



Development of hybrid multi-level inverters of the PF coils of SUNIST-2 spherical tokamak

IoT TW 2022
SUNIST

Zichong SONG¹, Yi TAN¹, Shouzhi WANG¹, Wenbin LIU^{2,3}

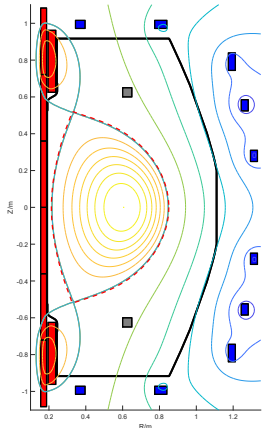
¹ Department of Engineering Physics, Tsinghua University, Beijing 100084, China

² College of Physics and Optoelectronic Engineering, Shenzhen University, Shenzhen 518060, China

³ Advanced Energy Research Center, Shenzhen University, Shenzhen 518060, China

Introduction

High-performance PF power supply for fast and accurate magnetic control of plasma positions, shaping, VDE events, magnetic reconnection, etc.



No.	L / μH	R / $\text{m}\Omega$
PF1	421	10.26
PF2	402	9.87
PF3	1047	15.52
PF4	431	7.31
PF5	95	2.46

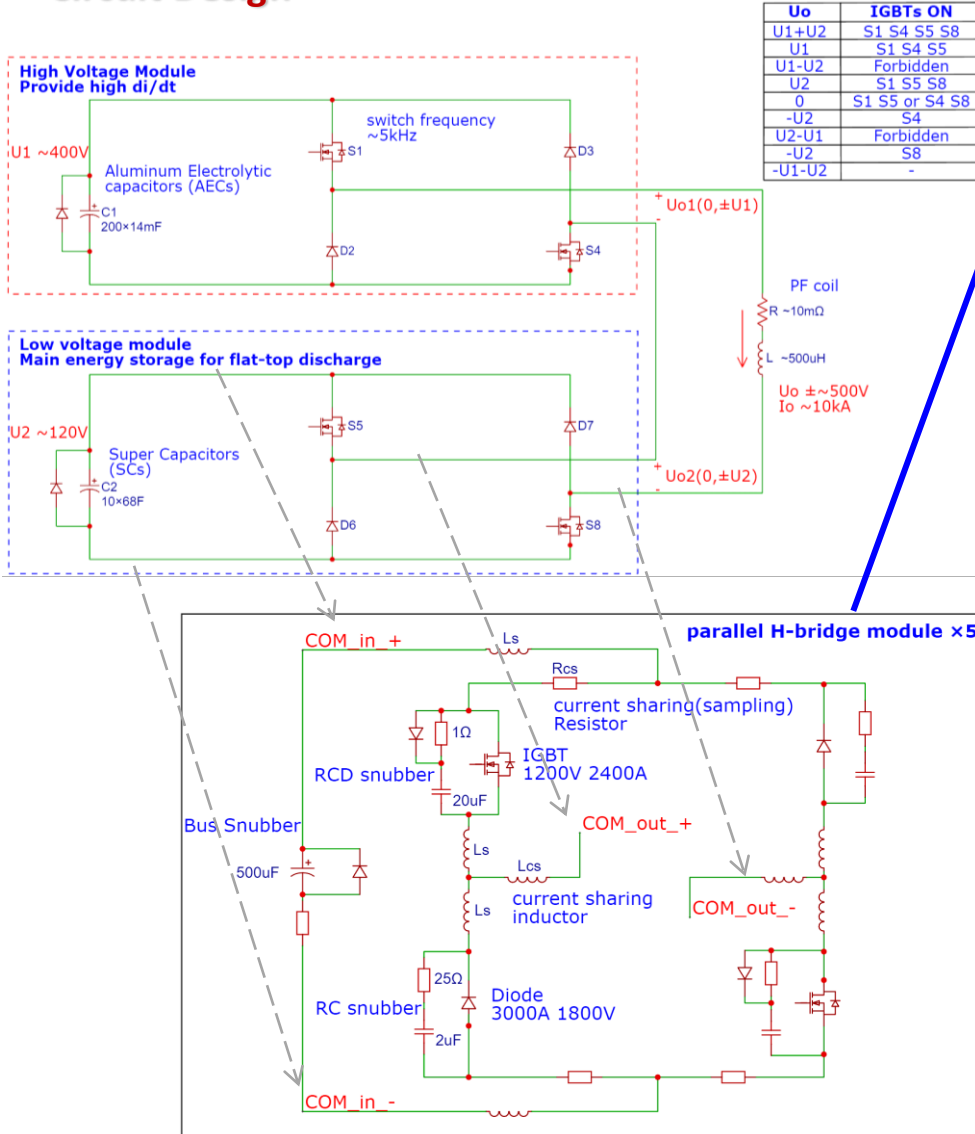
Typical Parameter:

- L ~ 500 μH
- R ~ 10 $\text{m}\Omega$
- Small U and I ripple
- "Affordable"
- ...

Design Goal:

- Flat-top current ~ 10 kA
- $(di/dt)_{\text{max}}$: 1 kA/ms
- Discharge duration ~ 1s

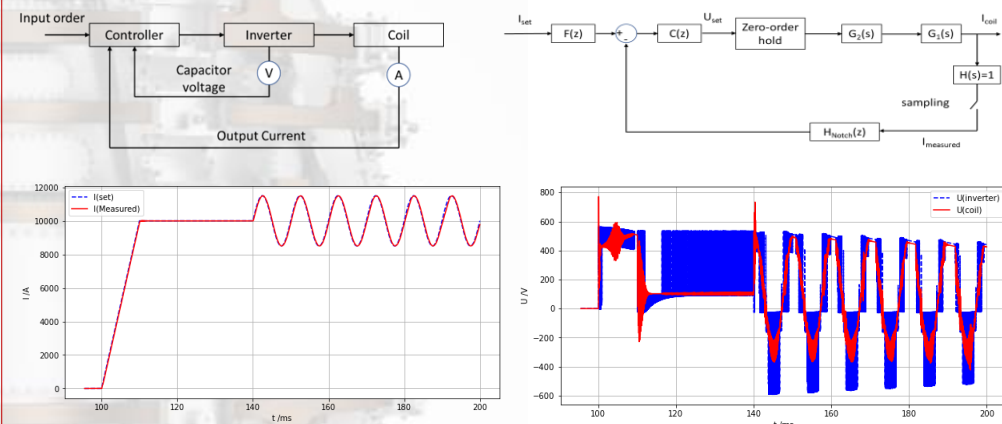
Circuit Design



Technical Characteristics:

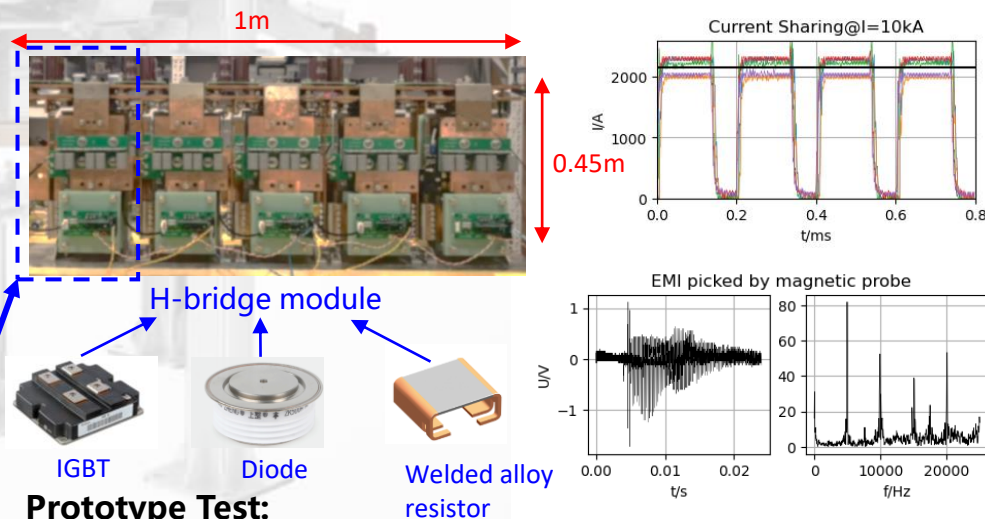
- 2 cascade modular H-bridge with 2 input capacitor banks
- 7 output voltage level, smooth di/dt
- Passive current sharing
- PWM control with current feedback
- Compact and Economic

Control Scheme & Simulation



- Current ripple < 1%
- Bandwidth ~ 500Hz ($f_{\text{v cutoff}} \sim 140\text{Hz}$)

Construction Progress

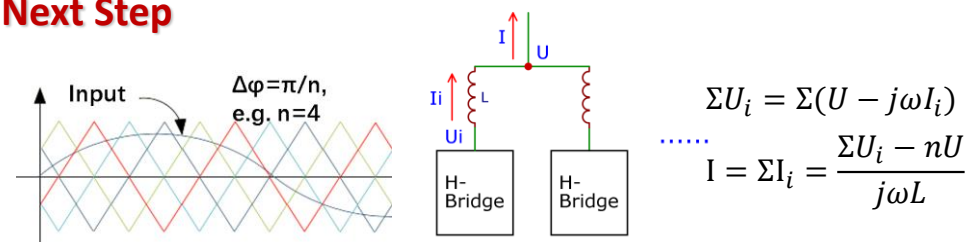


Prototype Test:

- Discharge current 10kA
- Current Sharing@5kHz $(\Delta I/I_{\text{avg}})_{\text{max}} < 10\%$
- Feedback control
- Full test

Finished
Finished
In Progress
In Progress

Next Step



- Adapt **Carrier Phase Shift PWM** control to reduce ripples and eliminate low-order harmonics
- Design suitable protection circuit and EMI shielding to protect switches, coils and sensitive electronics
- Introduce PF power supply into **plasma control and diagnostic systems**

Welcome Discussion!

This work is supported by NSFC under Grant Nos.11827810 and 11875177 and IAEA CRP under Research Contract No. 22733 and the Science Challenge Project, No. TZ2016005

Contact: songzc21@mails.tsinghua.edu.cn