ROHM Solution proposal for On Board Charger

2021.07.27
System Solutions Engineering Headquarters
FAE1 Dept.
High Power FAE Division
Electric Powertrain Group

Agenda

Ver. 20210716

- ROHM’s actual business and position in automotive market
- OBC (On Board Charger) market trend
- Recommended components by topology solution
  - New Hybrid-IGBT
  - New SiC Power Module
  - New High performance Op amps and Resistors
- SiC Power module Proposal
- Protection circuit Proposal
- Recommended surrounding components for drive circuit solution
- Introduction of application support tools
- Highlight of recommended components

If you are interested in the recommended parts, please contact with sales.
The detail presentations are prepared.

Propose solutions based on ROHM focus product families.

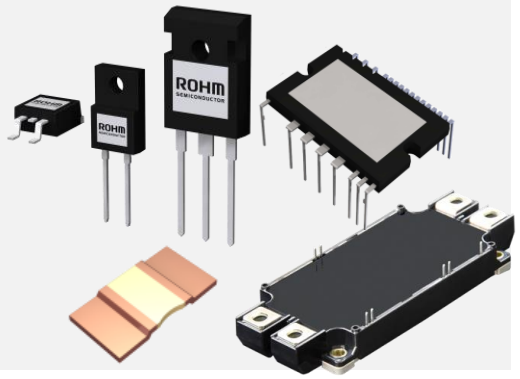
Solution Proposal with 3 product families of ROHM focus.

Customer

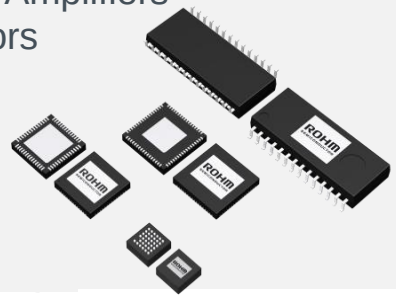
Solution

Power Devices	+	Analog ICs	+	Standard Products

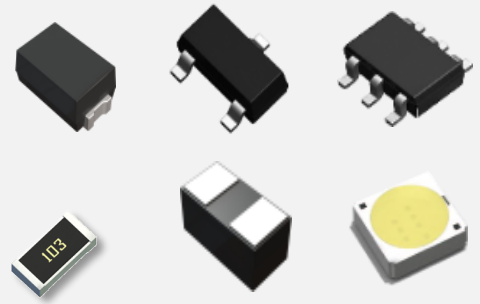
SiC MOSFETs
SiC SBDs
SiC Modules
IGBTs
Super Junction MOSFETs
IPMs
Si MOSFETs
Si Diodes
Shunt Resistors



Isolated Gate Drivers
Power Management
LED Drivers
Motor / Actuator Drivers
IPD (High / Low side Switch)
Interface / Communication
TN/STN LCD Drivers
Supervisor (Voltage Monitor)
EEPROM
Amplifiers & Linear
Audio Amplifiers
Sensors

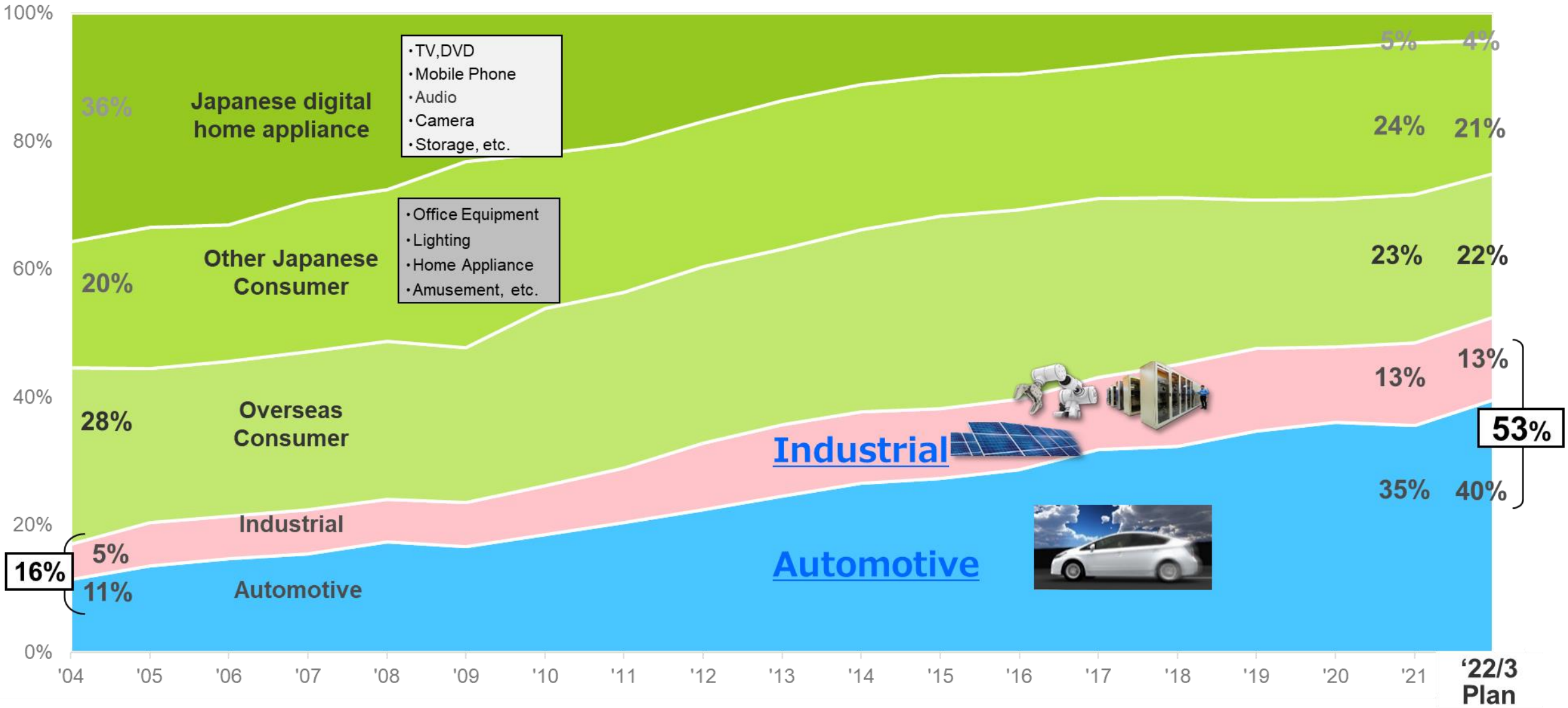


Small Signal MOSFETs
Digital Transistors
Bipolar Transistors
Small Signal Diodes
(Zener, TVS, SBD, FRD etc..)
Resistors
LEDs



Trend of Sales Composition Ratio By Market

ROHM is focusing on Automotive and Industrial markets, aiming for a sales ration of 53%

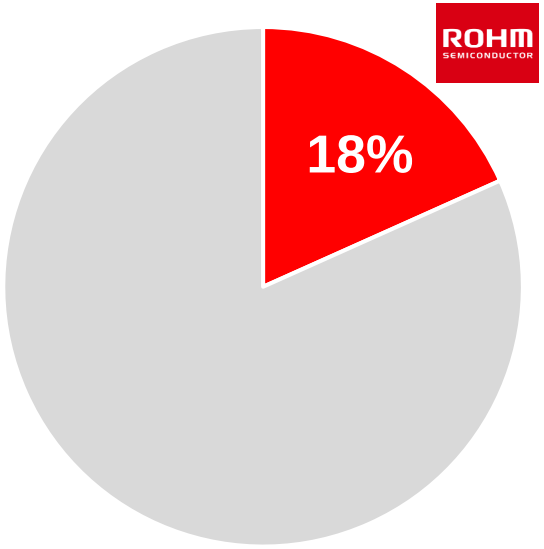


ROHM Discrete sales in automotive

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.

Resistor

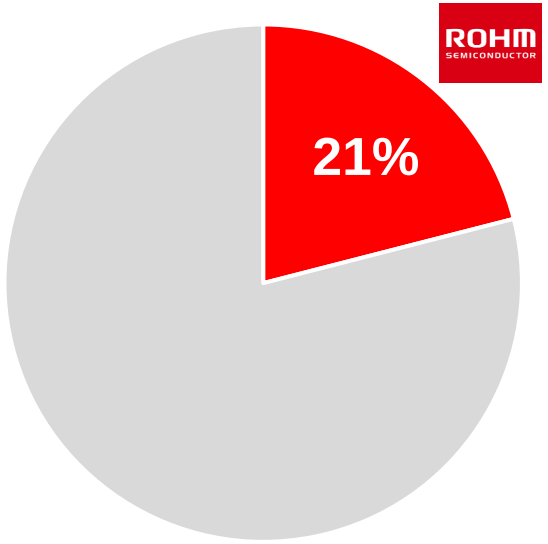
In automotive (No.1)



※Source : Fuji Chimera (2018)

Diode

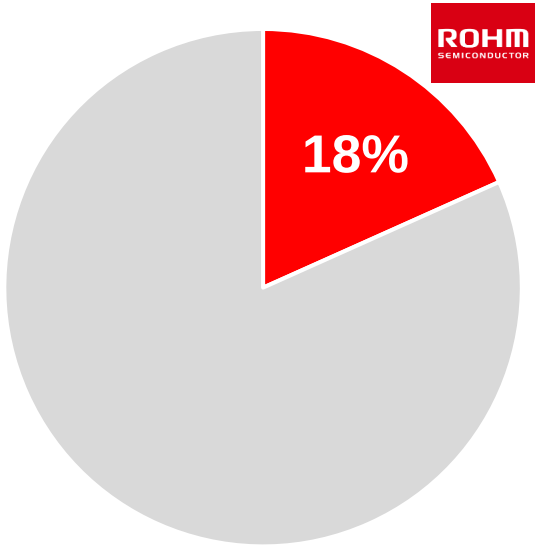
In automotive (No.1)



※Source : Gartner (2018)

SiC

W/W market



※Source : Yole (2019)

ROHM LSIs sales in Automotive

ROHM analog ICs are used in a lot of modules in automotive vehicles.
Because of High reliability and stable supply, high market share is achieved.

Isolated Gate driver	Traction inverter : 11 Customers OBC : 4 Customers	xEV
LDO	Cumulative Qty in automotive Over 3 Billion pcs	For MCU
Switching Regulator	Cumulative Qty in automotive Over 400 Million pcs	For MCU and Display
LED Driver	Shipment Qty for automotive market Over 200 Million pcs/Y	For Lighting

Supplier Award

Received the 2019 Supplier of the year from Continental AG ("Discrete Semiconductors" category)

・Continental AG comprehensively evaluates more than 900 strategic suppliers who meet certain standards set by the company in all aspects such as quality, technology, logistics, and cost, and has given an excellent prize every year since 2008.
In fiscal 2019, 12 companies were selected as excellent suppliers.
ROHM was awarded for the fifth time this time.

・ ROHM received the message as below.

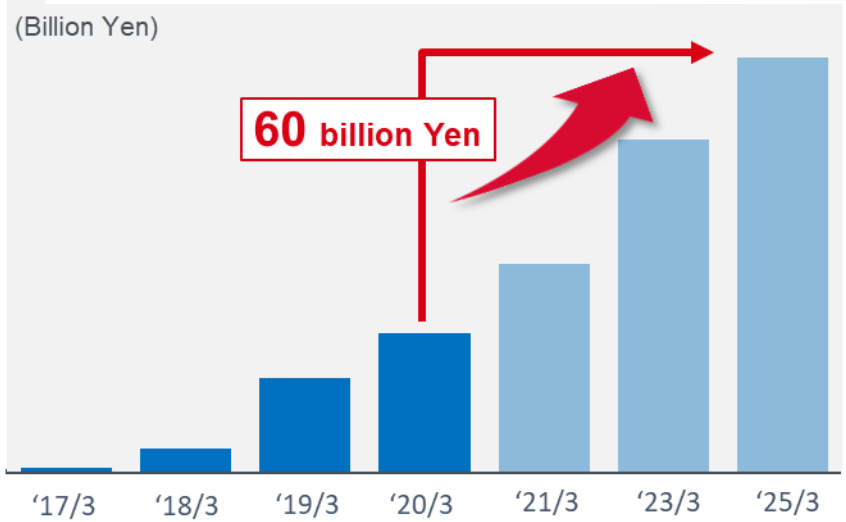
"We are pleased to honor ROHM Semiconductor's commitment with the Supplier of the Year 2019 Award," says Elena Rasmussen, Vice President Purchasing Electronics Discretes at Continental Automotive Group. "With its focus on quality and excellent logistical support, the company is a reliable supplier to meet the challenges in a rapidly changing market. ROHM Semiconductor is both the preferred partner for SiC technology in high voltage inverters and the company of choice in terms of power supplies. We look forward to continuing our close and trustful cooperation with ROHM in the future," adds Rasmussen.

Enhance production capacity for power solutions

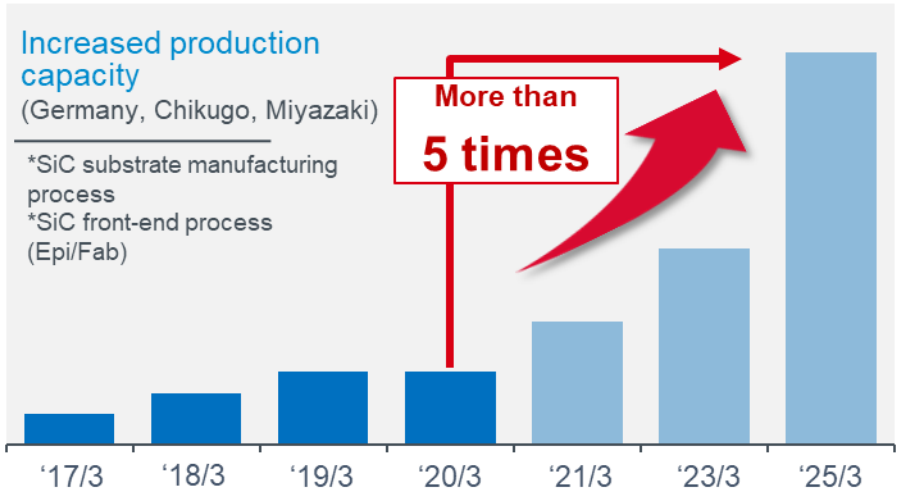
New SiC FAB (Apollo)

Dec. 2020 completion

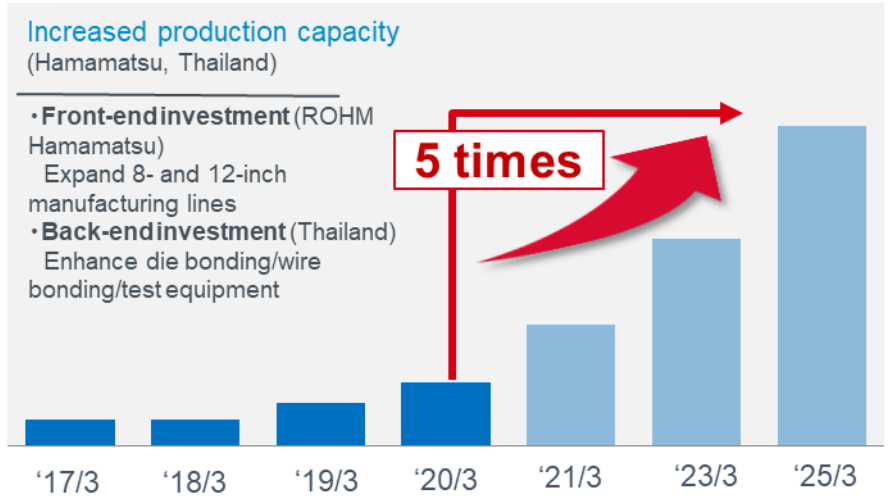
Investment plan (SiC device + Gate driver IC)



SiC production capacity



Gate driver production capacity



Standard Products

Continue to provide stable and long-term supply of standard products as a leading semiconductor supplier.

WW No.1 market share

- Small signal device
- Transistor
- Diode

Standard IC

- Voltage detector
- OP amp
- LDO
- EEPROM

Expanding capacity with new factory to support increasing market demand.

Wafer Fab	Assembly Factory		
Shiga factory	**RIST(Thailand)**	**RWEM(Malaysia)**	**REPI(Philippines)**
			
Started in 2016/Sep	Started in 2016/May	Started in 2017/April	Started in 2019/June
Acquired Tr Di	New building/ Expansion IC	New building/ Expansion Di	New building/ Expansion R

Quality Assurance in Worldwide

QA Center

QA engineers located in various areas throughout the world are able to quickly respond to local customer requests and quality issues

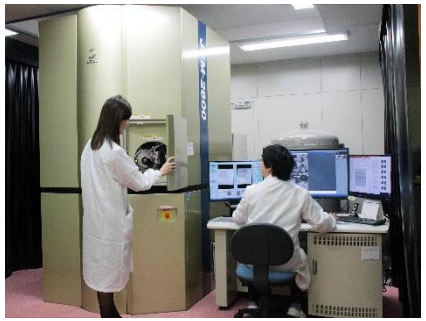
Analysis Center (Kyoto HQ)

Development and evaluation are carried out every day utilizing the latest analysis equipment and technologies to ensure the highest levels of quality and reliability.

Accredited under the international ISO/IEC17025 standard certifying competency for testing and calibration

≪ Authorized Tests ≫

- **Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES)**
- **X-Ray Fluorescence (XRF)**



Worldwide support of stable supply and technical support by Sales and FAEs

≫ Germany

Technical Center
- Willich

Sales Offices
- Dusseldorf
- Stuttgart
- Nuremberg

≫ Hungary

Sales Offices
- Budapest

≫ Korea

Sales Offices/ Technical Center
- Seoul

Sales Offices
- Changwon

≫ Finland

Sales Offices/ Software Development Center
- Oulu

≫ Japan

Sales Offices/Technology Centers
- Kyoto
- Yokohama

Sales Offices
- Tokyo
- Nagoya
- Nishi-Tokyo
- Takasaki
- Sendai
- Matsumoto
- Utsunomiya

≫ The USA

Sales Offices
- Detroit
- San Diego
- Boston
- Mexico

Sales Offices/ Technical Center
- Santa Clara

≫ United Kingdom

Sales Offices
- Milton Keynes

≫ France

Sales Offices
- Paris

≫ Spain

Sales Offices
- Barcelona

≫ Italy

Sales Offices
- Milan

≫ India

Sales Offices/ Technical Center/ Design Center
- Bangalore

Sales Offices
- New Delhi
- Pune

≫ Thailand

Sales Offices
- Bangkok

≫ Malaysia

Sales Offices
- Kuala Lumpur
- Penang

≫ Singapore

Sales Offices
- Singapore

≫ Hong Kong

Sales Offices
- Hong Kong

≫ Philippines

Sales Offices/ Design Center
- Manila

≫ Taiwan

Sales Offices/ Technical Center
- Taipei

Sales Offices
- Kaohsiung

≫ Beijing

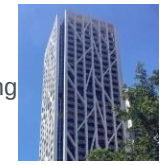
Sales Offices/ Technical Center
- Beijing

Sales Offices
- Tianjin
- Quindao
- Xian
- Dalian

≫ Shenzhen

Sales Offices/Technical Center
- Shenzhen

Sales Offices
- Dongguan
- Zhuhai
- Guangzhou
- Chongqing
- Xiamen
- Fuzhou



≫ Shanghai

Sales Offices/ Technical Center
- Shanghai

Sales Offices
- Nanjing
- Suzhou
- Hangzhou
- Wuhan
- Ningbo
- Hefei

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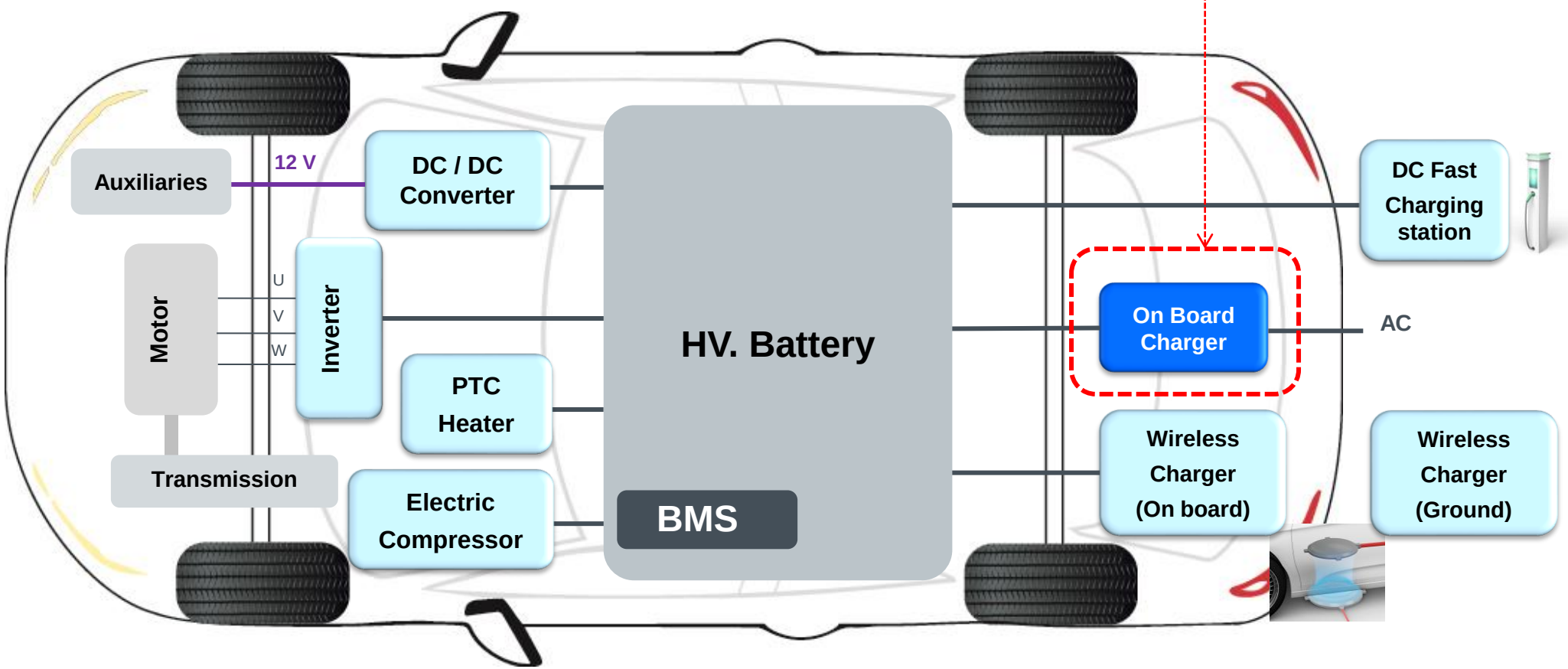
Target applications in xEV

ROHM proposes Total Solution with a focus on SiC to High voltage applications.

Focused application in this presentation.
OBC; On Board Charger

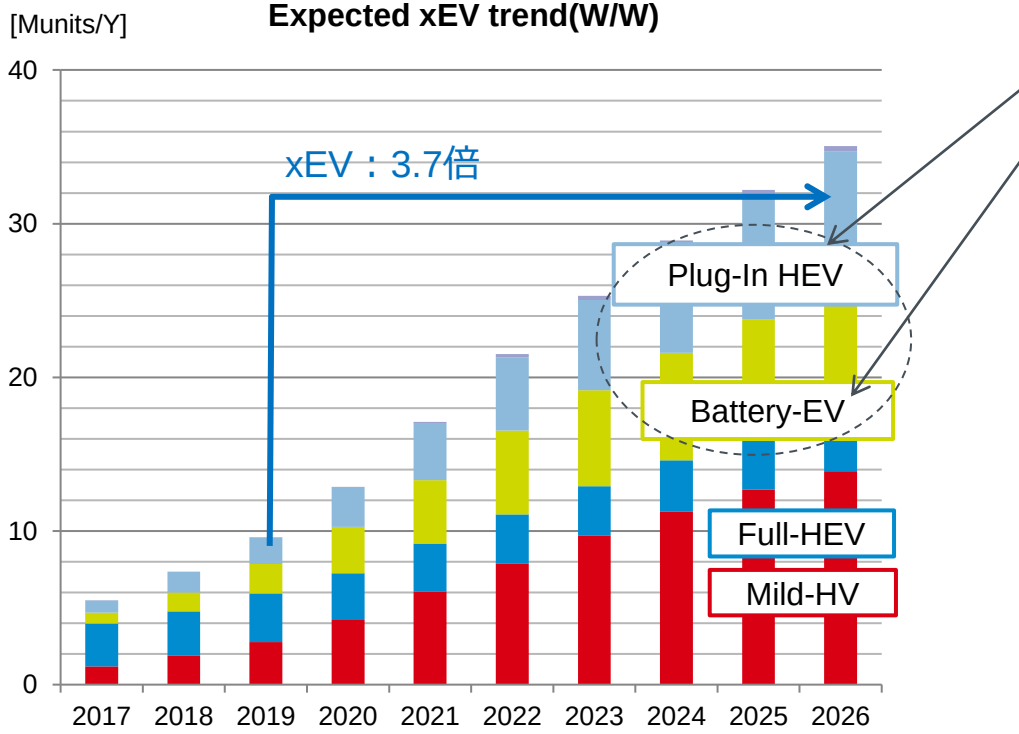


Target Applications

OBC market trend

Battery-EV and Plug-In-HEV mounted OBC market is growing rapidly. China sees strong production increase trend.

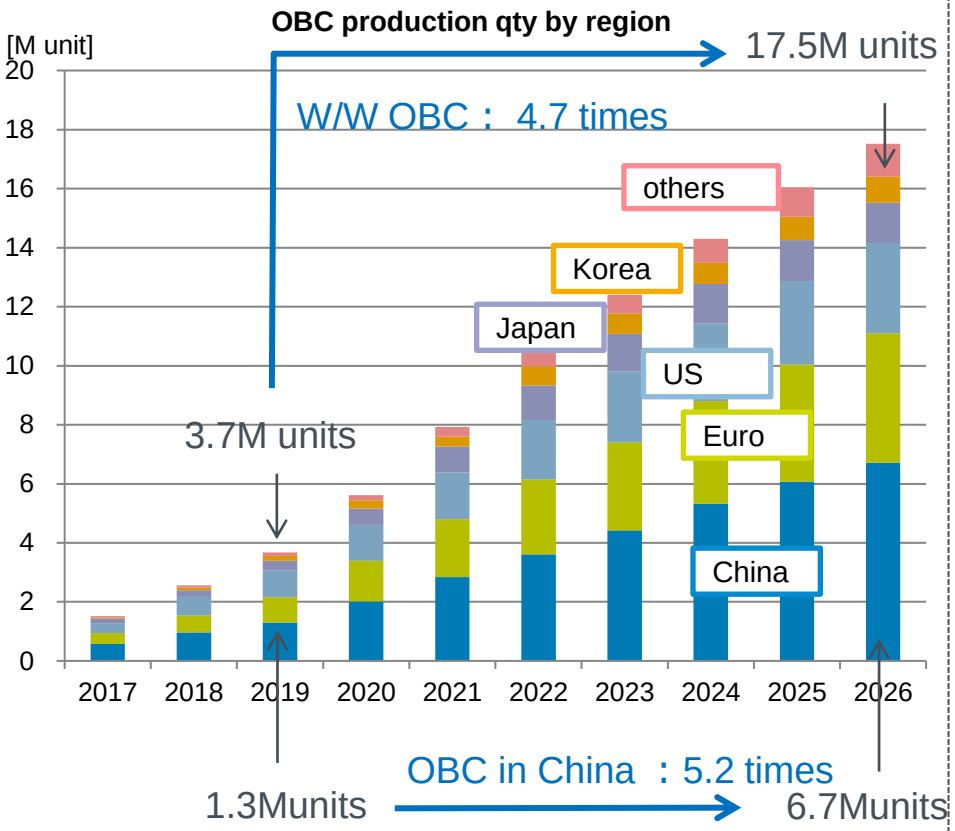
Expected xEV trend(W/W)



出典：Strategy Analysis(19 Sep.)

Expected OBC production

OBCs are mounted in Battery-EV and Plug-In HEV



Source：Strategy Analysis(’19 Sep.)

ROHM's activities for OBC

Address to various OBC requests with packaged products and modules centered on power devices.

OBC needs	Requirements for Semiconductor	ROHM's actions Roadmap
High Voltage 800V battery	High Voltage Power Devices	1200V SiC mass production 1200V IGBT mass production
Variations Output power 3.3～22kW Single/Three phase, Uni/Bi directions	Wide line-up to needs that focus efficiency and cost, etc..	SiC-MOS/SBD mass production Hybrid-IGBT under development * IGBT mass production TO-247: QS available TO-263:2021 Sep. : QS
Small / light weight Transformer miniaturization with high frequency Optimization of heat dissipation structure	Small and Surface mounted package High heat dissipation package Modularization	Package with driver-source terminal TO247-4,TO263-7 under development HSDIP module under development * 2022 Q1:DS
Minimize cost Transformer miniaturization Simplification of heat dissipation structure Reduction of implementation cost	Miniaturization Higher power More integration	Top side cooling package under planning Leadless DFN package(Si-MOS)

* Roadmap is subject to change without notice since it is under consideration.

QS：Qualification Sample、DS：Design Sample

Actual sales in OBC market

More than 20 companies adopt ROHM's SiC devices.
ROHM product portfolio could cover various needs. Not only SiC also IGBT, Hybrid-IGBT, and Power module opportunities are drastically increasing.

SiC: 5companies SOP
1company ready to SOP
Hybrid-IGBT: 2companies under evaluation
Gate-driver: 2companies ready to SOP
Power module: 2company under evaluation

SiC： 2companies SOP
Gate-driver：1Company SOP
Power module: 2company under evaluation

SiC: 3companies SOP
Gate-driver: 1company SOP

SiC: more than 10companies SOP
IGBT: 3company SOP
1companies ready to SOP
Gate-driver: 1company SOP

SiC: 4companies SOP
IGBT: 1company under evaluation
Gate-driver: 1company SOP
Power module: 1companies under evaluation

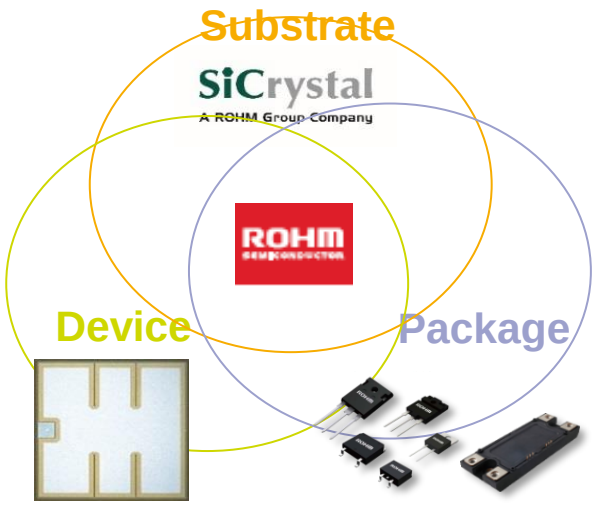
As of Jul. 2021

Why choose ROHM's SiC?

Automotive records based on the fully integrated production system, total solution, and w/w leading technology.

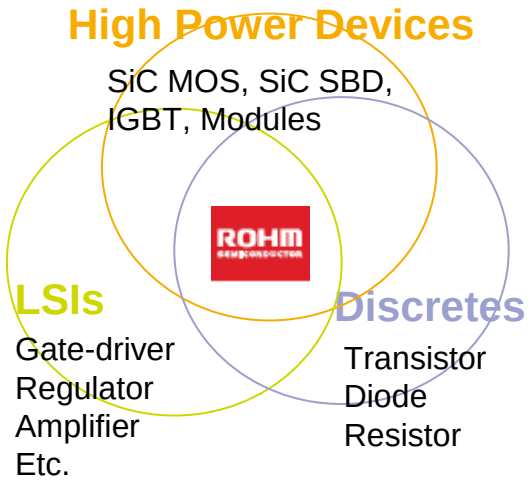
Experienced automotive records

■ Fully integrated production system



Long-term stable supply system and quality assurance from SiC wafers to package assembly

■ Total solution



Competitive device combination
Solution proposal based on understanding customer requirements.

■ Technology leader

2012: World-first
AEC-Q101 qualified
SiC SBD released
Adopted for OBC

2017:
AEC-Q101 Qualified
Planer type SiC MOSFET
Adopted for OBC and
DCDC converter

2018: World-first
AEC-Q101 qualified
SiC Trench MOS released

World-first trench structure.
World-first automotive grade.

Contribution to application

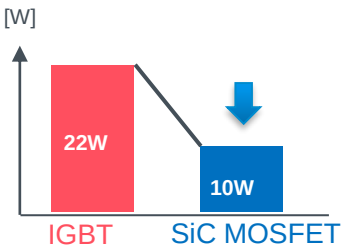
Contribute to miniaturization and high efficiency with the best Power Devices as SiC.

ROHM Solutions

Customer Requirements.

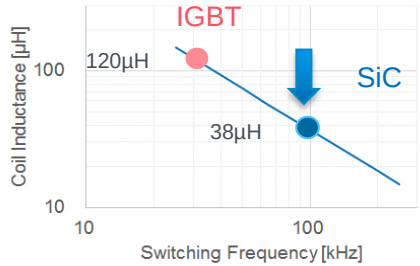
Need to downsizing board design with low cost

Reduction of power loss by SiC



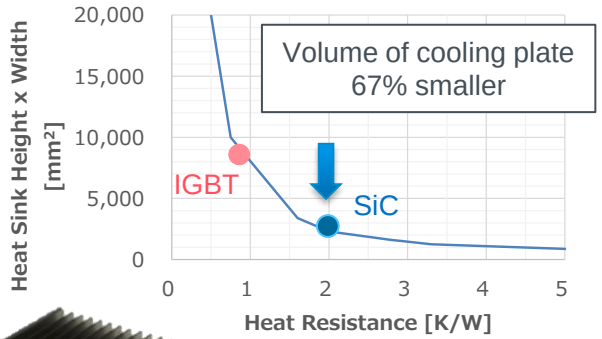
Power loss

High SW freq. drive by SiC



Boost, VIN:220Vac, POUT:4kW

Miniaturization of Cooling Fan



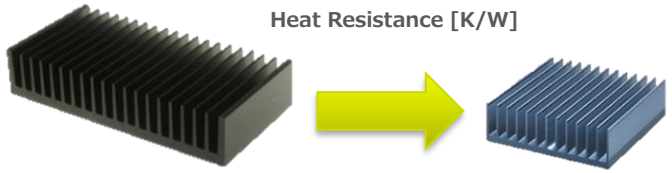


Image of cooling fan miniaturization

Transformer miniaturization by reducing winding wire and core size.

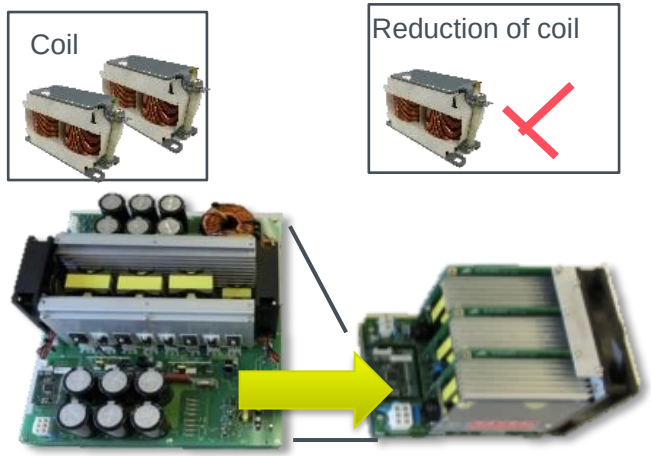


Image of decreasing mounting space

OBC topology by power class

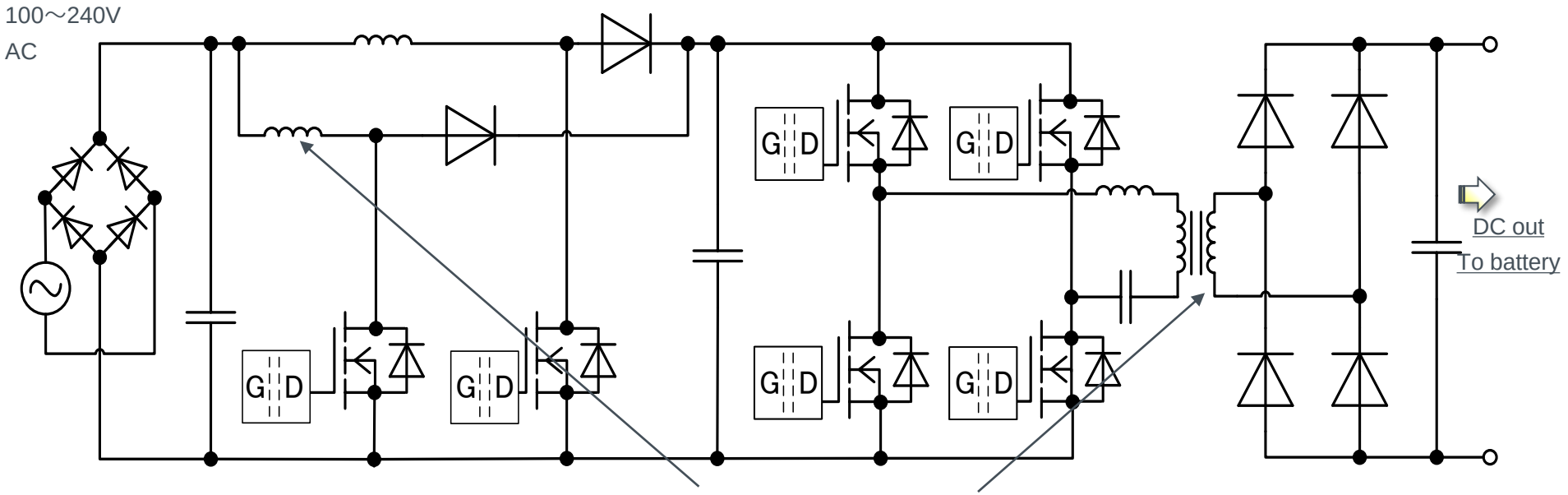
Rohm offers solutions for every type of topologies including bi-directional and higher power systems.

PFC			Output power			
			3.3-3.6kW	6.6-7.2kW	10-11kW	20-22kW
Single Phase	Uni-direction	Interleaved	√	√		
		Bridgeless Totem-pole	√	√	√	
	Bi-direction		√	√	√	
Three Phase	Uni-direction	Bridgeless			√	√
		Vienna Rectifier			√	√
	Bi-direction	Bridgeless			√	√
		Vienna Rectifier			√	√

Interleaved PFC

SiC SBD enables efficiency improvement.

- Interleaved PFC is used in low power class mainly（Cost saving）
- SiC SBDs are widely used in PFC and secondary side（Fast recovery)
- Downsizing inductance and transformer by high SW frequency with SiC



Advantage of high SW

Downsizing of inductor

Downsizing of transformer

Advantage of high Efficiency

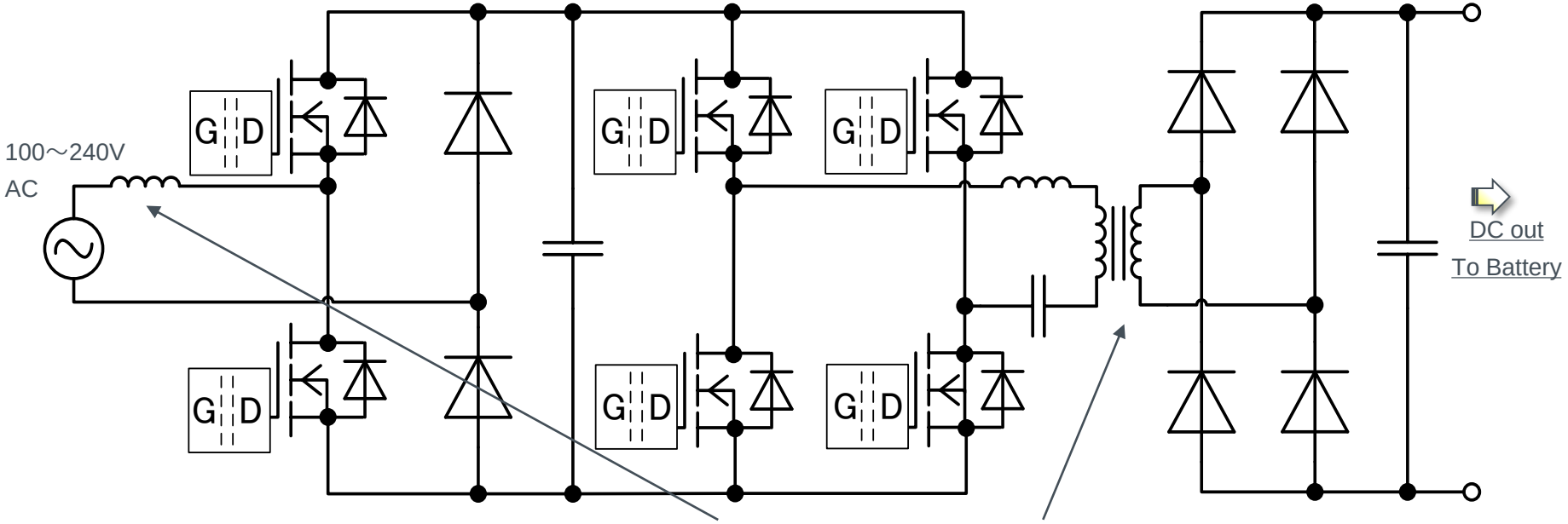
Miniaturization of Heat sink

Decreasing of charging time

Bridge-less totem pole PFC(single direction)

Fast recovery characteristics of SiC MOSFET make it the preferred switching device.

- Bridge-less totem pole PFC is used from low to middle power class.
- High efficiency by eliminating the diode bridge
- SiC MOS body diode has fast recovery characteristic.



Advantage of high SW

Downsizing of inductor

Downsizing of transformer

Advantage of high Efficiency

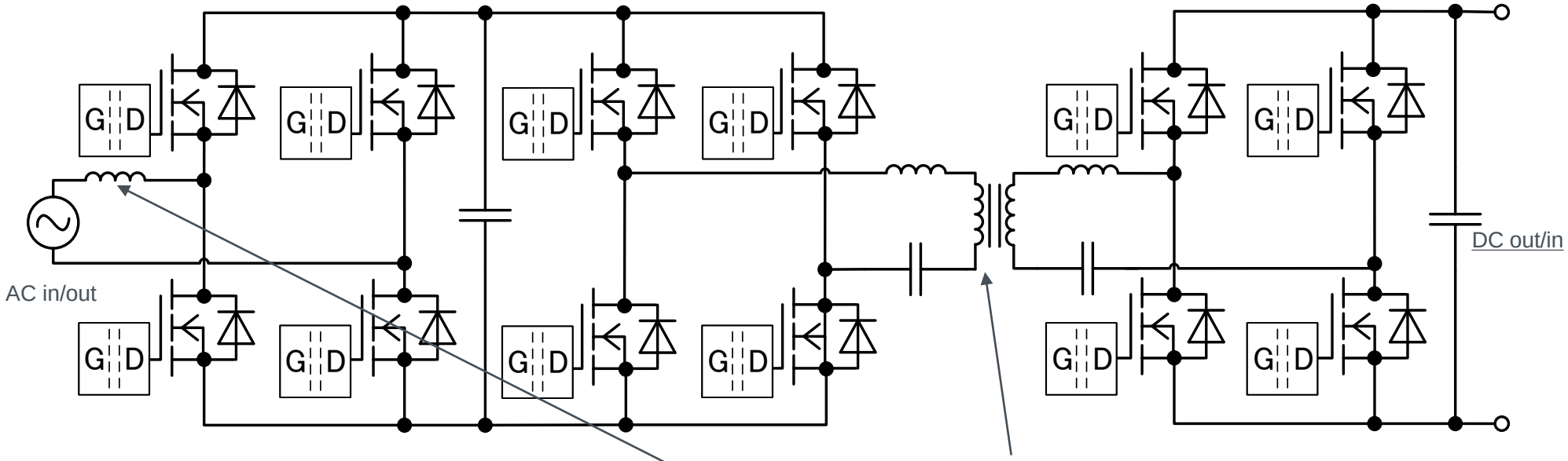
Miniaturization of Heat sink

Decreasing of charging time

Totem pole PFC Bi-directional type（Charge-Discharge)

Fast recovery characteristics of SiC MOSFET make it the preferred switching device.

- Possible AC output by bridge circuit of MOSFETs
- Ensure AC power supply in emergency case and leisure use
- SiC MOS body diode has fast recovery characteristic.



Advantage of high SW

Downsizing of inductor

Downsizing of transformer

Advantage of high Efficiency

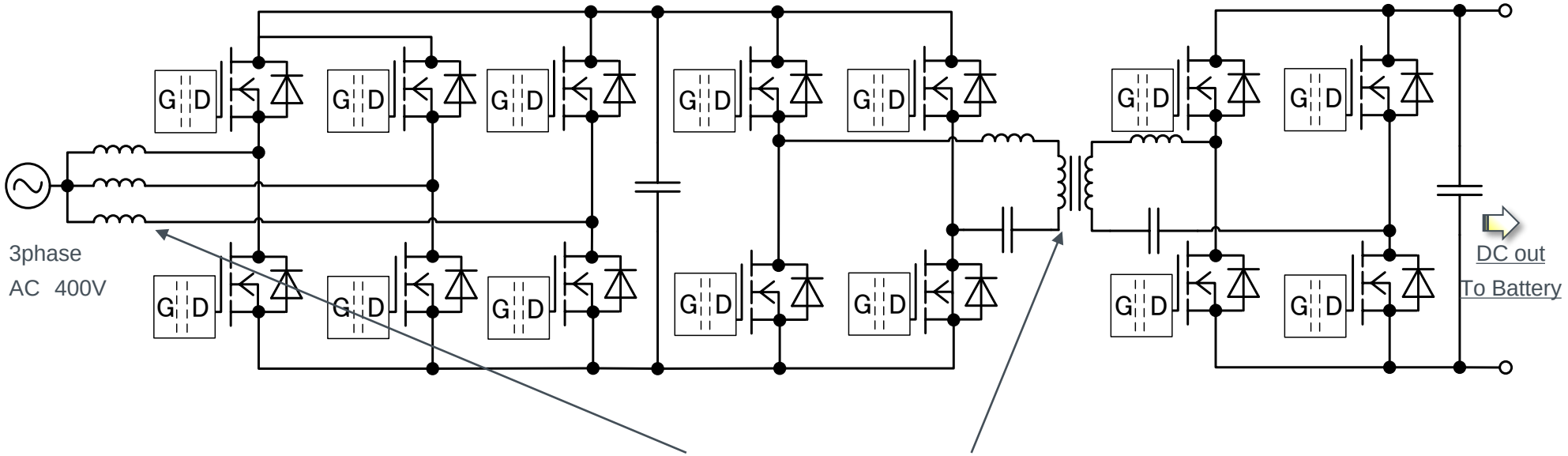
Miniaturization of Heat sink

Decreasing of charging time

Three phase PFC bi-direction （Charge-Discharge)

SiC is the best for High voltage(1200V）and low consumption requirements.

- High Power available for AC input 400V.
- Possible AC output by bridge circuit of MOSFETs
- 1200V SiC MOS realize both high voltage and low Ron



Advantage of high SW

Downsizing of inductor

Downsizing of transformer

Advantage of high Efficiency

Miniaturization of Heat sink

Decreasing of charging time

Agenda

- ROHM's actual business and position in automotive market
- OBC (On Board Charger) market trend
- Recommended components by topology solution
  - 1.Uni-directional OBC solution
    - -1 Interleaved PFC solution
    - -2 Totem pole PFC solution
    - -3 DCDC converter solution
  - 2. Bi-directional OBC solution
  - 3. 3-Phase OBC solution
- SiC Power Module
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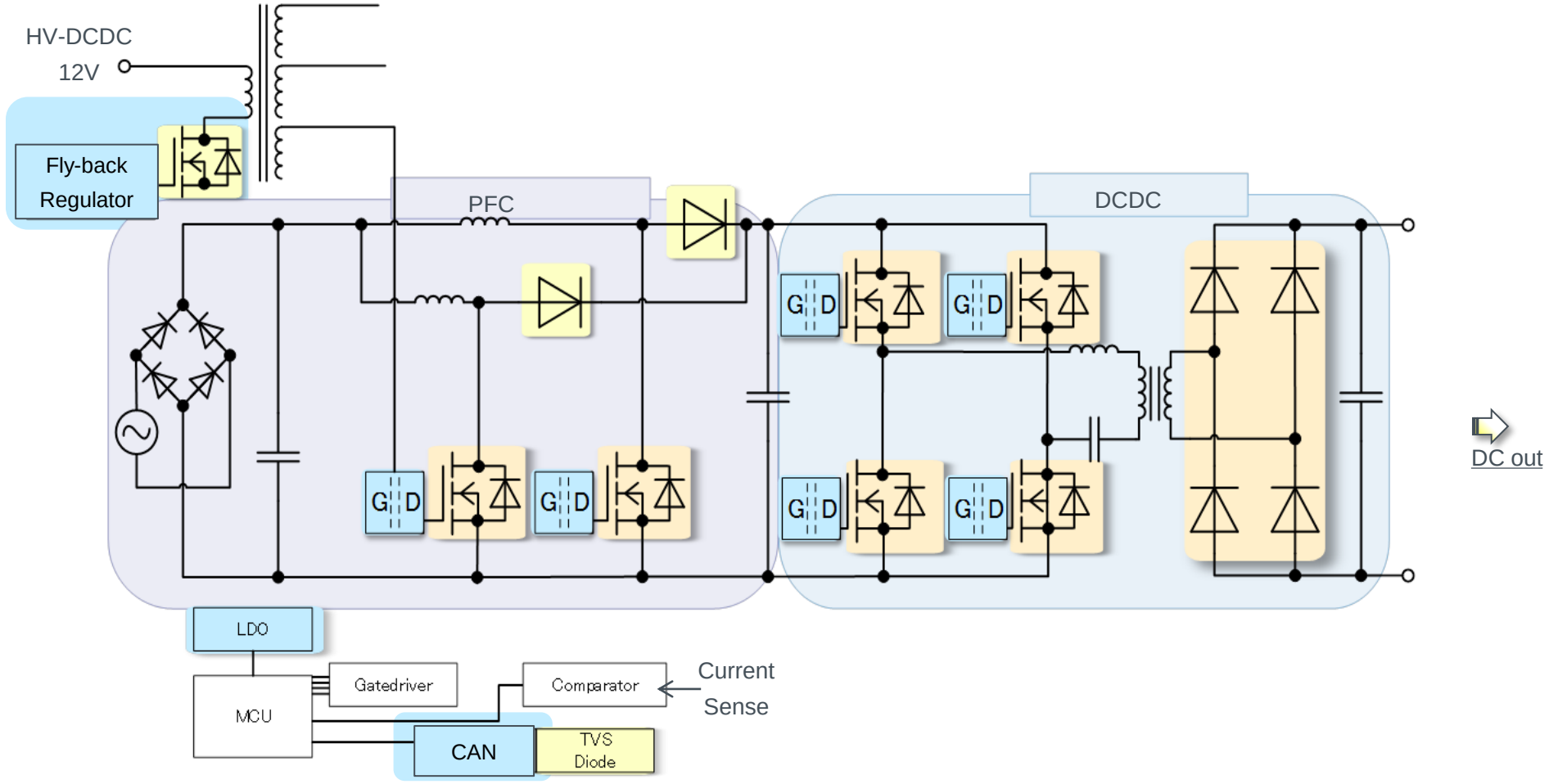
Proposal outline for Uni-directional OBC

Rohm solutions with wide selection from Power device, LSI to Discrete product lineup.



High reliability	High voltage & low loss	Extensive lineup
Power supply & driver **LSI**	IGBT/SiC **Power device**	TR/DI/R **Discrete**

Uni-directional OBC (Interleaved PFC)

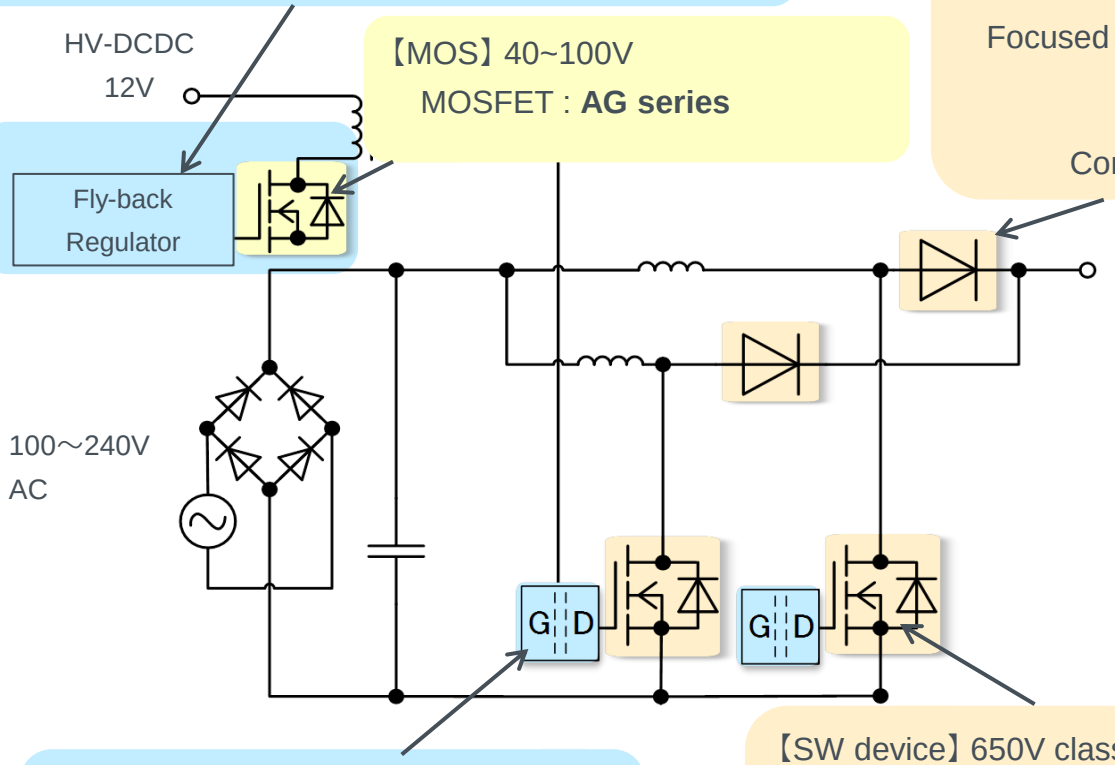
SiC-SBDs are commonly used. Rohm can propose Si FRDs and IGBTs for low cost solutions.

【Isolated DCDC】40V max.
DCDC:**BD7Fx05EFJ series(Developing)**

【MOS】40~100V
MOSFET : **AG series**

【Diode】600V class~
Focused on efficiency / SiC SBD : **SCS2xxA series**
Focused on cost / FRD : **RFUH series**
RFS series (Developing)

Contribution to downsizing and improving efficiency



【Gate driver】3,750V
: **BM61S/MxxRFV series**

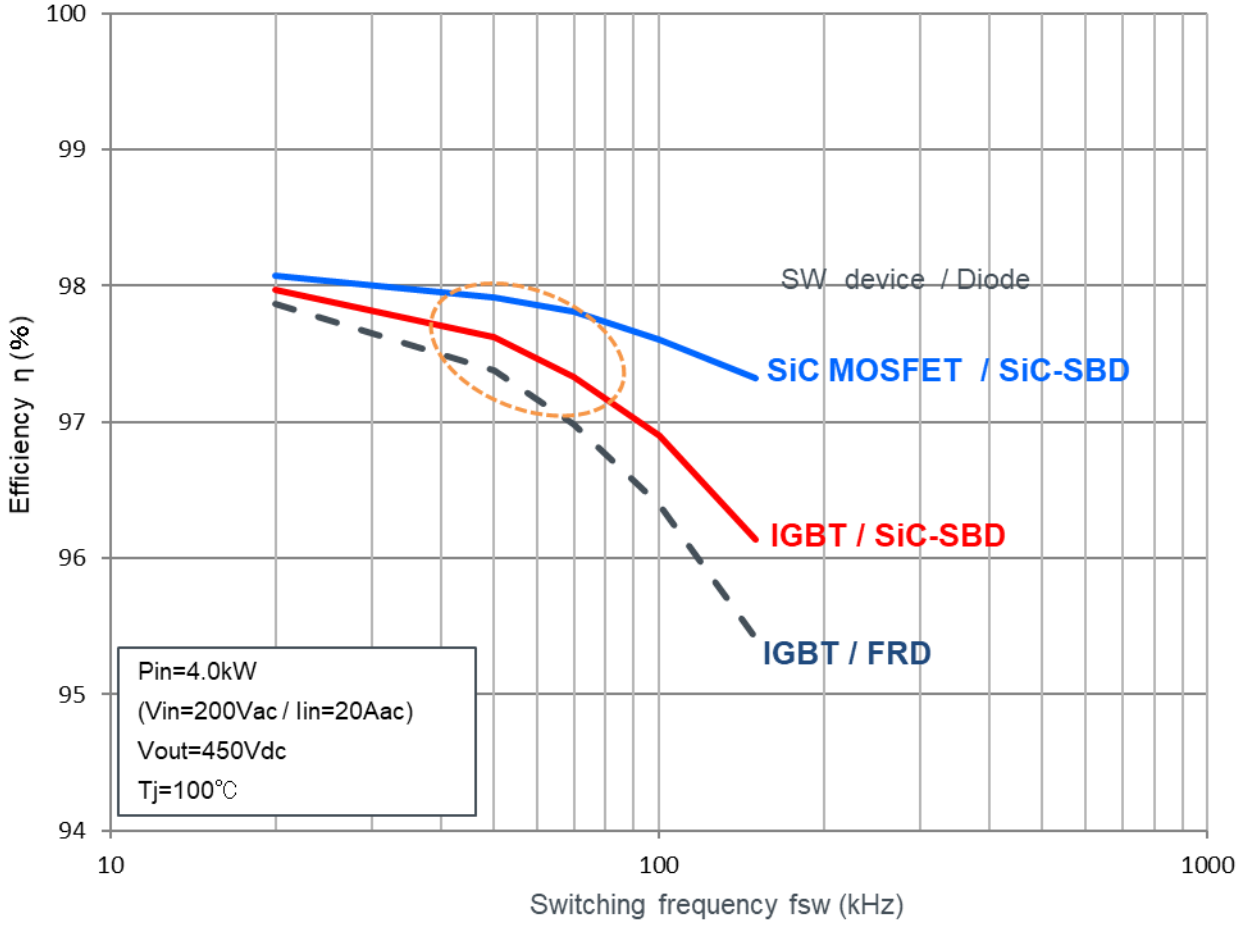
Integrated miller clamp

【SW device】650V class~
Focused on efficiency / SiC MOS: **SCT3xxxAL series**
Focused on cost / IGBT : **RGWxxxx65DHR series (Developing)**

Contribution to downsizing and improving efficiency

Simulation data (Interleaved PFC) Si vs SiC-1

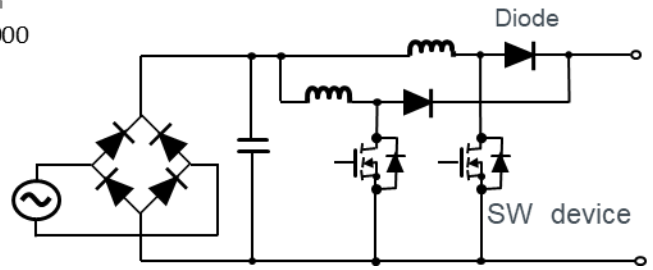
Replacing Si FRDs by SiC-SBDs improves efficiency by 0.3%.
SiC MOSFET could bring much higher efficiency.



SiC MOSFET
Efficiency : approx. 0.6% improvement
→Approx. 24W loss reduction
@ 4.0kW
Downsizing of heat sink
Ensure thermal design margin

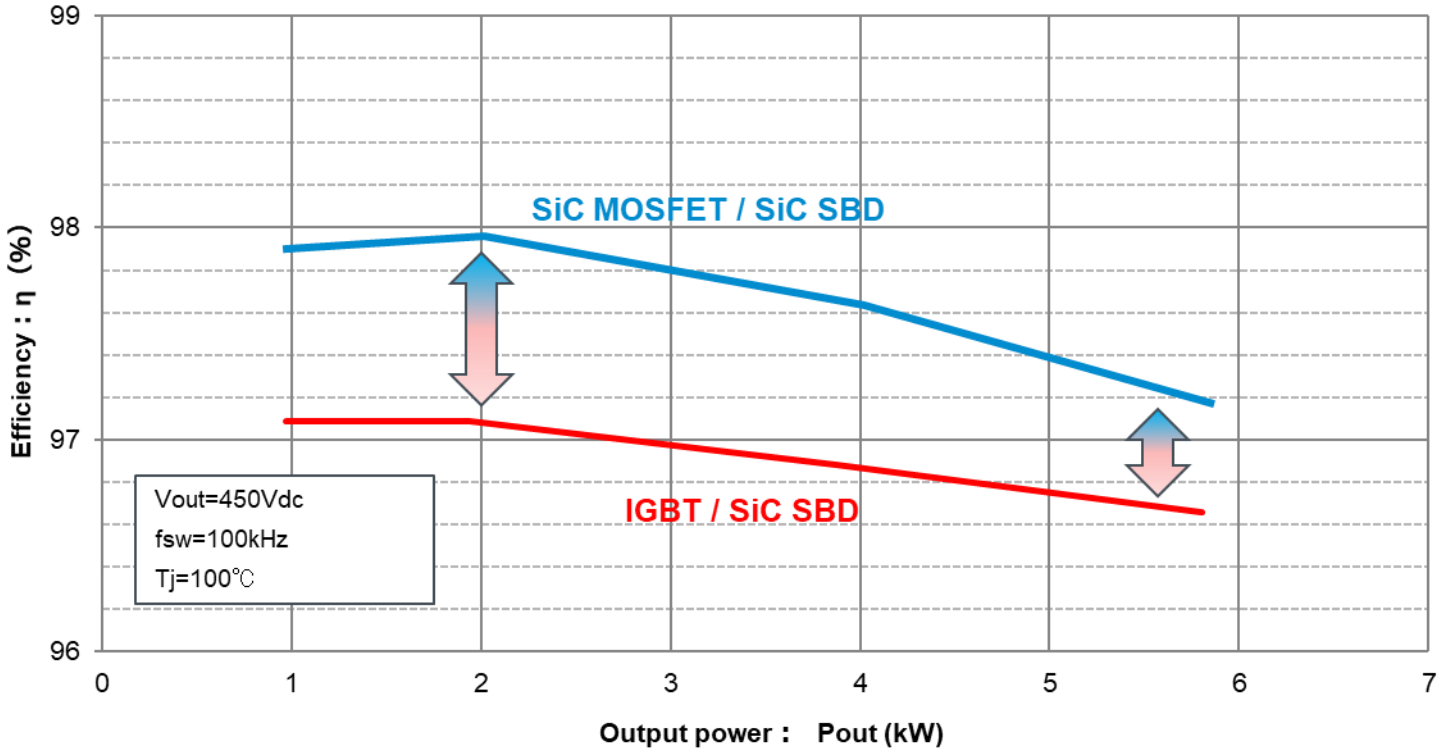
SiC SBD
Efficiency : approx. 0.3% improvement
→Approx. 12W loss reduction
@ 4.0kW
Downsizing of heat sink
Ensure thermal design margin

Bigger ← Application size → Smaller
Low freq High freq



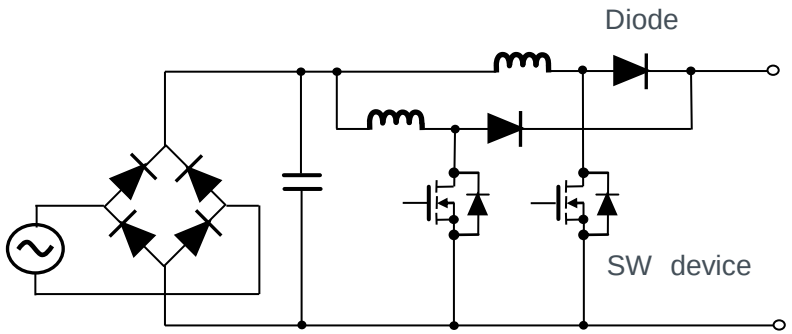
Simulation data (Interleaved PFC) Si vs SiC-2

SiC MOS achieves higher efficiency in all output power range.



Light load ← load condition → Heavy load

In case of interleaved PFC, SW loss has a big impact at light load condition, on the other hand on-resistance affects efficiency at heavy load condition. However SiC MOSFET has better efficiency in either situation.

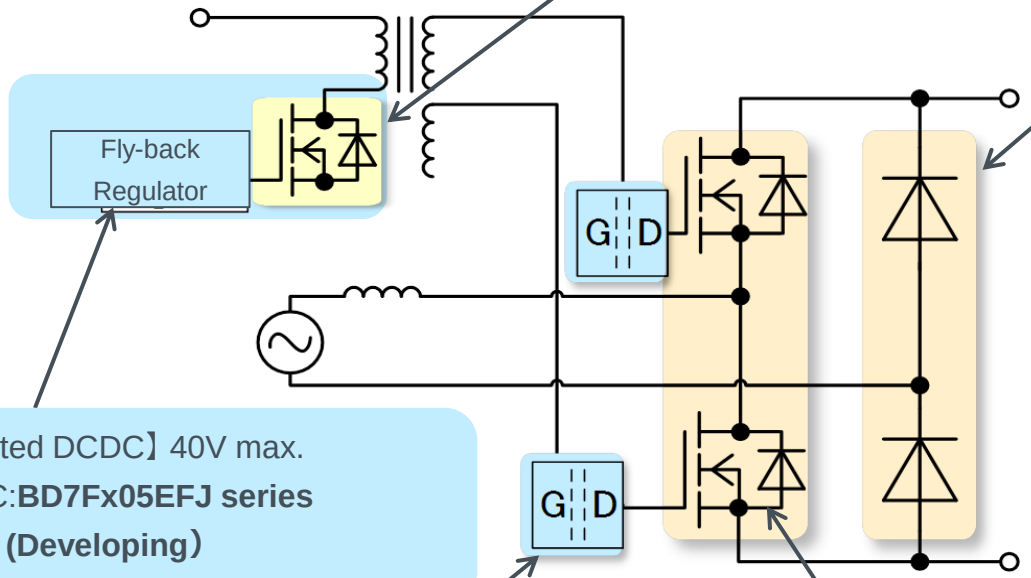


Uni-directional OBC (Totem pole PFC)

Fast Recovery characteristic of SiC MOSFET is the best choice for Totem Pole PFC circuits. Alternatively, Hybrid IGBT can also offer better efficiency than SJ-MOSFETs.

【MOS】40~100V
MOSFET : **AG series**

【Diode】600V class～
Si FRD : **RFN series**
RFL series (Developing)



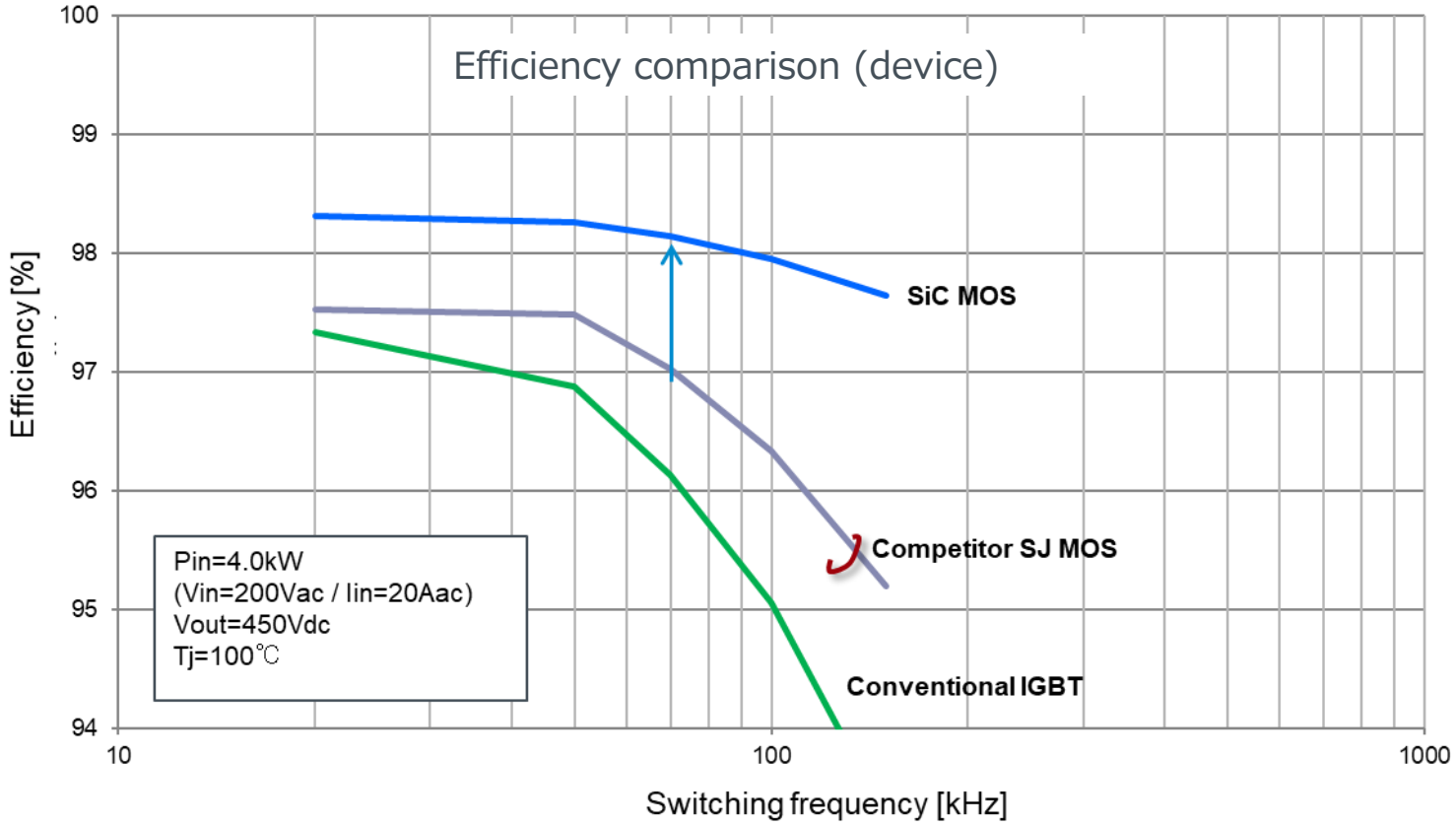
【Isolated DCDC】40V max.
DCDC:**BD7Fx05EFJ series**
(Developing)

【Gate driver】3,750V
: **BM61S/MxxRFV series**
＊Integrated miller clamp

【SW device】650V class～
Focused on efficiency / SiC MOS: **SCT30xx series**
/Hybrid IGBT: **RGWxxxx65C series (Developing)**
Focused on cost / IGBT : **RGWxxxx65D/E series**
Contribution to downsizing and improving efficiency

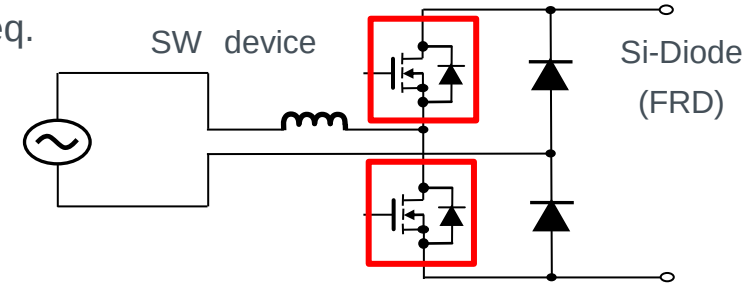
Totem pole PFC Efficiency Simulation-1 Si vs SiC

SiC MOSFET delivers highest efficiency thanks to lower recovery loss. Hybrid IGBT also offers better efficiency than SJ MOSFET.



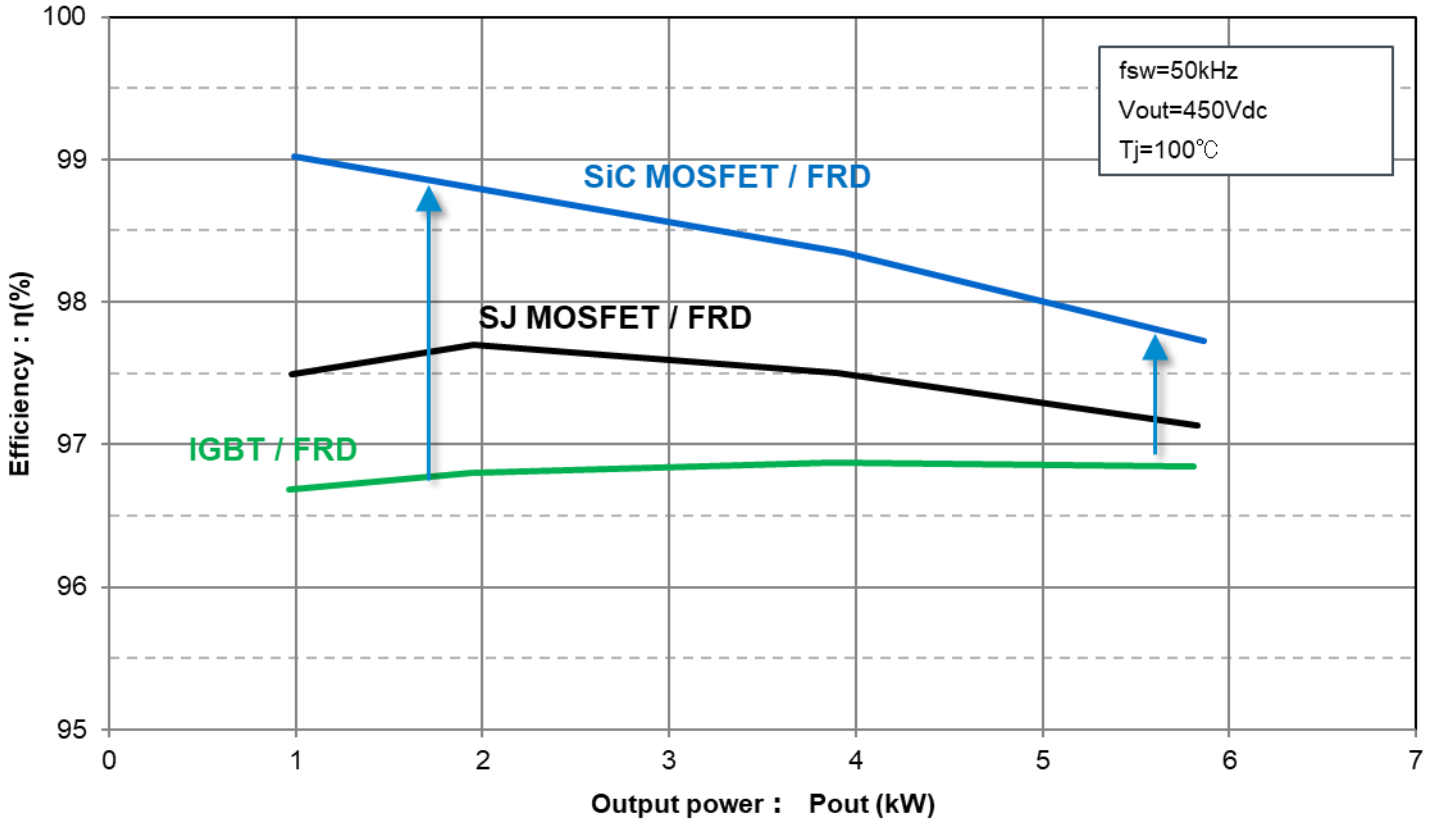
Lower freq. ← frequency condition → Higher freq.

- SiC MOS recovery loss is smaller than SJ-MOS one.
  - Efficiency: approx.1.1% improvement
    - → Aprrox.44W loss reduction @4.0kW
  - Downsizing of heat sink
  - Ensure thermal design margin

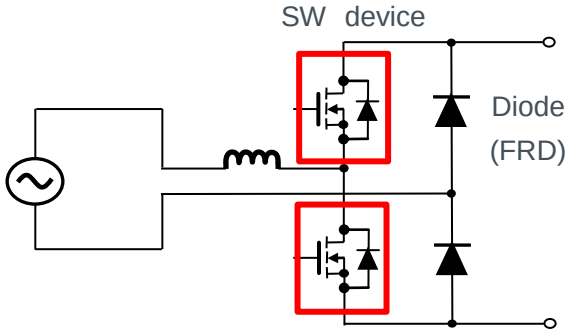


Totem pole PFC Efficiency Simulation-2 Si vs SiC

SiC MOSFET achieves higher efficiency in all output power range.



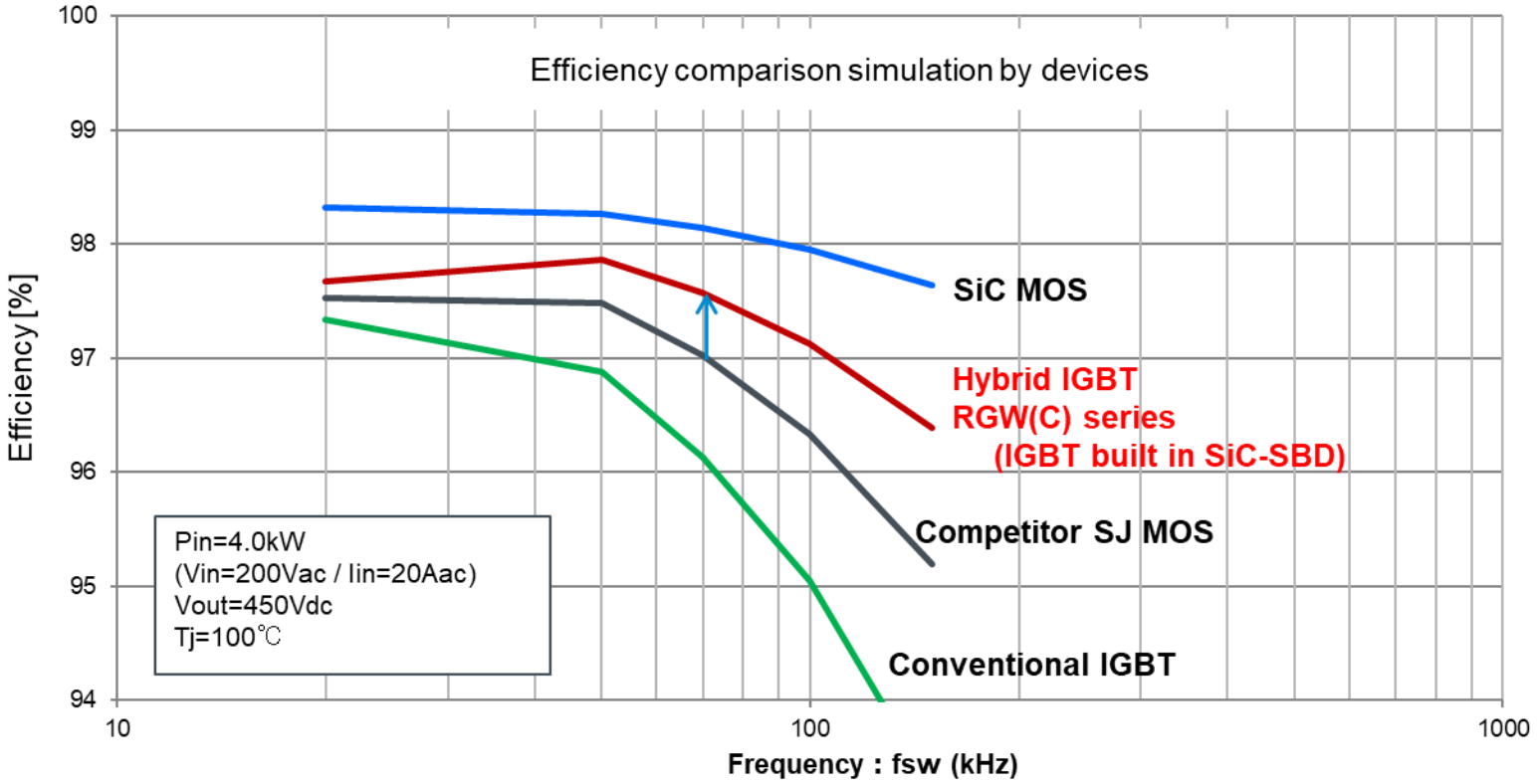
Light load ← load condition → Heavy load



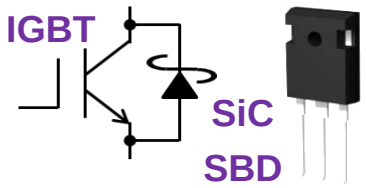
In case of totem pole PFC, SW loss has a big impact at light load condition, on the other hand on-resistance affects efficiency at heavy load condition. However SiC MOSFET has better efficiency in either situation.

Simulation data (Totem pole PFC) Si vs SiC

Hybrid IGBT has higher efficiency against SJ-MOS and is ideal for totem pole PFCs!



Hybrid IGBT includes an IGBT chip and SiC-SBD chip in one package.



Hybrid IGBT/RGW(C) series comparison with SJ MOS.

Efficiency: approx.0.5% improvement @70kHz

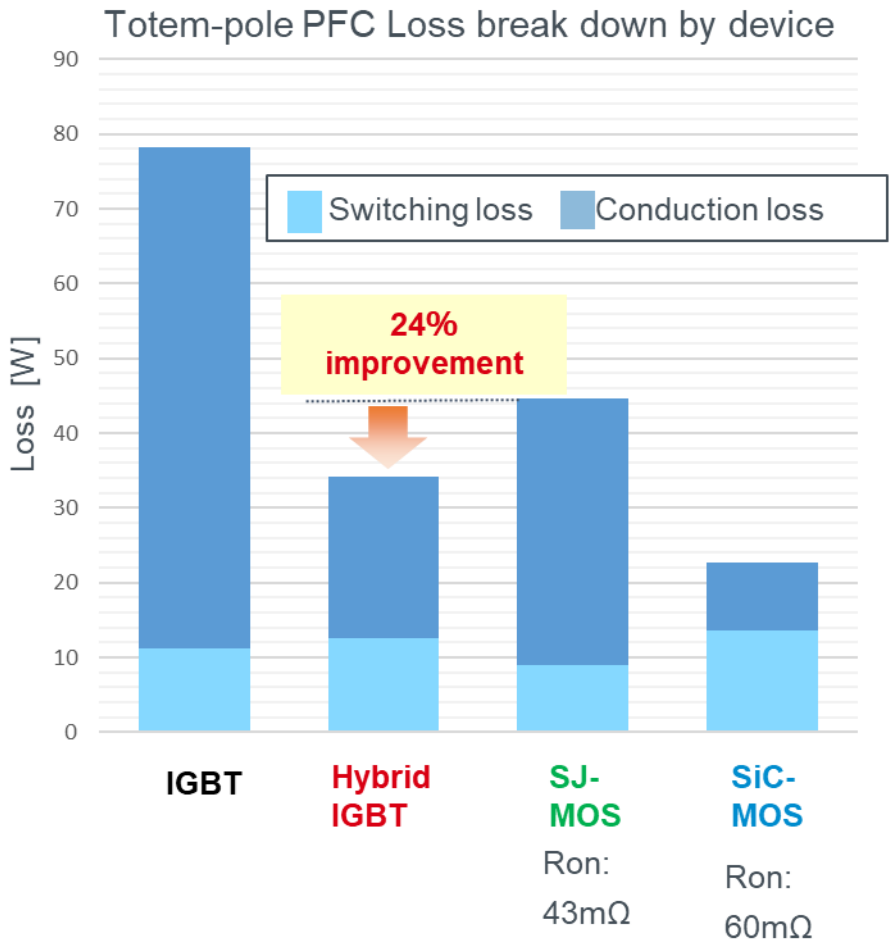
→ Approx.20W loss reduction@4.0kW

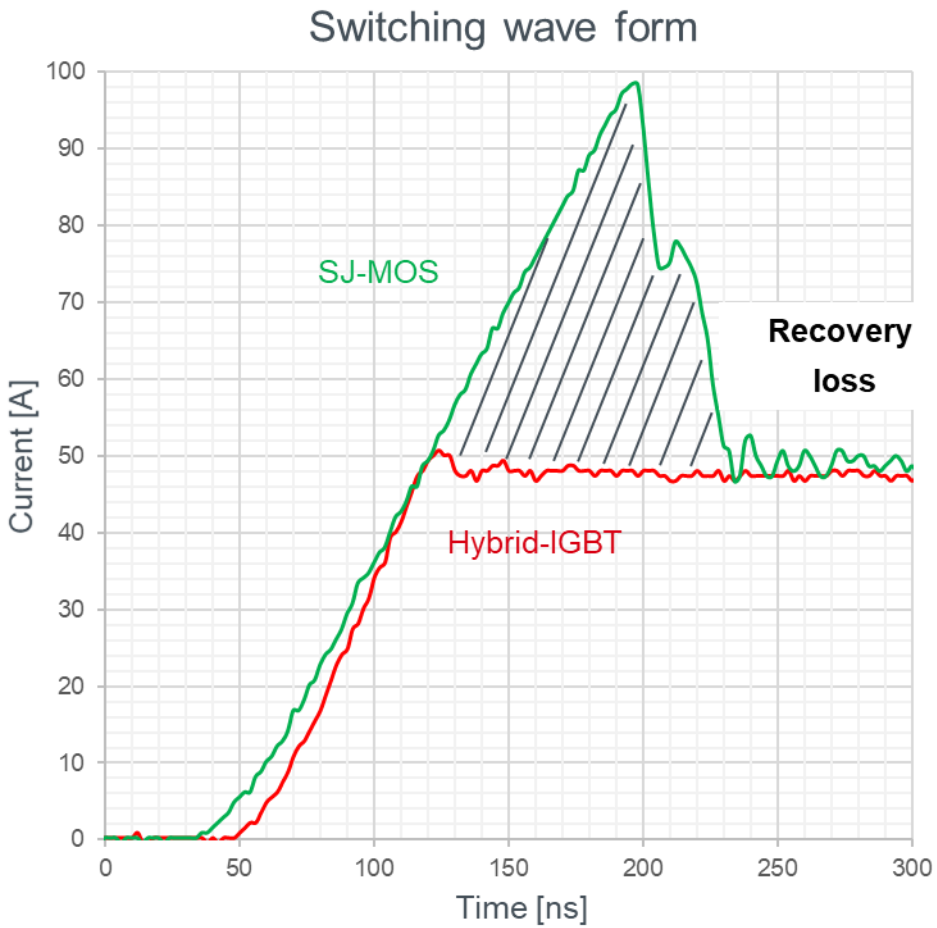
Downsizing of heat sink

Ensure thermal design margin

Totem pole PFC: Hybrid IGBT vs SJ-MOS

Hybrid IGBT has better switching loss thanks to no recovery loss.





Switching loss is more dominant than conduction loss in the efficiency of totem pole PFC

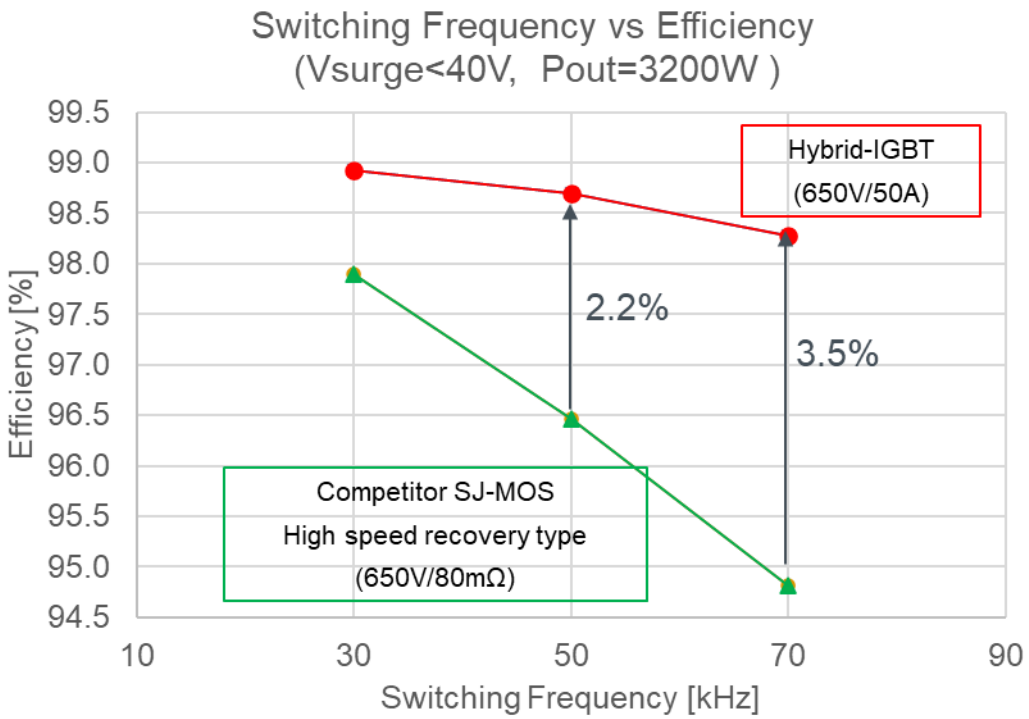
→Hybrid-IGBT：24% loss improvement

Hybrid-IGBT achieves high efficiency because there is almost no recovery current and switching loss can be reduced!

Totem pole PFC：Hybrid IGBT vs SJ-MOS

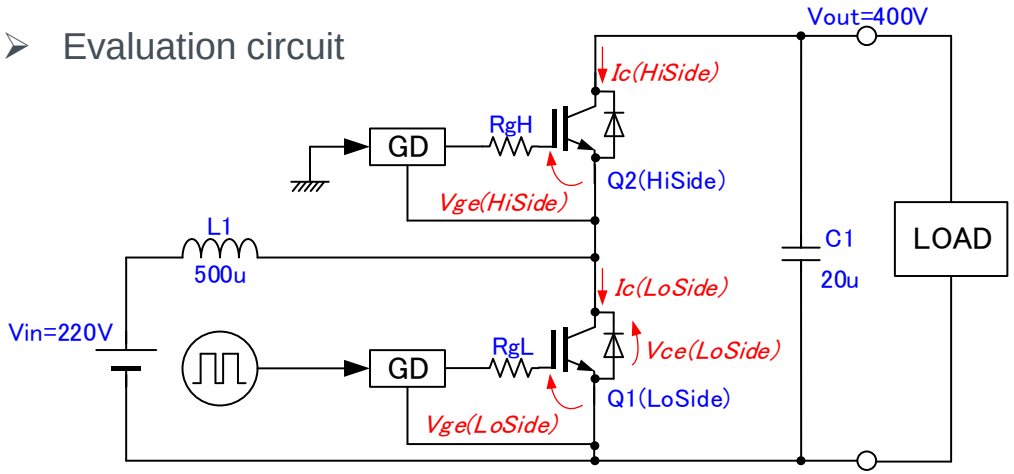
Hybrid IGBT has higher efficiency than SJ MOSFET and are ideal for totem pole PFC.

Actual Evaluation efficiency comparison by device



Efficiency 3.5% improvement @70kHz
：112W loss reduction @3.2kW output

➢ Evaluation circuit



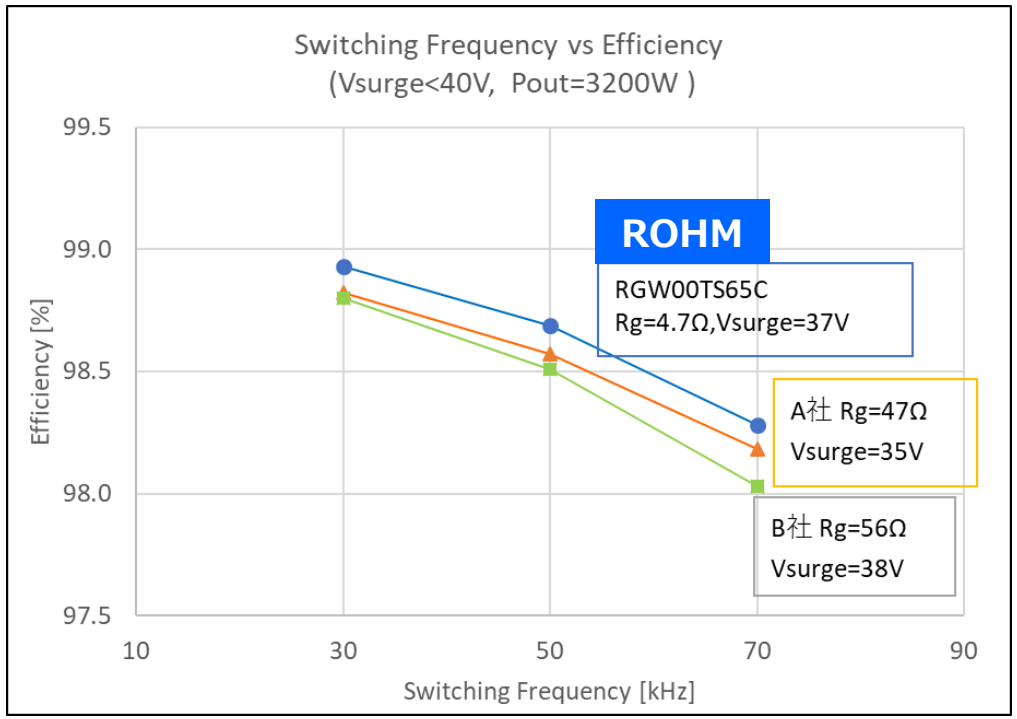
＊Totem pole PFC works same as Boost circuit with Hi side Vg=0V

➢ Evaluation Board

Totem pole PFC：Hybrid IGBT vs Competitors efficiency

ROHM Hybrid-IGBT achieves higher efficiency than other company's products. (surge voltage <40V)

➢ Comparison with competitors(real measurement)



➢ Evaluation condition

Vin=220Vdc, Vout=400Vdc
Iout=8Amax（Pout=3.2kWmax）
fsw=30k, 50k, 70kHz
Rg：Controlled at Vsurge<40V（countermeasure EMC）

RGW00TS65C which has a small Vcesat, offers better efficiency than that of other companies' Hybrid-IGBTs when operated at a surge voltage of 40V or less in consideration of the EMC measures of the set.

	ROHM	A company	B company
Efficiency（SW=50KHz）	98.7%	98.6%	98.5%
efficiency (SW=70KHz)	98.3%	98.2%	98.0%
Vcesat	1.9V	2.1V	2.1V

Why ROHM has best efficiency?

Conduction loss is lower than others, because Vcesat is lowest.

SW loss is not so different since recovery current of SiC SBD is almost zero.

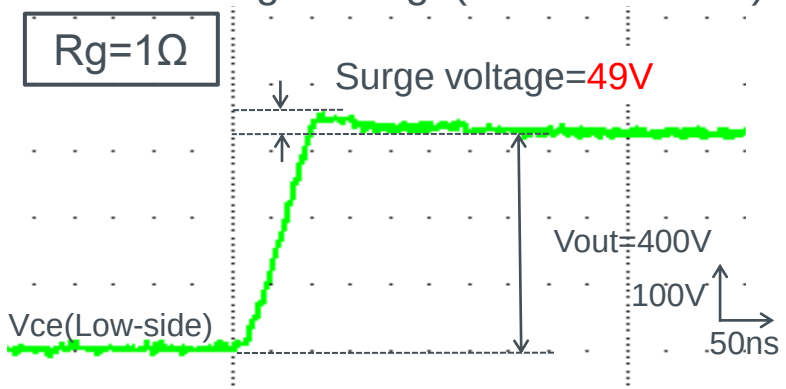
Totem pole PFC: Hybrid IGBT vs Competitors surge

Minimized surge voltage of IGBT makes easy EMC design.

■ Switching wave form comparison

➢ ROHM : RGW00TS65C

Small surge voltage(small EMC risk)

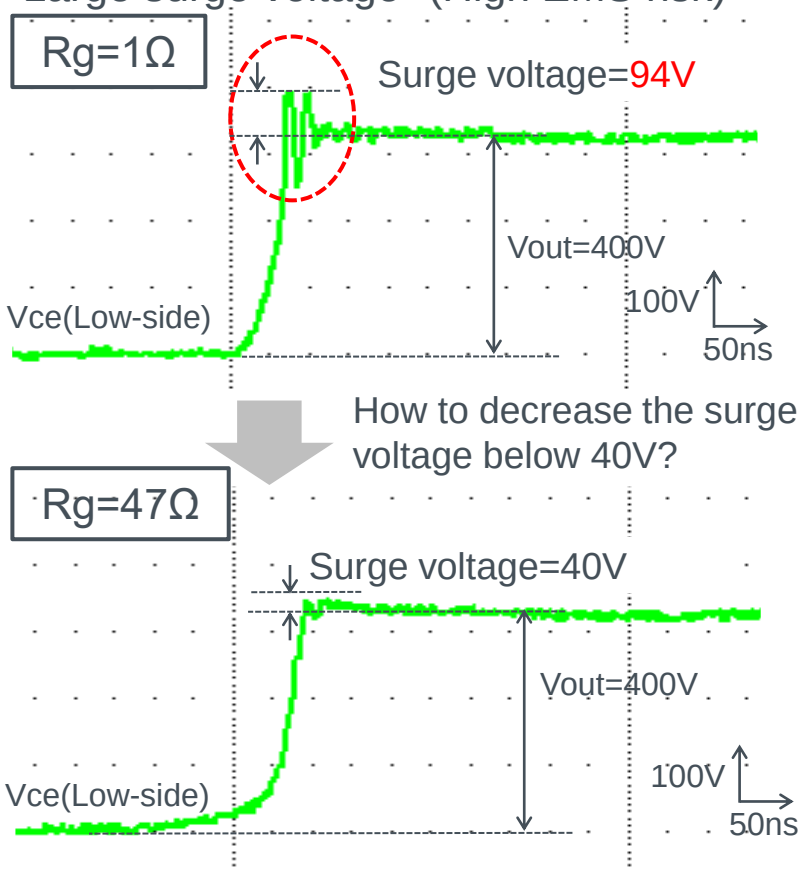


✓ Small surge voltage makes easy EMC design.

⇒ When EMC noise becomes large, the number of external components for countermeasures are increased.

➢ Competitor product(A company)

Large surge voltage (High EMS risk)

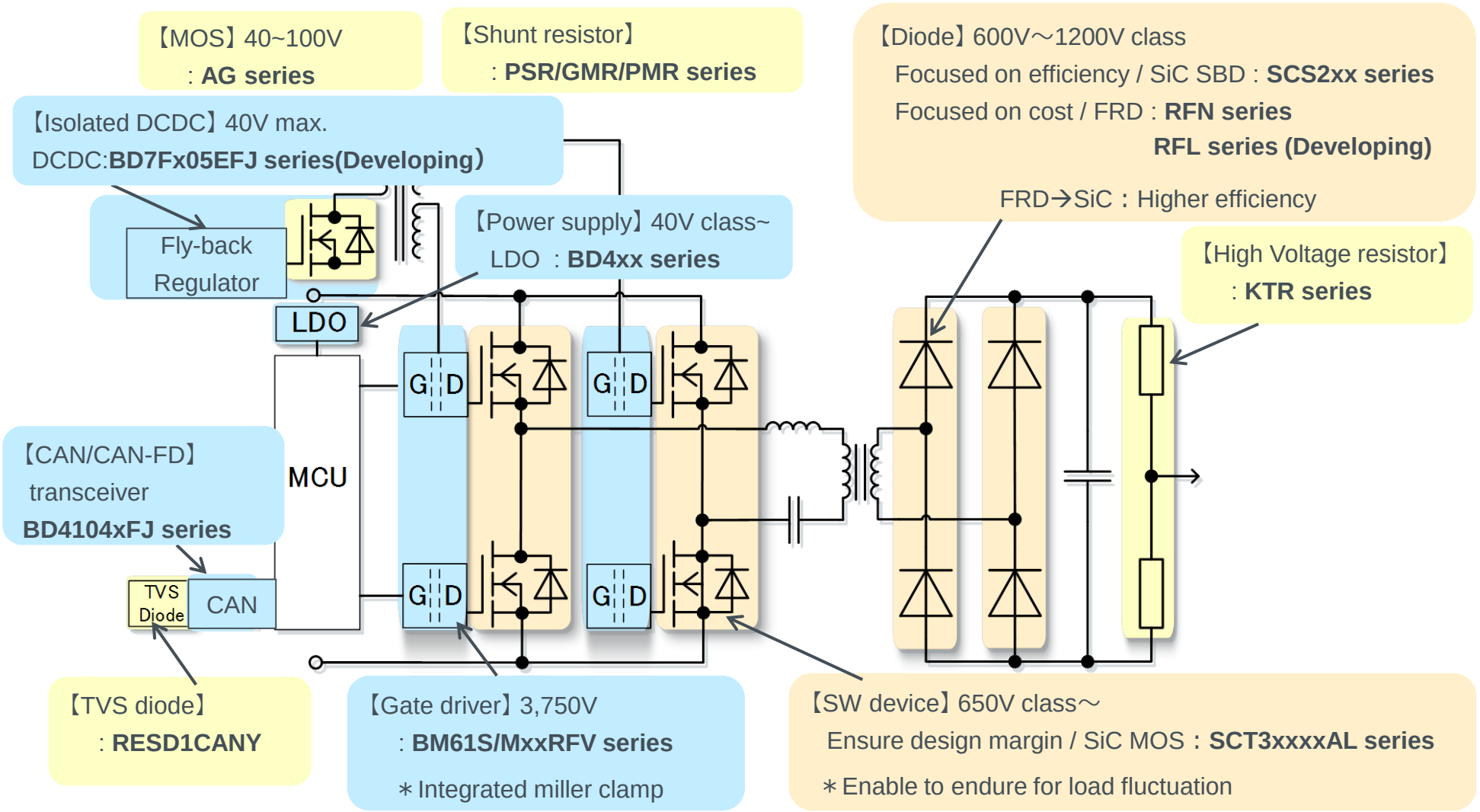


As a result, it is necessary to increase the gate resistance value, then efficiency becomes worse.

(Refer to previous page: efficiency graph)

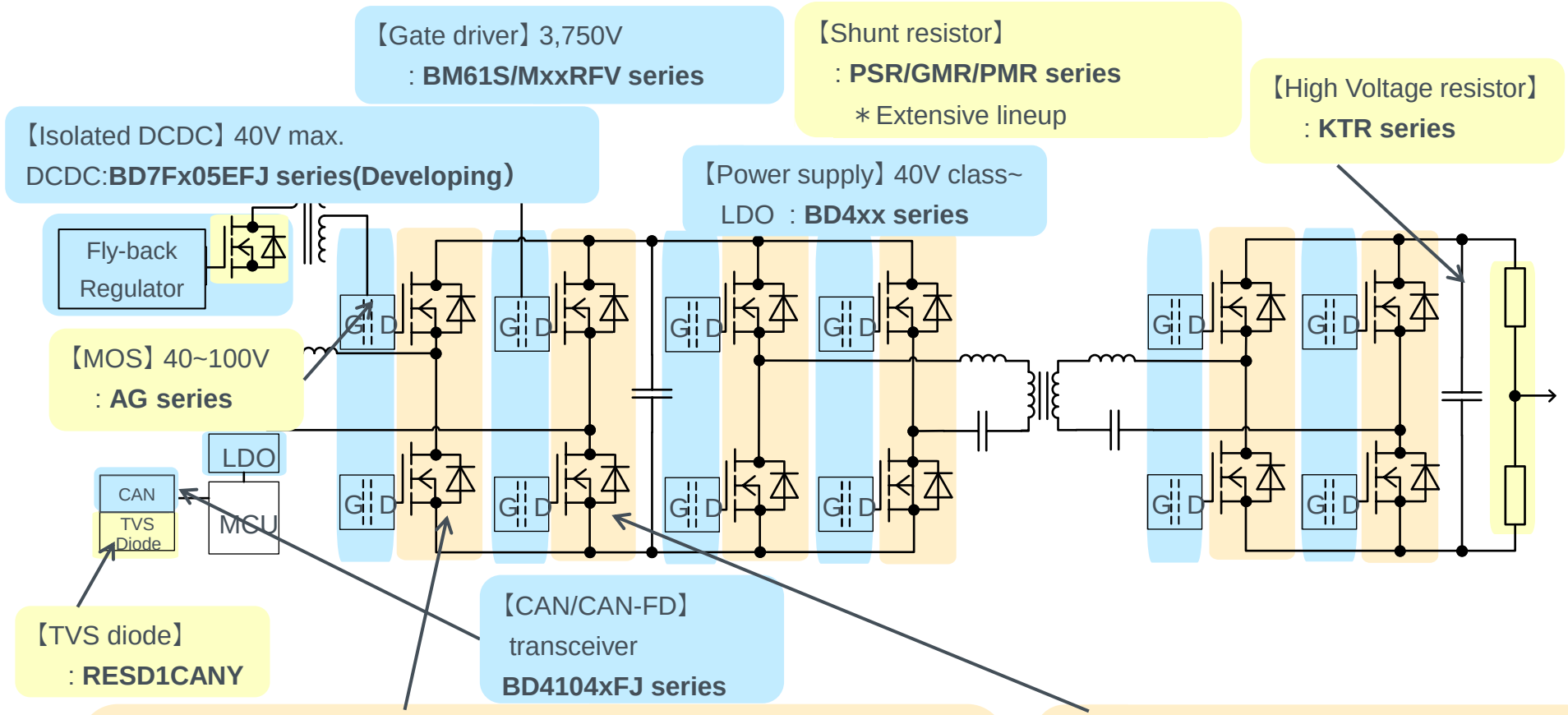
Uni-directional OBC（DCDC circuit）

SiC enables higher frequency operation and component size reduction.
Adopting SiC-SBD on secondary side leads to efficiency improvement.



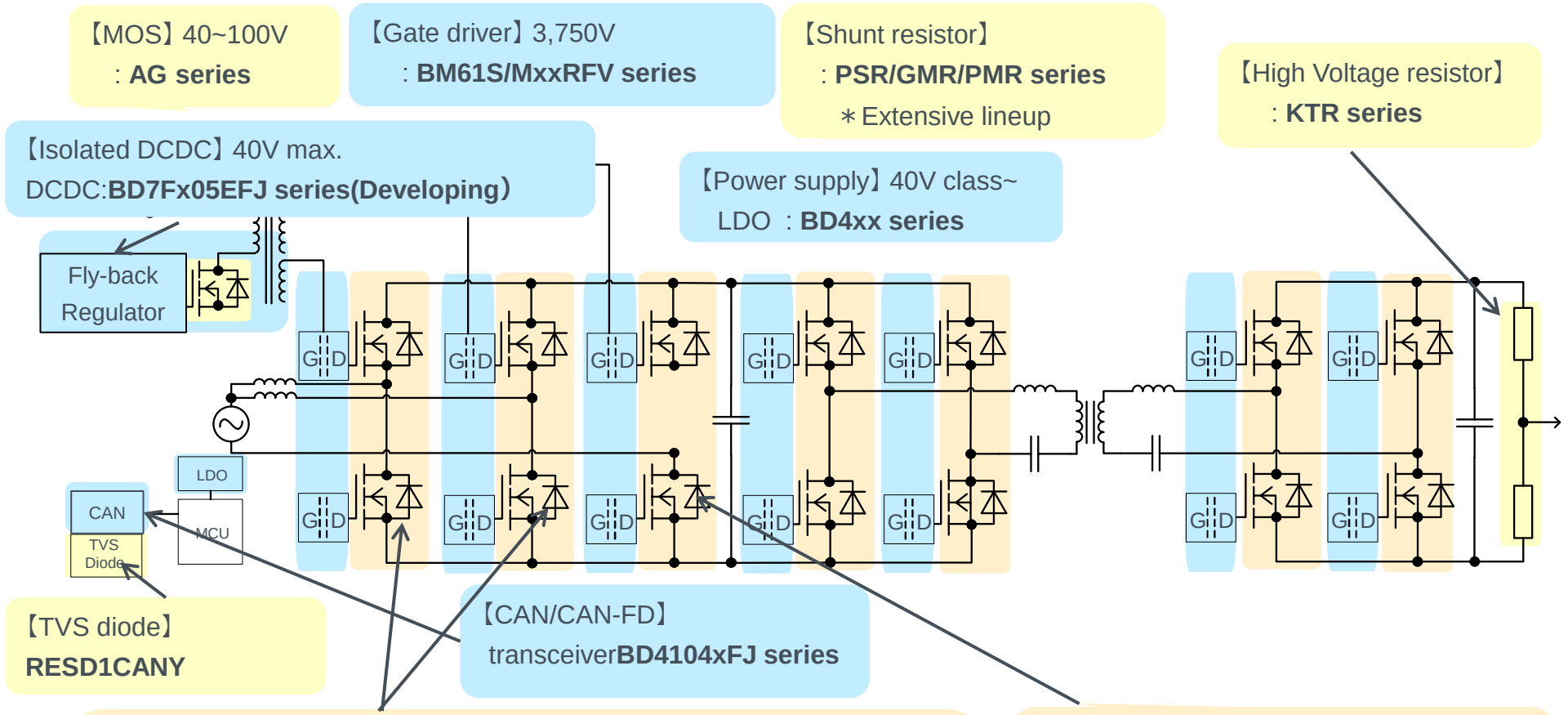
Bi-directional OBC solution (Totem pole PFC)

SiC high speed recovery characteristics is optimized for all the PFC and LLC circuit.



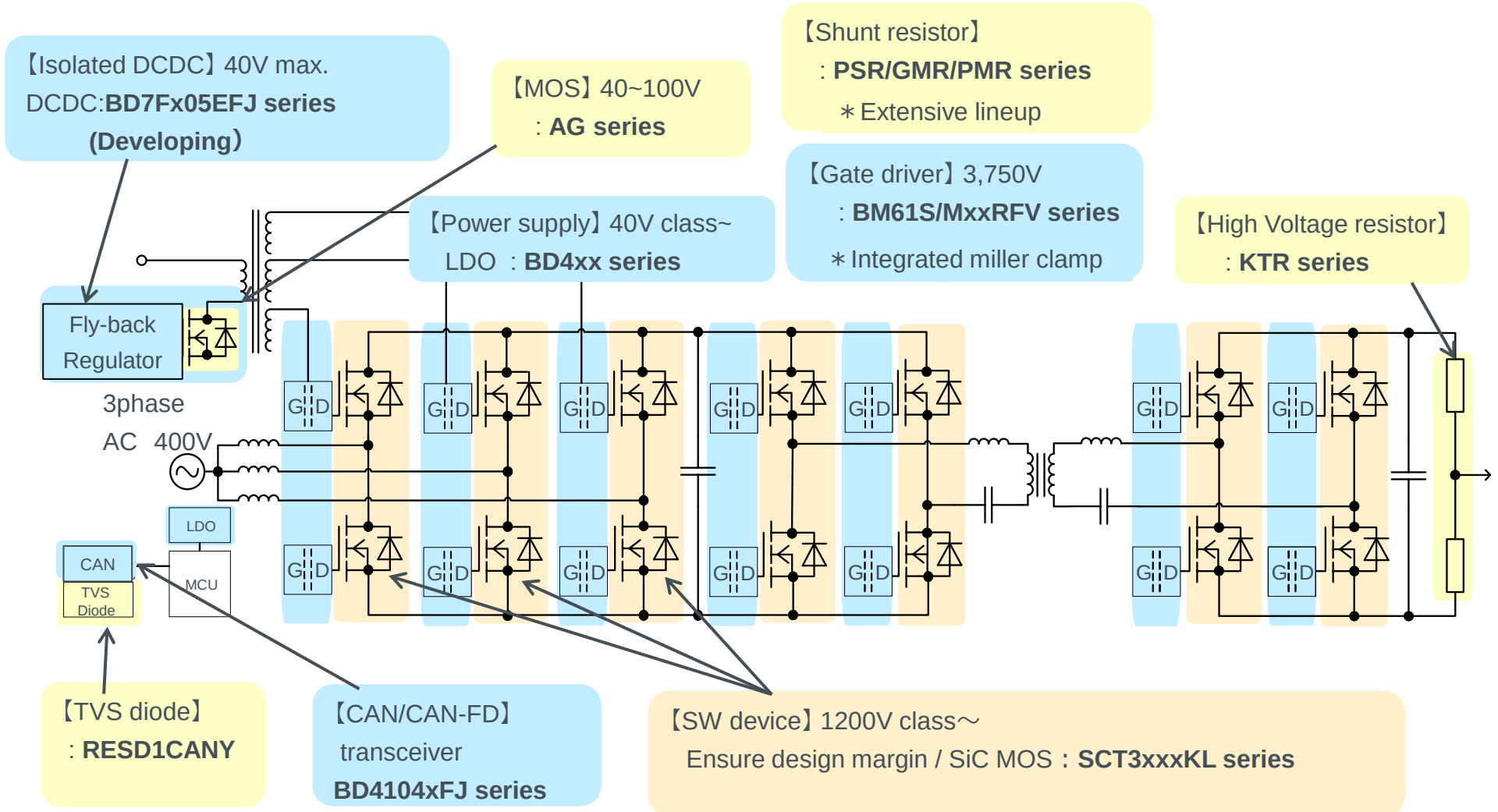
Bi-directional OBC solution (2phase interleave Totem pole PFC)

SiC high speed recovery characteristics is optimized for all the PFC and LLC circuit.



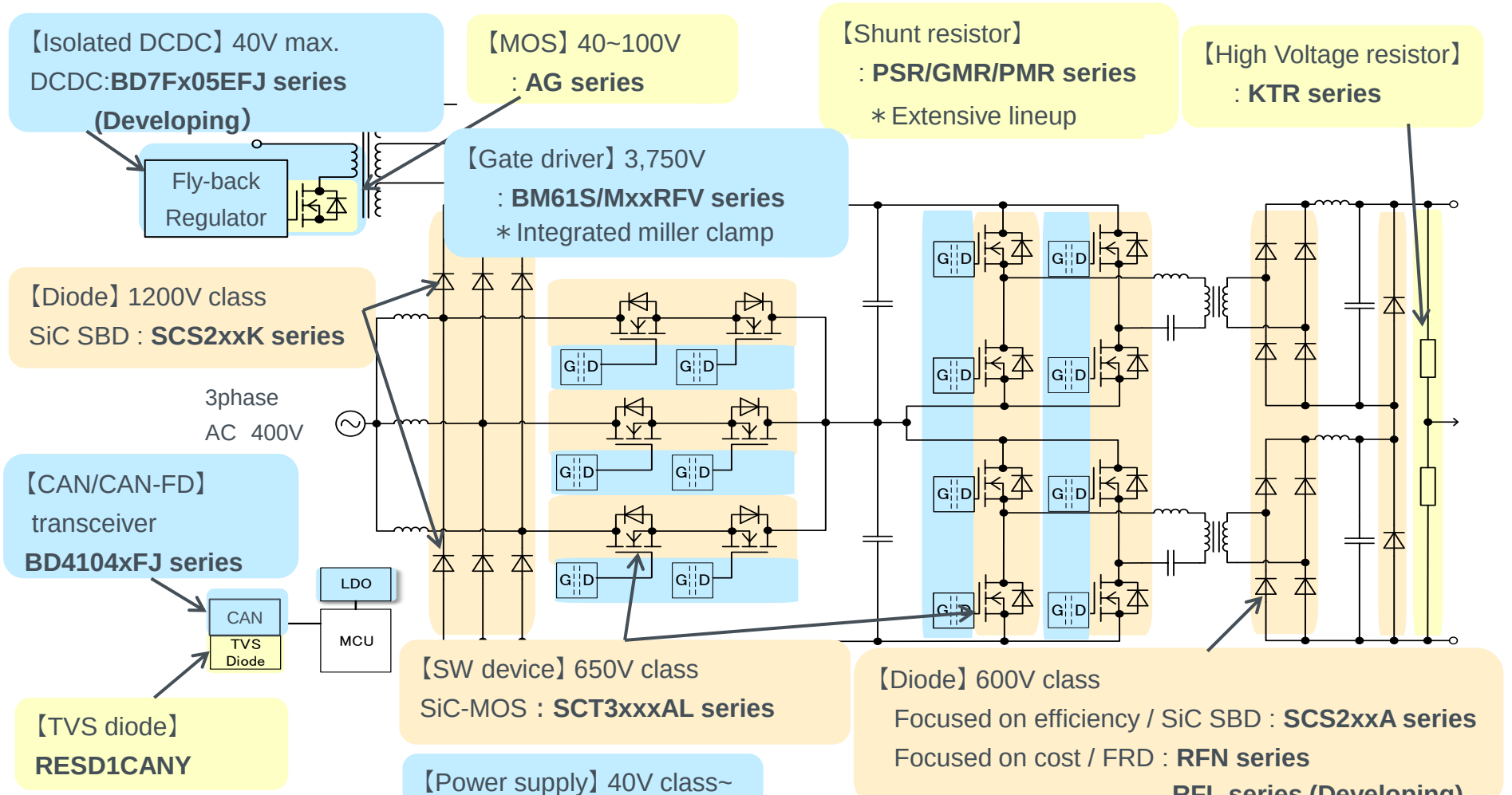
Bi-directional OBC solution (3phase PFC)

SiC is the best for High voltage(1200V） and low consumption requirements.



Uni-directional OBC solution（3phase Vienna PFC）

SiC SBD with minimal recovery loss is suitable for the input circuit.
Higher switching operation by SiC MOSFET helps to reduce components and volume.



Agenda

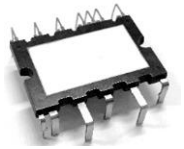
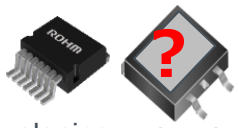
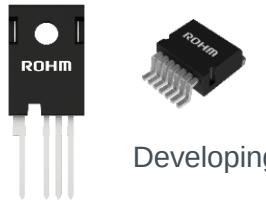
- ROHM’s actual business and position in automotive market
- OBC (On Board Charger) market trend
- Recommended components by topology solution
- SiC Power module Proposal
- Protection circuit Proposal
- Recommended surrounding components for drive circuit solution
- Introduction of application support tools
- Highlight of recommended components

If you are interested in the recommended parts, please contact with sales.
The detail presentations are prepared.

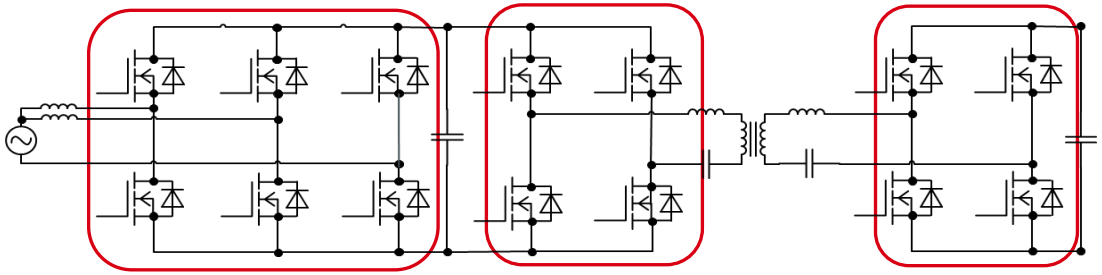
SiC Power Module

Developing

SiC power module corresponds to OBC trends for miniaturization and high frequency.

	OBC market trend	
	Miniaturization	High frequency
SiC Power Module	**Integration + Driver source**  Developing	
Discrete	**SMD / Topside cooling**  Developing Planning	**Driver source**  Developing

e.g. Bi-directional OBC



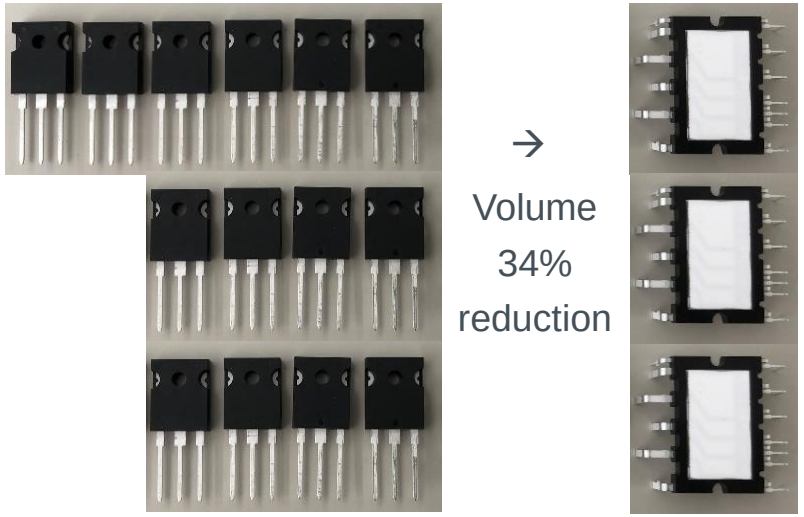
6pcs 4pcs 4pcs

Advantages

- Easy isolation design
- Unnecessary isolation sheet
- Miniaturization and Integration
- High frequency operation by driver source terminals

Space saving

TO-247:14pcs → HSDIP:3pcs



Volume 34% reduction

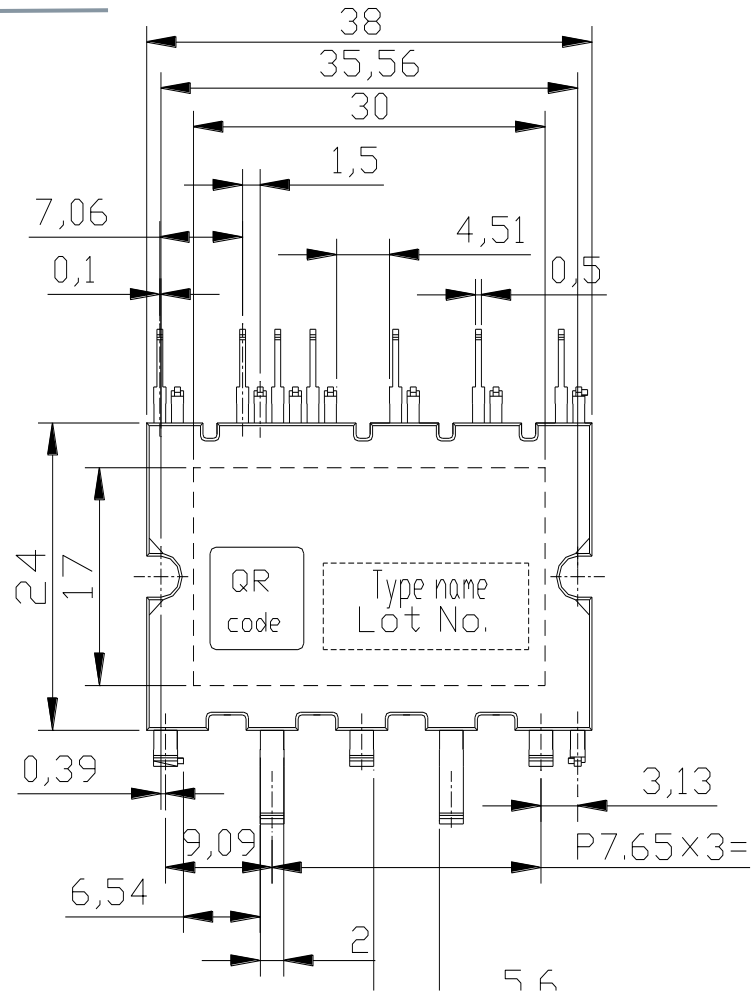
* Schedule and target specification are subject to change without notice.

SiC Power Module outline

Developing

750V and 1200V lineup covers entire OBC demand. (400V / 800V battery)

Dimensions



Product outline

- Gen4 SiC MOS integration
- 750V/45mΩ(4in1、6in1)
- 750V/26mΩ(4in1、6in1)
- 1200V/62mΩ(4in1、6in1)
- 1200V/36mΩ(4in1、6in1)
- 2,500V isolation (terminal to Heat sink)
- Creepage distance between terminal on PCB board (6.1mm)

Target schedule

- 2022 Q1: Design Sample
- 2023 Q1: Mass Production

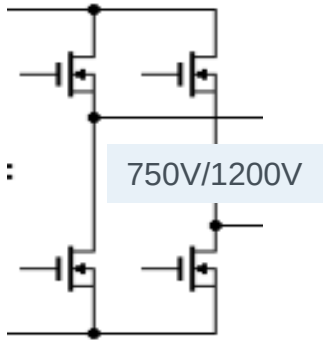
* Schedule and target specification are subject to change without notice.

SiC Power Module Target topologies

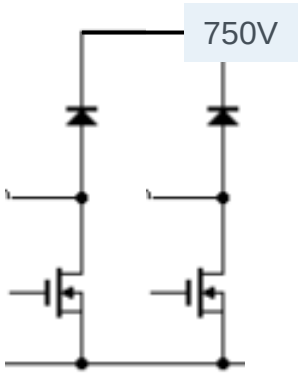
Developing

ROHM SEMICONDUCTOR

1) H bridge

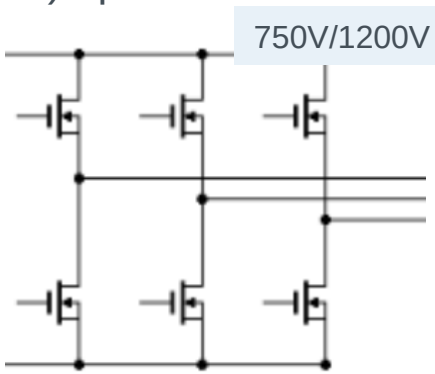


2) boost



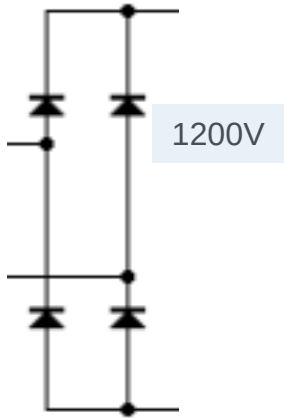
*MOS: SJ or SiC

3) 3phase B6



*Without external SBD

4)Diode bridge



Circuit block

1) H bridge	2) boost	3) 3phase B6	4)Diode bridge
Phase Shift, LLC DAB Single phase inverter Bi-directional chopper	Boost PFC(interleave)	3 phase inverter 3 phase rectifier	Secondary side rectification

Target applications

1) H bridge	2) boost	3) 3phase B6	4)Diode bridge
Data center OBC, 12V DCDC PV, Energy storage Wireless charger SMPS	Data center OBC PV inverter SMPS	Motor drive (elevator, servo, HVAC) PV inverter, UPS SMPS	OBC Wireless charger SMPS

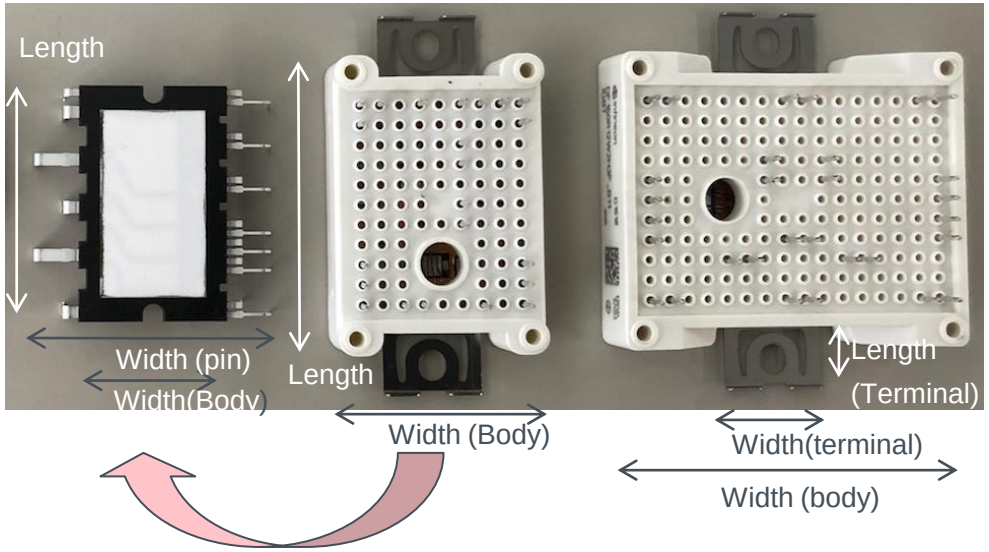
* Schedule and target specification are subject to change without notice.

Package comparison

Developing

24% mounting area reduction against general modules.

ROHM HSDIP　　General power modules



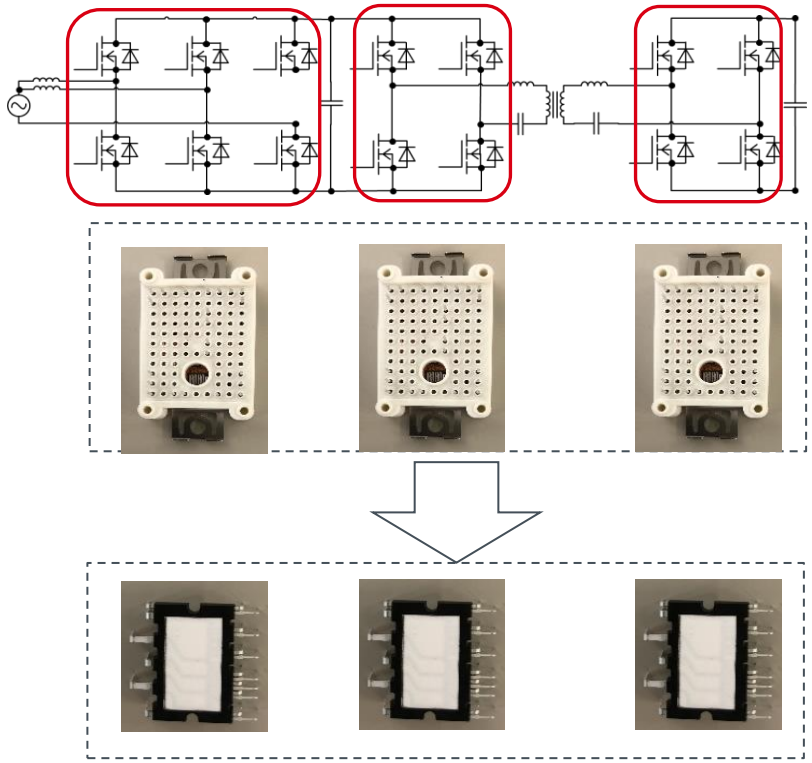
	ROHM HSDIP	Module A	Module B
Length (terminal)	38.0mm	48.0 (7.4)mm	48.0 (7.4)mm
Width(pin/body)	38.2/24mm	33.8mm	56.7mm
Height	5.5mm	12.0mm	12.0mm
Mounting area	1,451.6㎟	1,909.5㎟	3,008.7㎟
Volume	5,016㎣	19,468.8㎟	32,659.2㎟
Rth(max.) (Junction to case)	(1.12 K/W) tentative		

e.g. Bi-directional OBC

Mounting area: 24% space reduction

Volume: 75% reduction

Low height: 12mm→5.5mm

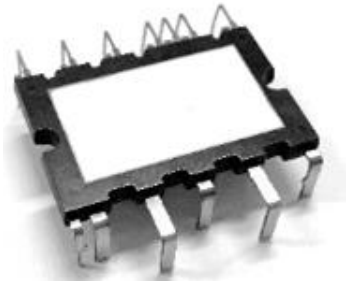


* Schedule and target specification are subject to change without notice.

SiC Power Module Target Spec

Developing

Automotive grade (AQG-324 qualified)



V_{DSS}	Ron @V_{GS}18V(typ.)	topology	DS Sample	CS Sample	MP
750V	45mΩ	4in1	1Q/2022	1Q/2023	2Q/2023
		6in1	1Q/2022	1Q/2023	2Q/2023
	26mΩ	4in1	1Q/2022	1Q/2023	2Q/2023
		6in1	1Q/2022	1Q/2023	2Q/2023
1200V	62mΩ	4in1	1Q/2022	1Q/2023	2Q/2023
		6in1	1Q/2022	1Q/2023	2Q/2023
	36mΩ	4in1	1Q/2022	1Q/2023	2Q/2023
		6in1	1Q/2022	1Q/2023	2Q/2023

* as of Jun. 2021

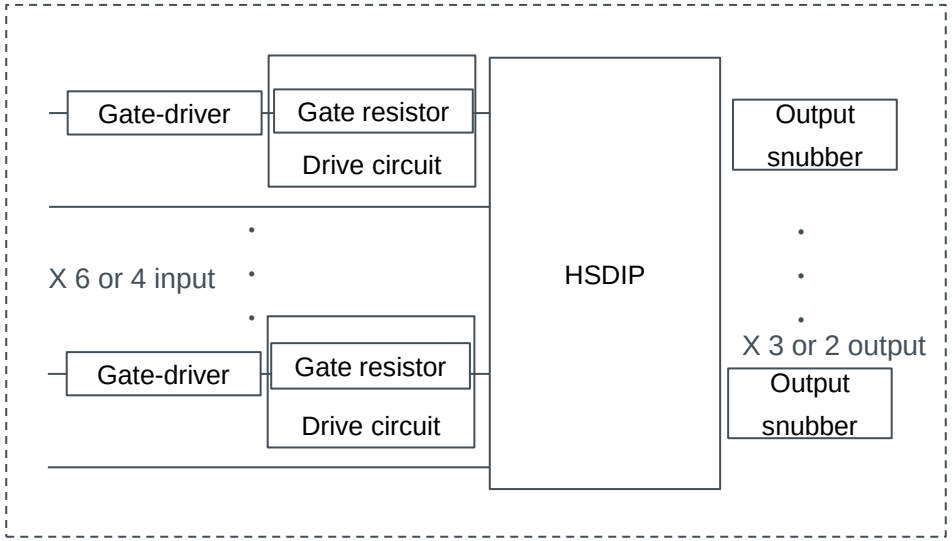
* Schedule and target specification are subject to change without notice.

SiC Power Module evaluation board

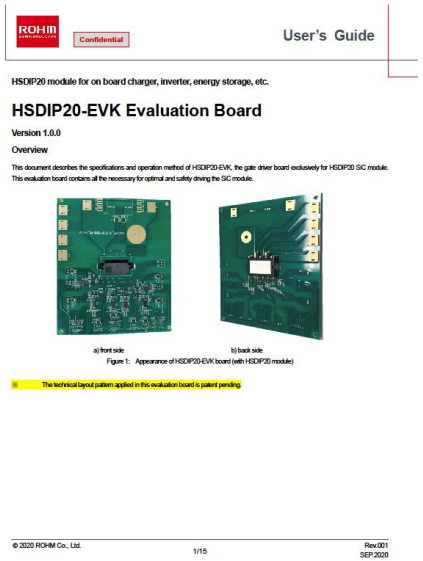
Developing

Please utilize the evaluation boards.

Evaluation board outline



User's Guide


ROHM Confidential User's Guide

HSDIP20 module for on board charger, inverter, energy storage, etc.

HSDIP20-EVK Evaluation Board

Version 1.0.0

Overview

This document describes the specifications and operation method of HSDIP20-EVK, the gate driver board exclusively for HSDIP20 SiC module. This evaluation board contains all the necessary for optimal and safety driving the SiC module.

a) front side b) back side

Figure 1: Appearance of HSDIP20-EVK board (with HSDIP20 module)

※ The technical layout pattern applied in this evaluation board is patent pending.

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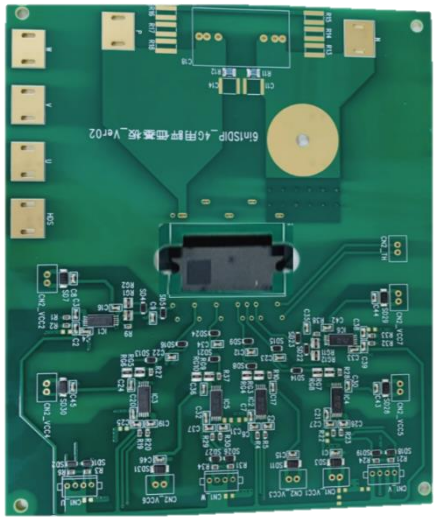


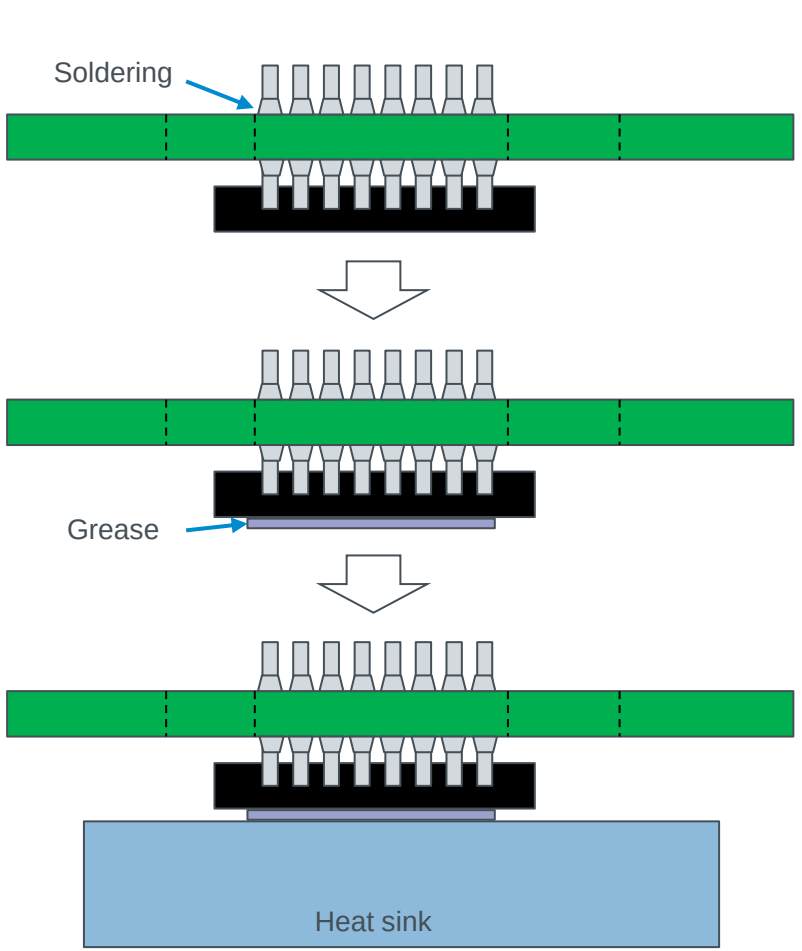
Front Side

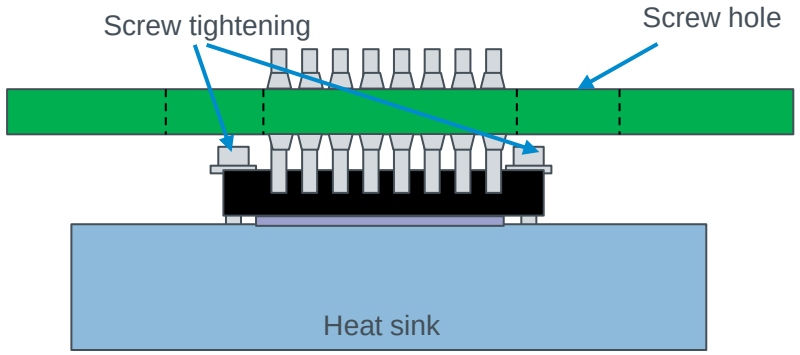
Back Side

* Schedule and target specification are subject to change without notice.

SiC Power Module implementation procedure1

Developing

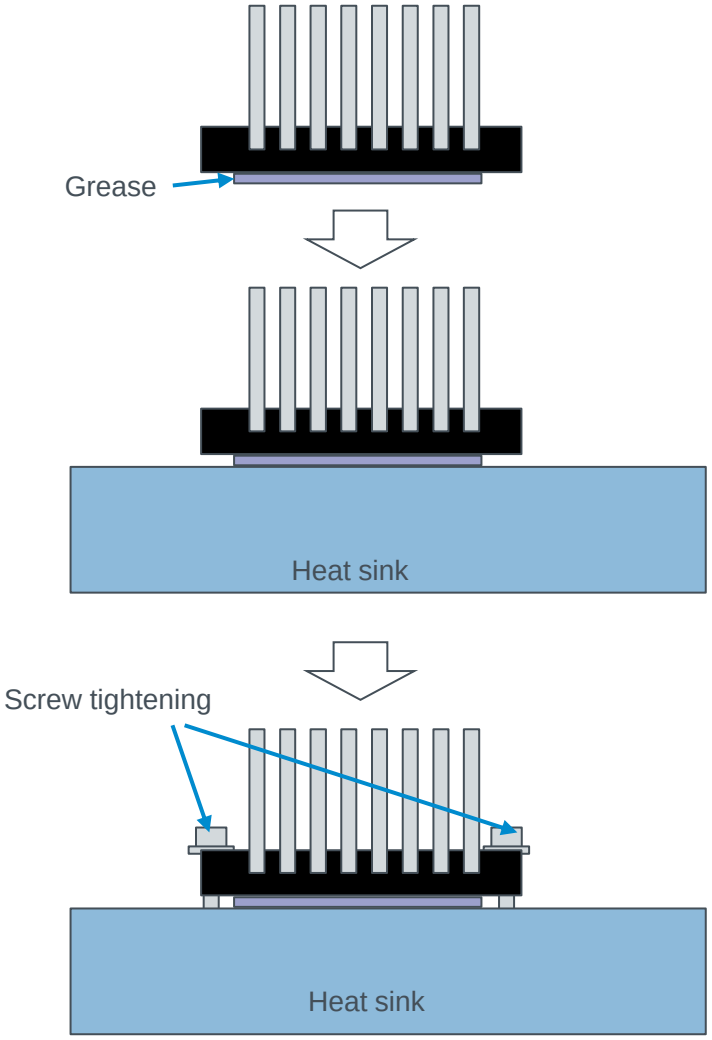


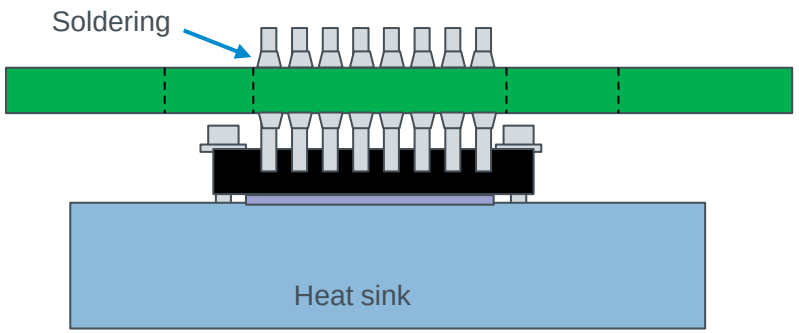


* Schedule and target specification are subject to change without notice.

SiC Power Module implementation procedure2

Developing





* Schedule and target specification are subject to change without notice.

Agenda

- ROHM’s actual business and position in automotive market
- OBC (On Board Charger) market trend
- Recommended components by topology solution
- SiC Power module Proposal
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- Highlight of recommended components

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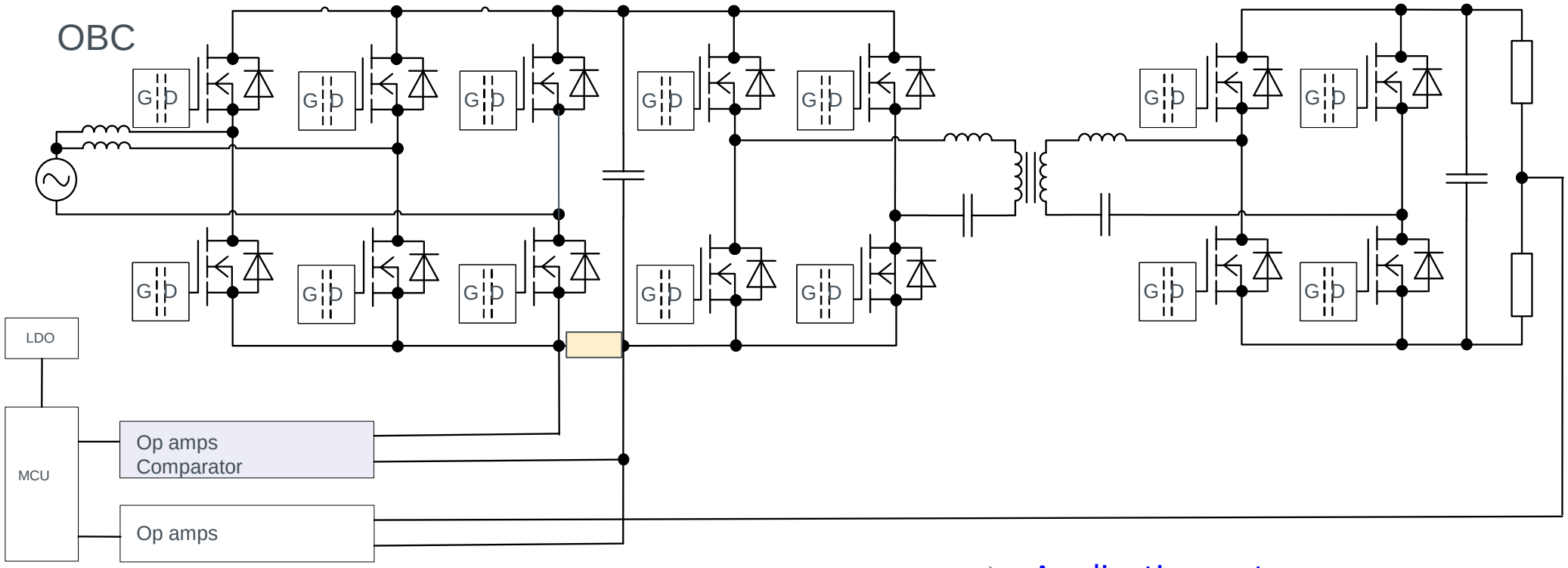
The detail presentations are prepared.

Current monitoring circuit

Propose a solution that can detect current with high accuracy and respond at high speed.



➢ High speed

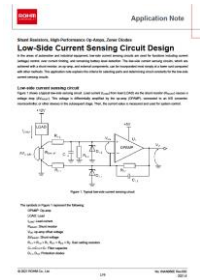
・High speed Op amps
In the event of a large current abnormality such as a ground short, it is necessary to instantly transmit it to the CPU and design it safely so that the protection sequence works.

➢ Space saving

・Ultra low ohmic resistors
PSR / PMR / GMR / LTR series
Contributes to space saving with a small and abundant lineup of resistance value, power, size, shape, etc..

➢ Application note

・Low side current sensing circuit design
Explains the guideline for component selection and circuit constant determination in the low-side current sensing circuit realized by shunt resistors, Op amps, and external components.



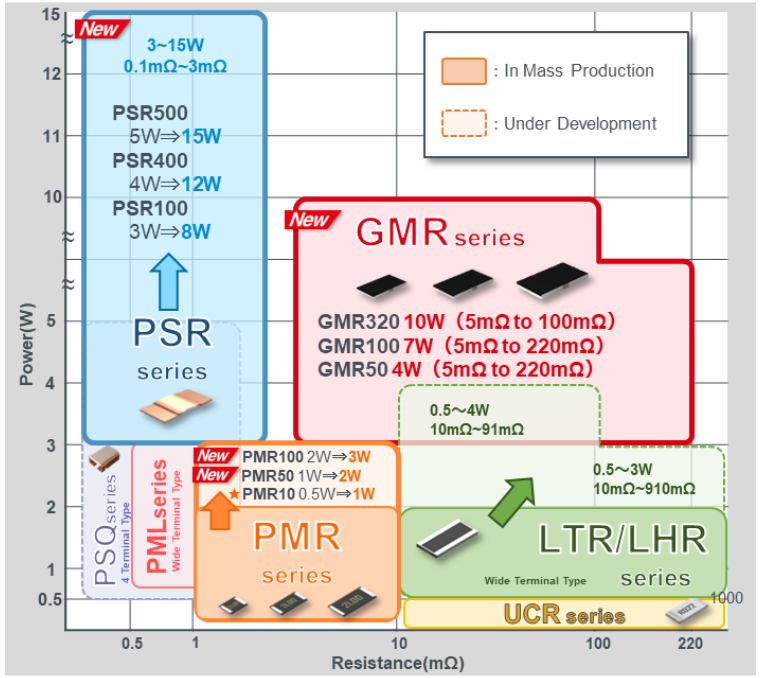
Proposal for Current monitoring circuit（High speed）

Propose an Op amps that realizes space saving with a compact and ultra-low resistance shunt resistor and can respond at high speed for overcurrent detection.

Set Requirement	Request to detection resistors	Request to detection op amps
They detect the circuit current or power devices current for safety protection and control (stop) the system	・Ultra low ohmic, high power, small size detection current:30~50A(typ.) voltage : about 0.05~0.1V Low ohmic: about 1~3mΩ High power:1.5~5W	・High speed （To stop the system in emergency detection） High speed about 1μs transition from input change

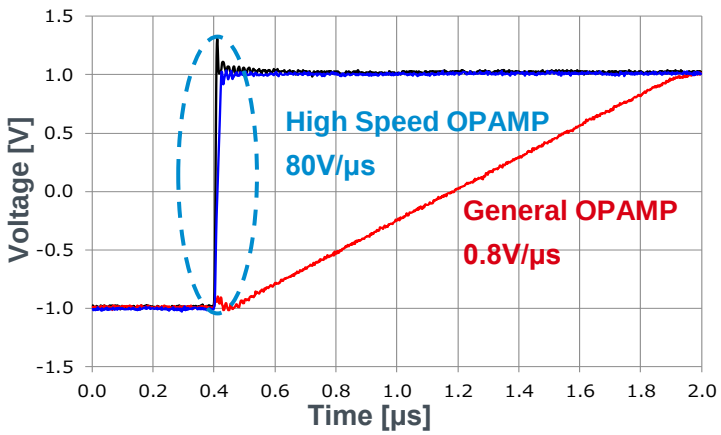
➢Ultra low ohmic resistors Feature

- ✓For over 50A high current detection
  ⇒ **PSR series**
- ✓For high accuracy current detection
  ⇒ **GMR series**
- ✓For any various uses
  ⇒ **PMR series**
  LTR series



➢High Speed Op amps feature

- ・High Slew Rate：80V/μs
- ・Gain Bandwidth Product：150MHz



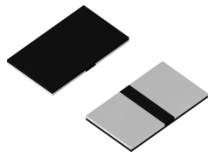
Current monitoring circuit : Proposal products

・Ultra low ohmic Metal plate/High power PSR series

Type	Size mm(inch)	Tolerance	Resistance Value (mΩ)	Rated Power at 70℃ (Ambient Temperature)	★Rated Power (Terminal Temperature) Rated Temperature 1	★Rated Power (Terminal Temperature) Rated Temperature 2	TCR (ppm/℃) +20 ～ +125℃	Operating Temp.
PSR 100	6432 (2512)	F (±1%)	0.3	3W	8W(75℃)	4W(140℃)	±150	-65 ～ 175℃
			0.5		8W(75℃)	4W(140℃)	±115	
			1.0		8W(75℃)	4W(140℃)	±100	
			2.0		6W(75℃)	4W(140℃)	±50	
			3.0		★4W(75℃)	★3W(140℃)	±50	
PSR 400	10×5.2 (3921)	F (±1%)	0.2	4W	12W(75℃)	5W(130℃)	125±50	
			0.3		★10W(75℃)	★5W(130℃)	±175	
			0.5		10W(75℃)	5W(130℃)	±175	
			1.0		8W(75℃)	5W(130℃)	±75	
			2.0		★6W(75℃)	★4W(115℃)	±75	
			3.0		5W(70℃)	3W(115℃)	±75	
PSR 500	15×7.75 (5931)	F (±1%)	0.1	5W	15W(75℃)	10W(120℃)	200±50	
			0.2		★15W(75℃)	★10W(120℃)	±225	
			0.3		★10W(75℃)	★7W(120℃)	±150	
			0.4		★10W(75℃)	★7W(120℃)	±150	
			0.5		10W(75℃)	7W(120℃)	±150	
			1.0		10W(75℃)	6W(120℃)	±75	
			2.0		7W(70℃)	4W(115℃)	±75	

・Low ohmic Metal plate/ High power GMR series

Type	Size mm(inch)	Rated Power (Terminal Temp.)	Tolerance	R.V range (mΩ)	TCR* (ppm/℃)	Operating Temp.
GMR50	5025 (2010)	3W(110℃) 4W(90℃)	F (±1%)	5	0 to +25	-55 ～ +170℃ ★-65 ～ +170℃
				10 ～ 220	±25	
GMR100	6432 (2512)	3W(110℃) ★5W(110℃) ★7W(70℃)		5	0 ～ +25	
				10 ～ 220	±20	
GMR320	7142 (2817)	7W(110℃) 10W(70℃)		5	0 ～ +25	
				10 ～ 100	±25	



・Ultra low ohmic Metal plate/General PMR series

タイプ	サイズ mm(inch)	定格電力	抵抗値 許容差	抵抗値範囲 (mΩ)	抵抗温度係数 (ppm/℃)	使用温度範囲
PMR01	1005 (0402)	0.2W	J(±5%)	10	0～200	-55～+155℃
PMR03	1608 (0603)	0.25W	J(±5%) F(±1%)	10	0～150	
PMR10	2012 (0805)	0.5W		2,3,4,5,6, 7,8,9,10	±150	
PMR18	3216 (1206)	1W ★1.5W		1,2,3,4,5 6,7,8,9,10 ★1.5W:1,2	±100	
PMR25	3225 (1210)	1W ★1.75W		1,2,3,4,5 ★1.75W:1	±100	
PMR50	5025 (2010)	1W ★2.0W		1,2,3,4,5, 6,7,8,9,10 ★2.0W:1,2	±100	
PMR100	6432 (2512)	2W		1,2	±150	
				3,4,5,6 7,8,9,10	±100	
		★3W		1,2	±150	-55～+170℃

Current monitoring circuit : proposal products

・High speed Op amps

Part No.	ch	Input Offset Voltage[Max.]	Slew Rate[Typ.]	GBW[Typ.]	Supply Current[Max.]	DS	CS	EMARMOUR	Package
BA3472YF/FV/FVM-C **BA3474YFV-C**	2 4	10mV	10V/μs	4MHz	4.00mA/ch	✓ ✓	✓ ✓	-	SOP8/SSOP-B8/MSOP8 SSOP-B14
BA83472YF/FVM-C **BA83474YFV-C**	2 4	10mV	8.5V/μs	3MHz	4.30mA/ch	✓ ✓	✓ ✓	✓	SOP8/MSOP8 SSOP-B14
LMR1701YG-C **LMR2701YFVM-C**	1 2	8mV	80V/μs	150MHz	9.60mA/ch	✓ Under plan	✓ Under plan	-	SSOP5 MSOP8

・Low noise low offset Op amps

Part No.	ch	Input Offset Voltage[Max.]	Temp Coefficient [Typ.]	Noise Voltage Density[Typ.]	Supply Current[Max.]	DS	CS	Package
LMR1801YG-C	1	950μV	-	5.0nV/√Hz@1KHz	0.95mA/ch	✓	✓	SSOP5
LMR1802YG-C	1	450μV	-	2.9nV/√Hz@1KHz	1.10mA/ch	✓	✓	SSOP5
TLR377YG-C **TLR2377YFVM-C** **TLR4377YFV-C**	1 2 4	1,300μV	4μV/℃	8.0nV/√Hz@1KHz	1.00mA/ch	✓ ✓ ✓	✓ ✓ '21/4Q	SSOP5 MSOP8 SSOP-B14
TLR376YG-C **TLR2376YFVM-C** **TLR4377YFV-C**	1 2 4	550μV	4μV/℃	8.0nV/√Hz@1KHz	1.00mA/ch	✓ ✓ ✓	✓ ✓ '21 4Q	SSOP5 MSOP8 SSOP-B14
LMR1001YF-C	1	12μV	0.05μV/℃	70nV/Hz@1KHz	2.5mA/ch	✓	Under Way	SOP8

Current monitoring circuit : Case study

We have Adoption example. Please try our products!

➢Ultra low ohmic resistors: shunt resistors

Adoption records

➢E compressor
Company C (PSR500), Company D (PSR100)、other

Advantage for customer

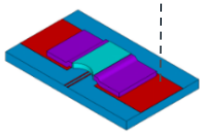
・To reduce the power consumption when detecting a large current

(example) When 30A is detected with 10mohm and 1mohm, the power consumption is 9W and 0.9W, and there is a big difference in power consumption.。

・Differentiate with technical support such as simulation Since the characteristics are determined by the physical characteristics of the material, it is difficult to give an advantage in the product specifications.

SIM comparison of potential distribution when the land pattern and voltage measurement point are changed

We can also propose the optimum pattern board design.



➢High Speed / Low offset Op amps

Adoption records

➢E compressor
Company P (BA3474YFV-C), Company F (TLR4376YFV-C)

Advantage for customer

・VA (low price) without the hassle of changing the circuit

We have a large lineup of equivalent products from competitors.

If you tell us the product you are using and your requirements, we will propose an equivalent product.

・Request example

Slew rate, Offset, noise, package, etc..

Proposal for HV battery voltage monitoring circuit : KTR Series

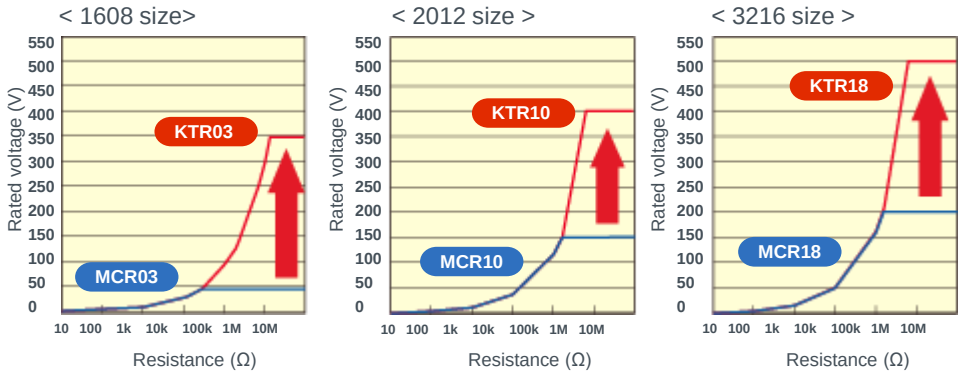
By using a high withstand voltage resistor at the dividing high voltage battery, it is possible to reduce the number of resistors and save the space.

Set Requirement	Request to detection resistors
For the safety / protection of drive control, it is necessary to detect the overvoltage / under voltage of the battery voltage and control (stop) the control.	・High accuracy(±1%) F class ・High Voltage 400V battery vehicle： 2~3 series (over 350V) 800V battery vehicle： 2~3 series (3ver 500V)

➢ High voltage resistor: KTR series feature

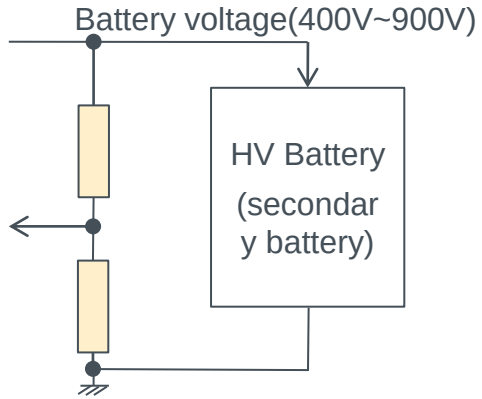
350V、400V、500V、600V withstand line up

■ Rated voltage comparison (KTR series vs MCR series)



ROHM's unique resistance pattern and trimming design prevent concentration of the voltage burden, resulting in more than twice voltage resistance of our own standard conventional parts(MCR series).

➢ Place in use



➢ Space saving

・High voltage resistor：KTR series(350~600V)
To divide the battery voltage such as 400V or 800V by resistance
With the high withstand voltage KTR series, the number of resistors can be reduced and space can be saved. !

➢ Case study (Company A : KTR18)

MCR18 200V guarantee x 5pcs

KTR18 500V guarantee x 2pcs

・Mounting cost can be saved

Agenda

- ROHM’s actual business and position in automotive market
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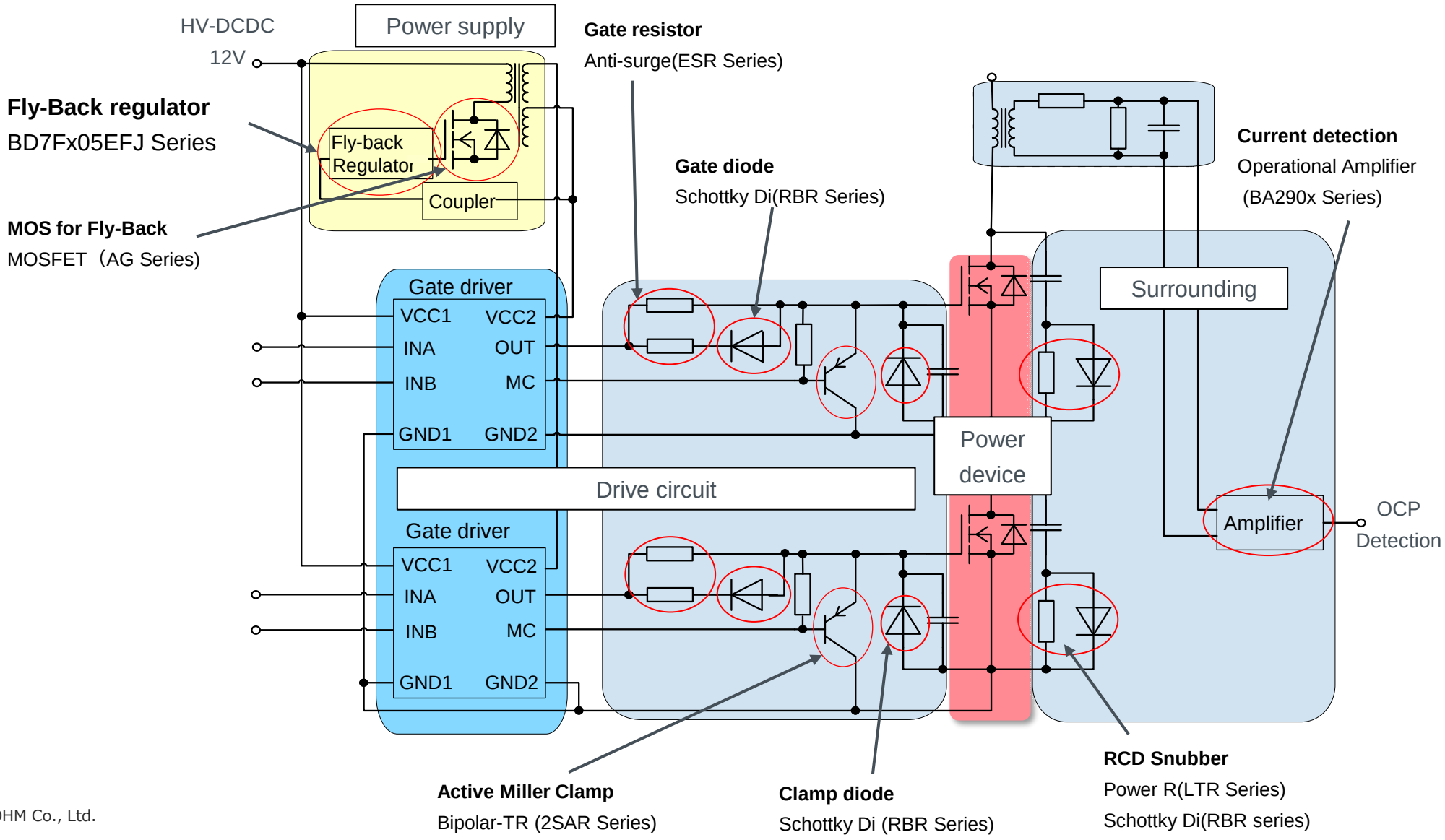
- Protection circuit Proposal
- **Recommended surrounding components for drive circuit solution**
- Introduction of application support tools
- Highlight of recommended components

If you are interested in the recommended parts, please contact with sales.
The detail presentations are prepared.

Surrounding parts for drive circuit

Customized drive circuit solutions with diverse Discrete(TR/DI/R) lineup.



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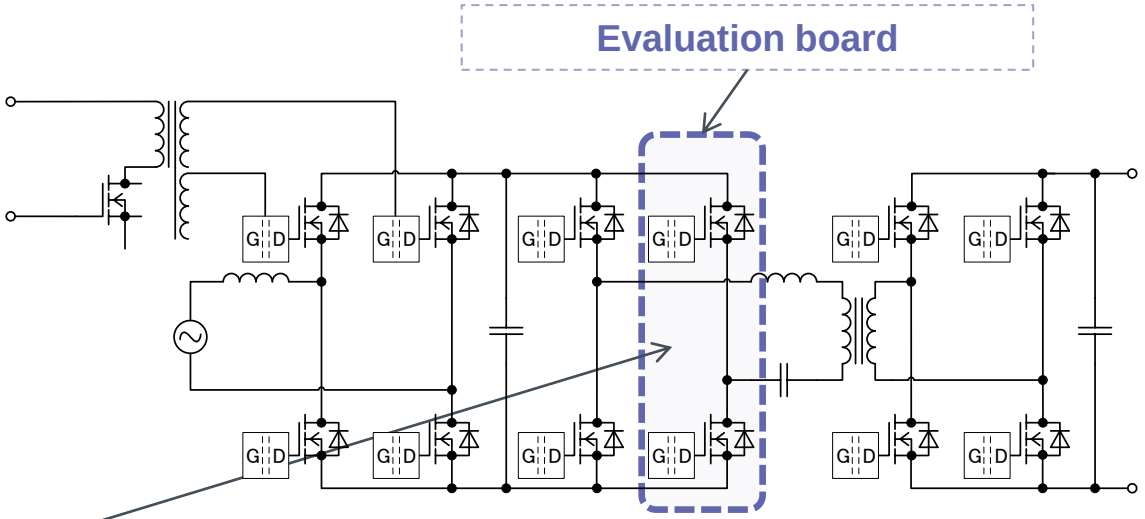
Evaluation board for half bridge configuration

Solution support from power devices to LSIs and discretes.

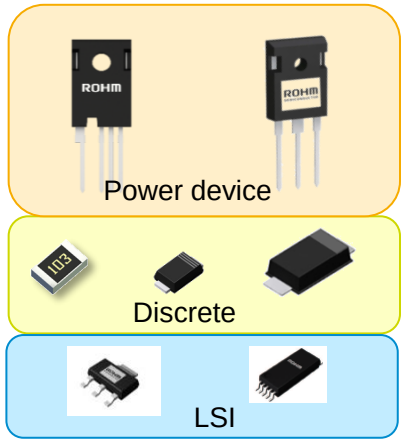
P02SCT3040KR-EVK-001

＜Evaluation board overview＞

Power Device	: SiC MOS: SCT3xxx series
Gate Driver	: Isolated Gate Driver: BM6101FV
Power supply	: LDO for MCU, Fly-back
Drive circuit	: Gate resistor, Protection diode, Miller clamp MOS, etc..



Total solution（P19）



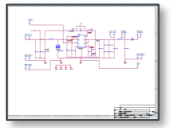
- Double pulse test at max 150A
- Max 500kHz switching operation is available.
- Possible to evaluate several topologies
  (Buck, Boost, Half-Bridge)
- Protection from simultaneous turn-on of high and low side devices.
- Integrated over current protection function (DESAT, OCP)

ROHM's application support

Provides full coverage application support in your development flow

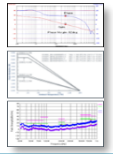
Specification

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




Proto-typing

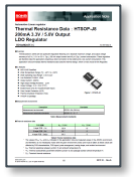
Evaluation Board (EVK) / User's guide
System reference design
EVK with customized parameter, provided with measurement results

Schematic Design

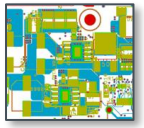
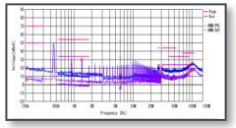
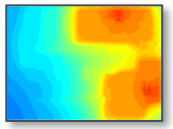
Calculation tool for external component parameter
Application notes
SPICE model /PLECS model / Thermal model
ROHM Solution Simulator (Web based simulation)





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

PD: Power Device, GDIC: Gate Driver IC

Focused application and technologies

Support and resolve customer's troubled cases by system solution

xEV

Traction inverter
OBC, DC/DC converter

ADAS

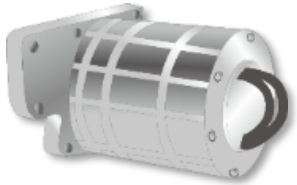
Cluster, Infotainment

LED lamp

Automotive application

Data center,
base station

Energy system



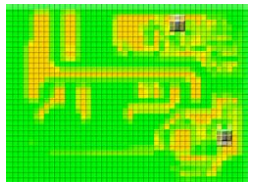
Motors

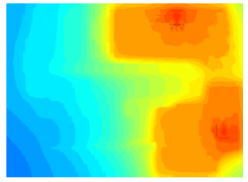
Industry application

System complexity	Small form factor	High power	High efficiency	Regulations

Thermal

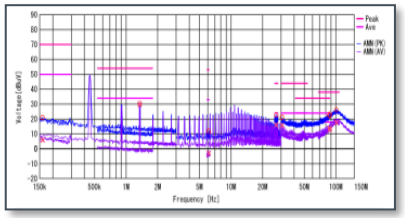
Importance of thermal management is increasing. Transient thermal analysis, thermal sim model and thermal resistance measurement are available.





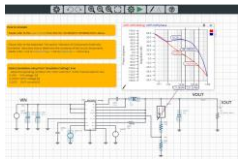
EMC (Noise)

Customer need to qualify EMC regulation, we support circuit and PCB design by accumulated know-how.



Simulation

We support model-based design (MBD) by providing simulation models and verification environments for devices tailored to customer's verification applications and objectives.

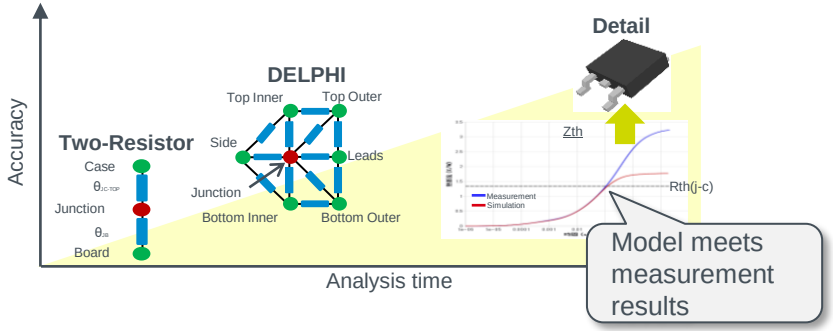


Thermal design support

Thermal simulation including PCB patterns allows you to verify thermal design before prototyping. Measurements and simulations will help to resolve issue.

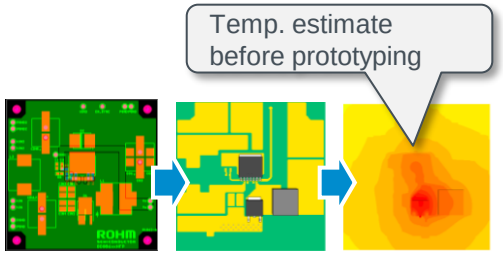
Provide Thermal model

Provide thermal model for each devices.



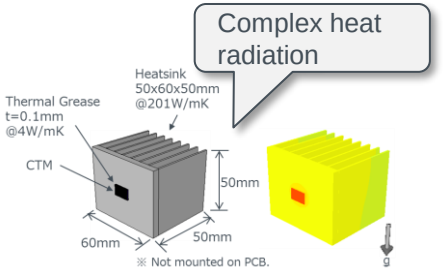
Thermal Simulation with customers PCB and Module

Use PCB design data



Importing CAD data into sim

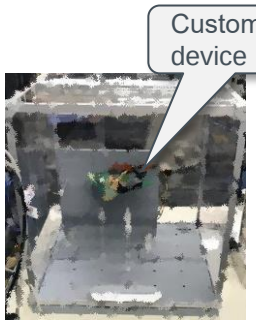
Heat sink information included



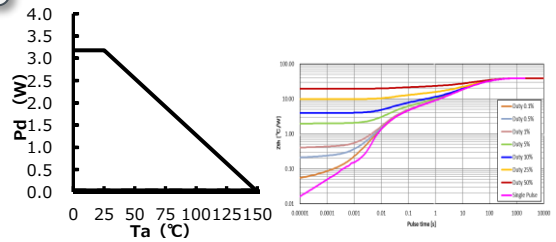
Sim with Heatsink attached

Thermal measurement with Customers PCB

Measure thermal resistances with customer's device

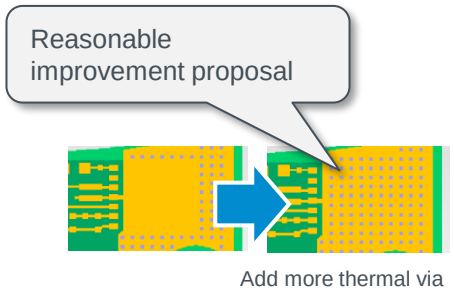


Environment

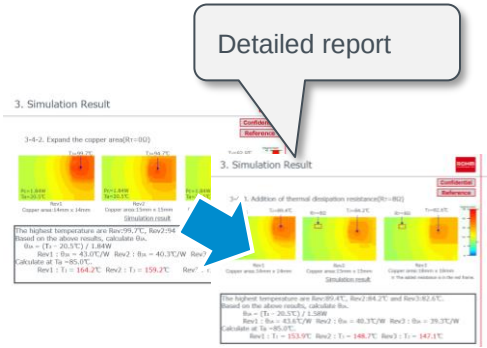


Measurement result

Improvement proposal by thermal simulation



Layout improvement proposal



Simulation and report

(Note) The above service is subject to charge. For more details, please contact our sales representative.

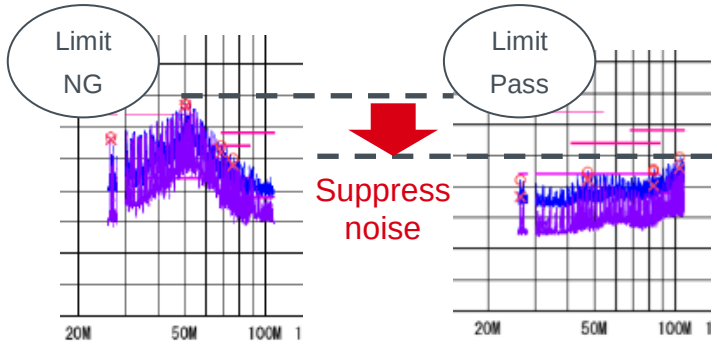
EMC design support

From the conception to the prototype stage, our engineers, who have accumulated know-how through numerous support projects, help customers resolve their EMC issues.

EMC measurement support

- Radio anechoic chamber in Shin-Yokohama office
- Reproduce customer EMC issues and validate and evaluate improvement proposals

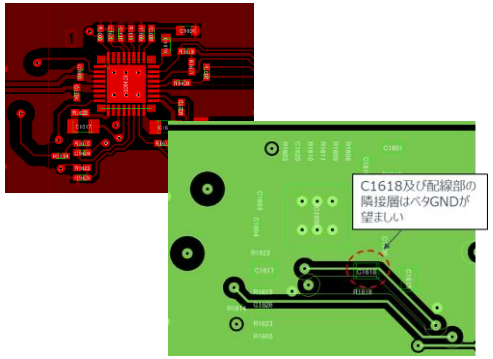
Anechoic chamber (YTC) for EMC measurements



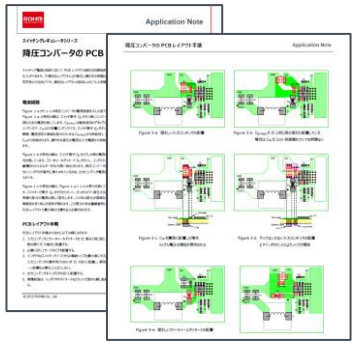
Before　　After

EMC design support

- Engineers check the EMC perspective based on layout data
- Application notes to guide you in creating a layout



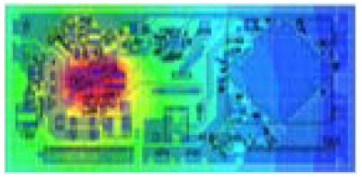
Check PCB layout

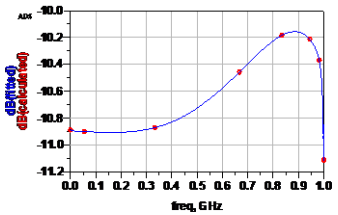


Application note for PCB layout guideline

EMC simulation support

- Quantify the performance of the board based on the layout data
- Visualization of EMC characteristics





Note) Some of the above support is subject to charge. Please contact a sales representative for details.

Contributing to the reduction of customer development man-hours by providing Solutions

We can support our customers in all their development processes.

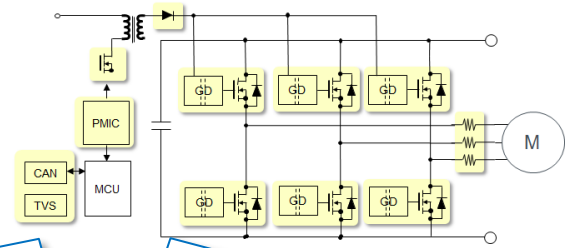
Proposal as a solution

Propose the best topology and parameter settings for power management ICs and power devices for various applications as a reference design.

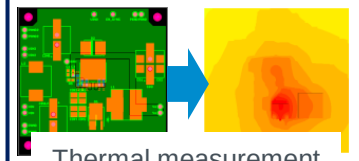
SiC-MOSFET
SCT3040KR

Gate Driver IC
BM6101FV-C

DCDC IC
BD9P Series

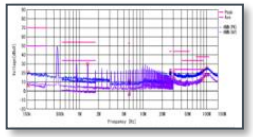


Thermal design



Thermal measurement

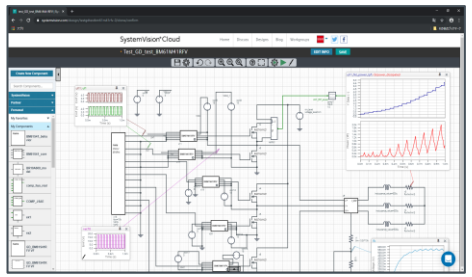
EMC support



EMC measurements

Simulation (Models & Web Sim)

- Simulation model equivalent to real devices
- Solution boards and reference circuit library for various power supply topologies
- Web based simulator
- Thermal Simulation
- EMC Simulation



Link

Reference Design / EVK

- Reference design with Thermal and EMC tested
- Device evaluation is possible under conditions close to real use cases.
- Provide various design files

3rdGen-SiC Power Solution reference for On board charger, Inverter, PV

power tree reference design for automotive app.
ADAS Cluster, Infotainment

With the free web simulation tool (ROHM Solution Simulator), you can easily design and verify a circuit

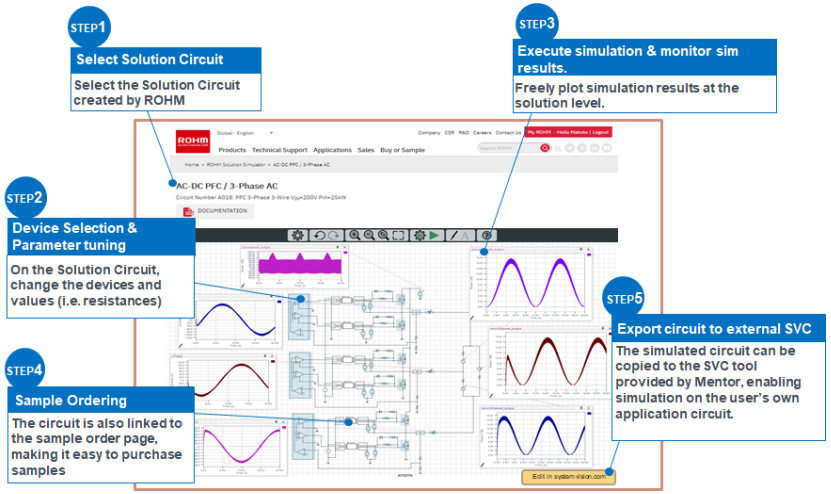
Reduce system design man-hours because the solution circuit can be simulated.

Free web simulation tool

https://www.rohm.com/solution-simulator
*User registration is required.

Easy from simulation to sample ordering

- Simulate, check results, order samples in 4 Steps
- Can also be deployed to your own circuits

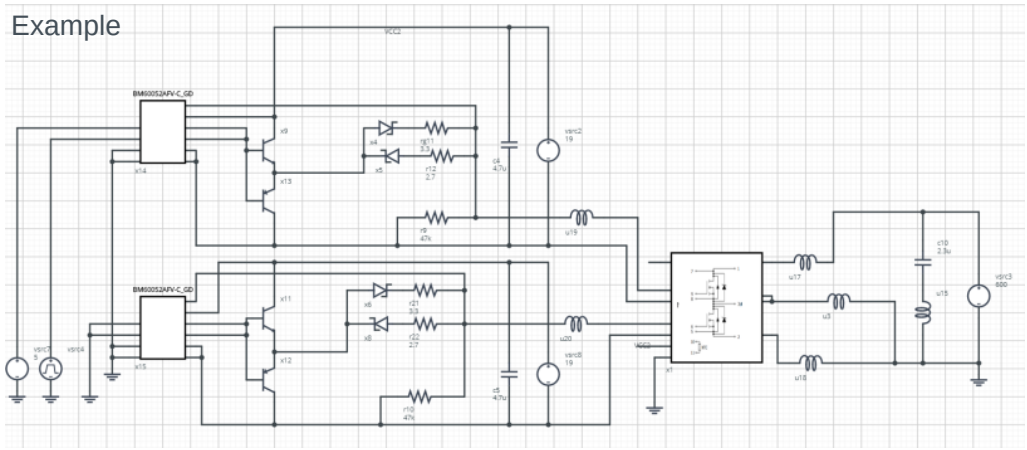


Choose from a wide variety of solution circuits with a focus on power devices + gate drivers

- Power Device Solution Circuit
- Automotive Power Tree Solution
- ICs Solution Circuit

128 solution circuits lineup at Mar/'21 More to be posted soon

Example



SiC Module EVK
BSMGD3G12D24-EVK001

SiC Module
BSM600D12P3G001

Application notes

Introducing circuit design know-how for driving high voltage and current power devices!

New

SiC Power device, module

This application note covers everything from the basic

physical properties of SiC devices to application examples in each circuit.

Contents

- SiC device
- Features SiC - SBD/MOSFET
- Evaluation board for discrete device
- How to drive the gate terminal
- SiC power module features
- Evaluation board for power module
- Reliabilities
- Rules of part number
- Application examples

https://fscdn.rohm.com/en/products/databook/applinote/discrete/sic/common/sic_appli-e.pdf

Behavior of gate source voltage

Basics of the gate drive circuit in a bridge configuration.

How to think about the behavior of current and voltage during turn-on and turn-off.

How to design a snubber circuit

From the theory of surge between drain and source to the selection and design method of various snubber circuits.

Thermal measurement also supported

New

How to measure and use thermal resistance RthJC

How to measure the thermal resistance between the junction and the case of a discrete power device and notes on how to use the RthJC, etc..

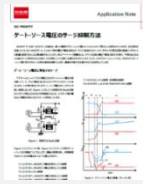
New

Points to note when measuring the backside of a package with a thermo- couple

How to measure temperature of back side of the package using a thermocouple to determine the junction temperature during actual operation

Surge suppression method for gate source voltage

Guidance for measures against positive voltage surges, negative voltage surges, etc.. that occur in the gate-source voltage.



Improved switching loss by driver source pin

Effects and precautions for use of packages with Kelvin source terminals, etc.. (TO-247-4L,TO-263-7L)

Points to note when measuring gate- source voltage

Accurate measurement of surge voltage between gate sources.

Probe mounting position. Points to note, etc..

First, go to the power device support page!

- **Evaluation board lineup**
  Link to online distributors
- Various documents
(application notes, links to products)
- Case studies

https://www.rohm.com/power-device-support

Agenda

- ROHM’s actual business and position in automotive market
- OBC (On Board Charger) market trend
- Recommended components by topology solution
- SiC Power module Proposal
- Protection circuit Proposal
- Recommended surrounding components for drive circuit solution
- Introduction of application support tools
- Highlight of recommended components

If you are interested in the recommended parts, please contact with sales.
The detail presentations are prepared.

SiC schottky barrier diodes (2nd Gen)

AEC-Q101 qualified

650V	P/N	6A	8A	10A	12A	15A	20A	30A	40A
TO-220AC	SCS2xxAGHR	√	√	√	√	√	√		
TO-247	SCS2xxAE2HR **Dual chip**						√	√	√
TO-263AB (LPTL / D2PAK)	SCS2xxAJHR	√	√	√	√	√	√		

1200V	P/N	5A	10A	15A	20A	30A	40A
TO-220AC	SCS2xxKGHR	√	√	√	√		
TO-247	SCS2xxKEHR	√					
	SCS2xxKE2HR **Dual chip**		√		√	√	√

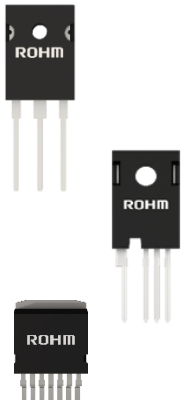
√ Mass Production

As of Mar. 2020

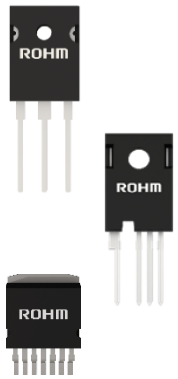
SiC MOSFETs (3rd Gen trench type)

Automotive grade (AEC-Q101 qualified)

650V	Part No. / Status	17mΩ	22mΩ	30mΩ	60mΩ	80mΩ	120mΩ
TO-247N	SCT3xxxALHR	√	√	√	√	√	√
TO247-4L	SCT3xxxARHR MP: Q1/22			√	√	√	
TO-263-7L	SCT3xxxAW7HR MP: Q1/22			√	√	√	√



1200V	Part No. / Status	22mΩ	30mΩ	40mΩ	80mΩ	105mΩ	160mΩ
TO-247N	SCT3xxxKLHR	√	√	√	√	√	√
TO247-4L	SCT3xxxKRHR MP: Q1/22			√	√	√	
TO-263-7L	SCT3xxxKW7HR MP: Q1/22			√	√	√	√



* as of Jun. 2021

MP: Mass production

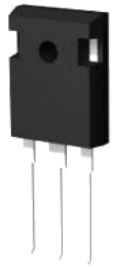
√ Mass Production √ Under development

RGW series for Automotive Application

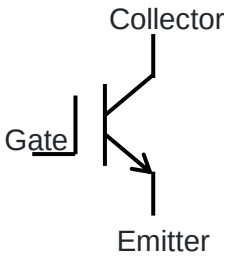
Gen.3 Auto

■Features
・Trench Gate & Thin Wafer Technology (3rd gen.)
・Low VCE(sat) 1.5V typ.
・High Speed SW tf 30ns typ.
・Low SW Loss & Low SW Noise
・Low Gate Charge
・Built in Very Fast & Soft Recovery FRD
・Based upon AEC-Q101
■Applications
On-board Charger , PFC , DC/DC , DC/AC

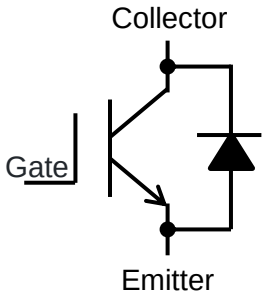
TO-247N



・Without FRD



・Built in FRD



■ Line up (650V)

P/N	IC[A]		VCE(sat)[V]		tf[ns]		Cies[pF]		Cres[pF]		FRD	VF[V]		trr[ns]		Package
	25℃	100℃	Typ.	IC [A]	Typ.	IC [A]	Typ.	VCE [V]	Typ.	VCE [V]		Typ.	IF [A]	Typ.	IF [A]	
RGW60TS65HR	60	30	1.5	30	35	30	2530	30	46	30	-	-	-	-	-	TO-247N
RGW60TS65DHR											レ	1.45	20	92	20	
RGW60TS65EHR											レ	1.45	30	95	30	
RGW80TS65HR	78	40	1.5	40	34	40	3320		60		-	-	-	-	-	
RGW80TS65DHR											レ	1.45	20	92	20	
RGW80TS65EHR											レ	1.45	40	101	40	
RGW00TS65HR	96	50	1.5	50	33	50	4200		79		-	-	-	-	-	
RGW00TS65DHR											レ	1.45	30	95	30	
RGW00TS65EHR											レ	1.45	50	102	50	
RGWX5TS65HR	132	75	1.5	75	31	75	5980		118		-	-	-	-	-	
RGWX5TS65DHR											レ	1.45	40	101	40	
RGWX5TS65EHR											レ	1.45	75	109	75	

* This table shows development plan as of today. Schedule and target specification are subject to change without notice.

RGW series for Automotive Application

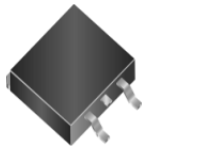
Gen.3 Auto

◆OBC / PFC / UPS / IH / Welding / PV Inverter

<Features>

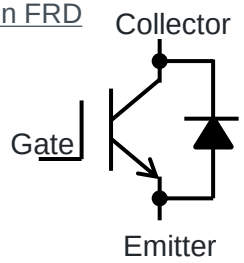
- High speed switching
- Based upon AEC-Q101

P/N	IC[A]		VCE(sat)[V]		FRD	VF[V]	
	25℃	100℃	Typ.	IC [A]		Typ.	IF [A]
★RGW40NL65DHR	TBD	20	1.5	20	レ	1.45	10
★RGW50NL65DHR	TBD	25	1.5	25	レ	1.45	12
★RGW60NL65DHR	TBD	30	1.5	30	レ	1.45	15
★RGW80NL65DHR	TBD	40	1.5	40	レ	1.45	20



LPDL
(D2-Pak)

・Built in FRD

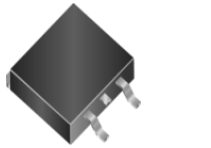


◆OBC / PFC / UPS / IH / Welding / PV Inverter

<Features>

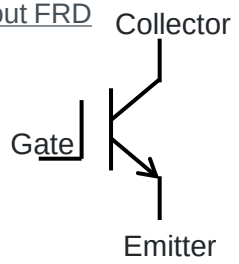
- High speed switching
- Without FRD
- Based upon AEC-Q101

P/N	IC[A]		VCE(sat)[V]	
	25℃	100℃	Typ.	IC [A]
★RGW40NL65HR	TBD	20	1.5	20
★RGW50NL65HR	TBD	25	1.5	25
★RGW60NL65HR	TBD	30	1.5	30
★RGW80NL65HR	TBD	40	1.5	40



LPDL
(D2-Pak)

・Without FRD



This table shows development plan as of today.

Hybrid IGBT（RGW series built in SiC-SBD）

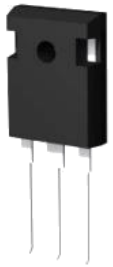
Developing

Gen.3 Auto

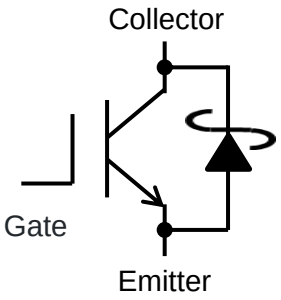
■Features
- Trench Gate & Thin Wafer Technology (3rd gen.)
- Low VCE(sat) 1.5V typ.
- High Speed SW tf 30ns typ.
- Low SW Loss & Low SW Noise
- Low Gate Charge
- **Built in Extreme Fast Silicon Carbide SBD**
- Based upon AEC-Q101

■Applications
On-Board Charger , PFC , DC/DC , DC/AC

TO-247N



・Built in SiC-SBD



■ Line up (650V)

P/N	IC[A]		VCE(sat)[V]		tf[ns]		Cies[pF]		Cres[pF]	
	25℃	100℃	Typ.	IC [A]	Typ.	IC [A]	Typ.	VCE [V]	Typ.	VCE [V]
RGW60TS65CHR	60	30	1.5	30	70	15	2530	30	46	30
RGW80TS65CHR	78	40	1.5	40	40	20	3320		60	
RGW00TS65CHR	96	50	1.5	50	40	25	4200		79	

FRD	VF[V]		trr[ns]		Package
	Typ.	IF [A]	Typ.	IF [A]	
SiC-SBD	1.35	20	34	15	TO-247N
SiC-SBD	1.35	20	34	20	
SiC-SBD	1.35	20	33	25	

Sample schedule	Qualification sample
RGW60TS65CHR	Available
RGW80TS65CHR	Aug. 2021
RGW00TS65CHR	Available

* This table shows development plan as of today. Schedule and target specification are subject to change without notice.

Hybrid IGBT（RGW series built in SiC-SBD）

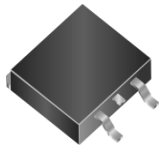
Developing

Gen.3 Auto

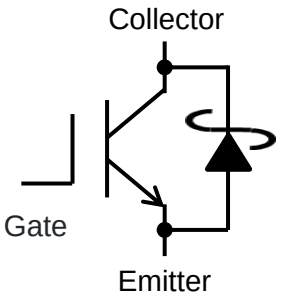
■Features
- Trench Gate & Thin Wafer Technology (3rd gen.)
- Low VCE(sat) 1.5V typ.
- High Speed SW tf 30ns typ.
- Low SW Loss & Low SW Noise
- Low Gate Charge
- **Built in Extreme Fast Silicon Carbide SBD**
- Based upon AEC-Q101

■Applications
On-Board Charger , PFC , DC/DC , DC/AC

LPDL
(TO-263L , D2PAK)



・Built in SiC-SBD



★ Under development

■ Line up (650V)

P/N	IC[A]		VCE(sat)[V]		tf[ns]		Cies[pF]		Cres[pF]	
	25℃	100℃	Typ.	IC [A]	Typ.	IC [A]	Typ.	VCE [V]	Typ.	VCE [V]
★RGW40NL65CHR	40	20	1.5	20	49	10	1680	30	31	30
★RGW50NL65CHR	50	25	1.5	25	54	12.5	2080		38	
★RGW60NL65CHR	60	30	1.5	30	70	15	2530		46	

FRD	VF[V]		trr[ns]		Package
	Typ.	IF [A]	Typ.	IF [A]	
SiC-SBD	1.35	12	18	10	LPDL
SiC-SBD	1.35	12	18	12.5	
SiC-SBD	1.35	12	18	15	

Sample schedule	Design sample	Qualification sample
RGW40NL65CHR	Available	Sep. 2021
RGW50NL65CHR	Available	Sep. 2021
RGW60NL65CHR	Available	Sep. 2021

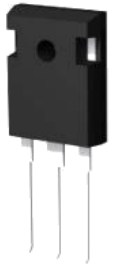
* This table shows development plan as of today. Schedule and target specification are subject to change without notice.

IGBT RGS series

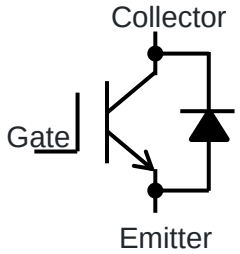
■Features
- Trench Gate & Thin Wafer Technology (2nd gen.)
- Short Circuit SOA 8-10μs min.
- Low SW Loss & Low SW Noise
- Low Gate Charge
- Built in Very Fast & Soft Recovery FRD
- Based upon AEC-Q101

■Applications
Compressor / Heating system

TO-247N



・Built in FRD



■ Line up (650V) / Short Circuit Withstand Time 8μs

P/N	IC[A]		VCE(sat)[V]		tf[ns]		Cies[pF]		Cres[pF]		FRD	VF[V]		trr[ns]	
	25℃	100℃	Typ.	IC [A]	Typ.	IC [A]	Typ.	VCE [V]	Typ.	VCE [V]		Typ.	IF [A]	Typ.	IF [A]
RGS60TS65D	56	30	1.65	30	101	30	980	30	13	30	レ	1.45	30	98	30
RGS80TS65D	73	40	1.65	40	96	40	1240		16			1.45	30	98	30
RGS00TS65D	88	50	1.65	50	91	50	1570		23			1.45	30	98	30
RGS00TS65E	88	50	1.65	50	91	50	1570		23			1.45	50	113	50
RGSX5TS65D	114	75	1.7	75	87	75	2324		23			1.45	50	113	50
RGSX5TS65E	114	75	1.7	75	87	75	2324		23			1.45	75	116	75

■ Line up (1200V) / Short Circuit Withstand Time 10μs

RGS30TSX2D	30	15	1.7	15	128	15	1272	30	8	30	レ	1.65	15	157	15
RGS50TSX2D	50	25	1.7	25	205	25	2095		12			1.65	25	182	25
RGS80TSX2D	80	40	1.7	40	227	40	2820		25			1.65	40	198	40

* This table shows development plan as of today. Schedule and target specification are subject to change without notice.

As of Mar. 2020

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)

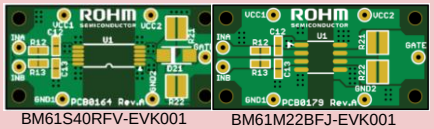
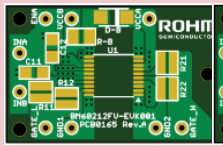
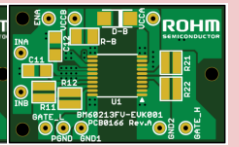
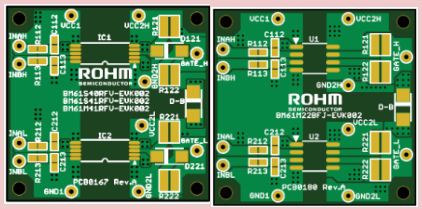
ITEM	FEATURES														Status
	Package	Isolation [kVrms]	Negative Power Supply	Output Current	GCCD(Source)	Gate Resistance Selecting	Miller Clamp	Short Circuit Protection	Soft Turn OFF	A-Soft Turn OFF	Tj Feedback for SCP Vth	Flyback Controller	Temp Monitor	N of Fail Output	
BM6101FV	SSOP-B20W	2.5	✓	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

Isolated gate driver evaluation boards

Enable to replace from existing gate driver.

- Target ：Automotive DCDC, OBC, E-compressor, PTC heater etc..
- Easy to evaluate from exiting board
- Started to sale them at online distributor
  (Digikey / Mouser / Future / Chip 1 stop / ZAIKO Store)

EVK Name	ch.	Drive for	Board	Size[mm]
BM61S40RFV-EVK001	1	SiC-MOS	 BM61S40RFV-EVK001 BM61S41RFV-EVK001 BM61M41RFV-EVK001 BM61M22BFJ-EVK001	33 x 16
BM61S41RFV-EVK001	1	SiC-MOS		
BM61M41RFV-EVK001	1	Si-MOS		
BM61M22BFJ-EVK001	1	IGBT,Si-MOS		
BM60212FV-EVK001	2	IGBT,Si-MOS	 BM60212FV-EVK001  BM60213FV-EVK001	33 x 21
BM60213FV-EVK001	2	IGBT,Si-MOS		
BM61S40RFV-EVK002	2	SiC-MOS	 BM61S40RFV-EVK002 BM61S41RFV-EVK002 BM61M41RFV-EVK002 BM61M22BFJ-EVK002	33 x 32
BM61S41RFV-EVK002	2	SiC-MOS		
BM61M41RFV-EVK002	2	Si-MOS		
BM61M22BFJ-EVK002	2	IGBT,Si-MOS		

Isolated Fly-back regulator BD7Fx05EFJ-C

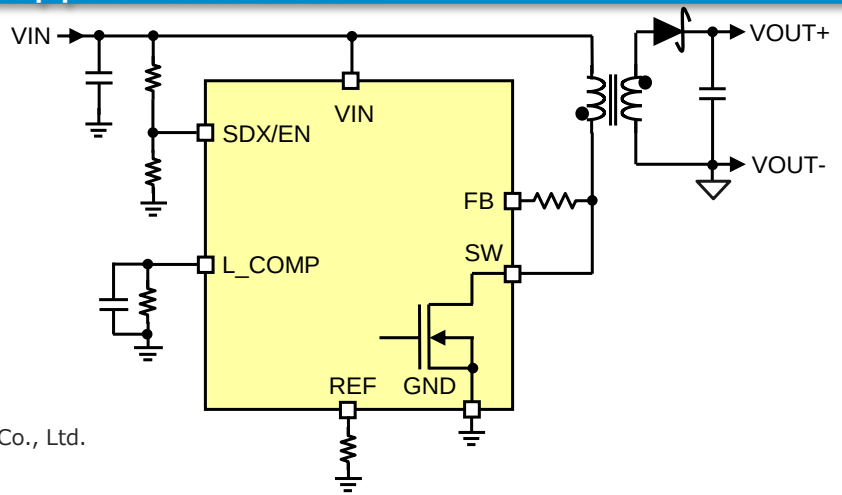
Developing

Ideal for supplying power between high-voltage boards and low-voltage boards. Highly reliable design for Automotive.

Feature

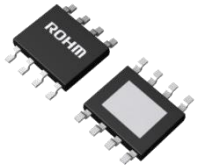
- AEC-Q100 Qualified (Grade 1)
- Primary control without optocoupler and sub winding
- No Need compensation network by On-time control
- Low ripple voltage and fast response by On-time control
- Low EMI by spread spectrum and ON-time control
- High efficiency by Light load mode
- Output voltage compensation of secondary diode Vf
- Input voltage 3.0V to 40V
- Integrated 60V MOSFET
- Protection function
  (OCP, UVLO, SCP, REF OPEN, BSP, TSD)
- Output voltage adjustable with external resister and transformer winding ratio

Application circuit



Spec

- Input voltage : 3.0V to 40V (Maximum 45V)
  *IC don't stop at VIN=2.7V for cold clanking.
- Drain voltage : 60V
- Junction temperature : -40 to 150℃
- Operating Current : 500μA @ VIN=12V
- Switching frequency : 400kHz (Typ.)
- Current limit : 2.2A/3.8A



HTSOP-J8
4.90mm×6.00mm×1.00mm
1.27mm pitch

Line up

Product Name	Output Power@ VIN=6～32V	Current Limit
BD7F105EFJ-C	4.0W	2.20A
BD7F205EFJ-C	8.0W	3.80A

Design Sample: Nov. 2021
Qualification Sample : Jun. 2022

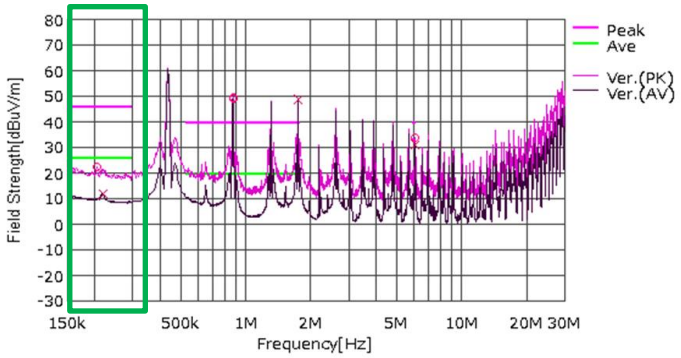
As of Jul. 2021

Advantage of BD7F205EFJ-C

Developing

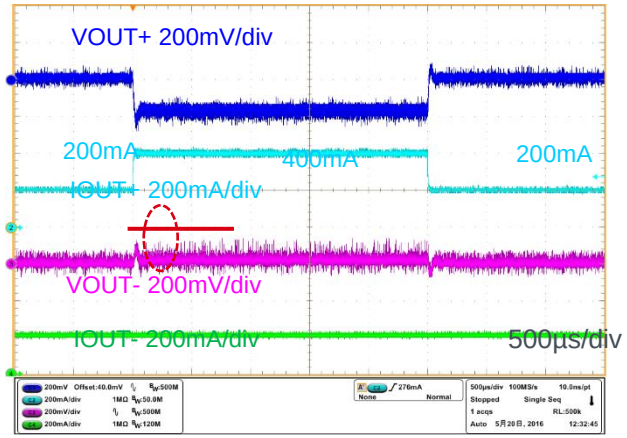
① Low EMI

EMI result at Rohm ＊ No input filter



AM width (150～300kHz) : OK

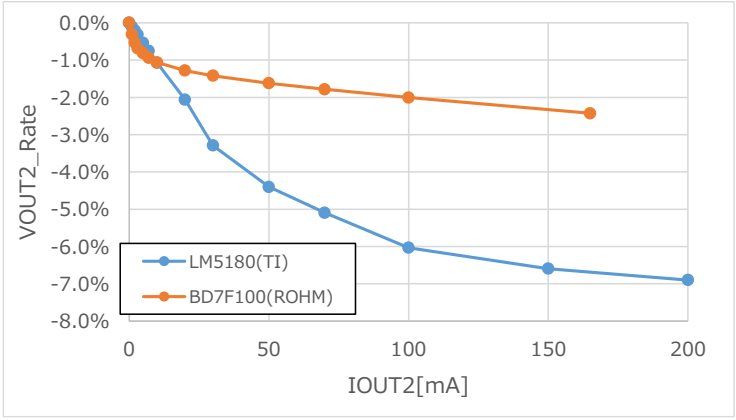
② Fast Response



2output

Output variation Δ80mV

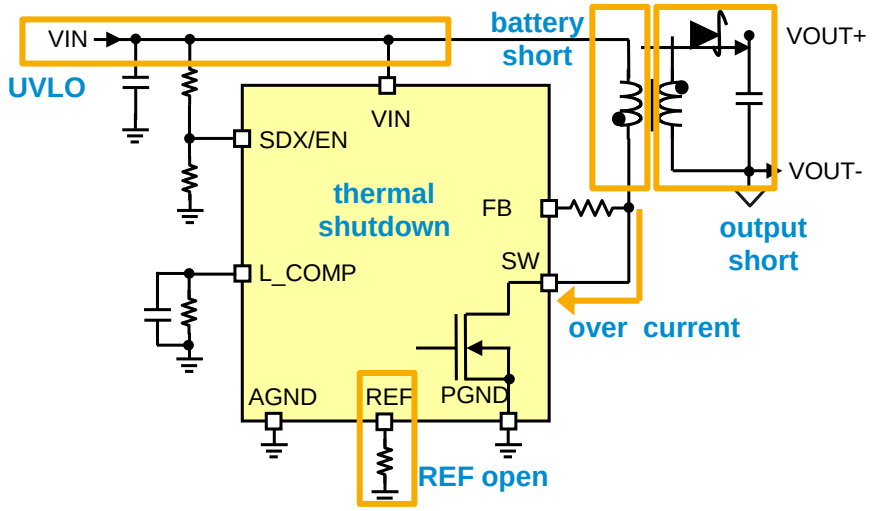
③ Cross regulation



CH1(IOUT1) vs CH2(VOUT2_rate) (IOUT2 : 82mA fix)

* Output voltage of CH2 are different from Rohm and T company. So they compare to use output rate for 0mA.

④ Rich Protection



OPEN & Short protection for IC Pin & External parts

Linear Regulator Family 1

xx=Output Voltage yy=Package

Red: in Development Blue: in Planning Light blue: under Concept

1ch LDO Series for Automotive

Standard LDOs (Standard Series) | Nano Energy™ LDO (Nano Energy) | Nano Cap™ LDO (Nano Cap)

Voltage / Current	Up to 0.1A	0.2A	0.3A	0.5A	1.0A and over
45V to 50V	[Low Quiescent Current and Small Type LDO Series] **BD7xxL05G-C** *0.05A output items [Nano Energy™ LDO Series] **BD9xxL1yy-C** *0.1A output items	[Low Quiescent Current LDO Series] **BD7xxL2yy-C** [Standard LDO Series] **BD4xxM2yy-C** **BD4xxS2yy-C** **BD6xxM2yy-C** [Nano Energy™ LDO Series] **BD9xxL2yy-C** [Nano Cap™ LDO Series] **BD9xxN1yy-C** ※0.15A Output	[Standard LDO Series] **BD6xxM3yy-C**	[Low Quiescent Current LDO Series] **BD7xxL5yy-C** [Standard LDO Series] **BD4xxM5yy-C** **BD4xxS5yy-C** **BD6xxM5yy-C** **BD800M5yy-C** [Nano Energy™ LDO Series] **BD9xxL5yy-C** [Nano Cap™ LDO Series] **BD9xxN5yy-C**	[Standard LDO Series] **BD6xxC0yy-C** (Temporary) *1A output items **BD6xxD0yy-C** (Temporary) *2A output items
30V to 36V			**BD3650FP-M**		**BDxxC0Ayy-C**
15V to 20V			**BDxxGA3MEFJ-M** **BDxxGA3MEFJ-C**	**BDxxGA5MEFJ-M** **BDL00A5yy-C**	**BDxxGC0MEFJ-M**
10V			**BDxxHA3MEFJ-M** **BDxxHA3MEFJ-C**	**BDxxHA5MEFJ-M**	**BDxxHC0MEFJ-M** **BDxxHC5MEFJ-M**
6.5V to 7V		**BUxxSD2MG-M** **BUxxJA2VG-C** **BUxxJA2DG-C** **BUxxJA2MNVX-C**	[New Secondary LDO Series] **BUxxJA3DG-C**	**BDxxIA5MEFJ-M** **BD00IA5MHFV-M**	**BDxxIC0MEFJ-M** **BD00JC0MNUX-M**

(Note) Schedules, specifications, and model names under development/planning may change depending on the market trend and developing situation.

Linear Regulator Family 2

xx=Output Voltage yy=Package

Red: in Development Blue: in Planning Light blue: under Concept

Voltage Tracker Series for Automotive

Standard LDOs
Standard Series

Vin/ Io	0.05A	0.07A	0.25A	0.40A
45V to 50V	BD42500G-C BD92500G-C	BD42540FJ-C BD92540G-C	BD42530EFJ/FPJ/FP2-C BD92530yy-C	BD92510FPJ-C

Multi-Function LDO Series for Automotive

Multi-Function LDOs
Multi-Function Series

Vin / Io	0.2A	0.5A
45V to 50V	[Multi-Function Standard Series] **BD3010AFV-M** : 5V LDO + 4.25V RESET + WDT(T/O) **BD4269EFJ/FJ-C** : 5V LDO + 2ch Adjustable RESET [Low Quiescent Current Series] **BD820F50EFJ-C** : 5V LDO + 4.20V RESET + WDT(T/O)	[Multi-Function Standard Series] **BD3020HFP-M** : 5V LDO + Adjustable RESET + WDT(T/O) **BD3021HFP-M** : 5V LDO + 4.50V RESET + WDT(T/O) **BD4271HFP/FP2/EFJ-C** : 5V LDO + 4.65V RESET + WDT(T/O) **BD42754HFP/FP2-C** : 5V LDO + 4.62V RESET

RESET: Voltage Monitoring and Reset Function
WDT: Watch-Dog-Timer Function
T/O: Timeout-type (Watch-Dog-Timer)
W: Window-type (Watch-Dog-Timer)

WDT + RESET Series for Automotive

Vin / Io	WDT + RESET
40V	**BD37/87Bxxyy-C** : 2.3V to 4.6V FIXED RESET + WDT(T/O) **BD87B00yy-C** : Adjustable RESET + WDT(T/O) **BD87Cxxyy-C** : 2.3V to 4.6V FIXED RESET + WDT(W)

(Note) Schedules, specifications, and model names under development/planning may change depending on the market trend and developing situation.

LDO for MCU BD4xx/7xx series

A lineup in which the standard series and low quiescent current series can be selected according to the set current consumption requirement at key-off.

BD4xxMxxx-C (Standard series) Feature

- Output voltage accuracy : ±2% (Tj = -40°C to +150°C)
- Output transistor : Pch DMOS
- Output ON resistance : 0.6Ω (5V, 500mA; Typ.)
  1.6Ω (5V, 200mA; Typ.)
- Output capacitor : Effective value 6μF or larger
  (Electrolytic capacitor applicable. ESR ≤ 5Ω)
- EN function equipped
- Standby current : 5μA (Max.) @ Ta = 125°C
- Internal protections
  Over current protection / Thermal shutdown
- AEC-Q100 qualified

BD7xxLxxx-C(Ultra Low Quiescent) Feature

- Output voltage accuracy : ±2% (Ta = -40°C to +125°C)
- Output transistor : Pch DMOS
- Output ON resistance : 1.25Ω (5V, 500mA; Typ.)
  2Ω (5V, 200mA; Typ.)
- Output capacitor : Effective value 4.7μF or larger
  (Electrolytic capacitor applicable. ESR ≤ 10Ω)
- Internal protections
  Over current protection / Thermal shutdown
- AEC-Q100 qualified

BD4xxMxxx-C series Key Specifications

- Input voltage range : 3.0V to 42V
- Output voltage : 3.3V / 5.0V
- Output current : 200mA / 500mA
- Low quiescent current : 38μA (500mA; Typ.)
  : 40μA (200mA; Typ.)
- Operate temperature range (Tj) : -40°C to +150°C

BD7xxLxxx-C series Key specifications

- Input voltage range : 3.0V to 45V
- Output voltage : 3.3V / 5.0V
- Output current : 200mA / 500mA
- Low quiescent current : 6μA (Typ.)
- Operate temperature range (Ta) : -40°C to +125°C


Detector IC Lineup for Automotive
Operating Temperature Range : -40℃ to 125℃

Standard Voltage Detector

Part No	Items	Detection Accuracy [%]	Detection Voltage V_{DET}[V]	Detection Step [V]	Output topology	Icc [μA]		Hysteresis Voltage [V]	Package
						ON	OFF		
BD70HxxG-2C series	5	±1.4 (-40 to 125℃)	3.06, 3.46 to 3.76	0.1	Open-Drain	0.27	0.3	–	SSOP5
BD73HxxG-2C series	4				Push-Pull				

Programmable time delay Voltage Detector

Part No	Items	Detection Accuracy [%]	Detection Voltage V_{DET}[V]	Detection Step [V]	Output topology	Icc [μA]		Hysteresis Voltage [V]	Package
						ON	OFF		
BD52xxG-2C series	42	±3 (-40 to 125℃)	0.9 to 5.0	0.1	Open-Drain	0.23	0.27	V_{DET}×0.05	SSOP5
BD53xxG-2C series	42				Push-Pull				
BD52xxNVX-2C series	6	±2.5 (-40 to 125℃)	2.6 to 3.1	0.1	Open-Drain			V_{DET}×0.05	SSON004R1010
BD53xxNVX-2C series	6				Push-Pull				

Low EMI Operational Amplifiers

Excellent EMI Characteristics OPAMP Line up

Part No.	Ch	Device Type	Supply Voltage	Input Offset Voltage [MAX.]	Slew Rate [TYP.]	Input Common-mode Voltage Range	Supply Current [MAX.]	Package
BA82904Yxxx-C	2	Bipolar	3V ~ 36V	9mV	0.2V/μs	0V ~ VCC-2.0V (Ground Sense)	1.2mA	SOP8 / MSOP8
BA82902Yxxx-C	4						3.0mA	SOP14 / SSOP-B14
BA83472Yxxx-C	2		3V ~ 36V	10mV	8.5V/μs	0V ~ VCC-2.6V (Ground Sense)	6.0mA	SOP8 / MSOP8
BA83474YFV-C	4							SSOP-B14
BD87581YG-C	1	CMOS	4V ~ 14V	10mV	3.5V/μs	0V ~ VCC (Rail to Rail)	4.5mA	SSOP5
BD87582YFVM-C	2						8.0mA	MSOP8

Excellent EMI Characteristics COMP Line up

Part No.	Ch	Device Type	Supply Voltage	Input Offset Voltage [MAX.]	Response Time [TYP.]	Input Common-mode Voltage Range	Supply Current [MAX.]	Package
BA82903Yxxx-C	2	Bipolar	3V ~ 36V	9mV	0.2V/μs	0V ~ VCC-2.0V (Ground Sense)	2.5mA	SOP8 / MSOP8
BA82901Yxxx-C	4							SOP14 / SSOP-B14

High Speed OPAMP

Summary

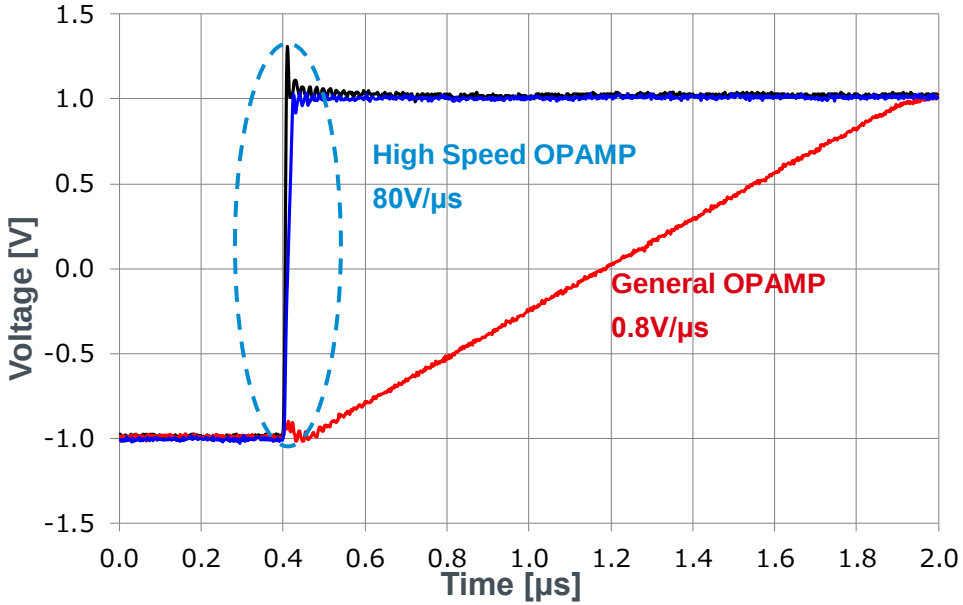
「High Slew Rate」
「Wide Frequency Band」

High Speed OPAMP

This product is most suitable for motor overcurrent detection and various detection circuits that Require high-speed response.

- **High Slew Rate**
  80V/μs
- **Gain Bandwidth Product**
  150MHz

Feature



High Speed 5V CMOS OPAMP

NEW

Part No.	Ch	Input Offset Voltage [MAX.]	Slew Rate [TYP.]	Supply Current [MAX.]	DS	CS	Package
LMR1701YG-C	1	8mV	80V/μs	16mA	✓	✓	SSOP5
LMR2702YFVM-C	2			32mA	Under Plan	Under Plan	MSOP8

Fast control system is realized by fast voltage response time.

Low Offset & Low Noise CMOS OPAMP

Summary

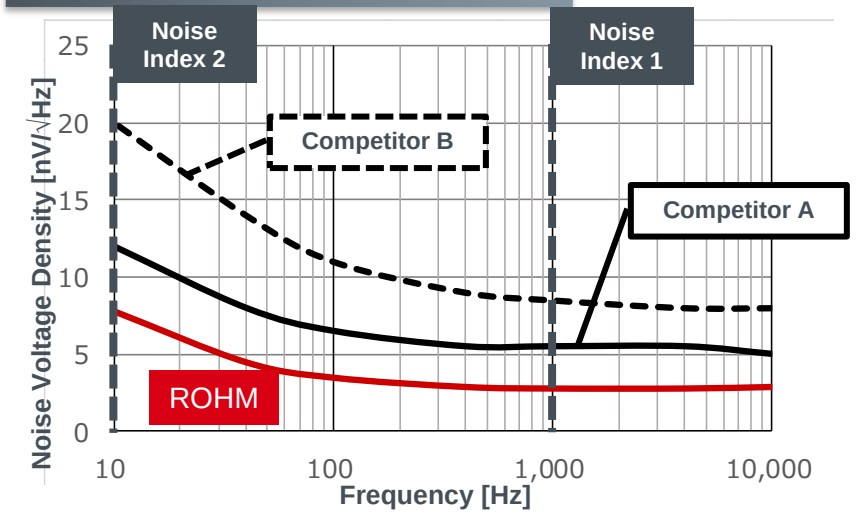
「Low Offset」

「Low Noise」

High precision operational amplifier

- **Input Offset Voltage**
  950μV,450μV,550μV
- **Input Bias Current 0.5pA (Ta=25℃)**
- **Input Referred Noise Voltage Density**
  2.9nV/√Hz(1kHz) 7.8nV/√Hz(10Hz)

Feature



Low Noise 5V CMOS OPAMP Line Up

NEW

Part No.	Ch	Input Offset Voltage【MAX.】	Noise Voltage Density【TYP.】	Supply Current【TYP.】	DS	CS	Package
LMR1801YG-C (Ground Sense)	1	950μV	5.0nV/√Hz @1KHz	0.95mA	✓	✓	SSOP5
LMR1802YG-C (Ground Sense)	1	450μV	2.9nV/√Hz @1KHz	1.10mA	✓	✓	SSOP5
TLRx377YG-C (Rail to Rail)	1,2	1,300μV	8.0nV/√Hz @1KHz	1.00mA @1ch	✓ ✓ ✓	✓ ✓ '21/4Q	SSOP5 MSOP8 SSOP-B14
TLRx376YG-C (Rail to Rail)	1,2,4	550μV	8.0nV/√Hz @1KHz	1.00mA @1ch	✓ ✓ ✓	✓ ✓ '21 4Q	SSOP5 MSOP8 SSOP-B14

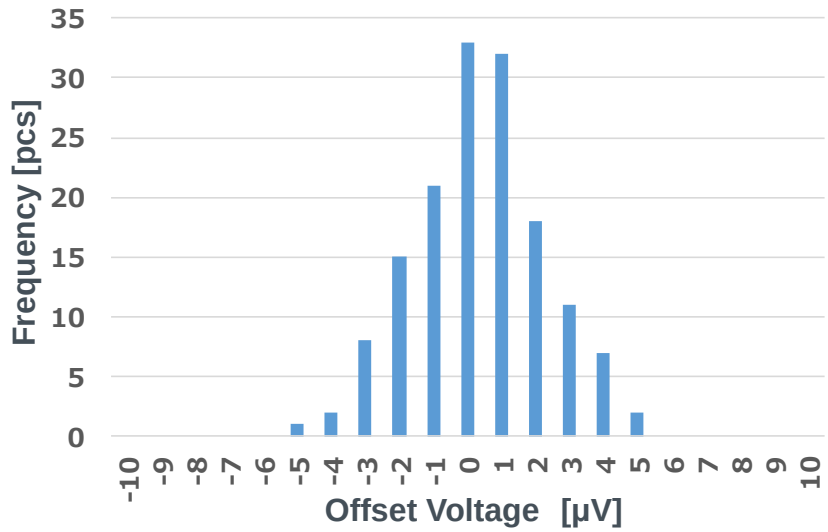
Ultra Low Offset Chopper CMOS OPAMP

Summary

By chopper method,
With 「Ultra Low Offset Voltage」
High precision OPAMP

- **Low Offset Voltage**
  12μV【MAX.】
- **Temperature Coefficient of Offset Voltage**
  0.05μV/℃【TYP.】
- **Input Bias Current**
  ±150pA【TYP.】
- **Supply Current**
  1.5mA【MAX.】

Feature



Ultra Low Offset 5V CMOS OPAMP

Under Development

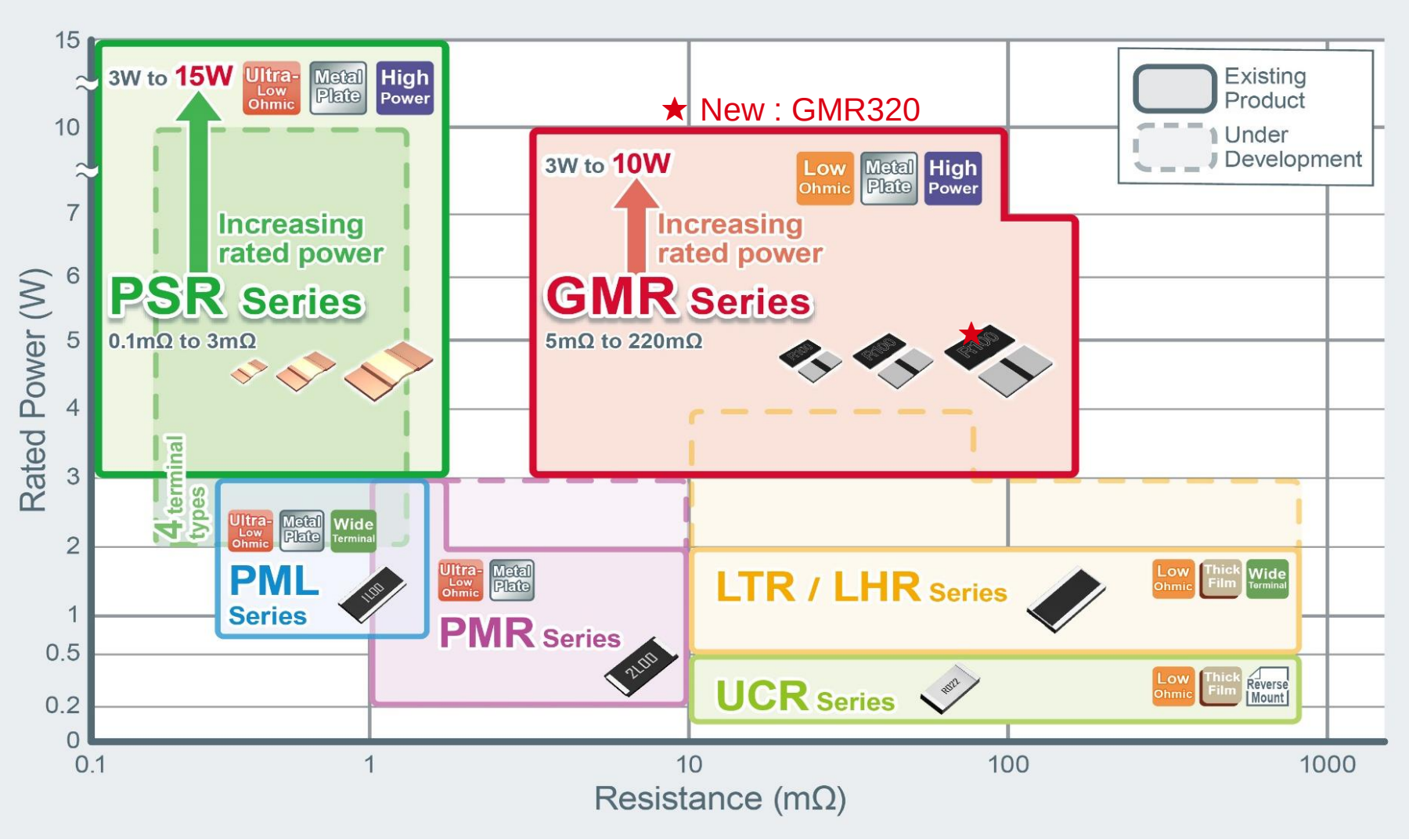
Part No.	Ch	Input Offset Voltage【MAX.】	Temp Coefficient【TYP.】	Supply Current【MAX.】	DS	CS	Package
LMR1001YF-C	1	12μV	0.05μV/℃	1.5mA	✓	Under Way	SOP8

Ultra-high-precision OPAMP most suitable for small voltage amplification.

Shunt resistors lineup

GMR320 series which guarantees max 10W is just released.

Expanded rated power of PSR series up to 15W.



PSR Ultra Low Ohmic Series Metal Plate / High Power

Features

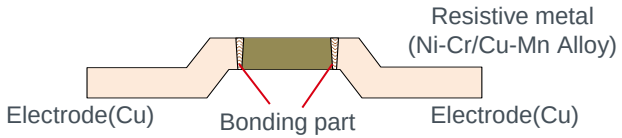
・Large Electricity (3W～5W)

Rohm's unique welding technology achieves copper electrode and thick metal resistor combine to have good heat dissipation.

・ Ultra low ohmic (min. 0.1mΩ)

We achieve low TCR* even at ultra-low resistance range by adopting a high-performance alloy material in metal resistor.

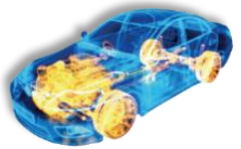
Structure



Application

For Current detection

- •Automotive （EPS, Battery charger, etc.…）
- •Renewal Energy（Power conditioner）
- •Industrial （Air conditioner, Refrigerator



Specification ： 0.1mΩ～3.0mΩ

Type	Size mm (inch)	Toler-ance	Resistance (mΩ)	Rated Power		Conventional	New	Operating Temp.
				Ambient Temperature	New Terminal Temperature	TCR(ppm/℃) +20 ～ +125℃	TCR(ppm/℃) +20 ～ +175℃	
PSR100	6432 (2512)	F (±1%)	0.3	3W (Ta@70℃)	8W(Tk@75℃) 4W(Tk@140℃)	±150	0～+150	-65 ～ 175℃
			0.5		8W(Tk@75℃) 4W(Tk@140℃	±115	0～+100	
			1.0		8W(Tk@75℃) 4W(Tk@140℃)	±100	0～+100	
			2.0		6W(Tk@75℃) 4W(Tk@140℃)	±50	0～+50	
			3.0		4W(Tk@75℃) 3W(Tk@140℃)	±50	0～+50	
PSR400	10×5.2 (3921)	F (±1%)	0.2	4W (Ta@70℃)	12W(Tk@75℃) 5W(Tk@130℃)	125±50	125±50	
			0.3		10W(Tk@75℃) 5W(Tk@130℃)	±175	0～+100	
			0.5		10W(Tk@75℃) 5W(Tk@130℃)	±175	0～+100	
			1.0		8W(Tk@75℃) 5W(Tk@130℃)	±75	0～+75	
			2.0		6W(Tk@75℃) 4W(Tk@115℃)	±75	0～+75	
			3.0		5W(Tk@70℃) 3W(Tk@115℃)	±75	0～+75	
PSR500	15×7.75 (5931)	F (±1%)	0.1	5W (Ta@70℃)	15W(Tk@75℃) 10W(Tk@120℃)	200±50	200±50	
			0.2		15W(Tk@75℃) 10W(Tk@120℃)	±225	0～+150	
			0.3		10W(Tk@75℃) 7W(Tk@120℃)	±150	0～+150	
			0.4		10W(Tk@75℃) 7W(Tk@120℃)	±150	0～+150	
			0.5		10W(Tk@75℃) 7W(Tk@120℃)	±150	0～+150	
			1.0		10W(Tk@75℃) 6W(Tk@120℃)	±75	0～+75	
			2.0		7W(Tk@70℃) 4W(Tk@115℃)	±75	0～+75	

PSR Ultra Low Ohmic Series Metal Plate / High Power Case Study

Product

・PSR series (PSR100/400/500)
High power shunt resistor

Topology

・PFC, LLC, Secondary
current detection

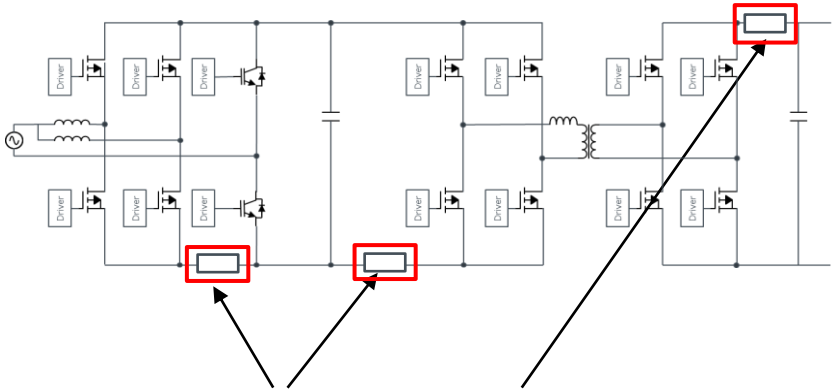
Customers

2 companies

Why ROHM?

➢ High power with small PKG

・High current detection is necessary.
(From 3W to 5W and below 1mohm)



➢ Simulation support

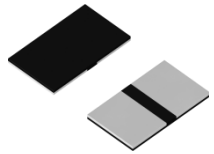
・Optimal PCB and land pattern design is important for current detection circuit since it affects current detection accuracy. ROHM enables to support such simulation support.

If technical support is necessary, please contact with ROHM sales.

GMR Low Ohmic Series Metal Plate / High Power

Feature

- **High power up to 10W.**
- **ROHM's original structure for excellent heat dissipation.**
- Line up from 5mΩ to 220mΩ.
- Special metal alloy allows low TCR.



Specification : 5mΩ～220mΩ

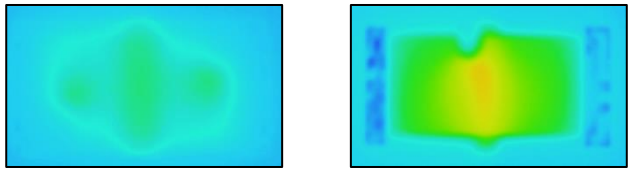
Type	Size mm(inch)	Rated Power (Terminal Temp.)	Tolerance	Resistance (mΩ)	TCR* (ppm/℃)	Operating Temp.
New GMR50	5025 (2010)	4W(90℃) 3W(110℃)	F (±1%)	5	0 to +25	-65 ～ +170℃
				10 ～ 220	±25	
New GMR100	6432 (2512)	7W(70℃) 5W(110℃)		5	0 ～ +25	
				10 ～ 220	±20	
New GMR320	7142 (2817)	10W(70℃) 7W(110℃)		5	0 ～ +25	
				10 ～ 100	±25	

High power
Low TCR
Wide temperature range

Characteristic Comparison

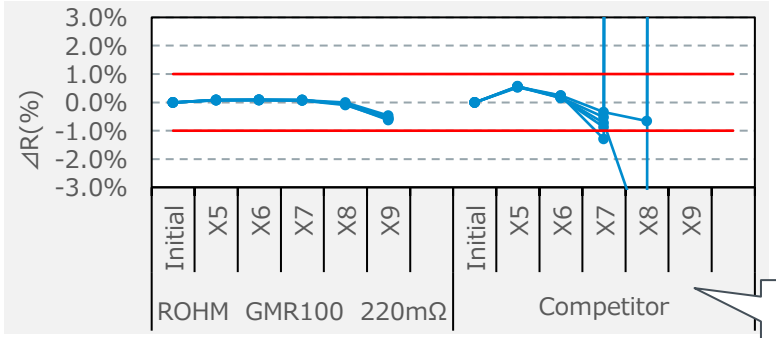
GMR series has better heat dissipation than the competitors

＜GMR100/10mΩ＞ ＜Competitor/10mΩ＞



＜107℃ at 3W＞ ＜140℃ at 3W＞

■ **Overload Test**



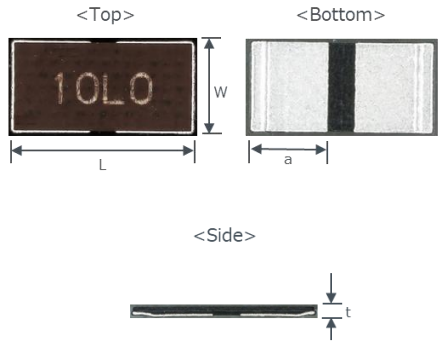
Competitor varies over ±3% with ×8 overload

Application

For Current detection

- Automotive（ECU, Motor peripheral circuit, etc.）
- Industrial（General inverter）
- Renewal Energy（Power conditioner）
- Air conditioner, Refrigerator
- Power supply

Appearance



PMR Ultra Low Ohmic Series Metal Plate / General

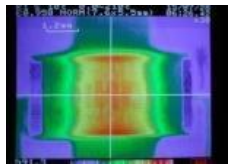
Features

◆ Rohm original trimming-less structure

Surface Temperature

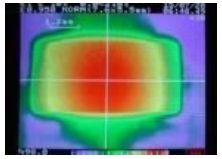
Size：6432
Rated Power：1W
ROHM：PMR
Competitor：Metal element type

＜ROHM＞



(88.7℃)

＜Competitor＞



(98.8℃)

Our design allows unique temperature diffusion

Structure

◆ Special alloy for Resistor!

Conventional product (Alumina base)	Resistive metal element (PMR series)
Overcoating (Resin) Resistive element Alumina substrate Side electrode (Ag/Ni/Sn)	Overcoating (Resin) Metal plate inner electrode（Cu） mid electrode（Ni） outer electrode（Sn）

Specification ： 1mΩ～10mΩ

Type	Size mm(inch)	Rated Power	Tolerance	Resistance (mΩ)	TCR(ppm/℃)	Operating Temp.
PMR01	1005 (0402)	0.2W	J (±5%)	10	0～200	-55～+155℃
PMR03	1608 (0603)	0.25W	J (±5%) F (±1%)	10	0～150	
PMR10	2012 (0805)	0.5W		2,3,4,5,6, 7,8,9,10	±150	
PMR18	3216 (1206)	1W		1,2,3,4,5 6,7,8,9,10	±100	
PMR25	3225 (1210)	1W		1,2,3,4,5	±100	
PMR50	5025 (2010)	1W		1,2,3,4,5, 6,7,8,9,10	±100	
PMR100	6432 (2512)	2W		1,2	±150	
				3,4,5,6 7,8,9,10	±100	

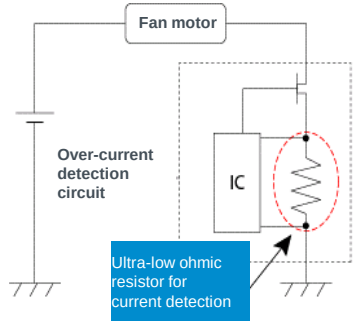
Application

Current detection purpose

Laptop PC, HDD, Mobile phones,
Small batteries, Chargers,
DC/DC converter, and other general
Power supplies

Circuit Example

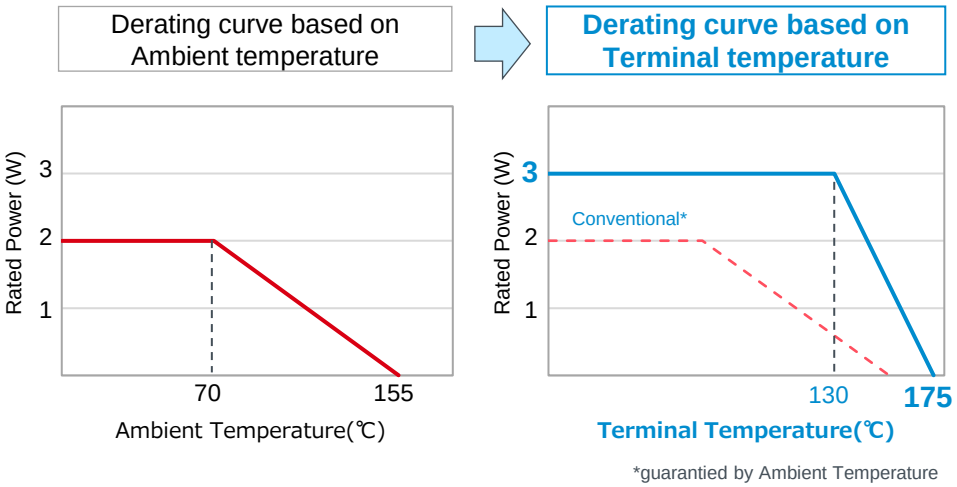
＜Overcurrent detection ＞



PMR Improved Rated Power Series Shunt / Metal Plate

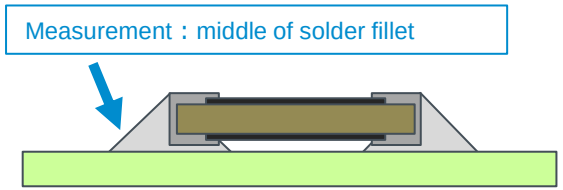
Features

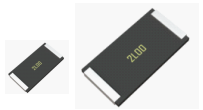
・Guarantees high power with terminal temp. rule
・Enlargement of operating temp.
・Re-examination of TCR



*guarantied by Ambient Temperature

(Terminal temperature rule)





Specification ： -65℃ ～ +175℃

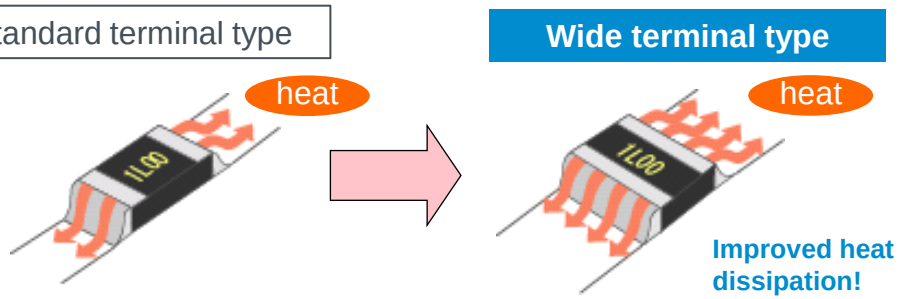
	Size mm(inch)	Rated Power	Rated Terminal Temp.	Tolerance	Resistance (mΩ)	TCR (ppm/℃)	Operating Temp	Schedule
PMR01	1005 (0402)	**★0.5W**	130℃	J (±5%)	10	**0～200**	**-65～ +155℃**	'21/3Q
PMR03	1608 (0603)	**★0.75W**		J (±5%) F (±1%)	10	**0～150**		'21/3Q
PMR10	2012 (0805)	**★1.0W**			2	**±100**		'21/2Q
PMR18	3216 (1206)	**★1.5W**			1, 2	**±100**		'21/2Q
PMR25	3225 (1210)	**★2W**			1	**±75(F) ±150(J)**	**-65～ +175℃**	'21/2Q
PMR50	5025 (2010)	**★2W**			1, 2	**±75(F) ±150(J)**		'21/2Q
PMR100	6432 (2512)	New **3W**			1, 2	**±75(F) ±150(J)**		Available

★：Under development ＊Design and specification is supposed to change

PML Ultra Low Ohmic Series Metal Plate / Wide Terminal

Features

Wide terminal configuration for high joint reliability !



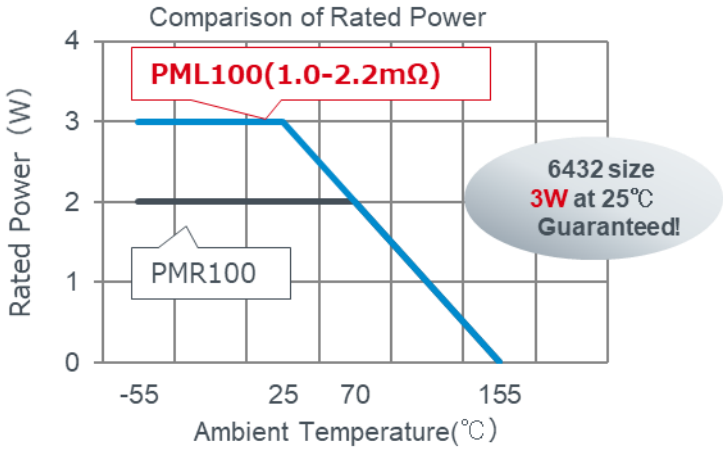
- Introducing special alloy, with higher reliability, as resistive element.
- Rohm original trimming-less structure has improved current /heat dissipation characteristics. at dissipation characteristics.

Specification : 0.5mΩ～2.5mΩ

Available for high current! Lineup from ultra low 0.5mΩ.

Type	Size mm(inch)	Rated Power	Tolerance	Resistance (mΩ)	TCR(ppm/℃)	Operating Temp.
PML10	1220 (0508)	0.66W	J (±5%) G (±2%)	1.0, 1.5, 2.0, 2.5	±200	-55～+155℃
PML18	1632 (0612)	1W		0.5, 1.0, 1.5, 2.0, 2.5	±150	
PML50	2550 (1020)	2W	J (±5%)	0.5, 1.0, 1.5, 2.0, 2.2	±200	
PML100	3264 (1225)	2W (3W at 25℃)		1.0, 1.5, 2.0, 2.2	±100	
		2W		0.5	±150	

Rated Power Comparison



Application

・Automotive motors, EPS, Laptop PC, Current detection circuit, etc.

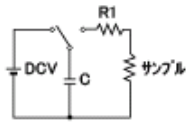
Suitable for the detection of high current!

ESR Anti-Surge Series Anti-Surge / Thick Film

Features

◆ Guaranteed 2～5kV ESD resistance! (EIAJ4701-1 Human Model)

■ Anti-surge chip resistors (ESR series) vs Conventional chip resistors (MCR series)



	ESR01	ESR03 /10/18	ESR25
SCV(Applied voltage)	2kV	3kV	5kV
Applied cycle	±5times	±10times	±10times
C(Capacitor)	100pF	100pF	100pF
R1(Discharge resistance)	1.5kΩ	1.5kΩ	1.5kΩ

Surge-resistance is much improved by longer conducting distance and resistance pattern to avoid concentration of voltage burden.

◆ Superior rated power!

mm	ESR series	MCR series
1005	**0.20W**	0.063W
1608	**0.25W**	0.10W
2012	**0.40W**	0.125W
3216	**0.50W**	0.25W
3225	**0.66W**	0.25W
5025	**-**	0.50W

Improvement of surge-resistance enables to displace smaller size of resistors, and it contributes space savings in your set.

Specification

Type	Size mm(inch)	Rated Power	Tolerance	Resistance (Ω)	TCR(ppm/℃)	Operating Temp.
ESR01	1005 (0402)	0.2W	J (±5%)	1 ～ 9.1 10 ～ 10M	+500/-250 ±200	-55～+155℃
			F (±1%)	10 ～ 2.2M	±100	
ESR03	1608 (0603)	0.25W	J (±5%)	1 ～ 10M	±200	
			F (±1%)	1 ～ 9.76 10 ～ 10M	±200 ±100	
			D(±0.5%)	10 ～ 1M	±100	
ESR10	2012 (0805)	0.4W	J (±5%)	1 ～ 30M	±200	
			F (±1%)	1 ～ 10M	±100	
			D(±0.5%)	10 ～ 1M	±100	
ESR18	3216 (1206)	0.5W	J (±5%)	1 ～ 15M	±200	
			F (±1%)	1 ～ 10M	±100	
			D(±0.5%)	10 ～ 1M	±100	
ESR25	3225 (1210)	0.66W	J (±5%) F (±1%) D(±0.5%)	J,F: 1 ～ 10M D:10 ～ 1M	J：±200 F,D：±100	

ESR01 (Guaranteed 2kV) ESR03 (Guaranteed 3kV) ESR10 (Guaranteed 3kV) ESR18 (Guaranteed 3kV) ESR25 (Guaranteed 5kV)

LTR High Power Series Anti-Surge / Thick Film / Wide Terminal

Shunt / Thick Film / Wide Terminal

Features

✓ ROHM's unique structure has improved heat dissipation characteristics and resulting higher rated power.

■ Rated Power Comparison

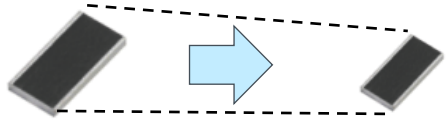
サイズ mm(inch)	MCR series (General)	LTR series
2012(0805)	0.25W	**0.5W**
3216(1206)	0.25W	**1.0W**
5025(2010)	0.5W	**2.0W**
6432(2512)	1.0W	**3.0W**

Superior power ratings

✓ Available to replace from the general package.

<Competitor> 5025 size / 1W

<ROHM LTR18> **1632 size / 1W**



60% Mount space saved!

Specification : 10mΩ～9.1Ω

Type	Size mm(inch)	Rated Power	Tolerance	Resistance(Ω)	TCR(ppm/℃)	Operating Temp.
LTR10	1220 (0508)	0.5W	J (±5%) F (±1%)	47m ～ 9.1	±150	-55～+155℃
LTR18	1632 (0612)	1.0W		10m ～ 18m	0 ～ 300	
				20m ～ 47m	0 ～ 200	
				51m ～ 470m	0 ～ 150	
				510m ～ 1.0	±100	
New **LTR50**	2550 (1020)	**2.0W**		10m ～ 18m	0 ～ 300	
				20m ～ 47m	0 ～ 200	
				51m ～ 91m	0 ～ 150	
				100m ～ 910m	±100	
LTR100	3264 (1225)	**★4.0W**		★10m ～ 18m	0 ～ 300	-65～+155℃
				★20m ～ 47m	0 ～ 200	
				★51m ～ 91m	0 ～ 150	
		2.0W **★3.0W**		100m ～ 910m	J : ±200	-55～+155℃
				100m ～ 200m	F : 0～150	
				220m ～ 910m	F : 0～100	

★ : Under development ＊ Design and specification is supposed to change

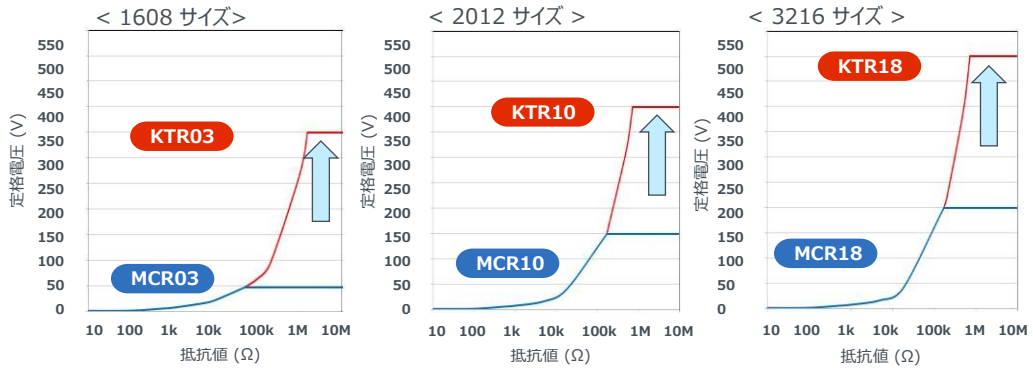
Application

- Automotive , Power supply
- Motor control circuit
- Battery

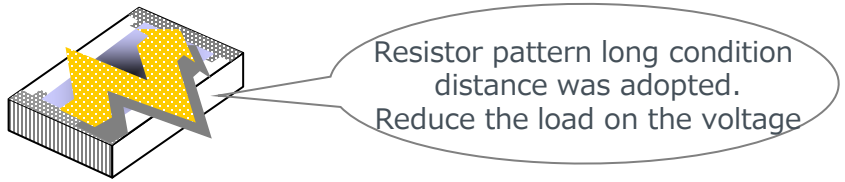
KTR High Voltage Resistance Series High V.R. / Thick Film

Features

■ Rated voltage comparison（KTR series VS. MCR series）



ROHM's unique resistance pattern and trimming design prevent concentration of the voltage burden, resulting in more than twice voltage resistance of our own standard conventional parts(MCR series).



The KTR series reduces the number of resistors required in high-voltage applications. Also available to replace from the lead type.

Specification

Type	Size mm(inch)	Rated Power	Rated Voltage	Tolerance	Resistance Range(Ω)	TCR(ppm/℃)	Operating Temp.
KTR03	1608 (0603)	0.1W	**350V**	J (±5%) F (±1%)	1 ～10M	J :±200 F :±100	-55～+155℃
KTR10	2012 (0805)	0.125W	**400V**		1 ～10M		
KTR18	3216 (1206)	0.25W	**500V**		1 ～10M		
KTR25	3225 (1210)	0.33W	**600V**		1 ～10M		

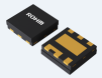
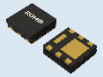
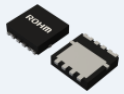
Application

High voltage circuit

- AC/DC Power supply
- Automotive (BMS, etc.)
- FA apparatus（General inverter , AC servo）
- Office appliance（MFP , LBP）
- Renewal Energy（Power conditioner）
- Home appliance（Air conditioner, Refrigerator）

Gen.4th Nch MOSFET for Automotive

Developing

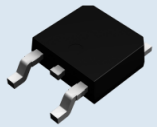
Package	Part No.	BV_{DSS} (V)	Pw Tc=25℃ (W)	ID (A)	RON Typ. (mΩ)		RON Max. (mΩ)		Qg(nC) V_{GS}=10V	Ciss(pF)	
					V_{GS}=10V	V_{GS}=4.5V	V_{GS}=10V	V_{GS}=4.5V			
DFN2020WF-L7 	RF9G120BF	40	23	12	21	26	27	35	9.1	520	★
DFN2020WF-L8 	RF7G120BF										★
HSMT8AG 	RQ3G270BF	40	T.B.D	27	8.8	10.8	11.7	14.8	21	1170	★
	RQ3G120BF	40	T.B.D	12	21	26	27	35	9.1	520	★

★ :DS OK

※This is tentative Specification, we may change contents without notice.

Gen.4th Nch MOSFET for Automotive

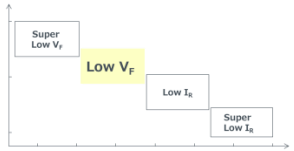
Developing

Package	Part No.	BV_{DSS} (V)	Pw Tc=25℃ (W)	ID (A)	RON Typ. (mΩ)		RON Max. (mΩ)		Qg(nC) V_{GS}=10V	Ciss(pF)	
					V_{GS}=10V	V_{GS}=4.5V	V_{GS}=10V	V_{GS}=4.5V			
HPLF5060 (SOT-669) 	AG073DGS4	40	133	120	1.8	2.2	2.3	3.0	98	5500	★
	AG070DGS4	40	115	120	2.2	3.0	3.0	4.0	80	4000	★
	AG072DGS4	40	37	38	15	19	19	26	9.5	550	
TO-252 	AG004DGD3	40	136	80	2.5	2.9	3.3	4.0	105	5800	★
	AG086DGD3	40	97	80	3.5	4.3	4.6	5.9	51	2900	★
	AG087DGD3	40	78	80	4.5	5.7	6.0	7.9	36	2000	★
	AG042DLD3	60	T.B.D	80	7.6	8.4	10.2	11.3	47	2650	
	AG043DLD3	60	71	80	11.2	12.5	15	17.1	30	1700	★
	AG045DLD3	60	39	15	36.1	40.0	48.7	54.0	9.3	460	

★ :DS OK

※This is tentative Specification, we may change contents without notice.

SBD RBR Series [Low V_F]



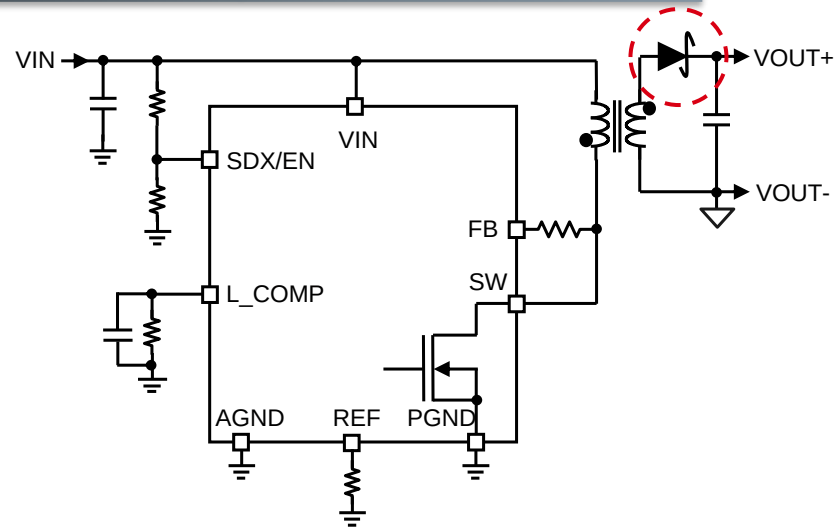
Features

- Low V_F SBD, applicable for various applications.
- Efficiency increase of high current, by implementing high-accuracy process.
- Lineups: V_{RM}=30V/ 40V/ 60V

Applications

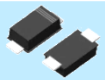
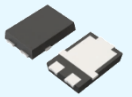
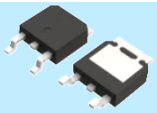
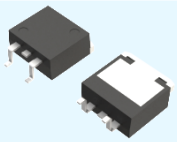
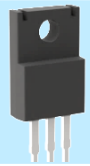
- Switching power supplies
  (secondary side rectification)
- Freewheel
- Reverse connection protection

Circuit example



Lien up

Various rated voltages with various package lineups.
Please refer to the lineups attaching at the end.

Package	Current range (I_O)
[PMDE] 2.5×1.3×0.95mm 	30V / 40V / 60V: 1A, 2A
SOD-123FL [PMDU] 3.5×1.6×0.8mm 	30V / 40V / 60V: 1A, 3A
SOD-128 [PMDTM] 4.7×2.5×0.95mm 	30V / 40V / 60V: 1A, 5A
SMA [PMDS] 4.7×2.5×0.95mm 	30V / 40V / 60V: 1A, 5A
New **TO-277A** 6.4×4.3×1.1mm 	40V: 3A, 10A (開発中・P.13)
TO-252AA 10.0×6.6×2.2mm 	30V / 40V / 60V: 10A, 20A
TO-263S 13.1×10.1×4.5mm 	30V / 40V / 60V: 10A, 40A
TO-220FN 19.0×10.0×4.5mm 	30V / 40V / 60V: 10A, 30A

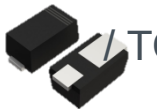
AEC-Q101
(Only Automotive grade products)

Middle power FRD series

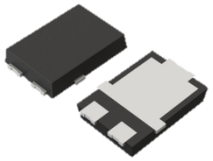
☆Under Development☆

ROHM SEMICONDUCTOR

New topics : PMDE



/TO-277



Feature

・Low forward voltage
・High current overload capacity
・Low thermal resistance

Applications

ECU/ADAS etc.. - automotive applications
Switching power supply - high frequency rectifiers

Circuit

surge absorber
reverse connection prevention

Package position

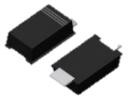
TO-252
(DPAK)

thinner
up to surge tolerance

PMDS
(SMA)

PMDE

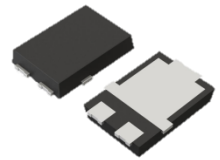
smaller
power up



PMDU
(SOD-123)

PMDT
(SOD-128)

high power



TO-277
TENTATIVE

full name			package	I_o [A]	I_{FSM} [A] sin 60Hz	V_F max [V]		I_R max [μA]		t_{rr} max [ns]	circuit	AEC-Q101	sample / mass pro.
P/N	code	tube					I_F[A]		V_R[V]				
RFN1VWM2S	-	TR	PMDE	1	15	0.93	1	1	200	25	single	-	CS : OK, MP : Jun./ '21
	TF	TR										qualified	MP : Oct./ '21
RFN2VWM2S	-	TR	PMDE	2	15	0.99	2	1	200	25	single	-	CS : OK, MP : Jun./ '21
	TF	TR										qualified	MP : Oct./ '21
RFN4RSM2S	-	TL	TO-277	4	40	0.93	4	1	200	25	single	-	CS : Oct./'21, MP : Dec./ '21
	TF	TL										qualified	MP : Feb./ '22
RFN6RSM2S	-	TL	TO-277	6	60	0.93	6	1	200	25	single	-	CS : Oct./'21, MP : Dec./ '21
	TF	TL										qualified	MP : Feb./ '22
RFN10RSM2S	-	TL	TO-277	10	100	0.98	10	1	200	30	single	-	CS : Oct./'21, MP : Dec./ '21
	TF	TL										qualified	MP : Feb./ '22

Middle power FRD package line up

Another line ups (200V~700V)

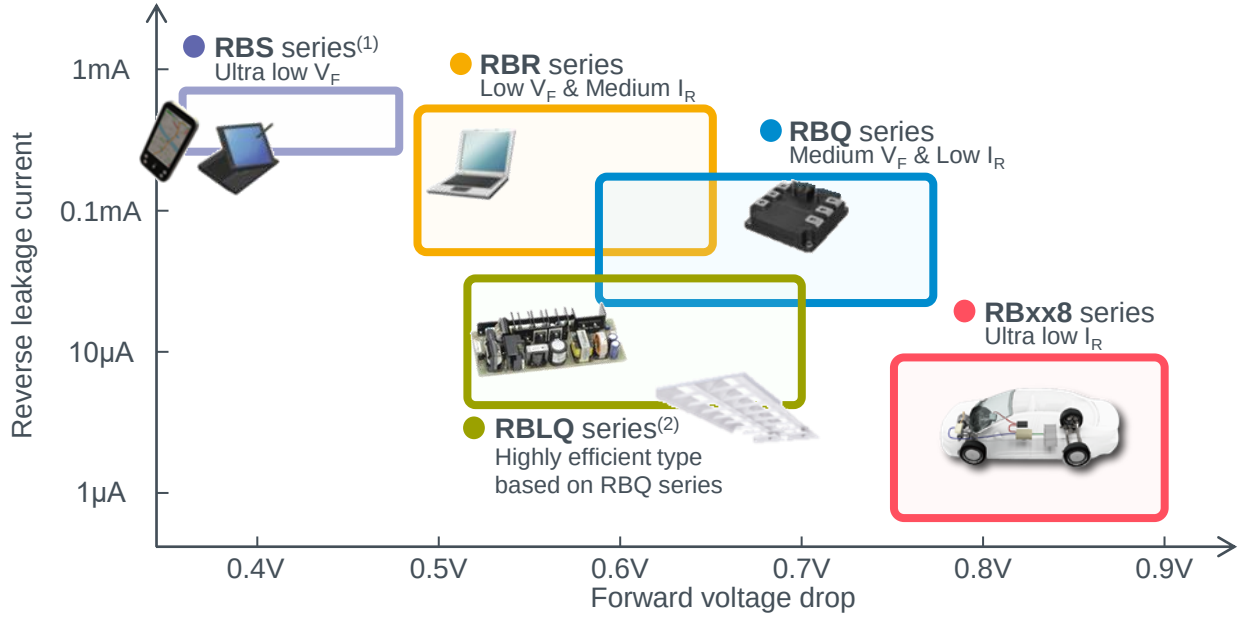
full name			package	I_o [A]	I_{FSM}[A] sin 60Hz	V_F max [V]		I_R max [μA]		t_{rr} max [ns]	circuit	AEC-Q101
P/N	code	tube					I_F[A]		V_R[V]			
RFC02MM2S	-	TR	SOD-123FL(PMDU)	0.5	10	0.95	0.5	1	200	35	single	Qualified (add code "TF")
RF071MM2S	-	TR	SOD-123FL(PMDU)	0.7	15	0.85	0.7	10	200	25	single	Qualified (add code "TF")
RF081MM2S	-	TR	SOD-123FL(PMDU)	0.8	20	0.95	0.8	10	200	25	single	Qualified (add code "TF")
RF081LAM2S	-	TR	SOD-128(PMDT)	1.1	25	0.98	1	10	200	25	single	Qualified (add code "TF")
RF101LAM2S	-	TR	SOD-128(PMDT)	1	20	0.87	1	10	200	25	single	Qualified (add code "TF")
RF201LAM2S	-	TR	SOD-128(PMDT)	2	20	0.87	2	10	200	25	single	Qualified (add code "TF")
RF202LAM2S	-	TR	SOD-128(PMDT)	2	20	0.93	2	10	200	25	single	Qualified (add code "TF")
RF302LAM2S	-	TR	SOD-128(PMDT)	3	20	0.92	3	10	200	25	single	Qualified (add code "TF")
RF071LAM4S	-	TR	SOD-128(PMDT)	1	15	1.25	0.7	10	400	25	single	Qualified (add code "TF")
RF101LAM4S	-	TR	SOD-128(PMDT)	1	25	1.25	1	10	400	25	single	Qualified (add code "TF")
RF201LAM4S	-	TR	SOD-128(PMDT)	1.5	50	1.2	1.5	1	400	30	single	Qualified (add code "TF")
RFN2LAM4S	-	TR	SOD-128(PMDT)	1.5	50	1.2	1.5	1	400	30	single	Qualified (add code "TF")
RFN1LAM6S	-	TR	SOD-128(PMDT)	0.8	15	1.45	0.8	1	600	35	single	Qualified (add code "TF")
RFN2LAM6S	-	TR	SOD-128(PMDT)	1.5	40	1.55	1.5	1	600	35	single	Qualified (add code "TF")
RFN1LAM7S	-	TR	SOD-128(PMDT)	0.8	15	1.5	0.8	1	700	80	single	Qualified (add code "TF")
RF081L2S	TF	TE25	SMA, DO-214AC(PMDS)	1.1	25	0.98	1	10	200	25	single	Qualified (only automotive grade)
RF101L2S	DD	TE25	SMA, DO-214AC(PMDS)	1	20	0.87	1	10	200	25	single	Qualified (only automotive grade)
RF201L2S	DD	TE25	SMA, DO-214AC(PMDS)	2	20	0.87	2	10	200	25	single	Qualified (only automotive grade)
RF071L4S	TF	TE25	SMA, DO-214AC(PMDS)	1	15	1.25	0.7	10	400	25	single	Qualified (only automotive grade)
RF101L4S	TF	TE25	SMA, DO-214AC(PMDS)	1	25	1.25	1	10	400	25	single	Qualified (only automotive grade)
RF201L4S	DD	TE25	SMA, DO-214AC(PMDS)	1.5	50	1.2	1.5	1	400	30	single	Qualified (only automotive grade)
RFN2L4S	DD	TE25	SMA, DO-214AC(PMDS)	1.5	50	1.2	1.5	1	400	30	single	Qualified (only automotive grade)
RFN1L6S	DD	TE25	SMA, DO-214AC(PMDS)	0.8	15	1.45	0.8	1	600	35	single	Qualified (only automotive grade)
RFN2L6S	DD	TE25	SMA, DO-214AC(PMDS)	1.5	40	1.55	1.5	1	600	35	single	Qualified (only automotive grade)
RFN1L7S	DD	TE25	SMA, DO-214AC(PMDS)	0.8	15	1.5	0.8	1	700	80	single	Qualified (only automotive grade)

Schottky barrier rectifier lineup overview

■ Features of ROHM's schottky barrier rectifier

- 5 series are line up from the ultra low V_F type for the mobile to the automotive requiring ultra low I_R type.
- Wide range of package lineup.
- High quality corresponding to the automotive (Automotive grade).

■ Series selection chart

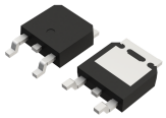


■ Series lineup table

Series	RBS	RBR	RBQ	RBxx8	RBLQ
Automotive	No	Yes	Yes	Yes	Yes
Technology	Planar				Trench
Features	Ultra low V_F	Low V_F	Low I_R	Ultra low I_R	High efficiency
20V	✓ (1)				
30V		✓		✓	
40/45V		✓	✓	✓	
60/65V		✓	✓	✓	
100V			✓	✓	✓ (2) New
150V				✓	
200V				✓ New	

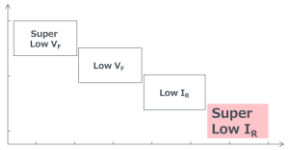
(1) RBS series has NO automotive grade products.
(2) RBLQ series is in developing.

■ Packages

PMDE New	SOD-123FL (PMDU)	SOD-128 (PMDTM)	DO-214AC/SMA (PMDS)	TO-277A New	TO-252AA (DPAK)	TO-263S (D2PAK)	TO-220FN
							
2.5×1.3×0.95mm	3.5×1.6×0.8mm	4.7×2.5×0.95mm	5.0×2.6×2.0mm	6.4×4.3×1.1mm			

RBxx8 Series

- Ultra Low I_R type general schottky

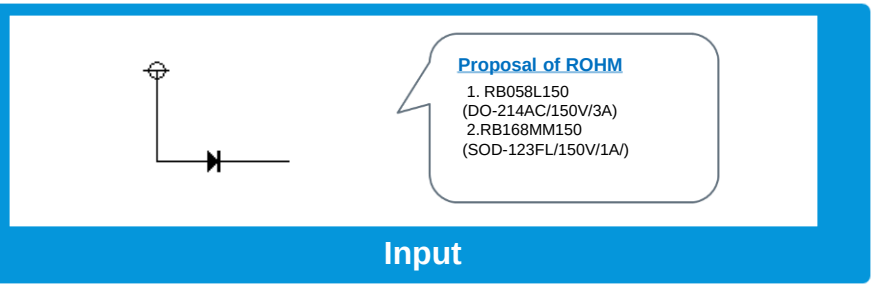


Features

- Low leak ⇒ No Thermal runaway
- High Reliability

Applications

- Automotive Power Supply Industrial (Under high temperature)



Examples

AEC-Q101
(Only Automotive grade products)

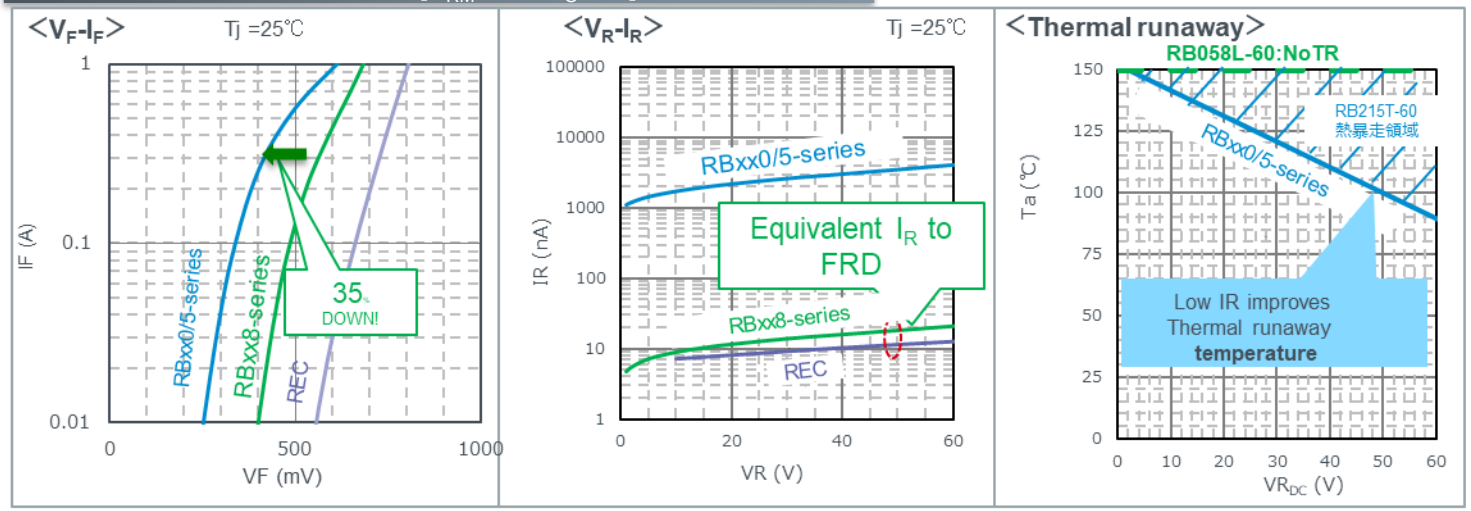
REC [200V/3A] SOD-214AB(SMC)	Mounting area：72% down	**RB058LAM150** [150V/3A] SOD-218〈SMAL〉(PMDTM)
REC [200V/1A] DO-214AC(PMDS/SMA)	Mounting area：64% down	**RB168MM-60** [60V/1A] SOD-123FL(PMDU)

Low V_F = Low leak → **same rated current in smaller package**

Lineup

- 30～200V / 0.5～40A / TUMD2M～D2PAK

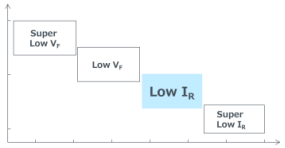
Electrical characteristic [V_{RM}=60V/ I_O=3A]



Replacing from rectifier diode , it enables miniaturization and high efficiency at a time ！ !

RBQ Series

- Low I_R type general schottky



Features

・Low IR, Mid-range VF SBD, most suitable for switching power supplies.
・Efficiency increase of high current, by implementing high-accuracy process.
・Lineup voltage are V_{RM}=45V/ 65V/ 100V.

Applications

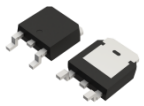
・Switching power supplies(secondary rectification)
・Freewheel
・Reverse connection protection

Packages

TO-277A
New

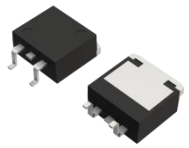
6.4×4.3×1.1mm

TO-252AA (DPAK)



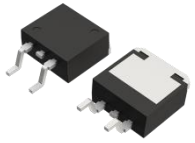
10.0×6.6×2.2mm

TO-263S (D2PAK)
(Short terminal type)



13.1×10.1×4.5mm

LPDL (D2PAK)
(Long terminal type)



15.1×10.1×4.5mm

TO-220FN

19.0×10.0×4.5mm

Lineup

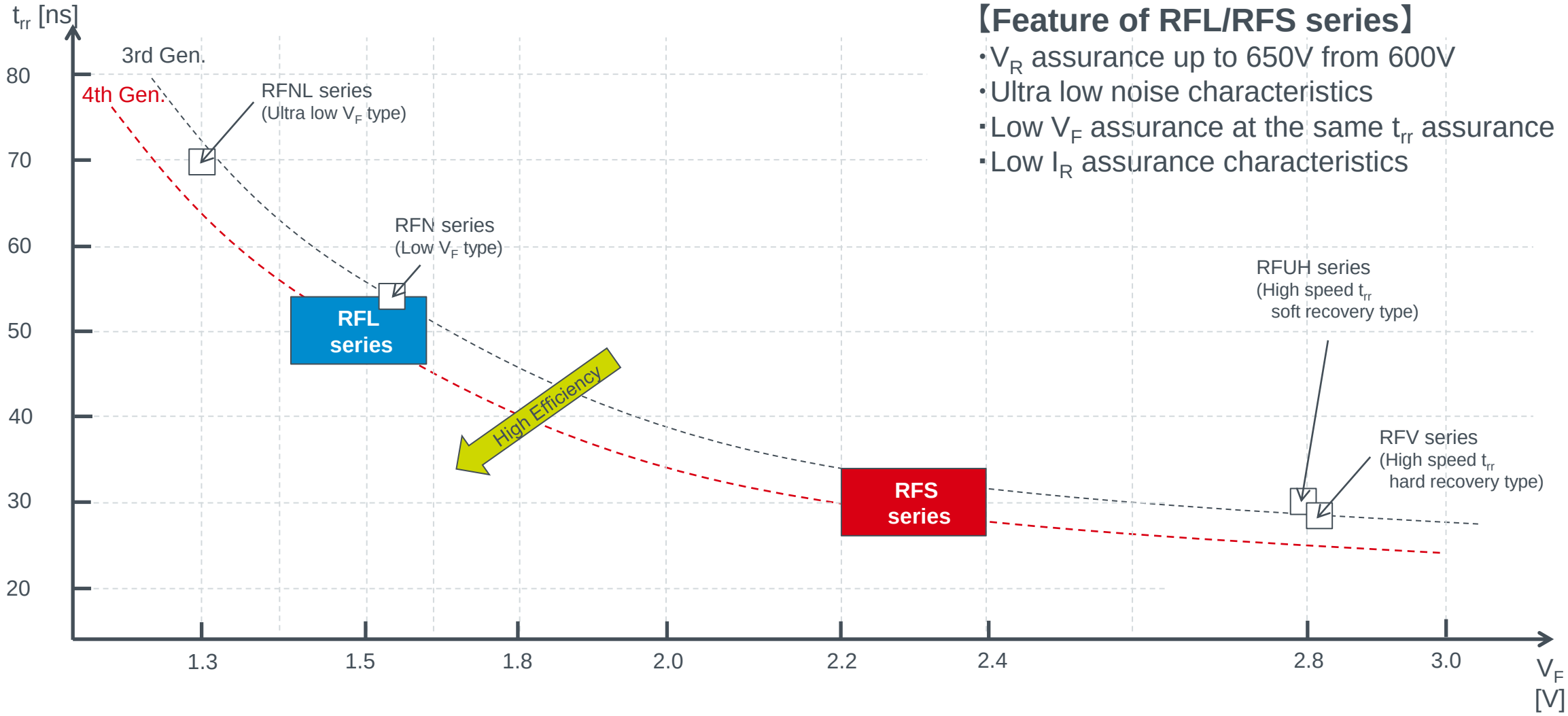
AEC-Q101 qualified*
*: Only Automotive grade products

Package	Circuit	Part No.	Absolute Maximum Ratings		Electrical Characteristics (T_J=25℃)		
			V_{RM} (V)	I_O(A)	V_F Max. (V)	at I_F(A)	I_R Max.(μA) (V_R=V_{RM})
V_{RM} = 45V Type							
TO-252AA		RBQ10BM45A	45	10	0.65	5	70
		RBQ15BM45A	45	15	0.59	7.5	140
		RBQ20BM45A	45	20	0.59	10	200
TO-263S		RBQ10NS45A	45	10	0.65	5	70
		RBQ20NS45A	45	20	0.65	10	140
		RBQ30NS45A	45	30	0.65	15	200
TO-220FN		RBQ10T45A	45	10	0.65	5	70
		RBQ20T45A	45	20	0.65	10	140
		RBQ30T45A	45	30	0.65	15	200
LPDL		U/D RBQ10NB45B	45	10	0.62	10	100
		U/D RBQ16NB45B	45	16	0.61	16	200
TO-263S		RBQ30NS45B	45	30	0.59	30	350
TO-220FN		RBQ30TB45B	45	30	0.59	30	350
V_{RM} = 65V Type							
TO-277A		New RBQ3RSM65B	65	3	0.57	3	50
		New RBQ5RSM65B	65	5	0.64	5	50
		New RBQ10RSM65B	65	10	0.67	10	90
TO-252AA		RBQ10BM65A	65	10	0.69	5	70
		RBQ15BM65A	65	15	0.63	7.5	140
		RBQ20BM65A	65	20	0.63	10	200
TO-263S		RBQ10NS65A	65	10	0.69	5	70
		RBQ20NS65A	65	20	0.69	10	140
		RBQ30NS65A	65	30	0.69	15	200
TO-220FN		RBQ10T65A	65	10	0.69	5	70
		RBQ20T65A	65	20	0.69	10	140
		RBQ30T65A	65	30	0.69	15	200
V_{RM} = 100V Type							
TO-277A		New RBQ3RSM10B	100	3	0.70	3	80
		New RBQ5RSM10B	100	5	0.70	5	140
		New RBQ10RSM10B	100	10	0.70	10	250
TO-252AA		New RBQ10BM100A	100	10	0.77	5	80
		New RBQ15BM100A	100	15	0.71	7.5	140
		New RBQ20BM100A	100	20	0.69	10	200
TO-263S		New RBQ10NS100A	100	10	0.77	5	80
		New RBQ20NS100A	100	20	0.77	10	140
		New RBQ30NS100A	100	30	0.77	15	200
TO-220FN		New RBQ10T100A	100	10	0.77	5	80
		New RBQ20T100A	100	20	0.77	10	140
		New RBQ30T100A	100	30	0.77	15	200

4th generation 650V FRD (RFS/RFL series)

In Development

V_F-t_{rr} trade-off matrix



【Feature of RFL/RFS series】

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

RFS Series

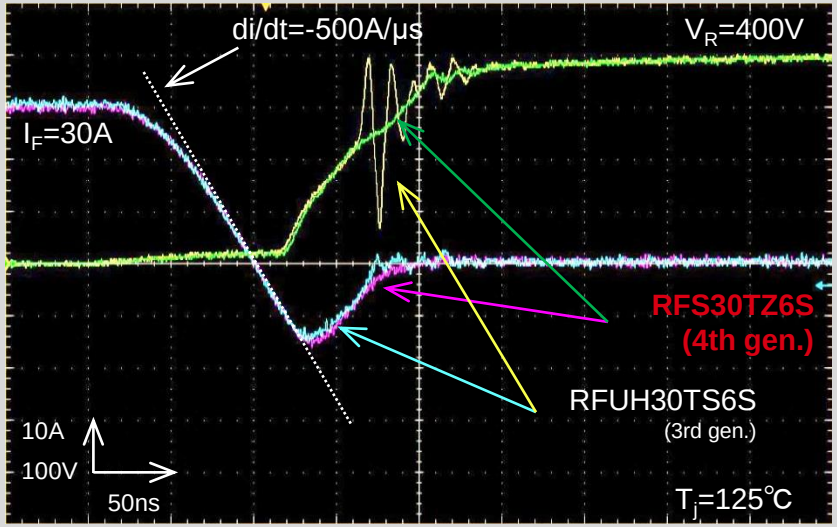
- High speed type 4th generation fast recovery rectifier

Features

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

In Development

Consumer / Industry
CCM PFC (ex.air-conditioner)
Secondary side rectification


air conditioner


compressor

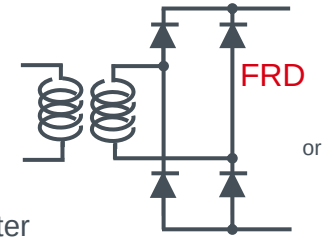

TV power


server

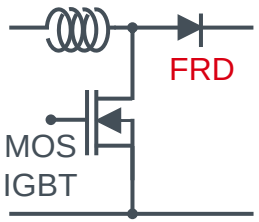

robotics

Automotive
On Board Charger
Charger station
(PFC, Secondary rectification) etc..


OBC / charger station

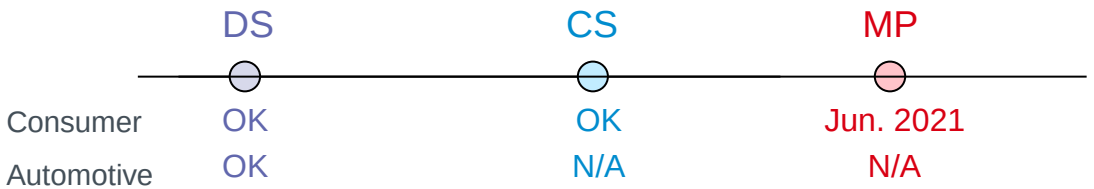


Full bridge LLC converter



PFC circuit

Target Schedule



This schedule is subject to change without notice.

RFL Series

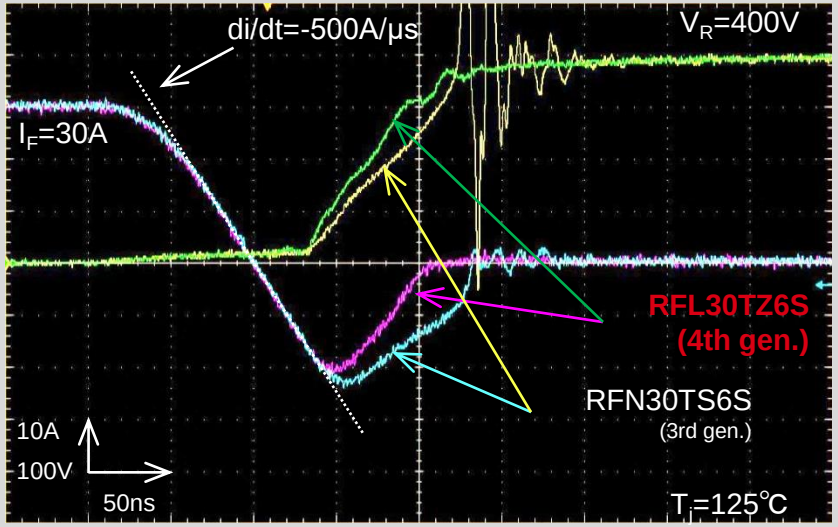
- Low V_F type 4th generation fast recovery rectifier

Features

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

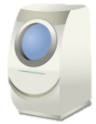
In Development

Consumer

DCM PFC (ex.air-conditioner)
Inverter FWD
(air-conditioner, washing machine, refrigerator)


air conditioner

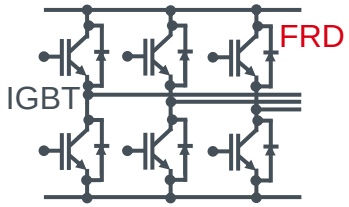

OBC


Washing machine

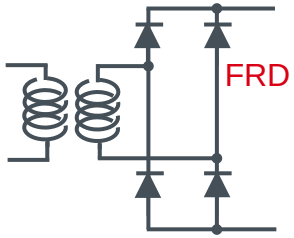

refrigerator

Automotive

On Board Charger
(Secondary rectification) etc..

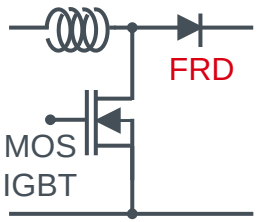


Inverter circuit



Full bridge LLC converter

or



PFC circuit

Target Schedule

	DS	CS	MP
Consumer	OK	OK	Jun. 2021
Automotive	OK	N/A	N/A

This schedule is subject to change without notice.

4th generation 650V FRD lineup

TO-220ACFP

TO-247N-3L

TO-247N-2L

In 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 [μA]		t_{rr} max [ns]	circuit	AEC-Q101
P/N	code	tube					I_F[A]		V_R[V]			
RFS20TJ6S	G	C18	TO-220FP-2L	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	35	single	-
	FHG	C11	TO-247N-2L	30	160	2.3	30	5	650	35	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	15x2	80	2.3	15	5	650	30	cathode common	-
RFS60TS6D	G	C13	TO-247GE-3L	30x2	150	2.3	30	5	650	35	cathode common	-

RFL series (V_F type)

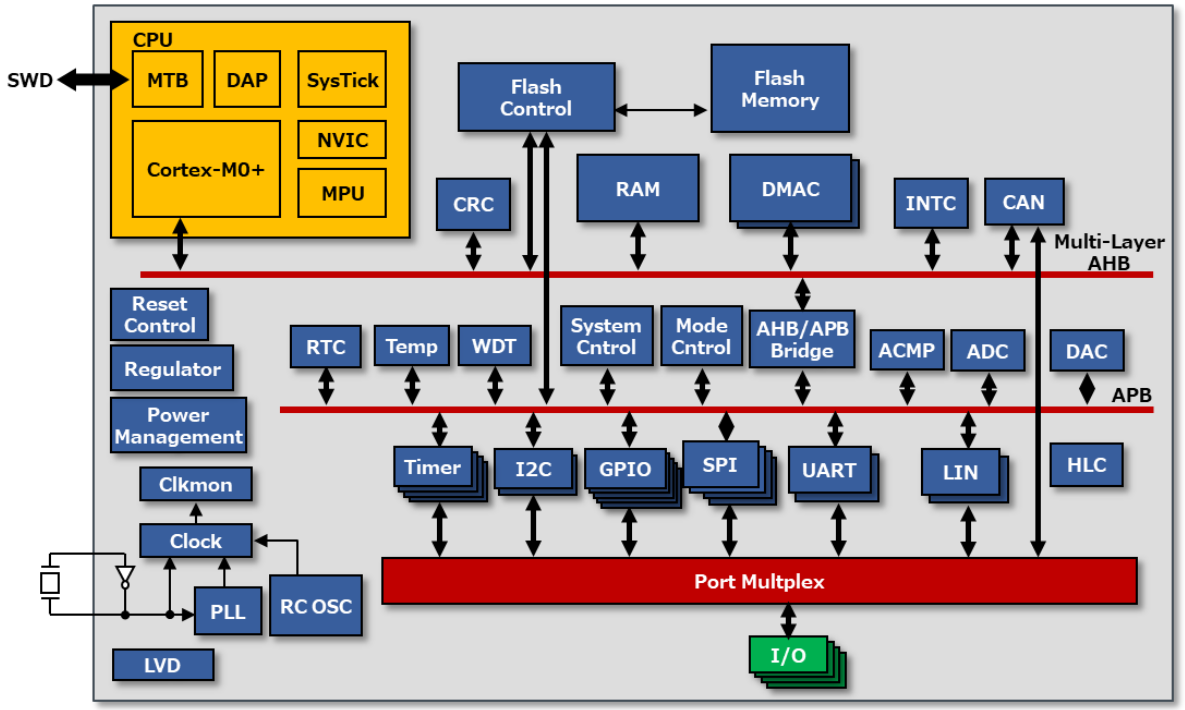
full name			package	I_o [A]	I_{FSM} [A] sin 60Hz	V_F max [V]		I_R max [μA]		t_{rr} max [ns]	circuit	AEC-Q101
P/N	code	tube					I_F[A]		V_R[V]			
RFL30TZ6S	G	C13	TO-247GE-2L	30	200	1.5	30	5	650	55	single	-
	FHG	C11	TO-247N-2L	30	200	1.5	30	5	650	55	single	qualified
RFL60TZ6S	G	C13	TO-247GE-2L	60	320	1.5	60	10	650	75	single	-
	FHG	C11	TO-247N-2L	60	320	1.5	60	10	650	75	single	qualified
RFL30TS6D	G	C13	TO-247GE-3L	15x2	100	1.5	15	5	650	45	cathode common	-
RFL60TS6D	G	C13	TO-247GE-3L	30x2	180	1.5	30	5	650	55	cathode common	-

G : halogen free
FHG : halogen free for automotive grade
t_{rr} condition : I_F=0.5A,I_R=1A,I_{rr}=0.25xI_R

These specs are subject to change without notice.

Automotive Microcontroller ML63Q8000

Included useful function for sensor and motor application



ACMP: Analog Comparator
HLC: Hardware Linkage Controller

Under development

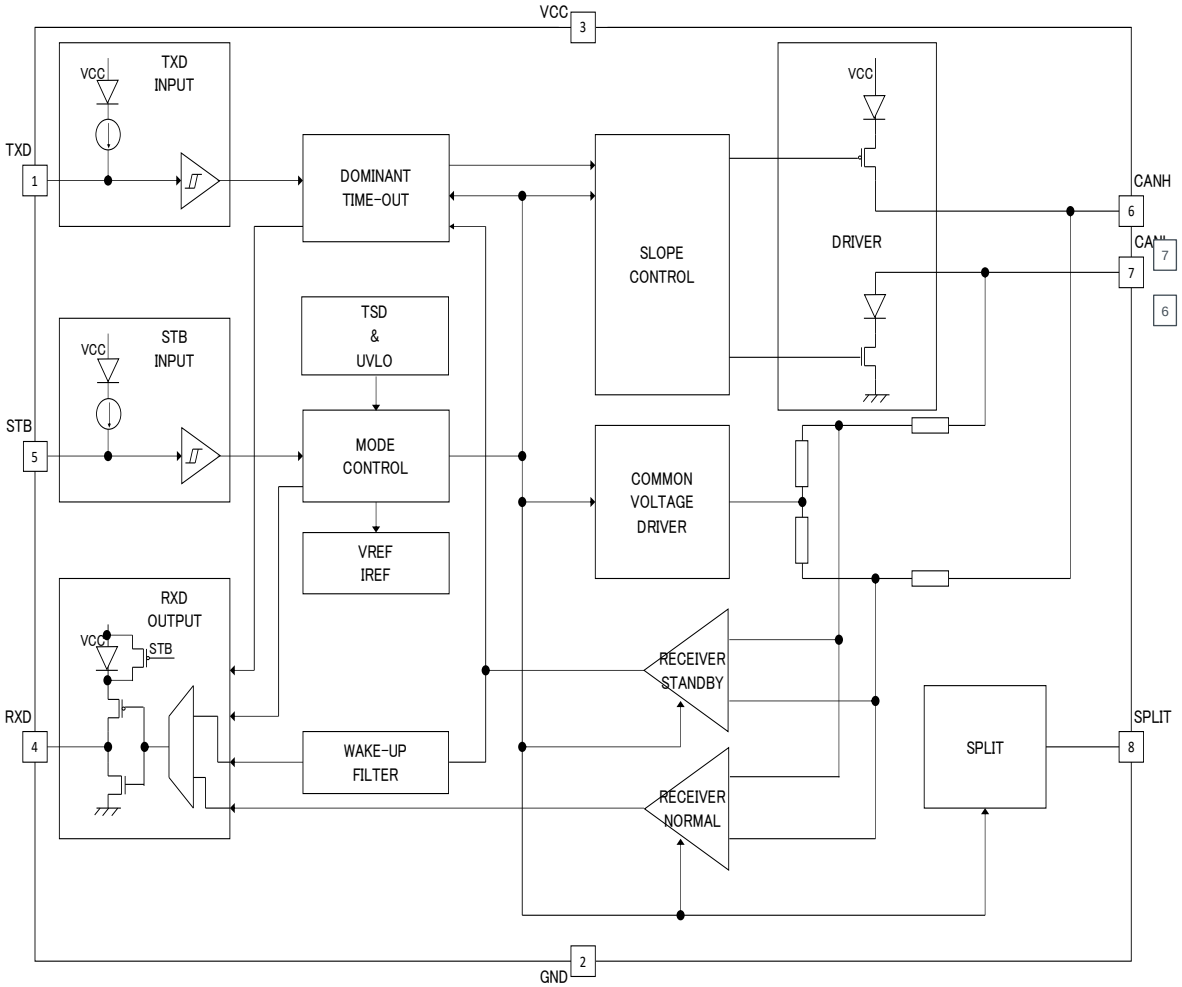
■ Feature
- Support functional safety (ISO26262)
- 32bit ARM® Cortex®-M0+ Core
- CPU/BUS ～48MHz Peripherals ～64MHz
- Flash memory size Program ～480KB Data ～16KB
- RAM size ～32KB
- WDT with dedicated clock generator
- CAN controller (CAN FD, CAN2.0B)
- LIN controller
- 12bit ADC 16ch with average calculation accelerator
- 12bit DAC
- Peripheral control accelerator
- Peripheral connection selector（HLC）
- 16bit timer 17ch
- Three-phase PWM
- Interface SPI, UART, I2C, I2S
- RTC counter
- included Low frequency generator
- I/O Port Multiplex

■ Operating range
- VCC=2.7 to 5.5V
- Ta=-40～+125℃

■ Package
- 48pin TQFP 7×7×1.0mm pitch 0.5mm
- 64pin TQFP 10×10×1.0mm pitch 0.5mm

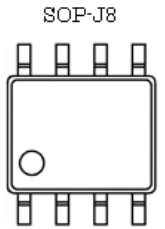
This specification is subject to change without notice

CAN Transceiver BD41041FJ-C



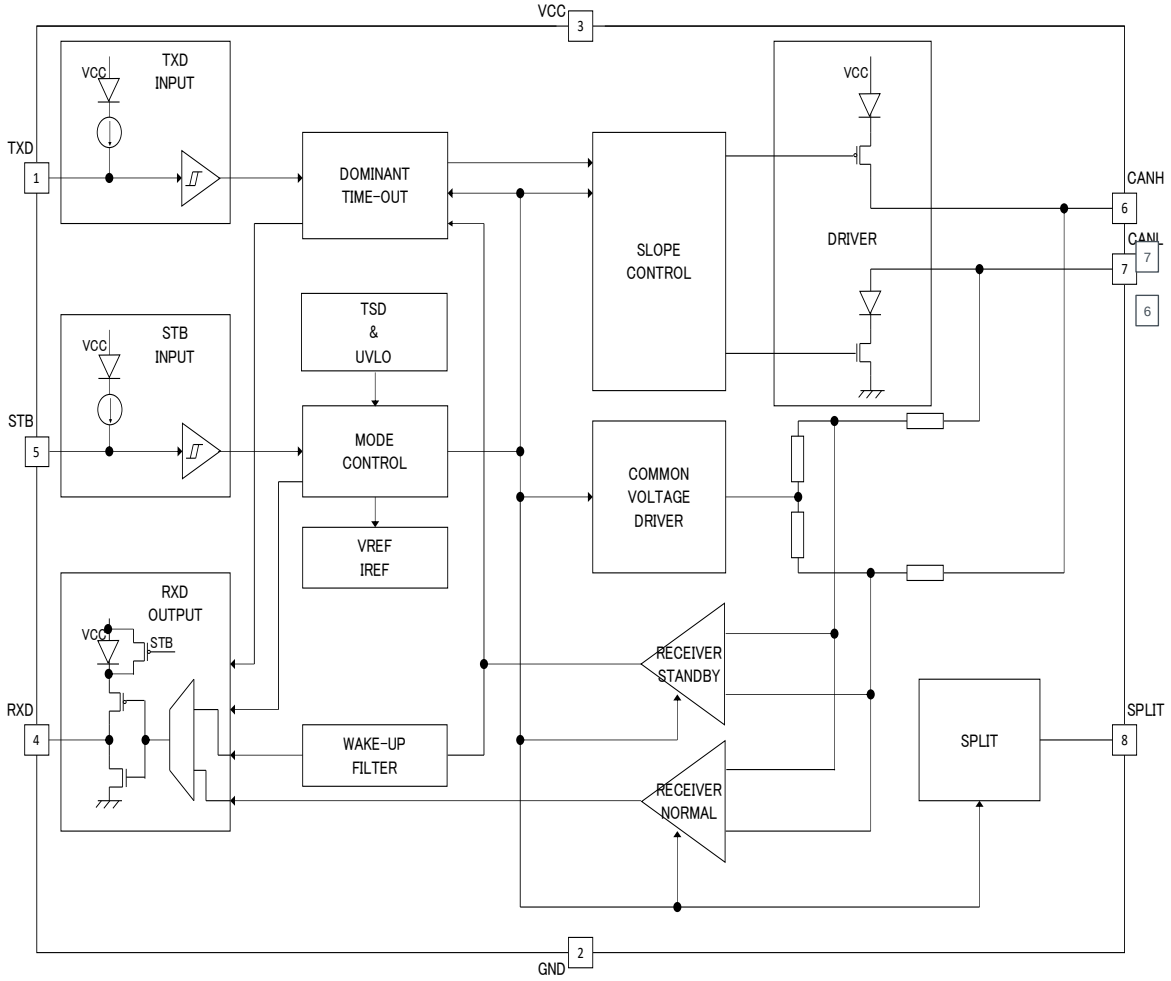
Features of BD41041FJ-C

- ISO11898-2:2016 standards compliant
- VCC terminal : 5V
- CANH/CANL/SPLIT terminal : -27V to 40V
- Communication speed：to 1Mbps
- Responded to low current consumption by Stand-by Mode : Max. 15μA
- Dominant time-out function
- Fail Safe functions
  Thermal Shut Down
  Under Voltage Lock Out
- Package : SOP-J8 (JEDEC standard)



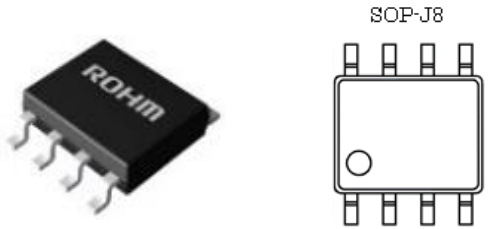
SOP-J8
4.9mm×6.0mm×1.65mm

CAN-FD Transceiver BD41044FJ-C



Features of BD41044FJ-C

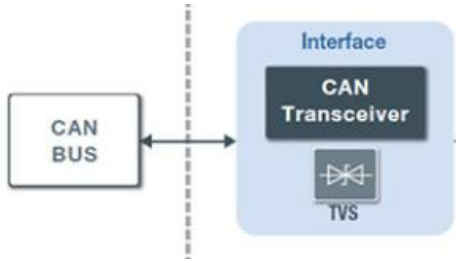
- ISO11898-2:2016 standards compliant
- VCC terminal : 5V
- CANH/CANL/SPLIT terminal : 27V to 40V
- Communication speed : to 5Mbps
- Responded to low current consumption by Stand-by Mode : Max. 15µA
- Dominant time-out function
- Fail Safe function
  Thermal Shut Down
  Under Voltage Lock Out
- Package : SOP-J8 (JEDEC standard)

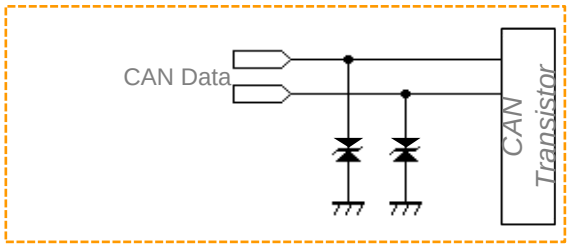


SOP-J8
4.9mm×6.0mm×1.65mm

TVS for CAN Communication Surge Protection

■Suitable Item, “RESD1CANYFH”



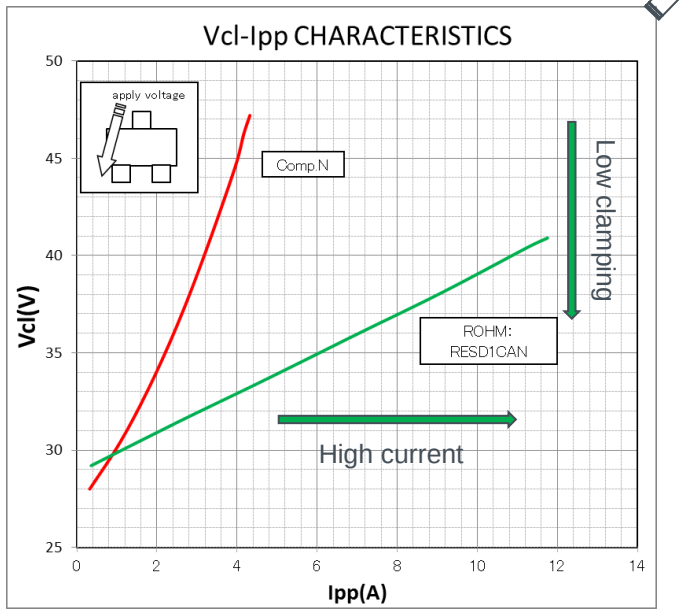


▼Recommended Point ▼MP Status : On MP

Very common package and has been used for so long in the market
→full-compatibility w/ competitors→Very easy to replace as the alternative
→ROHM has the enough capacity and no worry about that.
→Productive efficiency is very high and it helps your design better.

RESD1CANY has been designed to protect CAN transceiver in high speed and fault tolerant network from ESD and other harmful transient voltage event.(AEC-Q101 qualified)

ROHM is high P_{PP} surprisingly in spite of high current and low clamping voltage.



ROHM has some green lights for competitors!

	Comp.N	Comp.O	ROHM
P/N	P**D1C*N	SZ*U**10*L/N**21*5*	RESD1CANYFH
PKG	SOT-23	SOT-23	SOT-23
Circuit	C-common (Bidirection)	C-common (Bidirection)	C-common (Bidirection)
Pd	N/A	N/A	225mW
V_{RWM}	24V	24V	24V
Ct	17pF	30pF	30pF
P_{PP}	200W	350W	350W
Tj	150C	-55-150C	150C
Tamb	-65-150C	N/A	N/A
Tstg	-65-150C	-55-150C	-65-150C
V_{ESD}(Con)	±23kV	±30kV	±30kV
MIL-STD883	±10kV	N/A	±16kV
I_R	50nA	100nA	100nA
V_{BR}	25.4V-30.3V	26.2V-32V	26.2V-32V
V_{CL}	70V max	44V	44V
I_{PP}	3A	8A	8A

SOT-23
(2.9 x 2.4 mm)

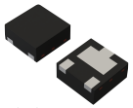
DFN Product for Automotive

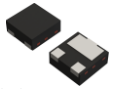
On MP

▼DFN New Products

- 100% Final test(HOT)
- 100% Gate oxide screening at Vgs>Vgsmax
- AEC-Q006 During evaluation

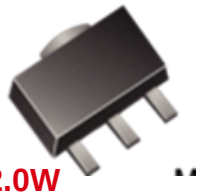

DFN1616-6W


DFN1212-3W


DFN1010-3W

Part Number	Qualified to AECQ101	Polarity	VDSS[V]	ID[A]	Drive Voltage [V]	RDS(on)[mΩ]														Package	Status (DS Schedule)
						@VGS=10V		@VGS=4.5V		@VGS=4.0V		@VGS=2.5V		@VGS=1.8V		@VGS=1.5V		@VGS=1.2V			
						Typ.	Max.	Typ.	Max.	Typ.	Max.	Typ.	Max.	Typ.	Max.	Typ.	Max.	Typ.	Max.		
RV4C020ZP HZG	Yes	P	-20	-2.0	-1.5	-	-	180	260	-	-	240	340	360	480	400	560	-	-	DFN1616-6W	MP
RV4E031RP HZG	Yes	P	-30	-3.1	-4.0	75	105	108	152	122	172	-	-	-	-	-	-	-	-	DFN1616-6W	MP
RV4E032UN HZG	Yes	N	30	3.2	2.5	-	-	75	94	78	98	101	128	-	-	-	-	-	-	DFN1616-6W	DS
RV4L016SN HZG	Yes	N	60	1.6	4.0	237	305	290	374	317	408	-	-	-	-	-	-	-	-	DFN1616-6W	CS
RV6E022UN HZG	Yes	N	30	2.2	2.5	-	-	110	150	-	-	140	200	-	-	-	-	-	-	DFN1212-3W	TBD
RV6L009SP HZG	Yes	P	-60	-0.9	-4.0	629	808	753	967	804	1036	-	-	-	-	-	-	-	-	DFN1212-3W	TBD
RV8C010UN HZG	Yes	N	20	1.0	1.2	-	-	340	470	-	-	400	560	470	650	540	810	700	1050	DFN1010-3W	MP
RV8L002SN HZG	Yes	N	60	0.25	2.5	1700	2400	2100	3000	2300	3200	3000	12000	-	-	-	-	-	-	DFN1010-3W	MP
BSS84X HZG	Yes	P	-60	-0.25	-4.5	2800	5300	3500	6400	-	-	-	-	-	-	-	-	-	-	DFN1010-3W	MP
RV8E016UN HZG	Yes	N	30	1.6	2.5	-	-	200	287	-	-	278	390	-	-	-	-	-	-	DFN1010-3W	2021/10

Bipolar Transistor (Automotive)



SOT-89
(MPT3)
2.0W
4.5×4.0×1.5mm

●Features

- ・Low $V_{CE(sat)}$
- ・Fast switching speed
- ・Halogen free
- ・Terminal finish : Sn 100%

P/N	Polarity	V_{CEO} [V]	I_C [A]	h_{FE}	Conventional product							
					P/N	V_{CEO} [V]	I_C [A]	HFE	P/N	V_{CEO} [V]	I_C [A]	h_{FE}
2SAR293P HZG	PNP	-30	-1	270~680	2SAR293P FRA	-30	-1	270~680	2SB1132 FRA	-30	-1	120~390
2SAR512P HZG	PNP	-30	-2	200~500	2SAR512P FRA	-30	-2	200~500	2SB1188 FRA	-32	-2	120~390
2SAR552P HZG	PNP	-30	-3	200~500	2SAR552P FRA	-30	-3	200~500	-	-	-	-
★2SAR592P HZG	PNP	-30	-5	200~500	2SAR542P FRA	-30	-5	200~500	-	-	-	-
2SAR513P HZG	PNP	-50	-1	180~450	2SAR513P FRA	-50	-1	180~450	2SA1900 FRA	-50	-1	120~270
2SAR553P HZG	PNP	-50	-2	180~450	2SAR553P FRA	-50	-2	180~450	2SB1561 FRA	-60	-2	120~270
2SAR533P HZG	PNP	-50	-3	180~450	2SAR533P FRA	-50	-3	180~450	2SA1797 FRA	-50	-3	120~270
2SAR514P HZG	PNP	-80	-0.7	120~390	2SAR514P FRA	-80	-0.7	120~390	2SB1260 FRA	-80	-1	120~390
2SAR554P HZG	PNP	-80	-1.5	120~390	2SAR554P FRA	-80	-1.5	120~390	-	-	-	-
2SAR544P HZG	PNP	-80	-2.5	120~390	2SAR544P FRA	-80	-2.5	120~390	2SA2109 FRA	-90	-2	120~270
2SCR293P HZG	NPN	30	1	270~680	2SCR293P FRA	30	1	270~680	2SD1664 FRA	30	1	120~390
2SCR512P HZG	NPN	30	2	200~500	2SCR512P FRA	30	2	200~500	2SD1766 FRA	32	2	120~390
2SCR552P HZG	NPN	30	3	200~500	2SCR552P FRA	30	3	200~500	-	-	-	-
★2SCR592P HZG	NPN	30	5	200~500	2SCR542P FRA	30	5	200~500	-	-	-	-
2SCR513P HZG	NPN	50	1	180~450	2SCR513P FRA	50	1	180~450	2SC5053 FRA	50	1	120~390
2SCR553P HZG	NPN	50	2	180~450	2SCR553P FRA	50	2	180~450	2SD2391 FRA	60	2	120~270
2SCR533P HZG	NPN	50	3	180~450	2SCR533P FRA	50	3	180~450	2SC4672 FRA	50	3	120~390
2SCR514P HZG	NPN	80	0.7	120~390	2SCR514P FRA	80	0.7	120~390	2SD1898 FRA	80	1	120~390
2SCR554P HZG	NPN	80	1.5	120~390	2SCR554P FRA	80	1.5	120~390	-	-	-	-
2SCR544P HZG	NPN	80	2.5	120~390	2SCR544P FRA	80	2.5	120~390	2SC5918 FRA	90	2	120~390
2SCR372P HZG	NPN	120	0.7	120~390	2SCR372P FRA	120	0.7	120~390	-	-	-	-
2SCR375P HZG	NPN	120	1.5	120~390	2SCR375P FRA	120	1.5	120~390	2SC4132 FRA	120	2	82~390

★Under development

High-side IPD and Low-side IPD

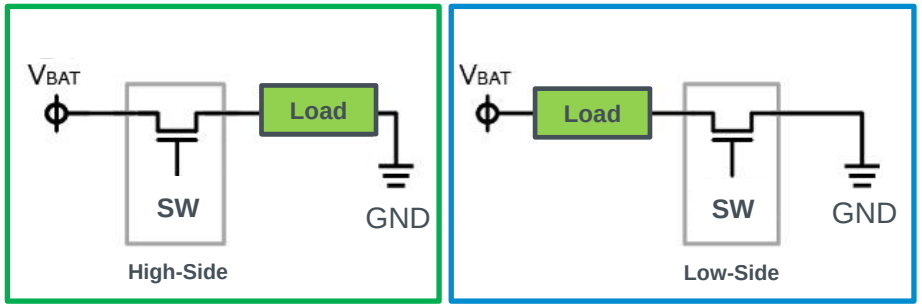
High-side and Low-side

High-side:

Connect between Power supply and load

Low-side:

Connect between GND and load

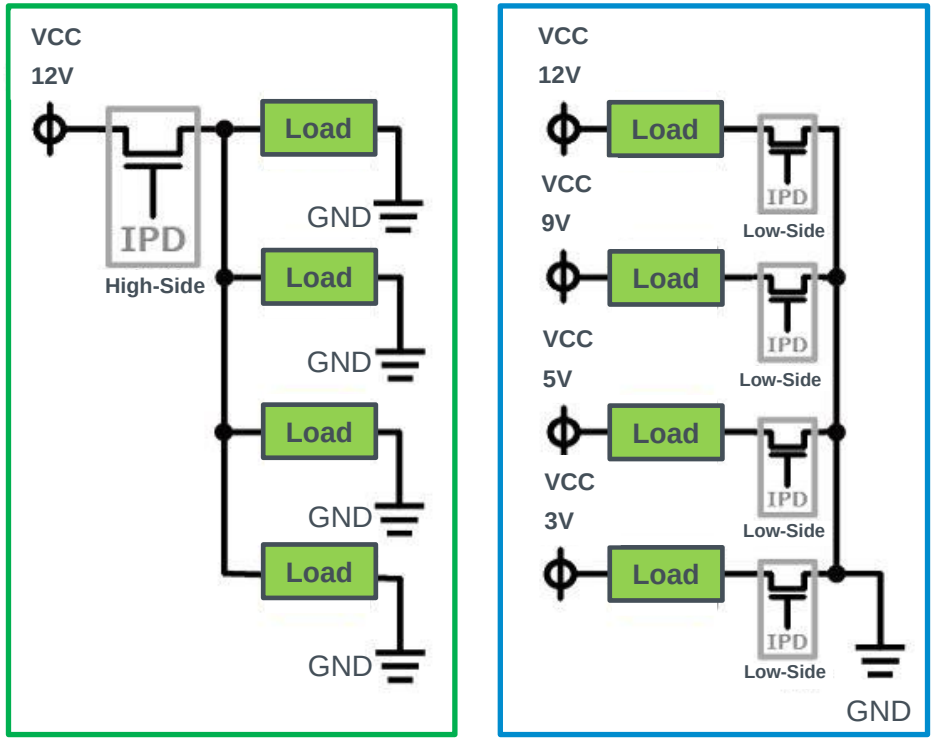


Usage of High-side/Low-side IPD

High-side IPD

Function：Protect load by cutting off the current directly flow from power supply

Use case： Power line of single power supply system like an automotive battery

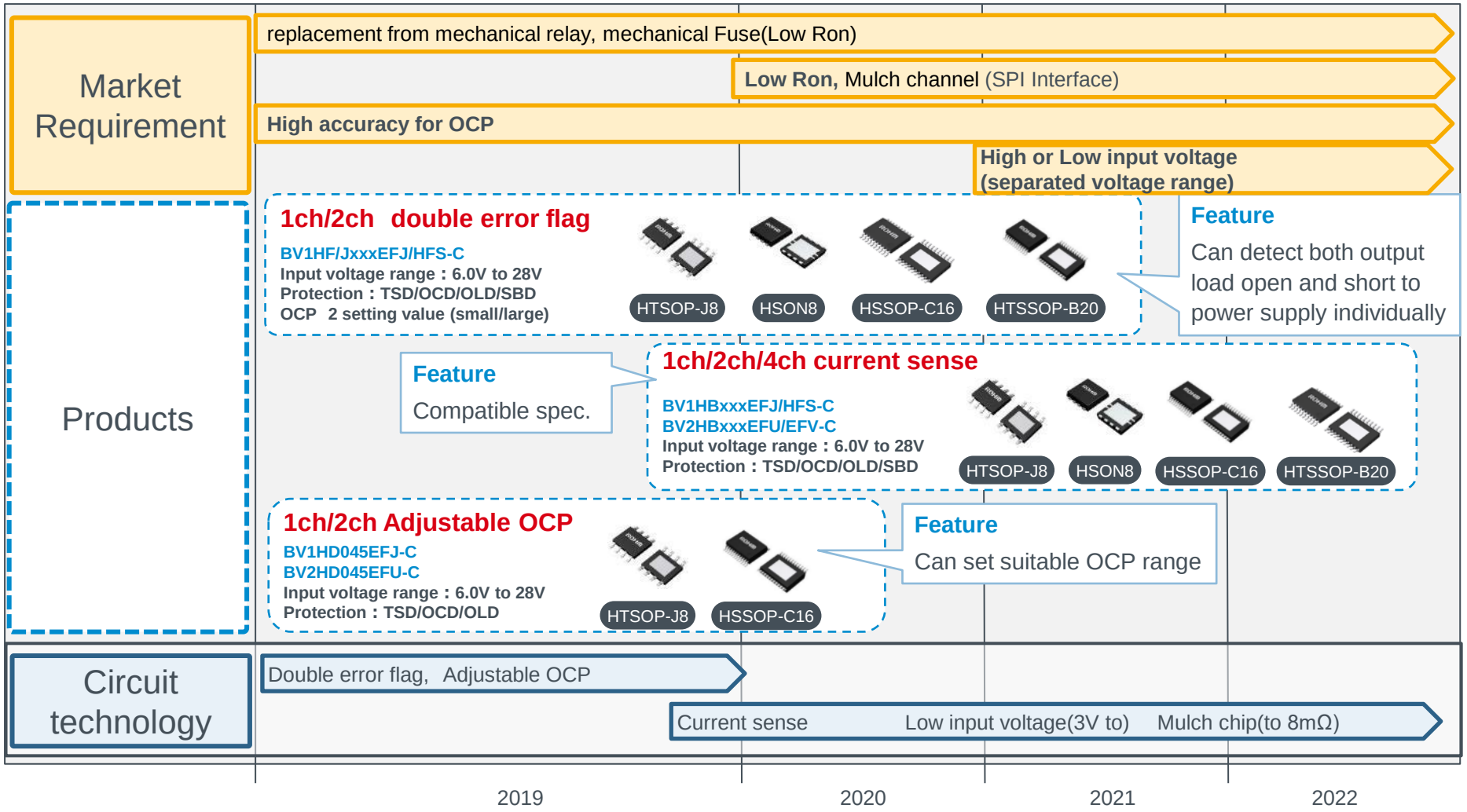


Low-side IPD

Function： Protect load by cutting off the current path to GND

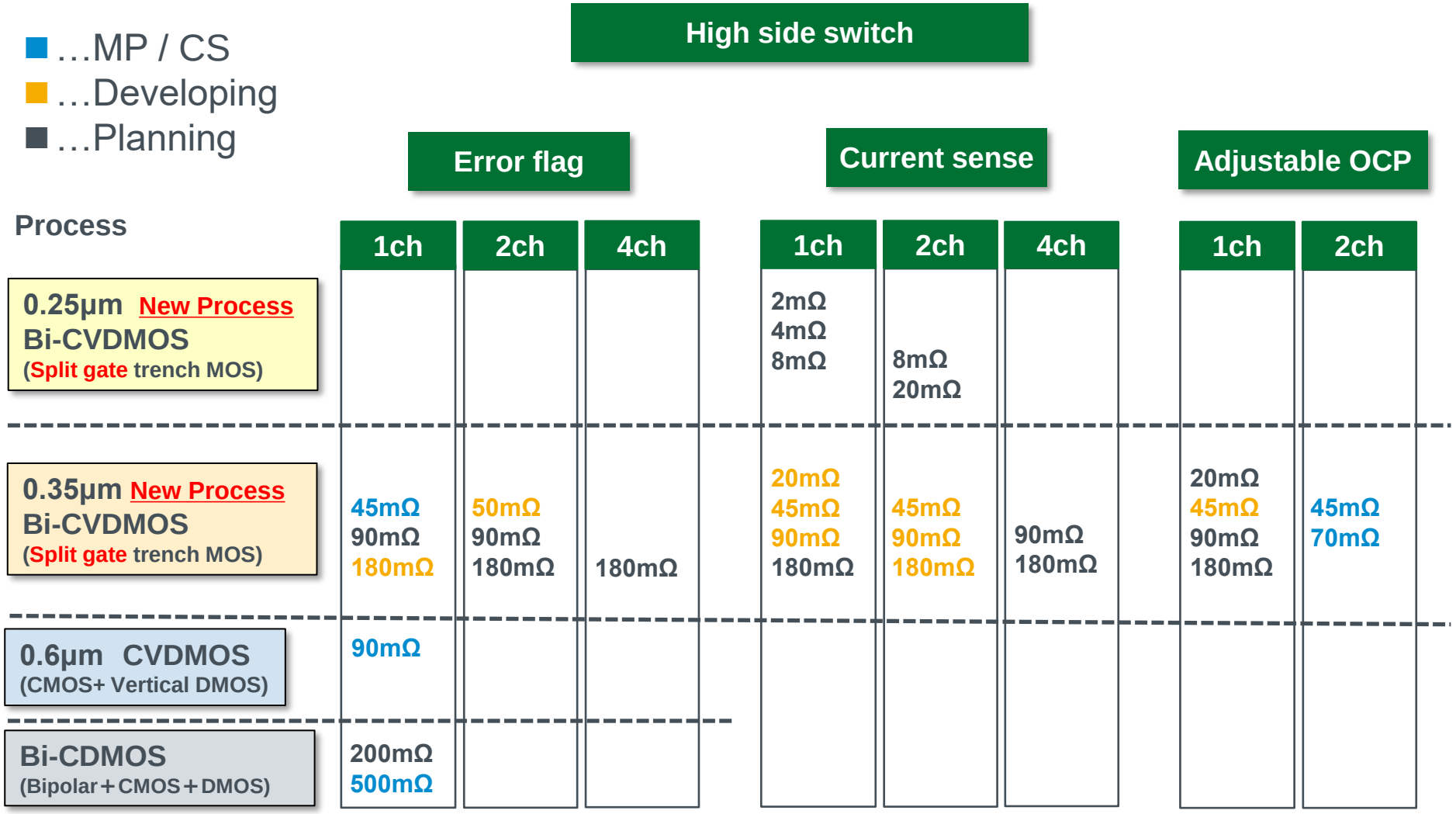
Use case：GND line of multiple power supply system

High side switch roadmap



High side switch Lineup

■ …MP / CS
■ …Developing
■ …Planning



DS :Design Sample、QS : Qualification Sample、MP : Mass Production

Automotive One Gate Series

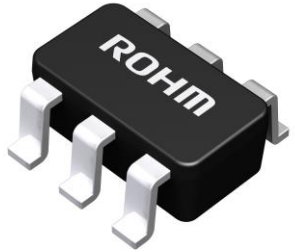
Features

- One Gate Logic
- Input Tolerant
- Output Tolerant
- AEC-Q100 Qualified
- ESD HBM : 4000V
- High speed operation
  Max : 12 ns
  @3.0V [BD7LS08(AND Gate)]

Key Specifications

- Supply Voltage Range : 1.65 V to 5.5V
- Quiescent Supply Current : ±10μA(Max.)
- Input Current : ±2μA(Max.)
- Operating temperature : -40°C to +125°C
- Package

SSOP5(SOT23-5)



SSOP6(SOT23-6)

2.90mm×2.80mm×1.25mm (Max.)

Applications

Engine ECU
Body
Audio System
Navigation System
etc..

Lineup

category	Function	Products
Schmitt	Schmitt Buffer	BD7LS17G
	Schmitt Inverter	BD7LS14G
Multi Function	Configurable Function	BD7LS97G
Standard Gate	Open Drain Buffer	BD7LS07G
	Buffer	BD7LS34G
	Inverter	BD7LS04G
	2-Input NAND	BD7LS00G
	2-Input NOR	BD7LS02G
	2-Input AND	BD7LS08G
	2-Input OR	BD7LS32G
	3-state Buffer	BD7LS125