

OEP Transformer Tests

As part of the drive to reduce the cost of the Mark 3 mixer I have looked at alternative transformers to replace the relatively expensive Sowter, Jensen and Cinemag types used currently. There are three types of transformer we need; 10K:10K line input; 1:10 mic input and 2K4:600 output.

10K:10K Line Input

There are three OEP products we could use

Z21807C (£15 from Canford, 50% Nickel core))
A187A13C (£25 from RS, 80% Nickel core)
K30A06C (£40 from RS, 80% Nickel core)

All are considerably cheaper than the typical Sowter 10K:10K which is around £75. The price of each OEP alternative is directly related to its core size. Normally, level handling capability, especially at low frequencies, is directly related to core size but it does also depend on core material.

The distortion, at a range of frequencies from 1KHz down to 20Hz ,was measured for each transformer. The input signal level used was +18dBu supplied by a Lindos MS10 Audio Test Set. The transformer output was loaded with 10K in the form of a Scarlett 2i2 line input which was connected to the REW software for making measurements. The results of the percentage distortion created by each transformer versus frequency are given in the table below:

Frequency	Z21807C	A187A13C	K30A06C
1KHz	0.0053	0.003	0.0024
400Hz	0.011	0.003	0.0018
100Hz	0.071	0.011	0.0018
80Hz	0.10	0.019	0.0016
63Hz	0.16	0.041	0.0023
50Hz	0.25	0.11	0.0037
40Hz	0.49	0.63	0.0063
30Hz	1.3	8.69	0.011
25Hz	5.46	17.6	0.017
20Hz	16.3	29	0.029

The performance of the Z21807C is remarkable for such a small cored transformer. Its distortion is below 0.1% down to 100Hz and quite acceptable down to 30Hz. It is only below 30Hz that its +18dBu performance falters.

The performance of the larger core A187A13C by contrast is rather disappointing. Although distortion is very low down to 50Hz, below that frequency it rises rapidly and soon overtakes that of the smaller Z21807C.

The performance of the large cored K30A06C is exceptionally good with very low distortion at +18dBu right down to 20Hz. I conducted some additional test on this transformer down to 10Hz where the distortion finally rose to 0.53%

The question is, is it really necessary to be able to cope with +18dBu signals below 40Hz? The lowest note on a bass guitar or orchestra instrument is 41.2 Hz. Some synths can reach lower but how often will such signals reach +18dBu?

2K4:600

There is no obvious OEP product for this job in their published catalogue. However, they sent me a sample of their K30A11C which is a 2K4:600 type. I tested this at +16dBu into a 600 ohm load. I also tested the Sowter 1461 which is the current preferred output transformer, at the same time. The signal source was the Lindos test set but to reach +16dBu at the secondary requires at least +22dBu at the primary which is beyond the capability of the Lindos. So the Lindos was fed into one channel of a Twin Line Amplifier which is quite capable of outputting +30dBu into a 2K4 load and it is also what will normally be driving these transformers. The output signal was again fed via a Scarlett 2i2 into REW. For reference, the very large Carnhill VTB2291 used in the EzTubeMixer project was also tested at the same level.

The results of the percentage distortion created by each transformer versus frequency are given in the table below.

At frequencies above 50Hz the Sowter has lower distortion than the OEP but both are very low. The Sowter has typically 6dB less distortion than the OEP. Below 50Hz the Sowter distortion rises more rapidly than the OEP and at 40Hz equals the OEP. Below 40Hz the Sowter distortion rises more rapidly than the OEP and is 15.7% at 20Hz compared with 4% for the OEP.

At mid band frequencies there is little to choose between the two but below 40Hz the OEP is definitely the better choice.

Frequency	OEP K30A11C	Sowter 1461	Carnhill VTB2291
1000	0.007	0.0053	0.031
400	0.013	0.0042	0.036
200	0.026	0.0076	0.035
100	0.054	0.019	0.033
80	0.070	0.026	0.024
63	0.095	0.041	0.023
50	0.14	0.085	0.027
40	0.22	0.21	0.035
32	0.46	0.93	0.05
25	1.36	4.74	0.084
20	4.16	15.7	0.16

The VTB2291 results are very interesting. You can see the difference in using an all steel core. Mid band distortion is much higher than the Sowter or OEP even though the VTB2291 core is huge in comparison. But the benefit at low frequencies is clear with distortion at 20Hz. being 28dB below the OEP and nearly 40dB below the Sowter

For completeness the Carnhill VTB2291 transformer was tested down to 10Hz at +16dBm and also tested down to 20Hz at +22dBm. The results are shown below:

Frequency	Distortion @+16dBm	Distortion @+22dBm
1000	0.031	0.046
400	0.036	0.046
200	0.035	0.043
100	0.033	0.044
80	0.024	0.042
63	0.023	0.042
50	0.027	0.050
40	0.035	0.086
31	0.05	0.22
25	0.084	0.85
20	0.16	2.61
16	0.37	
12.5	1.3	
10	4.19	

Clearly there is a trade off between performance and core type. Steel cores give higher mid band distortion but much better low frequency performance. On the other hand, cores containing nickel have much lower mid band distortion at the expense of much higher low frequency distortion. The Carnhill performance should be the standard by which alternatives are judged. With this in mind I tested two more transformers, the Carnhill VTB4096 (a high level input transformer similar to the Neve 31267) and the Cinemag 2820 which is a steel cored transformer but smaller than the VTB2291. Their measured percentage distortion at +16dBm into 600 ohms, with the VTB2291 figures included as a comparison are shown in the table overleaf.

Frequency	VTB4096	Cinemag 2820	VTB2291
1000	0.0075	0.011	0.031
400	0.0054	0.010	0.036
200	0.0074	0.0098	0.035
100	0.029	0.011	0.033
80	0.055	0.013	0.024
63	0.16	0.018	0.023
50	7.1	0.026	0.027
40		0.041	0.035
31		0.076	0.05
25		0.16	0.084
20		0.39	0.16
16		1.34	0.37
12.5		4.51	1.3
10		11.0	4.19

The VTB4096 is clearly not usable. The Cinemag transformer has a 50% Nickel core which probably explains why its mid band distortion performance is about 10dB better than the Carnhill VTB2291. However, from 40Hz downwards the differences disappear and the Carhill has lower distortion. However, the Cinemag CM2028 20Hz distortion at 0.39% is far superior to either the OEP K30A11C (4.15%) or the Sowter 1461 (15.7%). It would be interesting to ask Cinemag if they have a core that could make a PCB mounted transformer no more than 26mm tall.

1:10 mic input

The A187A15C is one of OEP's mic input transformer products. They offer several different turns ratios but the A187A15C is a 1:10 ratio type so it is comparable with the Sowter, Jensen and Cinemag types used at present. It was initially tested at an input level of -20dBu as this represents a typical maximum mic input level (with a 20dB pad engaged the input could handle 0dBu). However, it soon became clear that this transformer can handle much higher input levels so it was tested at -10dBu, -5dBu and 0dBu. The results are shown in the table below.

It is quite clear that at -20dBu the performance is exceptional with 20Hz distortion only 0.2% and even at 10Hz it is below 1%. At higher level the distortion increases but even at -5dBu the distortion at 20Hz is below 1%

Frequency	-20dBu	-10dBu	-5dBu	0dBu
1000	0.0032	0.015	0.026	0.049
400	0.0021	0.012	0.021	0.038
200	0.0043	0.011	0.018	0.033
100	0.0049	0.024	0.040	0.069
80	0.014	0.038	0.063	0.11
63	0.021	0.061	0.1	0.16
50	0.032	0.098	0.16	0.23
40	0.051	0.16	0.26	0.33
32	0.081	0.26	0.39	0.47
25	0.13	0.4	0.55	0.81
20	0.2	0.6	0.76	4.17
16	0.35	0.87	1.12	
12.5	0.55	1.2	2.45	
10	0.87	1.69		

Conclusions

Considering that most OEP transformers are half the price of their Sowter equivalents they turn in a very creditable performance. In some instances, especially at low frequencies and high levels, their performance exceeds the Sowter equivalents. At mid frequencies the Sowers undoubtedly perform better but the distortion levels in all the transformers tested are very low at these frequencies.

Considering that in a typical channel strip containing three transformers, using OEP types could reduce the BOM cost by over £100, they should at least be offered as an alternative.

Both the Sowter and OEP output transformers perform badly at low frequencies and high levels in comparison to an all steel core transformer like the Carnhill VTB2291. It is perhaps worth considering sourcing a smaller all steel core transformer just for the output stage.

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Addendum

Since writing this I have tested a medium sized 2K:600 output transformer. It is the CM 2820 made by Cinemag. It is perhaps 50% larger by volume than the OEP K30 series transformers but it is less than 25% of the volume of a Carnhill VTB2291. As with the other output transformers I tested it at +16dBm into a 600 ohm load. The result are shown below with the +16dBm results of the Carnhill VTB2291 repeated for comparison:

Frequency	CM2820 distortion %	Carnhill VTB2291
1000	0.011	0,031
400	0.010	0.036
200	0.010	0.035
100	0.011	0.033
80	0.013	0.024
63	0.018	0.023
50	0.026	0.027
40	0.041	0.035
31	0.076	0.05
25	0.16	0.084
20	0.39	0.16
16	1.34	0.37
12.5	4.51	1.3
10	11	4.19

This transformer has a 50% Nickel core which probably explains why its mid band distortion performance is about 10dB better than the Carnhill VTB2291. However, from 40Hz downwards the differences disappear and the Carhill has lower distortion. However, the Cinemag CM2028 20Hz distortion at 0.39% is far superior to either the OEP K30A11C (4.15%) or the Sowter 1461 (15.7%). It would be interesting to ask Cinemag if they have a core that could make a PCB mounted transformer no more than 26mm tall.

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