

(74) Agent: Einsel, Robert, Dipl.-Ing., Theodor-Stern-Kai 1,
D-6000 Frankfurt/Main 70 (DE)

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Specification

In communications equipment, particularly in television
receivers, it is known to effect the desired electrical
separation from the mains by means of so-called
switched-mode power supply transformers. Such
switched-mode power supply transformers are
considerably smaller and lighter than a mains
transformer working at 50 Hz for the same capacity
because they work at considerably higher frequency of
about 20 - 30 kHz. Such a switched-mode power supply
transformer (hereinafter called an SMPS transformer)
generally contains a primary side with the primary
winding serving as a working winding for the switch as
well as further additional auxiliary windings, and a
secondary side with the secondary winding to produce
the essential operating voltage and possibly further
additional windings to produce further operating
voltages of different magnitude and polarity. In
accordance with the VDE regulations, secondary side and
primary side are isolated from one another and have a
required dielectric strength so that touching live
parts at the secondary side remains harmless.

A further requirement for such an SMPS transformer consists in that the leakage inductance at least of the primary winding and of the secondary winding should be as low as possible. With too great a leakage inductance, transient phenomena may occur during the switching operation, which do not ensure any optimum switching operation of the switching transistor at the primary side and endanger this transistor through excessive power consumption. In addition, the internal resistance of the voltage sources for the individual operating voltages is increased in an undesirable manner by an increased leakage inductance.

It is known to construct the windings for such transformers in the form of a layer winding. Such layer packages contain feathered intermediate layers of foil between the windings, however, and, after completion, generally require potting of the package or of the complete transformer to ensure the VDE safety. A compartmented winding is not used in television sets at present because of the problems listed below. A compartmented winding would have the advantage, in particular, of being able to be wound more easily and rationally by automatic machines. If a compartmented winding were used on a switched-mode power supply, the desired isolation between primary side and secondary side would be achieved in the first instance by two compartments of which the one was filled only with windings of the primary side and the other only with windings of the secondary side. With such an arrangement, however, a slight coupling would result between the primary side and the secondary side and hence an undesirable high leakage inductance. On the other hand, if the number of compartments is selected considerably larger, the transformer becomes expensive and unnecessarily large. In addition, a larger core is

then also needed. Hitherto, no SMPS transformer with a compartmented winding has been envisaged in a television set.

It is the object of the invention to provide an SMPS transformer by the compartmented winding technique which renders possible a rational automatic winding operation, that is to say it can be wound with only one kind of wire, has a spatially narrow construction which is as flat as possible, and has the required isolation between primary side and secondary side and little leakage inductance. The transformer should not be potted and not be impregnated and nevertheless should not produce and disturbing noises in operation. The transformer should merely be held on its connecting pins in the printed circuit board by soldering without any mechanical aids.

This problem is solved by the invention described in Claim 1.

Advantageous further developments of the invention are described in the sub-claims.

As a result of the fact that the individual windings or part windings of the primary side lie only in compartments of the first group and the windings or the part windings of the secondary side lie only in compartments of the second group, that is to say primary side and secondary side are distributed in separate compartments, the necessary dielectric strength between primary side and secondary side is ensured. As a result of the distribution of the windings over a plurality of compartments and the interlaced arrangement of the compartments of primary side and secondary side, the desired firm coupling

between the primary side and the secondary side is achieved and hence the desired slight leakage inductances at the primary side and the secondary side. It has been found that a total number of compartments of the order of magnitude of 6 represents an economically favourable solution. With a smaller number of compartments the coupling between primary side and secondary side becomes less. With a higher number of compartments, however, either the individual compartments become too small or the whole transformer and in particular the core becomes too large.

One example of embodiment of the invention is explained with reference to the drawing.

Figure 1 shows the circuit diagram of a transformer for the switched-mode power supply; and

Figure 2 shows the distribution of the individual windings over various compartments.

Figure 1 shows a transformer provided for a switched-mode power supply, with the primary side P and the secondary side S which are electrically separated from one another while maintaining the necessary dielectric strength of 10,000 V for example. The primary side contains the primary winding 1 which, as the working winding, is connected into the collector circuit of the switching transistor which is switched at about 20-30 kHz. The primary winding 1 is divided into three part windings 1a, 1b and 1c which are connected in series. The beginning of the part winding 1a and the end of the part winding 1c are connected into the collector circuit of the switching transistor while the taps between the part windings 1a and 1b are not used but only form supporting points for the connection of

the terminals of the part windings. In addition, the primary side P contains an additional winding 3 to feed the feedback path with which the primary side is constructed in the form of a self-oscillating circuit. In addition, the primary side P contains an additional winding 4 for the control of the current starting point of the switching transistor in the sense of stabilizing the amplitude of the output voltages at the secondary side S.

The secondary side S contains first the secondary winding 2 from which the main operating voltage U1 is obtained via a rectifier circuit. The secondary winding 2 is divided into two part windings 2a and 2b connected in series. In addition, the secondary winding 3 contains an additional winding 5 to produce an operating voltage for the video amplifier and a further winding 6 to produce the operating voltage for the vertical deflection stage. In addition, an additional winding 7 is provided from which, after rectification, the operating voltage for the final sound stage is obtained. The winding 7 consists of three part windings 7a, 7b, 7c which are connected in parallel. The final sound stage has a greatly fluctuating current consumption between 50 mA and 1000 mA as a result of which the loading of the secondary side S varies greatly. This variation in loading can cause an unwanted variation in the operating voltage U1 which also influences the horizontal deflection amplitude. This unwanted dependency can be reduced by making the coupling between the winding 7 and the winding 4 for the control greater than the coupling between the winding 2 and the winding 4. This solution is described in more detail in DE-A-2 749 847. In the present case, this increased coupling between the windings 7 and 4 is achieved by the three windings

7a, 7b, 7c connected in parallel. A further winding 8 serves to produce, after rectification, a negative operating voltage of -30V.

Figure 2 shows the coil former 9 for the individual windings in Figure 1, which has a total of six compartments 10. Each third of the primary winding 1 is distributed, in the form of the part windings 1a, 1b, 1c, over the first, third and fifth compartments. Each half of the secondary winding 2 is distributed, in the form of the part windings 2a, 2b in the second and fourth compartments. The three part windings 7a, 7b, 7c of the winding 7 for the final sound stage are distributed between the second, fourth and sixth compartment. It can be seen that only windings or part windings of the primary side P or of the secondary side S lie alternately in the compartments. The interlacing of the windings as shown, that is to say the alternate arrangement of windings of the primary side and of the secondary side in successive compartments ensures the desired close coupling between the primary side P and the secondary side S. The arrangement of the windings 3, 4 roughly in the middle of the coil-former 9 over the part winding 1b ensures the desired close coupling of the windings 3,4 with the other windings.

In an example of embodiment tried out in practice, the individual windings had the following number of turns.

Winding No.

Number of turns

1a	22
1b	22
1c	22
2a	30
2b	30
3	3
4	10
5	25
6	1
7a	11
7b	11
7c	11
8	16

Patent Claims

1. A switched-mode power supply transformer, particularly for a television receiver having a power output between 40 and 150 watts, having a primary winding (1) and a secondary winding (2), characterised by the following features:

a) primary winding (1) and secondary winding (2) are divided into a plurality of part windings (1a-1c; 2a-2b),

b) the part windings of the primary winding (1) lie in a first group and the part windings of the secondary winding (2) lie in a second group of compartments (10) of a compartmented coil former (9).

c) the compartments (10) of the two groups are interlaced.

2. A transformer according to Claim 1, characterised in that the total number of the compartments (10) is about 6.

3. A transformer according to Claim 1, characterised in that the compartment width of the narrowest compartments is about 1 mm.

4. A transformer according to Claim 1, characterised in that the compartment widths of the 6 compartments are different.

5. A transformer according to Claim 1, characterised in that, in order to achieve a flat and optimally coupled transformer, the width of all 6 compartments only amounts to about 20 mm.



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6. A transformer according to Claim 1, characterised in that a third of the primary winding (1) and half of the secondary winding (2) are arranged alternately in each case in five successive compartments (10) in order to produce the main operating voltage U_1 .

7. A transformer according to Claim 1, characterised in that an additional secondary winding (7) for the production of a further operating voltage is likewise divided into a plurality of part windings (7a-7c) which lie in the compartments (10) of the second group.

8. A transformer according to Claim 7, characterised in that the part windings (7a-7c) of the additional secondary winding (7) lie beneath the part windings of the secondary winding (2).

9. A transformer according to Claim 7, characterised in that the additional secondary winding (7) is used to produce an operating voltage for a load (final sound stage) having a fluctuating current consumption.

10. A transformer according to Claim 1 or 7, characterised in that the part windings (7a-7c) are connected in parallel.

11. A transformer according to Claim 1, characterised in that the part windings (1a-1c) are connected in series.

12. A transformer according to Claim 1, characterised in that further primary auxiliary windings (3,4) are arranged above the part winding (1b) of the primary winding (1) in a compartment (10) of the first group which lies substantially in the middle of the coil former (9).



13. A transformer according to Claim 1, characterised in that all the compartments (10) of both groups are wound with wire of only one diameter.



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