



Mobile Robots: Battery Management System (BMS)

AGV – Automated Guided Vehicles

AMR – Automated Mobile Robots

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2022 Edition



Infineon is a globally leading semiconductor player



* over the cycle 9%+ revenue growth; 19% Segment Result margin; investment-to-sales ratio of 13%; targets to be approached as integration progresses

top 10

- › semiconductor company

~46,700

- › total employees

~7,800

- › R&D employees

leading player

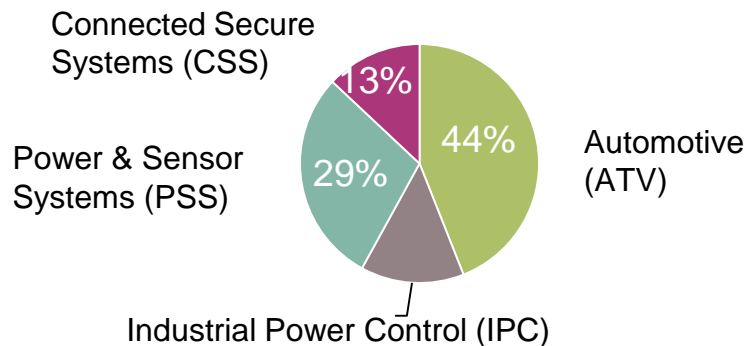
- › in automotive, systems for power management and drives, sensor systems, connected secure systems, wireless combos, differentiated memories

9%+ | 19% | 13%

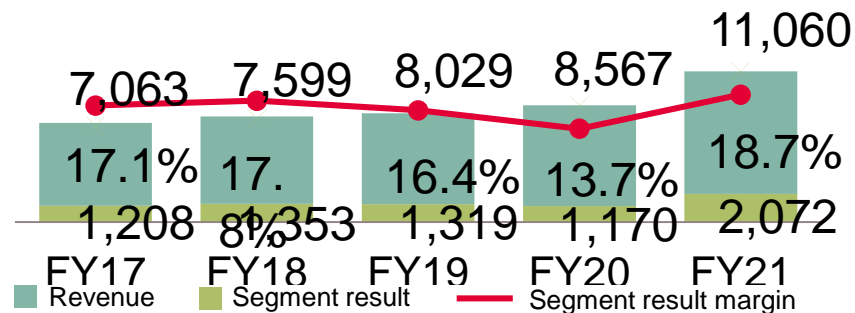
- › target operating model*

Infineon at a glance

Business segments revenue*



Financials

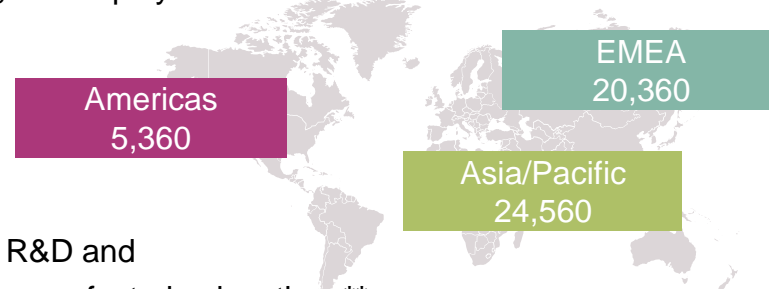


*2021 Fiscal year (as of 30 September 2021)

**as of 30 September 2021

Employees*

50,280 employees worldwide



56 R&D and
20 manufacturing locations**

Market position

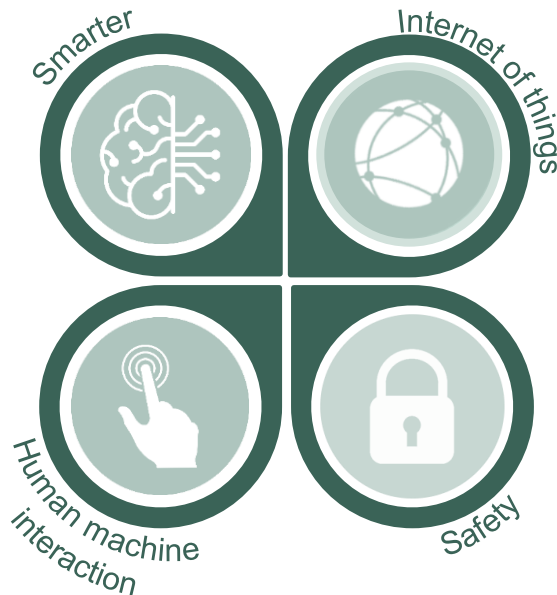


For further information: [Infineon Annual Report 2021](https://www.infineon.com/en/about-infineon/infineon-annual-report-2021)

Main trends and challenges in robot applications

Robots are moving toward Industry 4.0. This brings the need for robots to be smarter and interconnected but also calls for the need for standardization.

Human-robot collaboration is one important trend in robotics. The ability to work mutually with humans, enables robots to adapt to a rapidly changing environment.



Connectivity level and the need of data security correlate, so security must be integrated into all existing and new systems, but once again calls standardization needs for diverse robots & systems to interact properly.

Safety is key when robots interact with their environment with a special focus on human safety, work safety, routing accuracy and collision avoidance

Types and deployment of mobile robots

On high level mobile robots can be categories into AGVs and AMRs

AGV

Automated Guided Vehicle

AGVs are “fixed”. They follow predefined paths using lasers, beacons, barcodes or magnetic tape.



AMR

Autonomous Mobile Robot

AMRs are not “fixed” and don’t need external paths. Autonomously mapping and navigating by using sensors



Potential use cases: warehouse & logistic, last mile delivery, robots in hotels, banks, airports etc.

Mobile robots are a fast growing market and need sophisticated system solutions for each functional block

Application requirements

Different types of mobile robots require unique and appropriate solutions

Precise, efficient & compact motor drives

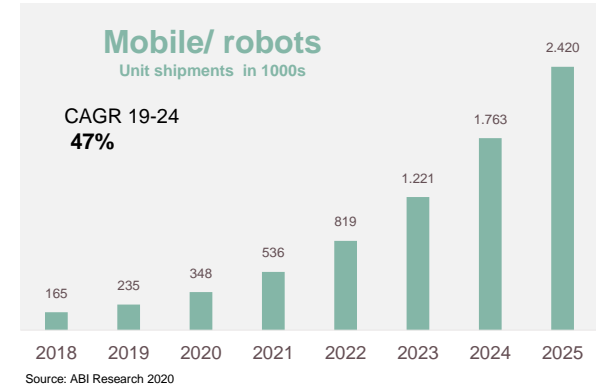
Fast charging reducing charging and idle time

Environmental sensing for navigation and safety

Connectivity enabling AI, real time monitoring and IoT

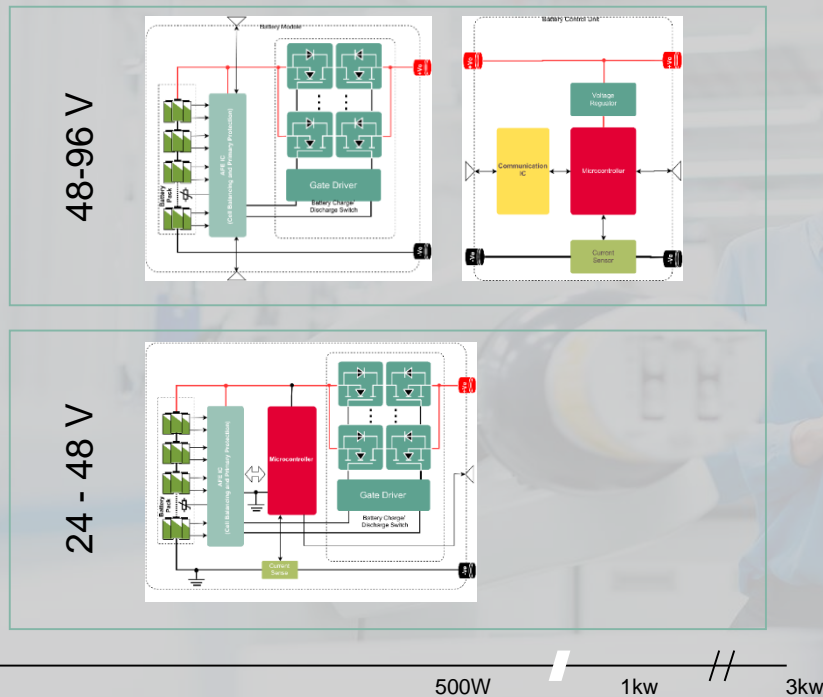
Connectivity enabling AI and IoT

Market outlook



Battery Management System (BMS)

[Back to overview](#)



Power switches

- > OptiMOS™ & StrongIRFET™ MOSFETs
- > EiceDRIVER™ Gate Driver

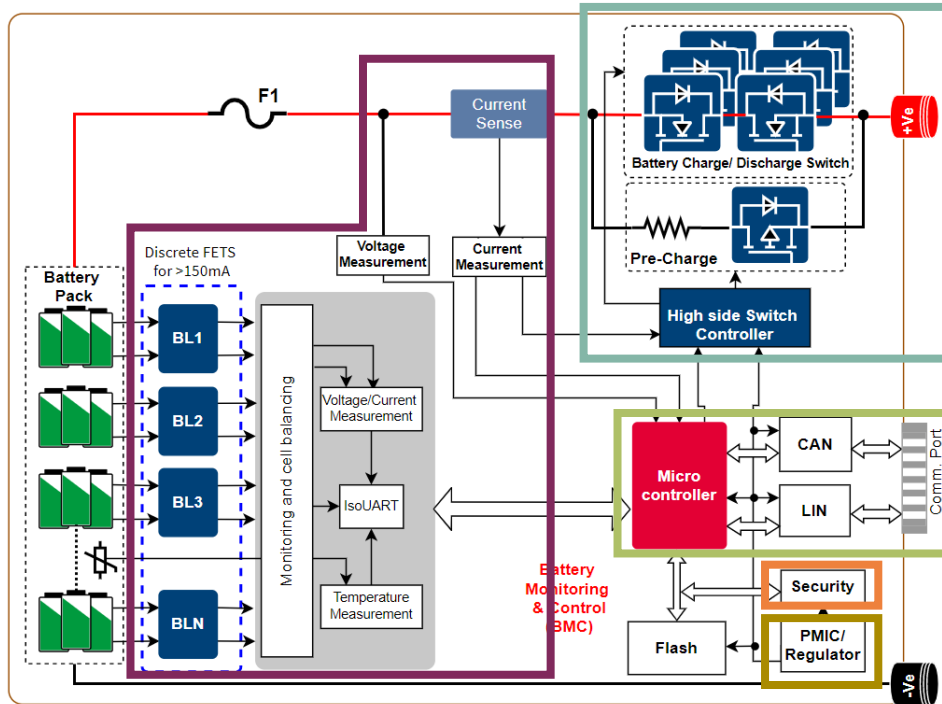
MCU

- > XMC
- > PSoC

Cell Monitoring & Balancing

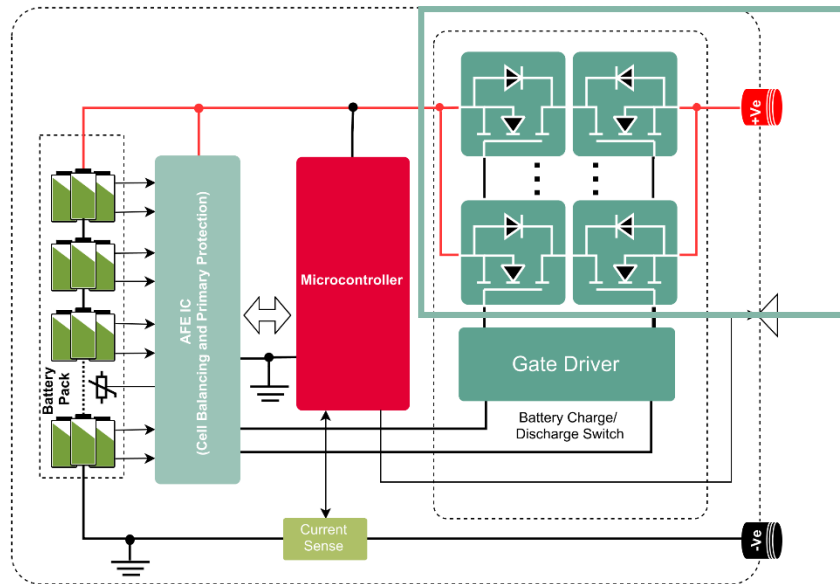
- > TLE9012
- > Small Signal MOSFETs

AGVs & AMRs Battery Block



Battery Protection Unit (BPU)	Over Charge / Deep Discharge
	Pre-charge
	Over Current and Short circuit
	Reverse Polarity
Battery Monitoring and control (BMC)	Cell balancing
	State of charge
	State of health
	Cell temperature
Security	Authentication
	Encryption
Regulators	Voltage regulators
	PMICs
Cell Monitoring and Balancing (CMB)	Voltage and Current Monitoring
	Temperature monitoring
	Cell Balancing

Battery Protection for mobile robots



Key features and benefits

- › Wider safe operating area (SOA)
- › Short circuit protection with higher peak current rates
- › more effective parallelization solutions
- › System cost reduction
- › Up to 250V MOSFET protection solutions

Battery Disconnect

	Low Power		Medium Power	High Power	
Package	S308	SS08	D2PAK	D2PAK-7Pin	TOLL
Dimension	3 X 3mm	5 x 6mm	10 X 15mm	10 X 15mm	10 X 12mm
Current	<30A	<60A	<100A	<200A	<200A

Battery Precharge

	PQFN	S308	SS08	SOT223	DPAK	
Package						
Dimension	2 X 2mm	3 X 3mm	5 X 6mm	6.5 X 6.5mm	6.5 X 6.5mm	
Current	≤5A	<10A	<20A	>2A	<2A	<10A
Type	N-Ch	N-Ch	N-Ch	N-Ch	P-Ch	N-Ch

Protection Switch need

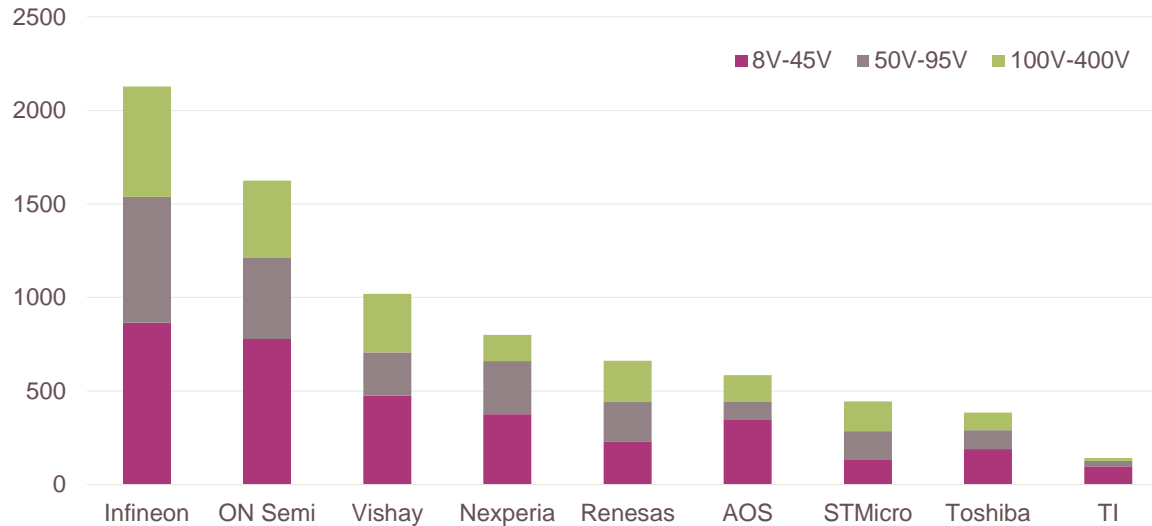
- › Low Drain to source on Resistance ($R_{DS(on)}$)
- › Low Thermal Resistance (R_{thJA})
- › Wide Safe Operating Area (SOA) in linear mode
- › Rugged Linear Mode operation

Infineon 20 V - 300 V portfolio size

Product portfolio vs. competition by voltage classes



Number of products by voltage class



¹Automotive & industrial products included

- › Infineon has the largest 20 V – 300 V MOSFET portfolio in the world with over 2K part numbers
- › Infineon offers both differentiated technical solutions, as well as Right Fit Products to meet any price and performance budget

*** Be aware that the essential product portfolios start ≥ 20 V**
Only a few products can be found for 8 V, 12 V and 16 V

Source: Aug 2019 IHS Markit & competitor database




Note: Sorting based on the number of products (largest to smallest), not related to revenue or market share

Recommended Protection MOSFETs

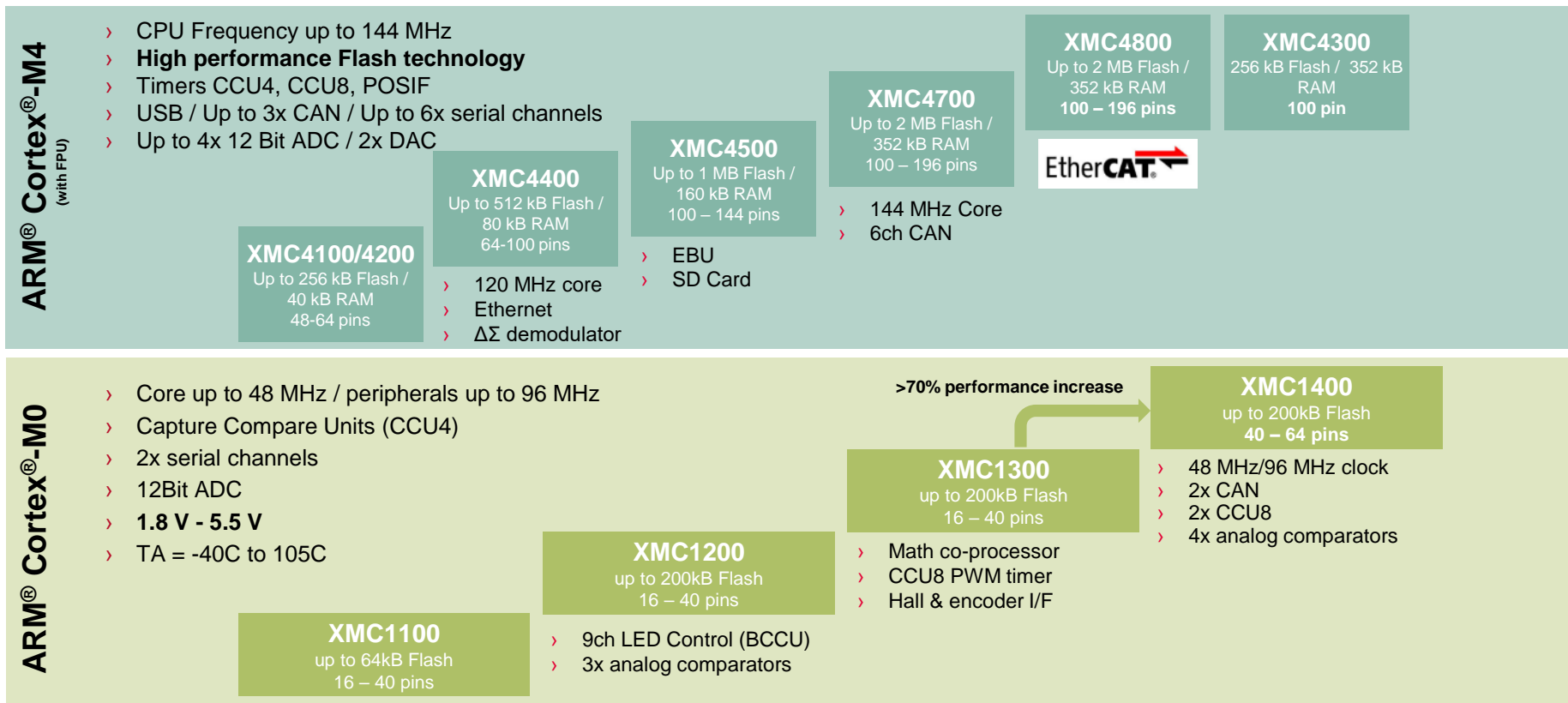
Battery Voltage	Package	RDSON	RthJC	Product
24V	D2PAK7P	$\leq 0.65 \text{ m}\Omega$	$\leq 0.36 \text{ }^{\circ}\text{C/W}$	IRL40SC228
	SuperSO8	$\leq 0.7 \text{ m}\Omega$	$\leq 0.8 \text{ }^{\circ}\text{C/W}$	BSC007N04LS6
	TOLL	$\leq 0.72 \text{ m}\Omega$	$\leq 0.3 \text{ }^{\circ}\text{C/W}$	IRL40T209
	D2PAK	$\leq 1.2 \text{ m}\Omega$	$\leq 0.4 \text{ }^{\circ}\text{C/W}$	IRFS7430
48 V	TOLL	$\leq 1.2 \text{ m}\Omega$	$\leq 0.4 \text{ }^{\circ}\text{C/W}$	IPT012N08N5
	SuperSO8	$\leq 2.5 \text{ m}\Omega$	$\leq 0.8 \text{ }^{\circ}\text{C/W}$	BSC025N08LS5
	TOLL	$\leq 1.5 \text{ m}\Omega$	$\leq 0.4 \text{ }^{\circ}\text{C/W}$	IPT015N10N5
	D2PAK	$\leq 1.7 \text{ m}\Omega$	$\leq 0.4 \text{ }^{\circ}\text{C/W}$	IPB017N10N5LF
	SuperSO8	$\leq 3.4 \text{ m}\Omega$	$\leq 0.8 \text{ }^{\circ}\text{C/W}$	BSC034N10LS5
	D2PAK7P	$\leq 3.9 \text{ m}\Omega$	$\leq 0.4 \text{ }^{\circ}\text{C/W}$	IRLS4030-7P
96V	D2PAK	$\leq 11 \text{ m}\Omega$	$\leq 0.5 \text{ }^{\circ}\text{C/W}$	IPB110N20N3LF
	TOLL	$\leq 11.1 \text{ m}\Omega$	$\leq 0.4 \text{ }^{\circ}\text{C/W}$	IPT111N20NFD
	SuperSO8	$\leq 32 \text{ m}\Omega$	$\leq 1 \text{ }^{\circ}\text{C/W}$	BSC320N20NS3 G
	DirectFET	$\leq 59.9 \text{ m}\Omega$	$\leq 1.4 \text{ }^{\circ}\text{C/W}$	IRF6641
	PQFN 3.3x3.3	$\leq 90 \text{ m}\Omega$	$\leq 2.5 \text{ }^{\circ}\text{C/W}$	BSZ900N20NS3 G
	D2PAK	$\leq 4.8 \text{ m}\Omega$	$\leq 0.4 \text{ }^{\circ}\text{C/W}$	IPB048N15N5LF
	SuperSO8	$\leq 7.4 \text{ m}\Omega$	$\leq 0.7 \text{ }^{\circ}\text{C/W}$	BSC074N15NS5
	D2PAK7P	$\leq 11.8 \text{ m}\Omega$	$\leq 0.4 \text{ }^{\circ}\text{C/W}$	IRFS4115-7P
	D2PAK	$\leq 12.1 \text{ m}\Omega$	$\leq 0.4 \text{ }^{\circ}\text{C/W}$	IRFS4115

Microcontroller Product Portfolio

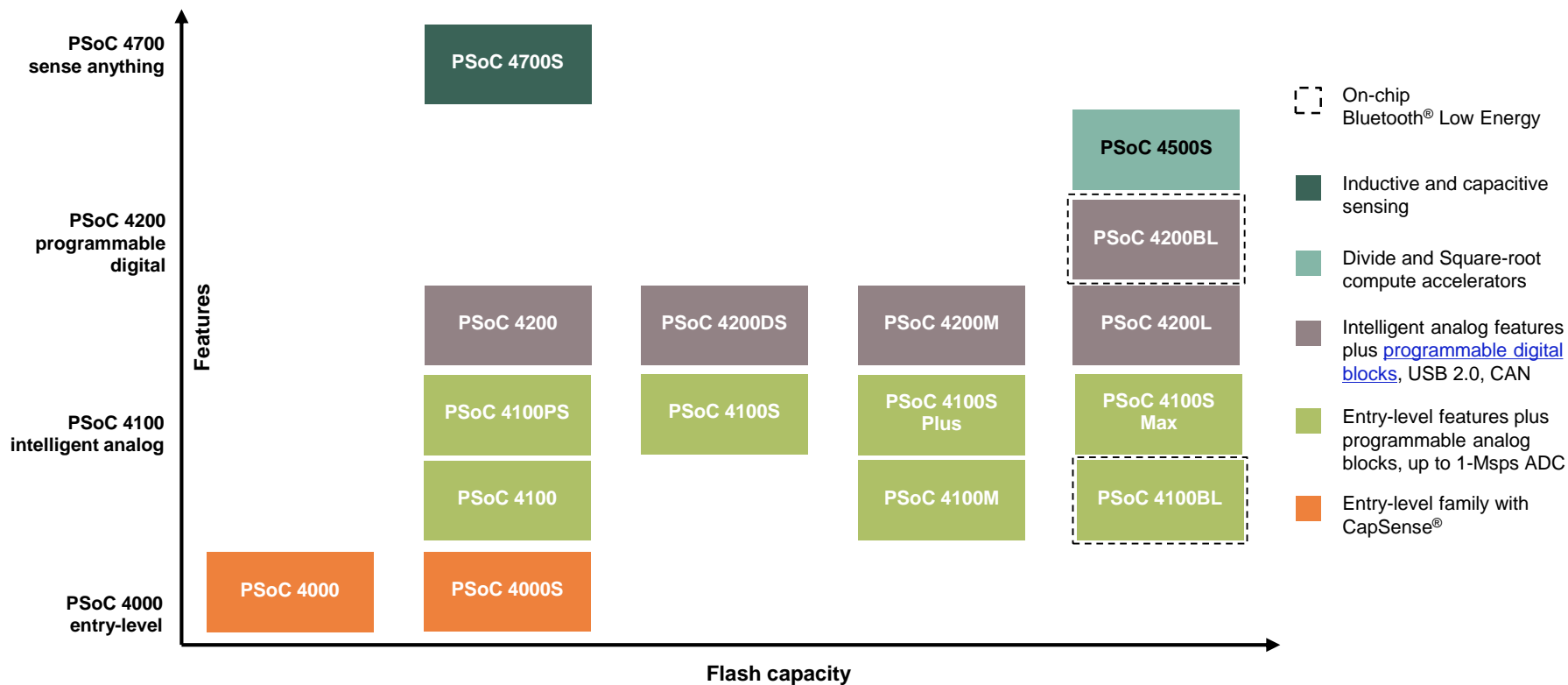
Note: Automotive, AURIX™ for Industrial, iMOTION™ covered separately

8-Bit	32-Bit Arm® Cortex®-M0/M0+	32-Bit Arm Cortex-M3	32-Bit Arm Cortex-M4 / Arm Cortex-M0+	32-bit Arm Cortex-Mx (next generation)
<p>IoT / Consumer</p> <p>PSoC 6 MCUs for the broad-base of IoT and Consumer applications, bringing best in class low power, connectivity, and security</p> <p>PSoC 4 delivers unique software-defined peripherals and industry leading capacitive sensing designs</p> 	<div> <p>PSoC 3 8051 CPU 67 MHz, 64KB Flash Up to 19 PAB, 30 PDB, 72 I/Os</p> </div> <div> <p>PSoC 1 M8C CPU 24 MHz, 32KB Flash 16 PAB, 16 PDB, 64 I/Os</p> </div> <div> <p>8FX 8-bit RISC MCU 16 MHz, 32–50KB Flash</p> </div> <div> <p>PSoC 4 Cortex-M0/M0+ 48 MHz, 384KB Flash Up to 13 PAB, 20 PDB, 98 I/Os</p> </div> <div> <p>FM0+ MCUs Cortex®-M0+ 40 MHz, 512KB Flash, 102 I/Os</p> </div> <div> <p>XMC1000 MCUs Cortex®-M0 32–48 MHz, 200KB Flash, 55 I/Os</p> </div>	<div> <p>PSoC 5LP Cortex-M3 80 MHz, 256KB Flash 20 PAB, 30 PDB, 72 I/Os</p> </div> <div> <p>FM3 MCUs Cortex-M3 144 MHz, 1.5MB Flash, 154 I/Os</p> </div> <div> <p>Industrial XMC™ is a family of high-performance Arm Cortex-M-based MCUs for industrial applications, with industrial control peripherals and extended temp range FM is a portfolio of high-performance Arm Cortex-M-based MCUs for industrial and consumer applications</p>  </div>	<div> <p>PSoC 6 150 MHz Cortex-M4/100 MHz M0+ 2MB Flash 7 PAB, 56 PDB, 104 I/Os</p> </div> <div> <p>FM4 MCUs Cortex-M4 200 MHz, 2MB Flash, 190 I/Os</p> </div> <div> <p>XMC4000 MCUs Cortex®-M4 80–144 MHz, 2MB Flash, 119 I/Os Industrial Comms, Ta 125C</p> </div>	<div> <p>Next Gen IoT MCU Multi-core Cortex-Mx ML-Ready, HMI Rich</p> </div> <div> <p>Industrial Evolution Multi-core Cortex-Mx Industrial Quality, ECC Memories</p> </div> <div> <p>Other Specialized and Legacy</p>  </div>

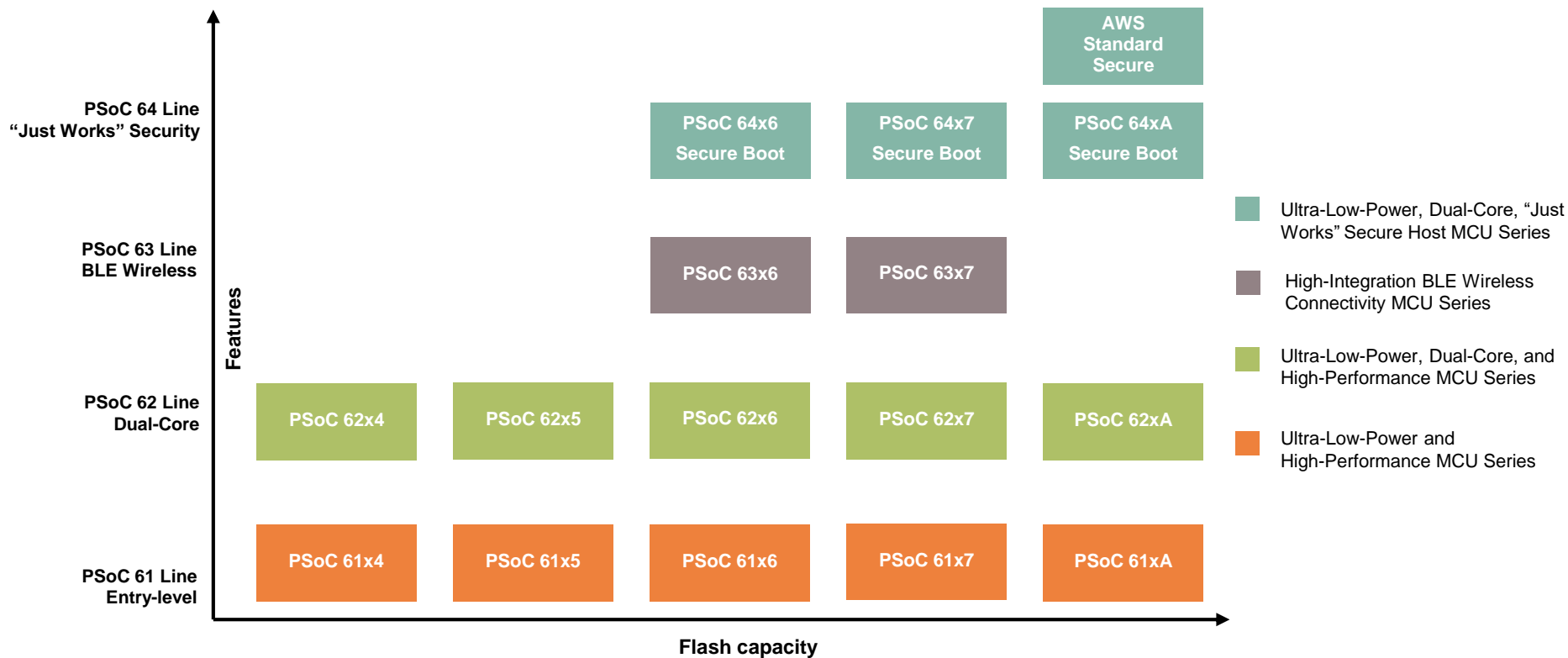
XMC™ MCU product portfolio



PSoC[®] 4 portfolio



PSoC® 6 portfolio



Cell Monitoring and Balancing

Battery Monitoring and Balancing IC



Accurate Voltage measurement

1. Synchronicity

12x Delta Sigma ADCs ensure that voltage of all cells is measured synchronously

2. Voltage measurement diagnosis

Additional block voltage measurement and comparator ensure that possible errors on the voltage measurement HW are detected

3. Accuracy

±5 mV end of life accuracy guaranteed by using a stress sensor and advance temperature compensation

4. Filtering

Several filtering modes ensure that desired noise can be eliminated from measured signal without influencing system cost

Cell balancing

1. Integrated balancing switch

Integrated switches with up to 150 mA using external resistors to reduce chip power consumption

2. Balancing diagnosis

Overcurrent, undercurrent and open load diagnosis available

3. Balancing time targets

Balancing can be programmed to stop after a given time up to 32 hours and does not need microcontroller interaction

4. External balancing switches

Supports external PMOS switches for increased balancing current

Host communication

1. UART based communication

Iso UART is based on UART frames that are transferred including an 8 bit CRC to ensure data integrity until Microcontroller register

2. High number of slaves

Communication allows up to 62 slaves without loss of signal

3. Ring mode topology

Supports ring topology to ensure fail operational state in case 1 slave/wire is failing

4. Power balanced

Each message will be sent over the full chain independent of the position of the receiver slave. Answers are also sent in both directions

5. Master-on-top or bottom selectable without tedious configuration

6. Bi-directional communication scheme using error management logic

7. Uses capacitive isolation which reduces the space and cost of Design

Cell Balancing MOSFETs

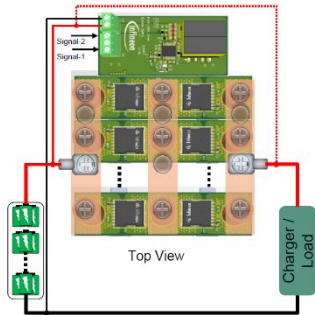
20/30V N/P Channel					
Package	SC59 (3 X 3)	SOT23 (3 X 2.5)	SOT323 (2 X 2)	TSOP6	SOT363-Dual (2 X 2)
Type					Single Dual
Equalising Current	<2A	>1.5A	<0.8A	<2A	<1A <0.5A

- › Wide range of Packages
- › Suitable for Space Constraints
- › Suitable equalizing Current between 0.5A to 2.5A
- › Compact solution with Smaller PCB footprint

BMS evaluation boards

Battery Protection

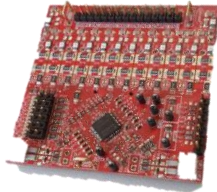
Bidirectional Switch
(Battery Protection)



Coming Soon

Cell Monitoring And Balancing

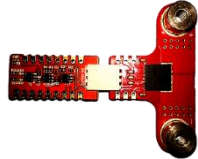
TLE9012 Kit
(BMS Analog Frontend)



TLE9015 Kit
(Isolated Communication)

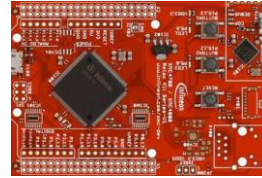


TLI4971 Kit
(Isolated Current Sensor)



Cell Monitoring and Controlling

XMC/ Cypress Evalkits
(Microcontrollers)



Cell Monitoring and Controlling

LIN/ CAN Eval Kits



Battery Security

Optiga X Eval Kits

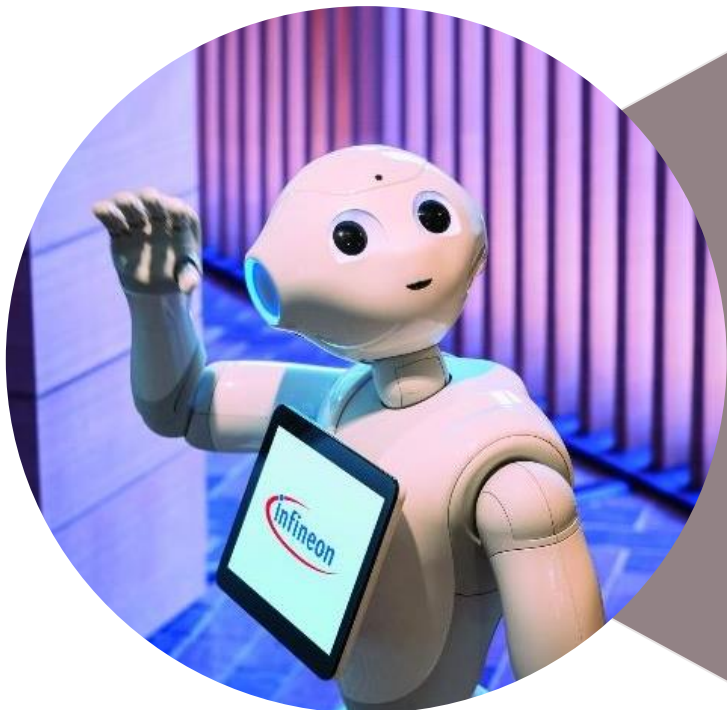


Optiga M Eval Kits





Further Material – BMS



Portfolio and further information can be found here:



- [Link](#) → MCU
- [Link](#) → MOSFET
- [Link](#) → Gate Driver
- [Link](#) → Battery Cell balancing & monitoring



Learn more on our [webpage](#)





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