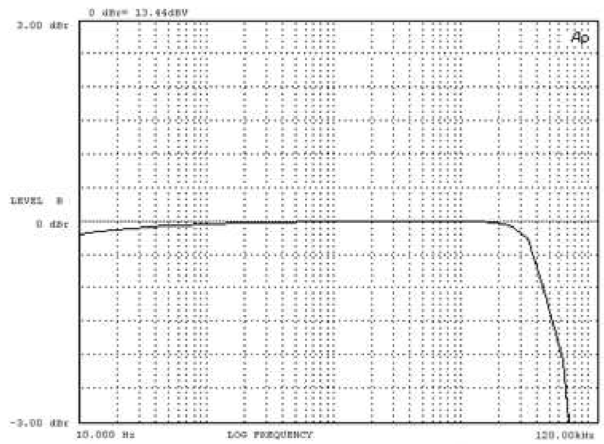
APPLICATION NOTE

DAC SOUND IMPPROVEMENTS USING A TRANSFORMER



1465 frequency response 100 Ohm source 20K Ohms

The sound quality of almost any commercial CD player or digital music systems can be improved by the use of a transformer and an external resistor to perform the current to voltage (I/V) conversion. There are 3 reasons for this:

1. The usually rather poor operational amplifier circuits which are fed by the I/V resistor are eliminated.
2. The digital and analogue grounds can be isolated which removes some complex distortion mechanisms.
3. The unique frequency characteristics of the transformer provides improved filtering of the quantization noise.

Our DAC transformers are constructed on Mumetal (76% Nickel) cores for minimal distortion and contained in heavy gauge Mumetal screening cans. The load can be balanced or unbalanced.

It has been found that the I/V resistor is best connected to the secondary of the transformer, so the DAC sees the load reflected load via the complex impedance of the transformer.

The 1465 can be configured to give a voltage ratio of 1:5 (recommended), 1:10, or 1:20. The lower ratio gives better bandwidth, but the higher ratio gives a greater output voltage for the same reflected load.

Whilst most DACS are designed to drive a current input (Zero Ohms) A reflected load of up to about 150 Ohms gives very good results.

NOTES
Two transformers are required for stereo. Everything works best when driving a high impedance input like a grid.

SECONDARY LOAD CALCULATION
To calculate the secondary voltage (Vs), we use the formula below where Rl is the applied secondary load resistance and N is the voltage ratio:

$$Vs = \frac{(Rl * iout * 0.71)}{N}$$

FLEXIBLE CONFIGURATION

1465 has two primary and 2 secondary windings which can be configured with various voltage ratios to optimise the performance in the user's particular environment. The most popular DACs provide a maximum current output of +/- 2.0 mA peak and below is our recommendation for the winding configuration and I/V resistor connected across the secondary. The table below illustrates this but please note the dc resistance of the windings will result in insertion loss which will reduce the secondary voltage a little.

Ratio N	DAC peak $iout$	Secondary load Rl	Secondary voltage	Load seen by DAC	Typical bandwidth (kHz)
1:5	2 mA	3.8 kOhms	1.0 V	152 Ohms	60 kHz
1:10	2 mA	7.5 kOhms	1.0 V	75 Ohms	40 kHz
1:20	2 mA	15 kOhms	1.0 V	38 Ohns	30 kHz

VOLTAGE RATIO CONNECTIONS

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                   _______● |||| ●______
        GREY              )||||(         VIOLET
                          )||||(
                          )||||(
        BROWN_____________)||||(______   YELLOW
                           ||||
primary                    ||||                    secondary
                   _______● |||| ●______
        ORANGE            )||||(         PINK
                          )||||(
                          )||||(
        BLUE______________)||||(______   WHITE
                           ||||
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Ratio	Primary			Secondary		
		Link	Connection		Link	Connection
1:5	SERIES	BROWN ORANGE	GREY BLUE	PARALLEL	VIOLET PINK and YELLOW WHITE	VIOLET PINK
1:10	SERIES	BROWN ORANGE	GREY BLUE	SERIES	YELLOW PINK	VIOLET WHITE
1:20	PARALLEL	GREY ORANGE and BROWN BLUE	GREY BROWN	SERIES	YELLOW PINK	VIOLET WHITE

PARALLED DACS: Multiple DAC modules can be wired with the iout terminals in parallel to increase the current into the transformer. This will enable the output voltage to be increased, or the reflected load impedance can be reduced.
There is no realistic limit to the number of DACs which may be connected in parallel and thus the input current. Increasing the current into the transformer does not cause the core to saturate. If two DACs are used cancellation of quantisation noise can be achieved by inversion of the digital input to one side.
Type 1495 is provided for customers who want a high ratio transformer which can be used when feeding a high impedance input (like a valve grid). It can be configured as a 1:9 or 1:18 ratio and is also a lower cost option.

CURRENT OUT DAC DATA SHEETS (For use with 1465 or 1495)	**ANALOG VOLTAGE OUT DAC DATA SHEETS** (For use with 3603 or 9335)
AD1860N	AD1852
AD1862	AK4396
AD1865	AD1853
DSD1792	AK4399
PCM1702	AK4440
PCM1704	AK4490
PCM1738	AK4455
PCM1792	CS43122
PCM1794	CS4390
PCM1795	CS4398
PCM1796	ES9018
PCM1798	ES9038
PCM2702	EVM1072
PCM56	SAA7350
PCM63	WM8740
TDA1540	WM8741
TDA1541A	
TDA1543	
TDA1545A	
TDA1547	