

## US006501364B1

## (12) United States Patent Hui et al.

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### (54) PLANAR PRINTED-CIRCUIT-BOARD TRANSFORMERS WITH EFFECTIVE **ELECTROMAGNETIC INTERFERENCE** (EMI) SHIELDING

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U.S.C. 154(b) by 0 days.

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(56)

(22) Filed: Jun. 15, 2001

(51) Int. Cl.<sup>7</sup> ...... H01F 5/00 (52)

336/223; 29/606, 602.1

### References Cited U.S. PATENT DOCUMENTS

3,866,086 A	2/1975	Miyoshi et al.
4,494,100 A	1/1985	Stengel et al.
4,510,915 A	4/1985	Ishikawa et al.
4,613,843 A	9/1986	Esper et al.
4,748,532 A	5/1988	Commander et al.
4,890,083 A	* 12/1989	Trenkler et al 335/301
5,039,964 A	8/1991	Ikeda
5,431,987 A	7/1995	Ikeda
5,502,430 A	* 3/1996	Takahashi et al 336/232
5,579,202 A	11/1996	Tolfsen et al.
5,592,089 A	* 1/1997	Danby et al 324/318
5,844,451 A	12/1998	Murphy
6,023,161 A	* 2/2000	Dantsker et al 324/248

#### FOREIGN PATENT DOCUMENTS

EP	0 147 499		7/1985
JP	54-110424		8/1979
JP	4-10680		1/1992
JP	6013247 A	*	1/1994
JP	200111651 A	*	4/2001

### OTHER PUBLICATIONS

Tang et al., "Coreless planar printed-circuit-board (PCB) transformers—A fundamental concept for signal and energy transfer," IEEE Transactions on Power Electronics, vol. 15, No. 5, pp. 931941 (Sep. 2000).

Hui et al., "Coreless printed-circuit board transformers for signal and energy transfer," Electronics Letters, vol. 34, No. 11, pp. 1052–1054 (May 1998).

Hui et al., "Some electromagnetic aspects of coreless PCB transformers," IEEE Transactions on Power Electronics, vol. 15, No. 4, pp. 805–810 (Jul. 2000).

Onda et al., "Thin type DC/DC converter using a coreless wire transformer," IEEE Power Electronics Specialists Conference, pp. 1330-1334 (Jun. 1994).

Coombs, C.F., "Printed Circuits Handbook," 3rd Ed. McGraw-Hill, p. 6.32 (1998). No month.

Tang et al., "Characterization of coreless printed circuit board (PCB) transformers," IEEE Transactions on Power Electronics, vol. 15, No. 6, pp. 1275-1282 (Nov. 2000).

Paul, C.R., Introduction to Electromagnetic Compatibility, Chapter 11—Shielding, pp. 632–637 (1992), no month.

Tang et al., "A low-profile power converter using printedcircuit board (PCB) power transformer with ferrite polymer composite," IEEE Transactions on Power Electronics, vol. 16, No. 4, pp. 493–498 (Jul. 2001).

Hui et al., "Coreless PCB based transformers for power MOSET/IGBT gate drive circuits," IEEE Power Electronics Specialists Conference, vol. 2, pp. 1171–1176 (1997). No

Bourgeois, J.M., "PCB Based Transformer for Power MOS-FET Drive," IEEE, pp. 238-244 (1994). No month. Goyal, R., "High-Frequency Alalog Integrated Circuit Design," pp. 107-126 (1995). No month.

\* cited by examiner

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#### **ABSTRACT** (57)

Novel designs for printed circuit board transformers, and in particular for coreless printed circuit board transformers designed for operation in power transfer applications, are disclosed in which shielding is provided by a combination of ferrite plates and thin copper sheets.

### 5 Claims, 13 Drawing Sheets

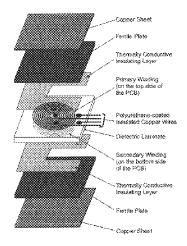
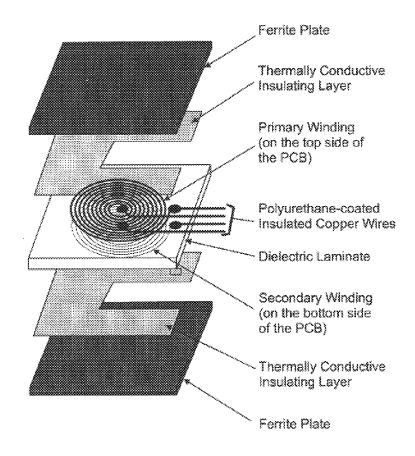




FIG.1 (Prior Art)



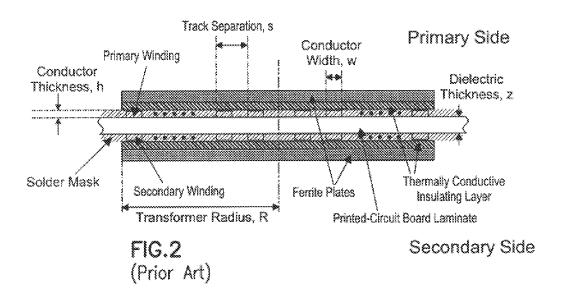
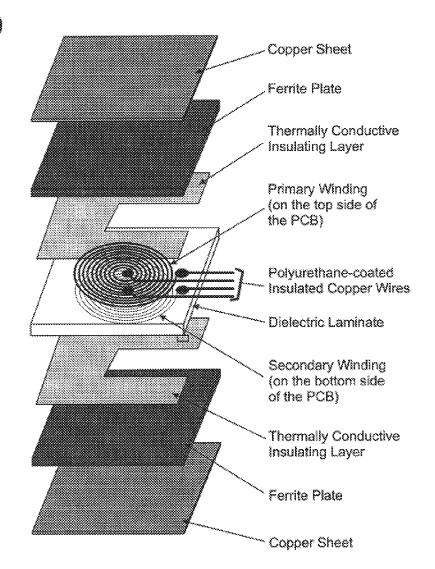
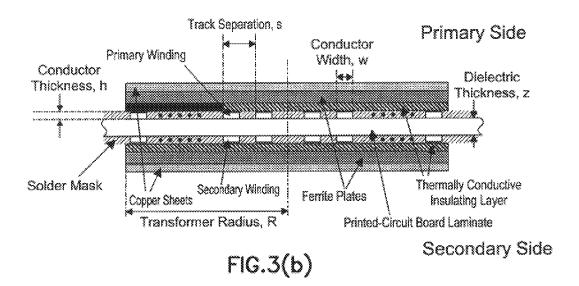


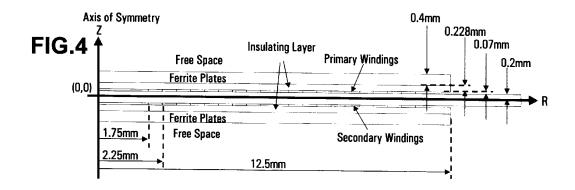


FIG.3(a)

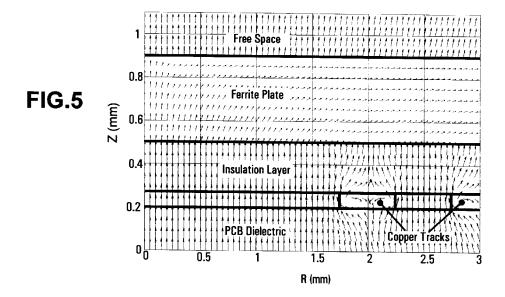
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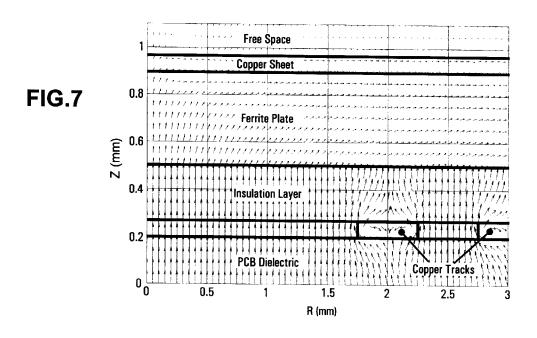


FIG.6

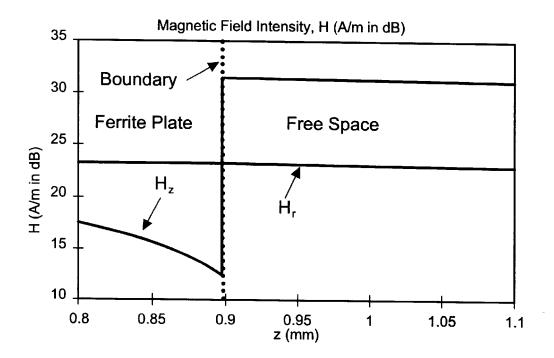
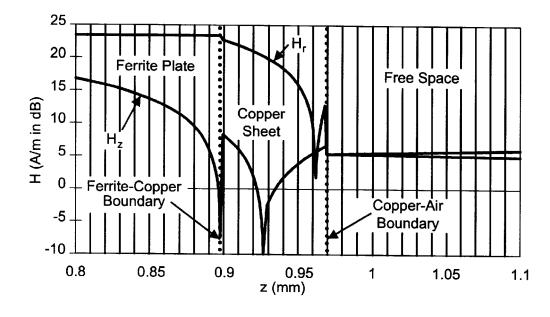


FIG.8





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