

# RENESAS

## MCU, Analog & Power Device Portfolio for xEV Applications

MARCH 2021

AUTOMOTIVE SOLUTIONS BUSINESS UNIT  
SAM GOLD  
PETER HOGENKAMP

# AGENDA

- Introduction
- Renesas xEV Solutions: Semiconductor for Traction Inverters
  - Microcontroller
  - Analog & Power
    - PMIC
    - High-Voltage Gate Driver
    - IGBT & FRD
    - Inductive Position Sensor
- BMS – Battery Management Solution
- Other Sessions

# INTRODUCTION

Name: Peter Hogenkamp

Renesas affiliation: Joint Renesas in 1997

Position: Principle Engineer

Automotive Technical Marketing  
Power Semiconductor Solutions



Name: Sam Gold

Renesas affiliation: Joint Renesas in 2008

Position: Senior Manager

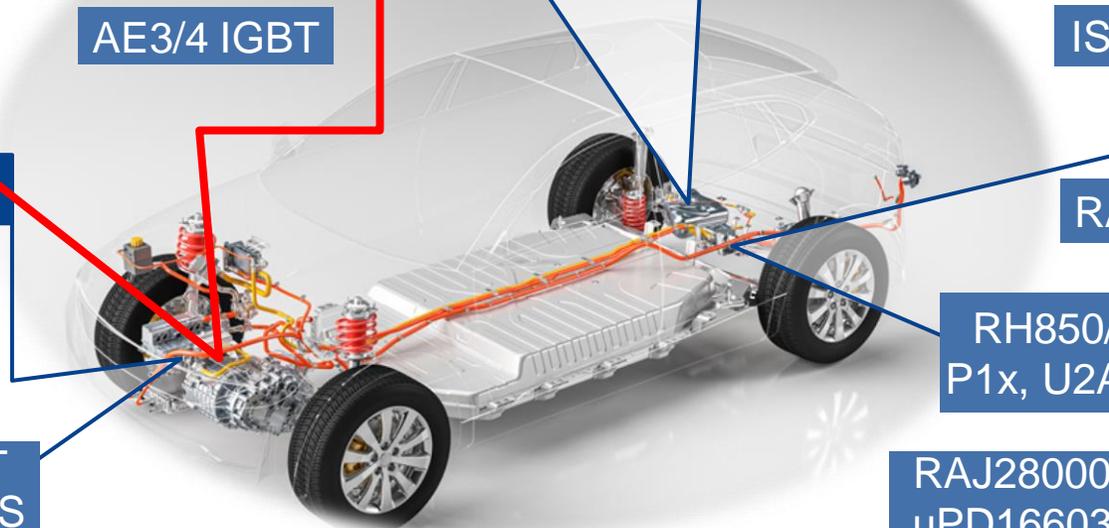
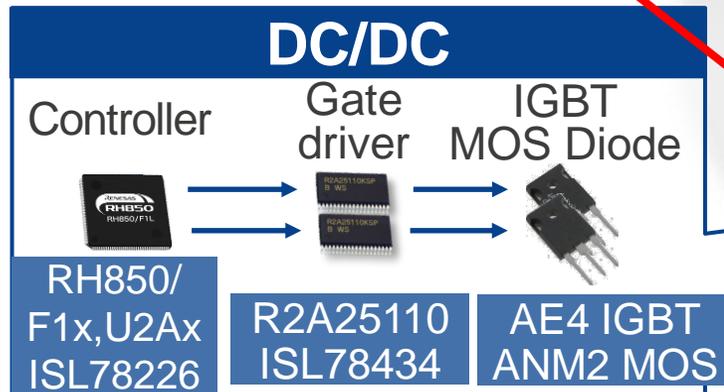
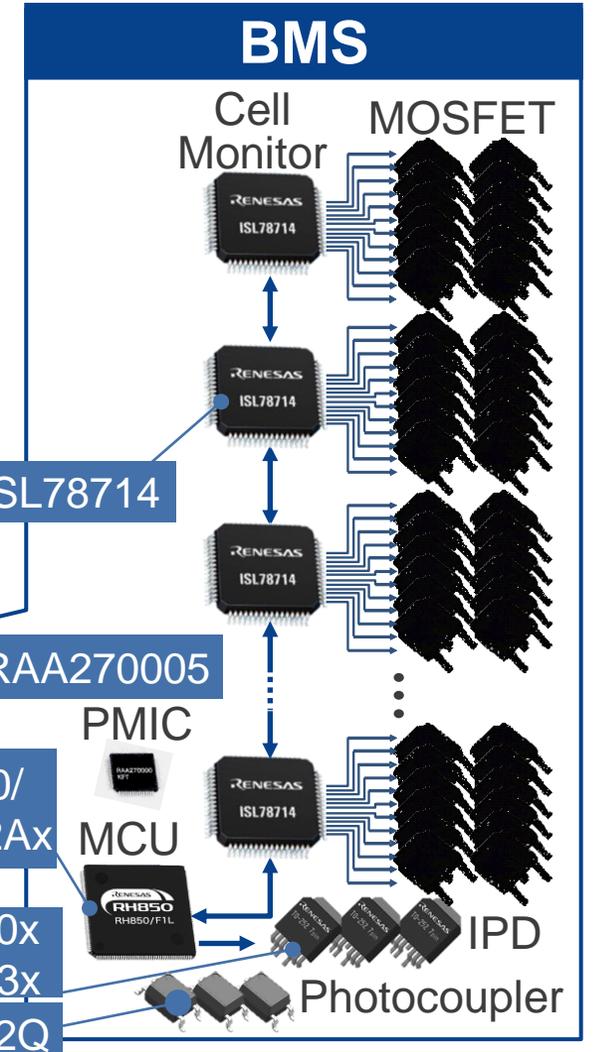
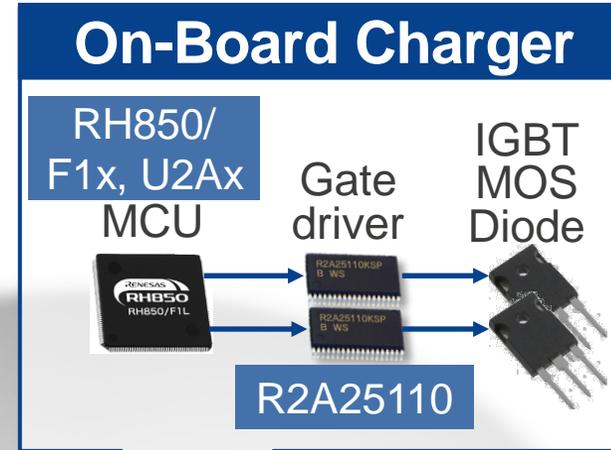
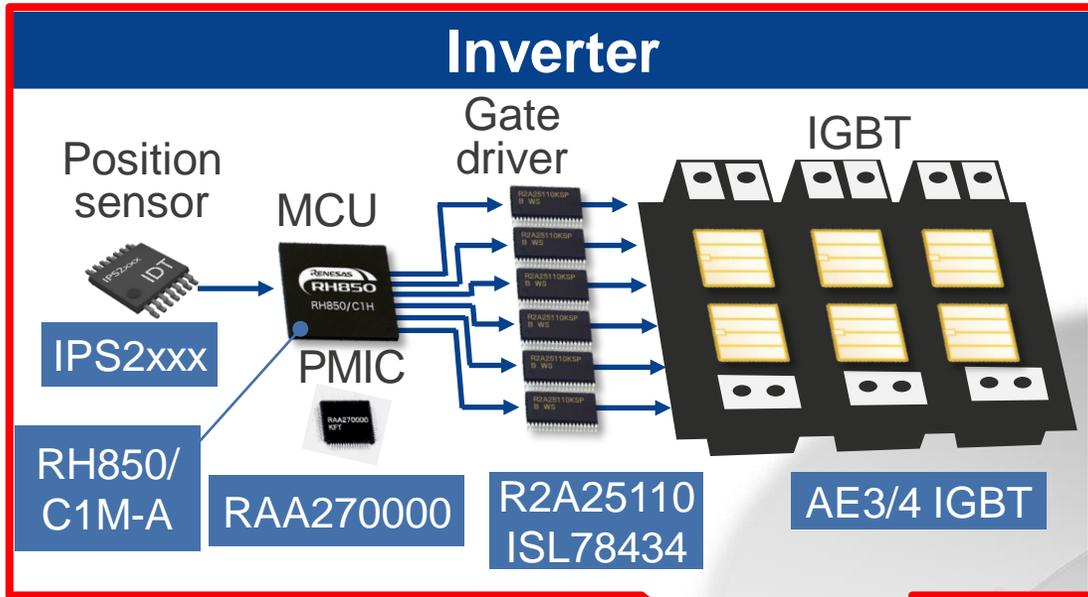
Automotive Digital Marketing  
Powertrain & xEV MCUs



# INVERTER SOLUTION

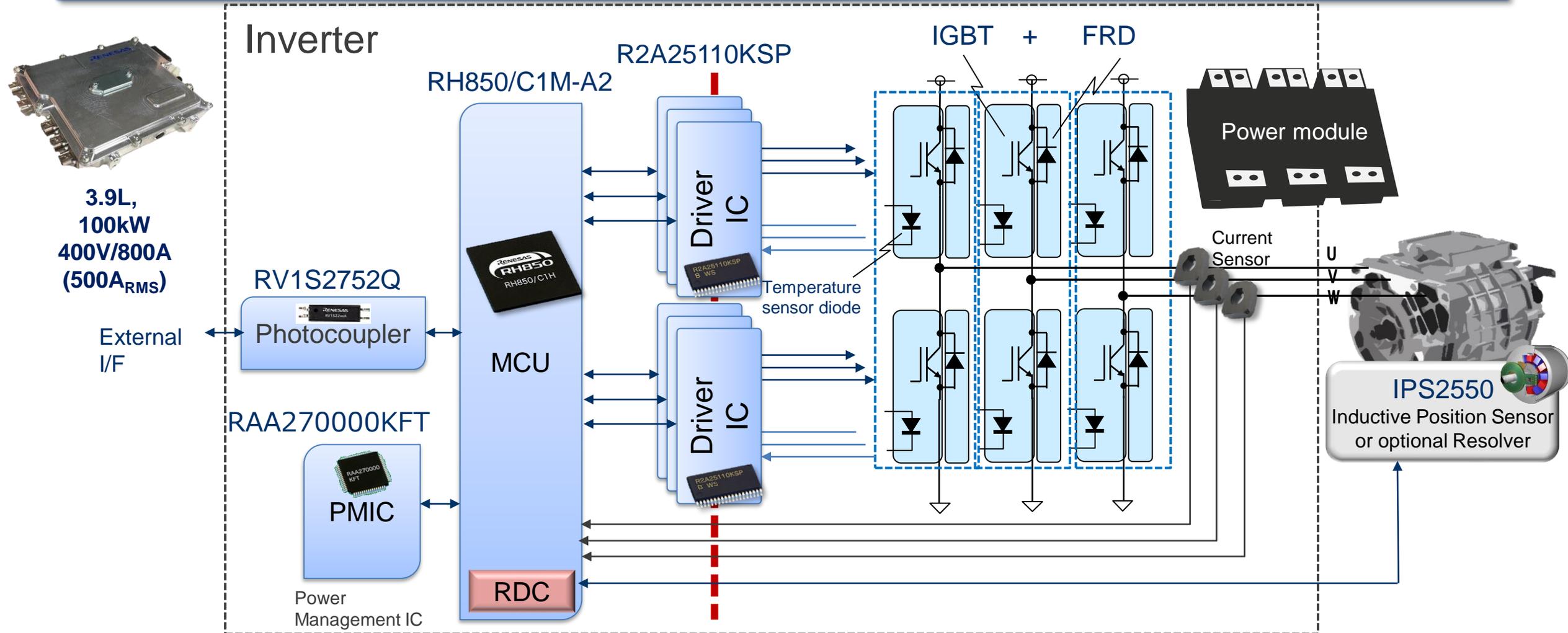


# xEV SYSTEM OVERVIEW - INVERTER -



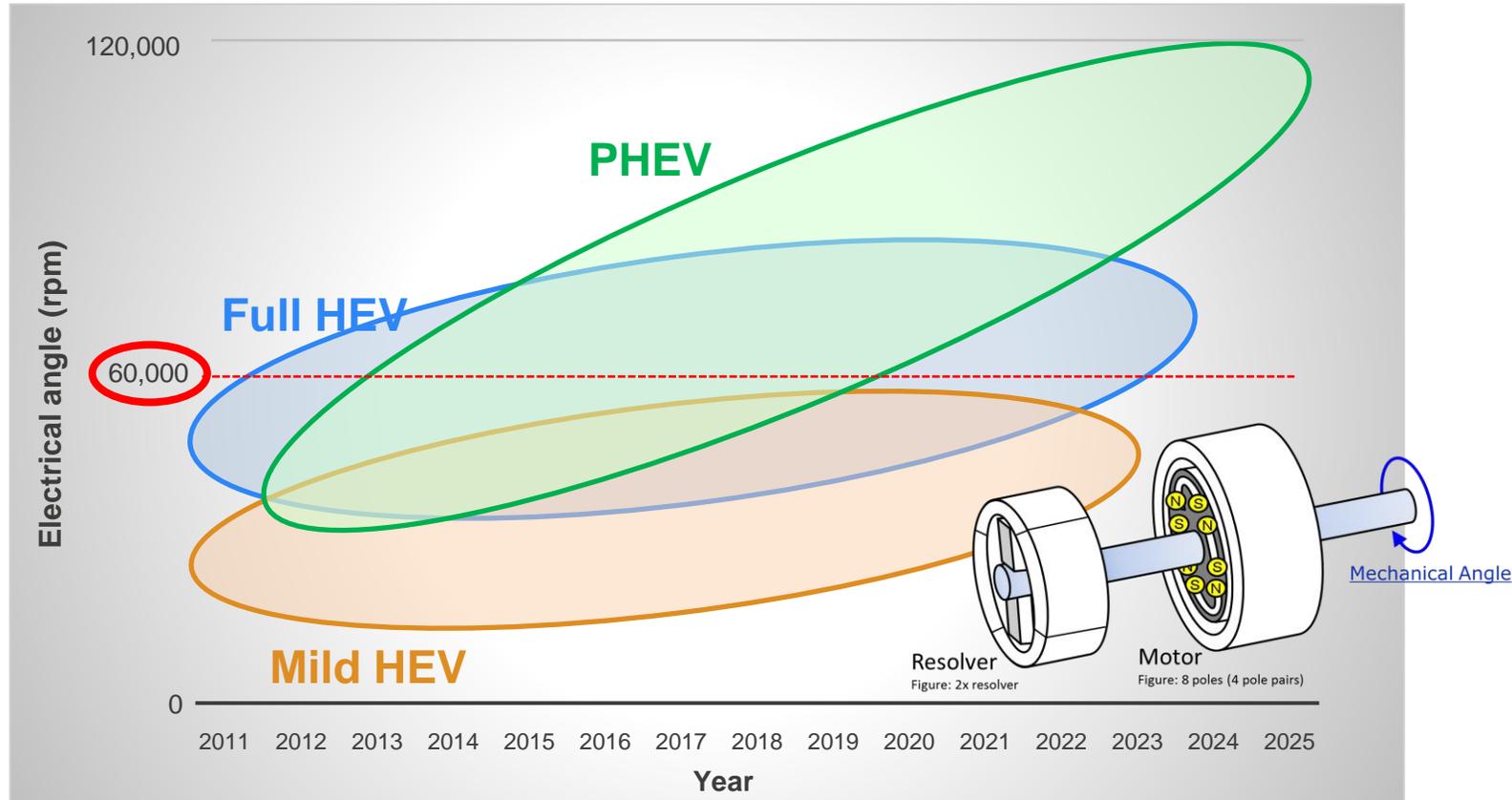
# xEV INVERTER SOLUTION SYSTEM CONFIGURATION

Renesas Inverter kit covers all major semiconductor for Inverter



# MICROCONTROLLER

# FUTURE HEV/EV → INCREASE ELECTRICAL ANGLE VELOCITY



- Increased RPM level will be required for full HEV and PHEV/EV in future to achieve smaller form factors of xEV components, like the e-motor
- Higher RPMs require high speed processing as the Inverter control feedback cycle becomes shorter

Renesas is providing system control solutions to achieve high speed RPM → cost down due to smaller system components

# RH850/C1M-A – HIGHLIGHTS & KEY FEATURES

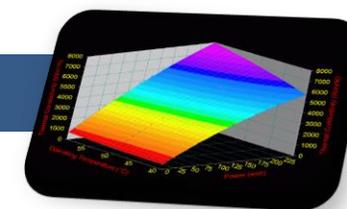
## Performance → Ideal Solution for Traction Motor Control

- Ideal for E-drive → control of 2 traction motors with 1 MCU
- 320MHz lock-step cores
- HW accelerator for E-Motor control Unit (EMU)
- Optimized system configuration with extremely fast memory access (flash, RAM)



## Scalability & Flexibility

- C1M-Ax is the successor of C1H. Two memory/performance options available (2MB single core + 4MB dual core)
- Seamless upgrade to successor products : same architecture for motor control and re-use of SW



## Technologies

- E-Motor position sensing → integrated Resolver-to-Digital-Converter (RDC) interface. Supporting as well REN inductive position sensor IPS2550
- FMONOS → extremely fast flash technology, reliable, proven, scalable

## Safety & Security → ASIL-C and EVITA-light

- Motor-control error detection concept, lock-step cores, Self-diagnosis implemented
- SHE supporting

## System Development Environment

- Comprehensive solution menu incl. all relevant 3rd-party tools, User Manual, various AppNotes, MCAL QM Starter kit + MCAL ASIL-C under preparation



# MCU CONCEPT FOR EV/HEV

## - INTEGRATION CONCEPT -

### 1. High performance & Safety

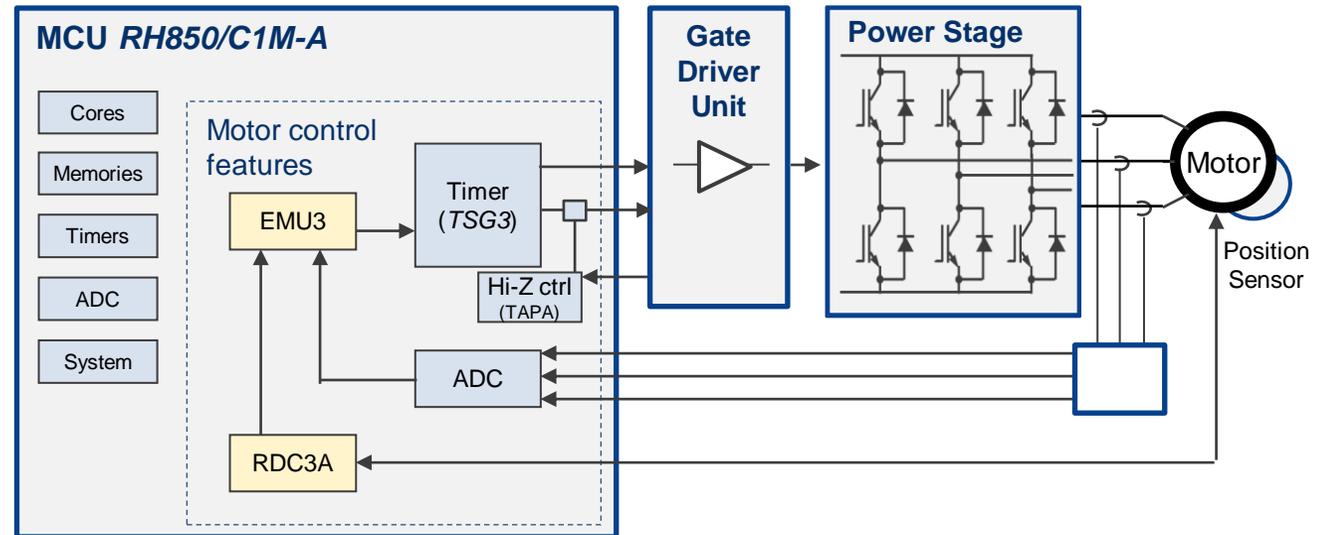
- Multi-core, 240/320 MHz
- Enhanced diagnostic functions
- Functional Safety

### 2. Integrated Resolver to Digital Converter (*RDC3A*)

- Reduce System Cost with integrated *RDC3A*
- Improvement of failure diagnosis

### 3. Integrated Motor Control Support (*EMU3*)

- Built-in flexible, optional Hardware Logic for Motor Control
- Able to control up to 2 motors independently in conjunction with the TSG3 timer







# RH850/C1M-A2

## 32-bit CPU

**2 + 1 RH850 G3MH Core**  
@ 320 MHz, Tj = -40 ~ +150 °C

MPU: 16 regions, FPU: 2

## System, Safety & Security

16ch DMA + 128 DTS

Clock Monitor

ICU-S  
Security Module

Error Control Module

MISG

Boundary scan

2 x DCRA

**Debug System**  
NEXUS, AUD

## Memory

4 MB Code Flash

Total: 320 KB RAM  
Local: 64 KB / core  
Global RAM: 128 KB

64KB Data Flash

## Analog

3 x ADC  
max. 48 ch (12-bit)  
6+6+4 T/H

## Interfaces

4 x RSCAN-FD

3 x SCI3

3 x CSIH

3 x RLIN3

4 x RSENT

## Generic Timers

4 x TAUD

2 x TAUJ

6 x TAPA

3 x TSG3

2 x ENCA

2 x TPBA

4 x OSTM

2 x WDTA

2 x SWDT

## Package & Power Supply

BGA252  
(0.8 mm pitch)

Dual voltage supply:  
I/O: 4.5 .. 5.5 V /  
Core: 1.15 .. 1.35 V

## Motor Control IP

2 x RDC3A

EMU3 2ch

**RH850 G3MH Core**  
1+0 @ 320 MHz

Device

Package

Order code

RH850/C1M-A2

BGA252-17x17-0.8

R7F701275EABG

# RH850/C1M-A1

## 32-bit CPU

**1 + 1 RH850 G3MH Core**  
@ 240 MHz, Tj = -40 ~ +150 °C

MPU: 16 regions, FPU: 1

## System, Safety & Security

16ch DMA + 128 DTS

Clock Monitor

ICU-S  
Security Module

Error Control Module

MISG

Boundary scan

2 x DCRA

**Debug System**  
NEXUS, AUD

## Memory

2 MB Code Flash

Total: 192 KB RAM  
Local: 64 KB / core  
Global RAM: 64 KB

64KB Data Flash

## Analog

3 x ADC  
max. 30 ch (12-bit)  
6+6+4 T/H

## Interfaces

4 x RSCAN-FD

3 x SCI3

3 x CSIH

3 x RLIN3

4 x RSENT

## Generic Timers

2 x TAUD

1 x TAUJ

4 x TAPA

2 x TSG3

2 x ENCA

1 x TPBA

3 x OSTM

1 x WDTA

1 x SWDT

## Package & Power Supply

**QFP176**  
(0.5 mm pitch)

Dual voltage supply:  
I/O: 4.5 .. 5.5 V /  
Core: 1.15 .. 1.35 V

## Motor Control IP

1 x RDC3A

EMU3 1ch

**RH850 G3MH Core**  
1+0 @ 240 MHz

Device

RH850/C1M-A1

Package

QFP176-24x24-0.5

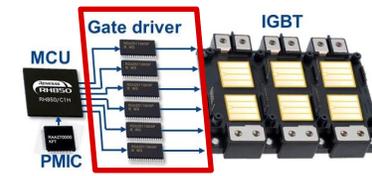
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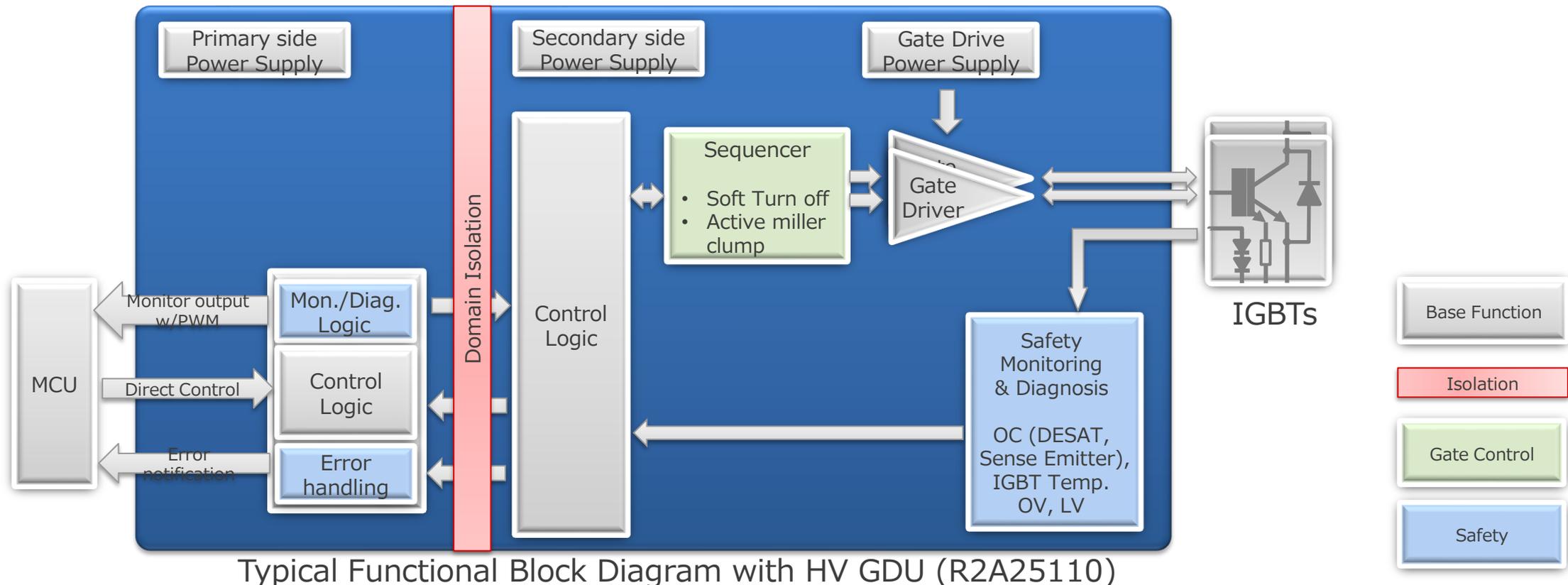
# ANALOG & POWER



# HV GDU - R2A25110KSP -

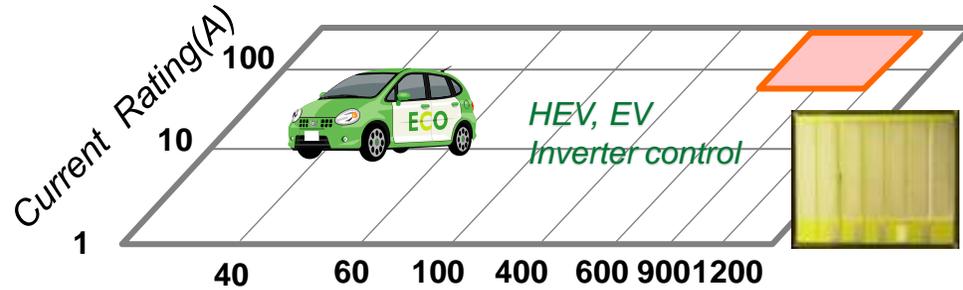
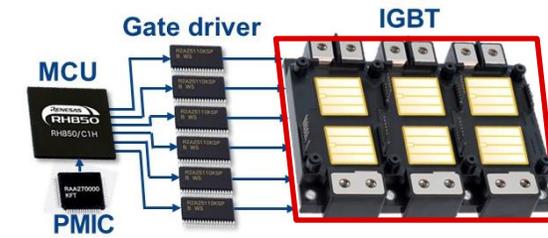


A key analog component associated with the controller in these HV traction motor systems is an isolated HV gate driver (HV GDU). HV GDUs connected to the controller drives the power switches such as IGBTs. They convert PWM signals from the controller into gate pulses for the power switches to turn and off.



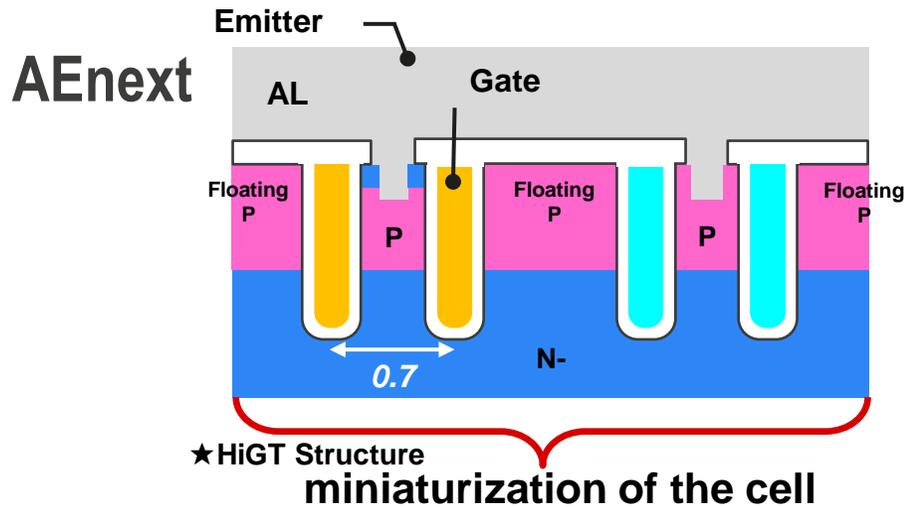
# IGBTs and FRDs

Provide high performance/robust IGBT for xEVs

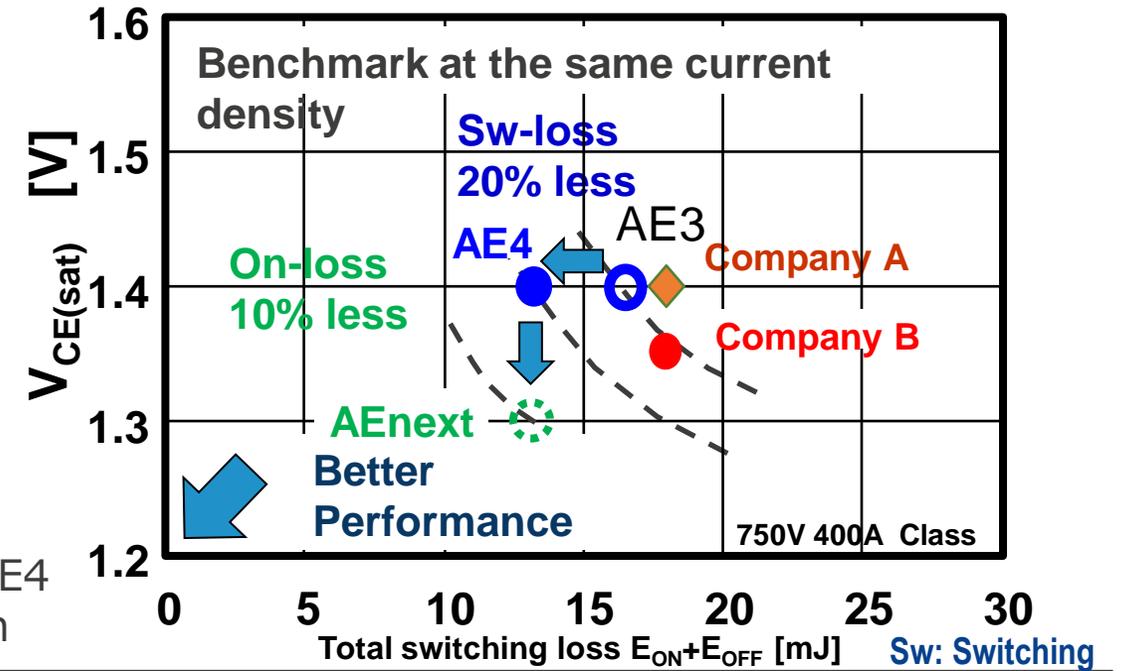


**IGBT**

- ◆ W/W Top switching loss performance
- ◆ High quality Bare chip
- ◆ 600~1200V、~500A



- AEnext (Under dev.) : Reduce -10%Vce(sat) against AE4
- Improve conductivity modulation by fine pitch cell design



# INDUCTIVE POSITION SENSOR - IPS2550 -

- Detect the position of a target metal based on electromagnetic induction of a coil
- Thinner, Lighter, High magnetic field immune
- Flexible multiplier, flexible mounting

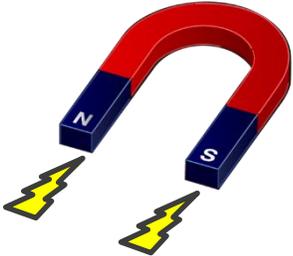
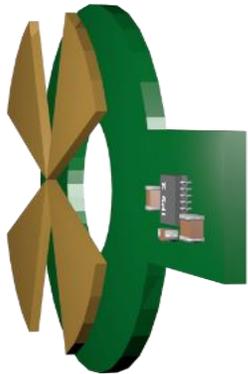
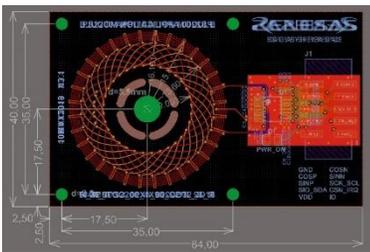
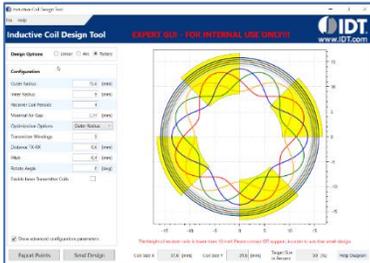
Easy-to-Use

Thin, Light

High magnetic field immune

Flexibility

PCB coil  
Layout design tool



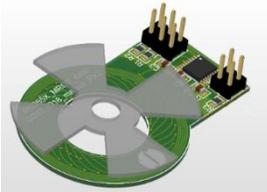
Flexible to different pole pairs



1 pole pair

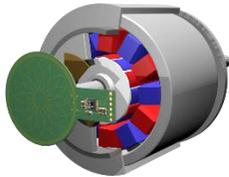


2 pole pair

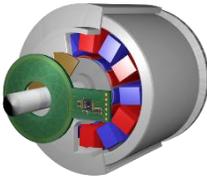


4 pole pair

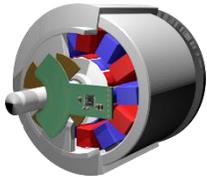
Flexible mounting



On-axis  
(end of shaft)



Off-axis  
(through shaft)



Off-axis  
(side shaft)

# xEV Inverter Reference Solution

## System Benefits

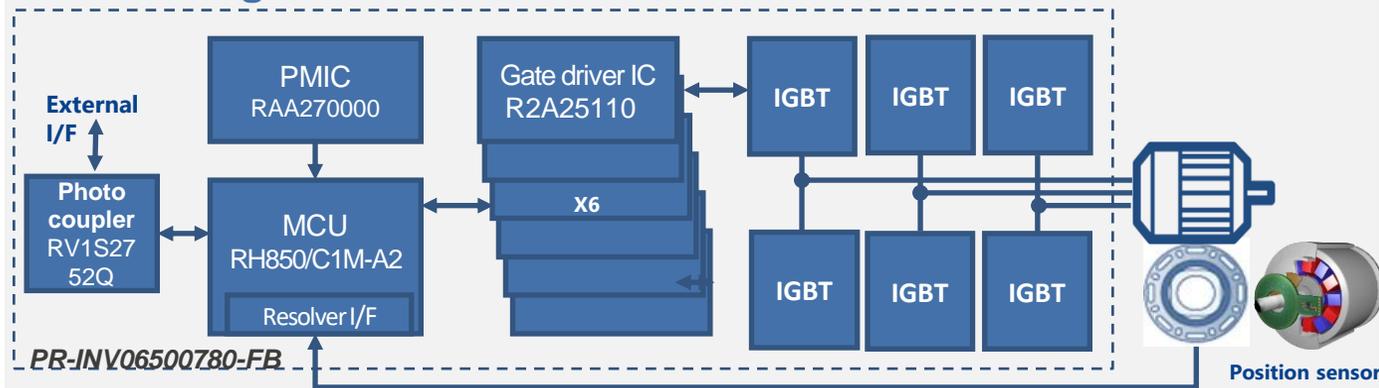
- Practical inverter specification for xEV 100kW class motor
- Reference solution kit including Inverter reference design, software, model base design and calibration tool
- Function and performance verified in Renesas motor bench
- 3.9L compact volume by highly integrate products and temperature management
- Superior power efficiency, achieved 99% maximum inverter efficiency
- Function is already proven in real car demo

## BOM List

Reference Design

|                        |                           |
|------------------------|---------------------------|
| <i>RH850/C1M-A2</i>    | 32bit Microcontroller     |
| <i>RAA270000</i>       | Power management IC       |
| <i>R2A25110</i>        | Gate driver IC            |
| <i>RJKxxxx/RJUxxxx</i> | IGBT / FRD                |
| <i>RV1S2752Q</i>       | Photo Coupler             |
| <i>IPS2550</i>         | Inductive Position Sensor |

## Block Diagram

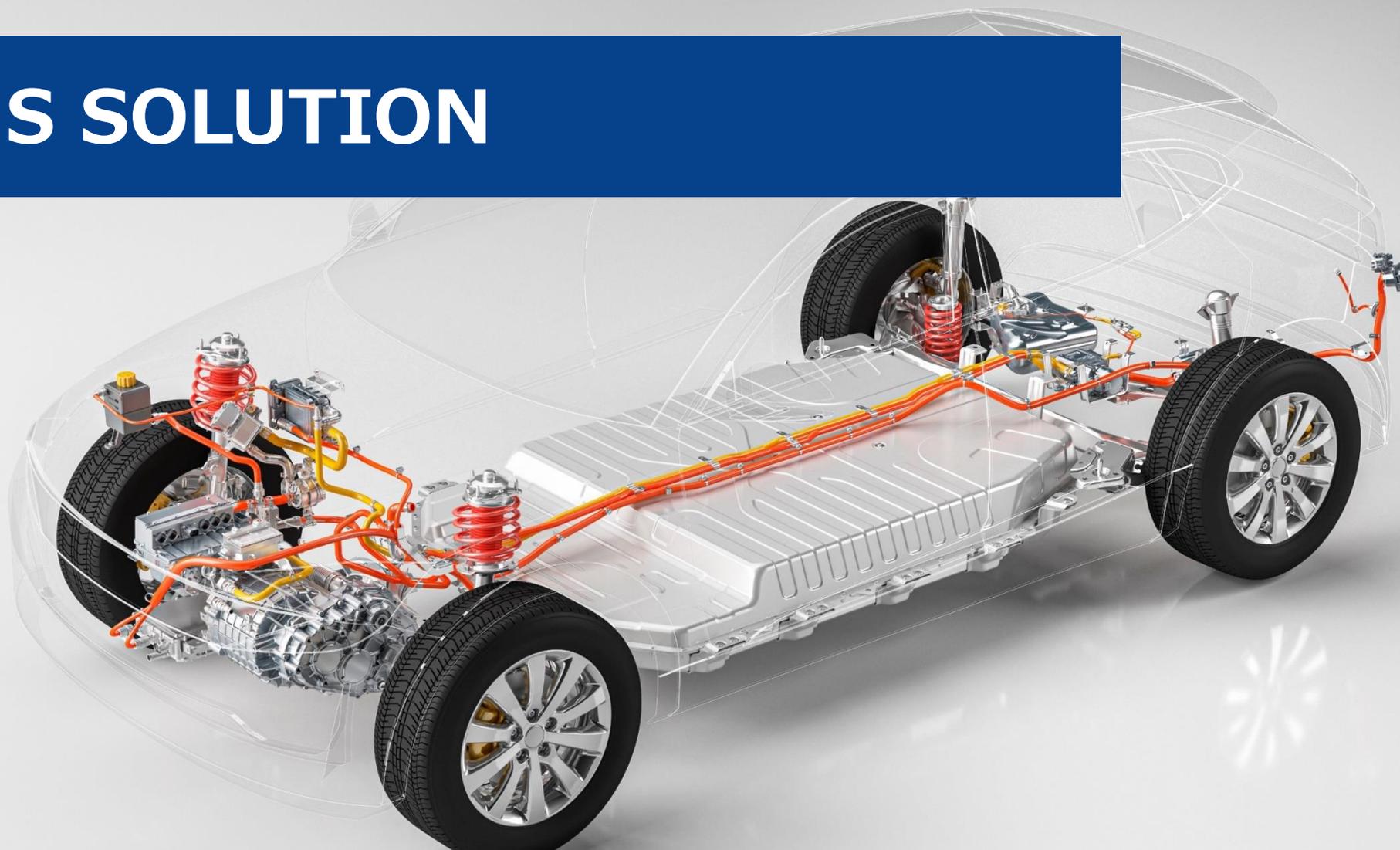


On ECU

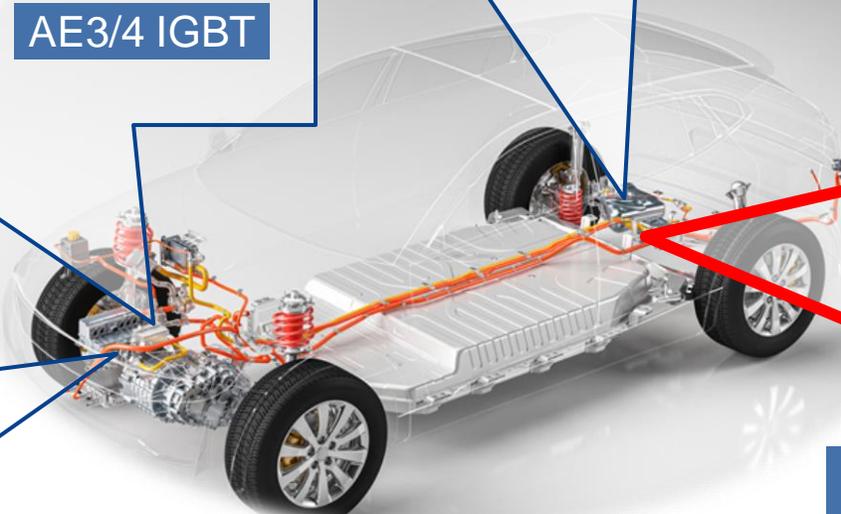
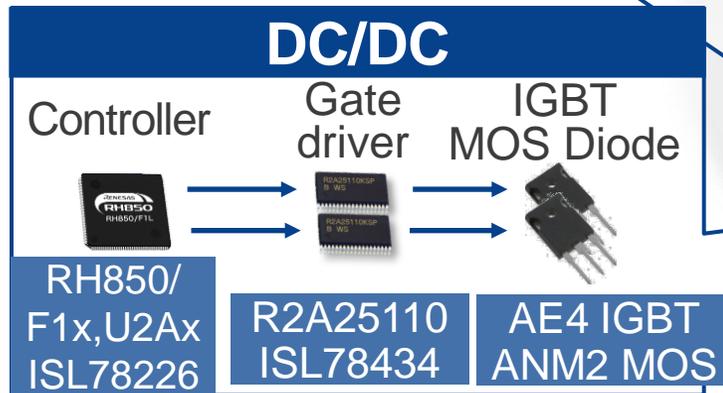
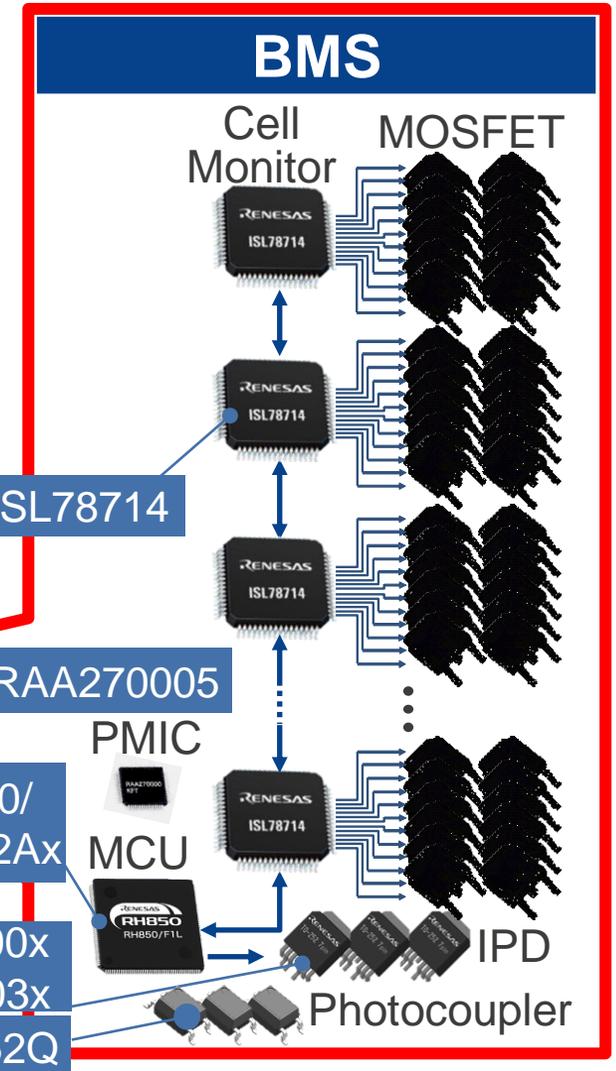
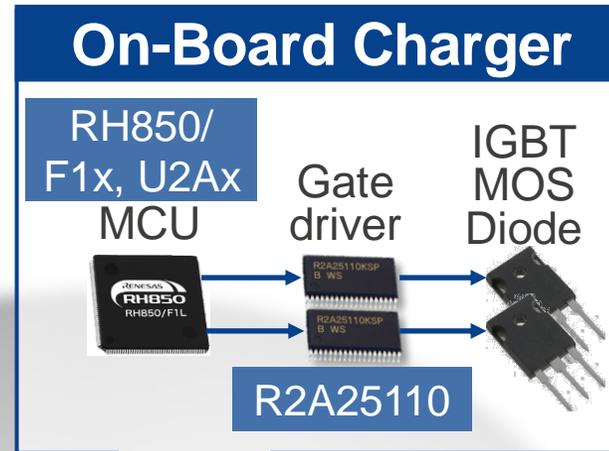
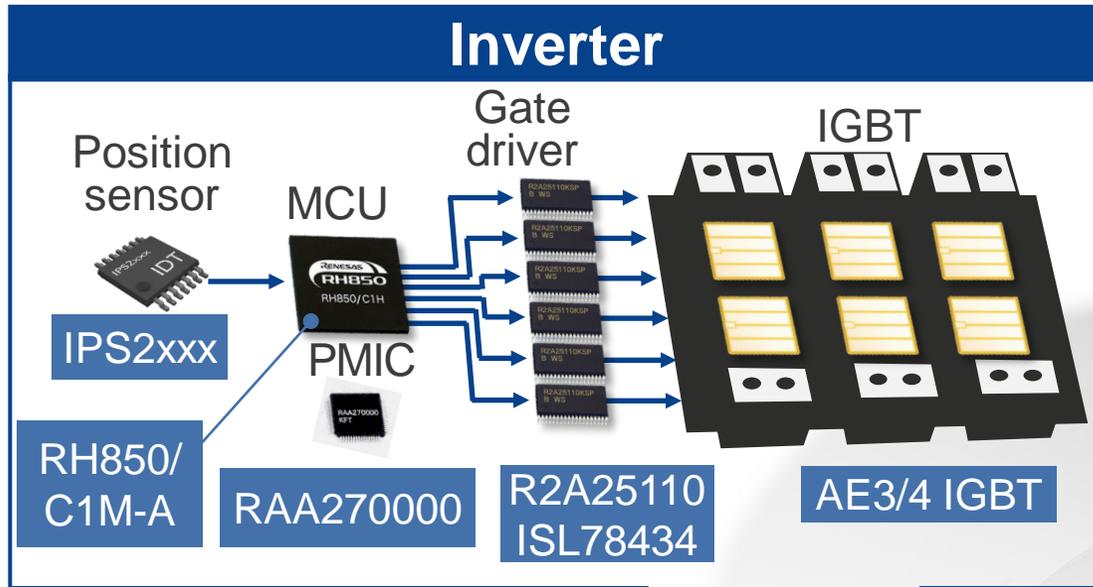
## Reference Board



# BMS SOLUTION



# xEV SYSTEM OVERVIEW

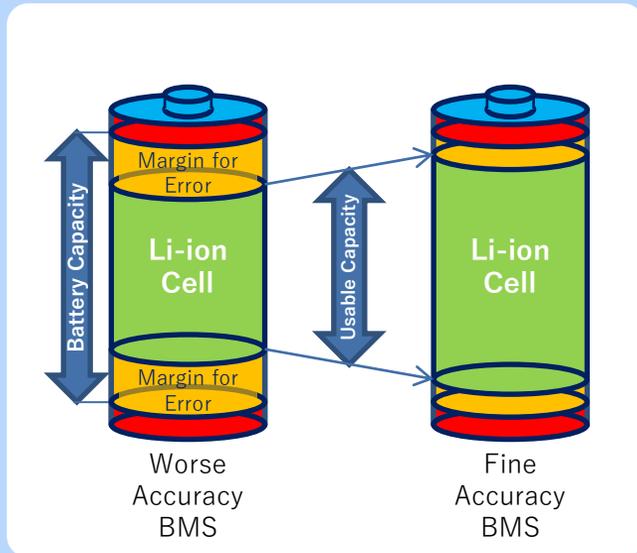


# RENESAS BATTERY MANAGEMENT SYSTEM SOLUTION

Contribute to maximizing battery capability, Safety and system cost reduction with high accurate voltage measurement, FUSA support and scalability of H/W & S/W.

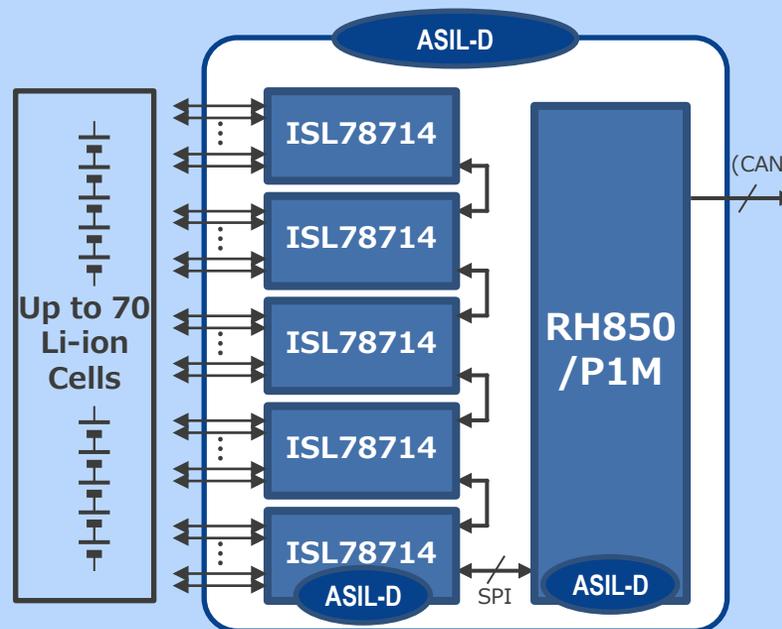
## Maximize Battery Capability

Best Voltage Measurement Accuracy



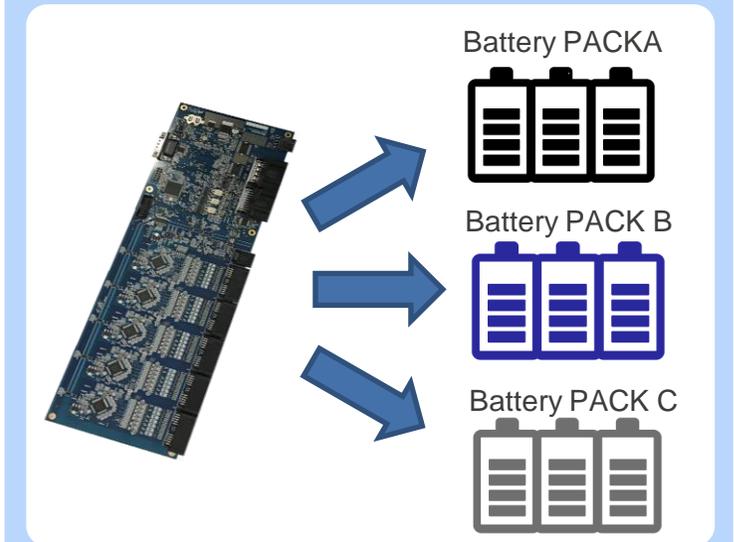
## Safety

ASIL D system support with BMIC and MCU



## Scalability

Pin-compatible product family (8cell, 12cell, 14cell, 16cell) supports battery packs with various number of cell



# SUMMARY

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## ✓ xEV Inverter

- Renesas Inverter solution covers all major semiconductor for BOM optimized high performance traction inverter
- Available Hardware and Software solutions support customer's development
- Advanced, BOM cost optimized motor position detection by Inductive Position Sensor

## ✓ Battery Management System

- Reference solution using Renesas MCU + PMIC + BMIC
- Accurate voltage measurement, functional safety support, and H/W and S/W scalability to maximize battery performance, safety, and reduce system development costs

# OTHER SESSIONS AT EMBEDDED WORLD

## Session:

- Power Management and Timing Solutions for Microprocessor/SoCs
- Winning Combinations, Analog & Digital
- Analog & Power portfolio overview

## Flyer:

- IPS2550 - Inductive Position Sensor
- R-Car SoC V3x Camera Solutions
- R-Car SoC Gateway Solutions

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