

Efficiency Improvement for Switching Power Supply at Light Load Using DSP Control

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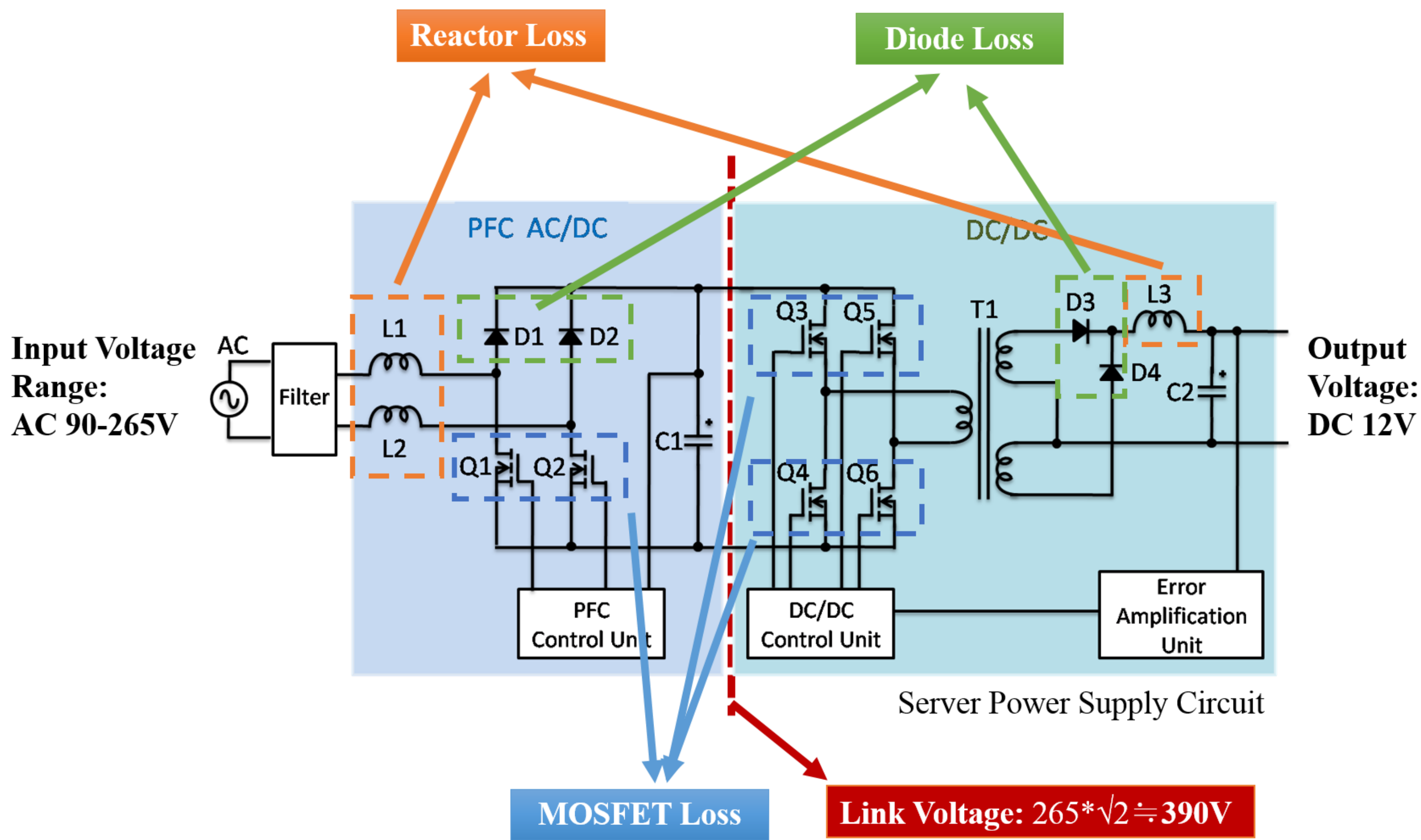
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INTRODUCTION

- Energy efficiency improvement of the server power supply → important with **Green IT**
- We have investigated its technique at **half-load and light load (under 20%)** using **digital control**.



LOSS MECHANISMS OF PFC AC/DC CONVERTER AND DC/DC CONVERTER



Reactor Loss / Iron Loss: $P_i = P_h + P_e = K(B_m^{2.77}, f^{1.55})$

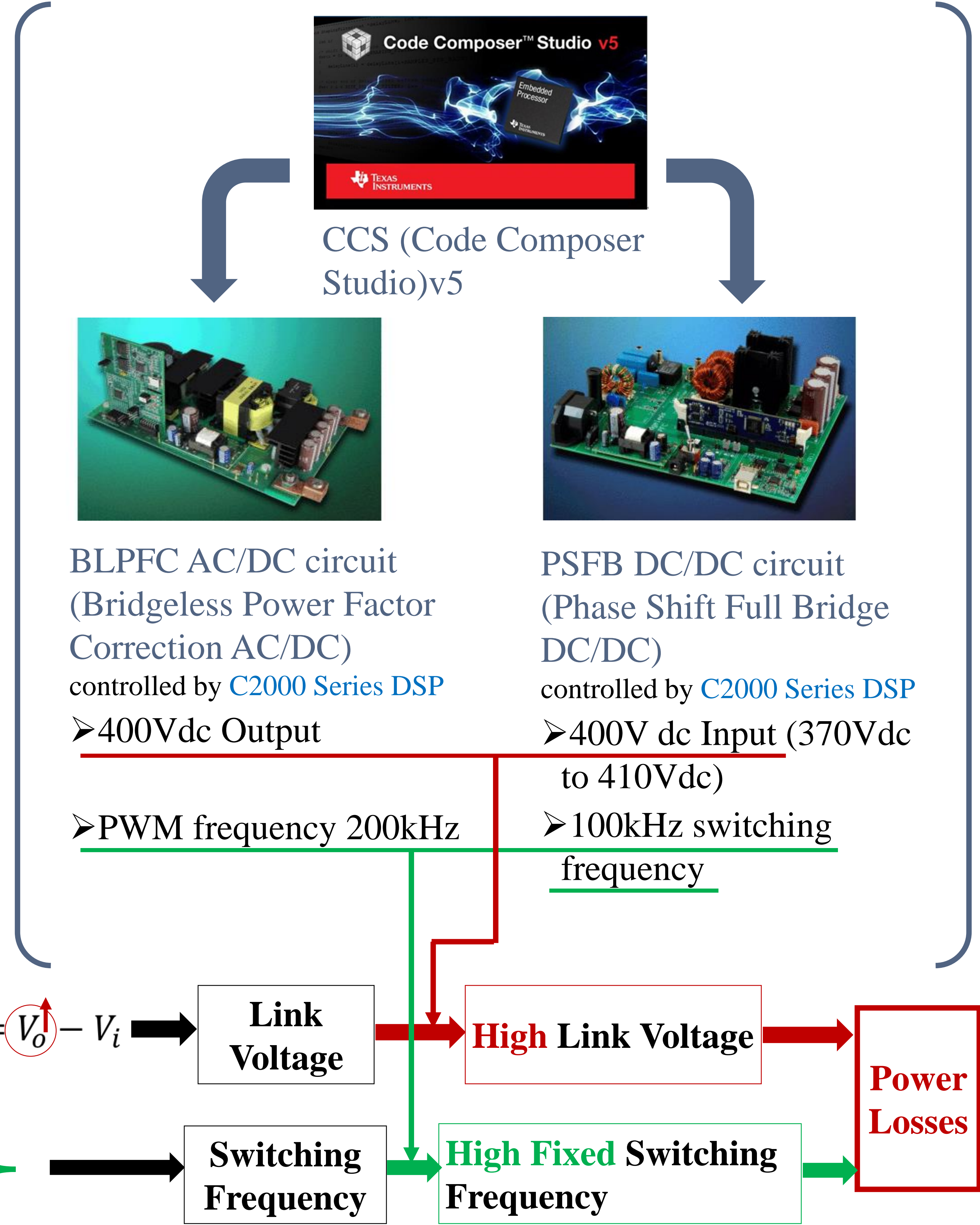
Eddy Current Loss: $P_e = k_e \frac{(te_L)^2}{f^{0.6}}$
 Hysteresis Loss: $P_h = k_h \frac{e_L^{1.6}}{f^{0.6}}$

Diode Loss: $P_{SW(DIODE)} = 0.5 \times V_{REVERSE} \times I_{RR(PEAK)} \times t_{RR} \times f_s$

MOSFET Loss: $P_{SW(MOSFET)} = 0.5 \times V_D \times I_D \times (t_{SW(ON)} + t_{SW(OFF)}) \times f_s$

$e_L = V_o - V_i$

EXPERIMENTAL ENVIRONMENT

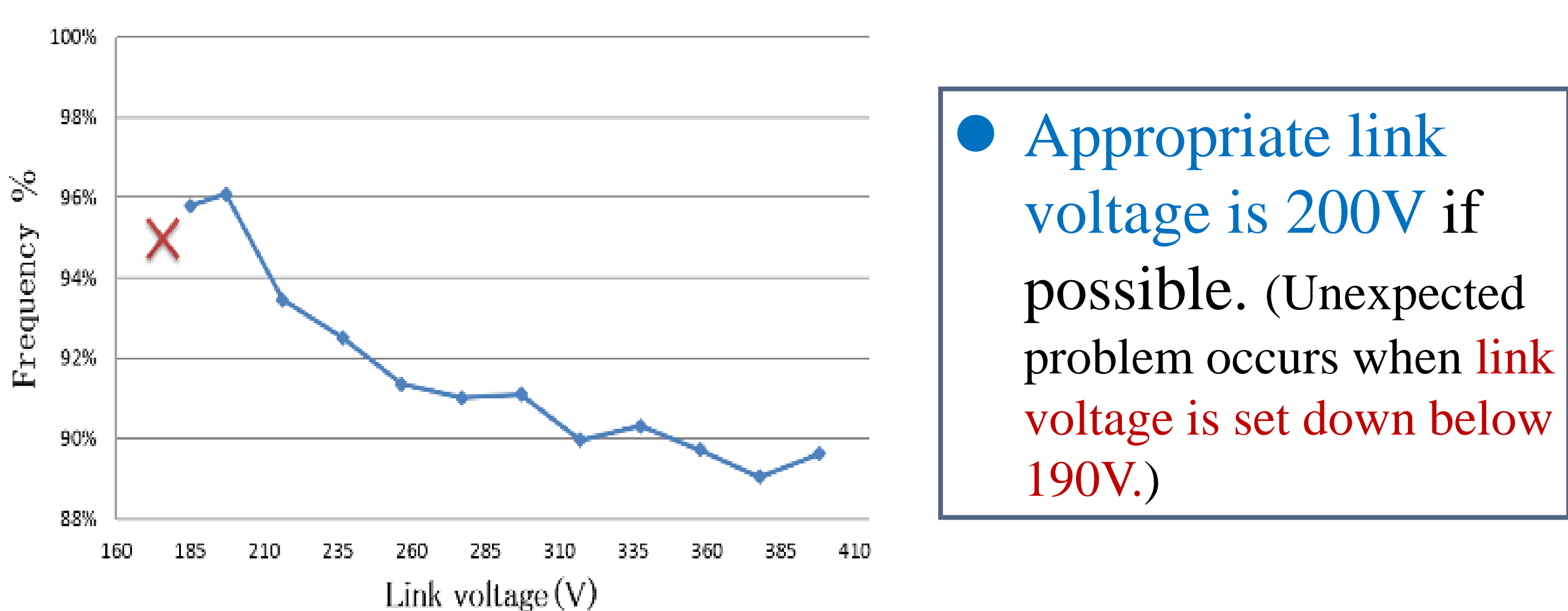


EXPERIMENT RESULTS

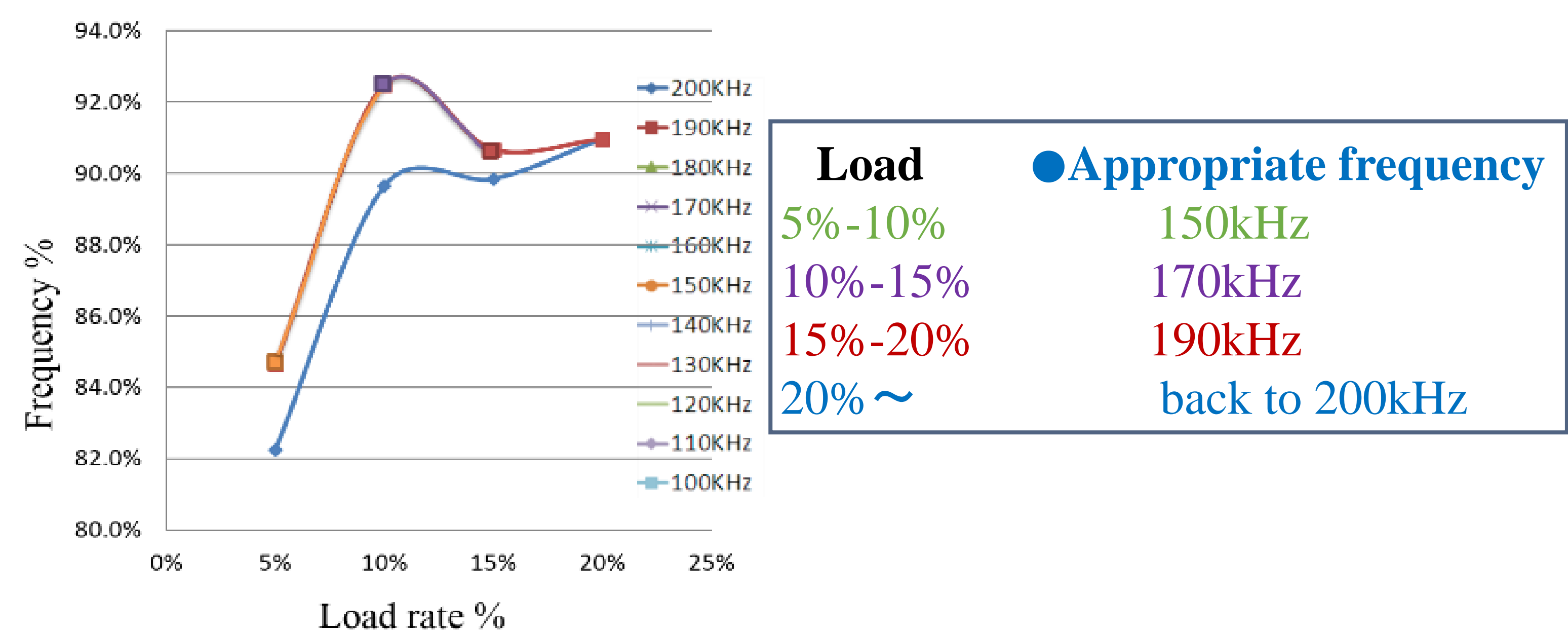
The experiment is conducted by a mean of **two parts** and three steps.

- BLPFC AC/DC part (Bridgeless Power Factor Correction AC/DC)
 - Step A: Load rate 50% → Deal with **Link Voltage**
 - Step B: Load rate 10%~20% → Deal with **PWM Frequency**
- PSFB DC/DC part (Phase Shift Full Bridge DC/DC)
 - Step C: Load rate 10%~20% → Deal with **PWM Frequency**

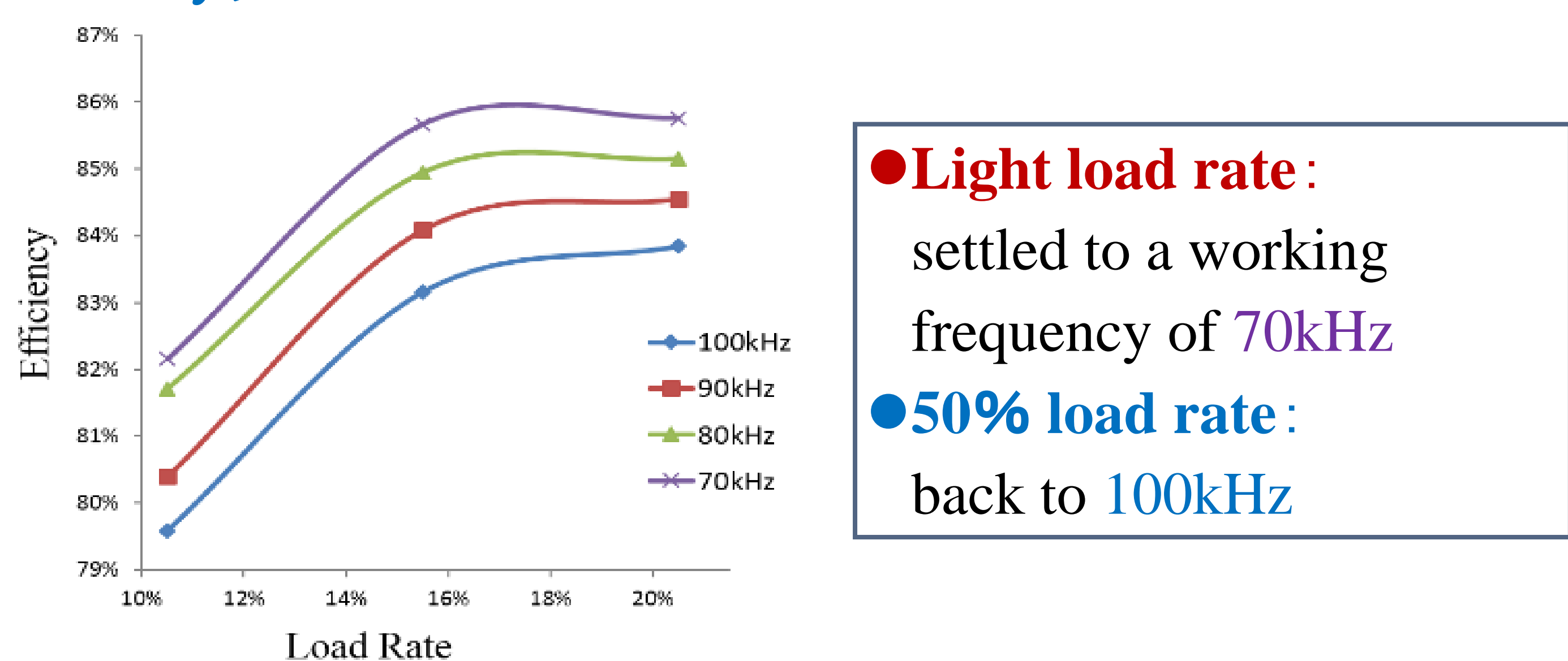
Experiment Results A: **Link Voltage Optimization of BLPFC AC/DC at a Half-Load**



Experiment Results B: **Optimization of PWM Frequency of BLPFC AC/DC at a Load Rate of 5% to 20%**



Experiment Results C: **Optimization of PWM Frequency of PSFB DC/DC at a Load Rate of 5% to 20%**



CONCLUSION

TI C2000 DSP series can improve the power supply efficiency at light load by **lowering link voltage** and **verifying PWM frequency** using digital control.

- AC/DC+variable link voltage: efficiency 6%↑ @50% load rate
- AC/DC+variable PWM frequency: efficiency 1~4%↑ @5%~20% load rate
- DC/DC+variable PWM frequency: efficiency 3~6%↑ @10%~20% load rate