

60kW Dual Active Bridge Converter based on 4-in-1 SiC MOSFET Module for PET Application

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Introduction-Power electronic transformer (PET) has attracted much attention because of its small size and high efficiency. Power device was required to have the good performance of high switching frequency ability and low power loss. This paper introduces the design and test results of 60kW dual active bridge (DAB) converter using 4-in-1 SiC power device.

Introduction of DAB in PET

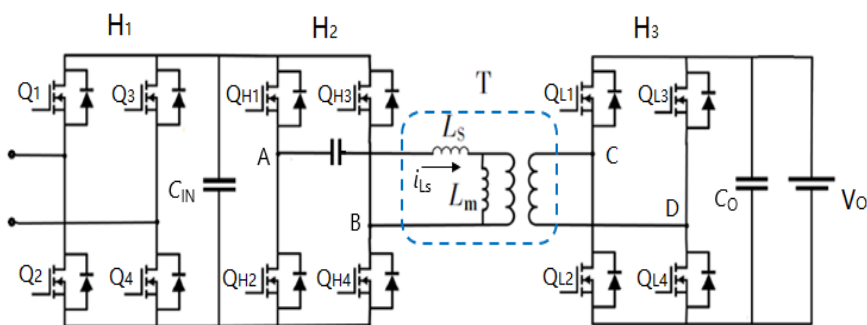


Fig.1 Topology of DAB

H₁ is PWM rectifier circuit; H₂ converts the DC power of C_{IN} into high-frequency AC power and transmits the AC power to H₃ through isolation transformer; Finally DAB output V_o after H₃ rectification.

Table.1 Design target of DAB

Item	target
Power rating	60kW
DC link voltage	750V
Switching frequency (fs)	20kHz
Topology	DAB
Modulation method	single phase shift

Power device selection

- Integrates H bridges topology;
- Built in short circuit protection by virtue of internal real time current control (RTC) circuit.



Fig.2 FMF300BXZ-24B

Power loss calculation

$$P_{con-H2} = \frac{1}{T_s} \int_{t_1}^{t_3} V_{DS} i_L(t) dt \quad (1)$$

$$P_{sw-H2} = f_s \times E_{off} \times \frac{i_L(t_3)}{I_{DN}} \times \frac{U_1}{U_{DSN}} \quad (2)$$

Table.2 Power loss and thermal rise in DAB

Item	FMF300BXZ-24B in H ₂
MOSFET conduction loss	52.7W
MOSFET switching loss	73.66W
SBD conduction loss	7.04W
T _s	85°C
T _{j-ave-MOS}	107°C
T _{j-ave-diode}	92°C

Key points in design

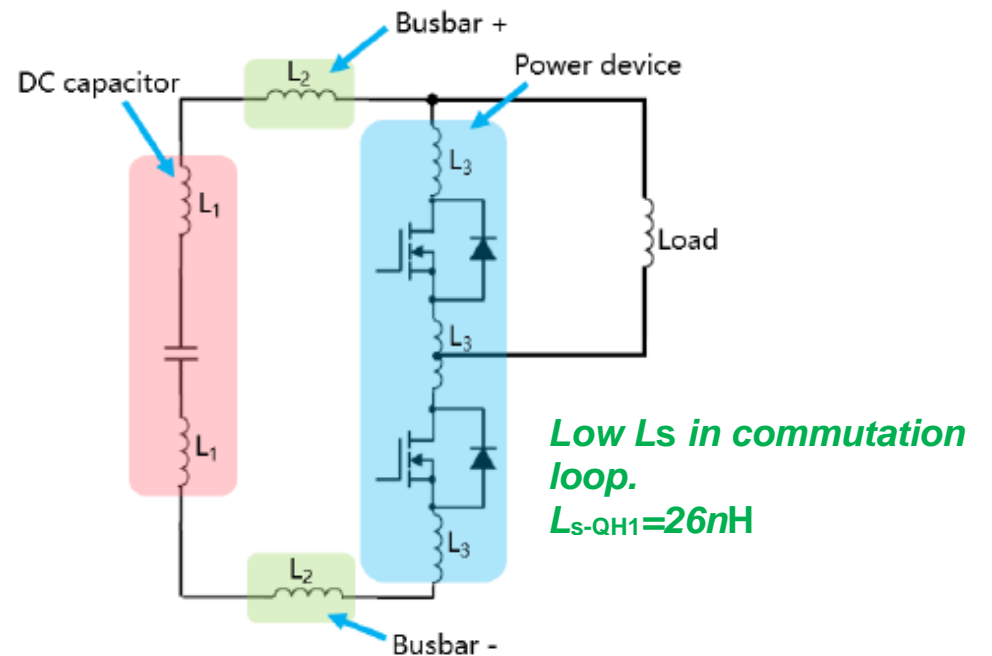


Fig.3 Stray inductance in commutation loop

Table.3 Di/dt and dv/dt

V _{DD} =750V, I _D =300A		R _{g_on} =3.3Ω, C _{GS} =10nF R _{g_off} =10Ω,
Turn on	di/dt	4500 A/us
	dv/dt	13571 V/us
Turn off	di/dt	2472 A/us
	dv/dt	18211 V/us

EMI noise control

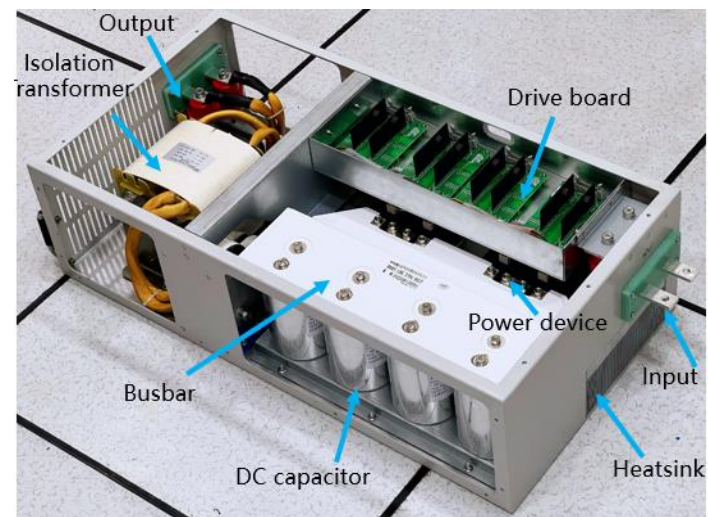


Fig.4 Structure layout of DAB

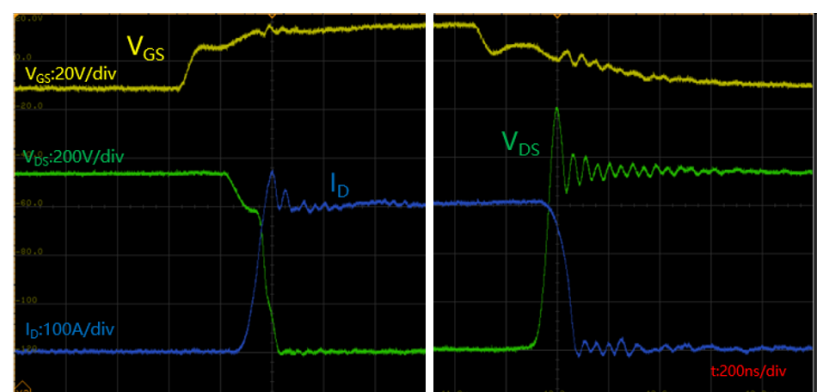


Fig.5 Switching waveforms

Test conditions: V_{DD}=DC750V, I_D=300A, V_{GS}=15V/-10V, R_{Gon}= 3.3 Ω, R_{Goff}=10 Ω, C_{GS}=10nF, Snubber C=2uF, T_a=25°C