平成 10 年度博士論文要旨

- 平成8年度入学　大学院博士後期課程　システム情報工学専攻（エレクトロメカニカル工学講座）

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論文題目：分極反転構造を導入した圧電トランスの研究

英訳題目：Piezoelectric transformer applied alternately poled structure

Abstract

This paper presents a study of new piezoelectric transformer which has higher step-up ratio than Rosen type piezoelectric transformer. Recently, liquid crystal display (LCD) is used as a display device of a notebook PC because of its thin shape. As an LCD does not radiate, a backlight is necessary. A cold cathode fluorescent lamp (CCFL) is used as a backlight lamp to illuminate an LCD. It is necessary to feed over 2W to CCFL in this application. Then, Rosen type piezoelectric transformer needs over 50V input voltage, which is too high for internal battery voltage. For this reason,I proposed a new piezoelectric transformer structure named alternately poled type to realize higher step-up ratio and to feed energy from a low-voltage battery. And then, it was confirmed that its step-up ratio was at least twice as large as that of Rosen type.

When drive voltage is small like as 0.5V, results of equivalent circuit analysis were agreed with measured data under the impedance matching condition to the load. However, as the output power increased, the step-up ratio became large. It was explained by temperature rise distribution ina piezoelectric transformer and temperature dependence of dielectric constant. From these results, it was shown that temperature rise was significant to design high power piezoelectric transformers.

High power design method was investigated. Output capacity should be defined by temperature rise. Then, a power parameter nA2 was proposed, where n and A2 indicated the mode number and force factor of generating part, respectively.

Durability for temperature rise and continuous driving was investigated. After heat aging under 110 degree C, step-up ratio decreased, but efficiency did not change and stood use. Temperature rise of an alternately poled piezoelectric transformer was lower than that of Rosen type, so that it was more durable for high power driving. There was large

temperature gradient in a generating part. FEM analysis predicts that it causes compressive thermal stress around side surface. It compensates residual stress by poling treatment, and may increase output capacity by increasing tensile strength. Changes of characteristics after 8000 hours continuous driving were similar to heat aging. It may be possible to accelerate continuous driving test by applying temperature stress.
It was confirmed that alternately poled piezoelectric transformer accomplished high step-up ratio and could be applied to practical use.