



ROHM

System solution information for charging station

May 10, 2021
Energy & Industry G
Power Device Application Dept.
Application Engineer Div.
System Solutions Engineering Headquarters

Actions for industrial market

Charging station Market trend

Solution information at ROHM

Introduction to application support

New components Introduction of device

It's simple materials that introduction to device.
If you are interested in it, we prepared presentation materials,
please feel free to contact our sales representative.



■ Actions for industrial market

■ Charging station Market trend

■ Solution information at ROHM

■ Introduction to application support

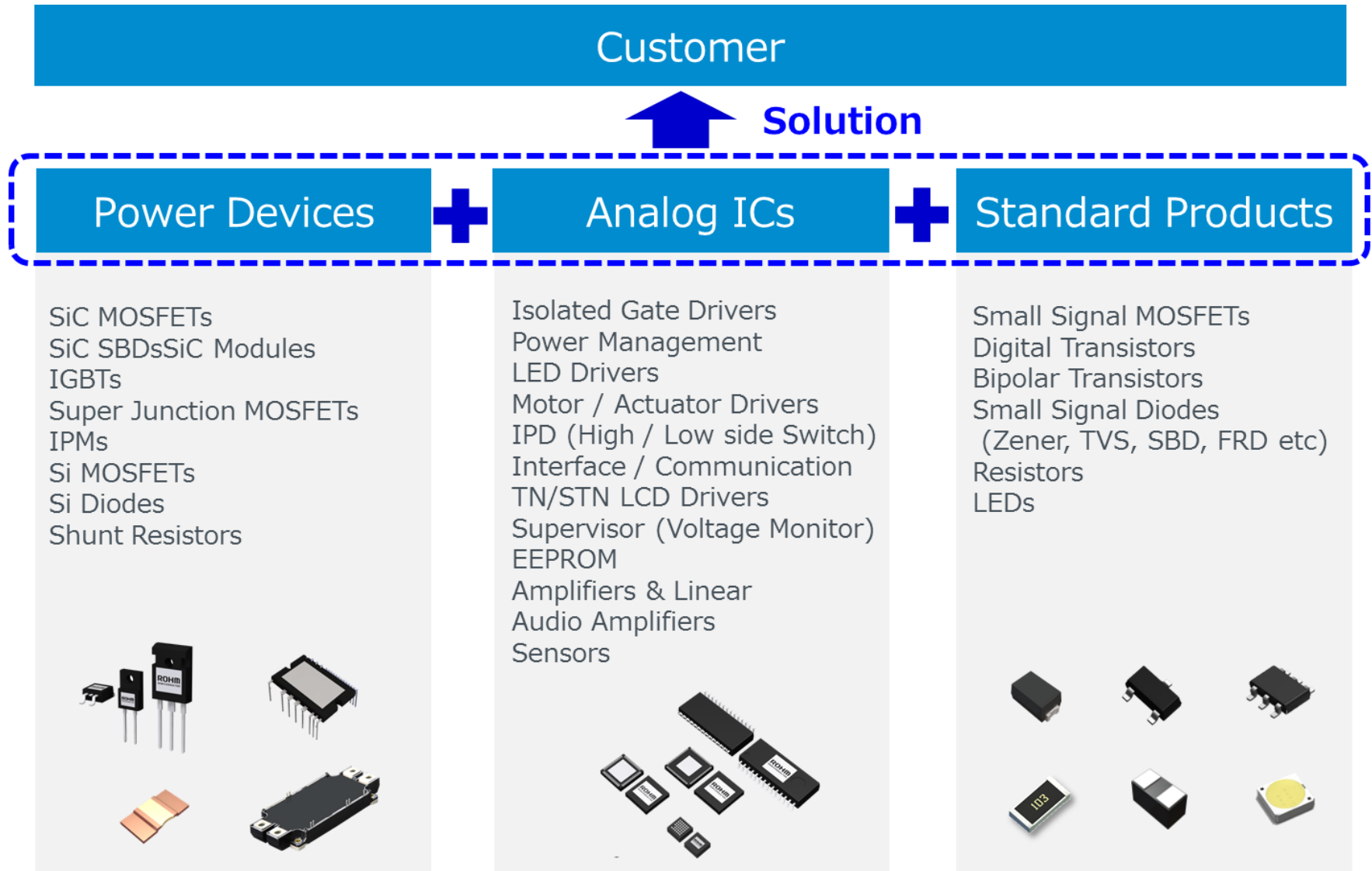
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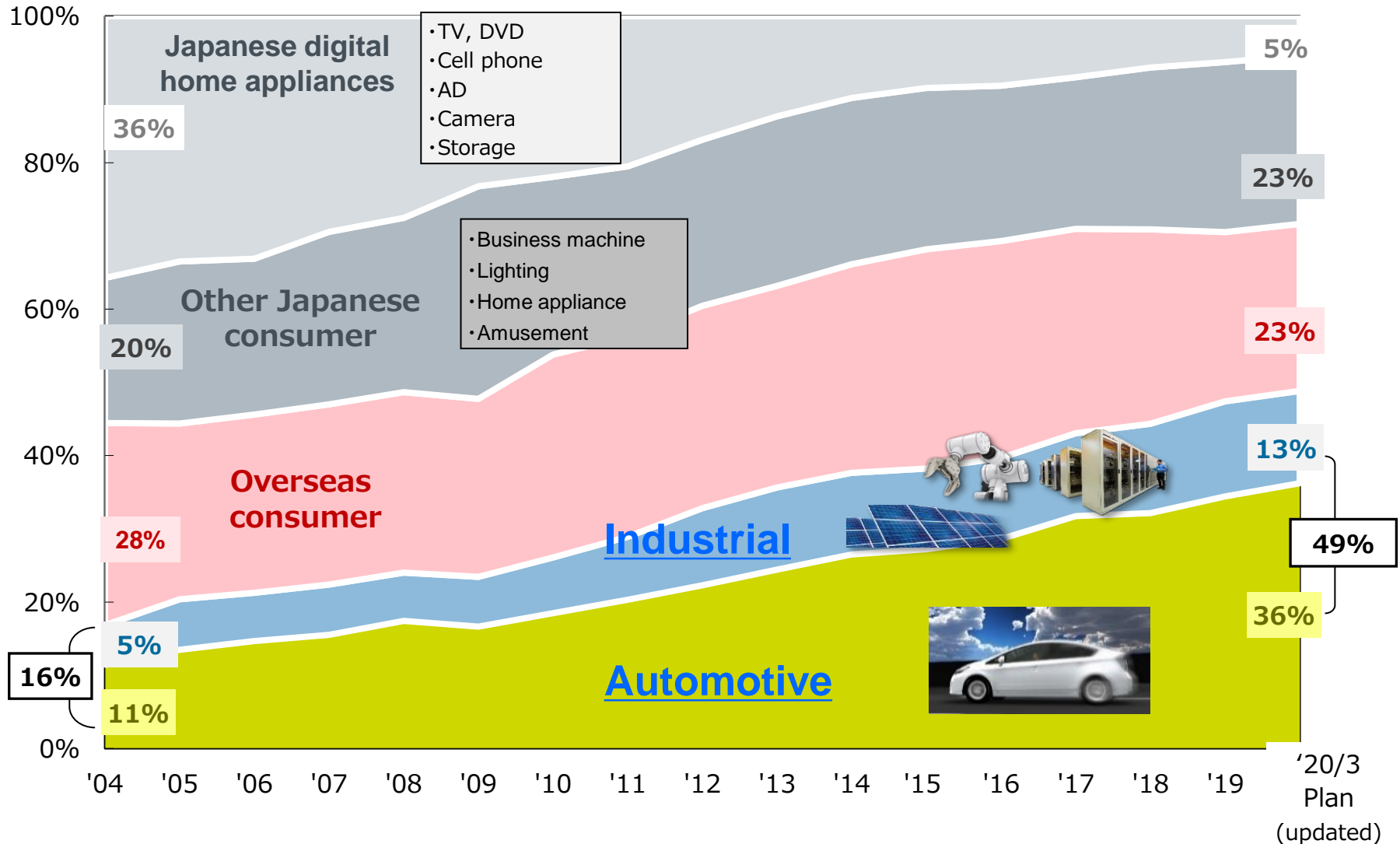
Propose solutions based on ROHM's focused product families

ROHM offered 3 product families as a solution.



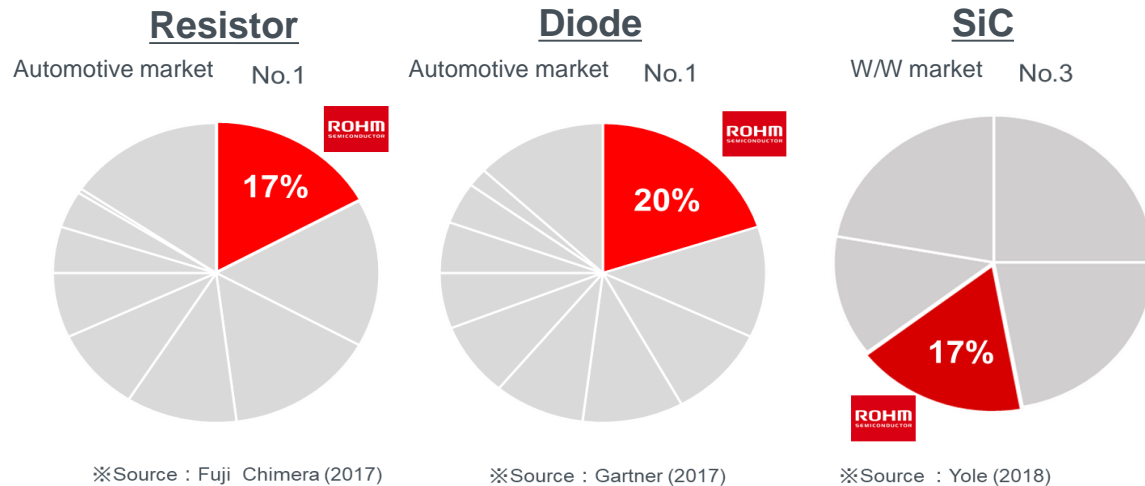
ROHM Sales ratio by market

Focusing on Automotive and Industrial markets, where sales are growing continuously and approaching 50% of overall revenue



ROHM Discrete sales in industrial

ROHM has wide variety of product line up from standard products to Power devices in discrete components.
ROHM discrete products are highly successful in automotive market with leading market shares.



Efforts for quality and environment are highly appreciated.

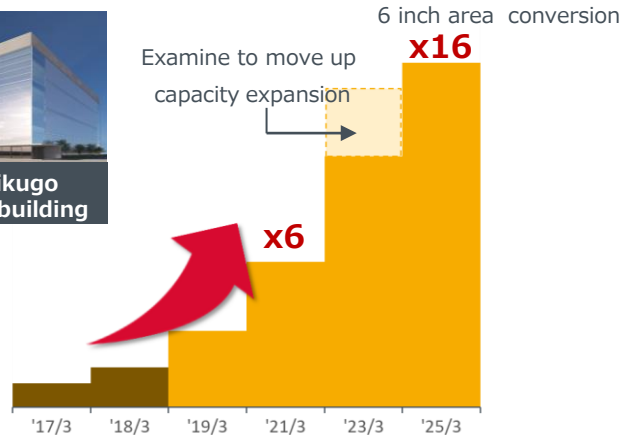


Efforts for long-term stable supply

Increase in production capacity for stable supply as a market leader.

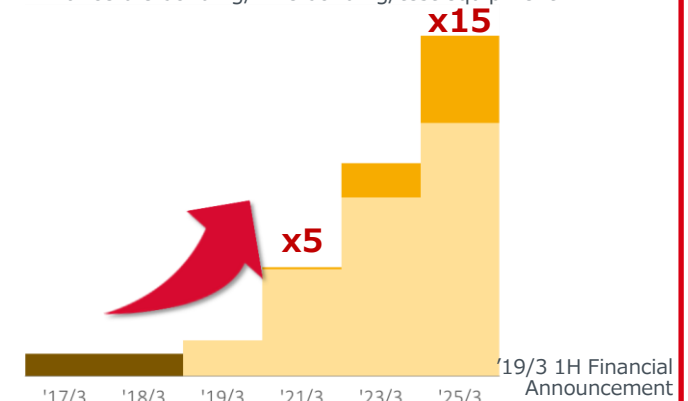
SiC

- SiC wafer (substrate) (SiCrystal Germany)
- SiC device process (Apollo Chikugo & Lapis Miyazaki)



Gate driver

- **Front-end investment** (ROHM Hamamatsu)
Expand 8- and 12-inch manufacturing lines
- **Back-end investment** (Thailand)
Enhance die bonding/wire bonding/test equipment



To build long-term stable supply system with standard products as a leading market shareholder.

Wafer Fab

Shiga factory

Started in 2016/Sep



Acquired



Assembly Factory

RIST(Thailand)

Started in 2016/May



New building/
Expansion



RWEM(Malaysia)

Started in 2017/April



New building/
Expansion



REPI(Philippines)

Started in 2019/June

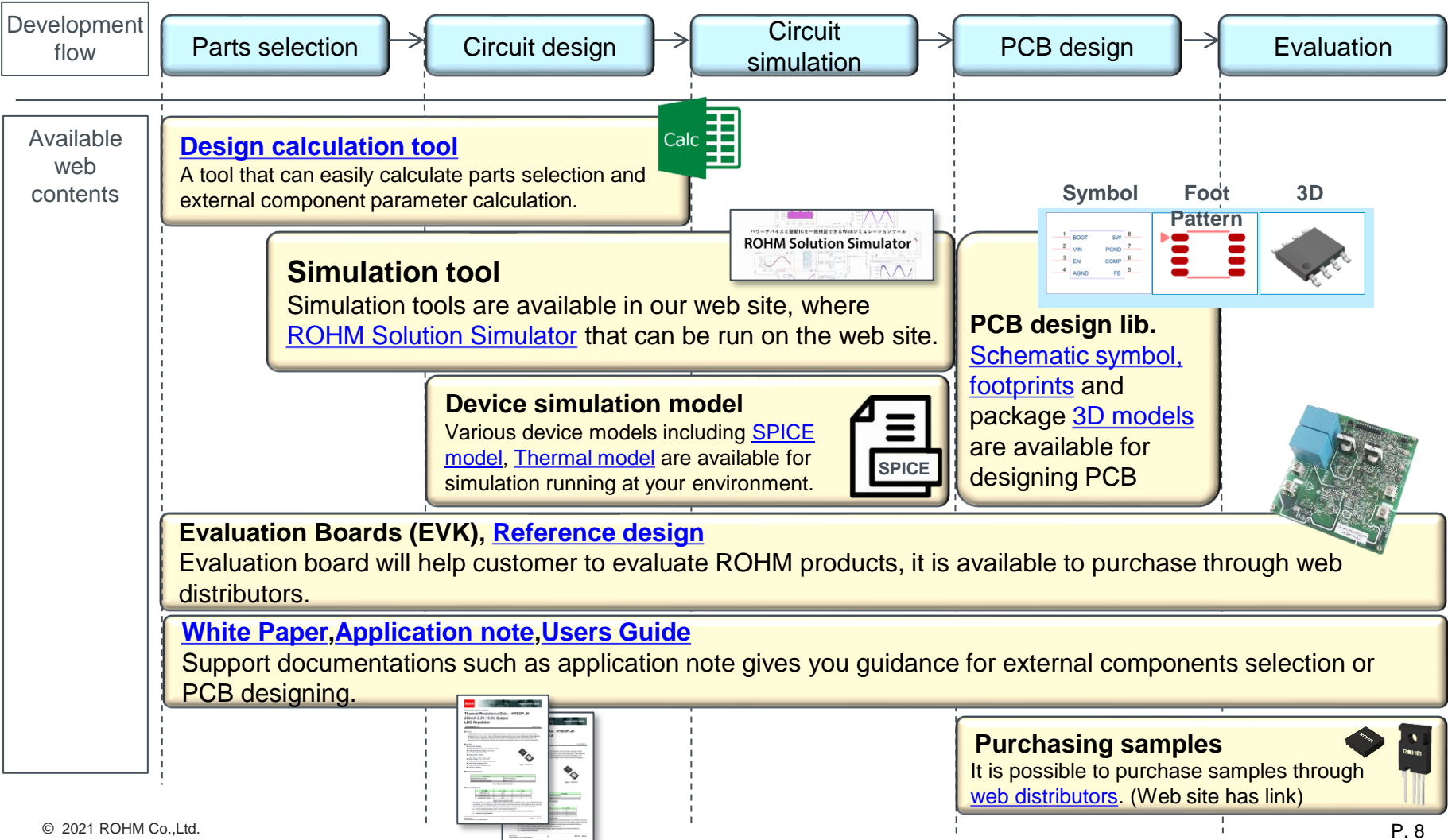


New building/
Expansion



Our application support covers each step of design flow

ROHM offer various type of application support which are including design files, libraries or documents. These contents are available in web site.



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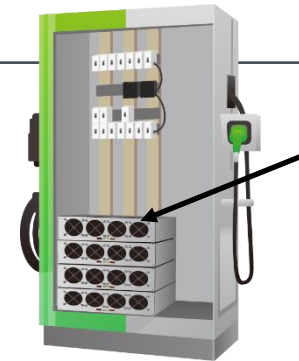


Trend of charging station

Improve cruising distance of EV

→ Increase of battery capacity

→ **Higher output power of charger to shorten charging time.**



Power supply unit

Some power supply units are used in one charging station

	2019	2020	From 2021 on.
EV battery capacity trend	40kWh	60kWh	More than 70kWh
Station power trend	120kW	120 to 350kW	Up to more than 350kW
Power unit electric power trend	15kW/ 20kW	30kW	More than 40kW
Circuit topology trend	Single phase inter leave	3 phase Vienna rectifier	

Difficulty of thermal management due to increased power density.

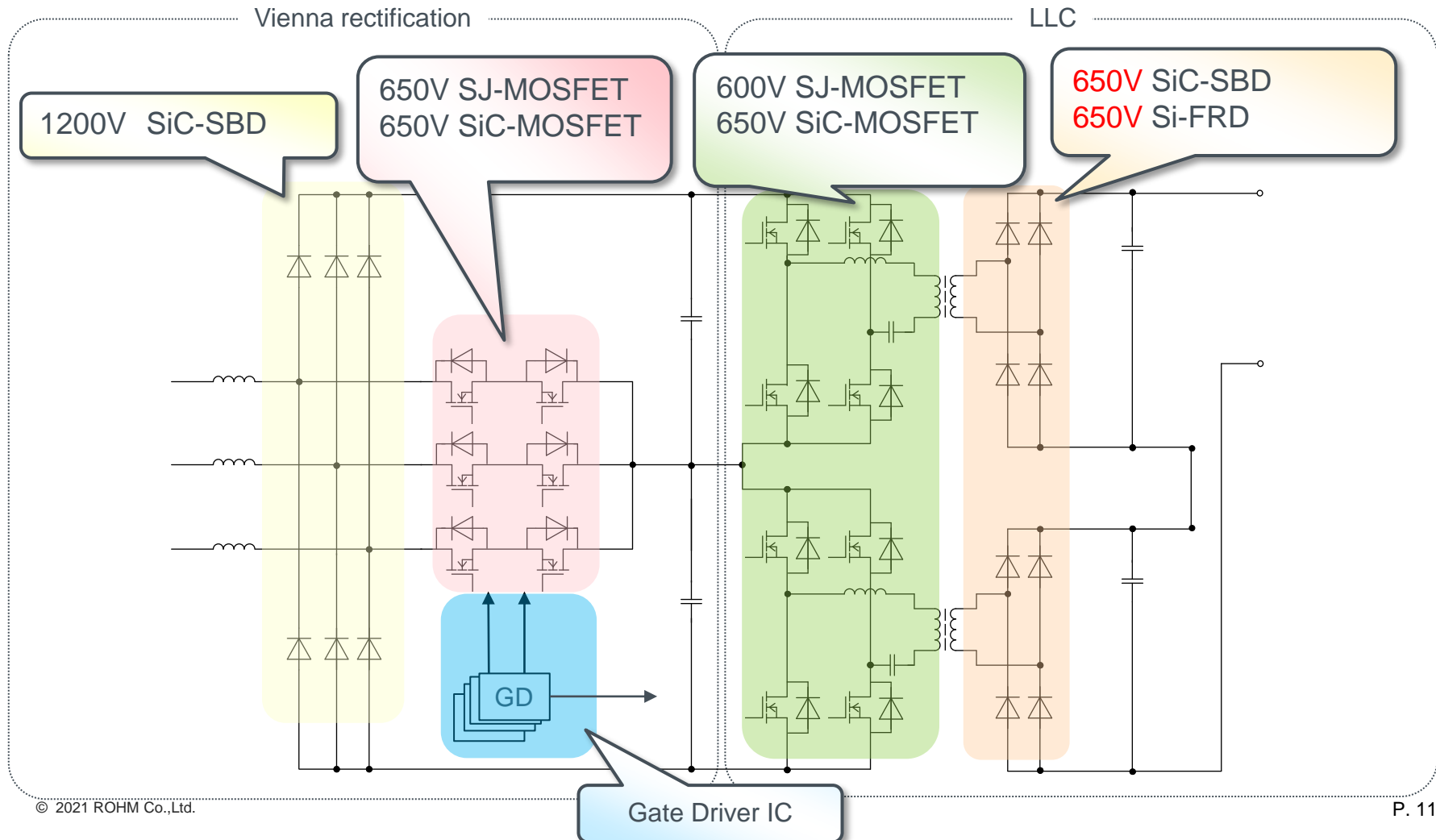
Solution: ROHM responds to **high efficiency** requirement with **SiC technology**

Charging station basic circuit configuration (Vienna rectification + LLC)

ROHM can offer:

CASE1: As cost oriented solution a combination of SJ-MOS, SiC SBD and Si FRD.

CASE2: As performance and size oriented solution, a combination SiC-MOS/SiC-SBD.



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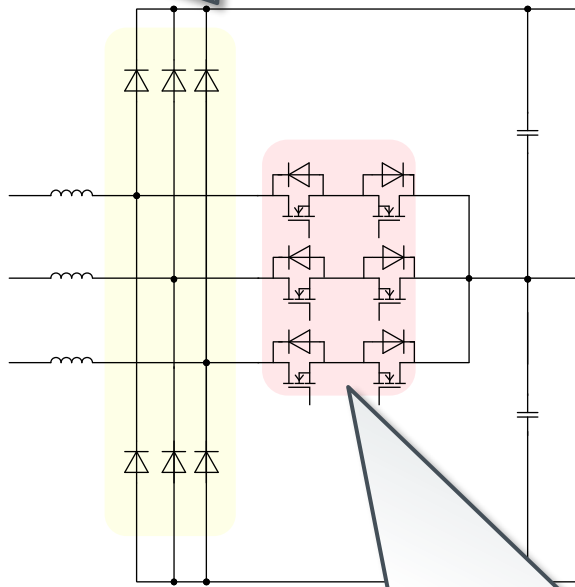


Proposal of SiC device in Vienna rectifier PFC

- Using SiC-SBD with ultra fast recovery contributes to high efficiency and miniaturization of filter
- SiC-MOS contributes to high efficiency due to lower $R_{DS(on)}$ and lower switching loss

1200V Diode

SiC-SBD : **SCS2xxxK series**

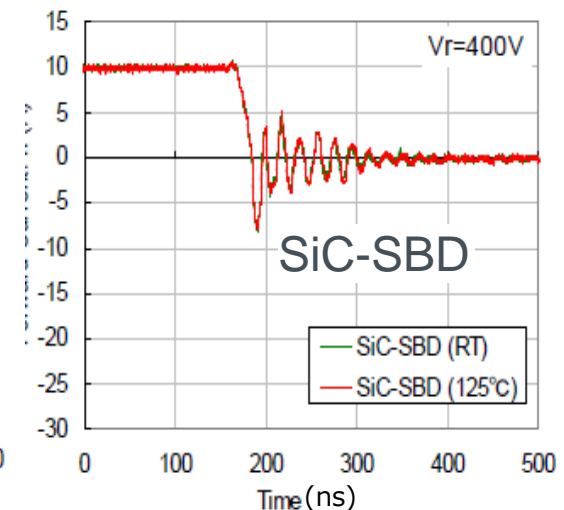
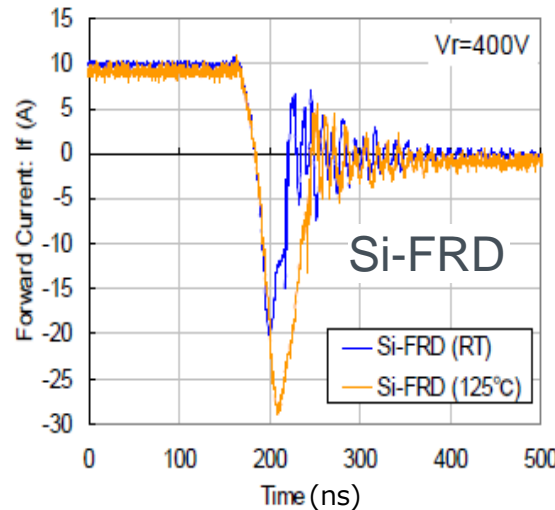


650V MOSFET

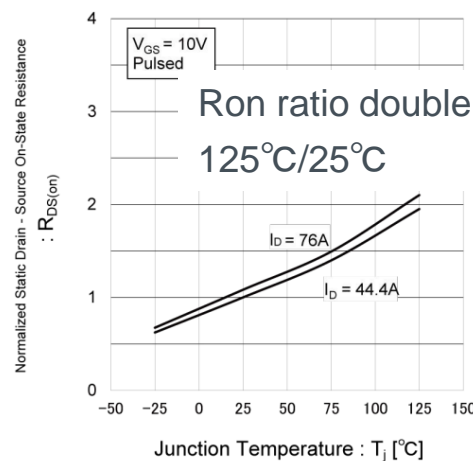
SiC-MOSFET **SCT3xxAL series**

Cost emphasis : SJ-MOSFET **R65**KN series**

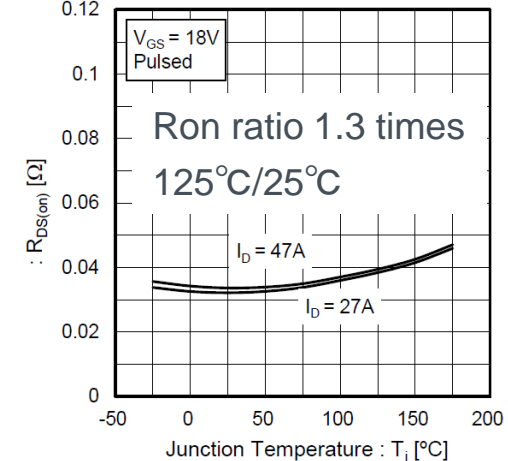
Reverse Recovery Waveform Comparison (600V/10A)



SJ-MOS

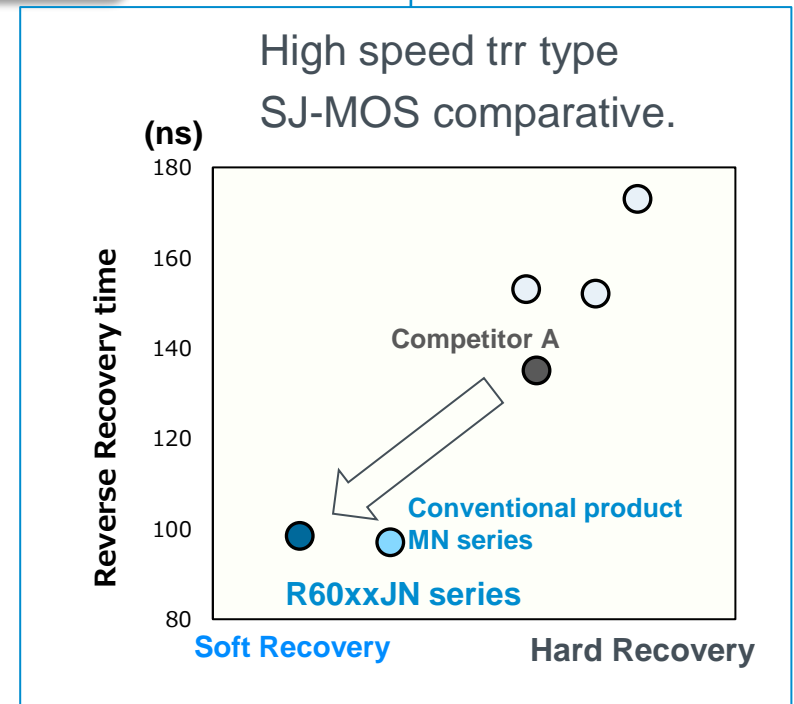
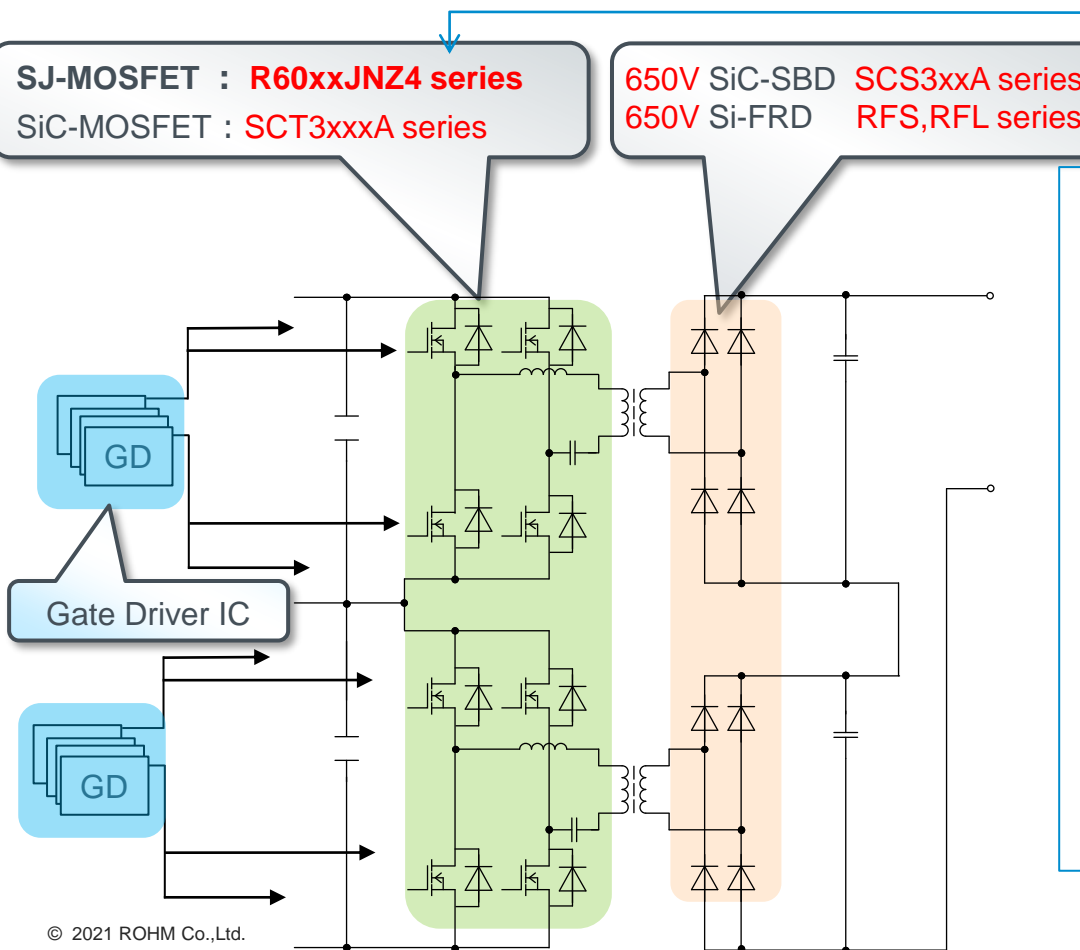


SiC-MOS



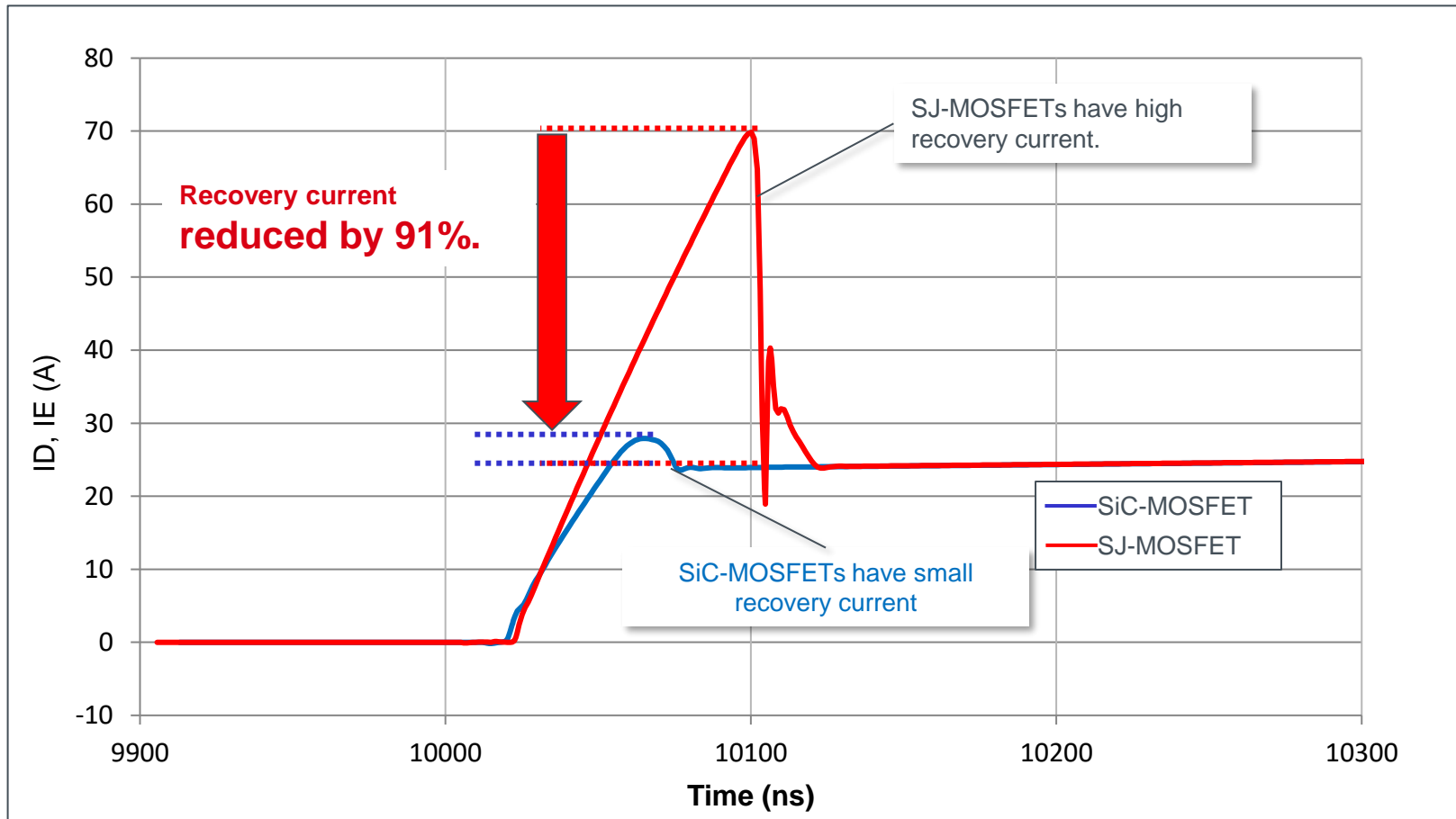
Proposal for rectifier circuit with two stage LLC secondary side.

- Fast recovery SJ-MOS JN series has low risk of destruction during off-resonant switching.
- SiC-MOSFET brings benefits of excellent temperature characteristics of on-resistance.
- FRD and SiC-SBD are suitable for secondary side.



Resonance misalignment (e.g. load fluctuation) causes hard switching, thus recovery characteristic is important for safety.

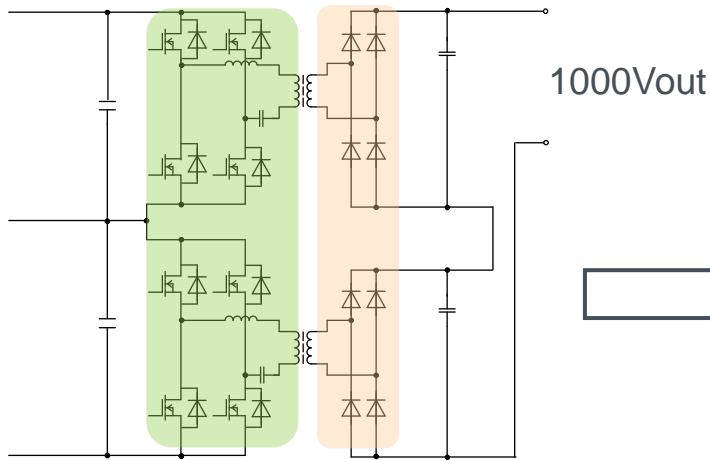
91% lower recovery current of SiC-MOSFETs (against fast recovery SJ-MOS) dramatically reduces the risk of device failure.



LLC part

Series of 650V SJ-MOS/FRD

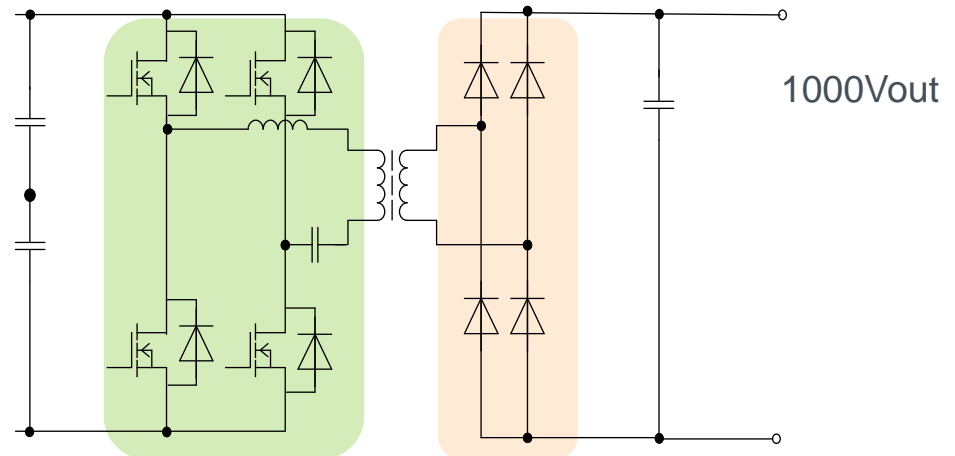
Conventional stacked configuration



Gate Driver IC 8pcs
650V SJ-MOS 8pcs
650V FRD 8pcs

→ 1200V SiC-MOS/SBD

New proposal simplified configuration



Gate Driver IC 4pcs
1200V SiC-MOS 4pcs
1200V SiC-SBD 4pcs

Advantage

Fewer power devices → **Space saving**, simplified circuit and **less failure rate**.

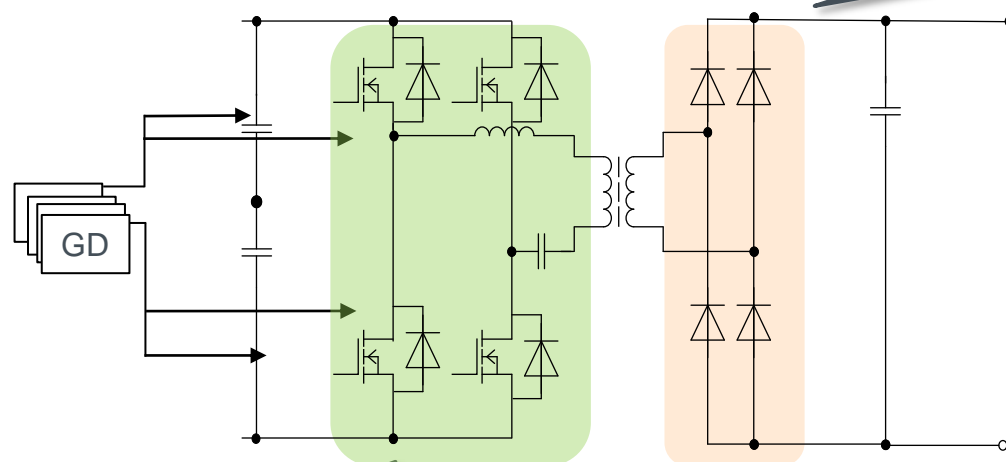
Fewer control elements → Simplified drive circuit, fewer microcontroller and port.

Single LLC with 1200V SiC

- By using fast switching 1200V SiC MOSFET, single LLC is possible without reducing switching frequency.
- Secure safety even in off-resonant hard switching operation by fast recovery characteristic of SiC-MOSFET
- We recommend low VF and fast recovery ROHM SiC-SBD on the secondary side.

ROHM new proposal

Single LLC + secondary side rectifier



SiC-SBD
1200V SiC-SBD **SCS2xxK series**

1200V SiC-MOSFET : **SCT3xxxK series**

IGBT : Large tail current, impossible for high frequency operation.
SJ-MOS : 1200 V is not available.

Only SiC MOSFET can realize !

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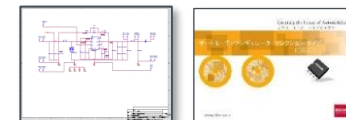


ROHM's application support

Provides full coverage application support in your development flow

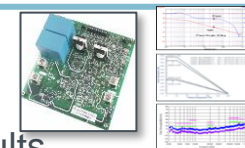
Specification

- ✓ Technical Seminar (On sight, Webinar)
- ✓ System solution such as **PD + GDIC, Power tree** etc
- ✓ Technical Proposal including external components



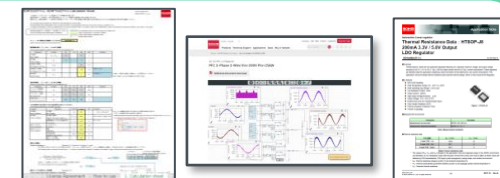
Proto-typing

- ✓ **Evaluation Board (EVK) / User's guide**
- ✓ **System reference design**
- ✓ EVK with customized parameter, provided with measurement results



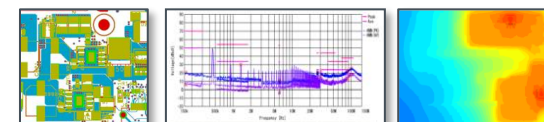
Schematic Design

- ✓ Calculation tool for external component parameter
- ✓ Application notes
- ✓ **SPICE model / PLECS model / Thermal model**
- ✓ **ROHM Solution Simulator** (Web based simulation)



PCB Design

- ✓ PCB design libraries (Footprint, 3D data etc)
- ✓ PCB design guidelines
- ✓ EMC design guidelines / **EMC simulation**
- ✓ Thermal design guidelines / **Thermal simulation**



Evaluation

- ✓ Measurement by EVK with customized parameter or by user's devices
- ✓ EMC measurement and improvement proposals
- ✓ Thermal measurement and improvement proposals

Mass Production



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SiC-MOSFET

ROHM can support your development with our excellent product lineup.

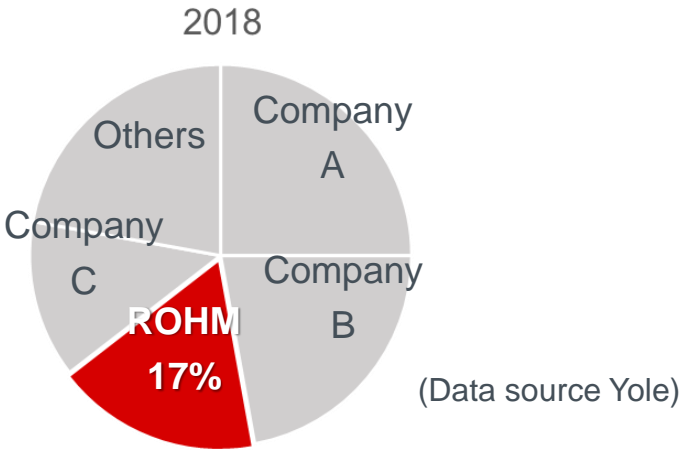
Line up

Package	650V	P/N	17mΩ	22mΩ	30mΩ	60mΩ	80mΩ	120mΩ
TO-220AB		SCT2xxxKE						✓
TO-247		SCT3xxxAL	✓	✓	✓	✓	✓	✓

Package	1200V	P/N	22mΩ	30mΩ	40mΩ	80mΩ	105mΩ	160mΩ	280mΩ	450mΩ
TO-220AB		SCT2xxxKE						✓	✓	✓
TO-247		SCT3xxxKL	✓	✓	✓	✓	✓	✓		

Package	1700V	P/N	750mΩ	1150mΩ
TO-3PFM		SCT2H12Nx		✓
TO-268-2L		SCT2HxxNY	✓	✓

SiC market share



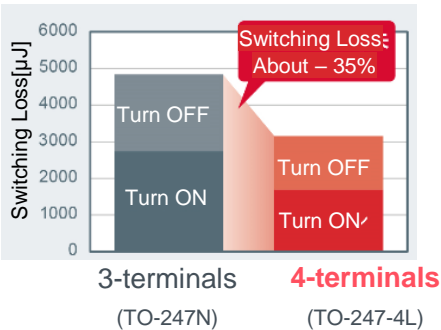
ROHM's strength

	In-house SiC Wafer	Trench Sic MOS	Solution with Gate drive
ROHM	✓	✓	✓
Company A	-	✓	✓
Company B	✓	-	-
Company C	✓	-	✓

SiC-MOSFET TO-247-4L package

Switching loss reduced with a 4-terminal package that enables high-speed switching compared to the conventional 3-terminal.

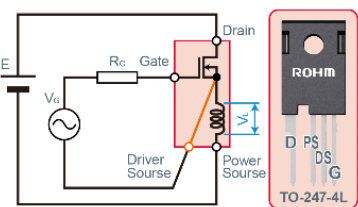
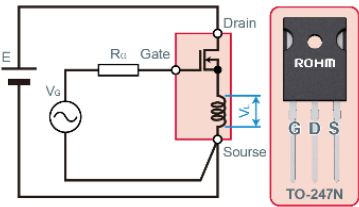
New item



P/N	VDS	RDS(on)	ID
SCT3030AR	650 V	30 mΩ	70 A
SCT3060AR	650 V	60 mΩ	39 A
SCT3080AR	650 V	80 mΩ	30 A
SCT3040KR	1200 V	40 mΩ	55 A
SCT3080KR	1200 V	80 mΩ	31 A
SCT3105KR	1200 V	105 mΩ	24 A

RDS (ON):. Typ @ 25°C

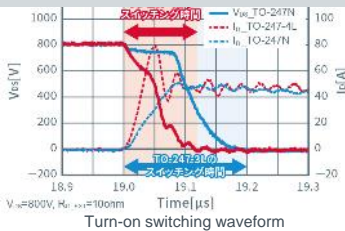
Package structure comparison in SiC MOSFET



<Conventional: 3Terminal package>
The inductor component with a source.
Gate voltage Lowering of
→ delay of switching speed

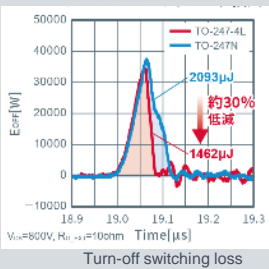
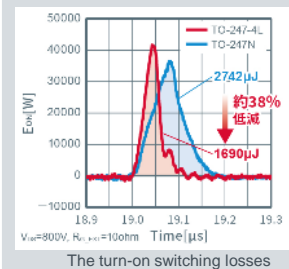
<New item: FourTerminal package>
And a power source terminal
Separation of the driver source
terminal
Of the effect of inductor component having the source
Reduction
→ **High-speed switching**

Loss improved due to the realization of high-speed switching



High-speed switching





About conventional product ratio 35% of Switching loss reduction





SiC-SBD


ROHM can provide a product lineup that is superior in SiC-SBD characteristics

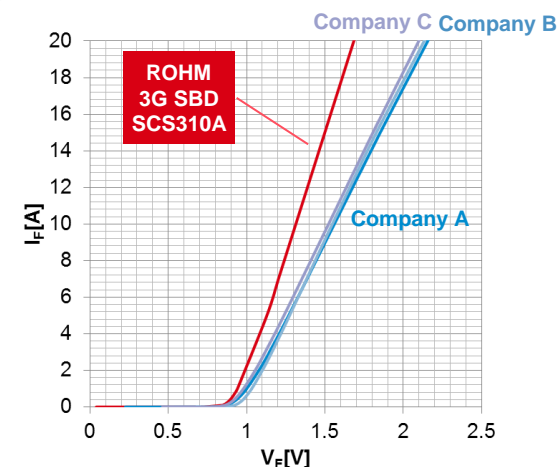
Line up

Package	650V	P/N	2A	4A	6A	8A	10A	12A	15A	20A	30A	40A
TO-220ACP		SCS3xxAHG	✓	✓	✓	✓	✓	✓	✓	✓		
TO-220FM 2L		SCS3xxAM		✓	✓	✓	✓	✓	✓	✓		
TO-247		SCS2xxAE							✓	✓	✓	✓
TO-263AB (LPL/D2PAK)		SCS3xxAJ	✓	✓	✓	✓	✓	✓	✓	✓		

Package	1200V	P/N	5A	10A	15A	20A	30A	40A
TO-220AC		SCS2xxKG	✓	✓	✓	✓	✓	✓
TO-247		SCS2xxKE		✓		✓	✓	✓

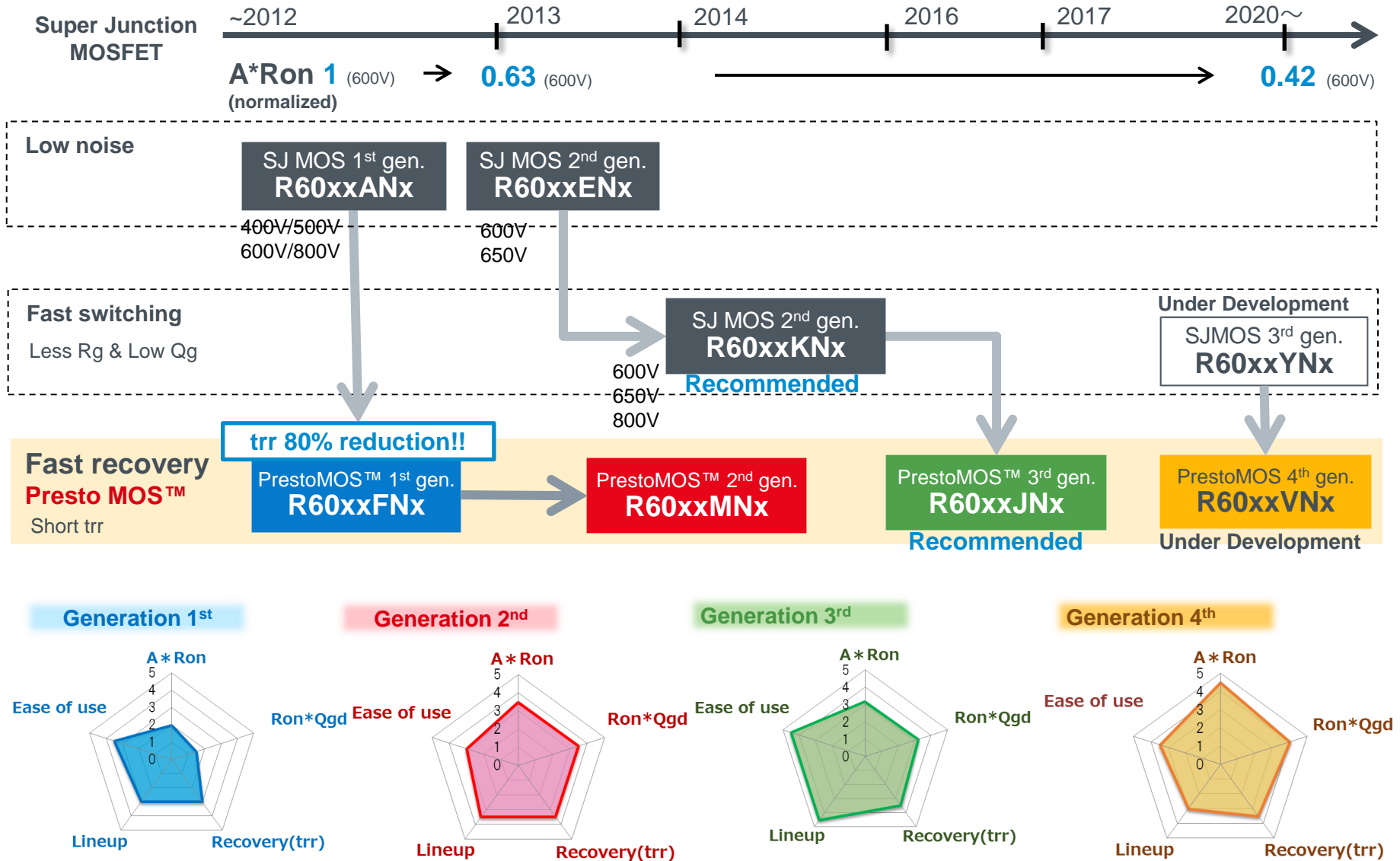
Competitor Comparison 650V/12A

	 SCS312AHG	Company C	Company B	Company A
$V_F@12A(25^\circ C)$ typ.	1.35V	1.50V	1.50V	1.56V
$I_R(25^\circ C)$ typ	0.04 μA	15 μA	0.65 μA	10 μA
I_{FSM} 50Hz 1pulse	99A	104A	97A	100A



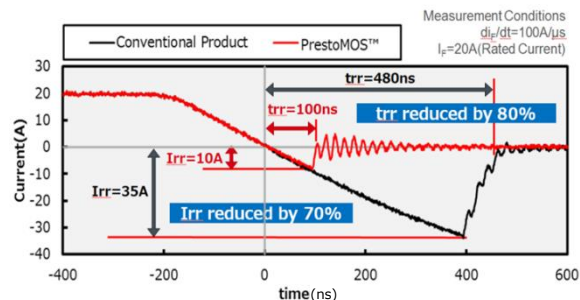
PrestoMOS™ Technology Roadmap

2019.10 update

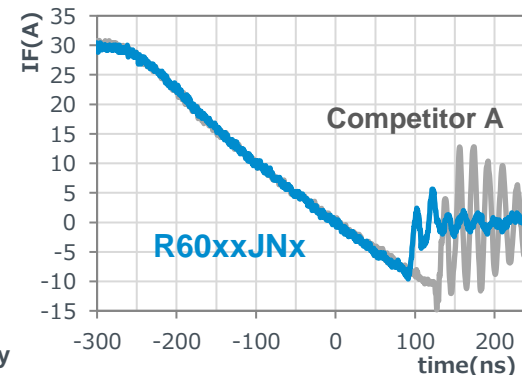
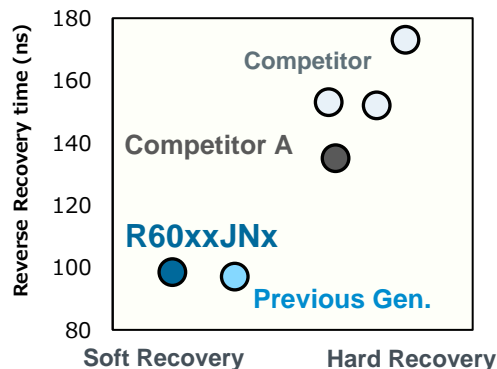


Features

- Fast & soft recovery
- Improves efficiency of motor applications
- Able to remove parallel diode



■ Fast recovery & soft recovery ⇒ Easy to use !



Applications

- Charging station for EV
- Solar (Power Conditioner)
- Motor applications considering energy saving
- White goods considering energy saving
- Others: LLC、Inverter, Totem pole PFC..



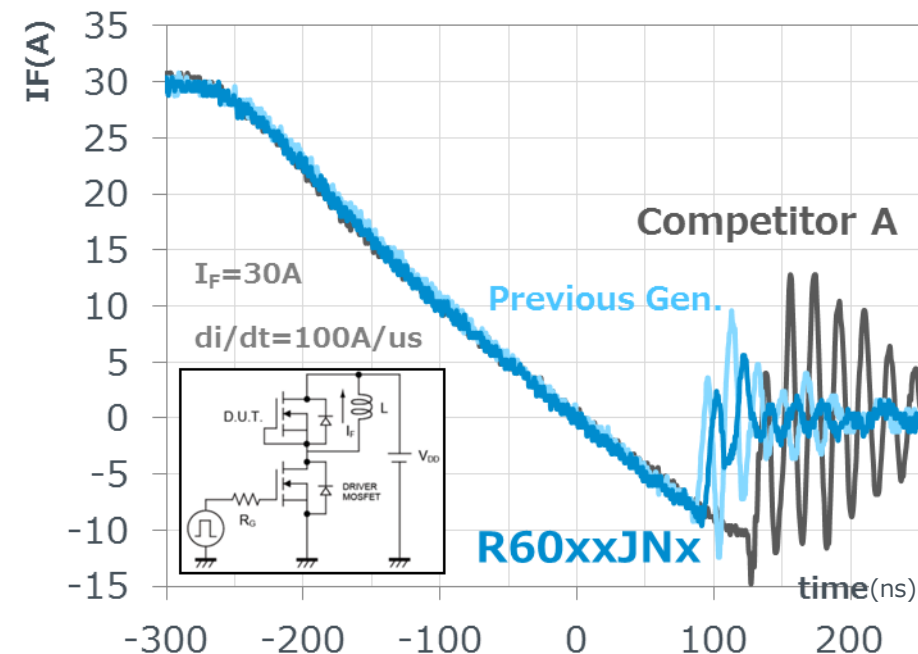
*not automotive qualified

☆ : Under Development

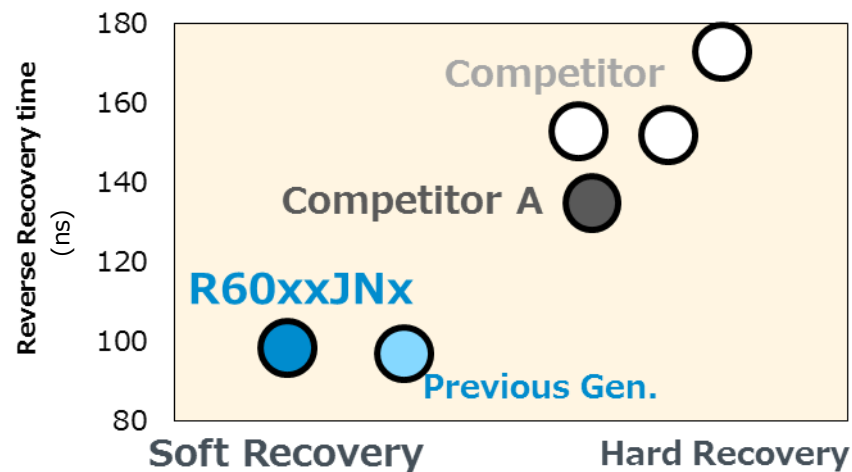
		Package				
		T0252	LPTS	T0220FM	T03PF	T0247
$V_{DS}=600V$						
$R_{on typ}$ (mΩ)	1100	New R6004JND3	New R6004JNJ	New R6004JNX		
	720	New R6006JND3	New R6006JNJ	New R6006JNX		
	600	New R6007JND3	New R6007JNJ	New R6007JNX		
	450	New R6009JND3	New R6009JNJ	New R6009JNX		
	350		New R6012JNJ	New R6012JNX		
	220		New R6018JNJ	New R6018JNX		
	180		New R6020JNJ	New R6020JNX	☆ R6020JNZ	New R6020JNZ4
	140			New R6025JNX	☆ R6025JNZ	New R6025JNZ4
	110			New R6030JNX	☆ R6030JNZ	New R6030JNZ4
	90					New R6042JNZ4
	60				☆ R6050JNZ	New R6050JNZ4
	45					New R6070JNZ4

Improvement of hard recovery

2019.10 update



Became one of easiest product to use in market by softening recovery characteristics from conventional product.



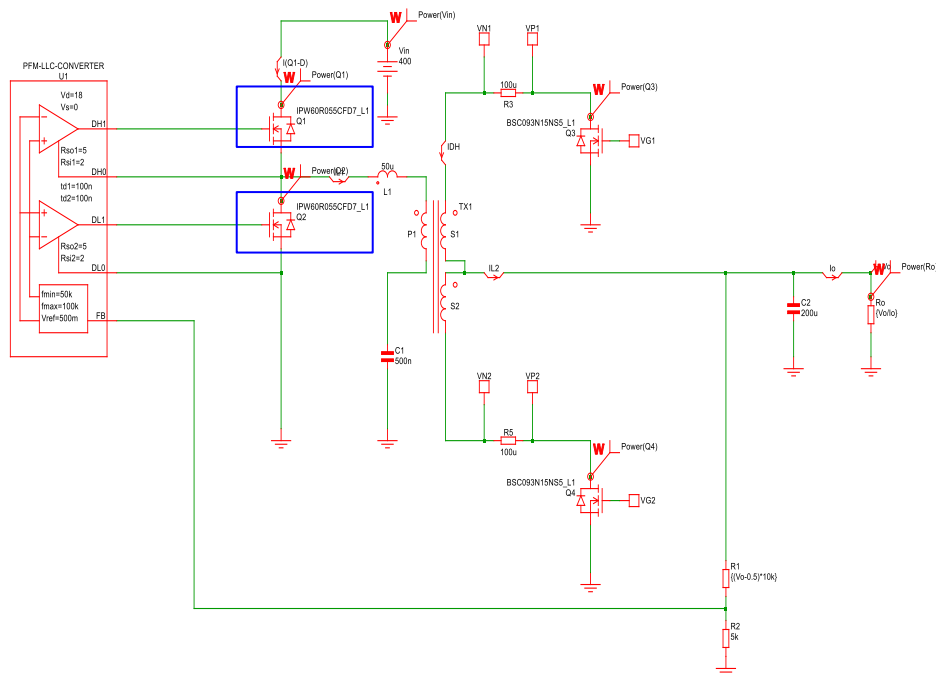
※Compared in RDS(on) typ. 0.11Ω class products

	t _{rr} (ns)	I _{rr} (A)	Q _{rr} (nC)	Soft recovery index	Peak of ringing(A)
R6030JNX	98	7.5	365	5.5	5.2
R6030MNX(Previous Gen.)	97	7.3	338	8.1	9.5
Competitor A	135	10.5	693	12.3	13

※Soft recovery index : value is high when recovery is harder (larger ringing)

- Efficiency is improved by using JN series, because high V_{th}

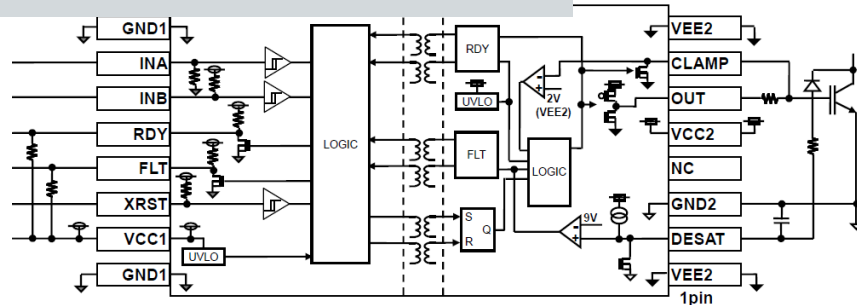
The efficiency is almost the same when the drive voltage is 12V and 15V.
Simulation result at half bridge LLC topology



Insulated gate driver products can be provided

Application circuit

Insulation element built-in

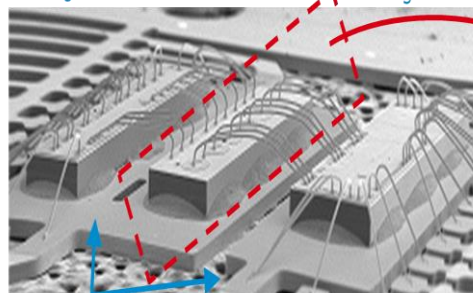


BM6105AFW-LB

<Inductive Isolation>

Low Voltage

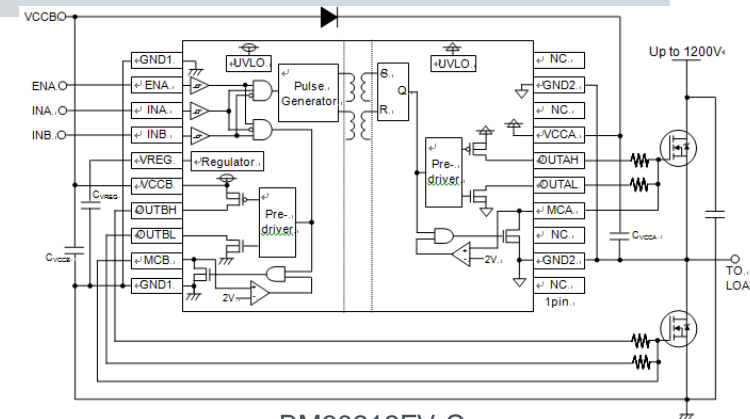
High Voltage



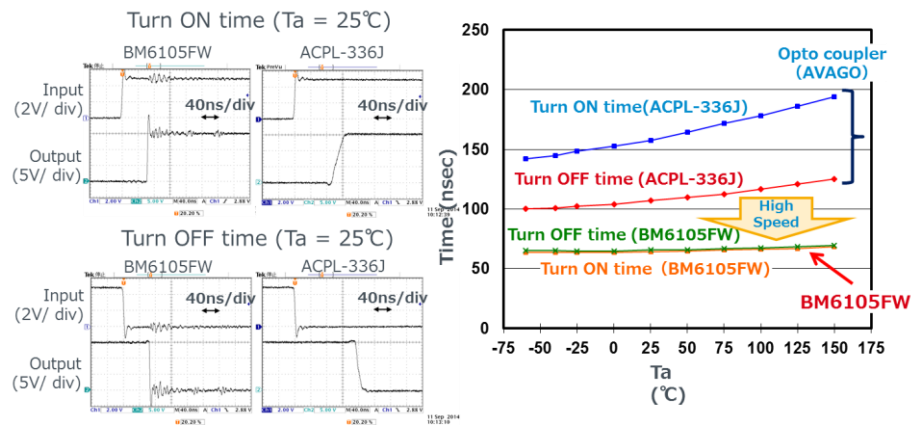
Cu Island

- Small delay time, temp dependence
- High robustness, reliability

Non-insulated Hside/Lside



BM60212FV-C



Gate Drivers (Simple Type)

ITEM	FEATURES									Status
	Channel	Package	Isolation [kVrms]	Delay Time [ns] (max)	Output Current	Miller Clamp	Separated Output	UVLO	OVP	
BM61M22BFJ	1ch	SOP-JW8	2.5	60	2A	NA	✓	7.4V	NA	MP Ready
BM61S40RFV	1ch	SSOP-B10W	3.75	65	4A	B	NA	14.5V	21.5V	MP
BM61S41RFV	1ch	SSOP-B10W	3.75	65	4A	B	NA	14.5V	NA	MP
BM61M41RFV	1ch	SSOP-B10W	3.75	65	4A	B	NA	7.4V	NA	MP
BM60212FV	2ch	SSOP-B20W	High: 1.2kVDC Low: Not Isolated	75	3A	B	✓	8.5V	NA	MP
BM60213FV	2ch	SSOP-B20W	High: 1.2kVDC Low: Not Isolated	75	3A	NA	✓	8.5V	NA	MP

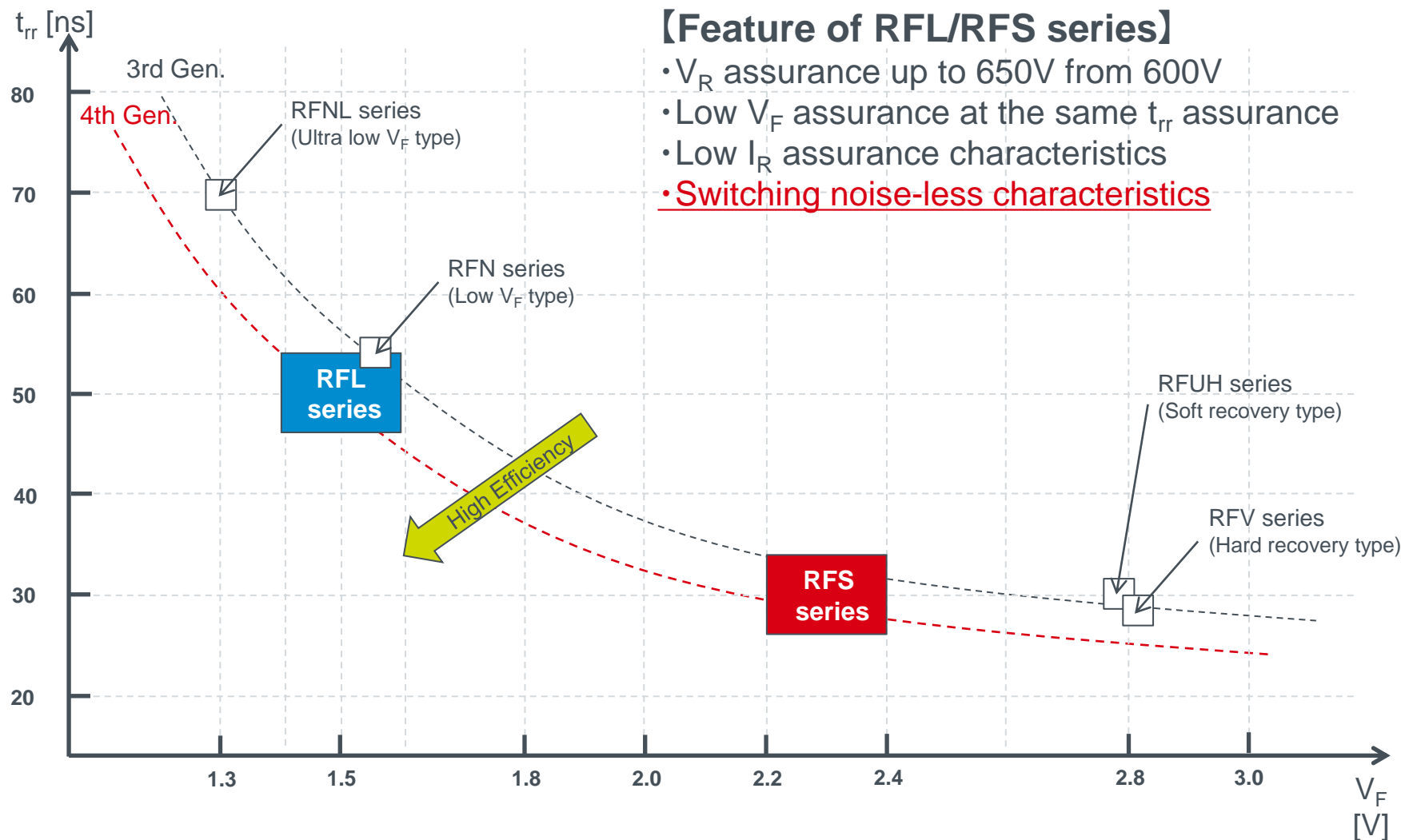
B: Built-in
 NA: Not Available
 MP : Mass Production

Gate Drivers (Complex type)

ITEM	FEATURES														Status
	Package	Isolation [kVrms]	Negative Power Supply	Output Current	GCCD(Source)	Gate Resistance Selecting	Miller Clamp	Short Circuit Protection	Soft Turn OFF	A-Soft Turn OFF	Tj Feedback for SCP Vth	Flyback Controller	Temp Monitor	N of Fail Output	
BM6101FV	SSOP-B20W	2.5	✓	3A	NA	NA	E	✓	✓	NA	NA	NA	NA	1	MP
BM6102FV	SSOP-B20W	2.5	NA	3A	NA	NA	E	✓	✓	NA	NA	NA	NA	1	MP
BM6104FV	SSOP-B20W	2.5	✓	3A	NA	NA	E	✓	✓	NA	NA	NA	NA	1	MP
BM6112FV	SSOP-B28W	3.75	✓	20A	NA	NA	E	✓	✓	✓	NA	NA	✓	2	MP
BM60052AFV	SSOP-B28W	2.5	✓	3A	NA	NA	B	D	✓	NA	NA	✓	NA	2	MP
BM60054AFV	SSOP-B28W	2.5	✓	3A	NA	NA	B	✓	✓	NA	NA	✓	NA	2	MP
BM60055FV	SSOP-B28W	2.5	NA	5A	NA	NA	B	✓	✓	NA	✓	✓	NA	3	MP
BM60059FV	SSOP-B28W	2.5	NA	10A (Sink)	✓	NA	B	✓	✓	✓	NA	✓	✓	1	MP Ready
BM60060FV	SSOP-B28W	2.5	NA	9A	NA	✓	B	✓	✓	✓	✓	✓	✓	1	MP

CCGD: Gate Constant Current Driving
B: Built-in, E: External Nch MOSFET
D:Desat
N:Not Available
MP : Mass Production

Silicon Fast recovery diodes (RFS/RFL series)

650V V_F - t_{rr} trade-off matrix**【Feature of RFL/RFS series】**

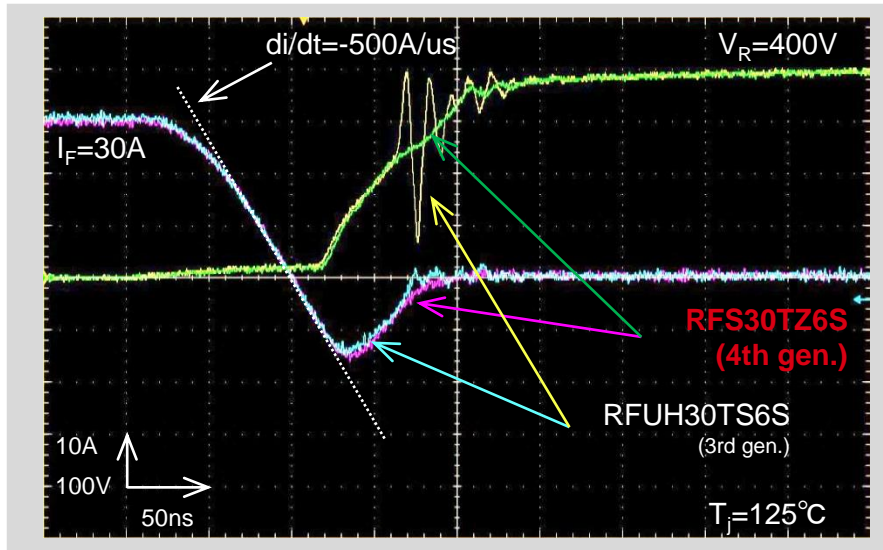
- V_R assurance up to 650V from 600V
- Low V_F assurance at the same t_{rr} assurance
- Low I_R assurance characteristics
- Switching noise-less characteristics

Feature

4th generation FRD
advanced from RFUH series

- **Super soft recovery** (Low noise)
- Low forward voltage
- Low Leakage current
- Ultra high speed switching

4th gen. vs 3rd gen. recovery comparison



RFS series have very low noise characteristics compare to RFUH series. So good influence to EMC improvement.

Applications

☆ Under Development ☆

Consumer / Industry

CCM PFC (ex.air-conditioner)

Secondary side rectification

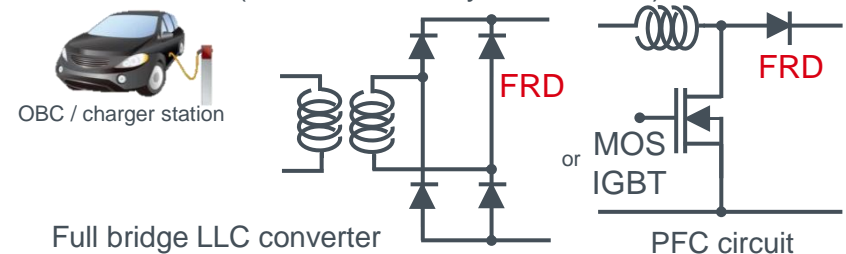
Charger station



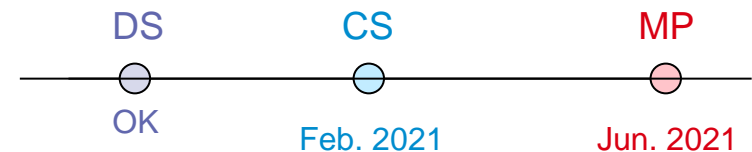
Automotive

On Board Charger

(PFC, Secondary rectification) etc.



Target Schedule



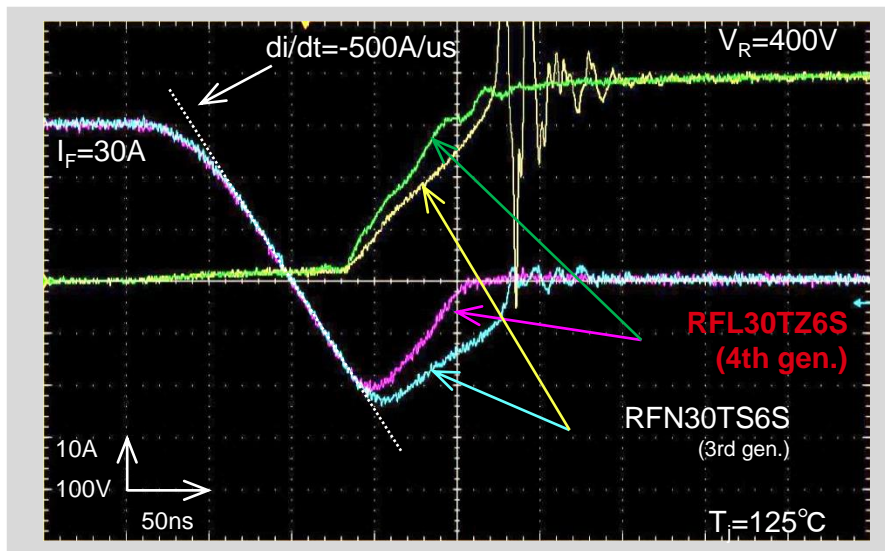
This schedule is subject to change without notice.

Feature

4th generation FRD
advanced from RFN series

- **Super soft recovery** (Low noise)
- Super low forward voltage
- Low Leakage current
- High speed switching

4th gen. vs 3rd gen. recovery comparison



RFL series have very low noise characteristics compare to RFN series. So good influence to EMC improvement.

Applications

☆ Under Development ☆

Consumer

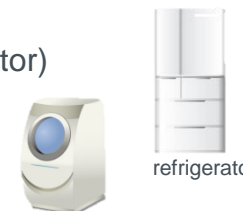
DCM PFC (ex.air-conditioner)



Inverter FWD

(air-conditioner, washing machine, refrigerator)

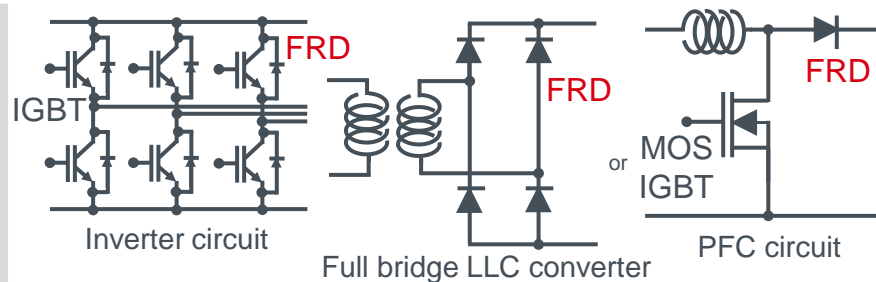
Charger station



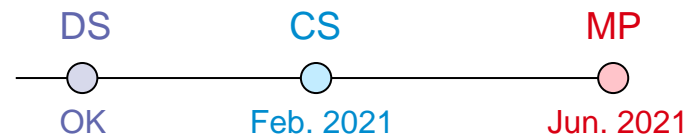
Automotive

On Board Charger

(Secondary rectification) etc.



Target Schedule

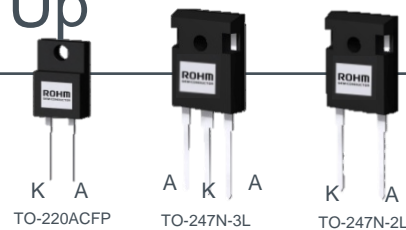


This schedule is subject to change without notice.

4th Generation 650 FRD Line Up

G : halogen free

FHG : halogen free for automotive grade

 t_{rr} condition : $I_F=0.5A, I_R=1A, I_{rr}=0.25I_R$ 

☆ Under Development ☆

TENTATIVE

RFS series (t_{rr} type)

full name			package	I _O [A]	I _{FSM} [A] sin 60Hz	V _F max [V]		I _R max [uA]		t _{rr} max [ns]	circuit	AEC- Q101
P/N	code	tube					I _F [A]		V _R [V]			
RFS20TJ6S	G	C9	TO-220ACFP	20	120	2.3	20	5	650	30	single	-
	FHG	C9	TO-220ACFP	20	120	2.3	20	5	650	30	single	qualified
RFS30TZ6S	G	C13	TO-247GE-2L	30	160	2.3	30	5	650	40	single	-
	FHG	C11	TO-247N-2L	30	160	2.3	30	5	650	40	single	qualified
RFS60TZ6S	G	C13	TO-247GE-2L	60	250	2.3	60	10	650	55	single	-
	FHG	C11	TO-247N-2L	60	250	2.3	60	10	650	55	single	qualified
RFS30TS6D	G	C13	TO-247GE-3L	30	80	2.3	15	5	650	30	cathode common	-

RFL series (V_F type)

full name			package	I _o [A]	I _{FSM} [A] sin 60Hz	V _F max [V]		I _R max [uA]		t _{rr} max [ns]	circuit	AEC- Q101
P/N	code	tube					I _F [A]		V _R [V]			
RFL30TZ6S	G	C13	TO-247GE-2L	30	200	1.5	30	5	650	55	single	-
	FHG	C11	TO-247N-2L	30	200	1.5	30	5	650	55	single	qualified
RFL60TZ6S	G	C13	TO-247GE-2L	60	320	1.5	60	10	650	75	single	-
	FHG	C11	TO-247N-2L	60	320	1.5	60	10	650	75	single	qualified

These specs are subject to change without notice.

