Technical Article

Fractional turns transformers save space, cut costs and improve the efficiency of AC/DC power supplies

Fractional turn transformers are not a new idea but it's not a concept that appears to have been applied to AC/DC power supplies in the past. For multiple output power supplies in particular it offers some significant advantages in terms of saving space, cutting cost and improving efficiency. Here's why.

The challenge comes when you need multiple outputs. In a power supply where 5V and 12V outputs are needed, it would be ideal to have the 5V winding as a single turn on the transformer, but the 12V winding then becomes 2.5 turns, which can't be manufactured. One solution is to make the 5V winding two turns, then 5 turns are needed for the 12V winding. But the low voltage, high current, 5V winding has to carry the full rated load of that output, so its made from thick copper foil, and the transformer has to become much larger if the number of turns is doubled.

In another common scenario, you may need 5V and 3.3V outputs. Normally, a regulator is used on the 5V output to produce the 3.3V rail. This lowers efficiency, eats up board space and adds costs.

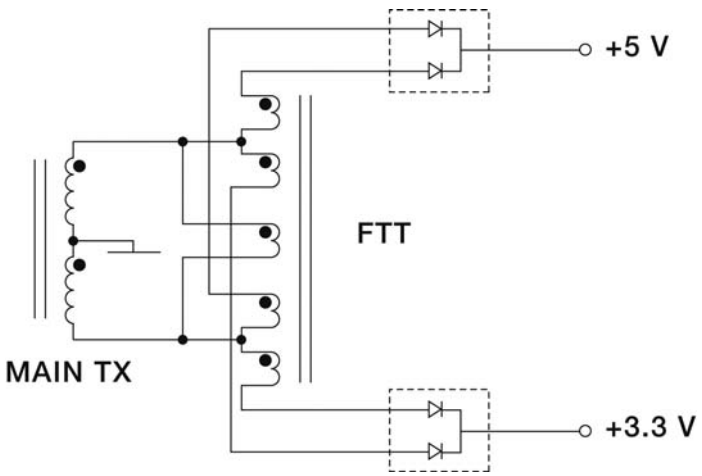

Figure 1

In both cases what's known as a fractional turn transformer solves a lot of problems. The term 'fractional turn' can be a little misleading because it's not a device with partial turns or tapped turns, both of which would unbalance the transformer, even if they could be implemented. Rather, it's a small transformer with a number of windings that connect to the secondary of the power transformer. The arrangement of these windings, shown in Figure 1, can be used to effectively add or subtract to the output voltage from the power transformer's secondary, depending on the phase in which it is connected. For example, where you need 5V and 3.3V the power transformer can be designed so that a single turn secondary winding delivers 4.5V. The separate fractional turns transformer adds 0.5V to deliver a 5V output and subtracts 1.2V to produce the 3.3V output. This additional transformer can be very small because it handles very little low power due to the low voltage present across each winding.

Where a 12V output it needed, the same power transformer can use a 3-turn secondary to produce 13.5V at its output, with a small fractional turn transformer utilized to reduce this to 12V. Of course, the magic is in how you design and connect the fractional turn transformer, but the general principle is very well demonstrated in XP Power's RCL175 family of compact, multi-output 175W AC/DC switchers, an example of which is shown in Figure 2. Here, customers can specify any voltage within the operating range of each output and the company delivers what is effectively a custom power supply simply by modifying the transformer arrangement. The power supplies have industrial, IT and medical approvals.

Figure 2

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