

StarPower Semiconductor Ltd.
StarPower Europe AG



Company Introduction



- ❖ Established: on April 27, 2005
- ❖ Campus: 70,700 m²
- ❖ Total employees: 500
- ❖ Revenue in 2018: US\$ 120 million (2017: US\$ 95 million)
- ❖ Locations China: Jiaxing (FAB1, 2 and 3), Shanghai (FAB4)
- ❖ Locations Europe: Nürnberg/ Germany (R&D), Cadenazzo/ Switzerland (Sales HQ)
- ❖ Certificates: [ISO9001](#), [ISO14001](#), [TS16949](#)



Jiaying/ Fab 1

- ❖ Clean Room Area: 1200m²
- ❖ Standard Module Production (600V / 1200V / 1700V)
- ❖ Capacity / Month: 150k pcs.



Jiaying/ Fab 2

- ❖ Clean Room Area: 2000m²
- ❖ L- and F- Types
- ❖ (6-pack, 7-pack, CIB)
- ❖ Capacity / Month:
 - ❖ 100k pcs. (Econo)
 - ❖ 100k pcs. (Easy/ Flow)



Application Test Centre

- ❖ Opened January 2019
- ❖ New lab for reliability testing and module qualification
- ❖ New engineering lab for application based module tests

Automated Module Production



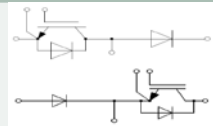
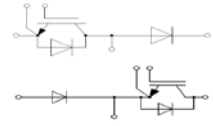
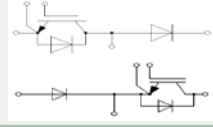
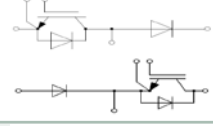
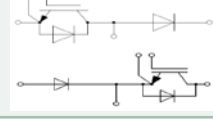
IGBT 1700V Focus Products



	V_{CES} (V)	I_c (A)	$V_{CE(sat)}$ @ $T_j=25^\circ C$ typ. (V)	$(E_{on}+E_{off})$ @ $T_j=125^\circ C$ typ. (mJ)	$R_{th(j-c)}$ K/W	Package Outline	Circuit Topology	Status
GD100HFX170C2S	1700	100	1,85	63,5	0,160	C2.0		Sampling
GD150HFX170C2S	1700	150	1,85	95,0	0,120	C2.0		Sampling
GD200HFX170C2S	1700	200	1,85	142,0	0,099	C2.0		Sampling
GD300HFX170C2S	1700	300	1,85	199,0	0,072	C2.0		Sampling
GD400HFX170C2S	1700	400	1,85	260,0	0,049	C2.0		Sampling
GD400SGX170C2S	1700	400	1,85	260,0	0,055	C2.1		Sampling
GD600SGX170C2S	1700	600	1,85	390,0	0,040	C2.1		Sampling

IGBT 1700V Focus Products



	V_{CES} (V)	I_c (A)	$V_{CE(sat)}$ @ $T_j=25^\circ\text{C}$ typ. (V)	$(E_{on}+E_{off})$ @ $T_j=125^\circ\text{C}$ typ. (mJ)	$R_{th(j-c)}$ K/W	Package Outline	Circuit Topology	Status
GD100CU/CLX170C2S	1700	100	2,00	63,5	0,160	C2.0		Sampling
GD150CU/CLX170C2S	1700	150	2,00	95,0	0,120	C2.0		Sampling
GD200CU/CLX170C2S	1700	200	2,00	142,0	0,099	C2.0		Sampling
GD300CU/CLX170C2S	1700	300	2,00	199,0	0,072	C2.0		Sampling
GD400CU/CLX170C2S	1700	400	2,00	260,0	0,049	C2.0		Sampling

Chopper modules in up and low side version available.

IGBT 1700V Focus Products



	V_{CES} (V)	I_c (A)	$V_{CE(sat)}$ @ $T_j=25^\circ C$ typ. (V)	$(E_{on}+E_{off})$ @ $T_j=125^\circ C$ typ. (mJ)	$R_{th(j-c)}$ K/W	Package Outline	Circuit Topology	Status
GD75FFX170C6S	1700	75	1,85	47,5	0,270	C6.2		Sampling
GD100FFX170C6S	1700	100	1,85	63,5	0,225	C6.2		Sampling
GD150FFX170C6S	1700	150	1,85	84,9	0,188	C6.2		Sampling
GD100FFX170C6SF	1700	100	1,85	63,5	0,225	C6.8 pressfit		Sampling
GD150FFX170C6SF	1700	150	1,85	84,9	0,188	C6.8 pressfit		Sampling
GD50PIX170C6S	1700	50	2,00	31,5	0,382	C6.0		Sampling
GD75PIX170C6S	1700	75	2,00	47,5	0,286	C6.0		Sampling

IGBT 1700V Focus Products



	V_{CES} (V)	I_c (A)	$V_{CE(sat)}$ @ $T_j=25^\circ\text{C}$ typ. (V)	$(E_{on}+E_{off})$ @ $T_j=125^\circ\text{C}$ typ. (mJ)	$R_{th(j-c)}$ K/W	Package Outline	Circuit Topology	Status
GD450HFX170P1S	1700	450	1,85	300	0,054	P1.0		Sampling
GD650HFX170P1S	1700	650	1,85	500	0,036	P1.0		Sampling
GD1000HFX170P2S	1700	1000	1,85	700	0,024	P2.0		Sampling
GD1400HFX170P2S	1700	1400	1,85	1074	0,174	P2.0		Sampling
GD450CU/CLX170P1S	1700	450	2,00	300	0,054	P1.0		Sampling
GD650CU/CLX170CP1S	1700	650	2,00	500	0,036	P1.0		Sampling
GD1000CU/CLX170P2S	1700	1000	2,00	700	0,024	P2.0		Sampling

Chopper modules in up and low side version available.

IGBT 1700V Focus Products



	V_{CES} (V)	I_c (A)	$V_{CE(sat)}$ @ $T_j=25^\circ C$ typ. (V)	$(E_{on}+E_{off})$ @ $T_j=125^\circ C$ typ. (mJ)	$R_{th(j-c)}$ K/W	Package Outline	Circuit Topology	Status
GD800SGX170C3SN	1700	800A	1,85	530	0,026	C3.2		Development
GD1200SGX170C3SN	1700	1200A	1,85	780	0,017	C3.2		Development
GD1600SGX170C3SN	1700	1600A	1,85	1030	0,014	C3.2		Development
GD2400SGX170C3SN	1700	2400A	1,85	1515	0,010	C3.2		Development
GD2400SGX170C4S	1700	2400A	1,85	1515	0,009	C4.0		Development
GD3600SGX170C4S	1700	3600A	1,85	2225	0,007	C4.0		Development

IGBT 1700V Focus Products



	V_{CES} (V)	I_c (A)	$V_{CE(sat)}$ @ $T_j=25^\circ C$ typ. (V)	$(E_{on}+E_{off})$ @ $T_j=125^\circ C$ typ. (mJ)	$R_{th(j-c)}$ K/W	Package Outline	Circuit Topology	Status
GD600HFX170C3S	1700	600A	1,85	405	0,034	C3.1		Development
GD800HFX170C3S	1700	800A	1,85	535	0,028	C3.1		Development
GD1200HFX170C3S	1700	1200A	1,85	795	0,021	C3.1		Development
GD600CU/CLX170C3S	1700	600A	2,00	405	0,034	C3.1		Development
GD800CU/CLX170C3S	1700	800A	2,00	535	0,028	C3.1		Development
GD1200CU/CLX170C3S	1700	1200A	2,00	795	0,021	C3.1		Development

Chopper modules in up and low side version available.

1200V NPT-IGBT

In Volume production since 2012

1200V FS-IGBT

In Volume production since 2016

650V FS-IGBT

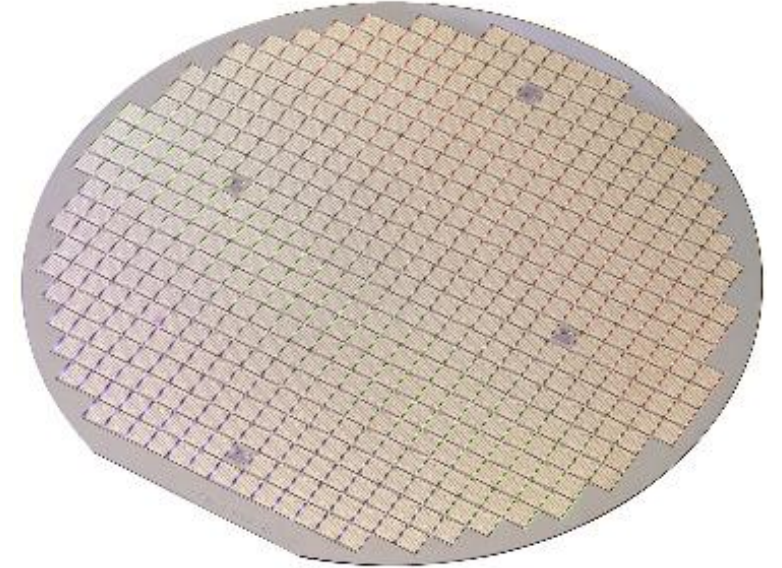
In Volume production since 2017

750V / FS-IGBT

In Volume production since Q1 2019

1700V FS-IGBT

Qualified Q1 2019, volume production started

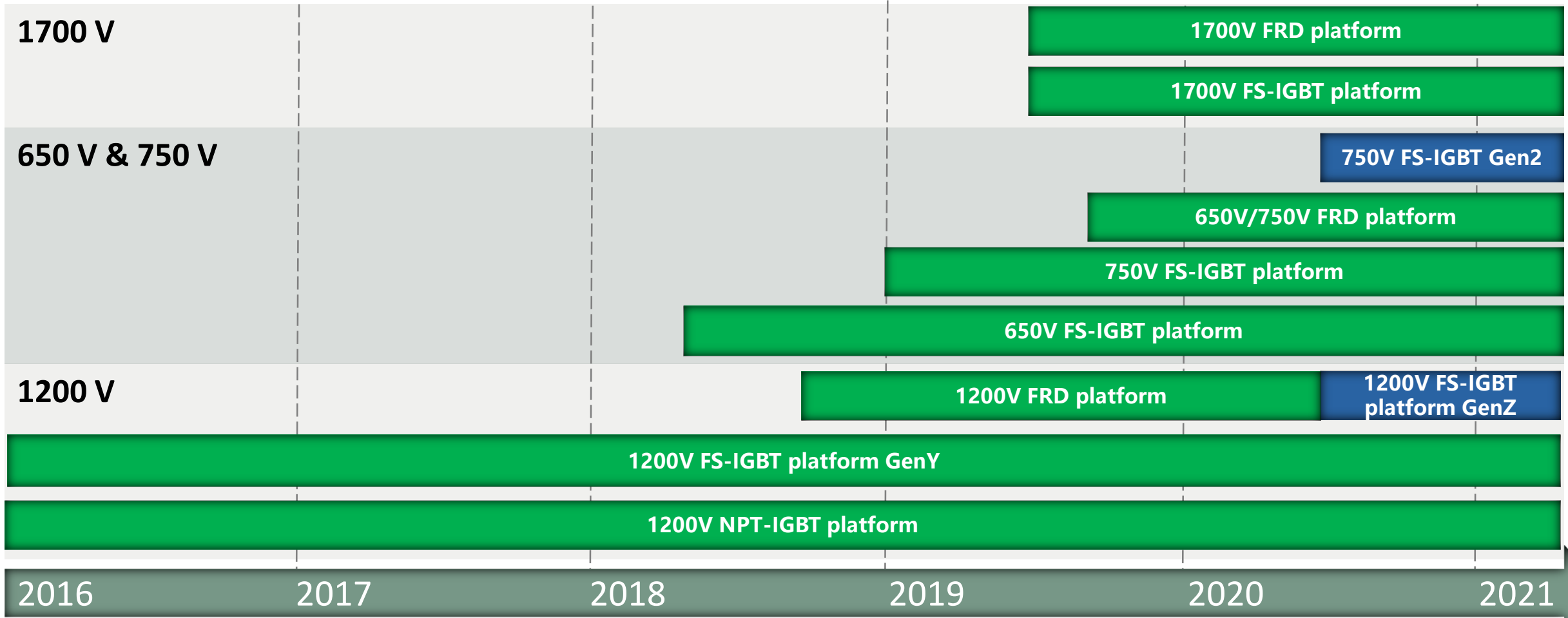


Trench FS-IGBT & FRD Roadmap



Roadmap: Develop a wide range of Power IGBT and FRD platforms, to supply all StarPower IGBT module requirements.

Future Platforms	Platforms under development
	In Production



❖ Silicon spec

- ❖ Trench FS IGBT
- ❖ Wafer thickness 190 μm
- ❖ Backside activation: laser anneal

❖ Features

- ❖ Trench cell constructions are the same as 1200V
- ❖ Added W plug for better planarity and therefore better power cycling capability

❖ Characteristics

- ❖ Good V_{cesat} vs E_{ts} tradeoff, lower power loss expected than competitors
- ❖ Square RBSOA @ $2 \times I_c$
- ❖ T_{jmax} of 175C
- ❖ Positive temperature coefficient for easy paralleling

Part number	Current (A)	Starpower die dimensions (mm)	Starpower die area (mm²)
SGC50T170M1000	50A	7.86 x 7.846	61.67
SGC75T170M1000	75A	9.38 x 9.366	87.85
SGC100T170M1000	100A	10.69 x 10.696	114.34
SGC150T170M1000	150A	13.47 x 12.49	168.24
SGC200T170M1000	200A	18.4 x 12.026	221.28

Parametric comparison on C2 module platform

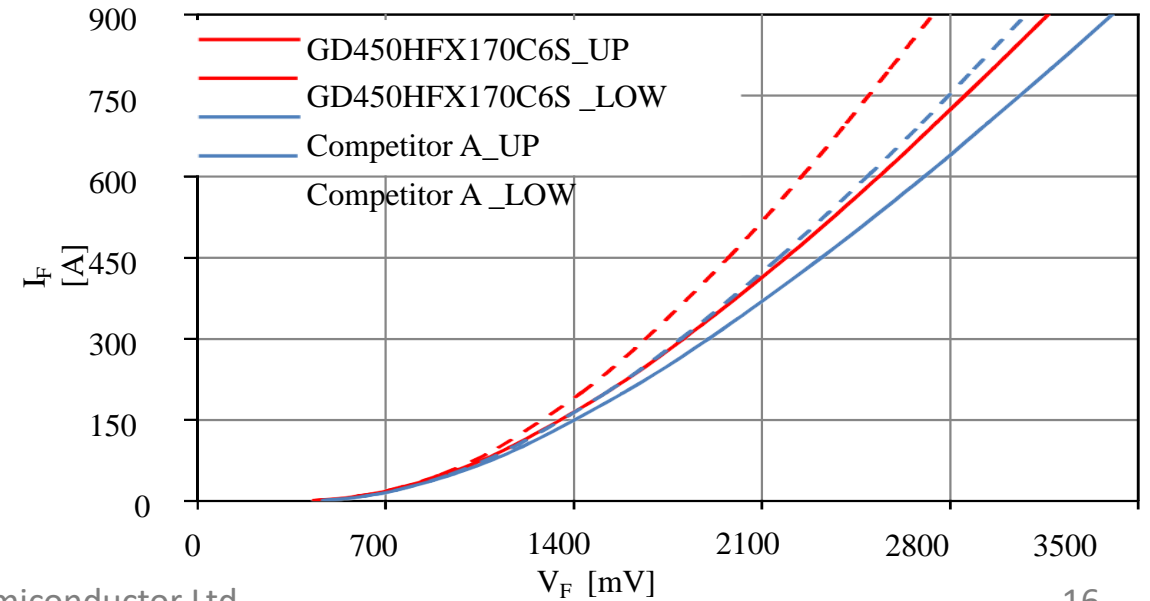
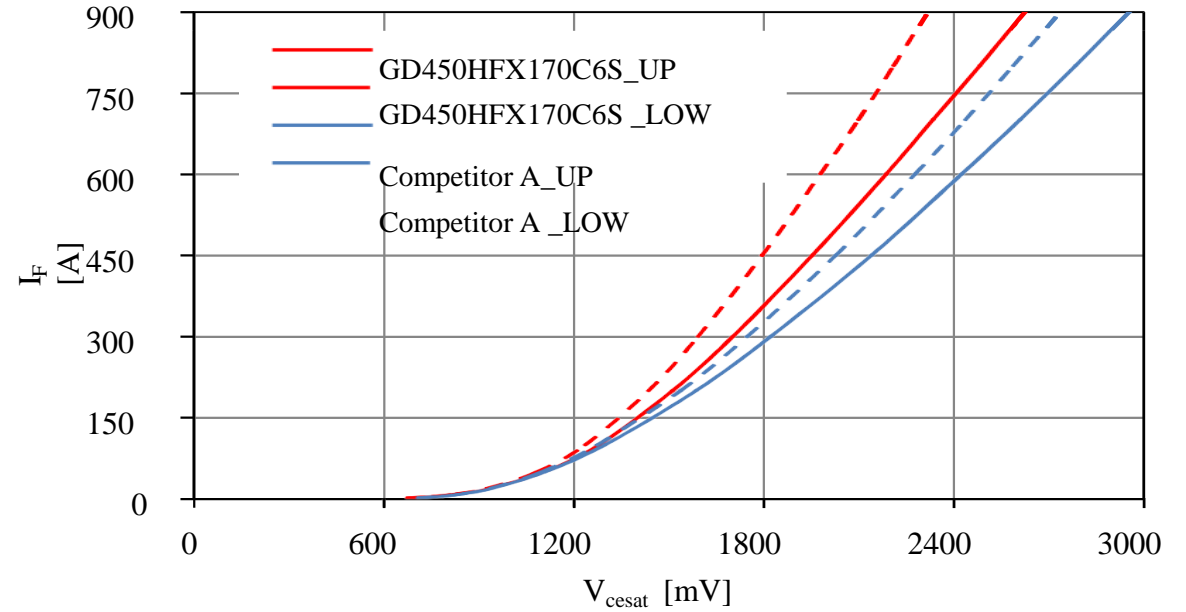


Main Parameters (25°C)	Competitor A (150A module)	Starpower (150A module)
B_{vces} (V)	>1700V	750V
V_{th} (V)	5-6.5 V	6.0 V
V_{cesat} (V)	2.06 V	1.96 V
E_{on} (mJ)	44.6 mJ	60.4 mJ
E_{off} (mJ)	25.9 mJ	30.4 mJ
Short Circuit Time	> 10us @ 150°C 900V	> 10us @ 150°C 900V
RBSOA	> 2 x rated	> 2 x rated

Parametric comparison on C6.1 module platform



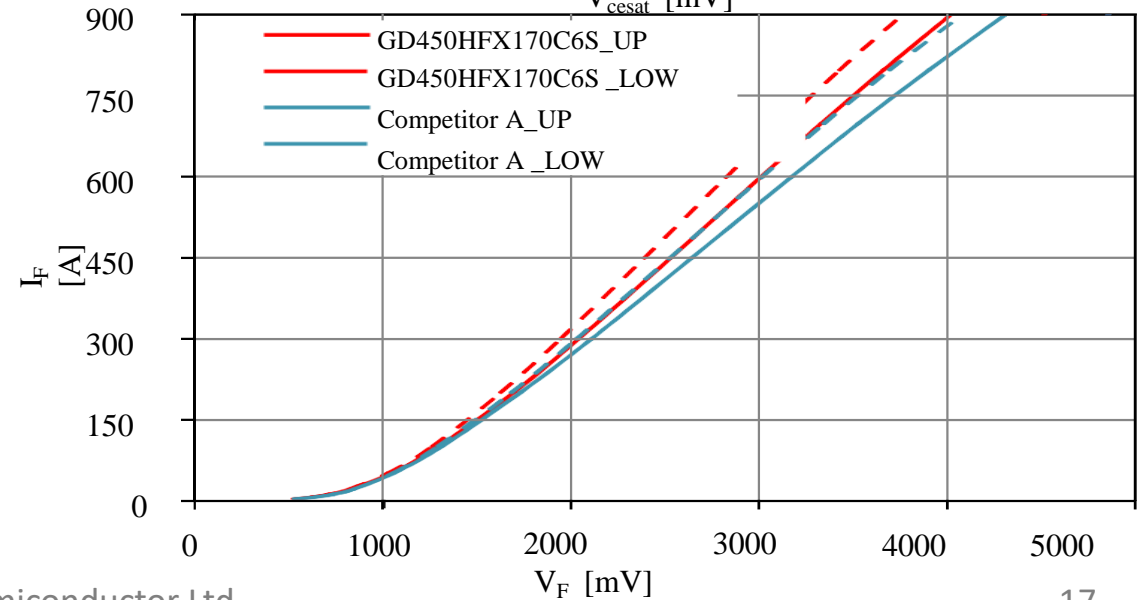
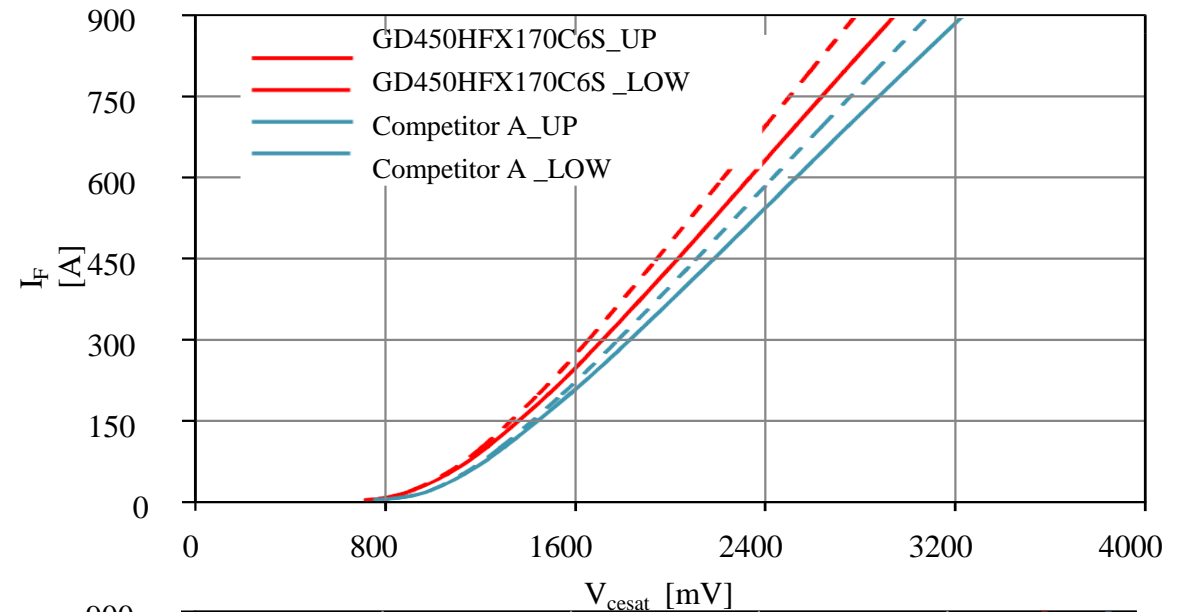
DC Performance (25°C)	Competitor A (450A module)	Starpower (GD450HFX170C6S)
$I_c = 450A, V_{ge} = 15V$ or $I_f = 450A, V_{ge} = 0V, UP$		
V_{cesat} (V)	2.265 V	2.103 V
V_f (V)	2.140 V	1.953 V
$I_c = 450A, V_{ge} = 15V$ or $I_f = 450A, V_{ge} = 0V, LOW$		
V_{cesat} (V)	2.188 V	2.011 V
V_f (V)	2.028 V	1.796 V



Parametric comparison on C6.1 module platform



DC Performance (150°C)	Competitor A (450A module)	Starpower (GD450HFX170C6S)
$I_c = 450A, V_{ge} = 15V$ or $I_f = 450A, V_{ge} = 0V, UP$		
V_{cesat} (V)	2.766 V	2.644 V
V_f (V)	2.320 V	2.188 V
$I_c = 450A, V_{ge} = 15V$ or $I_f = 450A, V_{ge} = 0V, LOW$		
V_{cesat} (V)	2.639 V	2.493 V
V_f (V)	2.161 V	1.974 V



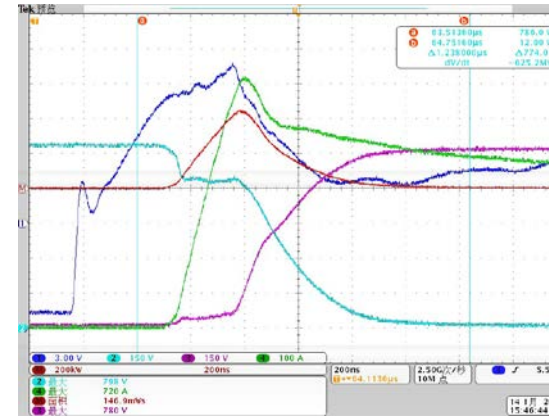
Parametric comparison on C6.1 module platform



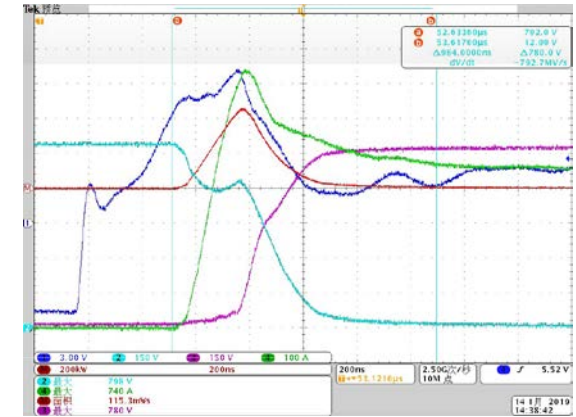
Turn-on (25°C)	Competitor A (450A module)	Starpower (GD450HFX170C6S)
$V_{cc} = 800V, I_c = 450A, R_{gon} = 3.0 \text{ Ohm}, V_{ge} = -8/+15V, UP$		
di/dt_{on} (A/us)	4127 A/us	3102 A/us
I_p (A)	740 A	720 A
E_{on} (mJ)	115.3 mJ	146.9 mJ
$V_{cc} = 800V, I_c = 450A, R_{gon} = 3.0 \text{ Ohm}, V_{ge} = -8/+15V, LOW$		
di/dt_{on} (A/us)	2996 A/us	2387 A/us
I_p (A)	692 A	668 A
E_{on} (mJ)	135.4 mJ	172.7 mJ

25° turn-on (high side)

GD450HFX170C6S

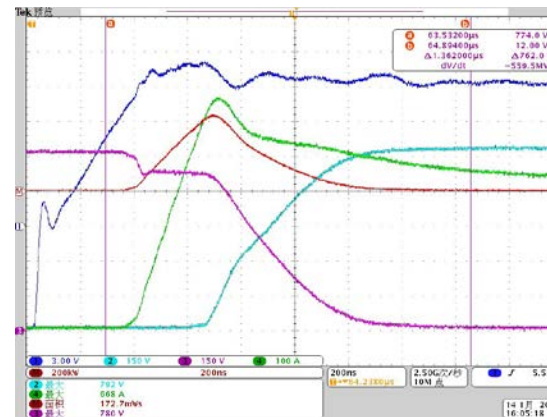


Competitor A

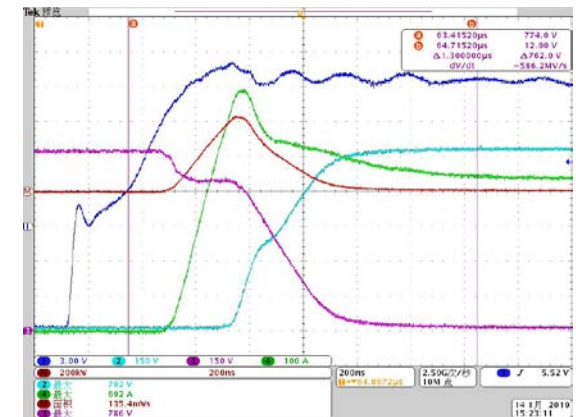


25° turn on (low side)

GD450HFX170C6S



Competitor A



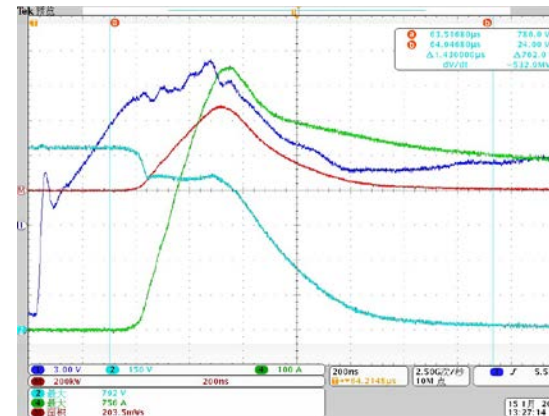
Parametric comparison on C6.1 module platform



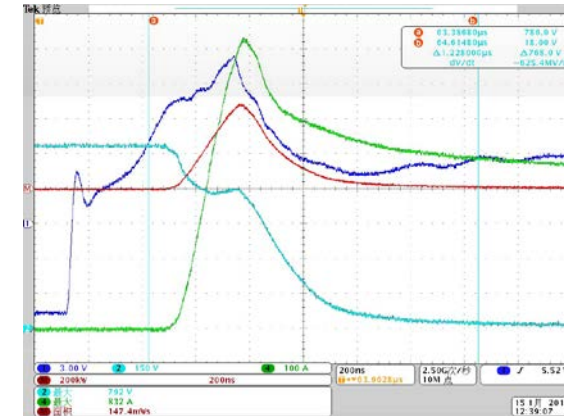
Turn-on (150°C)	Competitor A (450A module)	Starpower (GD450HFX170C6S)
$V_{CC} = 800V, I_c = 450A, R_{gon} = 3.0 \text{ Ohm}, V_{ge} = -8/+15V, UP$		
di/dt_{on} (A/us)	4181 A/us	2633 A/us
I_p (A)	832 A	756 A
E_{on} (mJ)	147.4 mJ	203.5 mJ
$V_{CC} = 800V, I_c = 450A, R_{gon} = 3.0 \text{ Ohm}, V_{ge} = -8/+15V, LOW$		
di/dt_{on} (A/us)	2921 A/us	1893 A/us
I_p (A)	732 A	704 A
E_{on} (mJ)	197.5 mJ	253.2 mJ

150° turn-on (high side)

GD450HFX170C6S

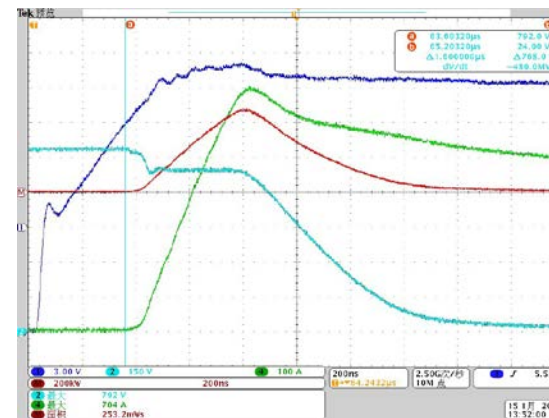


Competitor A

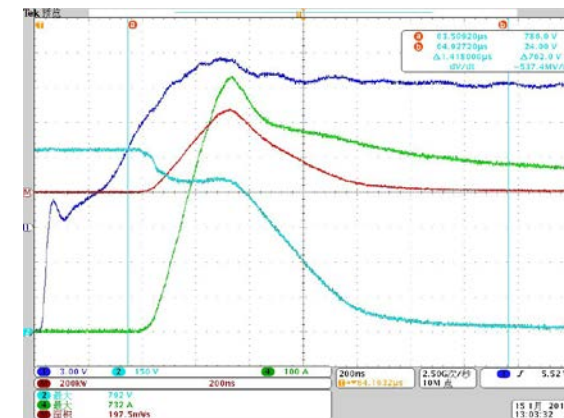


150° turn on (low side)

GD450HFX170C6S



Competitor A

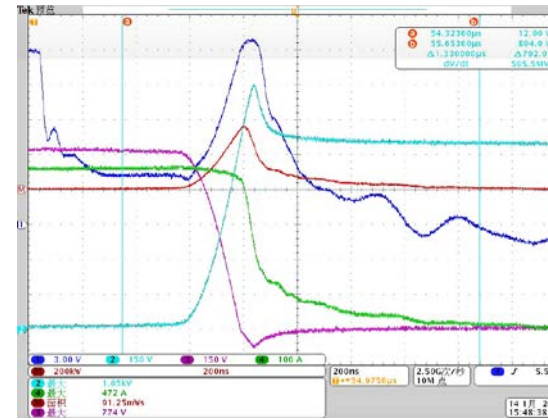


Parametric comparison on C6.1 module platform

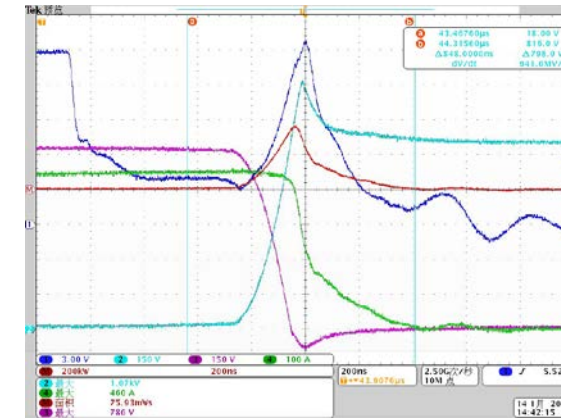


25° turn-off (high side)

GD450HFX170C6S

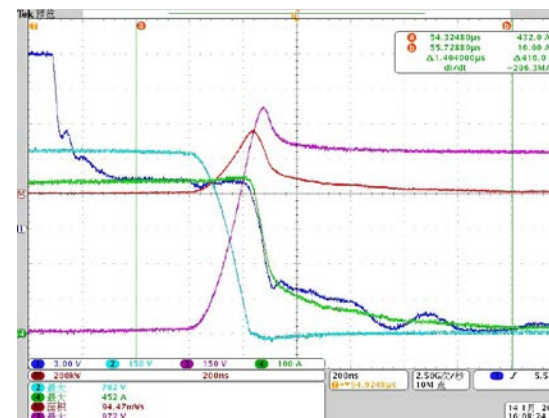


Competitor A

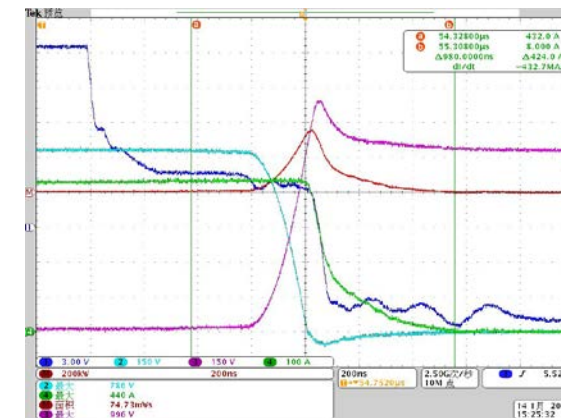


25° turn off (low side)

GD450HFX170C6S



Competitor A



Turn-off
(25°C)

Competitor A
(450A module)

Starpower
(GD450HFX170C6S)

$V_{cc} = 800V, I_c = 450A, R_{goff} = 3.0 \text{ Ohm}, V_{ge} = -8/+15V, UP$

di/dt_{off} (A/us)

4870 A/us

4870 A/us

di/dt_{off} (V/us)

6766 V/us

5647 V/us

V_p (V)

1070 V

1050 V

E_{off} (mJ)

75.93 mJ

91.25 mJ

$V_{cc} = 800V, I_c = 450A, R_{goff} = 3.0 \text{ Ohm}, V_{ge} = -8/+15V, LOW$

di/dt_{off} (A/us)

3791 A/us

4211 A/us

di/dt_{off} (V/us)

5585 V/us

5445 V/us

V_p (V)

996 V

972 V

E_{off} (mJ)

74.73 mJ

94.47 mJ

Parametric comparison on C6.1 module platform



Turn-off
(150°C)

Competitor A
(450A module)

Starpower
(GD450HFX170C6S)

$V_{cc} = 800V, I_c = 450A, R_{goff} = 3.0 \text{ Ohm}, V_{ge} = -8/+15V, UP$

di/dt_{off} (A/us)

2000 A/us

3500 A/us

di/dt_{off} (V/us)

4353 V/us

4632 V/us

V_p (V)

984 V

1010 V

E_{off} (mJ)

130.7 mJ

129.1 mJ

$V_{cc} = 800V, I_c = 450A, R_{goff} = 3.0 \text{ Ohm}, V_{ge} = -8/+15V, LOW$

di/dt_{off} (A/us)

2047 A/us

3163 A/us

di/dt_{off} (V/us)

4385 V/us

4476 V/us

V_p (V)

972 V

990 V

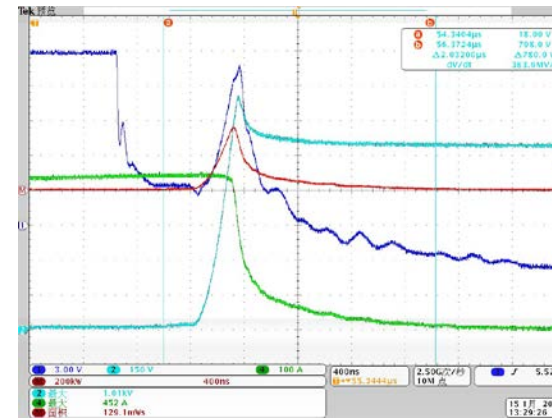
E_{off} (mJ)

132.8 mJ

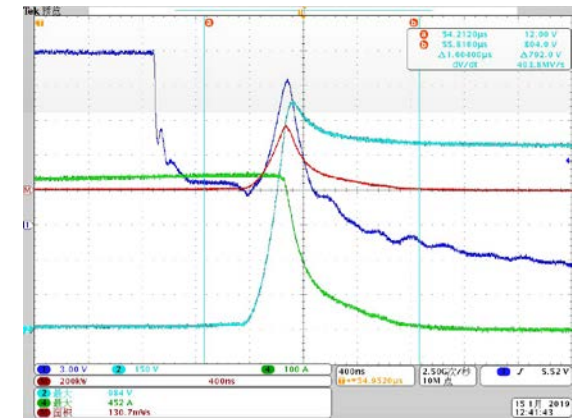
135.0 mJ

150° turn-off (high side)

GD450HFX170C6S

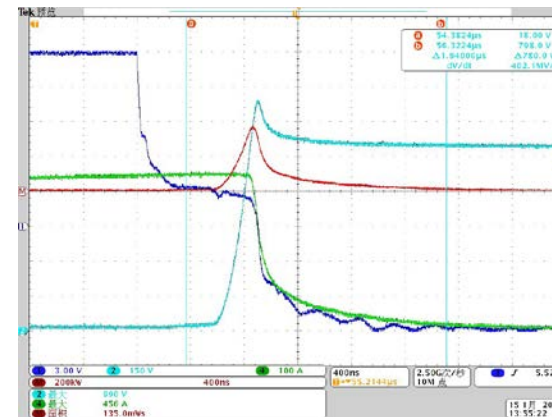


Competitor A

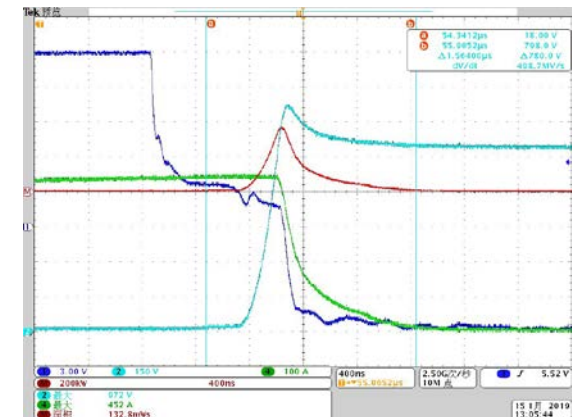


150° turn off (low side)

GD450HFX170C6S



Competitor A



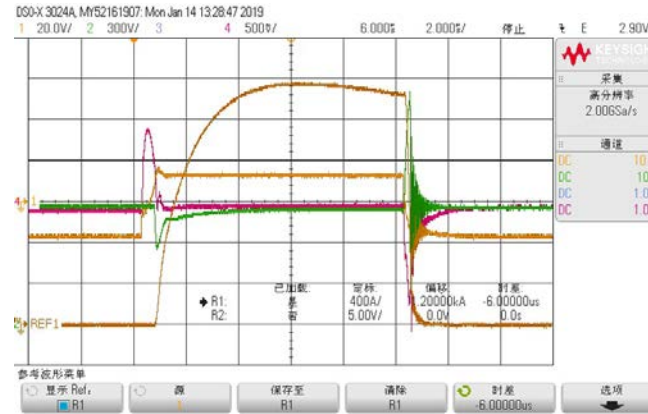
Parametric comparison on C6.1 module platform



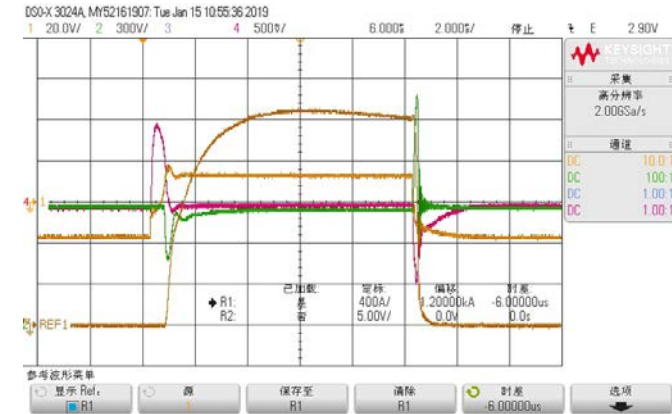
25° short-circuit (high side)

Short circuit (25°C)	Competitor A (450A module)	Starpower (GD450HFX170C6S)
$V_{cc} = 900V, t_p = 10\mu s, R_g = 2.7 \text{ Ohm}, V_{ge} = +/-15V, UP$		
I_p (A)	2080 A	2320 A
V_p (V)	1680 V	1695 V
$V_{cc} = 900V, t_p = 10\mu s, R_g = 2.7 \text{ Ohm}, V_{ge} = +/-15V, LOW$		
I_p (A)	1960 A	2120 A
V_p (V)	1410 V	1350 V

GD450HFX170C6S

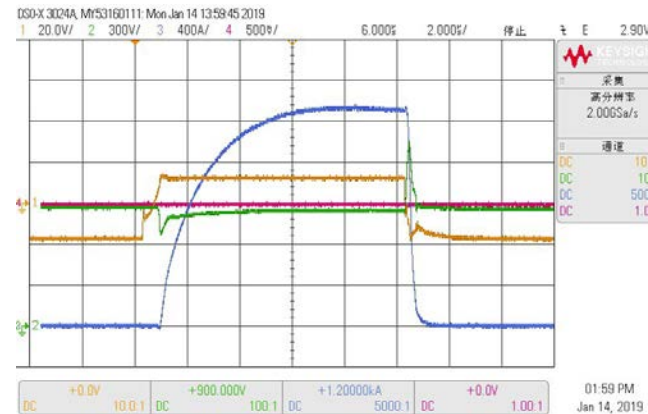


Competitor A

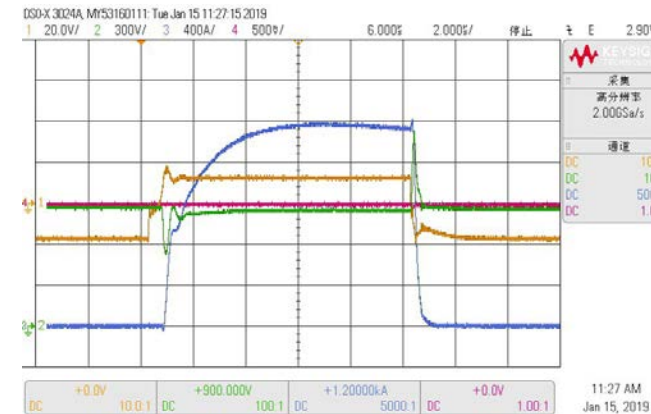


25° short-circuit (low side)

GD450HFX170C6S



Competitor A

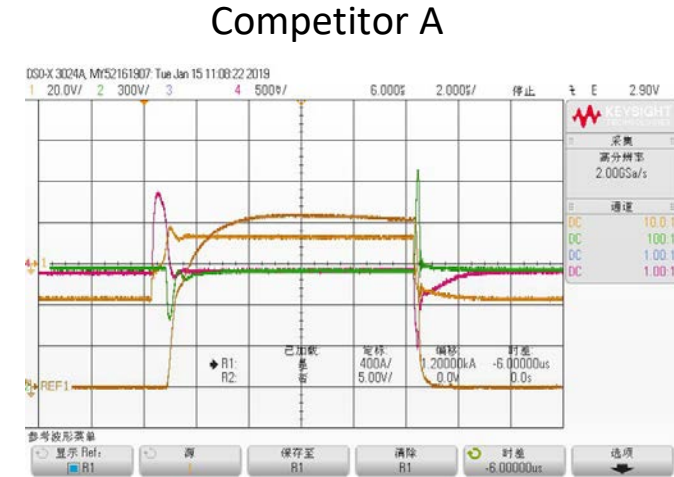
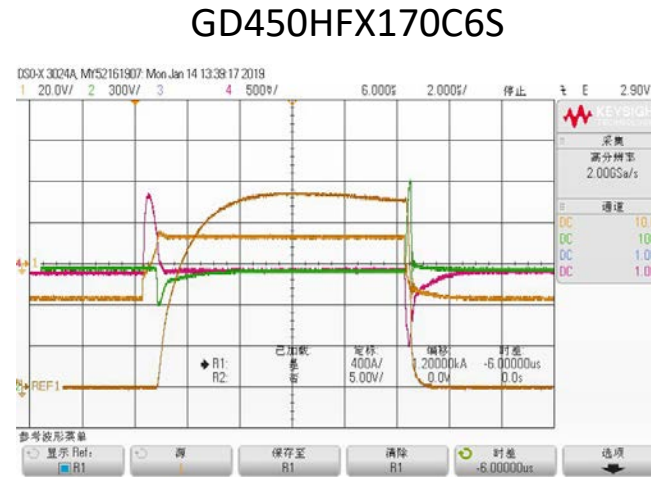


Parametric comparison on C6.1 module platform

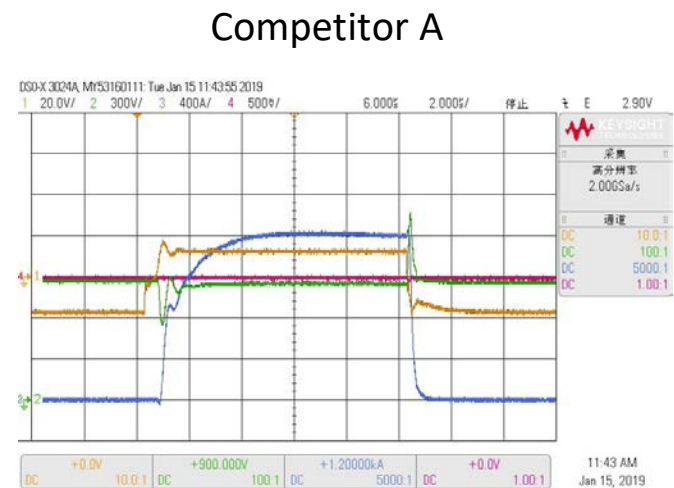
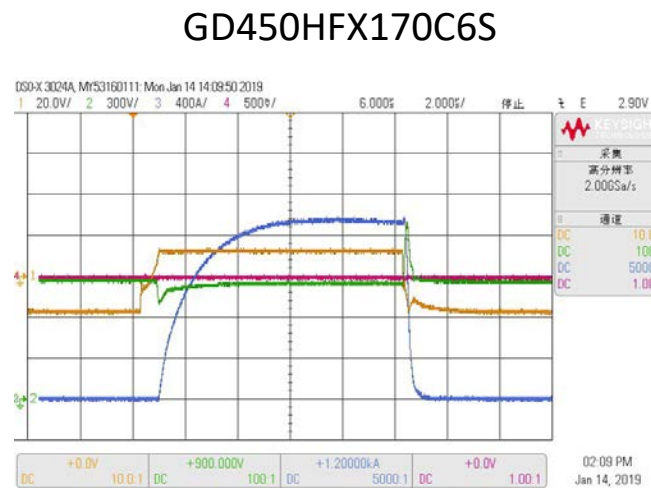


Short circuit (150°C)	Competitor A (450A module)	Starpower (GD450HFX170C6S)
$V_{cc} = 900V, t_p = 10\mu s, R_g = 2.7 \text{ Ohm}, V_{ge} = +/-15V, UP$		
I_p (A)	1680 A	1880 A
V_p (V)	1566 V	1500 V
$V_{cc} = 900V, t_p = 10\mu s, R_g = 2.7 \text{ Ohm}, V_{ge} = +/-15V, LOW$		
I_p (A)	1600 A	1752 A
V_p (V)	1350 V	1290 V

150° short-circuit (high side)



150° short-circuit (low side)



Reliability test equipment



HTRB/HTGS



THB



Power Cycling



Low Temperature Storage



High Temperature Storage



Thermal Cycling



Vibration

Qualification tests



Test	Parameter set	Standard
HTS	$T_a=140\pm 5^\circ\text{C}$ ($T_{j\text{max}} = 175^\circ\text{C}$) 1000h	
LTS	$T_a=-40^\circ\text{C}$ 168h	acc.3K3 EN60068-2-1
HTRB	$T_j=150\pm 2^\circ\text{C}$ ($T_{j\text{max}} = 175^\circ\text{C}$) $V_{ce}=0.8*V_{ce}(\text{max})$, 1000h	EN60747-9 (chip qualification)
HTGS	$T_j=150\pm 2^\circ\text{C}$ ($T_{j\text{max}} = 175^\circ\text{C}$) $V_{ge}=20\text{V}$, 1000h	EN60747-9 (chip qualification)
H3TRB	$T=85\pm 2^\circ\text{C}$ H: $85\pm 5\%$, $V_{ce}=80\%V_{ce}(\text{max})$, 168h (Standard) (1000h) internal	acc.to 60068-2-67 EN60749-5
TWT	$-40\pm 5^\circ\text{C} \dots 125\pm 5^\circ\text{C}$ 200 cycles, each 45min	EN60747-9
Vibration	5g, 10Hz-500Hz, 26sweeps, 3h	EN60068-2-6
Shock	30g, 6 directions, 100x per direction	EN60068-2-29Eb
PC	$\Delta T=110^\circ\text{C}$ @ $T_j=150^\circ\text{C}$	EN60749-34



Dream is driven by quality



Thank you