Compact Power Converters using GaN Power Devices (CKJ4-16)

Students: Wong Hong Chun, Yeung Ming Chuen
Supervisor: Prof Kevin J. Chen

Introduction

For the past 3-4 decades, power conversion technology has been developed quickly by the invention in silicon (Si) power devices. By the introduction of the metal oxide silicon field effect transistor (MOSFET) technology. It helps to improve efficiency and reduce the cost of power semiconductor device. It became a dominant power conversion in our daily lives.

During these few years, the development of silicon-based power electronic has been slow down by the Si approaches its theoretical limits.

Instead, the development of GaN transistor, which is a new type of transistor made of a semi-conductor compound called Gallium Nitride, is proliferating nowadays. Gallium Nitride comes with higher switching power performance than Silicon. This makes GaN transistor able to achieve a higher switching frequency and eventually improve the efficiency as well as reduce the physical size of other electronic component such as capacitor, inductor.

Aim and objective

- DC/DC power converter (48V to 1V)
- Enhance efficiency
- Reduce the size of power converter
- 1V for CPU operation
- Mobile devices, computer, Data center

Methodology

The GaN power devices is going to use GaN transistor as the switch of power converter to increase the switching frequency.

\[
\begin{align*}
(V_I - V_o)DT - V_o(1-D)T &= 0 \\
V_o &= V_I(1-D)
\end{align*}
\]

\[
D = \frac{V_o}{V_I}
\]

\[
L_{\text{min}} = \frac{(1-D)R}{2f}
\]

System block diagram

Methodology

Result

Figure 1: 2-step buck converter with GaN transistor

Figure 2: Input and output voltage of power converter

Conclusion:

Our group has designed a higher efficiency, less power dissipation and compact power converter. However, the performance of power converter can be further improved.

First, a control feedback system is required to install in the model to reduce the overshoot.

Second, the remaining EMI will cause power loss. However, for completely solving EMI problem, installing further EMI filter is not a feasible way since it will increase the power loss and the size of the product.