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

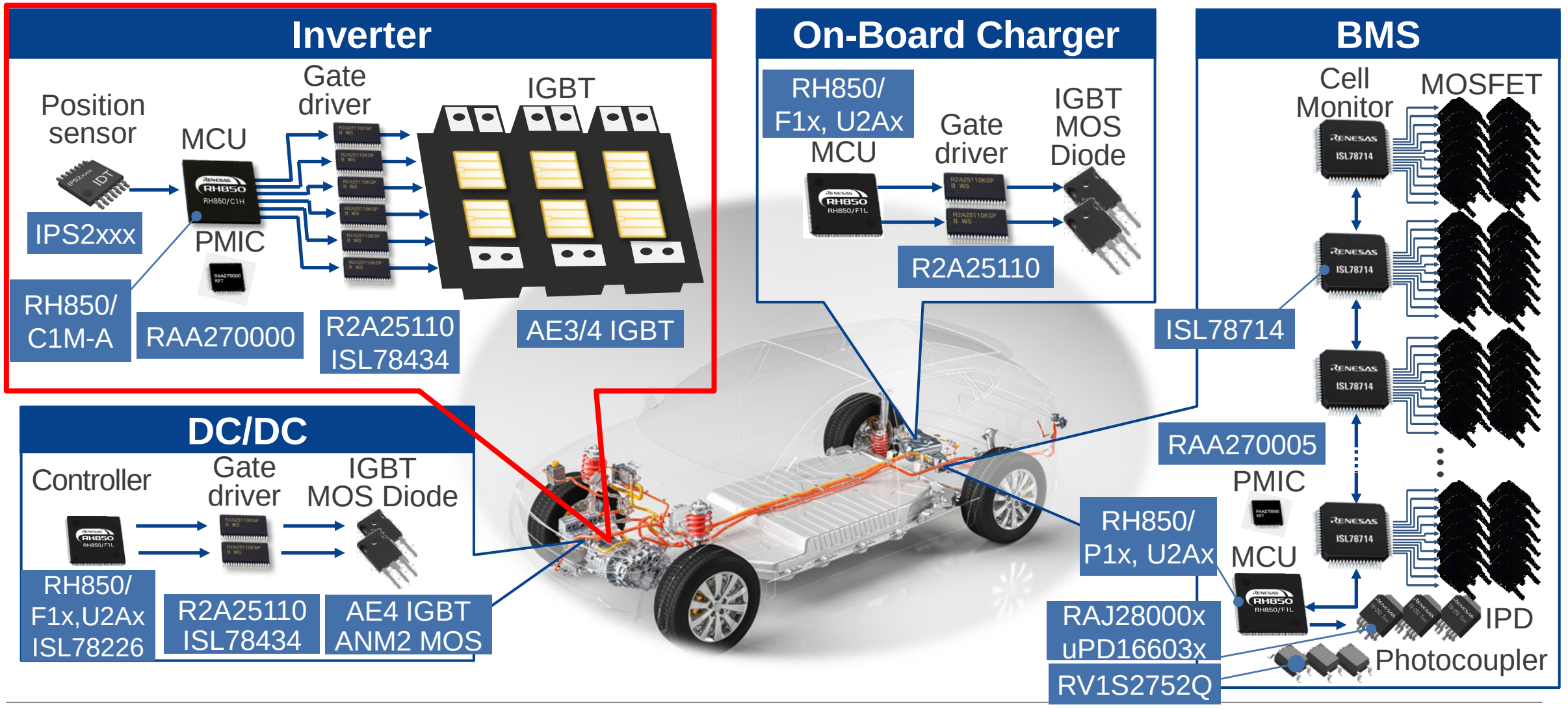
Name: Sam Gold

Renesas affiliation: Joint Renesas in 2008

Position: Senior Manager
Automotive Digital Marketing
Powertrain & xEV MCUs

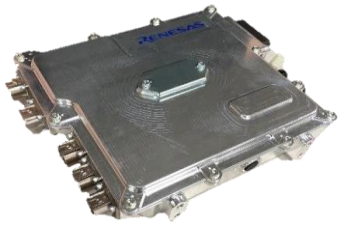
INVERTER SOLUTION

xEV SYSTEM OVERVIEW - INVERTER -



xEV INVERTER SOLUTION SYSTEM CONFIGURATION

Renesas Inverter kit covers all major semiconductor for Inverter



3.9L, 100kW 400V/800A ($500A_{RMS}$)

Inverter

External I/F

RV1S2752Q

Photocoupler

RH850/C1M-A2

MCU

RAA270000KFT

PMIC

Power Management IC

RDC

R2A25110KSP

Driver IC

Driver IC

Temperature sensor diode

IGBT + FRD

Power module

Current Sensor

U

V

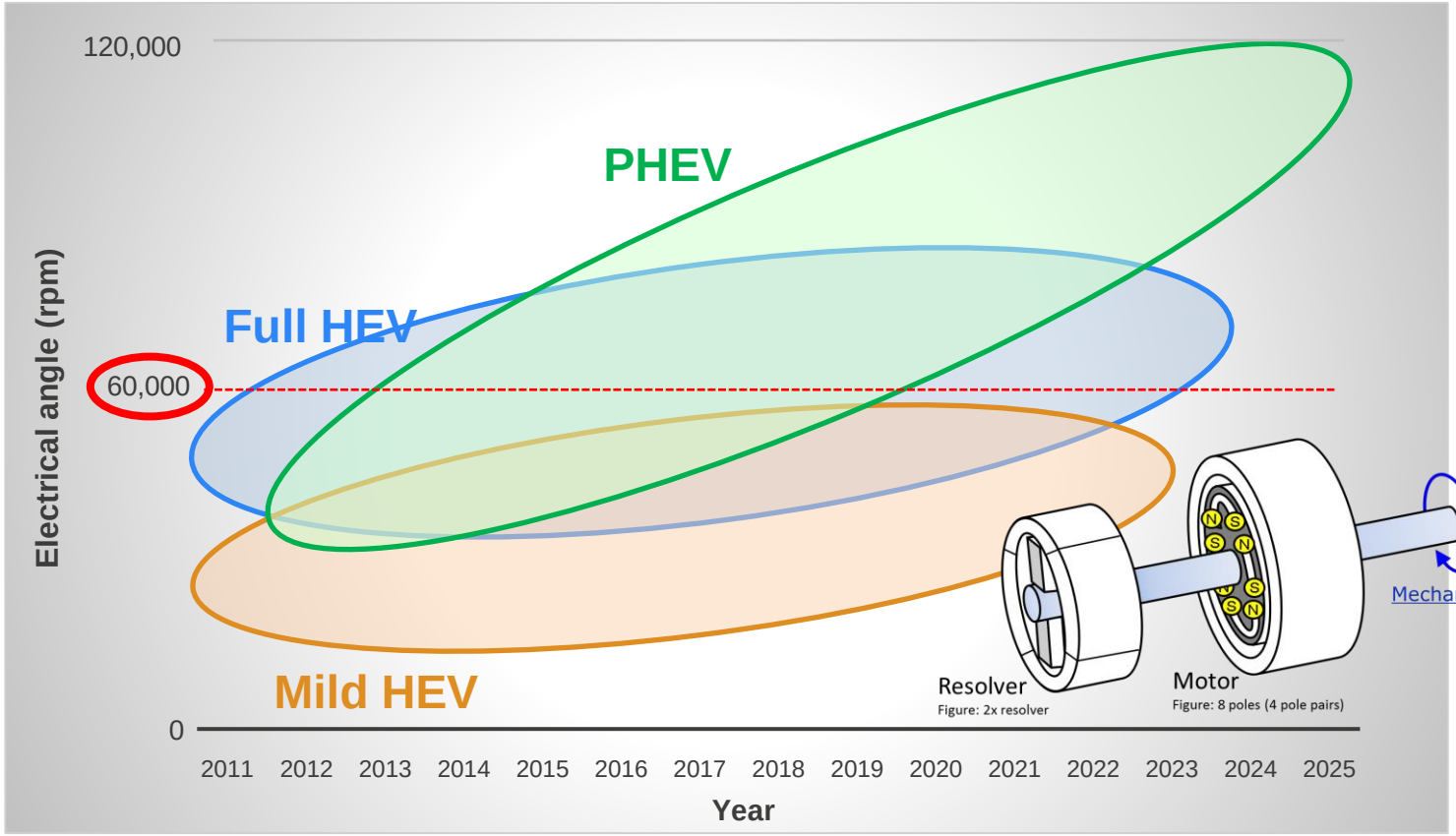
W

IPS2550

Inductive Position Sensor or optional Resolver

MICROCONTROLLER

FUTURE HEV/EV → INCREASE ELECTRICAL ANGLE VELOCITY



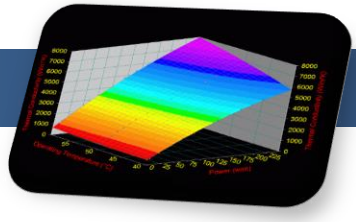
- Increased RPM level will be required for full HEV and PHEV/EV in future to achieve smaller form factors of xEV components, like the e-motor
- Higher RPMs require high speed processing as the Inverter control feedback cycle becomes shorter

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

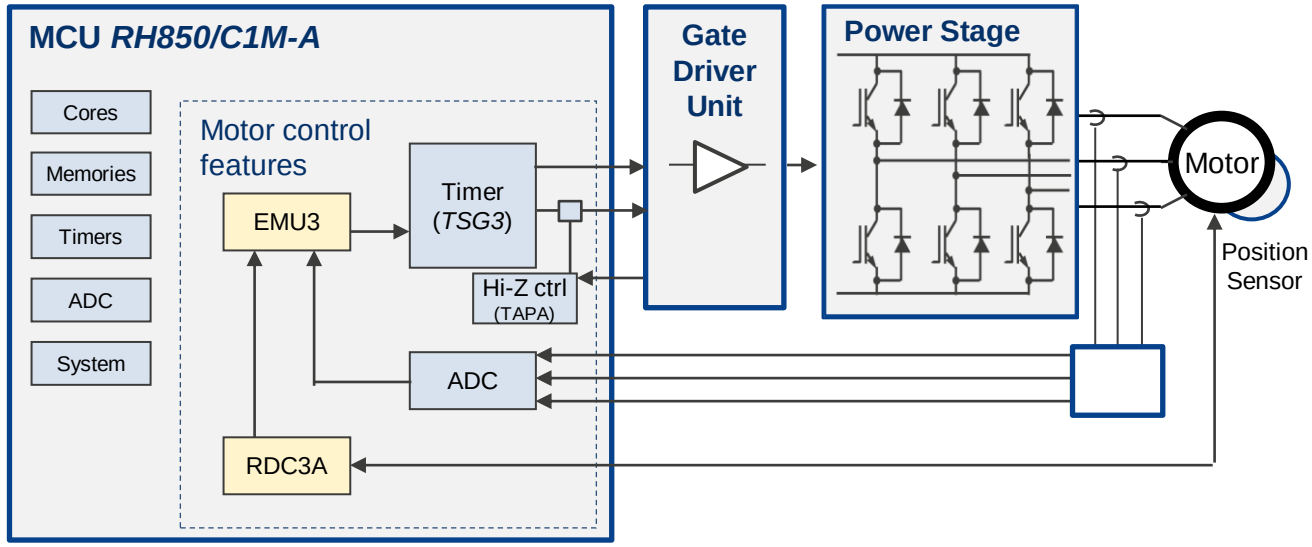
- INTEGRATION CONCEPT -

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

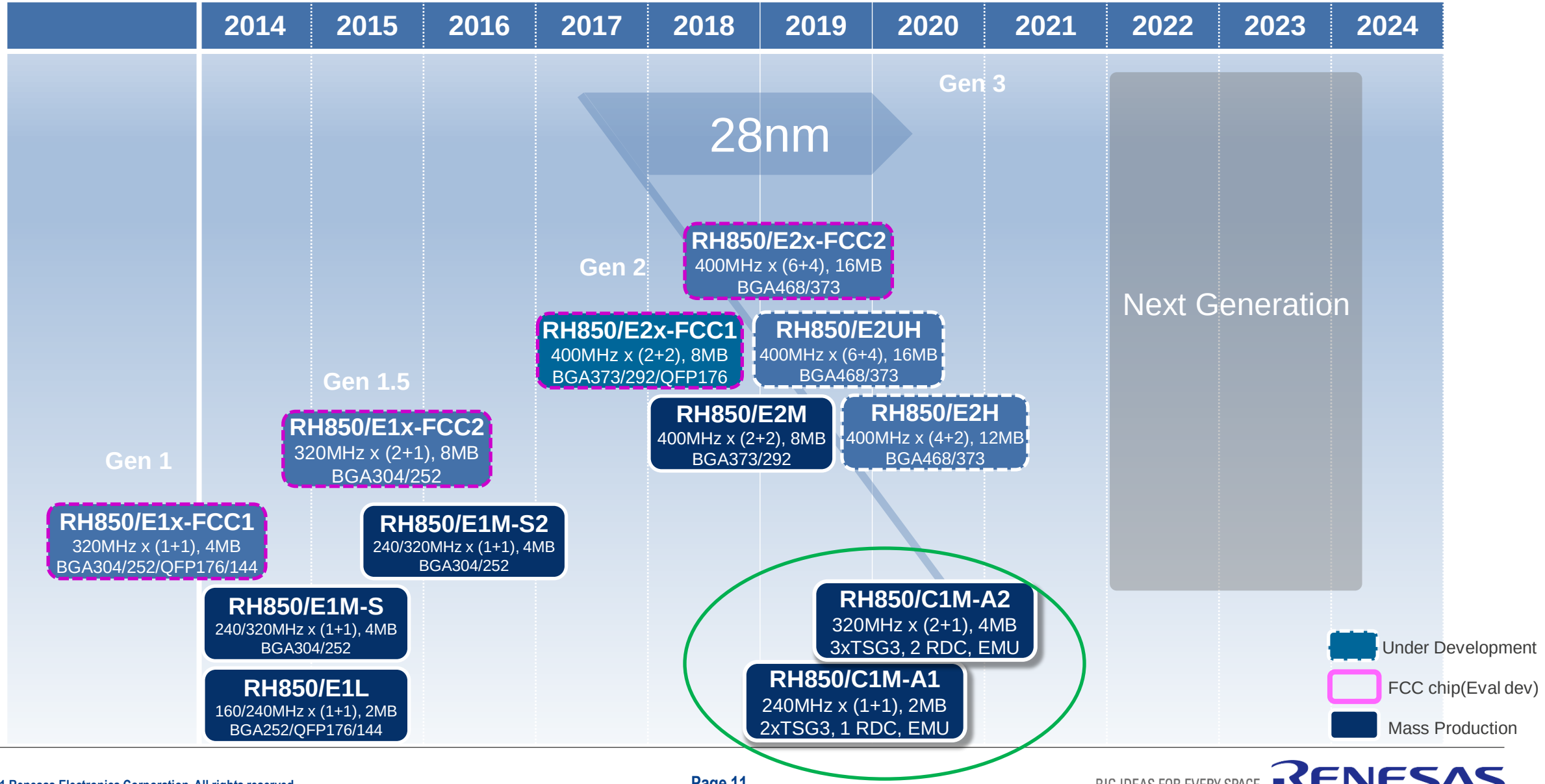


3. Integrated Motor Control Support (*EMU3*)

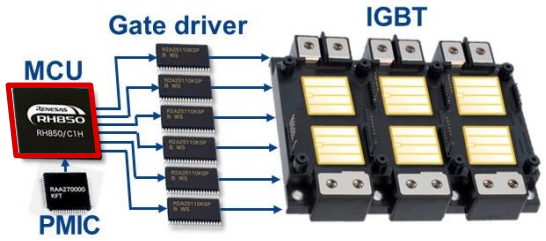
- Built-in flexible, optional Hardware Logic for Motor Control
- Able to control up to 2 motors independently in conjunction with the TSG3 timer

Preliminary

POWERTRAIN & XEV MCU ROADMAP



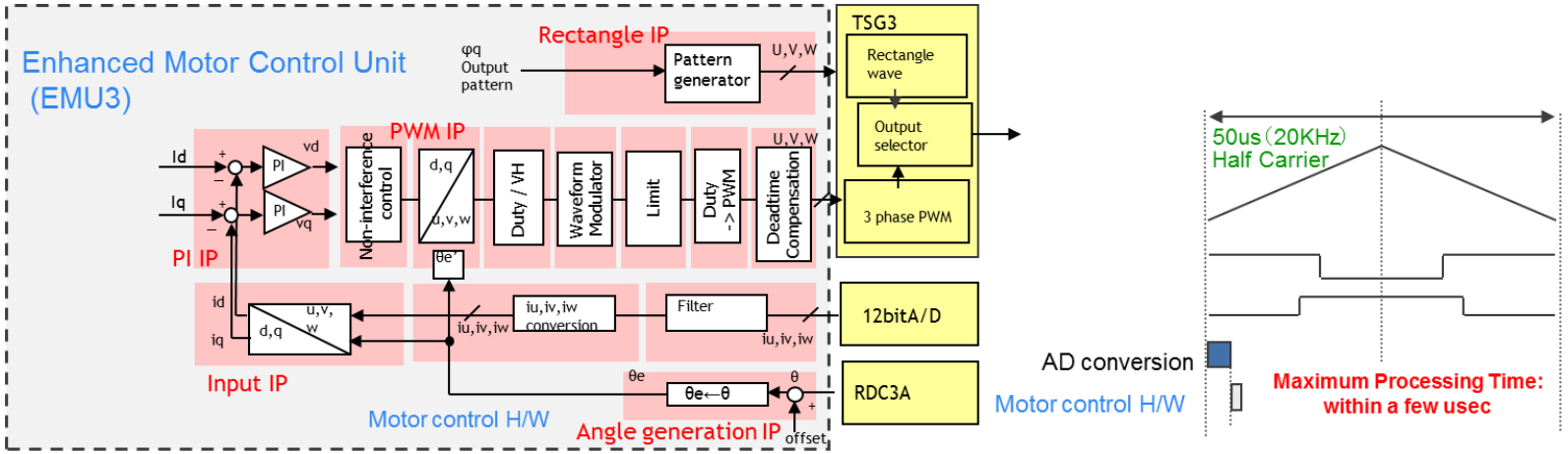
RH850/C1M-A MICROCONTROLLER



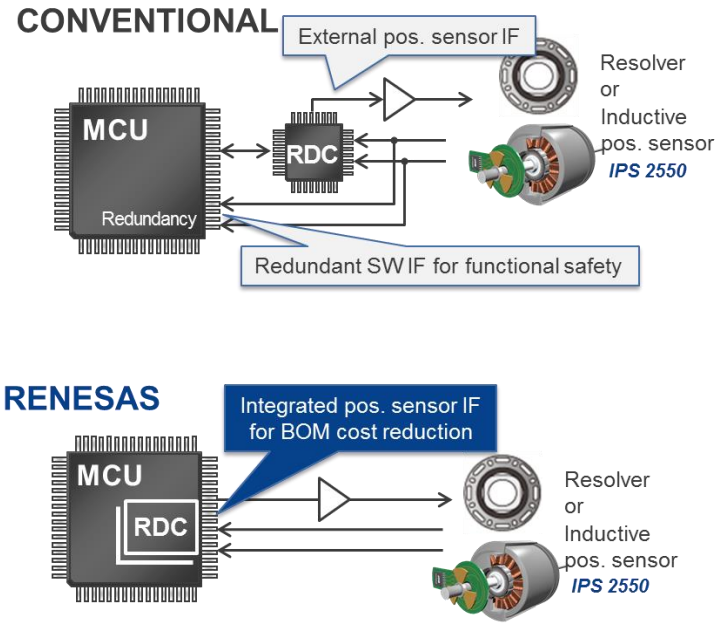
➢ Ideal solution for E-drive to control traction & generator motors with 1 MCU

- Control 2 motors with 1 MCU based on high performance multi core CPU
- Reduce CPU load with H/W-accelerator (EMU3) for high-speed motor control
- Reduce ECU BOM cost by an embedded Position sensor interface to connect either resolver- or inductive position sensors
- ISO-26262 ASIL-C compliant

EMU3 solution



Integrated RDC solution



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

ICU-S
Security Module

Clock Monitor

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

Motor Control IP

2 x RDC3A

EMU3 2ch

RH850 G3MH Core
1+0 @ 320 MHz

Package & Power Supply

BGA252
(0.8 mm pitch)

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

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
- ICU-S Security Module
- Clock Monitor
- 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

Motor Control IP

- 1 x RDC3A
- EMU3 1ch
- **RH850 G3MH Core**
  1+0 @ 240 MHz

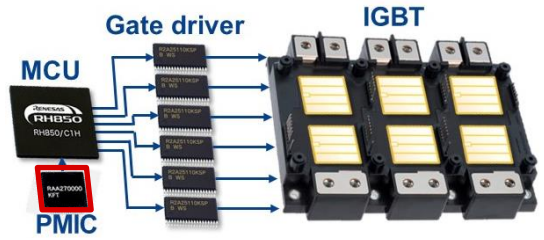
Package & Power Supply

- QFP176
  (0.5 mm pitch)
- Dual voltage supply:
  I/O: 4.5 .. 5.5 V /
  Core: 1.15 .. 1.35 V

Device	Package	Order code
RH850/C1M-A1	QFP176-24x24-0.5	R7F701278EAFP

ANALOG & POWER

PMIC FOR RH850/C1M-AX MCU



■RAA27000x PMIC for RH850

✓Optimized power supply for RH850 and integrate monitor and diagnosis functions

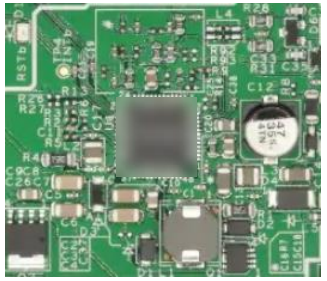
⇒ Easy to develop and reduce external BOM cost and PCB area

■Planning RH850 Next PMIC

✓Support ISO26262 ASIL D

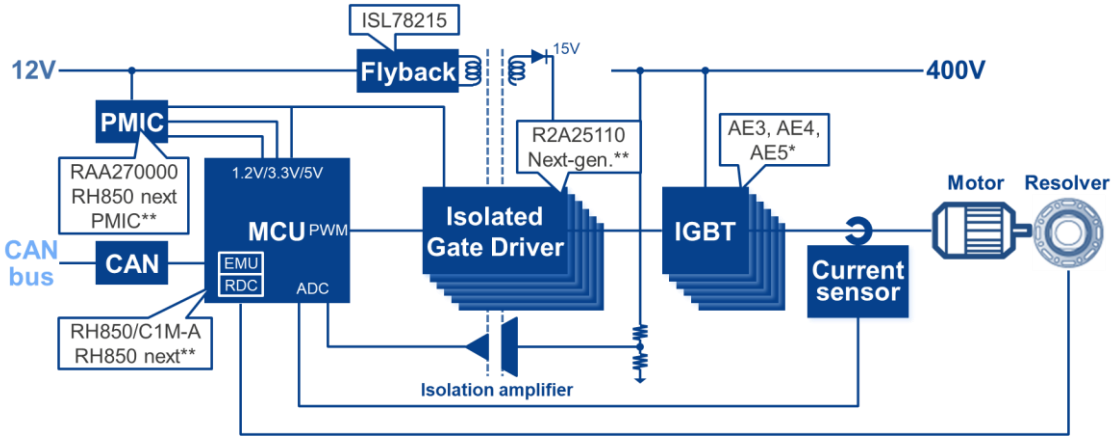
✓Support wide current supply range by changing external FET

Competitor PMIC



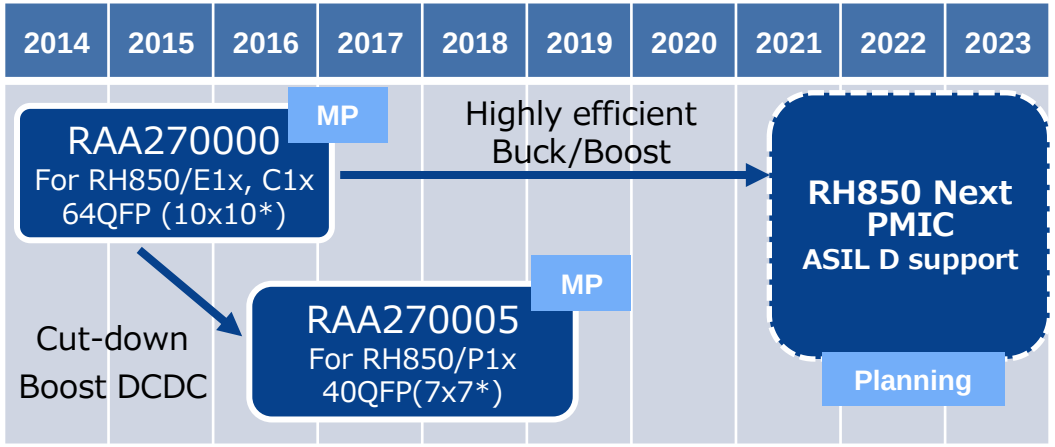
Ext. BOM: 43% Reduction
PCB area: 22% Reduction

REL PMIC RAA270000



*Under development **under planning

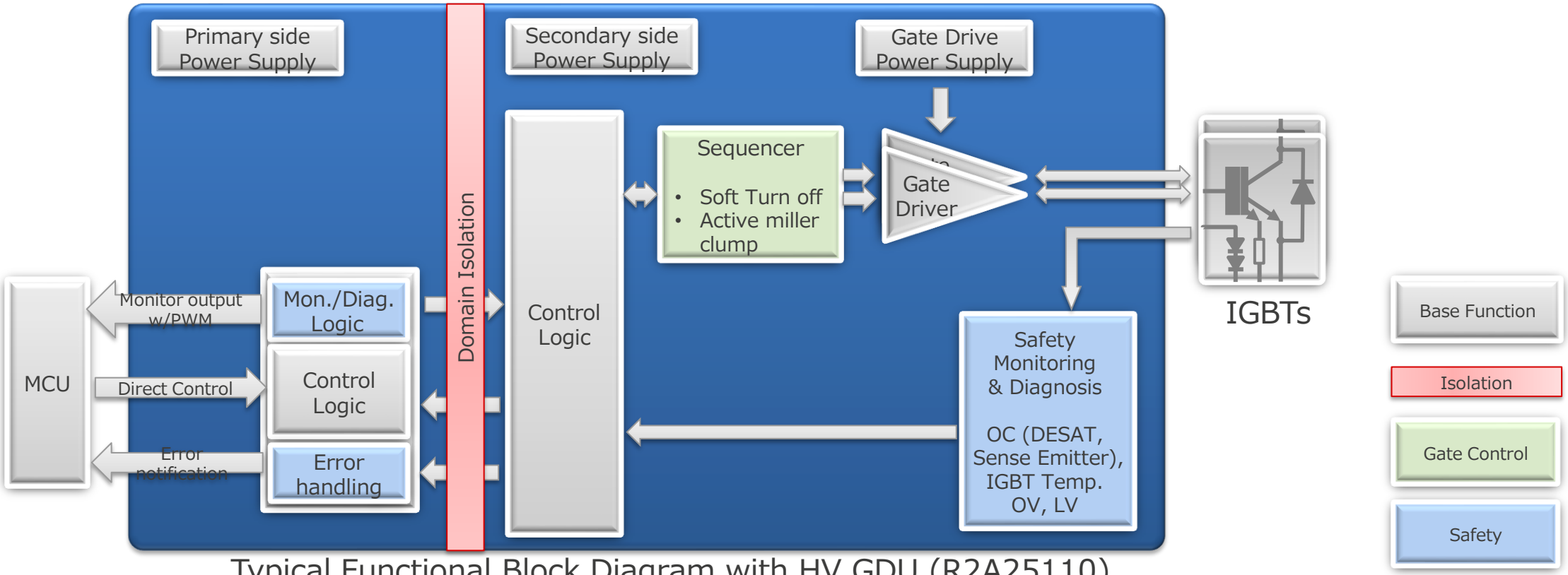
Solution example



Product roadmap

HV GDU - R2A25110KSP -

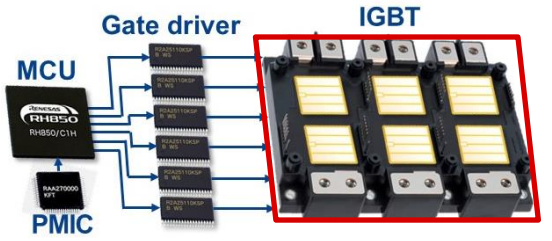
A key analog component associated with the controller in these HV traction motor systems is an isolated HV gate driver (HV GDU). HV GDUs connected to the controller drives the power switches such as IGBTs. They convert PWM signals from the controller into gate pulses for the power switches to turn and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



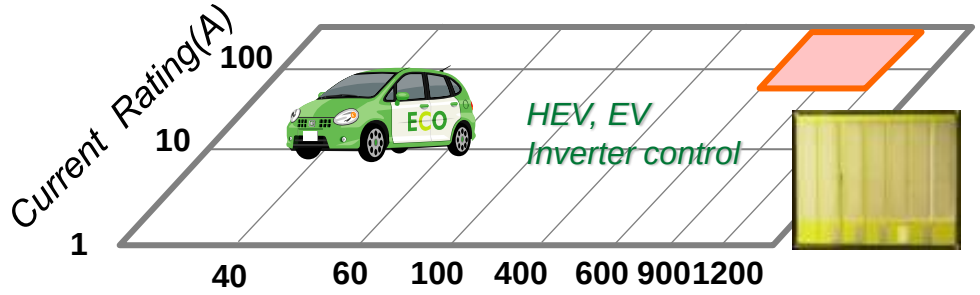
Typical Functional Block Diagram with HV GDU (R2A25110)

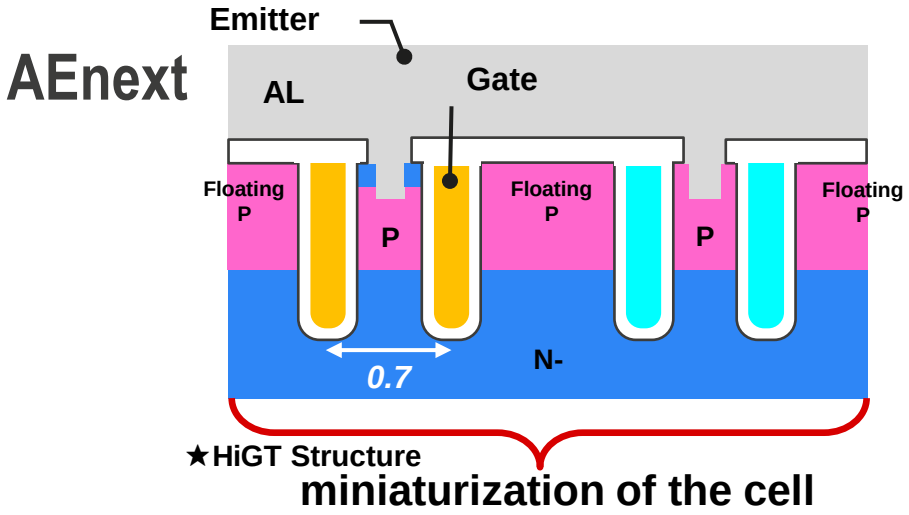
Page 17

IGBTs and FRDs



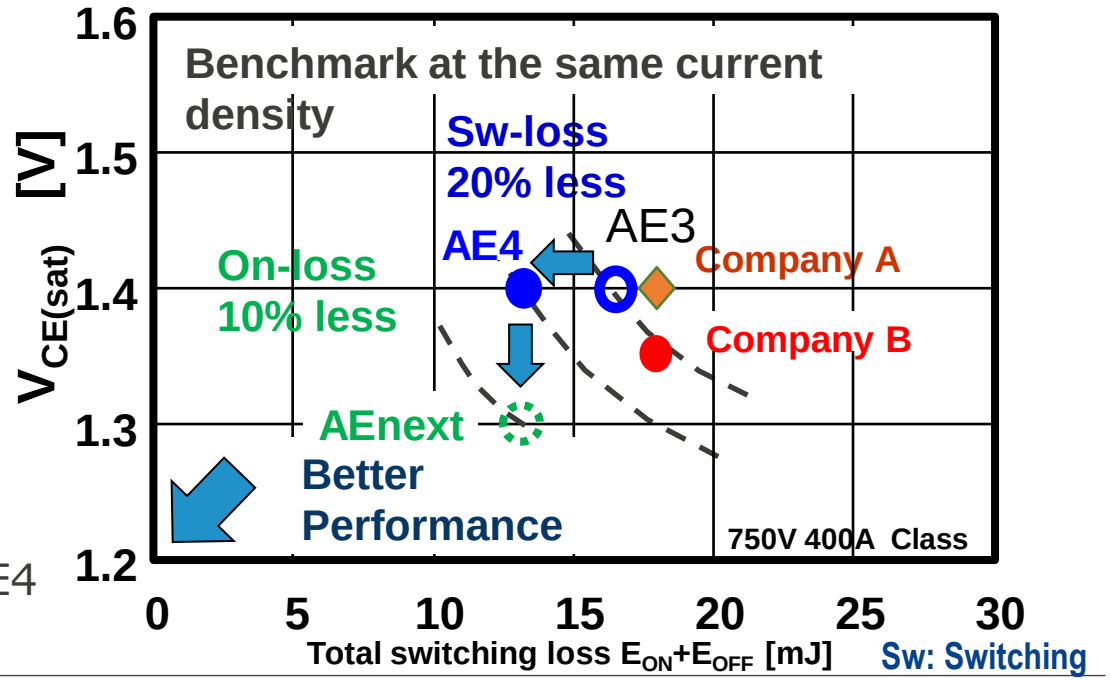
Provide high performance/robust IGBT for xEVs





IGBT

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



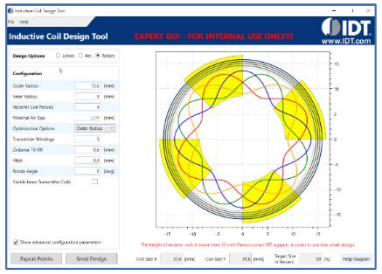
- AEnext（Under dev.） : Reduce -10%Vce(sat) against AE4
  Improve conductivity modulation by fine pitch cell design

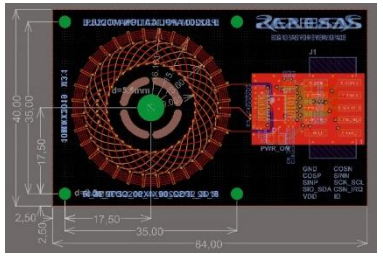
INDUCTIVE POSITION SENSOR - IPS2550 -

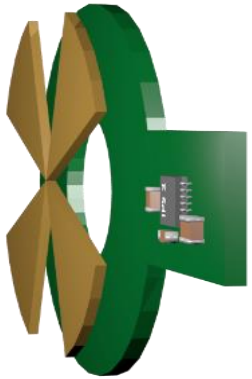
- Detect the position of a target metal based on electromagnetic induction of a coil
- Thinner, Lighter, High magnetic field immune
- Flexible multiplier, flexible mounting

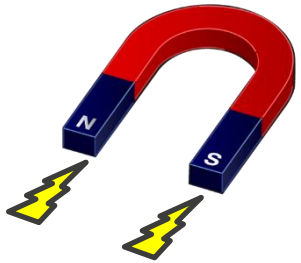
Easy-to-Use	Thin, Light	High magnetic field immune	Flexibility

PCB coil
Layout design tool

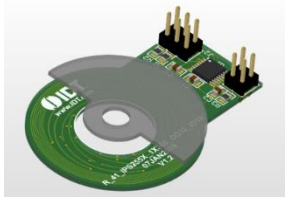






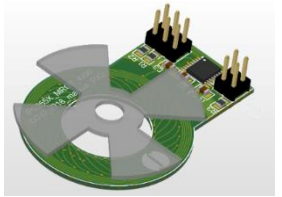


Flexible to different pole pairs



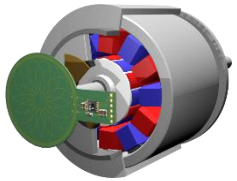
1 pole pair

2 pole pair

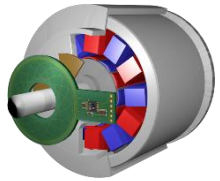


4 pole pair

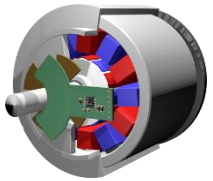
Flexible mounting



On-axis (end of shaft)



Off-axis (through shaft)



Off-axis (side shaft)

xEV Inverter Reference Solution

System Benefits

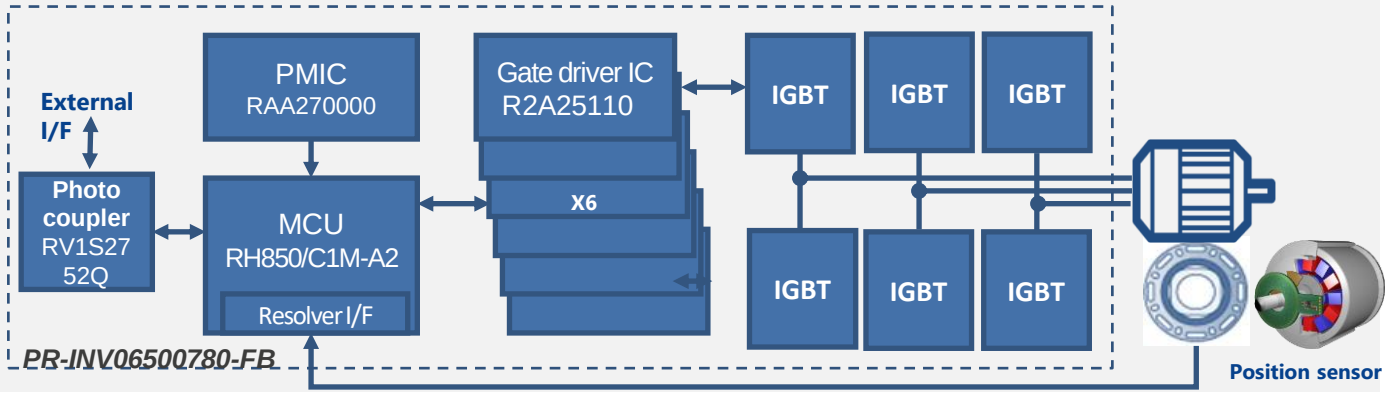
- Practical inverter specification for xEV 100kW class motor
- Reference solution kit including Inverter reference design, software, model base design and calibration tool
- Function and performance verified in Renesas motor bench
- 3.9L compact volume by highly integrate products and temperature management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

BOM List

Reference Design

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

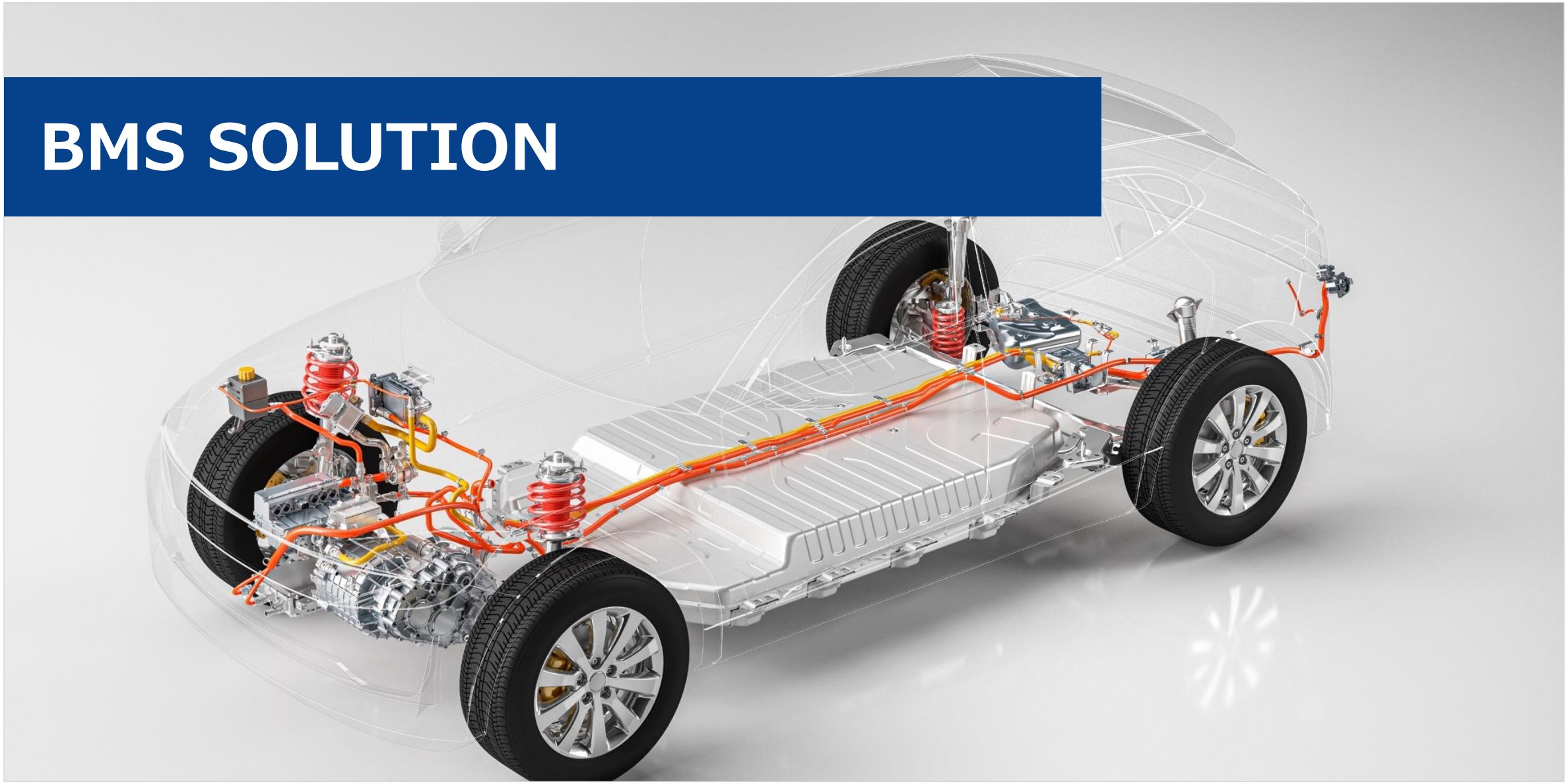
Block Diagram



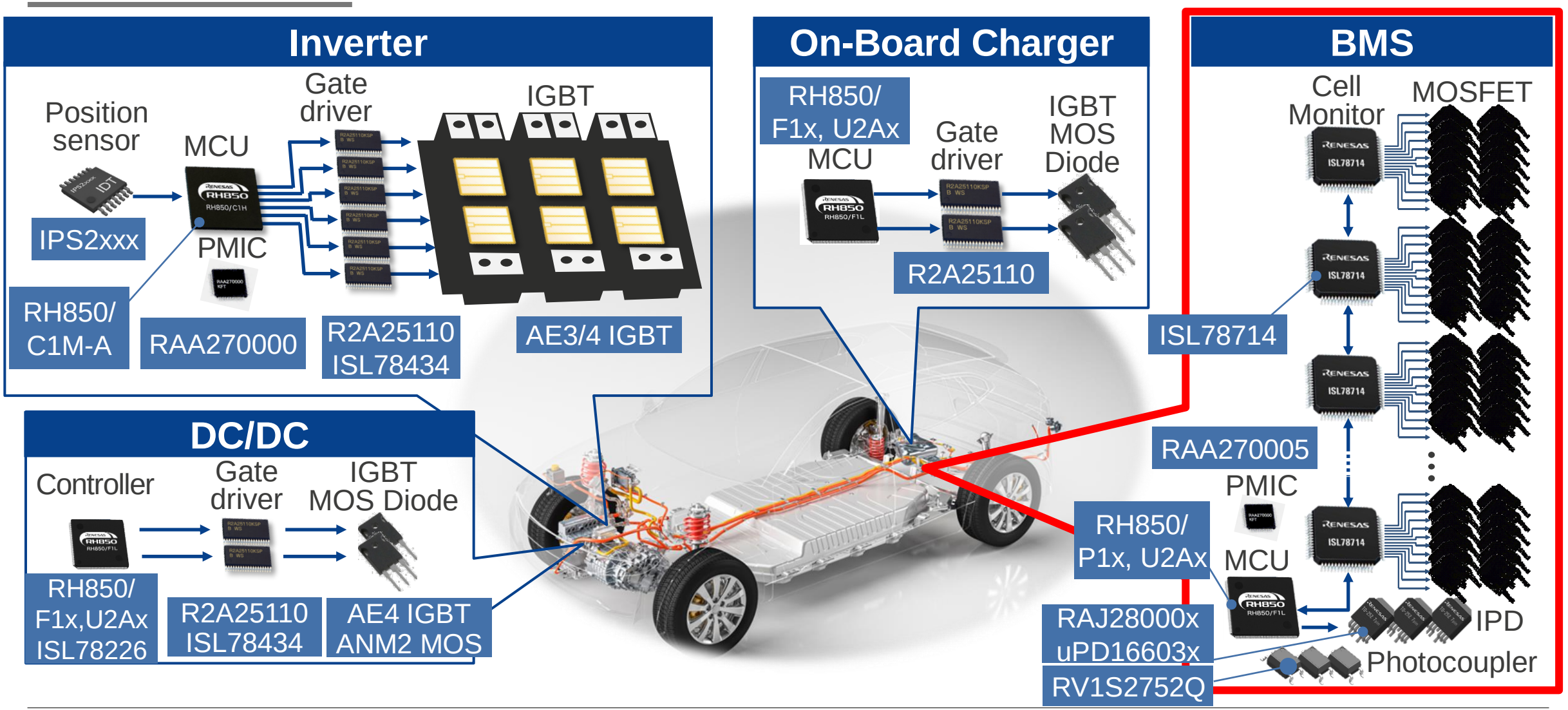
On ECU

Reference Board

BMS SOLUTION



xEV SYSTEM OVERVIEW

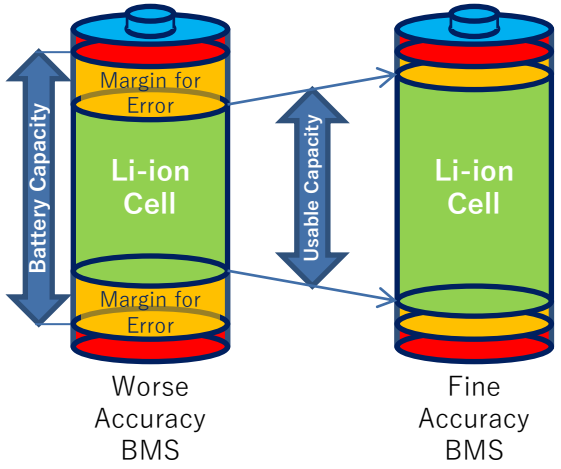


RENESAS BATTERY MANAGEMENT SYSTEM SOLUTION

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

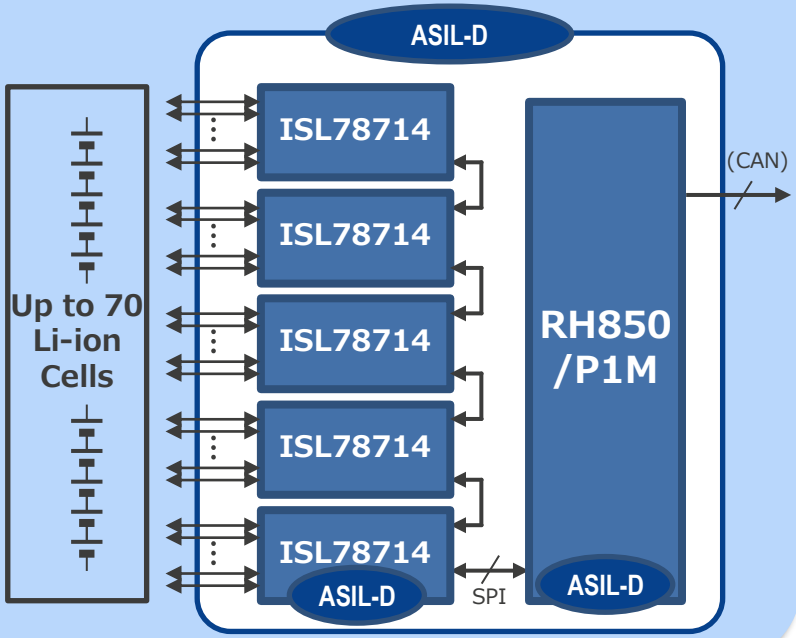
Maximize Battery Capability

Best Voltage Measurement Accuracy



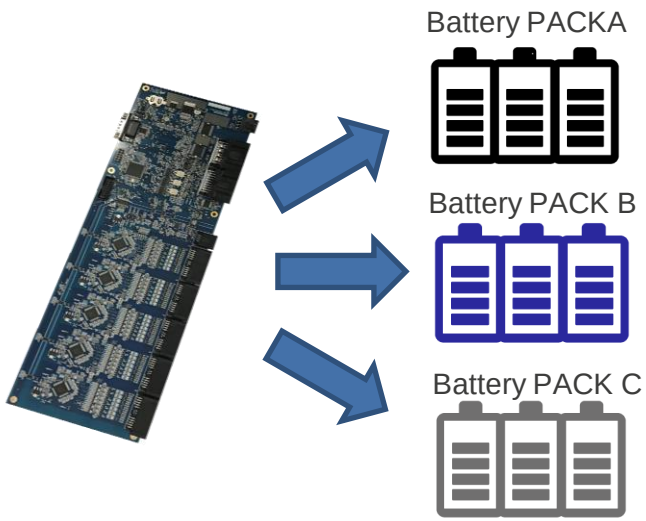
Safety

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

✓ 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

Renesas.com