Surround Sound
in Home Cinemas

Dolby 5.1

Number of full Audio channels

Number of LFE channels

Today's home cinema installations commonly include a Dolby surround sound system. For example a Dolby 5.1 describes the configuration with 5 full audio channels (left, centre, right, left surround, right surround) and one LFE channel (=Low Frequency Effects channel). The LFE channel originates from the cinema world with its rumbling bomb explosions and dinosaur stomps. These special sound effects are generated by a sub woofer covering the frequency range 20Hz- 120 Hz.

You may follow these guidelines to optimize the surround sound performance of a home cinema installation.

Exel Line: Minirator MR-PRO with XL2 Audio and Acoustic Analyzer

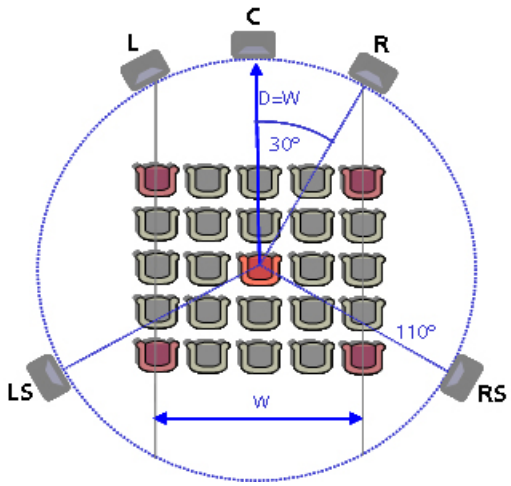
1. How to design the Room for the Home Cinema?

Listeners enjoy best sound performance from the direct speaker sound. Any additional reflections from walls, floor or ceilings irritates the directional perception of the sound source, thus the complete surround sound image worsens. The basic guideline for the architectural room design is to follow the common cinema approach:

- The side walls are not parallel, they are widening from the front to the rear. This design leads any sound reflections from the side wall directly to the rear wall.
- Sound absorbing treatment at the rear wall
- The ceiling is not parallel to the floor
- Carpets on the floor, curtains on the walls
- Prevent any hard, solid reflection materials, such as glass
- Seating areas made by cushioned seats instead of hard wooden chairs

2. How to Setup the Surround Sound System

You may align the speakers along the perimeter of a circle around the main seating position. In case of space restrictions the speaker arrangement shall be as close as possible to the circle alignment for best sound performance.



Dolby 5.1 Layout

The speaker height is best slightly above the listener's ears, e.g. 130-140 cm. The LFE sub woofer positioning is not crucial, as bass sound is non-directional. Commonly the LFE is situated near the centre speaker.

3. How to commission the Home Cinema Installation

Exel Surround Sound Set

Requirements:

- Digirator DR2 with extended file set (from the DVD)
- XL2 Audio and Acoustic Analyzer
- M4260 or M2210 Measurement Microphone
- Minirator MR-PRO
- Microphone stand
- 1m XLR audio cable

Some A/V amplifiers complete a basic commissioning automatically. The resulting sound performance refers to a certain person's perception. This guideline supports customized settings meeting your individual requirements.

Digirator DR2

The NTi Audio Digirator DR2 generates surround sound test sequences for verification and adjustment of professional Dolby and DTS installations. The XL2 Audio and Acoustic Analyzer in combination with the M4260 or M2210 measurement microphone forms a comprehensive acoustical analyzer. The DR2 and the XL2 together is an ideal couple to enhance the home cinema sound performance.

The recommended tests for a home cinema installation are:

- Basic Performance Test
- Polarity
- Frequency Response at different listening positions
- Sound Pressure Level
- Delays
- Crossovers

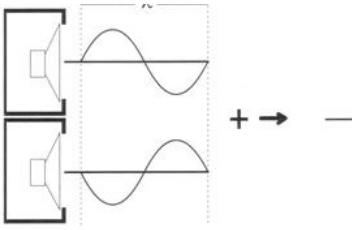
You may document all test results to your PC for backup and verification later on.

Home Cinema Test Configuration

Basic Performance Test

- Set the A/V amplifier gain to minimum.
- Connect the Digirator to the A/V amplifier input.
- Position the measurement microphone with a microphone stand at the main seating position in the typical height of the listeners head and connect the XL2 Audio and Acoustic Analyzer using a XLR cable.
- XL2: Select SLMeter, 123, L_{CFlive}
- Digirator: Select DOLBY -> D_51 -> PNOISE_L (pink noise signal at left channel)
- Increase the A/V amplifier gain up to the typical listening level in the main seating position, e.g. 75 dBSPL.
- Measure and adjust the basic sound pressure level of the other speakers in the same manner.

Speaker Polarity



Opposite polarity results in cancellations

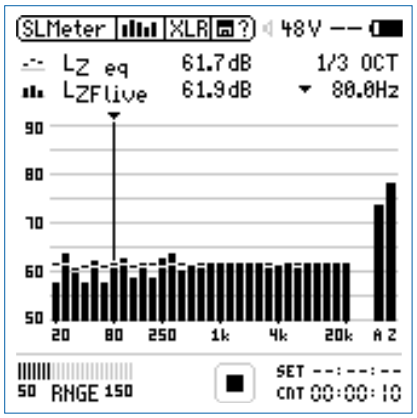
XL2 Screenshot Polarity

The polarity test verifies the correct cable and speaker polarity. Wrong polarity may mask sound or even cancel out some frequency ranges. Some loudspeaker manufacturers purposely design a speaker for negative polarity inside the speaker box for better sound performance. In case you observe different polarities (e.g. left speaker = negative) please ensure that the same characteristics is measured at the opposite speaker (right speaker = negative).

Please verify the speaker cabling at different polarity readings of left/right speaker or left/right surround speaker.

- Position the measurement microphone with a microphone stand at the main seating position in the typical height of the listeners head and connect the XL2 Audio and Acoustic Analyzer using a XLR cable.
- XL2: Select Polarity -> Signal Source XLR/RCA
- Digirator: Select DOLBY -> D_51 -> POLARI_L (polarity signal at left channel)
- Measure the speaker polarity
- Measure the polarity of the other speakers in the same manner. All polarities shall be same.

Frequency Responses at different seating positions

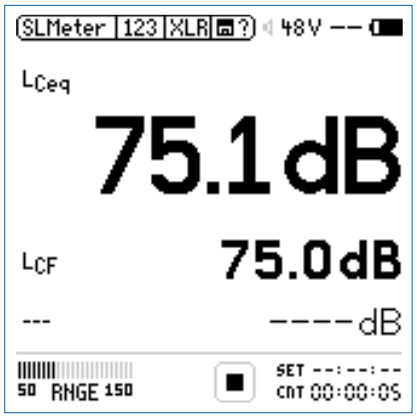


XL2 Screenshot Real Time Analyzer

The frequency response differs at every seating position. In order to optimize the sound characteristic for all seating positions you may take readings at different seats and average the results.

- XL2: Select the SLMeter, RTA Mode, 1/3 oct., L_{Zeq}
- Digirator: Select DOLBY -> D_51 -> PNOISE (pink noise signal at all channels)
- Measure the frequency response at the main seating position for 5 seconds and press the pause button.
- Move the microphone to an outside corner seat and continue the RTA measurement for 5 seconds and press the pause button.
- Continue the RTA measurement at the other corner seats for 5 seconds each and press the pause button in the same manner.
- Press the stop button after the last seat. The XL2 displays the average frequency response of all measurement positions.
- Adjust the EQ for a smooth frequency response (prevent lows and peaks at certain frequency bands)
- Repeat the measurement once at all positions to verify your EQ settings.

Sound Pressure Level



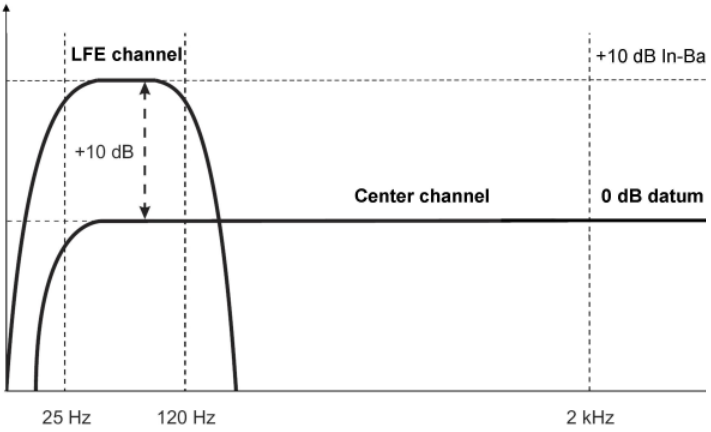
XL2 Screenshot Sound Level Meter

All speakers shall provide the same sound pressure level at the main seating position.

- Position the measurement microphone with a microphone stand at the main seating position in the typical height of the listeners head and connect the XL2 Audio and Acoustic Analyzer using a XLR cable.
- XL2: Select SLMeter, 123, L_{Ceq}, measurement time = 5 sec.
- Digirator: Select DOLBY -> D_51 -> PNOISE_L (pink noise signal at left channel)
- Set the sound pressure level to 75 dBSPL +/-0.5dB at the gain setting of the A/V amplifier
- Measure and adjust the sound pressure level of the other speakers to 75 dBSPL +/-0.5dB in the same manner.
- Note the typical sound pressure level at 1 kHz displayed in the RTA mode. This reading is required for the LFE level setting.

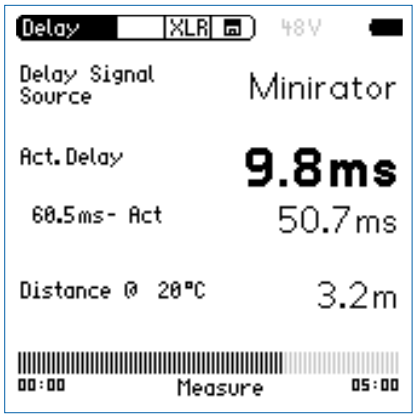
The LFE channel is tailored for the rumbling bomb explosions and dinosaur stomps. The LFE sound pressure level shall be about 10dB higher than the surround level within the typical LFE frequency range 20 Hz - 120 Hz.

- Digirator: Select DOLBY -> D_51 -> PNOI_LFE (pink noise signal at LFE channel)
- XL2: Select the SLMeter, RTA Mode, 1/3 oct., L_{Zeq}
- Measure the sound pressure level of the LFE sub woofer in the lower frequency bands 20Hz - 120Hz. The setting shall be about 10dB higher than the 1 kHz reading at the full audio channels.



Level alignment of LFE and surround sound speakers

Delays



XL2 Screenshot Delay

The sound of all surround sound speakers shall arrive at the same time at the main seating position.

- Connect the Minirator MR-PRO to the analog input.
- Select DELAY (delay test signal)
- XL2: Select Delay measurement function and synchronize the XLR input to the reference delay signal.
- Measure the delay time at the main seating position for the left speaker.
- Measure the delay of the other speakers in the same manner and adjust the same delay time at all speakers.

Crossovers

- XL2: Select the SLMeter, RTA Mode, 1/3 oct., L_{Zeq}
- Digirator: Select DOLBY -> D_51 -> PNOISE (pink noise signal at all channels)
- Verify the sound spectra at the crossover frequency.
- Any dips or bump shall be smoothed out for flat response by setting the sub woofer phase or crossover frequency.

Customize Settings

You may customize the surround sound performance by the equalizer according your personal perception.

- Listen to a typical surround sound audio sequence
- Carry out some minor adjustments of the equalizer for your preferred sound settings, e.g. more low or more high frequencies.