

## Advanced technical information



### Fully balanced signal path

Some of Thule Audio's products are marked with a "B". That means that **the product has a fully balanced signal path inside.**

In conventional amplifier design the ground path acts both as a signal reference and a waste area for currents returning from the power supply.

In the balanced design, the electrical sound signal appears as the difference between two identical amplifier circuits. The ground path is thus completely isolated from the signal path.

The advantage of the balanced signal path is:

- No noise from power supply current in the signal path.
- Improved drive capability, with two active amplifier outputs per channel.
- Balanced XLR cables for improved shielding.

To make the balanced signal path work optimal, the two amplifier circuits must match each other well (high common mode rejection). Thule Audio is therefore using high precision resistors and the precision digital volume control.

In order to achieve optimum results, a hi-fi system should preferably be designed to work either fully balanced *or* fully unbalanced.

Using XLR connection or pseudo balanced connection between, i.e. CD player and amplifier is not ideal if the amplifier itself is not working balanced inside. The conversion from balanced XLR cable to conventionally electronic inside the amplifier will just add more components in the signal path, without the most important benefit of excluding ground from the signal path inside the amplifier.

Unbalanced connection to a balanced amplifier, though not ideal, will still add the benefit of excluding the ground from the signal path inside the amplifier and is therefore recommended.

### SMD

SMD stands for Surface Mounted Devices, which are small components placed automatically on the PCB. The advantage of SMD is:

- Shorter signal path
- Lower production cost (automatically placed)
- Better production quality

### Digital potmeter

In all Thule Audio amplifiers the volume control is realized with a digital potmeter in an high performance integrated circuit (LM1972) under software control.

Each Integrated circuit contains 2x 80 pcs precision laser trimmed resistors, with one resistor for each 1 dB volume step. The distortion of the digital potmeter is not audible (distortion less than 0.002%).

The advantages over normal mechanical potmeters are:

- Significant improvement in precision at low volume levels, e.g. more than 10 times improvements over the Alps RK27

# B

[back](#)



**Digital potmeter technique**

mechanical potmeter, which is used in many expensive amplifiers.

No aging and consequently no scratching noises even after long term use.

Improved user comfort due to clear indication of listening level (i.e. "43" might indicate your normal listening level).

[back](#)

### Amplifier circuit design considerations

To have a detailed and dynamic sound, but without any harshness, the output signal must follow the input signal without significant distortion, overshoot or current limiting.

In contrary to above many amplifiers are optimized to have as low as possible distortion at 1 kHz in a simple 8 ohms load impedance, by using a lot of global feedback. This design philosophy gives good measuring figures for the brochure, but the sound will be bad, because the global feedback will add problems like poor stability at capacitive loads.

And in real life the loudspeaker is a complex load, not a simple 8 ohms' resistor.

Further the music signal will change in level and frequency in contrary to a simple 1 kHz tone.

Therefore Thule Audio has designed the new Spirit line with a holistic view, which mean at the same time optimizing performance for all audio frequencies, voltage, current and time response.

In view of this design philosophy, Thule Audio has chosen to design all amplifiers totally **without** a global feedback, and then limit the distortion with local error correction.

That mean we deal with the problem where it appears and do not involve other circuits, to obtain a simple feed forward signal path.

One topic of key interest is to reduce the switching distortion and output impedance without compromising the time response performance at a complex load. The switching distortion appears when the power output transistors are switching and sounds particular hard and unmusical.

For this reason Thule Audio has developed **a special error correction circuit**, which convert the power output transistors to an near perfect buffer, to eliminate nearly all switching distortion. The remaining distortion is a more "musical" type.

The damping factor is increased (= low output impedance) to about 80 for unbalanced and about 150 for balanced products and is identical for low and high frequencies, which are very good values.

Therefore the Spirit amplifiers have:

- None global feedback for good stability
- Reasonable low distortion (THD < 0.08%, 20-20k Hz).

- High damping factor, for both high and low frequencies, for good drive capability

This combination has the wanted dynamic, open and detailed sound, which on the other hand never becomes hard.

### Electronic Component selection

Generally Thule Audio's experience is that the circuit design is the most important factor to make a good sounding amplifier or CD player. To use expensive components in a bad circuit design is a waste of money. However, in the following critical places in the signal path, the component's quality is very important,



**Amplifier technique**

[back](#)

therefore Thule Audio uses the best components:

D/A converter: Burr Brown multilevel  
delta-sigma or selected multilevel (DIGIT)  
DC blocking: 1uF film capacitors  
Preamp OP-amps': Burr Brown OPA2134 FET  
op-amp  
Power transistors: ROHM 25Amp/30Mhz  
type  
Electrolytic capacitor: BHC 4 terminal  
T-POWER (IA150B and PA150B)  
Transformer: Low loss Toroid type

### **CD Player technology from Thule Audio**

The Spirit CD players are build from CDM14BL-5BD25  
laser unit and loader from Sony.

The servo parameters are optimized for standalone high  
end applications:

Bandwidth for radial servo, focus servo and  
sledge servo are reduced to improve  
tracking when discs have bad sections and  
reduce noise coupling to the sensitive analog  
section.

Motor currents are limited by series  
resistors and low servo bandwidth to  
decrease EMI noise and power supply surge  
from servo motors.

This makes the Spirit CD players able to play most  
scratches up to 2mm without any clicks in sound.  
Another trade off from this concept is that mechanical  
noise from the CD mechanism is extremely low when  
playing, because the whole system is "in standby mode"  
when the disc has no bad sections.  
The low mechanical noise will also improve long time  
reliability of the CD mechanism.  
When playing, try to compare mechanical noise from the  
Spirit CD player to other CD players.  
The disadvantage of a lower servo bandwidth is less  
immunity to mechanical shock, but heavy steel cabinet,  
damped feets and floating coupling of laser sledge makes  
the Spirit CD players more immune to mechanical shock  
than most CD players on the market.

[back](#)