



Introduction of CRRC IGCT Products

Zhuzhou CRRC Times Semiconductor Co., Ltd.

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IGCT Products & Technology

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Features of IGCT Products

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IGCT Manufacturing & QC

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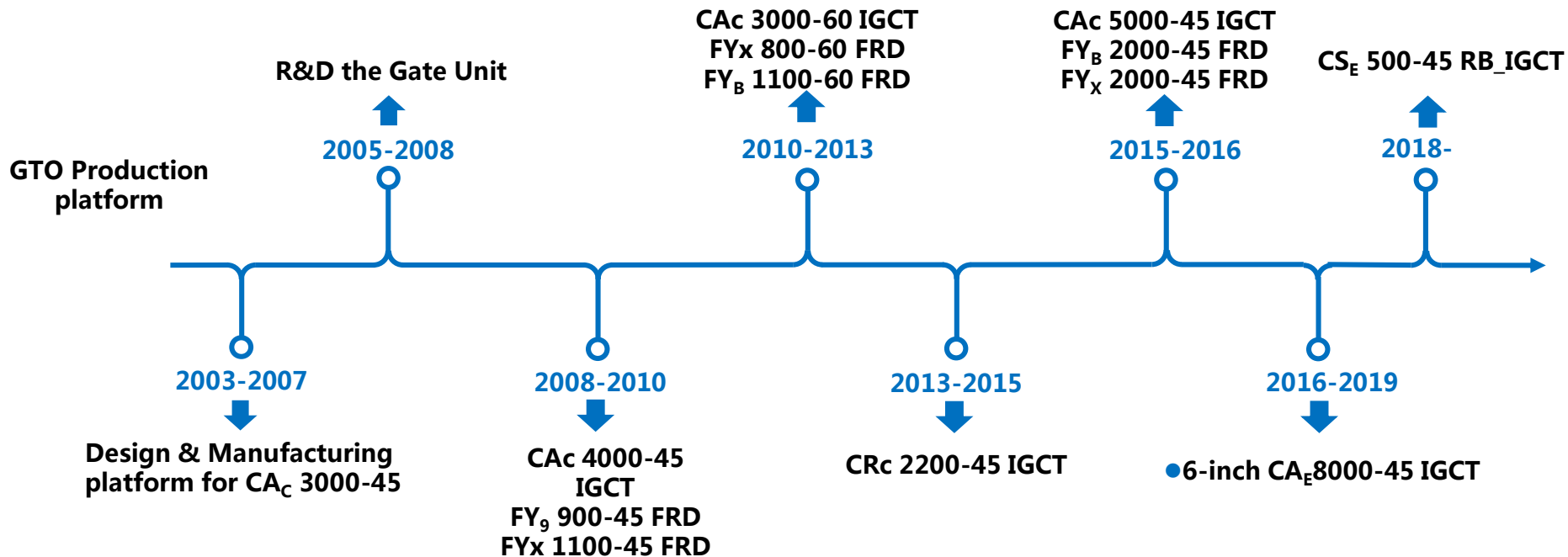
IGCT Application reference

Part 5

Prospects in 5 years

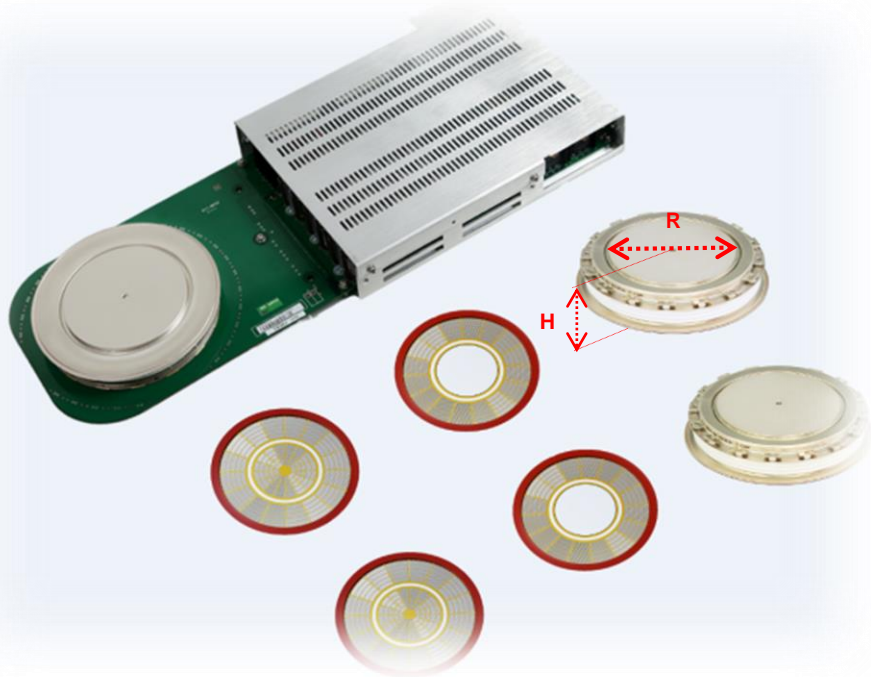
Part 1 IGCT Products & Technology

1.1 Products development milestone



Part 1 IGCT Products & Technology

1.2 IGCT products series



IGCT/GCT outline

Asymmetric Type	Package (mm)	Remark
CA _c 4000-45-01	85/26	Standard, Commercialization
CA _c 4000-45-02	85/26	LF application, Commercialization
CA _c 3000-60	85/26	
CA _c 5000-45	85/26	Released in 2017

Reverse Conducting Type	Package (mm)	Remark
CR _c 2200-45	85/26	

* Pole Diameter (D) /Case Height (H)

Part 1 IGCT Products & Technology

1.3 FRD products series

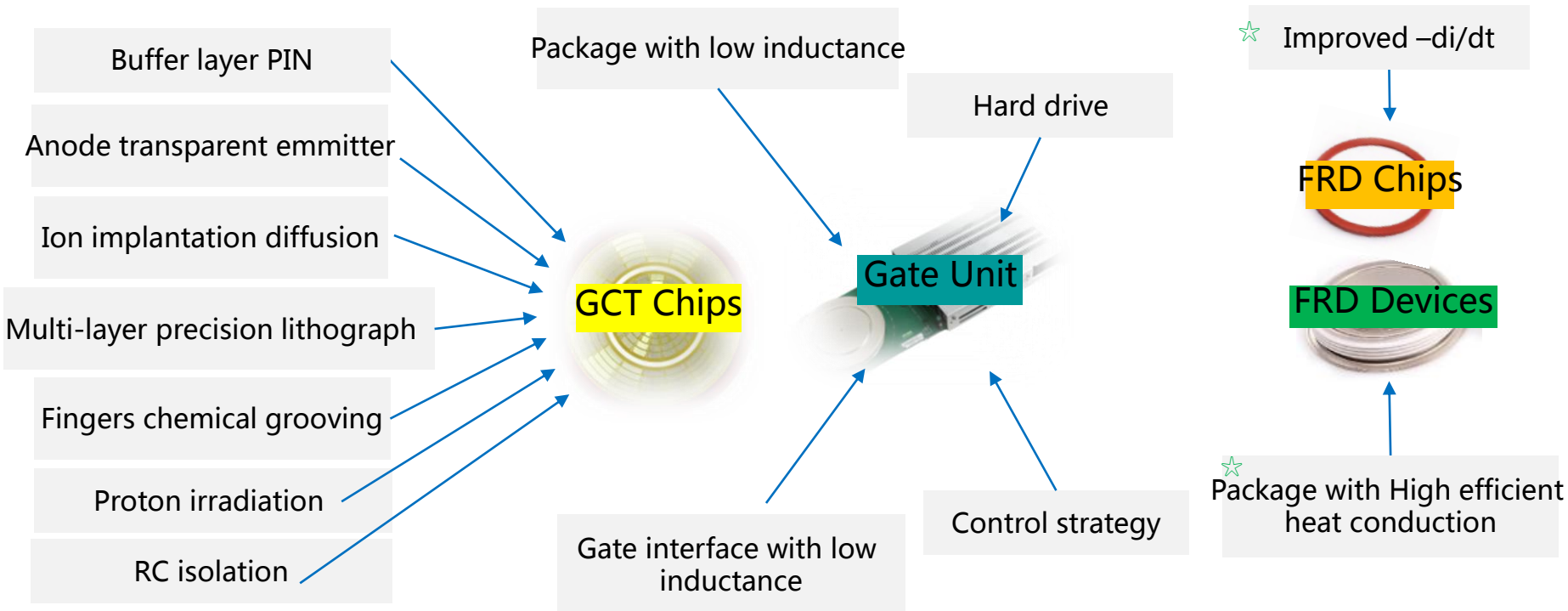
FRD TYPE (Free Floating)	Package (mm)	Remark
FY ₉ 600-45	47/26	Commercialization
FY _x 900-45	63/26	Commercialization
FY _x 1100-45	73/26	Commercialization
FY _x 800-60	73/26	Commercialization
FY _B 1100-60	84/26	Commercialization
FY _B 2000-45	84/26	Released in 2017



FRD outline

Part 1 IGCT Products & Technology

1.4 IGCT & FRD technologies



“★” Chinese invention patent is authorized12

“☆” Enterprise technical secret

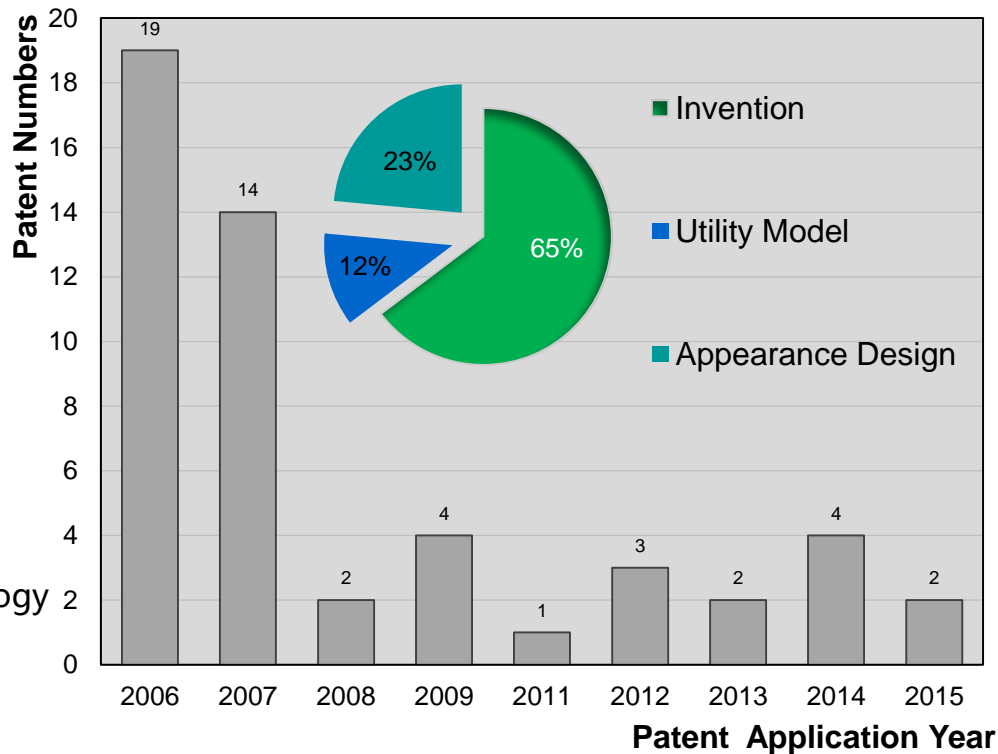
Part 1 IGCT Products & Technology

1.4 IGCT & FRD technologies (continued)

- Numbers: 51 patents applied by December 2015

Now there are 42 patents authorized, including 20 invention patents and 8 utility model patents.

- Type: Chinese invention patents
- Scope: Chip structure design, crucial process technology



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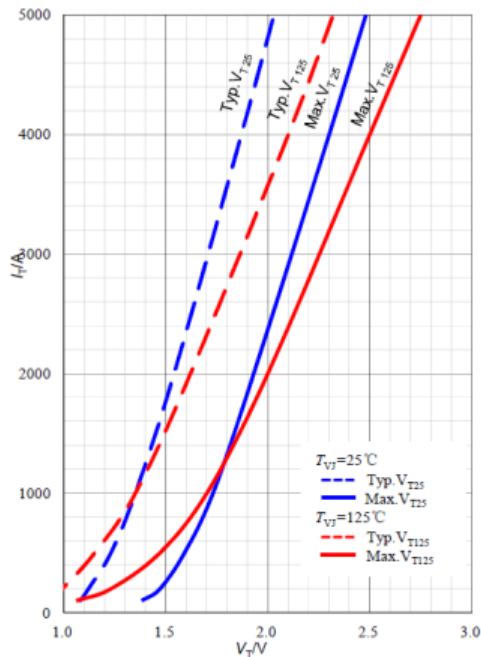
Part 2 Features of IGCT products

2.1 Key parameters of IGCT

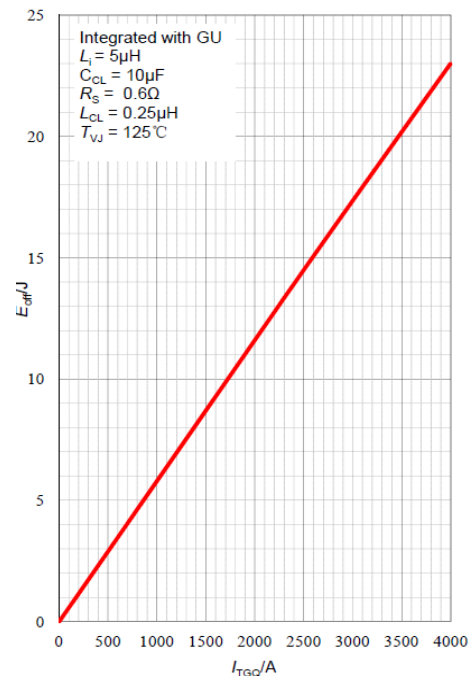


Standard CA_C 4000-45

- $V_{DRM} = 4500$ V
- $I_{GT} \leq 600$ mA
- $V_{TM} \leq 2.5$ V @ 4000 A
- 3200V @5s
- $I_{TGQM} = 4000$ A
- $E_{OFF} \leq 23$ J
- $I_{TSM} = 32$ kA



On-state voltage characteristics



Turn-off energy per pulse vs. turn-off current

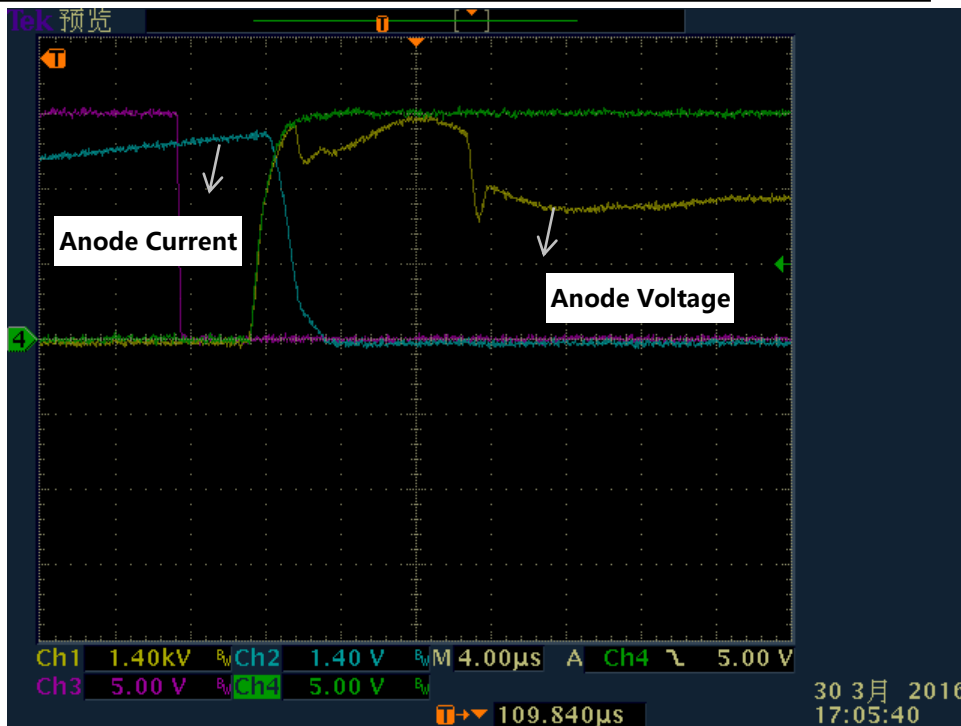
Part 2 Features of IGCT products

2.1 Key parameters of IGCT (continued)



Standard CA_C4000-45

- $V_{\text{DRM}} = 4500 \text{ V}$
- $I_{\text{GT}} \leq 600 \text{ mA}$
- $V_{\text{TM}} \leq 2.5 \text{ V @ } 4000 \text{ A}$
- 3200V @5s
- $I_{\text{TGQM}} = 4000 \text{ A}$
- $E_{\text{OFF}} \leq 23 \text{ J}$
- $I_{\text{TSM}} = 32\text{kA}$



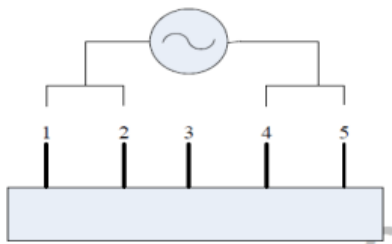
Single pulse turn-off wave form of $I_{\text{TQGM}} = 4000\text{A@}2800\text{V}$ at 125°C

Part 2 Features of IGCT products

2.1 Key parameters of IGCT (continued)

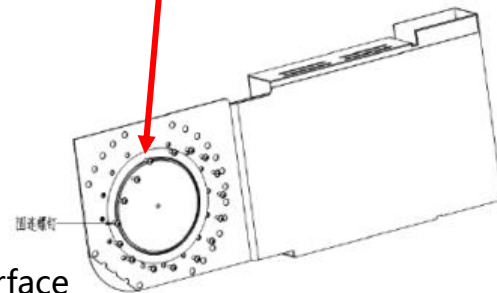
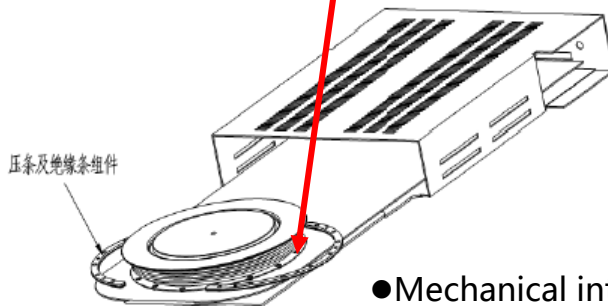
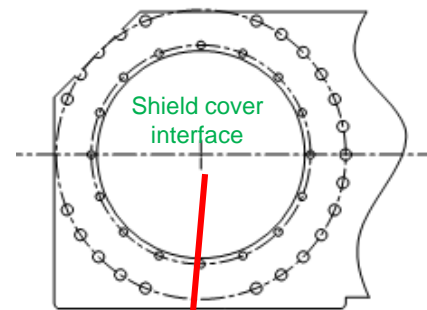
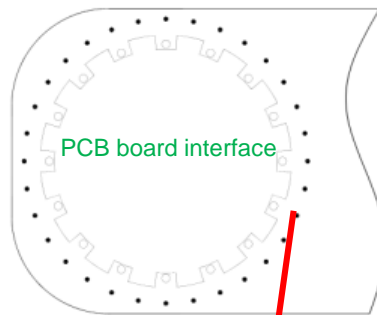


Main interfaces of IGCT



- Recommended power plug: AMP_MTA-156
- Optical signal interface

Optical Interface	Type
CS	HFBR 2528
FS	HFBR 1528



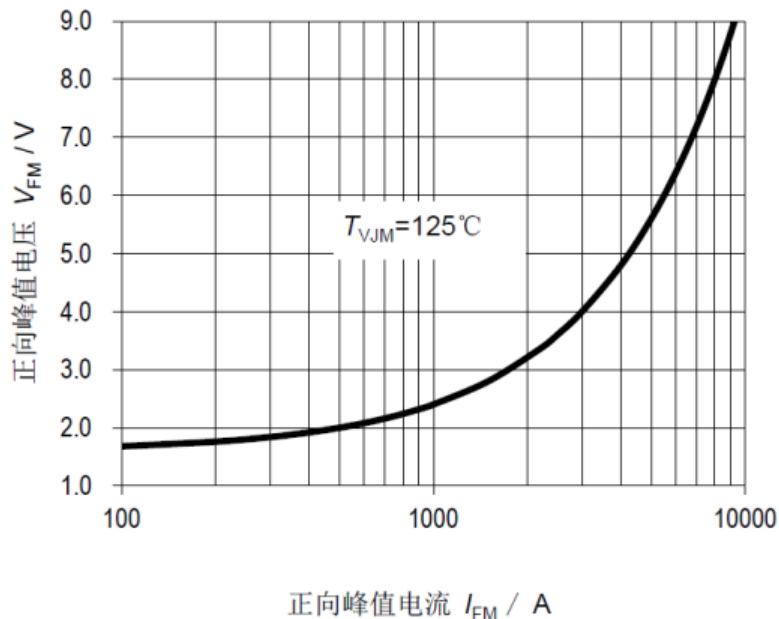
Part 2 Features of IGCT products

2.2 Key parameters of



FYx 1100-45

- $V_{RRM} = 4500V$
- $I_{FAV} = 1120A$
- $V_{FM} \leq 3.8V @ 2500A$
- $V_{fr} \leq 250V$
- $I_{rr} < 1520A$
- $Q_{rr} < 5250\mu C$



On-state voltage characteristics for FYx 1100-45

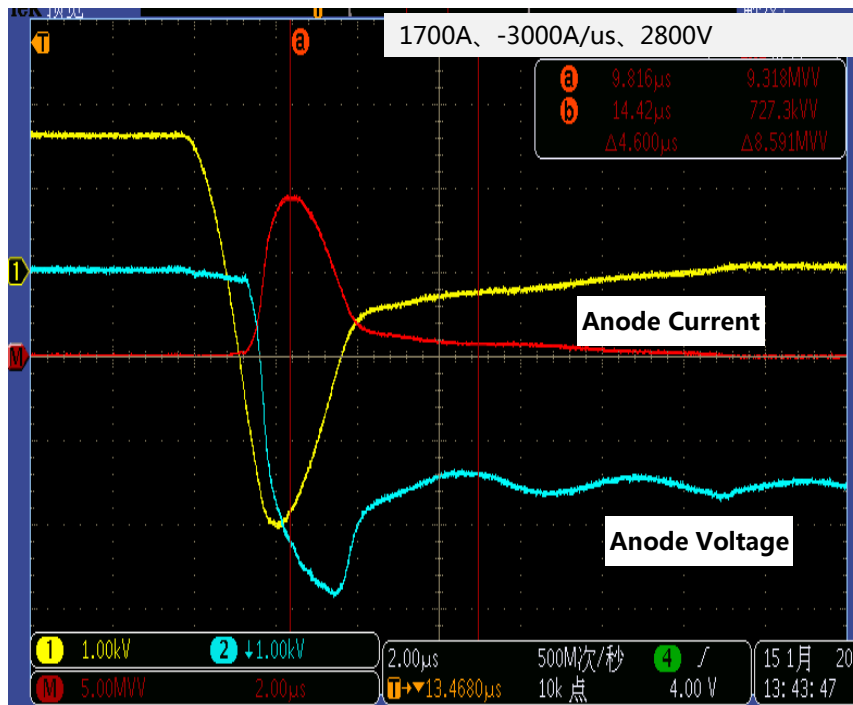
Part 2 Features of IGCT products

2.2 Key parameters of (continued)



ZKx 1100-45

- $V_{RRM} = 4500V$
- $I_{FAV} = 1184A$
- $V_{FM} \leq 3.8V @ 2500A$
- $V_{fr} \leq 250V$
- $I_{rr} < 1500A$
- $Q_{rr} < 5500\mu C$



Reverse recovery waveform of $I_F = 1700A @ 2800V$ at $125^\circ C$

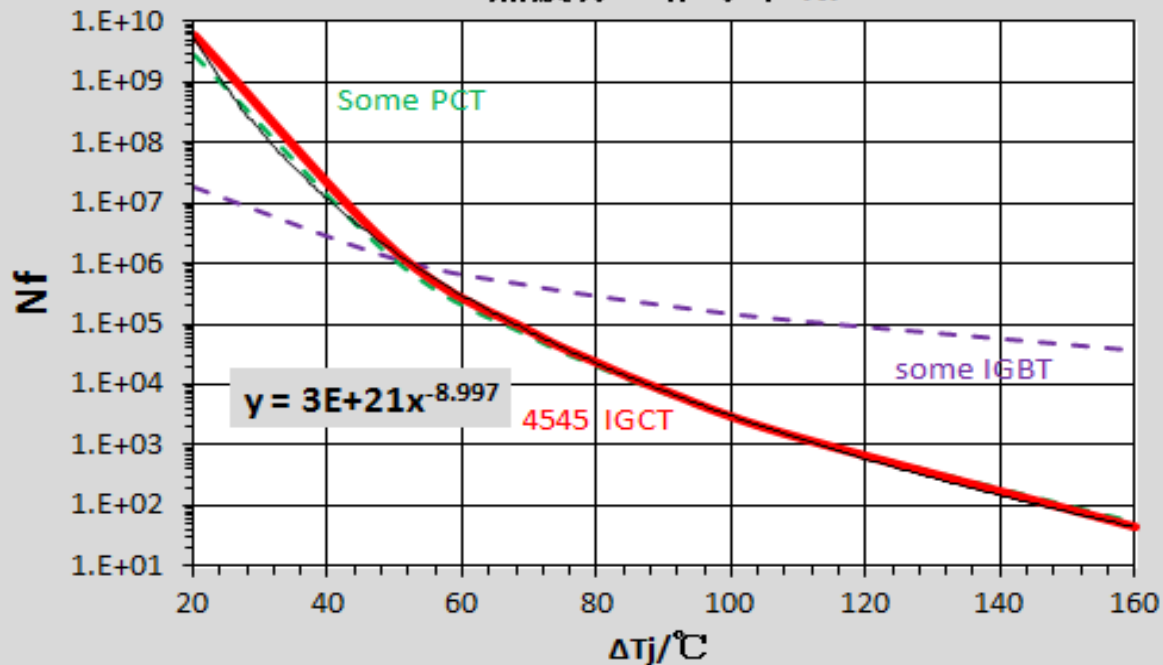
- ✓ high $-di/dt$
- ✓ No oscillation

Part 2 Features of IGCT products

2.3 IGCT Reliability

 Thermal cycle load test results

热疲劳工作寿命 Nf



Output (Some an test inventor)		
Calculation lifetime under the given conditions:		
MTBF:	18,649,594	Hours
	777,066	Days
	2129	Years
Failure λ :	53.62	Fit

第二部分 IGCT器件特性介绍

Part 2 Features of IGCT products

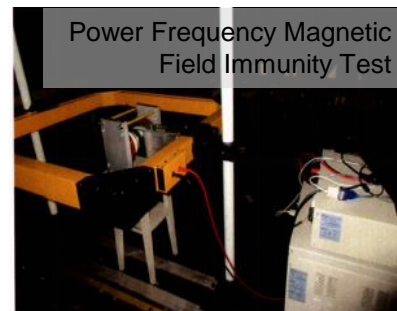
2.3 IGCT reliability

 EMC test results

No.	Item	Condition	Result
1	RF Electromagnetic Field Immunity Test	30V/m, 80MHz-1000MHz; 30V/m, 1.0GHz-3.0GHz; 1KHx, 80%AM	Pass
2	Industrial Frequency Magnetic Field Immunity Test	Transient magnetic field 1000A/m, 3s; Continuous magnetic field 1000A/m, 30s; 3 directions	Pass
3	Pulse Magnetic Field Immunity Test	Magnetic field 1000A/m, Positive/negative pulse for 5times.	Pass
4	Damped Oscillatory Magnetic Field Immunity Test	Magnetic field 100a/M, Oscillation frequency 1MHz, 400pulses/s, 60s;	Pass



射频电磁场抗扰度试验



工频磁场抗扰度试验



脉冲磁场抗扰度试验



阻尼振荡磁场抗扰度试验

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Part 3 IGCT Manufacturing & QM

3.1 Manufacturing Capability



Diffusion Tube



Lithography



Laser Cutting



Film deposition



Test Equipment



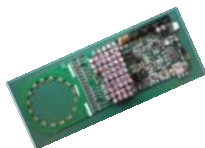
Radiation Sys.



Chips Package



GU Manufacture



Part 3 IGCT Manufacturing & QM

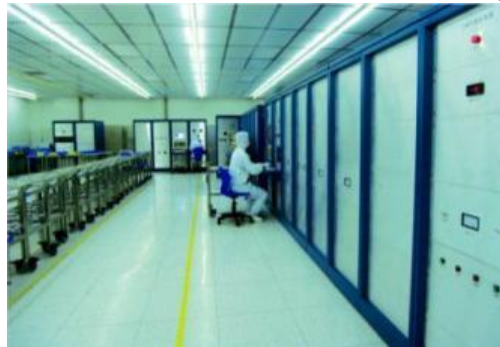
3.2 Complete testing capability

Test Standards :

- IEC60747-6-2000 Semiconductor Devices Part6 : Thyristors
- IEC60747-2-2000 Semiconductor Devices Discrete Devices And Integrated Circuits Part 2 : Rectifier Diodes



✓IGCT routine test for ratings of 4000A, 6000V and below



✓ Complete type test capability for IGCT and FRD devices



✓ Application assessment capability for IGCT and FRD devices

Part 3 IGCT Manufacturing & QM

3.3 IGCT Production and Supply Capability

No.	Capacity and Delivery		Remarks	
1	Manufacturing capacity	Asymmetric GCT	5000 pcs/year	Under current manufacturing capacity
		RC GCT	3000 pcs/year	
		GCT Gate Unit	≥5000 pcs/year	
		FRD	10000 pcs/year	
2	EXW Delivery	Volume Orders with forecast provided	3~5 weeks	Delivery varies in accordance with order qty.
		Volume Orders without forecast provided	5 months	
		Small qty orders	≥3 weeks	≤10pcs, without forecast provided

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Prospects in 5 years

Part 4 IGCT Application reference

CRRC IGCT Application References

IGCT 2-level application (CA_c 4000-45-01)

- In 2008, 2.5MVA two-level inverters for wind power
- In 2012-2015, 2.5MVA two-level rolling testing



two-level rolling testing for locomotive

IGCT 3-level application (CA_c4000-45-01)

- In 2009, 9.0MVA three-level electric drive system
- In 2014, 20MVA three-level inverter equipment for rolling mill



9.0MVA three-level electric drive system

Part 4 IGCT Application reference

CRRC IGCT Application References (continued)



IGCT Power pulse application

In 2012, 20kA/us electromagnetic pulse generator with 3000A/6000V IGCT



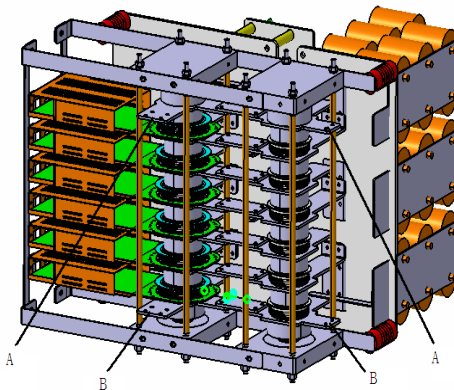
IGCT parallel application

In 2012, an special power supply with CA_c 4000-45 IGCT



IGCT DC breaker application (CAc4000-45-02)

In 2015, 10kV/3.5kA hybrid breaker for DC power networking



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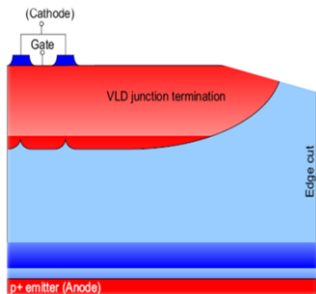
IGCT Application reference

Part 5

Prospects in 5 years

Part 5 Prospects in 5 years

- Developing a new generation of technology on the 6-inch HV GCT and GU to improve the ability and reliability of the power conversion



New GCT
Structure



6-inch GCT
chips prototype



Miniaturization
gate unit
prototype

I_{TGQM} : 6kA-10kA

V_{DRM} : 6.5kV、10kV

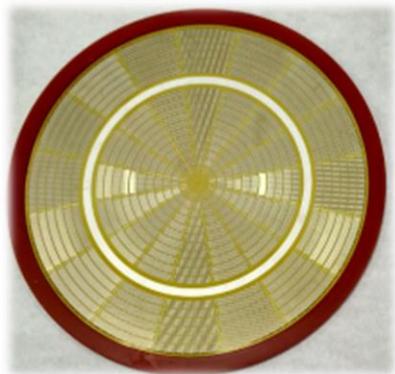
$I_{T(AV)}$: 3kA-5kA

Structure : A_S 、 R_C 、 R_B

IGCT products
roadmap

Part 5 Prospects in 5 years

IGCT R&D roadmap



6-inch GCT chip



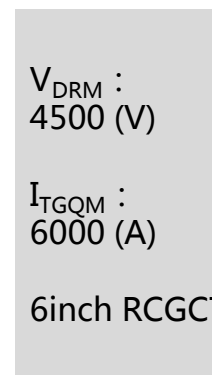
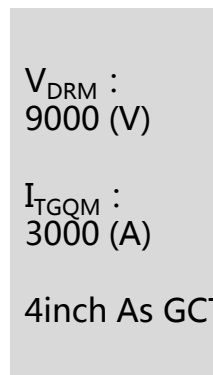
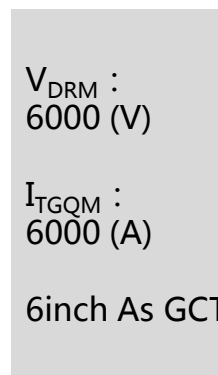
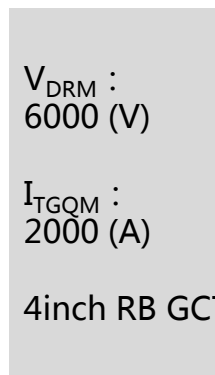
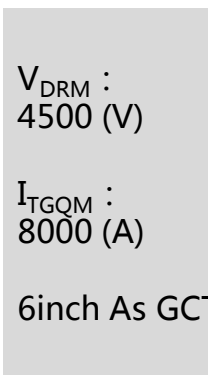
6kA~8kA rating GCT



RB IGCT



6kV、9kV rating IGCT



2019

2020

2021

2022

2023

Thanks for your attention!

