

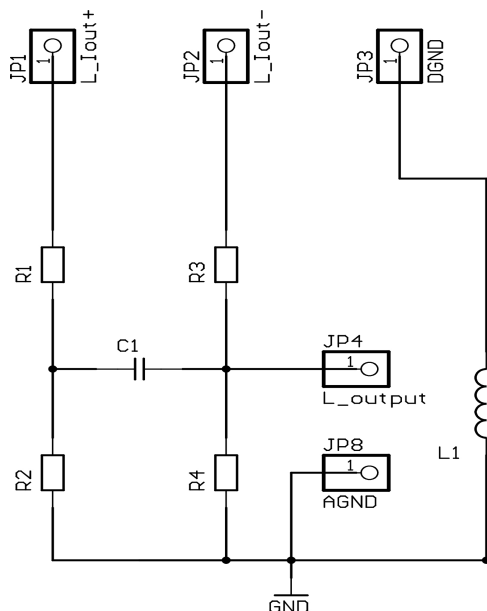
# NITRO

## The DAB

By Barbara E. Gerhold "TUBECLINIC"

**DAB** is the abbreviation for "*Digital Audio Balun*", which is the element to convert a **balanced** signal into an **unbalanced** one without any disturbance of any harmonics. Any differential output (*Time-Slice*) DAC-chip will need such a device in order to function properly. As I wrote within the introduction, any differential system deletes (subtracts) even harmonics. It is suitable for I-out DACs as well as for U-out DACs if they comprise differential outputs. Unfortunately, mostly all CD- and DVD-players in the market use such a differential system as an I/U-converter.

Have a look at the schematic:



This is a very simple but versatile and efficient circuit.

Both differential output currents from the DAC-chip enter this little circuit at JP1 (lout+) and JP2 (lout-). The ground-connection is given at JP3 (DGND), which resembles digital ground back to the chip.

The analog output voltage is tapped via JP4 (output) and JP8 (AGND) which resembles analog ground.

This DAB-circuit is also useable for voltage output DAC-chips, which I shall explain later in this article.

### Chapter 1: Functioning of the lout-DAB

The currents from lout+ as well as from lout- are loaded the same way, with exactly the same resistor values. Exact values are dependent on the several chips in use. Therefore, I shall explain the circuit for the widely used [PCM1798](#) [<sup>1</sup> pls. see below].

If you use another chip, please refer to glossary in behind.

<b>PCM1798</b>	<b>dig. silence</b>	<b>pos. full scale</b>	<b>neg. full scale</b>
<b>lout+ [mADC]</b>	3,5	5,5	1,5
<b>lout- [mADC]</b>	3,5	1,5	5,5

<sup>1</sup> **NOTE:** You may download this EXCEL-spreadsheet from my website to make your own calculations!

R1, R3 [ $\Omega$ ]	22	R2, R4 [ $\Omega$ ]	82
Value of total load [ $\Omega$ ]	104		
Uout+ [mVDC]	364	572	156
Uout- [mVDC]	364	156	572
DC-offset output [mVDC]	287		
output (mVACpeak)	0	164	
output (mVACrms)	0	116	
gain for 2Vrms [dB]	24,7	x - factor	17,2

Because the “music” signal in a digital system must always be smaller than digital full scale, most CDs in the market are therefore limited to -3dB value, so we can calculate a maximum output voltage of app. 80mVrms. Some “Audiophile” CDs are mastered to a much lower medium level, intended that they should need no further limiting.

From this value, we can calculate the needed gain of the following amplifying stage. Please note, that this -3dB limitation was not taken into account within the above table!

The central point of good sound is the cap (C1) in the middle of the bridge configuration. It is not intended to build a filter, but it may be understood as kind of an integrator. It will change its charge-value, each time the time-slice ratio of the switches behind each current output changes. It makes sound a big deal more transparent and more “lively”. Music sounds more fluently and leaves more air between the instruments or voices. Only good foil types should be used in this place. Considering the mentioned PCM1798, a value of app. 15nF for C1 proved to be optimum. I invite you to play around with this cap ( $\pm 40\%$ ), since listening sessions showed, that it seems to be a matter of taste, which is one’s personal optimum.

The choke L1 decouples the noisy digital ground (DGND) of the DAC-chip from the analog ground (GND) of the tube stage. Since its impedance is high in the ...MHz region, the RF-noise induced by the DAC-chip is isolated from the tube grid. I used a ferrite bead in this place. There is only one wire through the hole needed.

L1 is a ferrite bead of 3,5 x 3,25 mm (length x diameter), showing a central hole of 1 mm (type 2673000101; brand “Fair-Rite”) and app. 60  $\Omega$  at 25MHz. It may be purchased from <http://at.rs-online.com> . What I wrote about C1 is also true for L1: You might file the bead to get your personal best results.

Measurements show, that the total possible bandwidth of the CD can be achieved - without limitations. Tests by spectrum analyzer also showed, that all harmonics are treated the same way, so the sound is outstanding and – compared to other HiEnd products – it shows a performance much closer to the vinyl LP than any other DAC I know.

Listening sessions showed, that in some situations, listeners could only determine between LP and CD, because the CD does not show the characteristic basic noise floor of the LP. Vinyl’s only remaining advantage is the fact that it leaves a bit more air between instruments and voices and that it shows better imaging. Anyway, this fact is not always true for all recordings: Commonly spoken, AAD recordings seem to give better results than DDD ones, anyhow ... (?). This has to be investigated in the future, but that’s another story! Maybe one of you readers may help with some ideas!

## Chapter 2: Functioning of the Uout-DAB

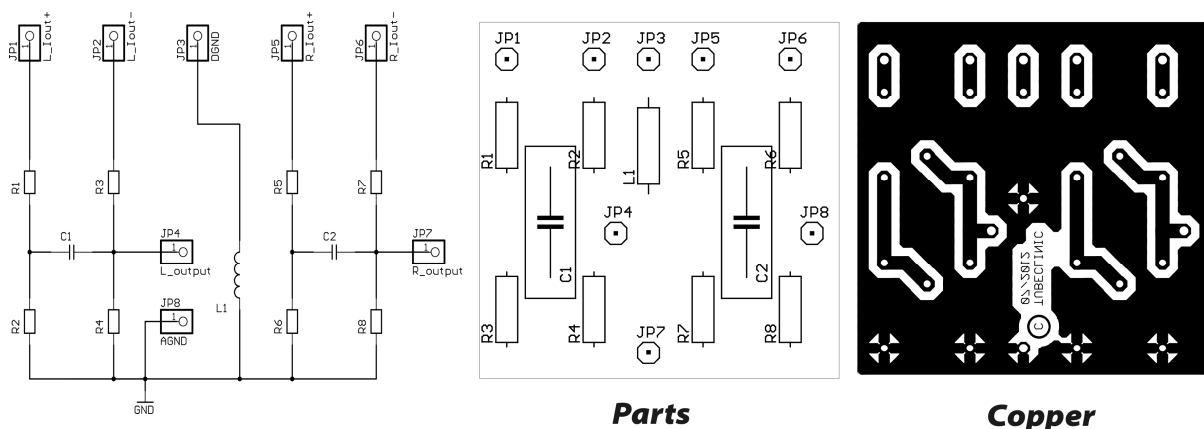
It works very similar to the already discussed lout-DAB. Only the values of its parts have to be altered. Most chips give an output voltage of app. 1VAC<sub>peak</sub> from each output, which will be equal to 1,4V<sub>rms</sub> in differential mode. On the other hand, most chips give best sounding results, if they “see” a load of app. 5 - 10kΩ per channel. This is a good value for the widely used CS4397 and should fit properly also to other chips with a minimum load of 1 – 2kΩ.

<b>CS4397</b>	<b>dig. silence</b>	<b>pos. full scale</b>	<b>neg. full scale</b>
<b>Vout+ [mVDC]</b>	2500	4000	1000
<b>Vout- [mVDC]</b>	2500	1000	4000
<b>R1, R3 [kΩ]</b>	1,8	<b>R2, R4 [kΩ]</b>	3,3
<b>Value of total load [kΩ]</b>	5,1		
<b>output (mVAC<sub>peak</sub>)</b>	0	971	
<b>output (mVAC<sub>rms</sub>)</b>	0	686	
<b>gain for 2V<sub>rms</sub> [dB]</b>	9,3	<b>x - factor</b>	2,9

The value of C1 becomes much lower in this version (in the 100pF range), so I would recommend using a silver-mica or a Styroflex® (preferred) cap in this place. L1 increases, but you could use the same ferrite bead as from the lout-DAB and wind 3 ... 5 turns around it. The conductor should become a single-strand of lacquered wire with a diameter of app. 0,2 ... 0,3 mm. Please be sure to use an insulated (lacquered) wire – ferrite material will conduct if it is not treated with epoxy at its surface! After you have finished the circuit and have done some listening sessions, you should fix the choke by some epoxy compound.

You should also try the “FETishizator” circuit as an output driver of this DAB. I instead used a tube-stage with a 6N16B-V Russian subminiature dual-triode. Nevertheless - this is a matter of taste!

Here is a sketch about how I solved the mechanical design of a stand-alone DAB; you may download a 1:1 PDF from my website:



I put a **glossary of DAC-chips** to the end of this article. If your chip is not in the table and you tested-out reliable data for it, please send me your findings and I shall fill them into this table for the interest of other readers. Please do the same if you find any mistake!

## DAC-chip glossary

lout	Type	Dig. silence [mA]	pos. full scale [mA]	neg. full scale [mA]	min. load [ $\Omega$ ]	max. load [ $\Omega$ ]	opt. load [ $\Omega$ ]	C1 [nF]
	PCM1798	3,5	5,5	1,5	0	150	22 + 82	15
	AD1862	0	1	-1	0	330	33 + 100	10

Uout	Type	Dig. silence [mV]	pos. full scale [mV]	neg. full scale [mV]	min. load [k $\Omega$ ]	max. load [ $\Omega$ ]	opt. load [k $\Omega$ ]	C1 [pF]
	CS4397	2500	4000	1000	2	NO	1,8 + 3,3	100
	AK4396	2500	3200	1800	1,5	NO	2,2 + 4,7	100
	WM8741	2500	3500	1500	2	NO	3,3 + 5,6	150
	DSD1793	1400	2200	600	1,7	NO	1,8 + 3,3	220