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(54) SAFETY SHIELDING IN PLANAR TRANSFORMER

SICHERHEITSABSCHIRMUNG BEI EINEM PLANARTRANSFORMATOR

BLINDAGE DE SÉCURITÉ DANS UN TRANSFORMATEUR PLAN

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Description

Prior Art

[0001] The present invention relates to a planar inductive element, in particular to a planar transformer. In particular, the invention relates to a low power transformer operating with high voltages. Such transformers are used for example for DC/DC converting in switch mode which involves switching the input voltage with high frequency which leads to high voltages at the secondary windings.

[0002] EP1811530 discloses a planar inductive element according to the preamble of claim 1.

[0003] Peak voltages occurring at inductive elements which are operated at high frequencies, e.g. switch mode transformers, are causing serious insulation problems even for applications with low input or output voltages. For example, according to the standard UL60950-1, 2nd ed., the minimum required clearance for double or reinforced insulation is 1.4 mm for working voltages between 70 and 140 V in absence of transients. The resulting required thickness by solid insulation for this working voltage is 0.4 mm. Such insulation has to be provided between the windings and the exterior of the inductive element as well as between the windings and the core structure, in particular if conductive core material is used. These minimum distances substantially decrease the package density which, however, is crucial for low power applications, e.g. electronics or in automotive applications. Further, the layout of the circuit using such inductive elements is impaired by additional insulation gaps and is required to address insulation problems when placing the elements around the inductive element. In particular, this relates to minimum gaps in horizontal direction which have to be provided due to the high voltages.

[0004] Further, extra insulation material or elements involve additional costs and manufacturing steps and, at the same time, do not reduce the space requirements for inductive operating at high voltages.

[0005] It is therefore an object of the invention to provide an inductive element with reduced space requirements and increased electrical properties as regards insulation.

Summary of the Invention

[0006] The planar inductive element, the electric power supply circuit as well as the method according to the independent claims substantially decrease the required space for an inductive element operating at high voltages and, at the same time, provide increased insulation properties. The insulation properties are significantly increased without additional manufacturing steps and, in particular, without a need for additional insulation elements or material. The insulation properties are significantly increased by an inventive shielding conductor which can be provided by a manufacturing step, which is already carried out when producing inductive elements, wherein only slight modifications are necessary to the manufacturing step. In particular, the risk involved with high voltages at the outer surface of an inductive element which has to be addressed when creating the layout of a printed circuit board and the pertaining placement of adjacent electronic components is reduced to zero when using the inventive structure. Further, when using a conductive core, no additional space has to be provided for insulation materials. Rather, the complete space within the core structure can be used for windings, which significantly increases the efficiency of the inductive element. In particular, when using the invention for providing a switching power supply, the effectiveness can be substantially increased which leads to significantly increased battery lifetime for mobile applications.

[0007] According to the invention, a planar inductive element is provided which comprises at least one planar winding as well as a core structure. The core structure is encompassed by the at least one winding of the inductive element such that the flux produced by the inductive element is focused within the core structure. According to the invention, the inductive element comprises at least one shielding conductor, wherein the at least one shielding conductor comprises an inner shielding conductor which encloses a leg of the core structure. In particular, the inner shielding conductor is arranged between the at least one planar winding and the core structure. Such an inner shielding conductor is particularly useful if a non-insulating material is used for the core structure, e.g. conducting ferrite material. The at least one shielding conductor comprises an outer shielding conductor which is at least partly enclosing the at least one winding. Thus, the outer shielding conductor is arranged between the winding and the exterior of the planar inductive element. The at least one shielding conductor can comprise the inner shielding conductor only or the outer shielding conductor only and, in particular, can comprise the inner shielding conductor as well as the outer shielding conductor. In embodiments in which the core structure substantially houses the at least one winding, it is essential to provide the inner shielding conductor between winding and core structure (in particular the inner leg of the core structure) since in these embodiments, the insulation between outer core structure and exterior of the inductive element is substantial. However, if only the inner shielding conductor, the outer shielding conductor or both shielding conductors are provided within the inventive planar inductive element, the shielding conductor is defined by the insulation requirements for the planar inductive element and depends on the application and the electronic elements surrounding the planar inductive element within the application.

[0008] According to an embodiment of the invention, the at least one planar winding and the at least one shielding conductor are coplanar, i.e. extend in the same plane. The at least one planar winding and the at least one shielding conductor can also be arranged on a substrate

supporting both, the at least one winding and the at least one shielding conductor. In another alternative, the at least one winding and the at least one shielding conductor are provided by tracks of a printed circuit board. The thickness of the windings can be defined by their application. For example, the tracks providing the winding can have a thickness of 70 μm copper, 100 μm copper, or more. Since the at least one shielding conductor does not conduct any substantial current, the track providing the shielding conductor can be thinner than the track providing the windings. However, according to a preferred embodiment, the tracks providing the winding and the shielding conductor have the same thickness which allows both, one single manufacturing step as well as using a circuit board with a conductive layer having a constant thickness. Nevertheless, the width of the shielding conductor can be smaller than the width of the winding.

[0009] However, if only the winding is provided by a printed circuit board and the shielding conductor is added by an additional manufacturing step, e.g. by a step arranging a thin wire or applying a conductive layer onto a printed circuit board, the shielding conductor can be thinner than the winding. In another embodiment, the at least one winding and the at least one shielding conductor are provided as conductive layers extending around the at least one winding and a leg of the core structure, respectively, as well as parallel to the leg of the core structure in form a sheet. The winding and/or the shielding conductor can be provided as sheets which are wound around the leg (or another part) of the core structure, wherein the wound-up layer providing the winding has a cross-section in form of a spiral, and the shielding conductor is in form of a cylindrically bound conductive sheet. Preferably, in all of these embodiments, the ends of the shielding conductor are not connected with each other and are provided as an open circuit. This can be provided by a shielding conductor which does not encompass a complete circumference or by insulating the ends of the shielding conductor at sections at which parts of the shielding conductor overlap each other.

[0010] Advantageously, the at least one shielding conductor forms an open circuit. Further, the shielding conductor preferably comprises a tap or another connection element which allows to connect the shielding conductor to a defined potential. In this way, the core and/or the external region of the inductive element adjoining the shielding conductor are confronted with the shielding conductor as a conductor at low potential which does not produce any insulation problems but is provided at a defined low voltage.

[0011] According to a particular embodiment of the invention, the planar inductive element, in particular its windings, are provided as tracks on several circuit boards. In such an inductive element, the at least one winding comprises a plurality of windings as tracks on distinct, stacked circuit boards. These stacked circuit boards are aligned to each other and have identical shapes. The windings of the distinct circuit boards can be connected in parallel, in series or can be grouped in series as well as in parallel. Similarly, the shielding conductor is provided on the stacked circuit boards, preferably on all stacked circuit boards as inner shielding conductor, as outer shielding conductor, or as both. Thus, in this preferred embodiment, the stacked circuit boards are identical, each of them carrying an inner and an outer shielding conductor which is formed of the tracks of a conductive layer of the printed circuit board, wherein this conductive layer also forms tracks providing the windings.

[0012] The inductive element can be provided as a coil or can be provided as a transformer. In particular, all of the windings are connected with each other within the inductive element providing the inductive element as a coil or as an autotransformer. An autotransformer is a transformer having a primary winding, the primary winding also comprising a secondary winding forming a voltage divider. Further, some of the plurality of windings can be mutually insulated, which provides secondary and primary windings (or further windings) which are not electrically connected with each other but are connected by encompassing the same magnetic flux.

[0013] In a further embodiment, the inductive element of the invention is provided for through-hole mounting and comprises terminals only at one side which adjoins to a printed circuit board after mounting the inductive element onto such a printed circuit board which also supports additional electronic or electrical elements. Thus, the inductive element comprises connection terminals (electrically connected to the winding and, if applicable, to the at least one shielding conductor). Thus, the inductive element further comprises connection terminals suitable for connecting the inductive element with external circuits, external substrates or external circuit boards. The connection terminals are preferably arranged only at one side of the inductive element, i.e. the mounting side of the inductive element. This side can also be considered as a connection plane. The connection terminals extend through such a connection plane, wherein the at least one shielding conductor partly extends in parallel to the connection plane. In this way, the shielding conductor shields the one winding within the inductive element with regard to the external circuit, external substrate or external circuit board on which the inductive element is mounted. The shielding conductor comprises a shielding section which is formed of all parts of the shielding conductor which are located at or on the connection plane (apart from any gaps which may be present). This section of the shielding conductor, preferably including a small gap between ends of the shielding conductor, located at the connection plane is formed of a continuous conductor and provides a continuously conducting shielding section. In particular, the shielding conductor is provided as an open circuit having two ends which are not directly connected with each other. In one embodiment, these ends are not arranged at the connection plane but at a location in distance to the connection plane.

[0014] However, if the insulation standards do not require a very strict insulation (in particular due to reasonable operating voltages within the windings), the open ends can also be provided within or at the connection plane. In this case, the layout of the external circuit board on which the inductive element is mounted does not provide a conductor or a sensitive electronic element directly at both ends of the shielding conductor. If the ends of the shielding conductor are arranged at or on the connection plane, the external substrate or the external circuit board on which the inductive element is mounted provides an insulation area between these ends and between the ends and other electrical components of the external circuit provided by the external substrate or external circuit board and the residual electrical components mounted thereon.

[0015] According to a particular application of the inductive element, the inventive inductive element is used within an electric power supply circuit. Such an inventive electric power supply circuit comprises the inventive inductive element. The inductive element comprises at least two mutually insulated windings, wherein the inductive element is connected as a transformer. In this embodiment of the at least one shielding conductor is connected to ground or to a low supply potential or voltage of the electric power supply circuit. In this way, the shielding conductor can be guaranteed to be below a critical voltage. In another embodiment, the inductive element is provided as a coil, as for example in step-up or step-down converters or other switching current circuits. In a simple embodiment, the electric power supply circuit comprises the inventive inductive element provided as a coil with two terminals, wherein the inductive element is switched to deliver magnetic field energy from one electric potential to another electric potential according to controlled switching. In general, the electric power supply circuit according to the invention can comprise the inventive inductive element which is provided as transformer or as a coil.

[0016] In a preferred embodiment of the electric power supply circuit, the circuit is a switching circuit power supply which comprises a chopper unit. This chopper unit or any other similar switching converting unit is supplied by an input power supply. The chopper unit drives at least one of the windings, preferably by switching a semiconductor switch, e.g. a MOSFET. The chopper unit switches the input power and forwards this input power to the windings, wherein at each increasing edge of the switched input power a magnetic field is induced within the inventive inductive element. When switching off the input power, the magnetic energy is stored in the core structure of the inductive element or is discharged into another part of the switching circuit power supply for providing the input power at a distinct voltage. By switching the input power, peak voltages occur within the windings. Therefore, the at least one shielding conductor is connected to a potential of the input power supply. This potential can be V_{CC}, ground, $-V_{CC}$ or any other potential insuring the accommodation of voltage/current peaks resulting from switched inductivities. In particular the pertaining potential should be stable and should not respond to a peak voltage occurring in the shielding with a substantial voltage change.

[0017] According to a further aspect of the invention, the invention can be realized by a method for shielding a planar inductive element, in particular the planar inductive element provided by the core structure and the at least one winding as defined above. The method provides for shielding a planar inductive element having at least one planar winding as well as a core structure. The method comprises to arrange at least one shielding conductor around a leg of the core structure or around the at least one winding of the planar inductive element, or both. The at least one shielding conductor and the winding (i.e. the at least one planar winding of the planar inductive element) are arranged in the same plane. Further, the method comprises to apply a low potential or a ground potential to the at least one shielding conductor. This results in shielding the surrounding and the core structure of the inductive element *versus* high voltages within the inductive element which occur when switching the inductive element. Since the core structure is close to the at least one winding, any shielding of the winding only indirectly leads to shielding the core structure. Further, due to the closeness of the core structure and the at least one planar winding, shielding the winding indirectly leads to shielding of the core structure. Of course, the shielding can be arranged as inner shielding conductor or as outer shielding conductor as described above with regard to the inventive planar inductive element. In a particular embodiment of the inventive method for shielding a planar inductive element, the planar inductive element is operated at a voltage or current comprising a substantial high frequency component. The application of the low potential or the ground potential to the at least one shielding conductor comprises conducting high voltages and high voltage peaks to the low potential or the to the ground potential. In this way, any peaks resulting as induction results within the shielding conductor are derived from potentials accommodating the peak currents without substantially increasing the potential.

Short Description of the Drawings

[0018]

Figure 1 is a top view of an embodiment of the inventive planar inductive element; and

Figure 2 is a sectional view of an embodiment similar to the embodiment of Figure 1.

Detailed Description of the Drawings

[0019] Figure 1 is a cross-sectional view of an embodiment of the inventive planar inductive element. The planar inductive element of Figure 1 comprises a planar

winding 10 as well as a core structure 12, 14a, b, wherein the core structure comprises a centre leg 12 which is encompassed by the winding 10. The core structure comprises three legs, a middle leg 12 and two outer legs 14a, b, wherein the outer legs 14a, b are provided for closing the magnetic circuit. The flux within the core structure is produced by the planar winding 10 inducing a magnetic flux into centre leg 12. This flux is focused within the core structure and is fed by outer legs 14a, b.

[0020] The embodiment of Figure 1 comprises at least one shielding conductor in form of an outer shielding conductor 16 and an inner shielding conductor 18. As can be seen form Figure 1, the inner and the outer shielding conductor 16, 18 are thinner than the planar winding 10. Further, it can be seen that the inner and the outer shielding conductor 16, 18 are arranged in the same plane in which also the planar winding 10 is arranged. The inner and the outer shielding conductor 16, 18 as well as the winding 10 are provided by tracks formed of a structured conductive layer of a printed circuit board (not shown). The circuit board (not shown) has a shape which allows to fit within the core structure. In particular, the circuit board comprises an opening through which the centre leg 12 extends. Additionally, the planar winding comprises two ends 10a, b which are connected to the connectors (not shown) extending perpendicular to the plane of projection of Figure 1. These connectors (not shown) connect the shown planar winding to other windings and/or to terminals of the planar inductive element for external connection. In addition, the inner shielding conductor 18 follows the shape of the centre leg 12 and comprises two ends which are not connected with each other, one end of which, referenced as 18a, comprises a connector. This connector 18a is connected to other parts of the planar inductive element or other elements external to the planar inductive element for defining the potential of inner shielding conductor 18 onto a low voltage. As can be seen, a small gap is provided between both ends of inner shielding conductor 18 to avoid any currents to be introduced into the inner shielding conductor 18. If the shielding conductor would be a closed circuit, the alternating magnetic flux within centre leg 12 would induce an undesired substantial current into the inner shielding conductor 18.

[0021] The planar inductive element of Figure 1 further comprises the outer shielding conductor 16 which partly encloses the planar winding 10. As can be seen, also the outer shielding conductor 16 is provided as open loop and comprises two ends 16a, b which are not connected to each other. In the embodiment of Figure 1, the shielding of the planar winding to the left side is not necessary (e.g. due to other insulation mechanisms, e.g. gaps, which are not shown). However, the outer shielding conductor 16 provides shielding of the planar winding 10 with regard to the outer legs 14a, b and also with regard to the right side of the planar inductive element shown in Figure 1. As can be seen from Figure 1, also the outer shielding conductor 16 comprises a connection element 16c which allows connection to ground or low potentials. Firstly, the connection elements of the shielding conductors 16, 18 can be connected to other connectors (not shown) of the planar element in order to connect the respective shielding with external potentials. Alternatively, the connection elements 16c and 18a of the inner end the outer shielding conductor 16, 18 can also be connected with one and of the planar winding if it is ensured by external connection that the end of the winding 10 to which the shielding conductor is connected to is connected to a low potential or to ground during operation.

[0022] Since the shielding conductors 16, 18 provide a surface with a defined, low potential, the gaps 20, 22 between the respective core structure section and the planar winding 10 are comparably small and allow high density packaging of the winding within the core structure resulting in a high efficiency of the planar inductive element.

[0023] Additional interlayer connections are shown as circles which provide connection between layers of the inductive element perpendicular to the plane of projection of Figure 1.

[0024] Figure 2 shows an embodiment of the inventive planar inductive element similar to the embodiment shown in Figure 1 in side view. The embodiment shown in Figure 2 comprises a core structure provided by core elements15a, 15b in form of an EI-core shape. The core structure 15a, 15b comprises two outer legs 14a, b as well as a centre leg 12. The windings are defined by tracks of a plurality of stacked, printed circuit boards 30 sandwiched between insulation layers 32 which can also be provided by (unlayered) circuit boards. Figure 2 is not drawn to scale. In particular, the thickness of the tracks arranged on the circuit board 30 are not drawn to scale. The embodiment of Figure 2 is comparable to the embodiment shown in Figure 1, wherein the cross section shown in Figure 2 is similar to the view of a cross section along A-A' as shown in Figure 1. In Figure 2, the printed circuit boards comprise a double-layered circuit board (the upper circuit board referenced as circuit board 30) as well as a single-layered printed circuit board (the lower circuit board of the circuit boards 30). Between each of the conductive layers of the circuit boards 30, insulating substrate is given. The tracks formed by the conductive layer of the printed circuit boards 30 form a first structure 10 (only some of which are referred to by reference signs 10 in Figure 2) providing wide tracks. Structure 10 defines the planar winding which is spirally wound around centre leg 12. Further, the conductive layer of printed circuit boards 30 defines an outer shielding conductor 16 at the outer periphery of the printed circuit board 30 as well as an inner shielding conductor 18, both of which are provided by a track which is significantly thinner than the tracks providing the planar winding 10. Preferably, the thickness and the width of the tracks providing the winding, the inner shielding and the outer shielding, are constant of the length of the respective tracks.

[0025] In addition to tracks providing conductors ex-

tending in the plane of the windings, the planar inductive element of Figure 2 further comprises intra- or interlayer connectors which allow the connection of the windings, inner shielding conductor or outer shielding conductor of distinct surfaces of the same circuit board or between surfaces of distinct circuit boards. In Figure 2, an intra-circuit board connector 24 connects the outer shielding conductor of two opposed sides of a double-sided printed circuit board. Further conducting elements can be provided which connect the shielding conductors with each other, with a terminal of the planar inductive element, or with a particular end of the planar winding, which are not shown in Figure 2. Further, an intra-circuit board connection 26 connects tracks providing planar windings of the circuit board located on opposed sides of the circuit board.

[0026] Terminals for connecting the shielding conductor(s) or the planar windings to internal circuitry are not shown in Figure 2. In general, such connection elements or terminals extend along the direction of extension of the centre leg 12 outside the core structure 15a, 15b.

[0027] Again referring to Figure 1, such terminals or intra-element connectors could be provided at places like connector 16c and connection 10b, or other. In addition, intra-inductive element connectors could be provided within or outside the core structure between circuit boards or between distinct surfaces of circuit boards. In addition, such intra-inductive element conductors and connectors external to the circuit board element could be connected by tracks provided by the printed circuit boards. Terminals for external connection can be provided below or above the core structure or outside the core structure at locations like 16c or 10b (cf. Figure 1) extending from the planar inductive element towards additional printed circuit boards on which the inventive planar inductive element is arranged together with other electric or electronic components.

[0028] According to one aspect of the invention, the inductive element according to the invention can be manufactured by structuring at least one printed circuit board, wherein structuring the circuit board comprises providing an inner shielding conductor, an outer shielding conductor or both at the same structuring step in which the planar winding is structured in form of a spiral. Further, this method can comprise to stack similar or comparable circuit boards onto each other. After providing the circuit board or the stack of circuit boards, at least a part of the core structure is introduced into a central opening of the circuit boards. Adding the core to the planar inductive element can comprise introducing a first part of the core structure into the opening of the printed circuit board as well as around the printed circuit board (or stacked thereon) and to add a complementary component closing the magnetic path of the part which has already been introduced into the opening of the circuit board.

[0029] By providing the shielding conductor(s) when structuring the at least one winding of the inductive element (as known by the prior art), no additional step is necessary for providing the inventive manufacturing method. Rather, only the structure has to be slightly modified in order to introduce the inner or the outer shielding conductor or both.

Claims

1. Planar inductive element, the inductive element comprising at least one planar winding (10) and a core structure (12, 14a, b) encompassed by the at least one winding of the inductive element, wherein the inductive element is further **characterized by** at least one shielding conductor, wherein the at least one shielding conductor comprises an outer shielding conductor (16) at least partly enclosing the at least one winding,
characterised in that
it also comprises an inner shielding conductor (18) at least partly enclosing a leg (12) of the core structure.

2. Inductive element according to claim 1, wherein the at least one planar winding (10) and the at least one shielding conductor (16, 18) extend coplanar or are arranged on a substrate supporting both, the at least one winding and the at least one shielding conductor, or wherein the at least one winding and the at least one shielding conductor are provided by tracks of a printed circuit board (30), or wherein the at least one winding and the at least one shielding conductor are provided as conductive layers extending around the at least one winding and a leg of the core structure, respectively, as well as parallel to the leg (12) of the core structure.

3. Inductive element according to claim 1 or 2, wherein the at least one shielding conductor forms an open circuit and comprises an electrical derivation connection suited to connect the at least one shielding conductor (16, 18) to a low potential internal or external to the inductive element.

4. Inductive element according to one of the preceding claims, wherein the at least one winding comprises a plurality of windings as tracks on a distinct, stacked circuit board (30, 32), wherein all of the windings are connected to each other within the inductive element providing the inductive element as a coil or an autotransformer, or wherein some of the plurality of windings are mutually insulated providing the inductive element as a transformer.

5. Inductive element according to one of the preceding claims, further comprising connection terminals suitable for connecting the inductive element to external circuits, external substrates or external circuit boards, the connection terminals extending through

a connection plane, wherein the at least one shielding conductor partly extends in parallel to the connection plane, the section of the shielding conductor extending in parallel to the connection plane forming a continuously conducting shielding section.

6. Electric power supply circuit comprising the inductive element according to one of the preceding claims, the inductive element comprising at least two mutually insulated windings, wherein the inductive element is connected as a transformer and wherein the at least one shielding conductor is connected to ground or a low supply potential of the electric power supply circuit.

7. Electric power supply circuit according to claim 6, wherein the electric power supply circuit is a switching circuit power supply comprising a chopper unit supplied by an input power supply, the chopper unit driving at least one of the windings, wherein the at least one shielding conductor is connected to a potential of the input power supply.

8. Method for shielding a planar inductive element according to claim 1 having at least one planar winding as well as a core structure, the method comprising: arranging at least one shielding conductor (16, 18) around a leg (12) of the core structure and around the at least one winding, wherein the at least one shielding conductor and the winding are arranged in the same plane, and applying a low potential or a ground potential to the at least one shielding conductor (16, 18), thereby shielding the surrounding and the core structure (12, 14a, b) of the inductive element from high voltages within the inductive element.

9. Method for shielding a planar inductive element according to claim 8, wherein the planar inductive element is operated at a voltage or current comprising a substantial high frequency component, wherein the application of the low potential or a ground potential to the at least one shielding conductor (16, 18) comprises conducting high voltages and high voltage peaks induced into the shielding conductor by the high frequency component to the low potential or to the ground potential.

Patentansprüche

1. Planares induktives Element, wobei das induktive Element mindestens eine Planarwicklung (10) und eine Kernstruktur (12, 14a, b) umfasst, die von der mindestens einen Wicklung des induktiven Elements umschlossen ist, wobei das induktive Element ferner durch mindestens einen Abschirmleiter gekennzeichnet ist, wobei der mindestens eine Abschirmleiter einen äußeren Abschirmleiter (16) umfasst, der die mindestens eine Wicklung wenigstens teilweise umgibt,
dadurch gekennzeichnet, dass
er außerdem einen inneren Abschirmleiter (18) umfasst, der einen Schenkel (12) der Kernstruktur wenigstens teilweise umgibt.

2. Induktives Element nach Anspruch 1, wobei die mindestens eine Planarwicklung (10) und der mindestens eine Abschirmleiter (16, 18) sich koplanar erstrecken oder auf einem Substrat angeordnet sind, das sowohl die mindestens eine Wicklung als auch den mindestens einen Abschirmleiter trägt, oder wobei die mindestens eine Wicklung und der mindestens eine Abschirmleiter durch Leiterbahnen einer gedruckten Leiterplatte (30) vorgesehen sind, oder wobei die mindestens eine Wicklung und der mindestens eine Abschirmleiter als leitende Schichten vorgesehen sind, die sich um die mindestens eine Wicklung bzw. einen Schenkel der Kernstruktur sowie parallel zum Schenkel (12) der Kernstruktur erstrecken.

3. Induktives Element nach Anspruch 1 oder 2, wobei der mindestens eine Abschirmleiter einen offenen Kreis bildet und eine elektrische Ableitungsverbindung umfasst, die zum Verbinden des mindestens einen Abschirmleiters (16, 18) mit einem niedrigen Potenzial innerhalb oder außerhalb des induktiven Elements geeignet ist.

4. Induktives Element nach einem der vorhergehenden Ansprüche, wobei die mindestens eine Wicklung eine Mehrzahl von Wicklungen als Leiterbahnen auf einer eigenen gestapelten Leiterplatte (30, 32) umfasst, wobei alle der Wicklungen innerhalb des induktiven Elements miteinander verbunden sind und das induktive Element als eine Spule oder einen Autotransformator bereitstellen, oder wobei einige der Mehrzahl von Wicklungen voneinander isoliert sind und das induktive Element als einen Transformator bereitstellen.

5. Induktives Element nach einem der vorhergehenden Ansprüche, ferner umfassend Verbindungsanschlüsse, die zum Verbinden des induktiven Elements mit externen Kreisen, externen Substraten oder externen Leiterplatten geeignet sind, wobei sich die Verbindungsanschlüsse durch eine Verbindungsebene erstrecken, wobei sich der mindestens eine Abschirmleiter teilweise parallel zur Verbindungsebene erstreckt, wobei der Abschnitt des Abschirmleiters, der sich parallel zu Verbindungsebene erstreckt, einen durchgehend leitenden Abschirmabschnitt bildet.

6. Stromversorgungskreis, umfassend das induktive

Element nach einem der vorhergehenden Ansprüche, wobei das induktive Element mindestens zwei voneinander isolierte Wicklungen umfasst, wobei das induktive Element als ein Transformator angeschlossen ist, und wobei der mindestens eine Abschirmleiter mit Masse oder einem niedrigen Versorgungspotenzial des Stromversorgungskreises verbunden.

7. Stromversorgungskreis nach Anspruch 6, wobei der Stromversorgungskreis eine Schaltkreisstromversorgung ist, die eine Zerhackereinheit umfasst, die durch eine Eingangsstromversorgung versorgt wird, wobei die Zerhackereinheit mindestens eine der Wicklung ansteuert, wobei der mindestens eine Abschirmleiter mit einem Potenzial der Eingangsstromversorgung verbunden ist.

8. Verfahren zur Abschirmung eines planaren induktiven Elements nach Anspruch 1 mit mindestens einer Planarwicklung sowie einer Kernstruktur, wobei das Verfahren umfasst: Anordnen mindestens eines Abschirmleiters (16, 18) um einen Schenkel (12) der Kernstruktur und um die mindestens eine Wicklung, wobei der mindestens eine Abschirmleiter und die Wicklung in der gleichen Ebene angeordnet werden, und Anlegen eines niedrigen Potenzials oder eines Massepotenzials an den mindestens einen Abschirmleiter (16, 18), um dadurch die Umgebung und die Kernstruktur (12, 14a, b) des induktiven Elements gegen hohe Spannungen innerhalb des induktiven Elements abzuschirmen.

9. Verfahren zur Abschirmung eines planaren induktiven Elements nach Anspruch 8, wobei das planare induktive Element bei einer Spannung oder einem Strom betrieben wird, die/der eine wesentliche Hochfrequenzkomponente umfasst, wobei das Anlegen des niedrigen Potenzials oder eines Massepotenzials an den mindestens einen Abschirmleiter (16, 18) ein Leiten von hohen Spannungen und hohen Spannungsspitzen, die durch die Hochfrequenzkomponente in den Abschirmleiter eingeführt werden, zum niedrigen Potenzial oder zum Massepotenzial umfasst.

Revendications

1. Élément inductif plan, l'élément inductif comprenant au moins un enroulement plan (10) et une structure de noyau (12, 14a,b) encerclée par l'au moins un enroulement de l'élément inductif, l'élément inductif étant en outre **caractérisé par** au moins un conducteur écran, l'au moins un conducteur écran comprenant un conducteur écran extérieur (16) entourant au moins partiellement l'au moins un enroulement, **caractérisé en ce qu'**il comprend également un conducteur écran intérieur (18) entourant au moins partiellement une colonne (12) de la structure de noyau.

2. Élément inductif selon la revendication 1, dans lequel l'au moins un enroulement plan (10) et l'au moins un conducteur écran (16, 18) s'étendent de façon coplanaire ou sont disposés sur un substrat supportant à la fois l'au moins un enroulement et l'au moins un conducteur écran, ou dans lequel l'au moins un enroulement et l'au moins un conducteur écran sont fournis par des pistes d'une carte de circuit imprimé (30), ou dans lequel l'au moins un enroulement et l'au moins un conducteur écran sont fournis sous forme de couches conductrices s'étendant autour de l'au moins un enroulement et d'une colonne de la structure de noyau, respectivement, ainsi que parallèlement à la colonne (12) de la structure de noyau.

3. Élément inductif selon la revendication 1 ou 2, dans lequel l'au moins un conducteur écran forme un circuit ouvert et comprend un raccord de dérivation électrique approprié pour raccorder l'au moins un conducteur écran (16, 18) à un faible potentiel interne ou externe à l'élément inductif.

4. Élément inductif selon une des revendications précédentes, dans lequel l'au moins un enroulement comprend une pluralité d'enroulements sous forme de pistes sur une carte de circuit distincte, empilée (30, 32), tous les enroulements étant raccordés les uns aux autres à l'intérieur de l'élément inductif, fournissant l'élément inductif sous la forme d'une bobine ou d'un autotransformateur, ou dans lequel certains de la pluralité d'enroulements sont mutuellement isolés, fournissant l'élément inductif sous la forme d'un transformateur.

5. Élément inductif selon une des revendications précédentes, comprenant en outre des bornes de raccordement appropriées pour raccorder l'élément inductif à des circuits externes, des substrats externes ou des cartes de circuit externes, les bornes de raccordement s'étendant à travers un plan de raccordement, dans lequel l'au moins un conducteur écran s'étend partiellement parallèlement au plan de raccordement, la section du conducteur écran s'étendant parallèlement au plan de raccordement formant une section écran continûment conductrice.

6. Circuit d'alimentation électrique comprenant l'élément inducteur selon une des revendications précédentes, l'élément inducteur comprenant au moins deux enroulements mutuellement isolés, l'élément inducteur étant raccordé comme un transformateur et l'au moins un conducteur écran étant raccordé à la terre ou un faible potentiel d'alimentation du circuit

d'alimentation électrique.

7. Circuit d'alimentation électrique selon la revendication 6, le circuit d'alimentation électrique étant une alimentation à circuit de découpage comprenant une unité de hachage fournie par une alimentation d'entrée, l'unité de hachage commandant au moins un des enroulements, l'au moins un conducteur écran étant raccordé à un potentiel de l'alimentation d'entrée.

8. Procédé de blindage d'un élément inductif plan selon la revendication 1 ayant au moins un enroulement plan ainsi qu'une structure de noyau, le procédé comprenant les étapes suivantes : disposer au moins un conducteur écran (16, 18) autour d'une colonne (12) de la structure de noyau et autour de l'au moins un enroulement, l'au moins un conducteur écran et l'enroulement étant disposés dans le même plan, et appliquer un faible potentiel ou un potentiel de terre à l'au moins un conducteur écran (16, 18) pour protéger ainsi l'environnement et la structure de noyau (12, 14a,b) de l'élément inducteur contre les hautes tensions à l'intérieur de l'élément inducteur.

9. Procédé de blindage d'un élément inductif plan selon la revendication 8, dans lequel l'élément inductif plan est utilisé à une tension ou un courant comprenant une importante composante haute fréquence, l'application du faible potentiel ou d'un potentiel de terre à l'au moins un conducteur écran (16, 18) comprenant la conduction des hautes tensions et des pics de haute tension induits dans le conducteur écran par la composante haute fréquence jusqu'au faible potentiel ou jusqu'au potentiel de terre.

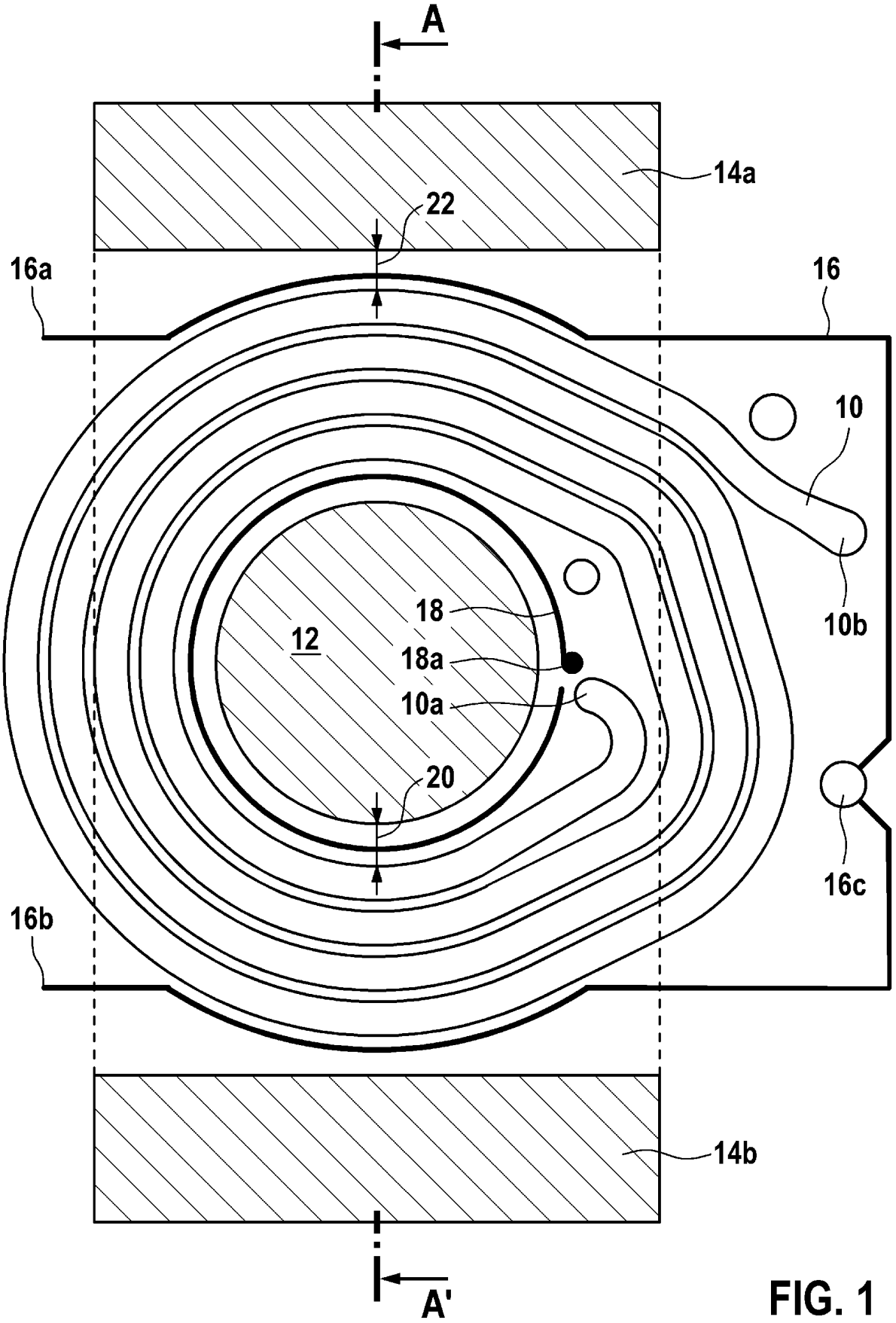


FIG. 1

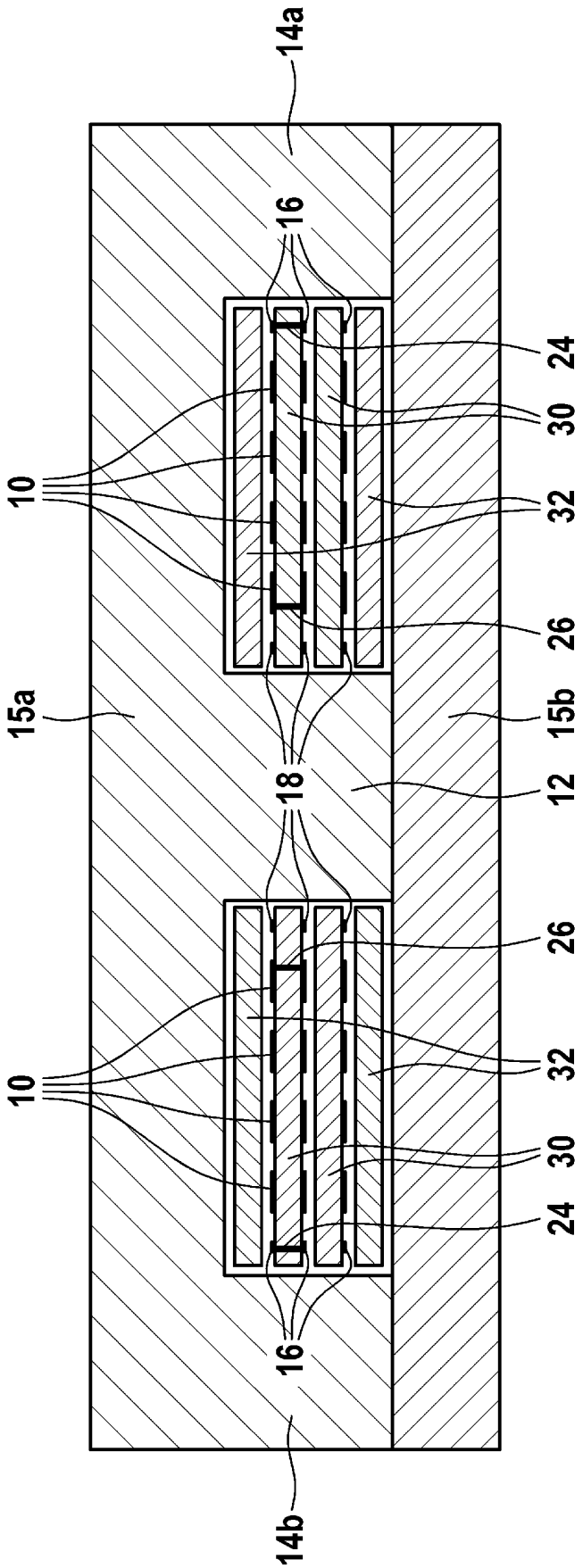


FIG. 2

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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