal is available on the left channel and the time expansion signal on the right, regardless of the setting of the HET/TIME EXP switch (see illustration below).



TAPE and PHONES output connections

### Technical specifications

Type:	Heterodyne and time expansion (x10 or x20)
Frequency range:	10 - 120 kHz (min.)
Display accuracy:	+/- 0.15 kHz
Bandwidth (het.):	8 kHz (+/- 4 kHz), -6 dB
Sampling frequency:	307 kHz
Memory size:	1M x 8 bits
Resolution:	8 bits
Storage time:	3.4, 1.7 or 0.1 sec. (selectable via switch)
Trigger modes:	Manual, level - broadband, level - narrowband
Pretrigger:	50% of the selected storage time
Battery:	1 x IEC 6LF22 (9V)
Quiescent current:	30 mA typ. including LCD backlight
Size:	119 x 60 x 25 mm
Weight:	170 g. including battery
Outputs:	2 x 3.5 mm jacks for headphones and recording device (appr 350 mV <sub>rms</sub> /3.3 kohm).
Comment switch:	Yes
Miscellaneous:	Overload indicator, adjustable input gain, replay of signal in memory through heterodyne system, control output for relay

Using the detector in intense electromagnetic fields may cause interference and/or temporary signal loss.