Everywhere you imagine. RENESAS

# Renesas Power Management Solution (Portable Application, Server Application, AC/DC Application)

# 1. Portable Application (Multi-channel DC/DC converters, Charger ICs)

# Multi-channel DC/DC

# Renesas DC-DC Converter Proposal

***Renesas application-specific DC-DC converter provide high performance and compact power designs for DSC***

## Multi DC-DC

**Provide higher performance**

- Built-in external components
- High speed switching
- High efficiency
- Fast response and High stability
- Large current driving
- Abundant protect function

**Smaller and thinner body!**
**Higher performance!**

## Power Management (Custom)

Under planning

**Integrate power management function**

- RTC
- Input/Output voltage surveillance
- Output sequence control
- Back-up battery Switching control
- Strobe charge, etc.

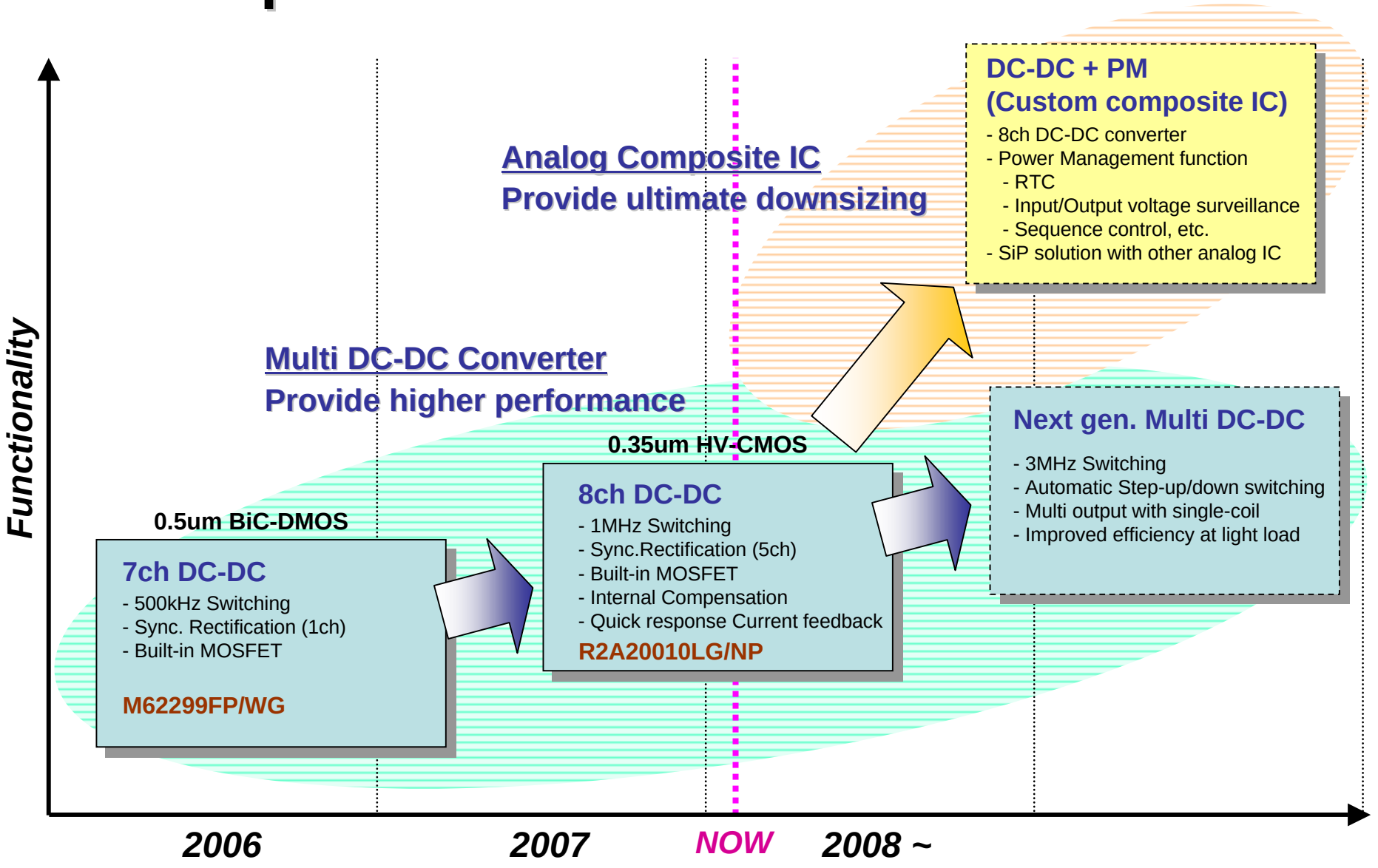
## SiP Solution

Under planning

**Provide ultimate downsizing**

- SiP with Motor Driver IC, etc.

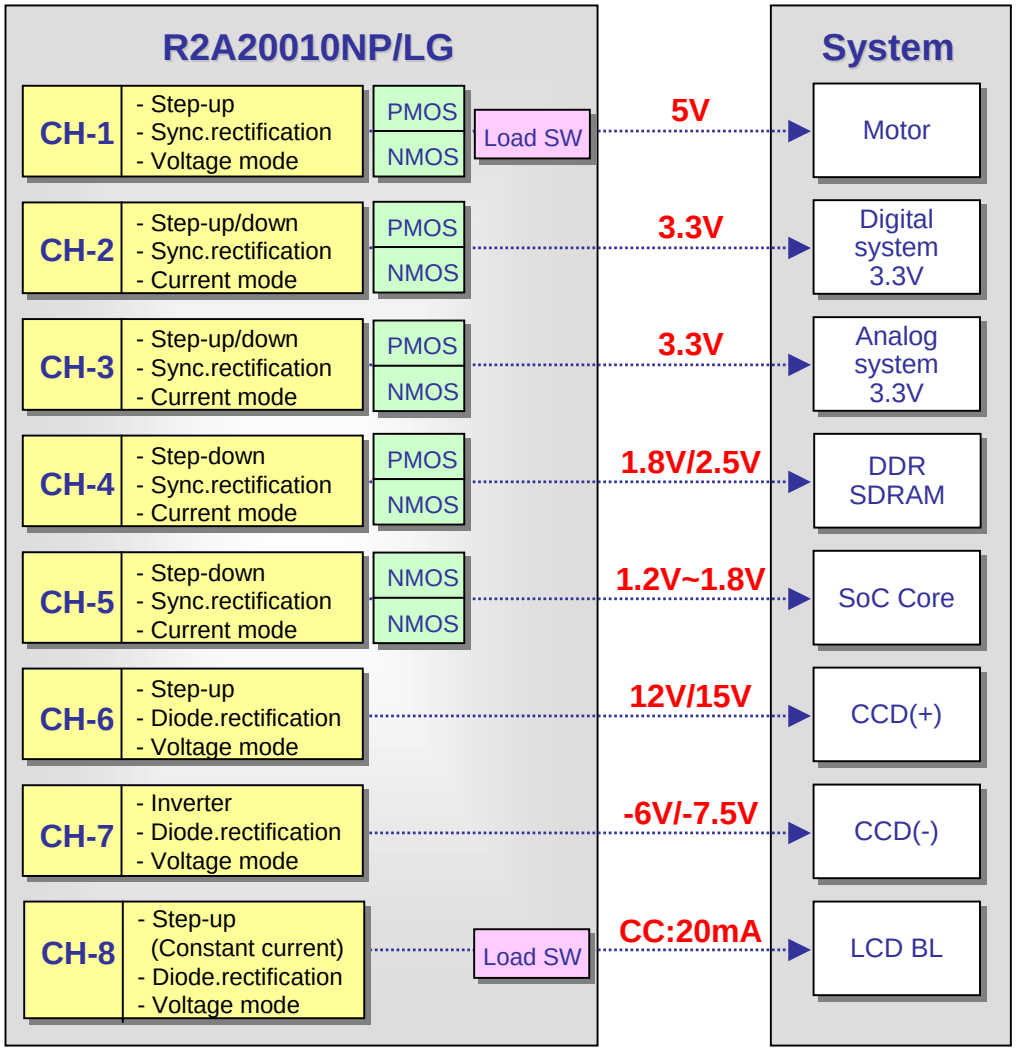
# Roadmap of Multi channel DC-DC converter



# Features of 8ch DC-DC R2A20010NP/LG

*- Flexible 8ch architecture including the power supply for DDR-SDRAM(2.5V typ.)*
*- Minimal-class external components*
*- Higher efficiency and quick response*

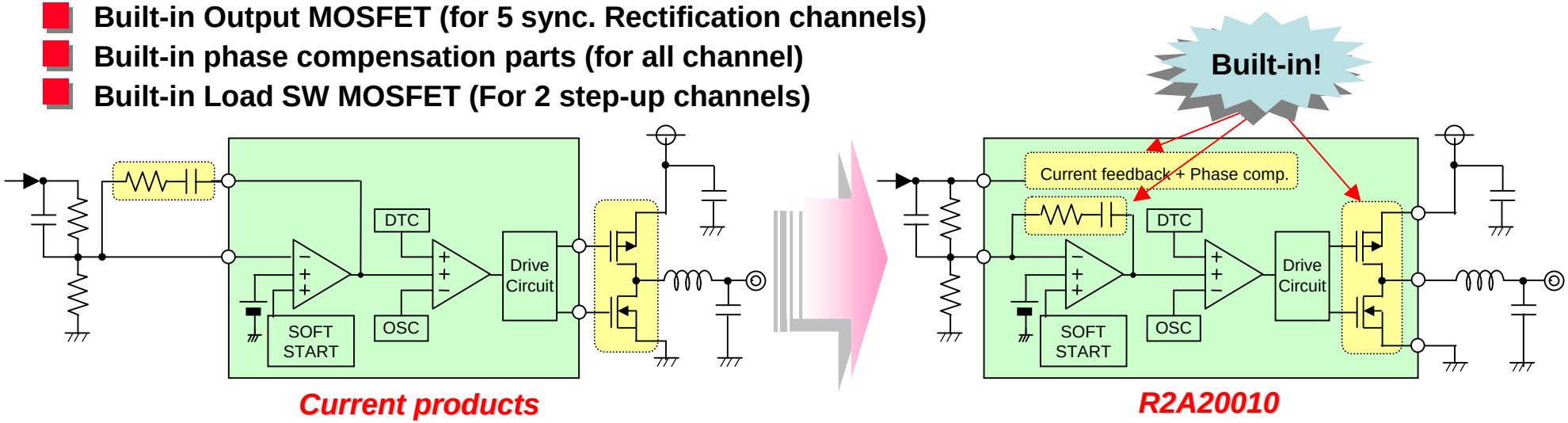
- **8-channel architecture**
  - 3 step-up
  - 2 selectable step-up/Step-down
  - 2 Step-down
  - 1 Inverter
- **Built-in external components**
  - Output MOSFET (5ch)
  - Load switch (2ch)
  - Phase compensate parts (All ch.)
- **High efficiency synchronous rectification** (5ch)
- **Fast response current feedback mode** (4ch)
- **High speed switching**
  - 1MHz for Sync. rectifying ch
  - 500kHz for Diode rectifying ch
- **Bootstrap circuit** (CH-5)
- **Low voltage operation : 1.4V to 4.5V**
  - Corresponds to 1-cell Li-ion and 2-cell AA battery
- **Dimmer control function for LCD BL** (CH-8)
- **Small Package**
  - R2A20010NP : 48pin QFN (6 x 6mm)
  - R2A20010LG : 49pin LGA (5 x 5mm)



# Key technologies for compact designs

## *Realized fewer external parts(-31.5%) and smaller mounting area(-20.6%) compared with current products*

- **Built-in Output MOSFET (for 5 sync. Rectification channels)**
- **Built-in phase compensation parts (for all channel)**
- **Built-in Load SW MOSFET (For 2 step-up channels)**




***Current products*** ***R2A20010***

## The number of external parts and the mounting area (Estimation)

[Conditions]
- Battery : Li-ion 1cell (3.0V to 4.2V)
- Output channel configuration

| Output Voltage | Application | Conversion Type | Rectification |
|---|---|---|---|
| 5.0V | Motor | Step-up from Battery | Sync. |
| 3.3V | Digital 3.3V | Step-down from 5.0V | Sync. |
| 3.3V | Analog 3.3V | Step-down from 5.0V | Sync. |
| 2.5V | SDRAM | Step-down from Battery | Sync. |
| 1.8V | SOC core | Step-down from Battery | Sync. |
| +15V | CCD(+) | Step-up from Battery | Diode |
| -7.5V | CCD(-) | Inverting from Battery | Diode |
| C.C.20mA | LCD BL | Step-up from Battery | Diode |

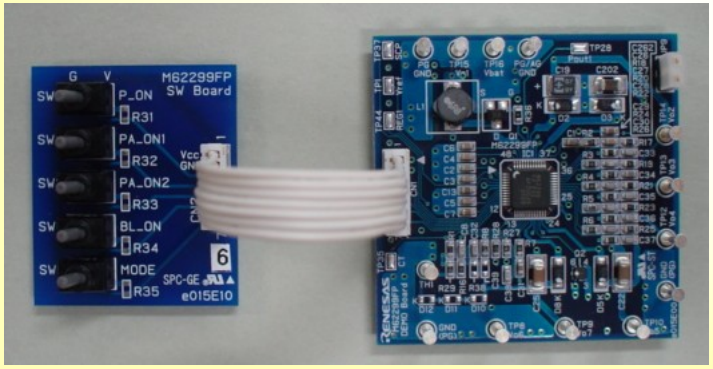
[Estimation result]

| | | Current product | | R2A20010 | |
|---|---|---|---|---|---|
| | Area($mm^2$) | Quantity | Area($mm^2$) | Quantity | Area($mm^2$) |
| DC-DC Converter IC (QFN-48) | 36.0 | 1 | 36.0 | 1 | 36.0 |
| MOSFET | 4.0 | 16 | 64.0 | 4 | 16.0 |
| Inductor | 16.0 | 8 | 128.0 | 8 | 128.0 |
| Diode | 4.2 | 4 | 16.6 | 4 | 16.6 |
| Capacitor | 1.3 | 39 | 45.5 | 30 | 35.1 |
| Resistor | 0.5 | 27 | 12.5 | 18 | 8.5 |
| Total | | 95 | 302.6 | 65 | 240.2 |

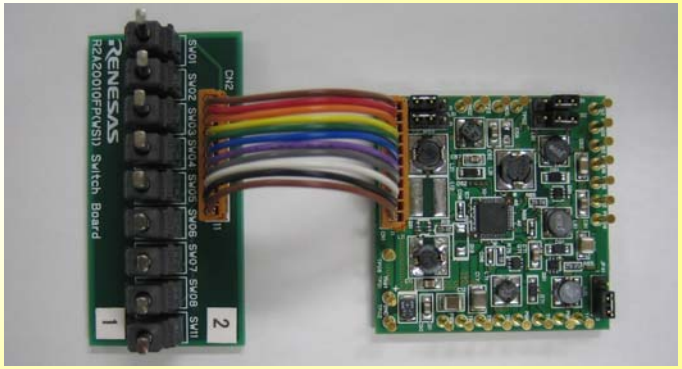
**The number of external parts : 31.6% reduced**
**The mounting area : 20.6% reduced**

# Development support tools

| | M62299 | | R2A20010 | |
|---|---|---|---|---|
| Parts No. | M62299FP | M62299WG | R2A20010NP | R2A20010LG |
| Package | 48pin QFN | 49pin LGA | 48pin QFN | 49pin LGA |
| Application note | *available* | | *available* | |
| Evaluation board | *available* | *available* | *available* | *available* |




<M62299FP Evaluation board>




<R2A20010NP Evaluation board>

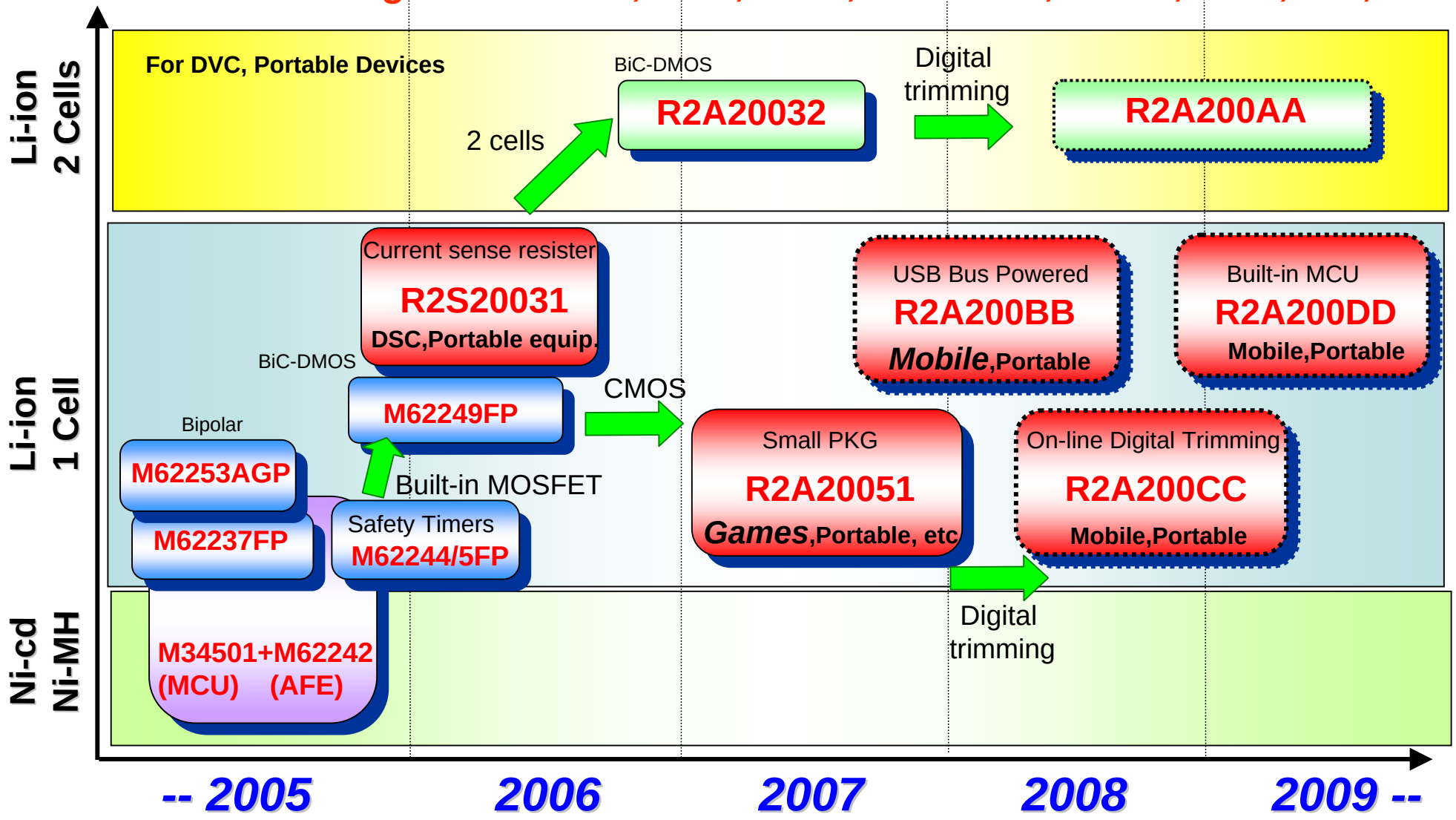
# Charger IC

# Renesas Charger ICs - Development Concept

1. **Reduce mounting space by smaller PKG.**
   - Buit-in MOSFET, current sense resistor
   - Small packages
2. **Easy set design**
   - Constant current, constant voltage charge control for Lithium-ion battery
3. **Higher performance**
   - Highly accurate charge control with internal high precision voltage reference
   - Various protection functions
4. **Low cost**
   - Optimized CMOS process technology

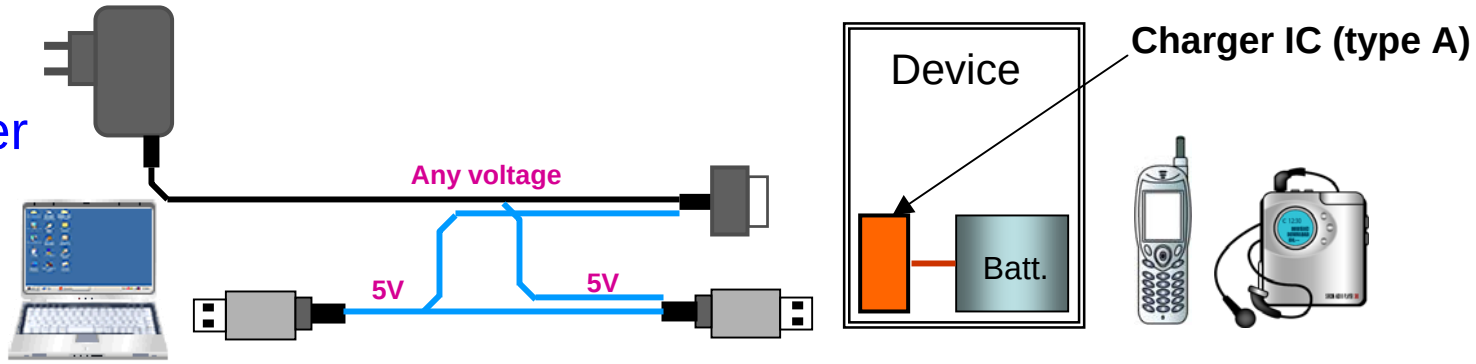
# Roadmap for Battery Charger ICs

## Built-in Digital Trimmer, OTP, MCU, MOS FET, Timer, USB, I2C, etc.

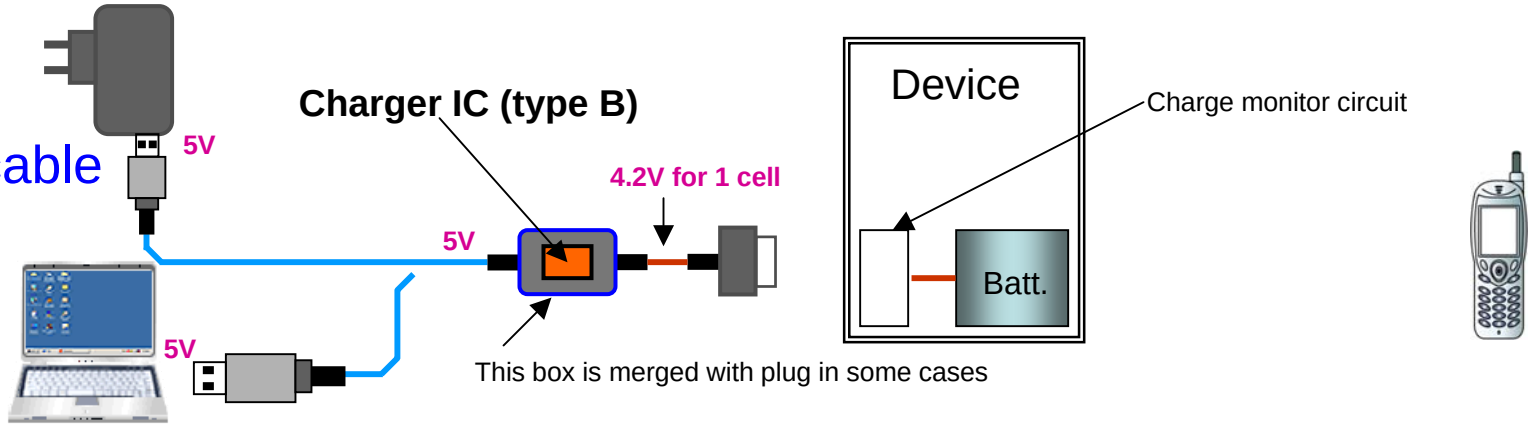


# Battery Charger Configuration (1)

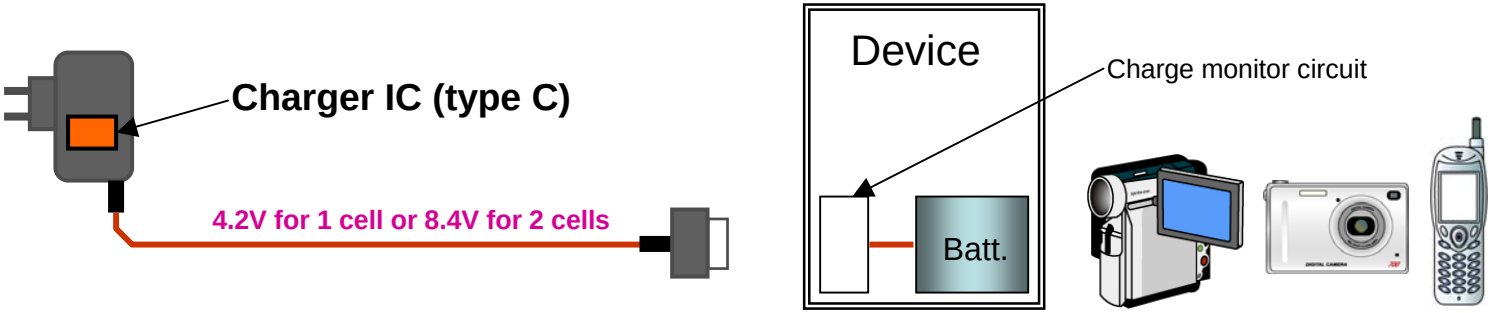
1.Internal charger




2.USB adaptor cable charger

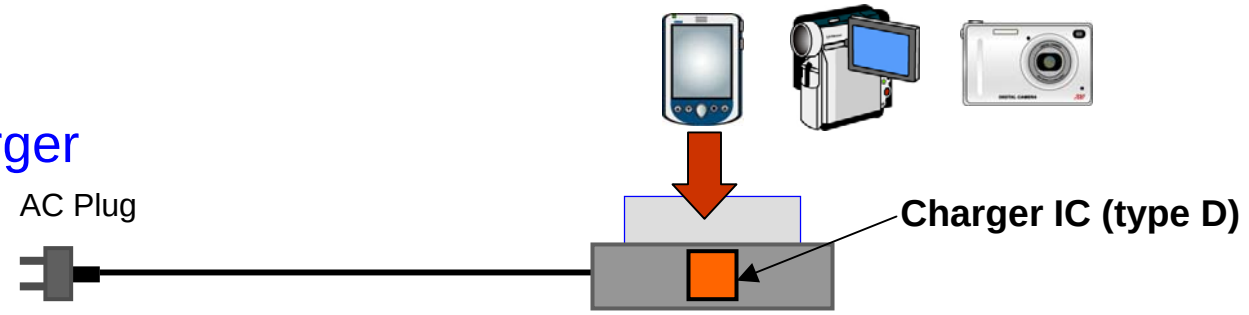



3.AC adaptor type charger

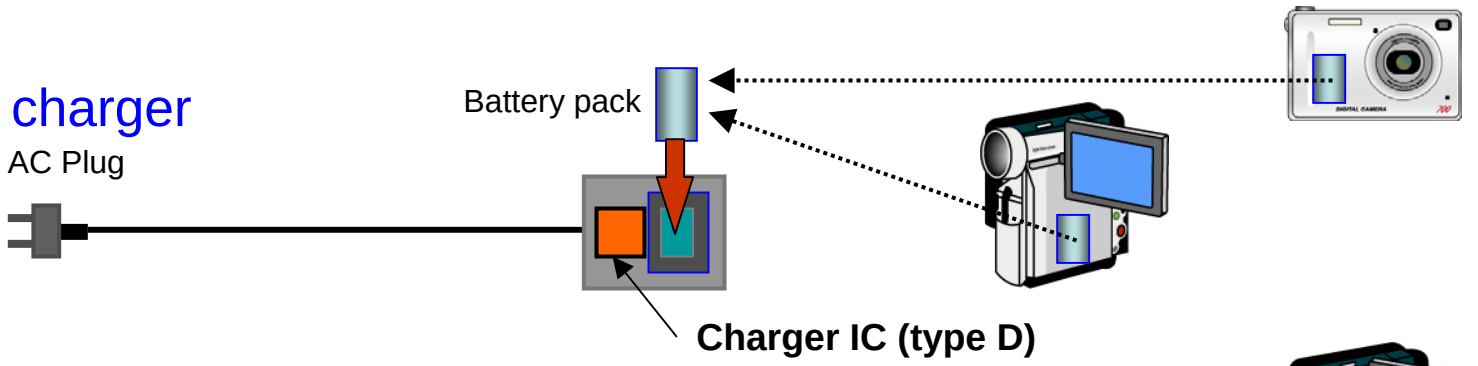


# Battery Charger Configuration (2)

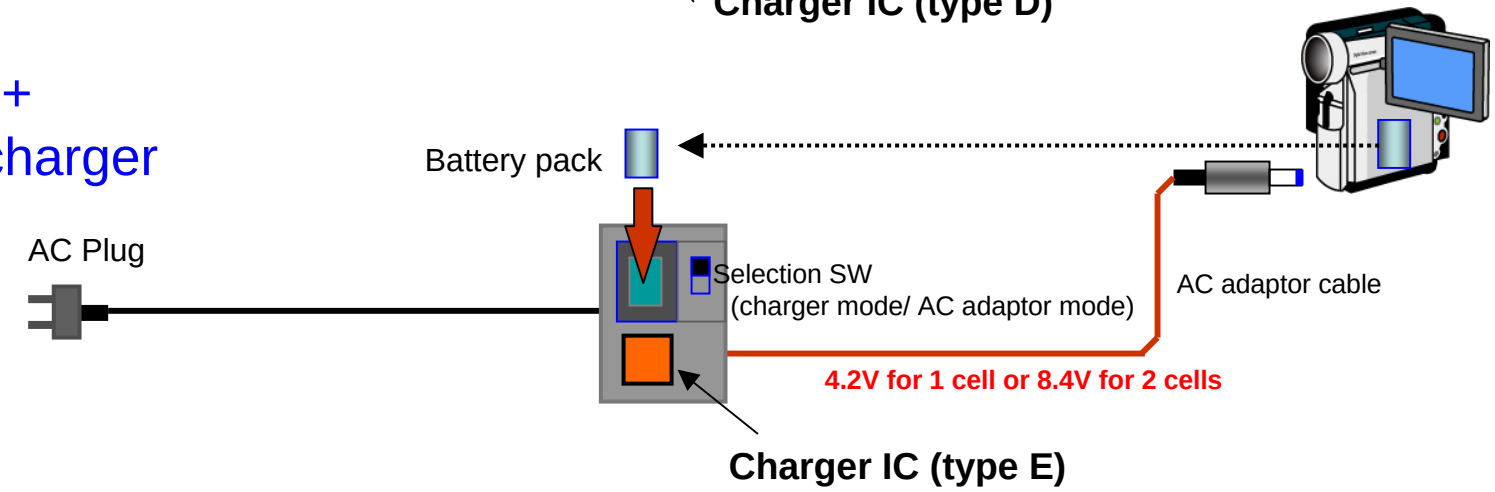
## 4.Cradle/ charger




## 5.Battery pack charger




## 6.AC adaptor + battery pack charger



# Type of Battery Charger IC & Renesas ICs

**Type A:** (No.1)
- Supports a few type of battery (only attachable batteries)
- Regulated DC input
- Small package

- **Mobile phones**
- **MP3 players/ PMPs**

**Type B:** (No.2)
- Regulated 5V DC input
- Small package

**-> Charger IC is better if it needs small size and small current dissipation**

- **Some of mobile phones**

**M62249**
**R2A20051**

**Type C:** (No.3)
- Feedback to primary (PWM) side with photo-coupler

**-> Charger IC is better for higher reliable system and easy design**

- **DVC**
- **Some of mobile phones**
- **Some of DSC**

**M62237**
**M62253A**
**R2S20031**

**Type D:** (No4&5)
- Supports a few type of battery (only attachable batteries)
- Feedback to primary (PWM) side with photo-coupler

- **PDA**
- **DSC**
- **Some of DVC**

**Type E:** (No.6)
- Supports a few type of battery (only attachable batteries)
- AC-DC converter function, as well as battery charger

- **DVC accessories**

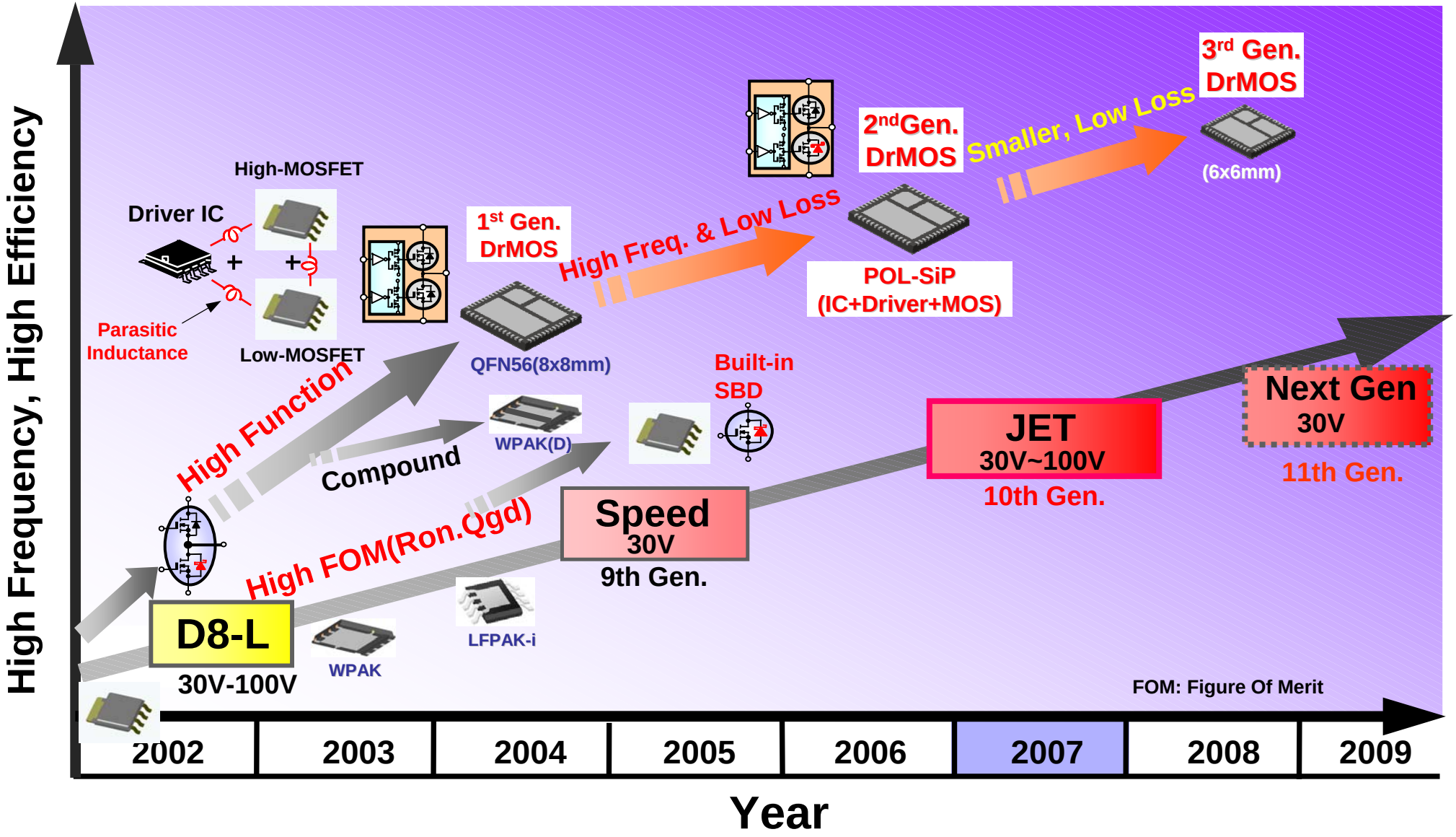
**R2S20031**

# Battery Charger IC Line-up

| | Bat. Type | | | Vcc(V) | Function | | | | | | | | | | Package | Protection | | | | | | | Supplements |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Li-ion | NiCd/NiMH | Cell count | | Built-in MOS FET | Buit-in current sense resistor | Primary control | MCU I/F | LED drive | Battery identification | AC adaptor detection | Setable charge ternimation | Pre-charge/ Tricke charge | Re-charge | | Over-discharge detection | Over-voltage detection | Over current detection | Temperature detection | Safety timer | Thermal protection | Compulsory charge stop | |
| M62240 | | ○ | 1 | 3-15 | | | ○ | | 1 | | ○ | | ○ | | SOP20 | | ○ | ○ | ○ | ○ | | | |
| M62237 | ○ | | 1 | 2.5-15 | | | ○ | | | | | | | | SOP8 | | | | | | | | Const. cureent/voltage |
| M62244 | ○ | | 1 | 3-6.5 | | | | | 2 | | ○ | | ○ | ○ | SSOP20 | ○ | ○ | ○ | ○ | ○ | | ○ | |
| M62245 | ○ | | 1 | 3-6.5 | | | | | 2 | | ○ | | ○ | | SSOP16 | ○ | ○ | ○ | ○ | ○ | | | |
| M62249 | ○ | | 1 | 4.75-6.1 | ○ | | | | 1 | | ○ | | ○ | ○ | QFN28 | ○ | ○ | | ○ | ○ | | ○ | |
| M62253A | ○ | | 1 | 5-15 | | | | | 2 | | | ○ | ○ | ○ | SSOP16 | ○ | | | ○ | | | | Chattering free |
| R2S20030 | ○ | | 1 | 4.75-6 | ○ | ○ | | | 1 | | | ○ | ○ | ○ | QFN28 | | ○ | | ○ | ○ | ○ | | |
| R2S20031 | ○ | | 1 | 3-6.5 | ○ | ○ | ○ | | 2 | | ○ | ○ | ○ | | SSOP20 | ○ | ○ | ○ | ○ | ○ | ○ | | |
| R2A20051 | ○ | | 1 | 4-6 | ○ | ○ | | | 1 | | ○ | | ○ | ○ | SON10 | ○ | ○ | | | ○ | ○ | ○ | Die temp. monitor |
| M62242 | ○ | ○ | 1,2 | 5.3-15 | | | | ○ | | ○ | | | ○ | ○ | SSOP16 | Realized with MCU | | | | | | | |
| M62255 | ○ | ○ | 3,4 | 7.5-22 | | | | ○ | | | | | ○ | | SSOP24 | Realized with MCU | | | | | | | DC-DC type regulator |

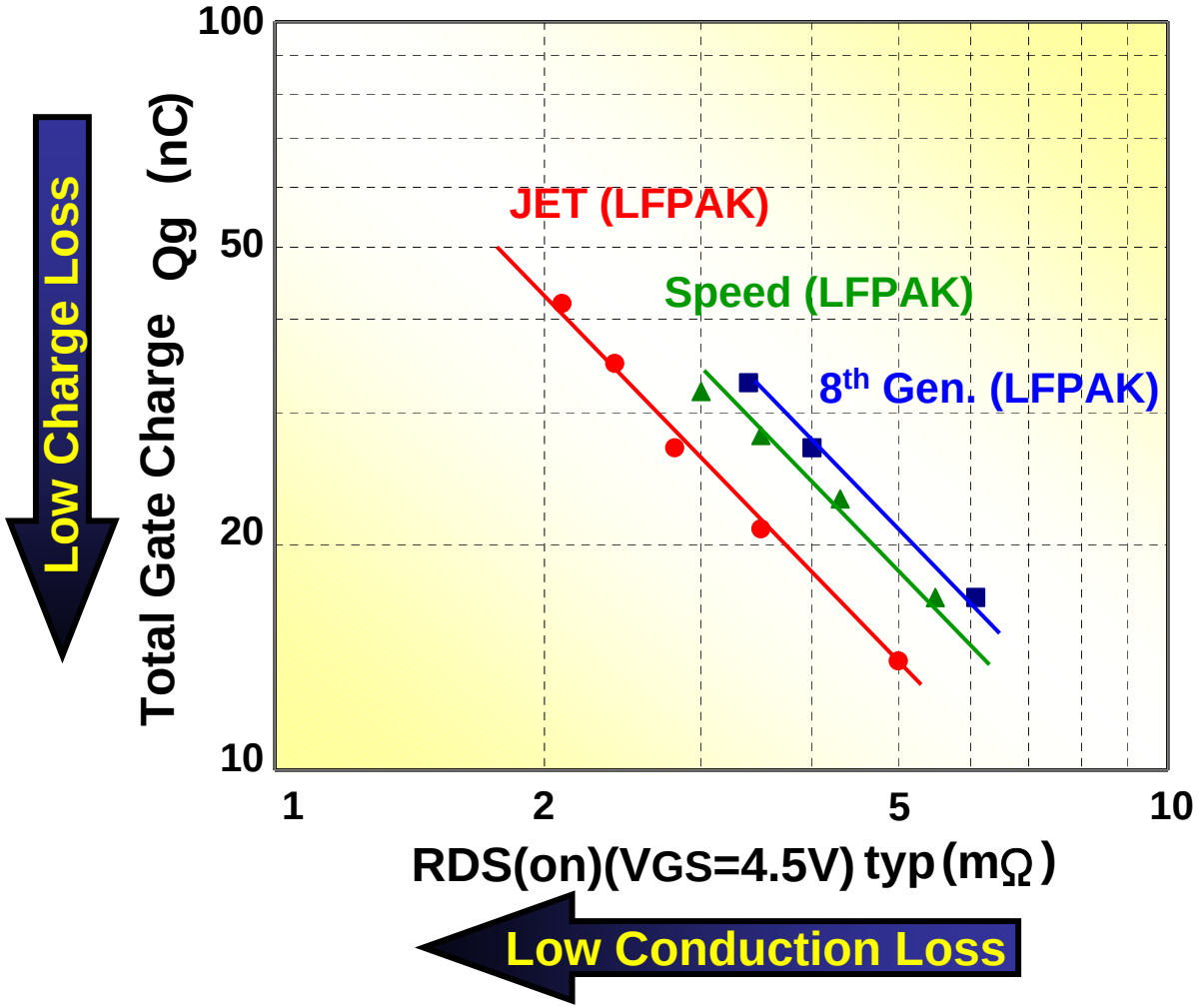
# 2. Server Application (Jet Series MOSFET, DrMOS, SiP-POL)

# Renesas Low Voltage MOSFET Road Map



# Feature of JET series in Low-side（VDSS=30V)

● Figure of Merit : FOM(Ron·Qg) at Vgs=4.5V

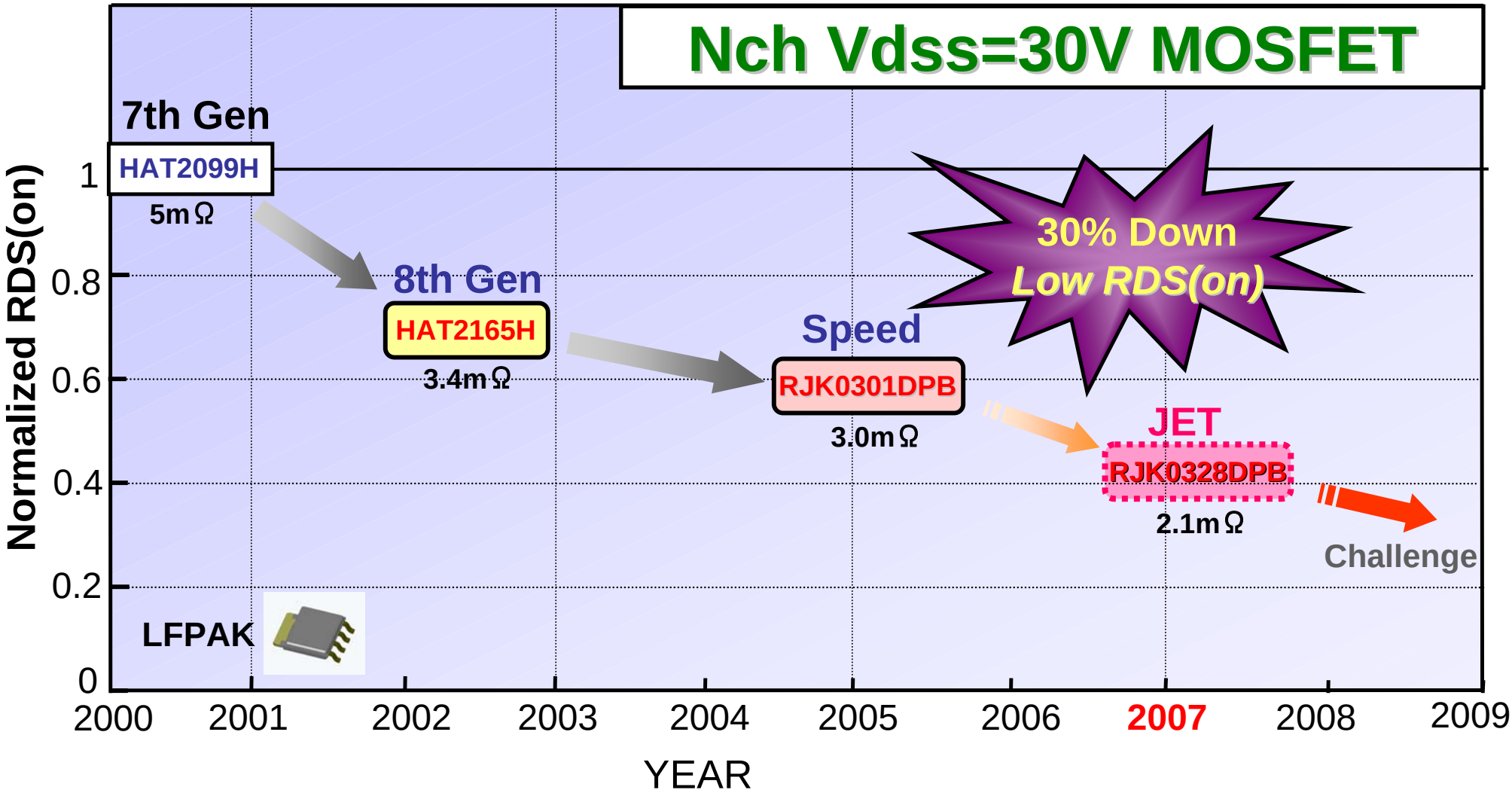



**Speed Series**
***97mΩnC***

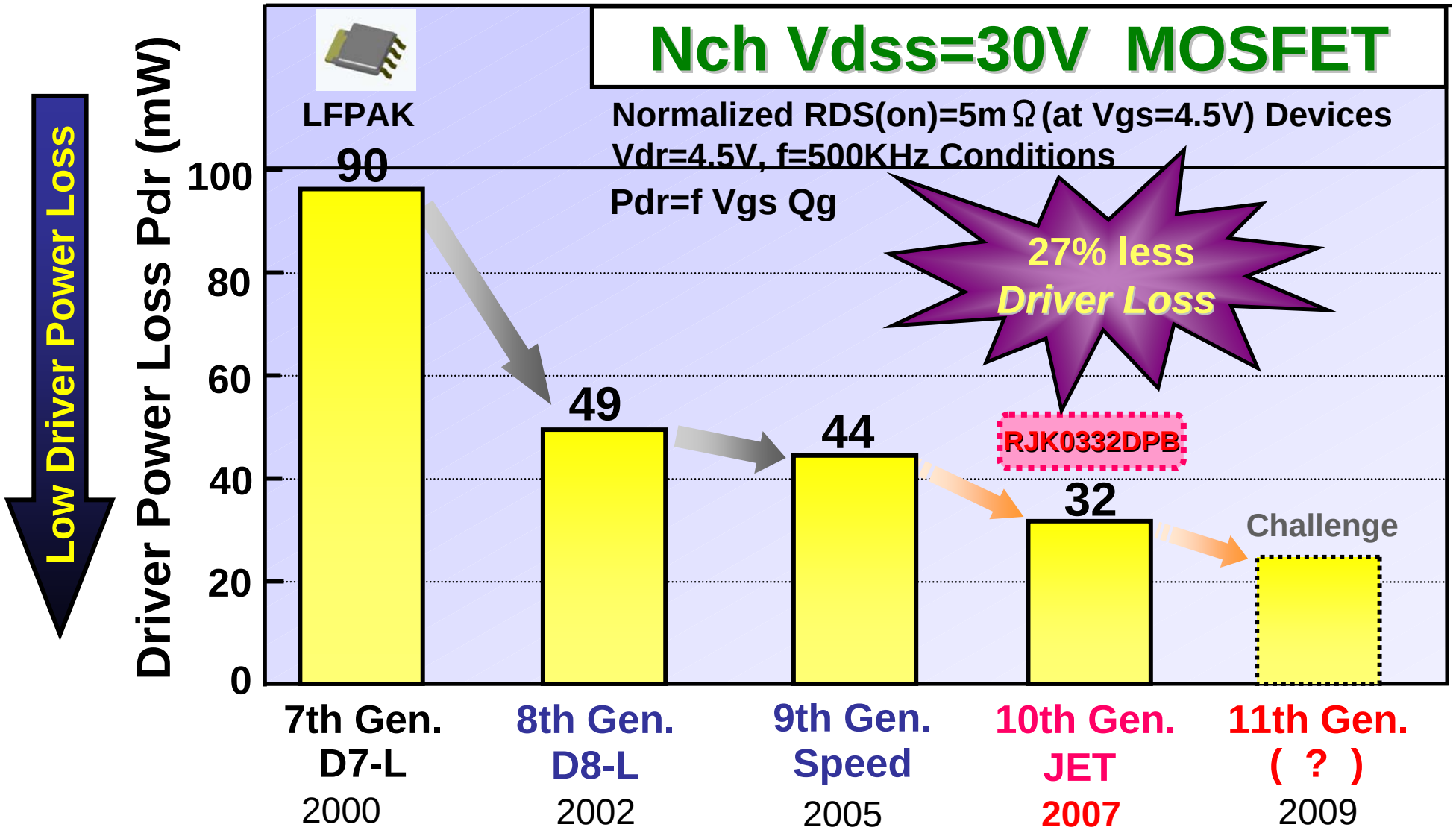
**20% Down**

**JET Series**
***78mΩnC***

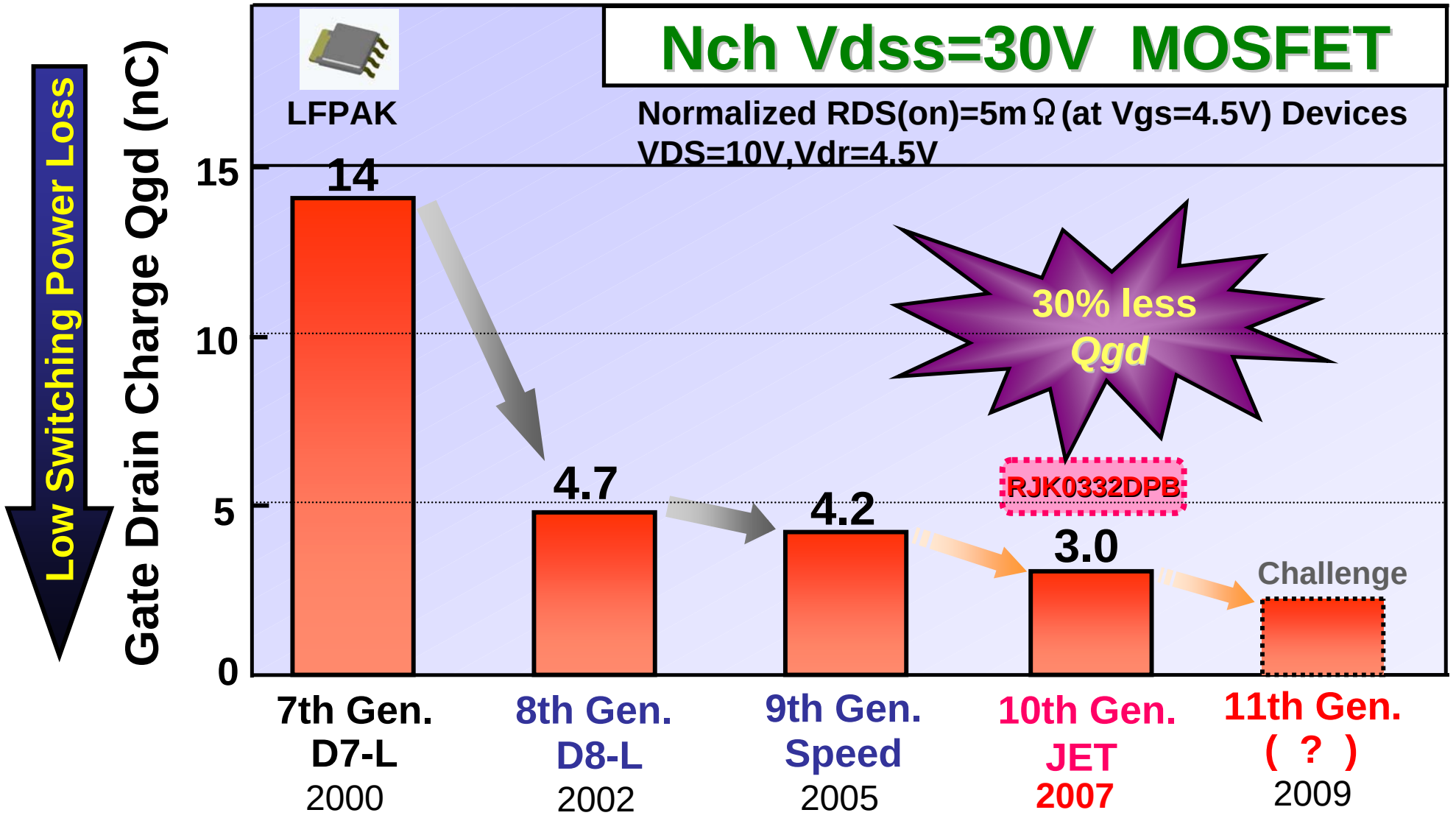
# Power MOSFET RDS(on) Trend



# Power MOSFET Qg Trend



# Power MOSFET Qgd Trend



# Feature & Merit of JET Series

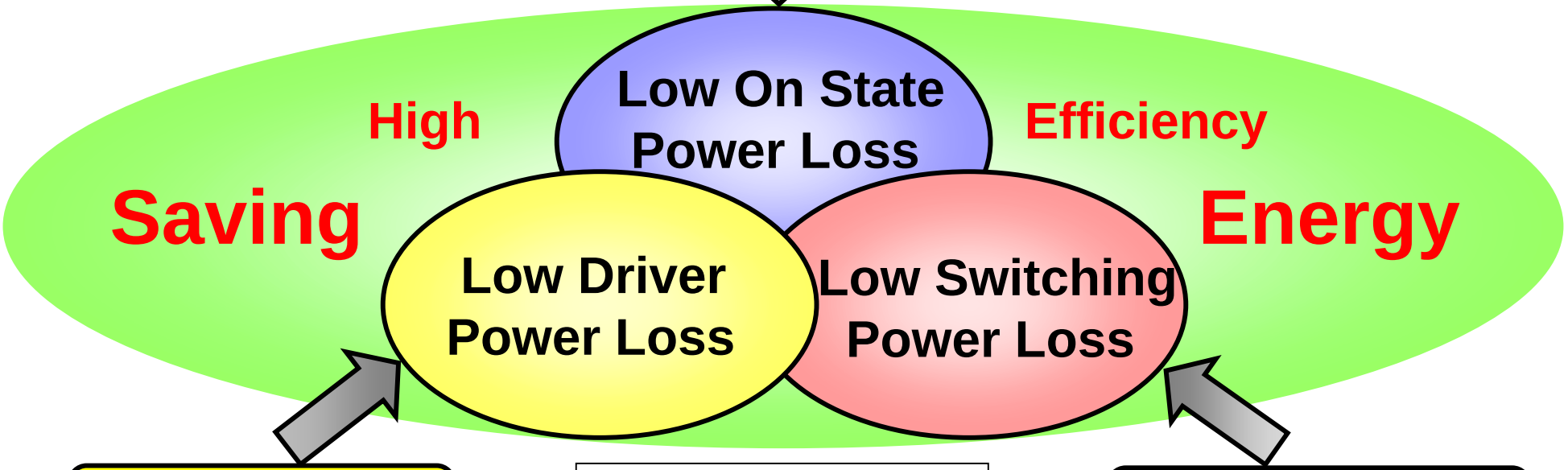
(Compared with previous)

**30% Cut RDS(on)**
**Ultra Low RDS(on)**

LFPAK 1.6mΩtyp
WPAK 1.5mΩtyp
SOP-8 2.6mΩtyp

Reduced the Thermal Temperature

Capable High Current High Performance



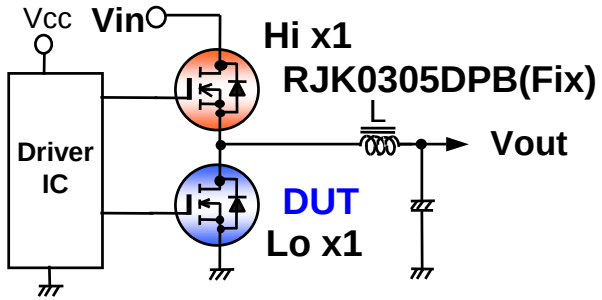

**27% Cut Qg**
**Low Qg**

Achieve High Freq. & High Slew Rate

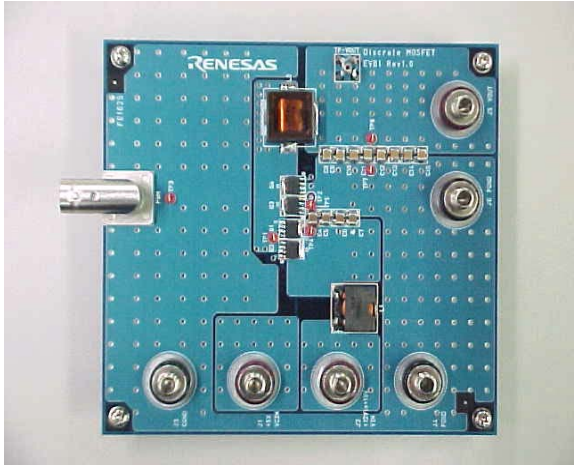
**30% Cut Qgd**
**Low Qgd**

Capable Smaller & Thin Size

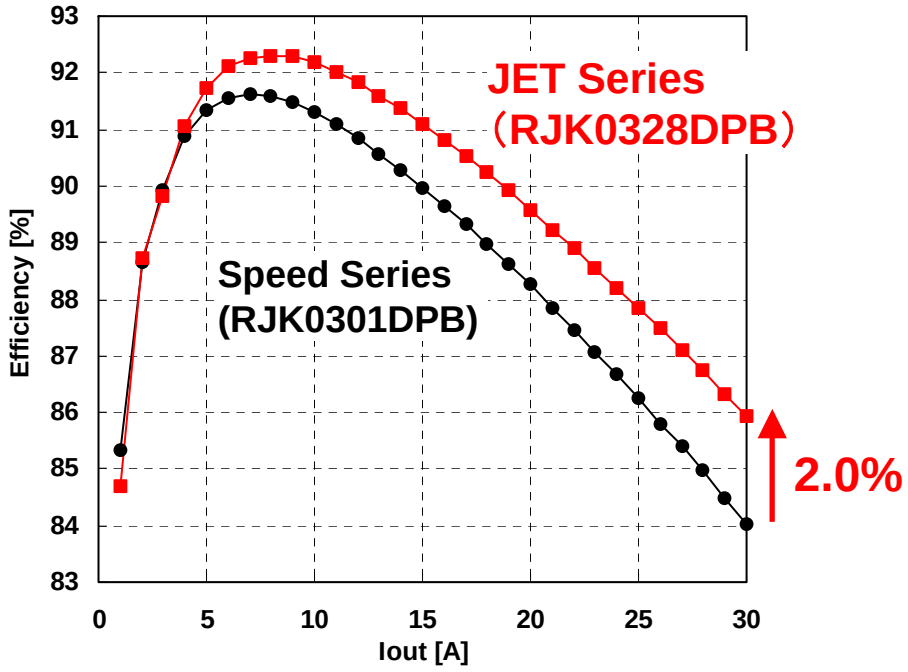
# Efficiency of JET series



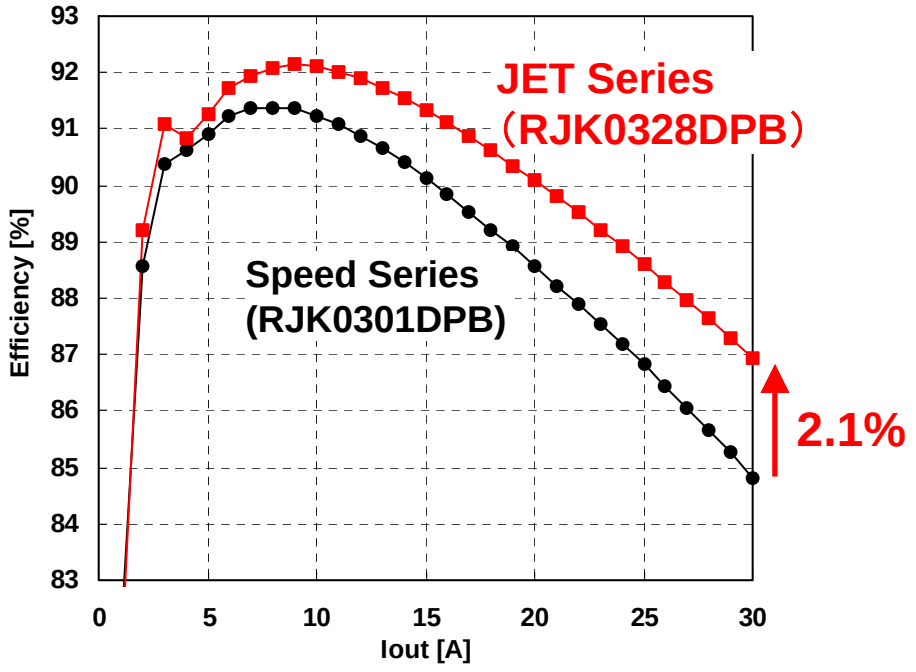

**Renesas Discrete EVB**
**Ta=25deg.C , No Air Flow**
**L=0.45uH**



**< Test Conditions >**
VIN=12V, Vout=1.2V
VDR=5V, fsw=500kHz




**< Test Conditions >**
VIN=19V, Vout=1.2V
VDR=5V, fsw=300kHz

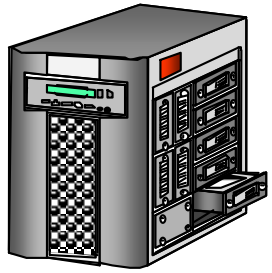


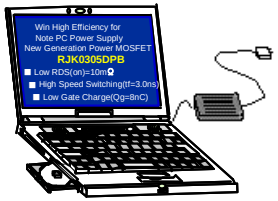
# JET Series Product Line-up

# Main Application for JET Series

- **VR* for CPU Core, GPU, Chipset and Memory**

  Server , Network, Telecom
  Note Book PC
  VGA






- **Secondary Synchronous Rectification for Brick Converter and AC/DC Power Supply(Vout<5.0V)**

  Server , Router
  Telecom

- **Power Management Switch for Li+Ion Battery (N/B PC) and Oring Switch.**

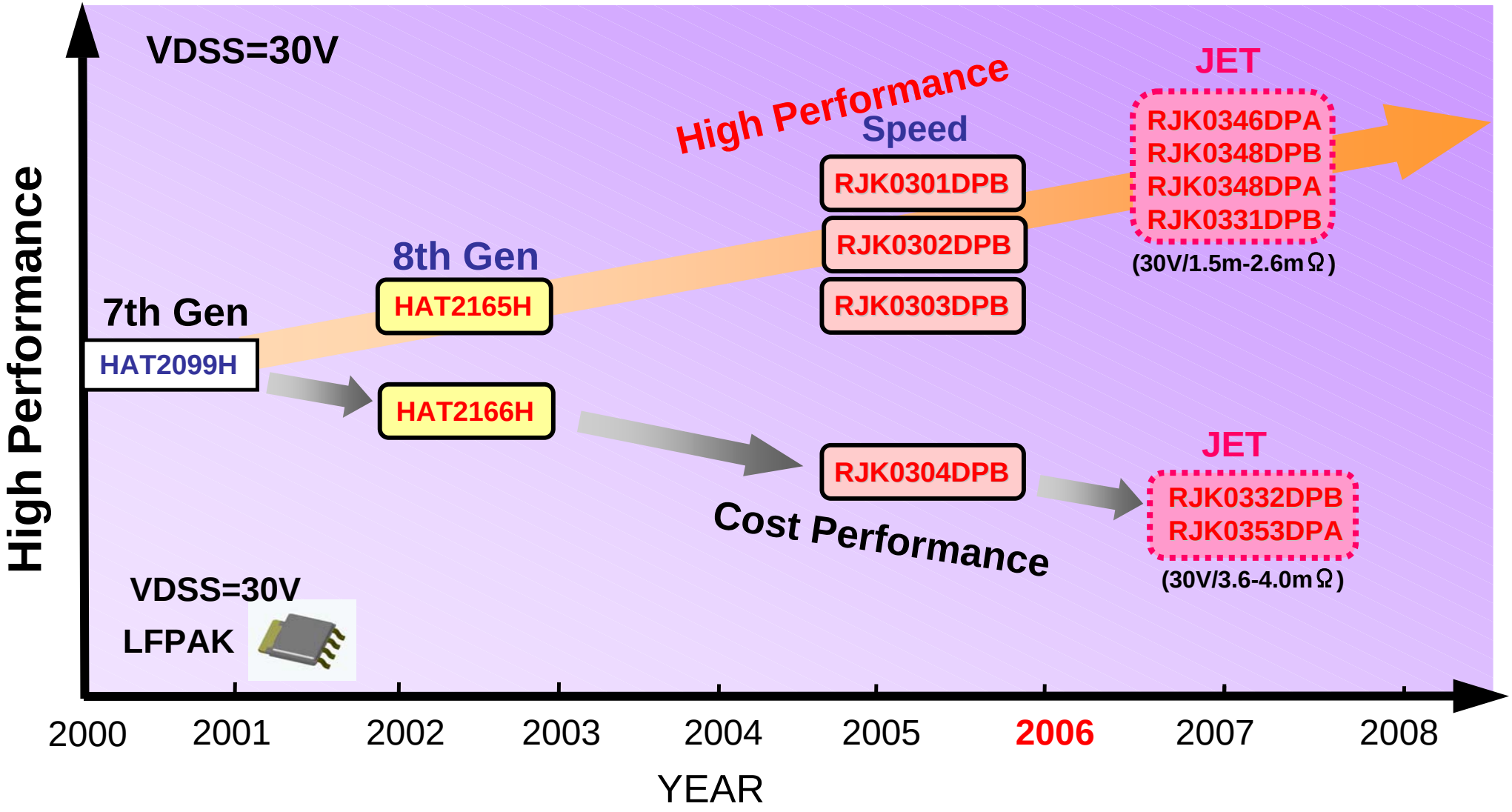
*** VR : Voltage Regulator**

# JET Series Recommended List

| | | Hi-Side | qty/ph | Lo-Side | qty/ph | Efficiency * | Price * |
|---|---|---|---|---|---|---|---|
| **Server High End** | **CPU** | RJK0305DPB | 1 | RJK0332DPB | **2** | 3 | 1 |
| | | RJK0305DPB | 1 | RJK0331DPB | **2** | 2 | 2 |
| | | RJK0305DPB | 1 | RJK0329DPB | **2** | 1 | 3 |
| | **ChipSet** | RJK0305DPB | 1 | RJK0331DPB | 1 | 3 | 1 |
| | | RJK0305DPB | 1 | RJK0330DPB | 1 | 2 | 2 |
| | | RJK0305DPB | 1 | RJK0329DPB | 1 | 1 | 3 |
| | **Memory** | RJK0371DSP | 1 | RJK0353DSP | 1 | 3 | 1 |
| | | RJK0371DSP | 1 | RJK0354DSP | 1 | 2 | 2 |
| | | RJK0371DSP | 1 | RJK0355DSP | 1 | 1 | 3 |
| **Server Middle End** | **CPU & Chipset** | RJK0305DPB | 1 | RJK0331DPB | 1 | 3 | 1 |
| | | RJK0305DPB | 1 | RJK0330DPB | 1 | 2 | 2 |
| | | RJK0305DPB | 1 | RJK0329DPB | 1 | 1 | 3 |
| | **Memory** | RJK0371DSP | 1 | RJK0353DSP | 1 | 1 | 3 |
| | | RJK0371DSP | 1 | RJK0354DSP | 1 | 2 | 2 |
| | | RJK0371DSP | 1 | RJK0355DSP | 1 | 3 | 1 |

* Rating in suggestions:
(Best) 1 > 2 > 3

# Proposal for Synchronous Rectifier



# Proposal for Isolated Brick DC/DC

**Optimized Design**

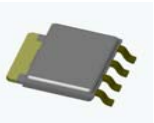
**Low RDS(on)**

**Low Ron/Qgd**
**HAT2267H**
**(80V/13mΩ)**

**Low Loss**

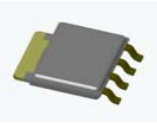
**Next Gen.JET**
**RJK0328DPB**
**(30V/1.6mΩ)**

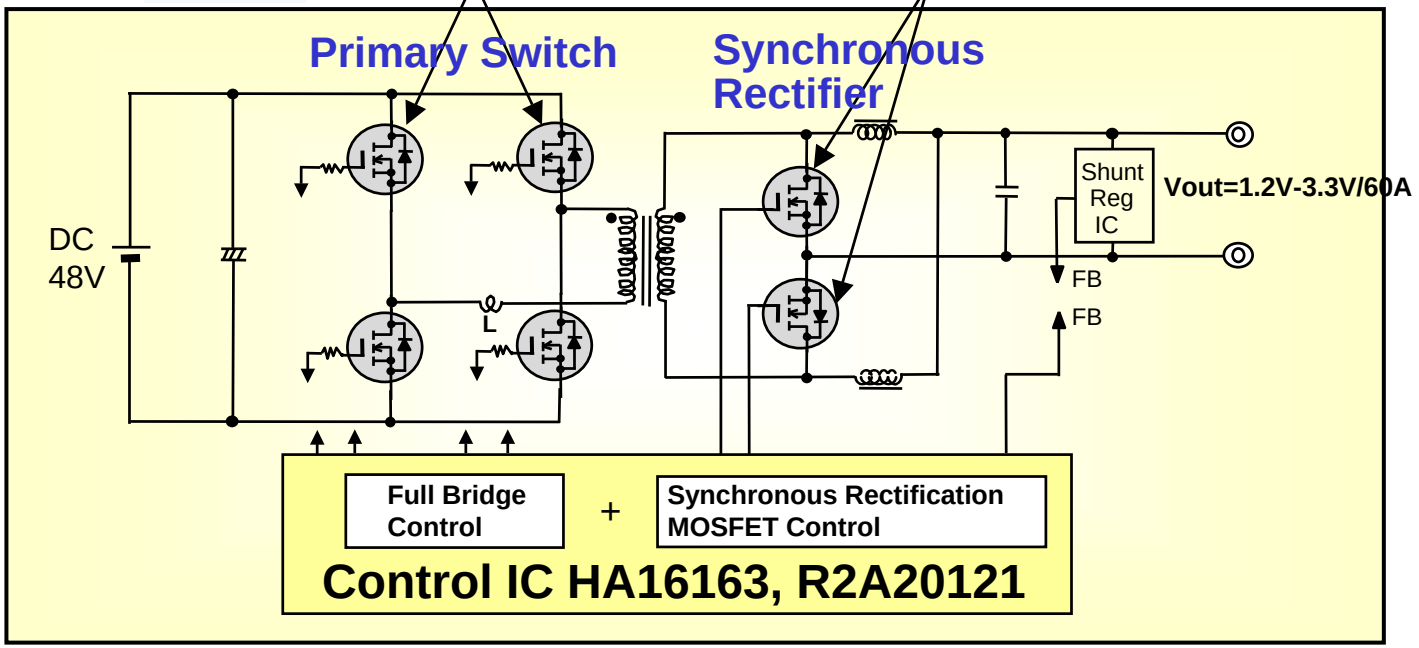
**LFPAK**
**(Wireless)**



**Low Ron/Qgd**
**D8-L HAT2175H**
**(100V/33mΩ)**

**Low Ron/Qg**
**D8-L HAT2165H**
**(30V/2.5mΩ)**



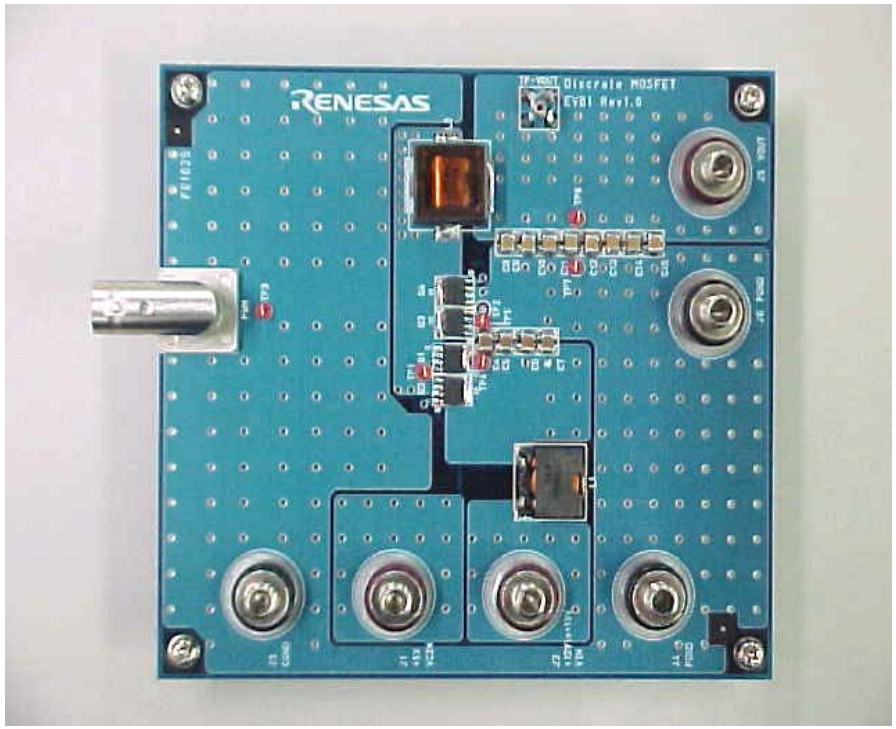


# Proposal for Brick Bus Converter

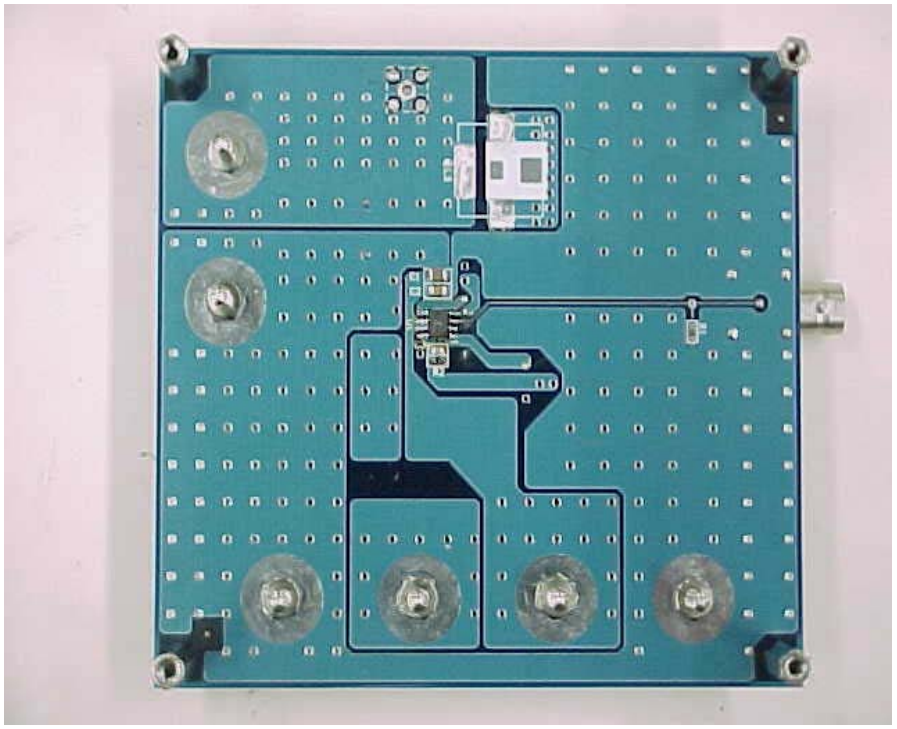
## Optimized Line-up by specific application !!

| Topology | Vdss | Primary SW MOSFET | Vout | Vdss | SR MOSFET LFPAK/i,WPAK | SR MOSFET SOP-8 |
|---|---|---|---|---|---|---|
| Full,Half Bridge | 100V | HAT2173H | 1~3.3V | 30V | RJK0328DPB | RJK0348DSP |
| | | HAT2175H | | | RJK0346DPA | RJK0349DSP |
| | | HAT2173N | | | RJK0332DPB | RJK0353DSP |
| | 80V | HAT2267H | 5.0V | 40V | HAT2169H | |
| Active Clamp | 150V | HAT2183WP | | | HAT2170H | |
| | | HAT2184WP | | | HAT2172H | |
| | | | 6~8V | 60V | HAT2266H | HAT2256R |
| One Forward | 200V | HAT2187WP | 12V | 80V | HAT2279H | |
| | | HAT2188WP | | | HAT2244WP | |

# Renesas Evaluation Board




< TOP VIEW >



< BOTTOM VIEW >

# 3. AC/DC Application (PFC IC, PWM Controller, DC/DC Controller)

# RENESAS Power Supply Control IC Lineup

## PFC

CCM

- R2A20114
- R2A20111
- HA16174
- HA16178

CRM

- R2A20112

Interleave

- R2A20113

Single

- HA16158/42

Forward, Suitable for Main

- HA16141

Fly back,Suitable for AUX

## PWM (Isolation DC/DC)

- R2A20121 — Full Bridge, Suitable for large power
- HA16163
- HA16150 — Half Bridge, Suitable for middle power
- HA17384 — Forward or Fly back, Suitable for small power
- M51995 — V-mode, Forward Suitable for small power
- R2A20123 — Quasi-Resonant mode Suitable for small power

+

## Non-Isolation DC/DC

- HA16167

High efficiency
exclude MOSFET
Suitable for mid/Hi power

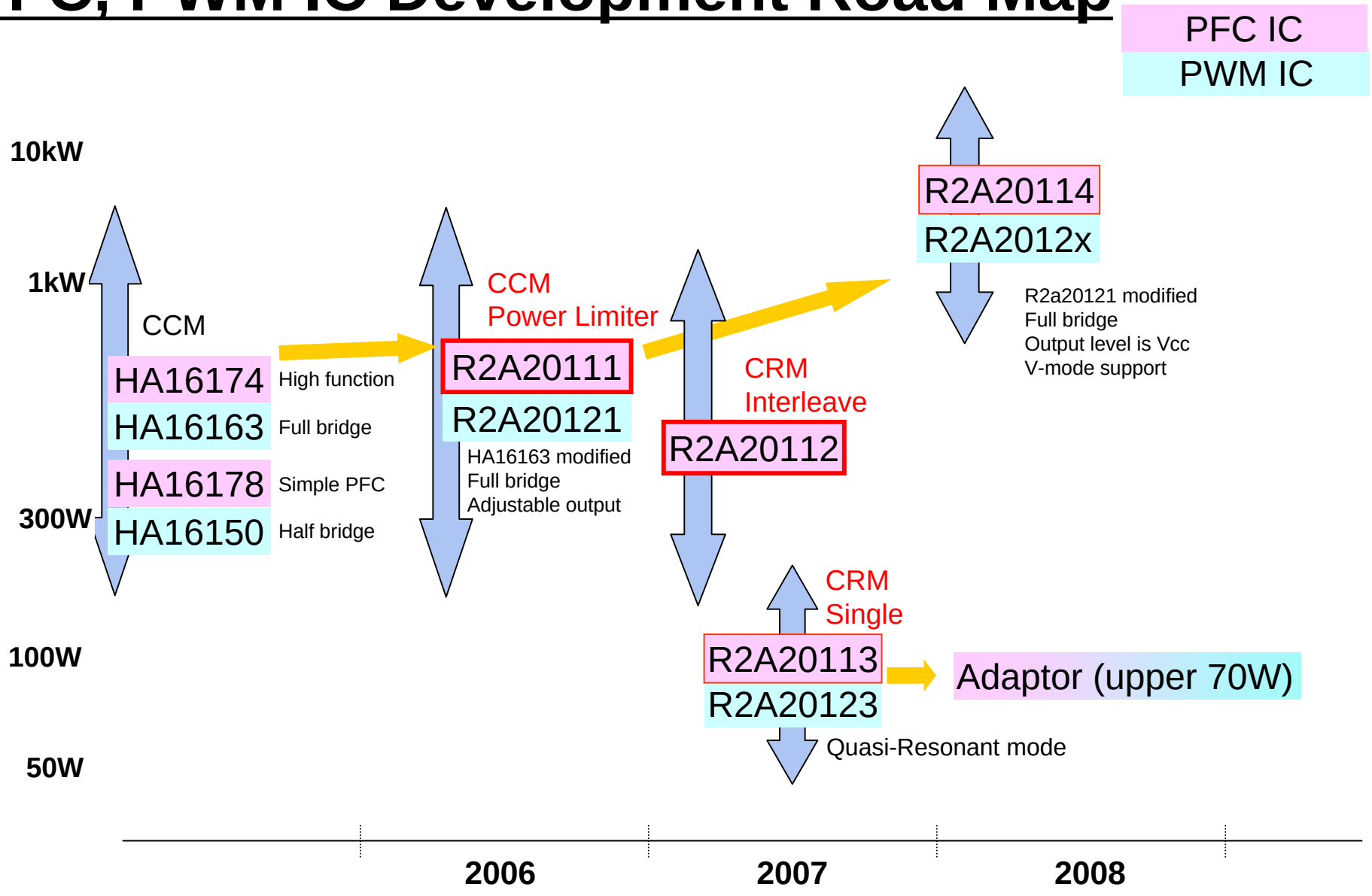
- HA16114
- HA16116

High input voltage(~40V)

- R2A20101

High efficiency
include MOSFET

# PFC, PWM IC Development Road Map



# PFC Control IC

# RENESAS PFC IC Lineup

| | HA16178 | HA16174 | R2A20111 | R2A20112 | R2A20113 |
|---|---|---|---|---|---|
| Mode | CCM | CCM | CCM | CRM | CRM |
| Interleave Technology | | | | Yes | |
| Constant Power Limiter | | | Yes | | |
| High voltage line less | | | | Yes | Yes |
| gm AMP for error AMP | Yes | Yes | Yes | Yes | Yes |
| Feedback Loop Detector | Yes | Yes | Yes | Yes | Yes |
| Hold Function | | Yes | Yes | | |
| Quick Soft Start | Yes | Yes | Yes | | |
| Power Good Function | | Yes | | | |
| OVP / OCP, UVLO | Yes | Yes | Yes | Yes | Yes |
| Package | SOP-16<br>DIP-16 | SOP-16<br>DIP-16 | SOP-16<br>DIP-16 | SOP-16<br>DIP-16 | SOP-8<br>DIP-8 |

# CRM Interleaving PFC
# R2A20112

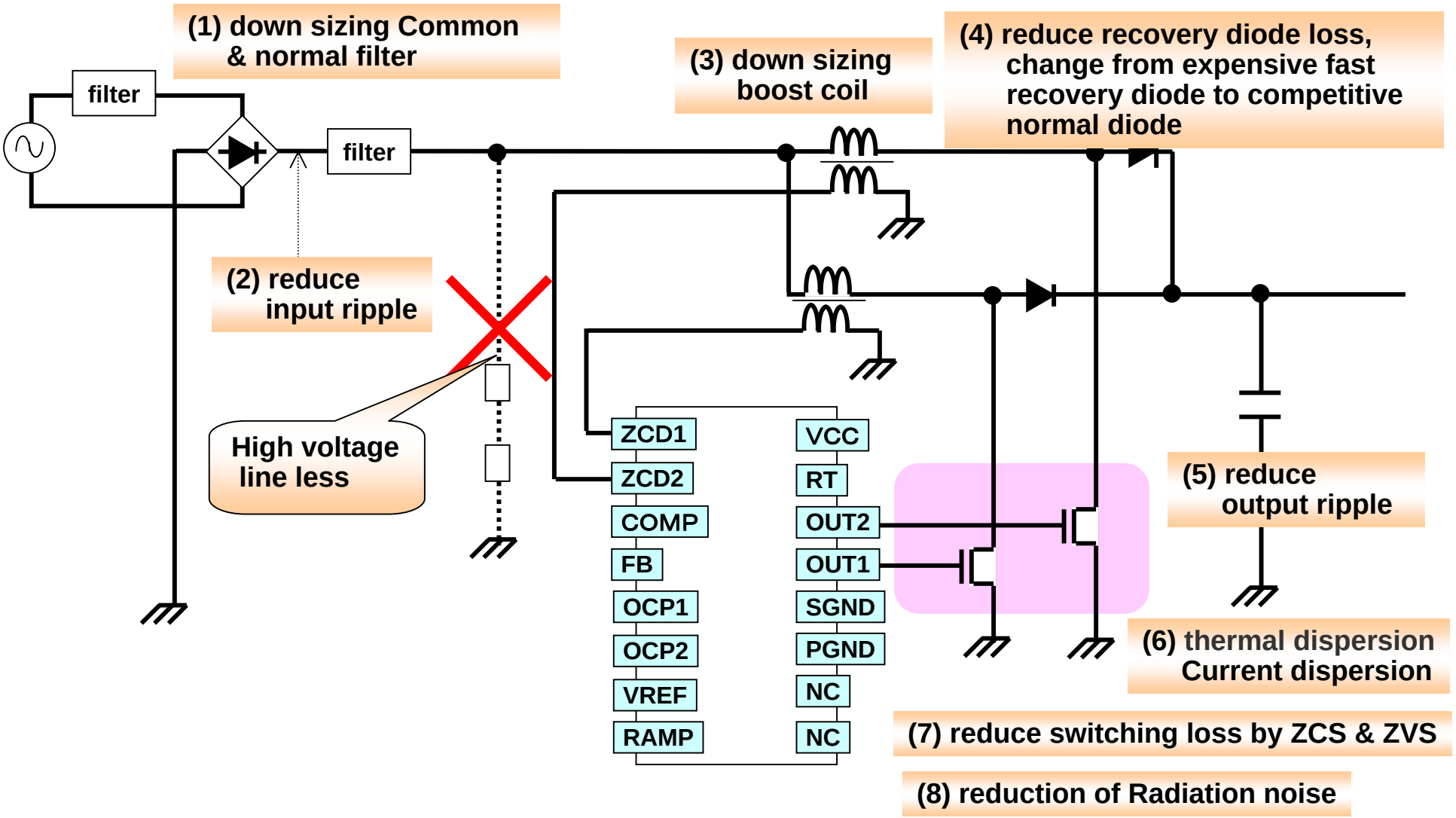
Realize the advantage of both CRM and CCM

✓High efficiency and Low switching noise (CRM)

✓Low ripple current (Interleave)

# Advantage of CRM Interleaving PFC

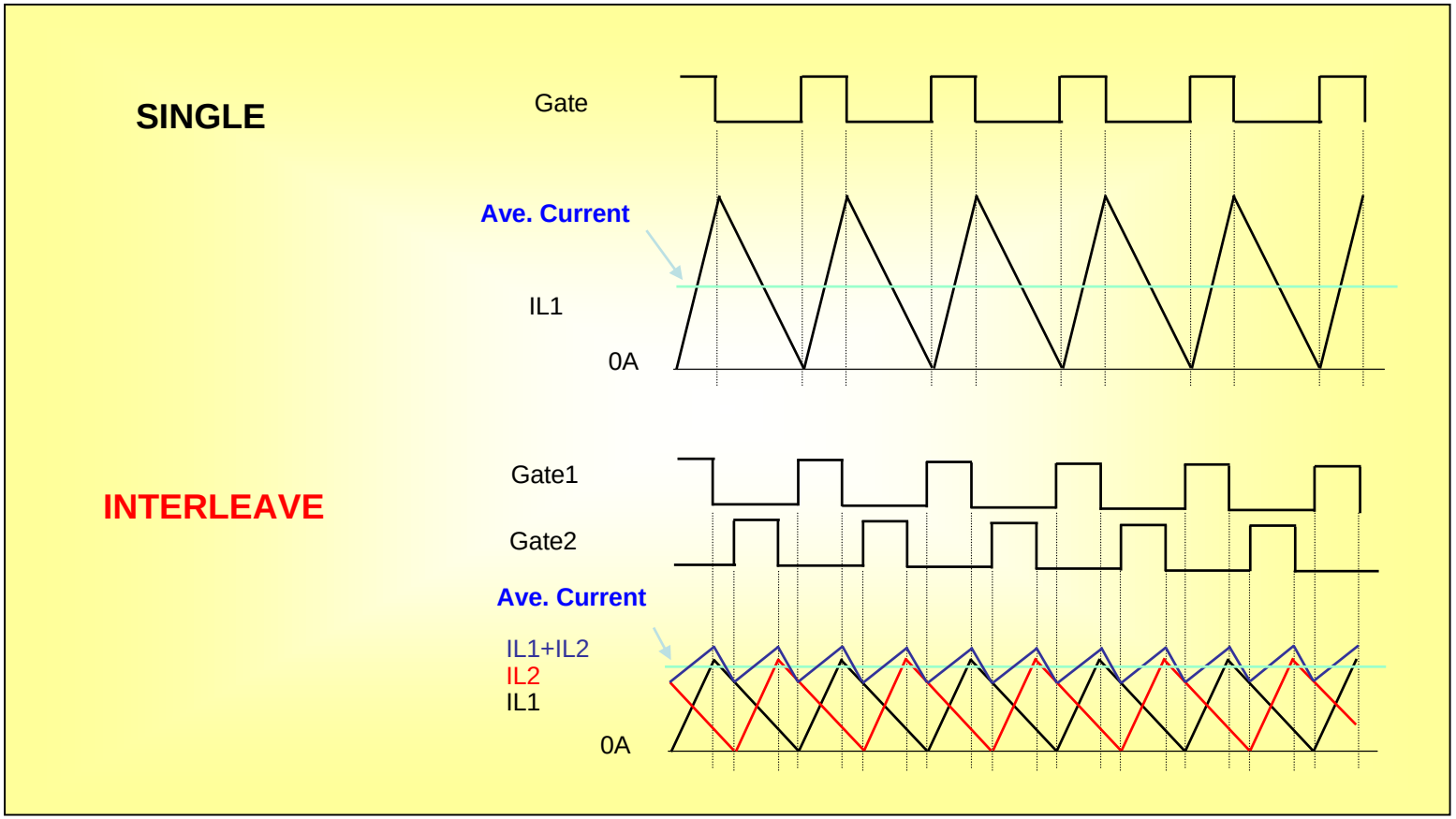
R2A20112



# Feature(1) Reduction of Line Noise & Ripple

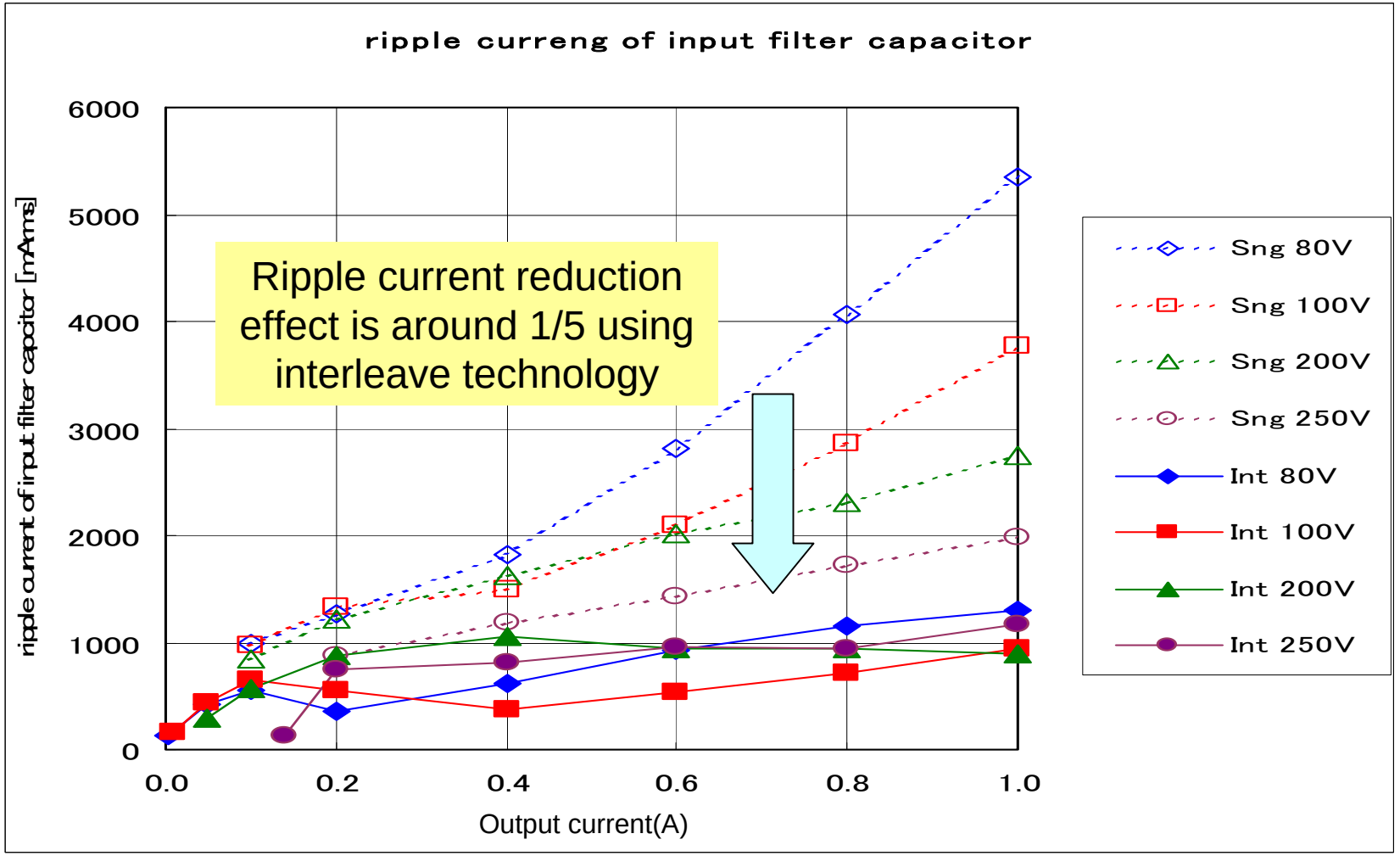
R2A20112

1. Reduce Input current ripple by interleave technology
2. Reduce switching noise of MOS FET by ZVS.
3. Reduce Diode recovery noise by ZCS.



# Feature(2) Reduction of Input Current Ripple

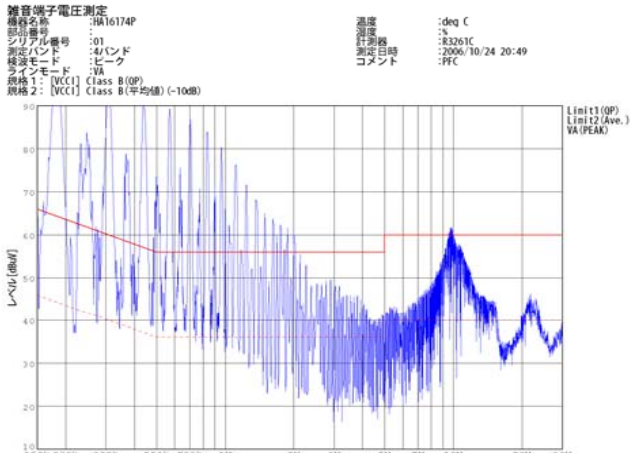
R2A20112



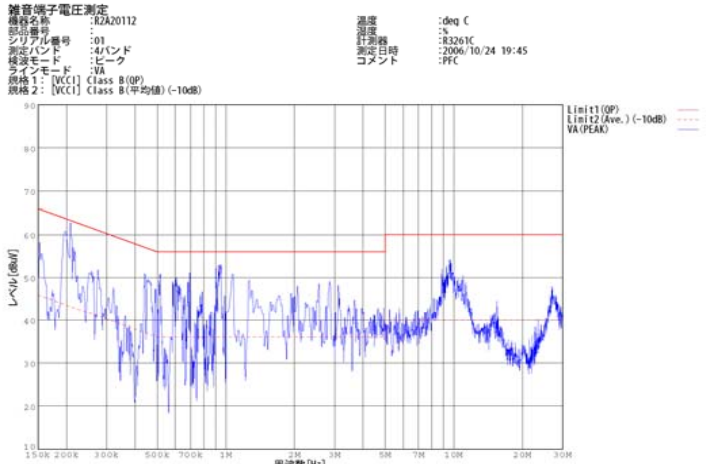
# Evaluation Result of Noise



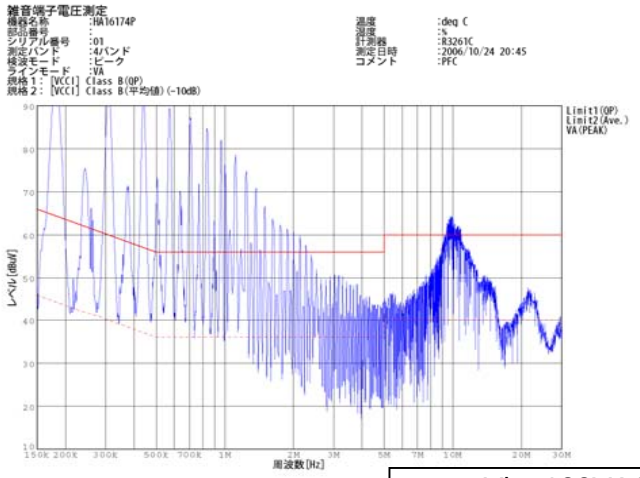
## CCM Single (R2A20111)

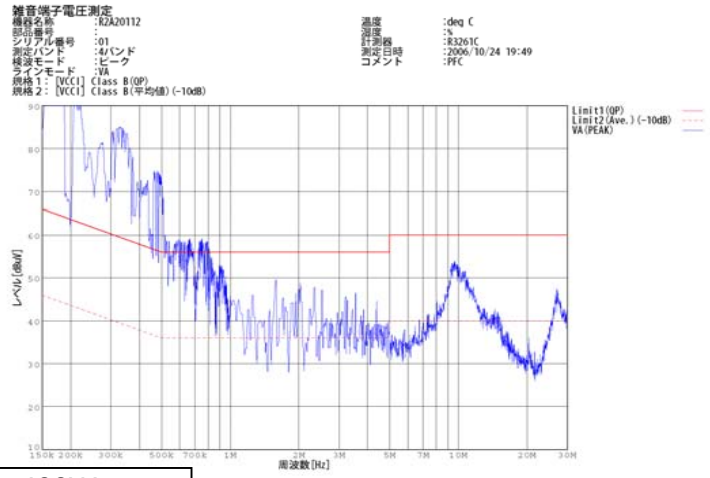



## CRM Interleave (R2A20112)




Vin=100VAC / Po=200W



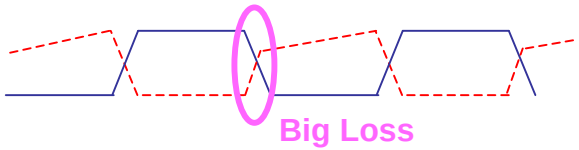

Vin=100VAC / Po=400W

# Feature(3) Principle of Power Loss Reduction

R2A20112

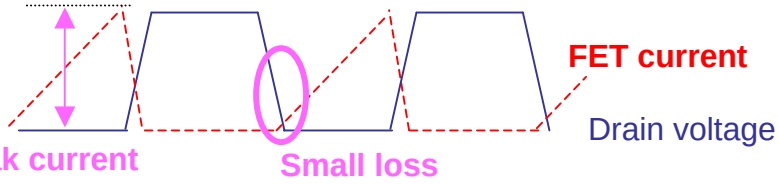
## Concept of power loss each mode

Single CCM



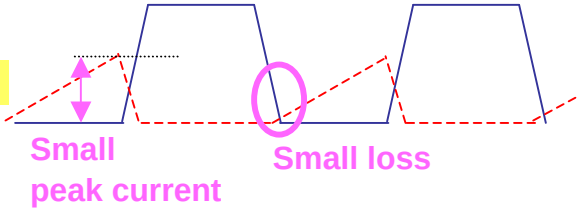

In CCM case, a peak current is small, but switching loss is big at Ton.

CRM Single




In CRM case, switching loss is small, but peak current is so big.

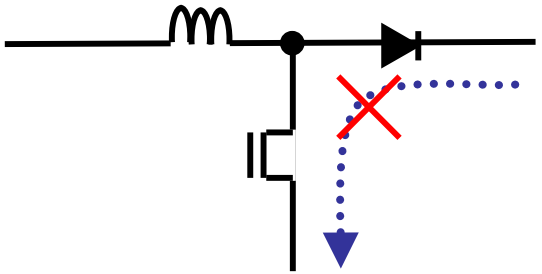
CRM inter leave




To sift CRM interleave, it is possible to keep small loss at Ton, and keep small peak current.

## Recovery Loss of Boost diode by ZCS

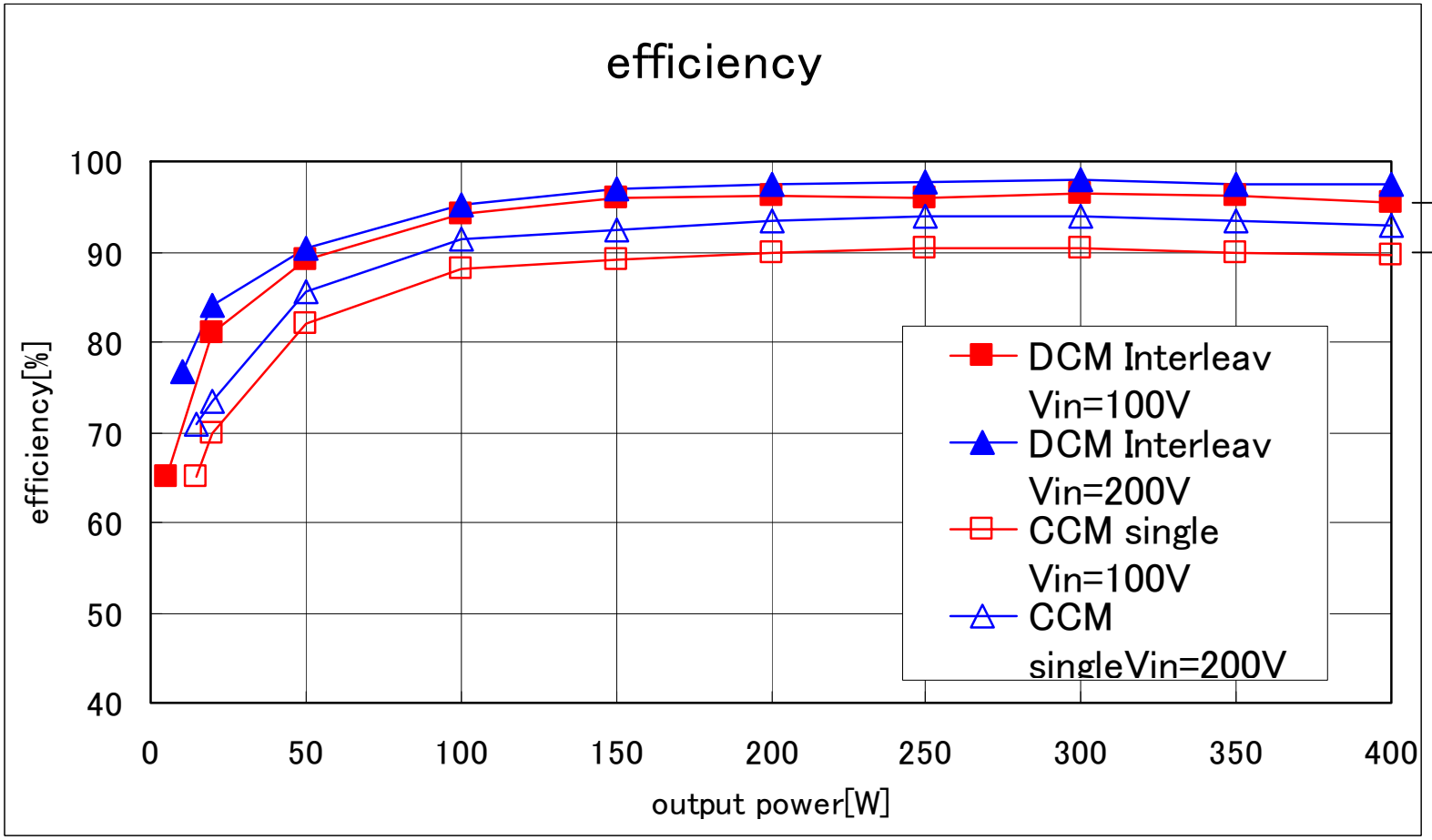
Basically no recovery diode loss by sensing Zero current



# Feature(3) Evaluation Data



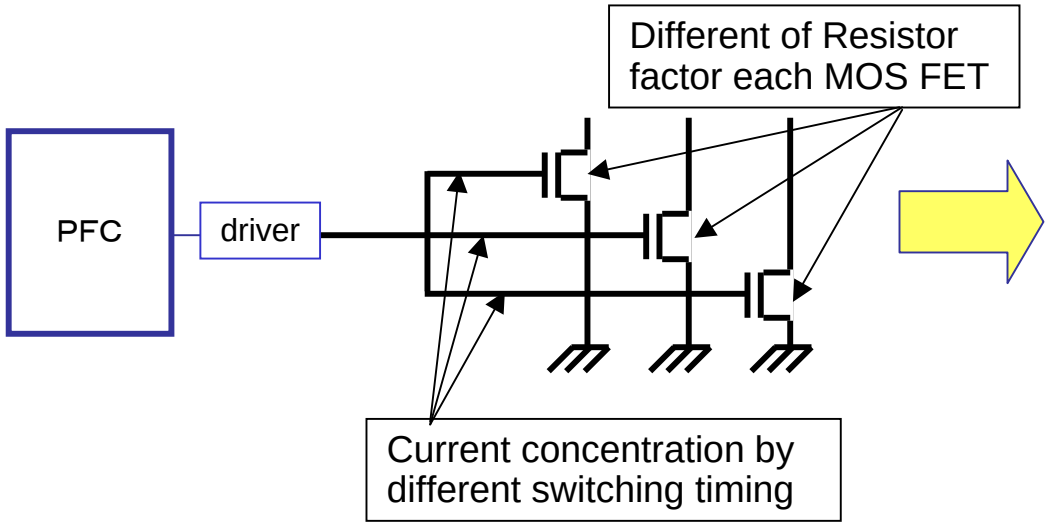
Improvement of efficiency by using CRM Interleave

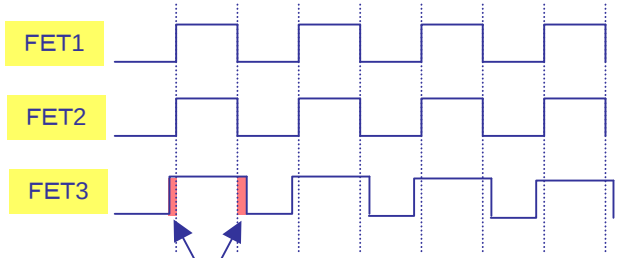


# Feature(4) Improvement of Thermal Balance

R2A20112

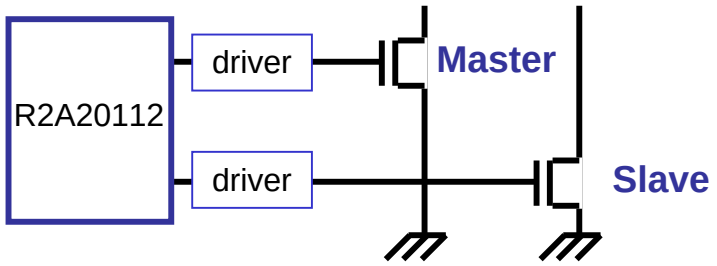
## Parallel switching by Single Mode



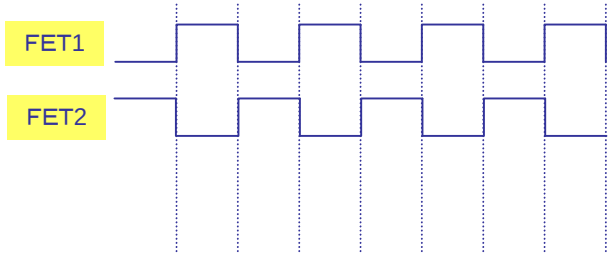




**Current concentration point**

## Independent control by Interleave



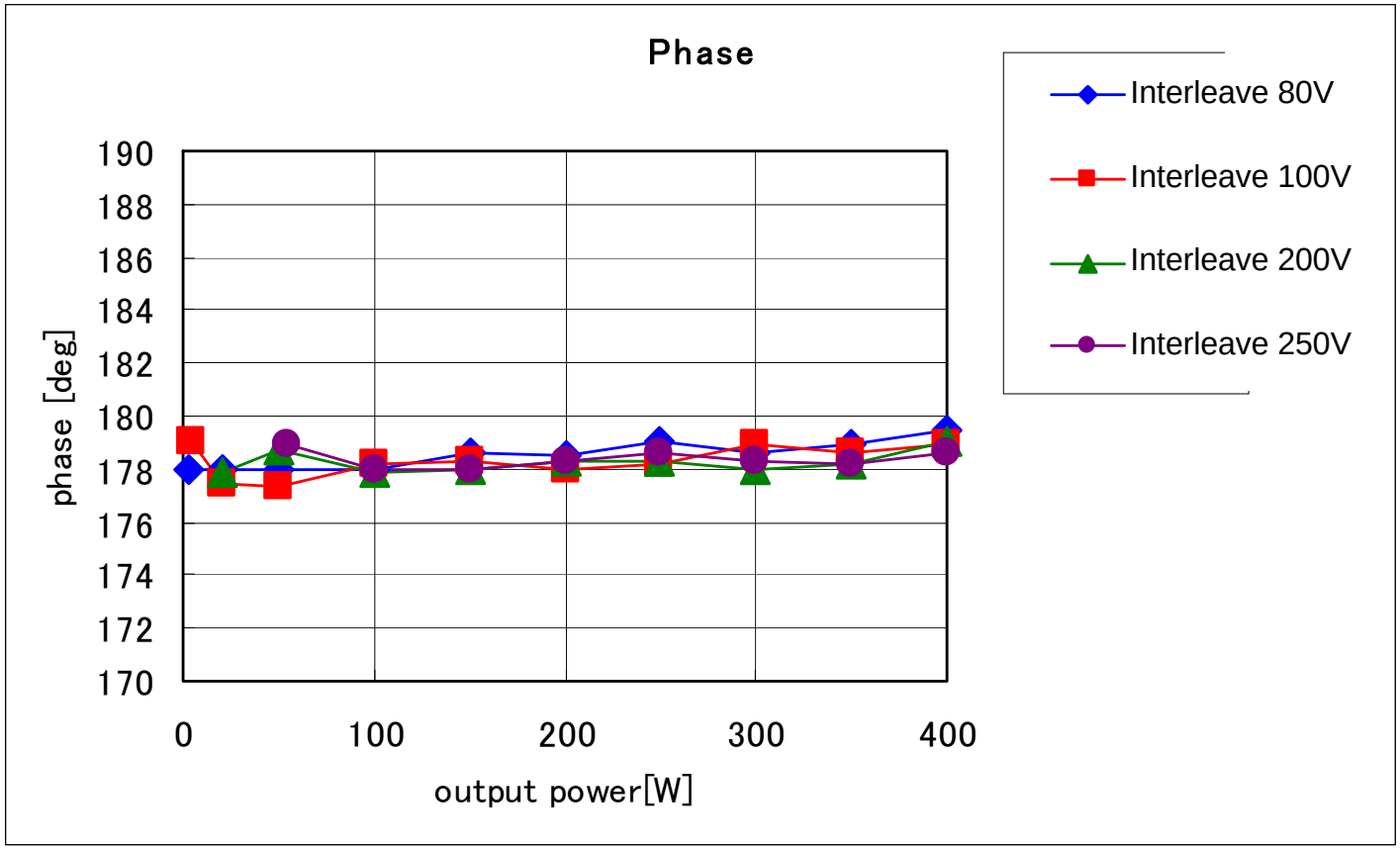

**Reduce unbalance by independence control**



# Evaluation Result of Phase Shift

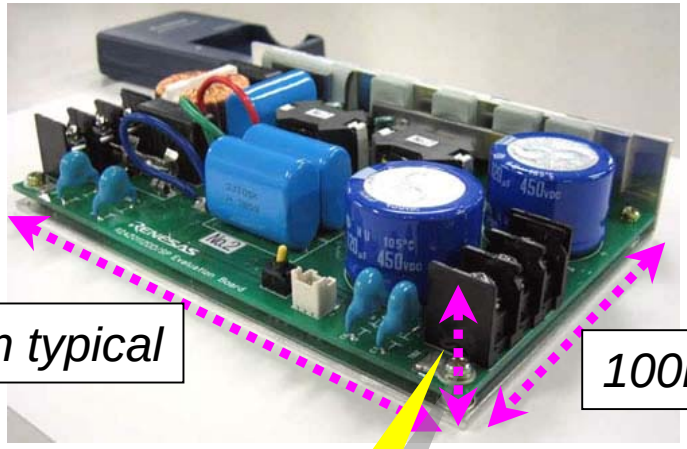


Phase control system realizes suitable timing between Master and Slave.



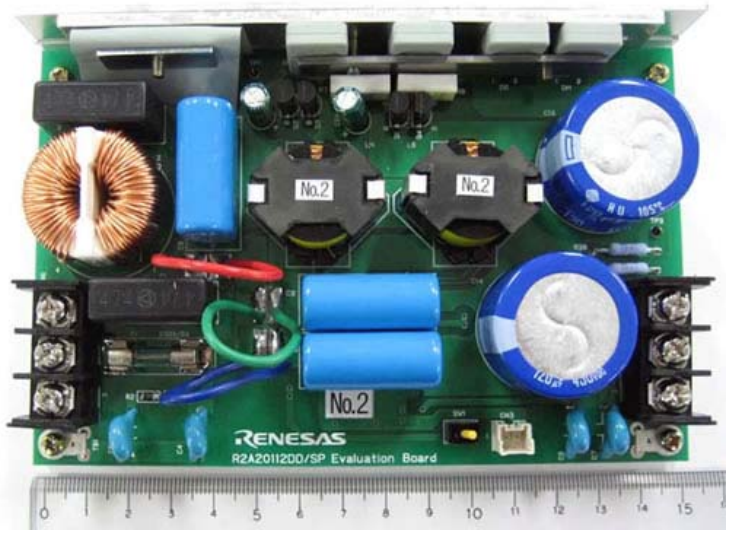
# Small size Demo Board of R2A20112

(1) size




(2) Electrical characteristic

Vin=85V to 265V
Vout=385V
***Po=0 to 400W***



# PWM Controller IC

# Bridge Topology Feature



## Bridge structure (Half Bridge, Full Bridge)

- ✓Trance down sizing
- ✓Available to use 500V MOS FET (In Forward case, it needs 800V type MOS FET)
- ✓Available to use Low resistor factor type MOS FET (same reason)

## Full Bridge structure

- ✓High efficiency by ZVS(zero voltage switching) technology.

# R2A20121 Feature [ Full Bridge Control IC ]

R2A20121

## Phase shift control by Delay adjustment

Reduced switching loss by ZVS operation → High efficiency

## Secondary side Delay adjustment

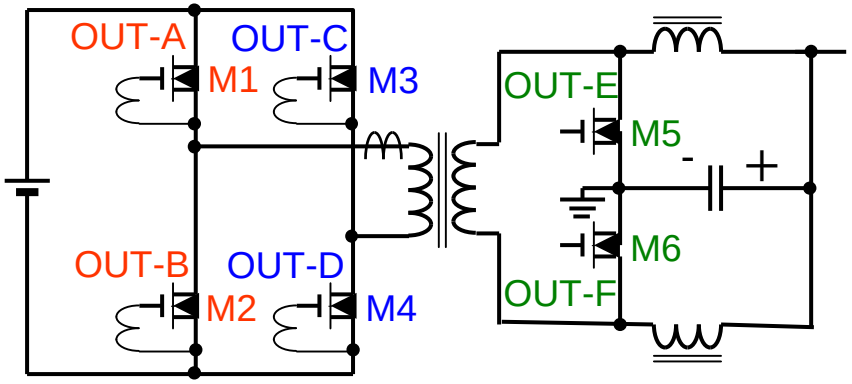
Reduced Body-diode conduction loss → High efficiency

## High frequency switching

2MHz max. OSC. frequency → Down sizing trance & capacitor

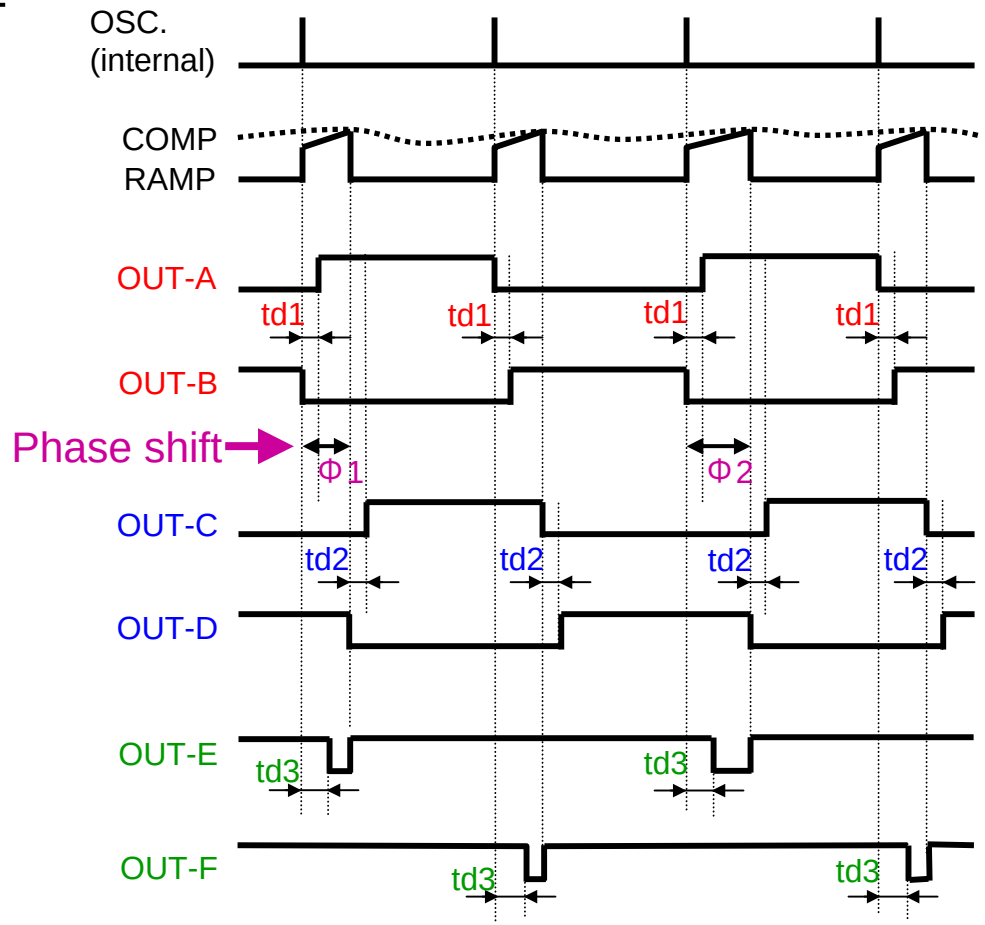
# Phase Shift Control by Delay Adjust






## Delay Adjust

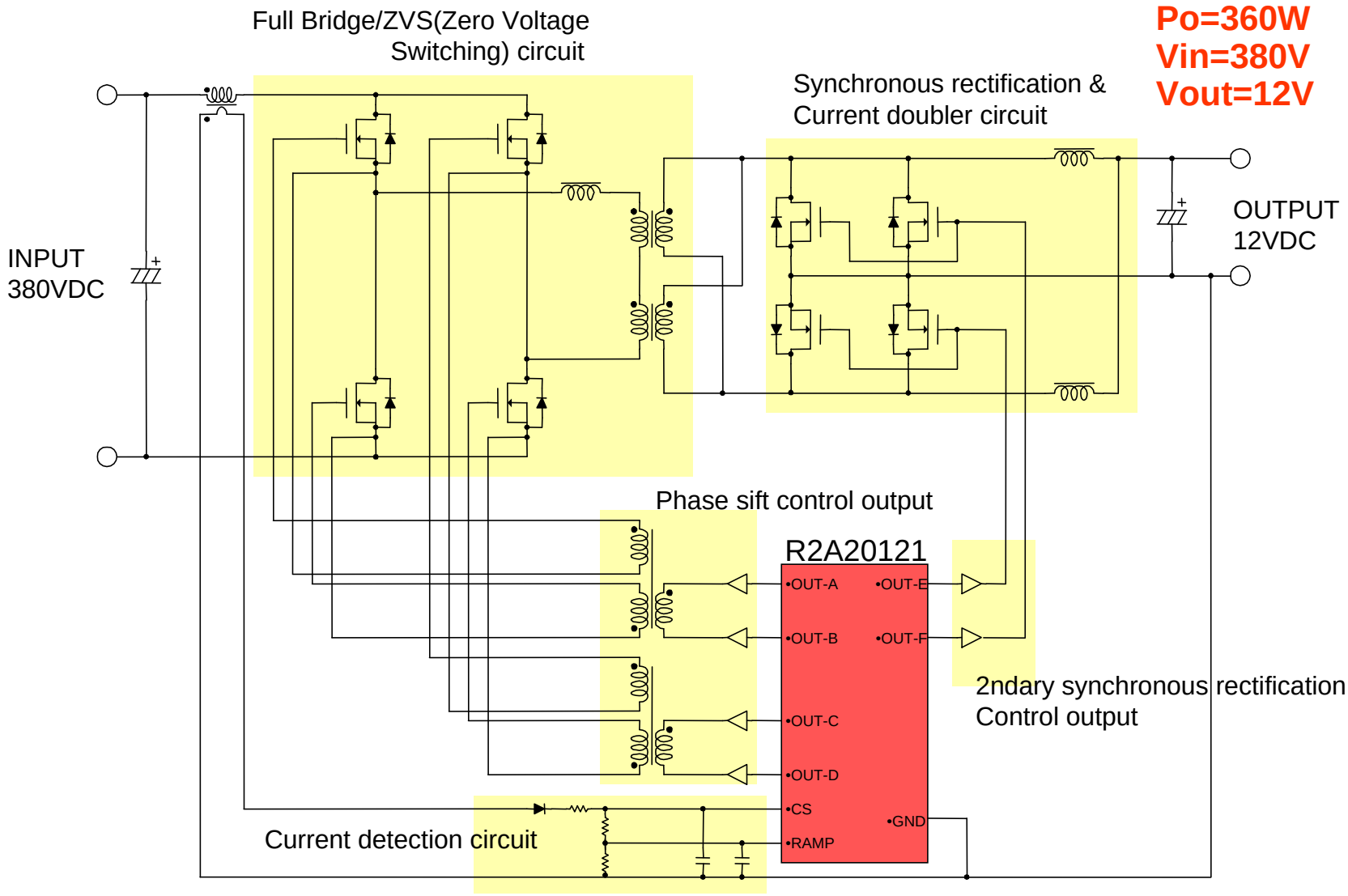
- ✓Primary side for ZVS
  - td1 : For M1 & M2
  - td2 : For M3 & M4
- ✓Secondary side to minimize Body-diode conduction loss
  - td3 : For M5 & M6



# Evaluation Board Circuit

R2A20121

**Efficiency : 92.7%**
**Po=360W**
**Vin=380V**
**Vout=12V**

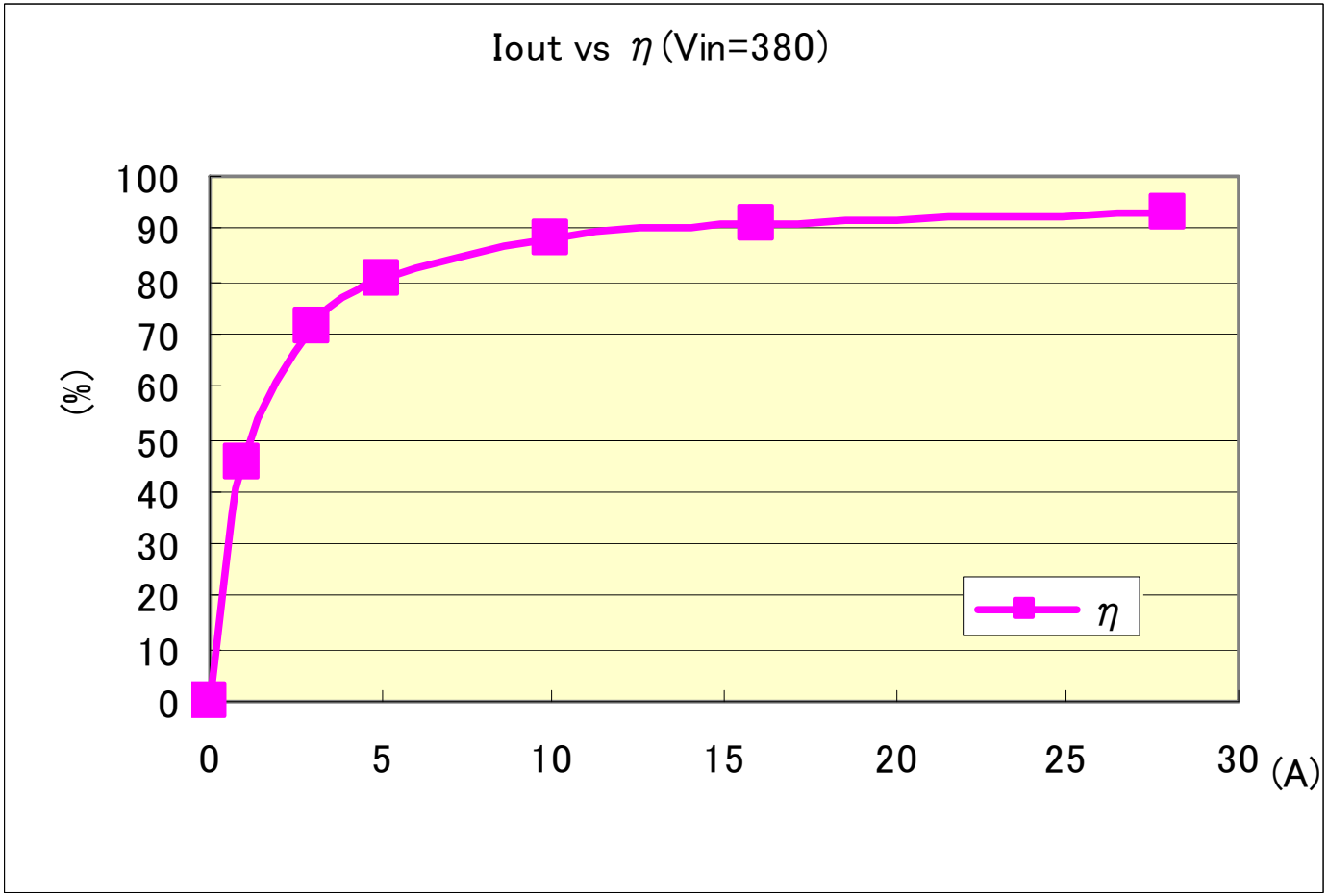


# Evaluation Board



# Efficiency on Evaluation Board

R2A20121



# DC/DC Controller IC

# DC-DC converter Lineup (1)

## Standard DC-DC

| | Conversion type | Operating Voltage | Operating Current (typ.) | Output Type | Output Voltage | Output current (max.) | SW Freq. | Max. ON Duty | Other Function | Package | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | DIP | SOP | SSOP |
| M5291 | Step-up<br>Step-down<br>Inverting | 2.5 to 40V | 1.4mA | Open Collector | Adjustable | 200mA | 100Hz to 100kHz | 85.7% | Peak current limitation | P (8) | FP (8) | - |
| M62212 | | 2.5 to 18V | 1.3mA | | | 150mA | to 300kHz | 0 to 100% (Adjustable with DTC terminal) | ON/OFF control<br>SCP, DTC<br>Soft start | P (8) | FP (8) | GP (8) |
| M62211 | Step-up<br>Step-down<br>Inverting<br>BL control | 2.5 to 35V | | | | | to 500kHz | | 2 input priority control<br>ON/OFF control<br>SCP, DTC<br>Soft start<br>External Sync. Input | P (14) | FP (10) | - |
| M62215 | | 8.6 to 25V | 9.5mA | Totem-pole | | +/-1A | | 90% | 2 input priority control<br>ON/OFF control<br>SCP, DTC<br>Soft start<br>External Sync. Input<br>Pulse by pulse CLM | - | FP (10) | - |
| M62216 | Step-up<br>Step-down | 0.9 to 15V | 850uA | Open collector | | 100mA | 155kHz | 87% | ON/OFF control | - | FP (8) | GP (8) |
| HA16114 | Step-down<br>Inverting | 3.9 to 40V | 8.5mA | Totem-pole | | +/-1A | to 600kHz | 0 to 100% (Adjustable with DB terminal) | ON/OFF control<br>Pulse by pulse CLM<br>Intermittent operation by timer<br>External Sync. Input(HA16114/120)<br>Soft start<br>Quick shut<br>High accuracy reference voltage<br>Vref OVP | P (16) | FP (16) | - |
| HA16120 | Step-up | | | | | | | | | - | FP (16) | - |
| HA16116 | CH1:Step-down<br>:Inverting<br>CH2:Step-down | | | | | | | | | - | FP (20) | - |
| HA16121 | CH1:Step-down<br>:Inverting<br>CH2:Step-up | | | | | | | | | - | FP (20) | - |

# DC-DC converter Lineup (2)

## Fixed output voltage type DC-DC

| | Conversion type | Operating Voltage | Operating Current (typ.) | Output Type | Output Voltage | Output current (max.) | SW Freq. | Max. ON Duty | Other Function | Package | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | SIP | SOP | SOT |
| M62220<br>M62221<br>M62222 | Step-down | 4 to 15V | 660uA | Open collector | 220:3.3V<br>221:3.0V<br>222:2.7V | 100mA | 110kHz | 90% | OCP | L<br>(5) | FP<br>(8) | - |
| M62270<br>M62271<br>M62272<br>M62273<br>M62274<br>M62275<br>M62276 | | | 500uA | | 270:3.3V<br>271:3.0V<br>272:2.7V<br>273:2.4V<br>274:2.1V<br>275:1.8V<br>276:1.5V | | | | | - | - | GP<br>(5) |
| M62290 | | 6 to 15V | 780uA | | 5.0V | | 120kHz | | | L<br>(5) | FP<br>(8) | - |
| M62291 | | | 570uA | | | | | | | - | - | GP<br>(5) |
| M62292<br>M62293<br>M62294<br>M62203 | | 4 to 15V | 1.0mA | | 292:3.3/1.8V<br>293:3.3/2.5V<br>294:3.3/2.0V<br>203:3.3/2.7V | 30mA | 110kHz | | Reset circuit for power supply(5V) and regulator output(3.3V) | - | FP<br>(8) | - |

## POL converter

| | Conversion type | Operating Voltage | Operating Current (typ.) | Output Type | Output Voltage | Output current (max.) | SW Freq. | Output MOSFET | Other Function | Package | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | TSSOP | QFN | CSP |
| HA16167 | Step-down | 4.5 to 14.5V | 3.6mA | Sync. Rectifying | Adjustable | 200mA | to 1MHz | - | ON/OFF control | A<br>(20) | - | - |
| R2A20101 | | 2.5 to 5.5V | 45uA<br>(Quiescent) | | | 650mA | to 2MHz | Built-in | ON/OFF control<br>Power Good | - | NP<br>(24) | BM<br>(15) |

# DC-DC converter Lineup (3)

## Multi channel DC-DC

| | Ch. No. | Conversion type | Operating Voltage | Operating Current (typ.) | Output Voltage | Output current (max.) | Rect. Type | Built-in components | | | SW Freq. | Max. ON Duty | Application | Other Function | Package | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | MOS FET | Load SW | Phase Comp. | | | | | QFN | LGA |
| M62298 | CH1 | Step-up | 2.5 to 6.0V | 5.0mA | 5.8V | 50/-100mA *2 | Diode | - | - | - | 500kHz | 85% | Motor | ON/OFF ctrl Soft start OVP,OCP,SCP | FP (52) | - |
| | CH2 | Step-down | | | 3.35V | 800mA | Diode | Built-in | - | - | | | SOC I/O,MCU | | | |
| | CH3 | Step-down | | | 1.85V | 500mA | Sync. | Built-in | - | - | | | SOC core | | | |
| | CH4 | Step-down | | | 3.45V | 300mA | Diode | Built-in | - | - | | | CCD AFE | | | |
| | CH5 | Step-up | | | 12V/-6.5V *1 | 200mA | Diode | Built-in | - | - | | | CCD(+),(-) | | | |
| | CH6 | Step-up | | | 12V | 200mA | Diode | Built-in | - | - | | | LCD | | | |
| | CH7 | Step-up | | | CC:20mA | 200mA | Diode | Built-in | - | - | | | LCD BL | | | |
| M62299 | CH1 | Step-up | 1.2 to 6.0V | 5.0mA | 5.0V | 50/-100mA *2 | Diode | - | - | - | 500kHz | 95% | Motor | ON/OFF ctrl Soft start OVP,OCP,SCP | FP (48) | WG (49) |
| | CH2 | Step-down | | | 3.35V | 800mA | Diode | Built-in | - | - | | | SOC I/O,MCU | | | |
| | CH3 | Step-down | | | 1.2V | 500mA | Sync. | Built-in | - | - | | | SOC core | | | |
| | CH4 | Step-down | | | 3.45V | 300mA | Diode | Built-in | - | - | | | CCD AFE | | | |
| | CH5 | Step-up | | | 12V | 200mA | Diode | Built-in | - | - | | | CCD(+) | | | |
| | CH6 | Inverting | | | -6.5V | 10/-20mA *2 | Diode | - | - | - | | | CCD(-) | | | |
| | CH7 | Step-up | | | CC:20mA | 200mA | Diode | Built-in | - | - | | | LCD BL | | | |
| R2A20010 | CH1 | Step-up | 1.2 to 6.0V | 4.0mA | 5.0V | 600mA | Sync. | Built-in | Built-in | Built-in | 1MHz | 95% | Motor | ON/OFF ctrl Soft start Current mode Bootstrap Dimmer ctrl OVP,OCP,SCP | NP (48) | LG (49) |
| | CH2 | Step-down | | | 3.3V | 400mA | Sync. | Built-in | - | Built-in | | | SOC I/O,MCU | | | |
| | CH3 | Step-down | | | 3.3V | 400mA | Sync. | Built-in | - | Built-in | | | CCD AFE | | | |
| | CH4 | Step-down | | | 1.8V/2.5V | 300mA | Sync. | Built-in | - | Built-in | | 100% | Memory | | | |
| | CH5 | Step-down | | | 1.2V | 500mA | Sync. | Built-in | - | Built-in | | 95% | SOC core | | | |
| | CH6 | Step-up | | | 15V | 50mA | Diode | - | - | Built-in | 500kHz | | CCD(+) | | | |
| | CH7 | Inverting | | | -7.5V | 100mA | Diode | - | - | Built-in | | | CCD(-) | | | |
| | CH8 | Step-up | | | CC:20mA | 50mA | Diode | - | Built-in | Built-in | | | LCD BL | | | |

*1) Need the transformer externally.

*2) Output sink/source current for external MOSFET