

EV BATTERY SAFETY AND CONDITION MONITORING

Craig Gannon, Honeywell (on behalf of Acal BFi)





Introduction

Craig Gannon, Product Manager
Honeywell

(on behalf of Acal BFi)



HONEYWELL

NYSE: HON | ~919 sites | ~100,000 employees | Charlotte, N.C. headquarter



AEROSPACE

Our products are used on virtually every commercial and defense aircraft platform worldwide and include aircraft propulsion, cockpit systems, satellite communications, and auxiliary power systems.



BUILDING TECHNOLOGIES

Our products, software, and technologies are in more than 10 million buildings worldwide, helping customers ensure their facilities are safe, energy efficient, sustainable, and productive.



PERFORMANCE MATERIALS AND TECHNOLOGIES

We develop advanced materials, process technologies, automation solutions, and industrial software that are revolutionizing industries around the world.



SAFETY AND PRODUCTIVITY SOLUTIONS

We improve enterprise performance and worker safety and productivity with automated material handling and voice, scanning and mobile computing technology, software solutions, and personal protective equipment and sensing technology.

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HONEYWELL CONNECTED ENTERPRISE

SENSING AND SAFETY TECHNOLOGIES

FOCUS MARKETS



Healthcare Sensing (HCS)

home healthcare, diagnostics, respiratory, fluid management and healthy air



Aerospace and Transportation Sensing (ATS)

urban air mobility (UAM) and unmanned aerial vehicles (UAV), electrification and defense as well as autonomous (ADAS) electrification



Industrial Sensing (IS)

industrial safety, smart factory, building & access and HVAC

Honeywell offers more than 50,000 sensors, switches and solutions used in critical healthcare, commercial aircraft, heavy-duty transportation and other equipment



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AGENDA

1. EV Market Overview

1. MEGA Trends (Transportation)
2. Drive Towards EV
3. Barriers to EV Adoption

2. Battery Safety

1. Thermal runaway

3. Current Sensing

1. Applications

4. Q&A

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TRANSPORTATION MEGA TRENDS

Across all sectors in the transportation industry there are trends in technology that will shift the way we think about transportation....

- *Digitalisation*
- *Autonomous*
- *Electrification (EV)*

3.7% CAGR

\$8.9t

Global
Transportation
Industry by 2030

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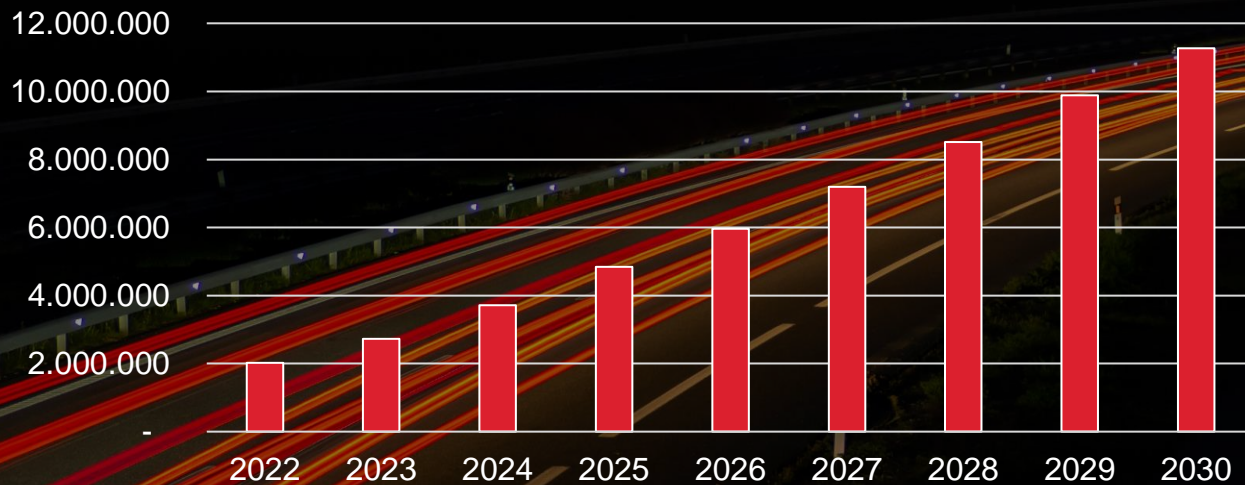
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DRIVE TOWARDS ELECTRIFICATION

Drives & Growth

- 27% of Greenhouse Gas Emissions
- Net zero ambition – Emission Targets
- 11.2m EV/24% CAGR EU - (2030)
- 21m EV - US (2030)

Europe - No. of EVs



Original equipment manufacturer	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
BMW Group			25		15-25%					10
BAIC Group		2			1.3					50%
Changan Automobile (Group)					33					
Daimler			10		25%					50%
Dongfeng Motor Co		1	30%	1		1			1	1
FAW					40%					60%
Ford		40				100%*				
GM Group			22		30	1				1
Honda										40%†
Hyundai-Kia					1					
Mazda			1							5%
Renault-Nissan			20							
Maruti Suzuki				20%						
SAIC						30%				30
Stellantis					38%*					70%*
Toyota Group					31%					35%**
Volkswagen					20%					70%*
Volvo (Geely Group)						75			26	50%**
		1	1	1	1	50%				100%*

■ % of sales electric
■ Annual sales (million)
■ New EV models (number)
■ Cumulative sales (million)

* European market only
 ** Chinese and US markets only
 † Includes both EVs and FCEVs

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BARRIERS TO EV ADOPTION



1. Charging Infrastructure



2. Performance



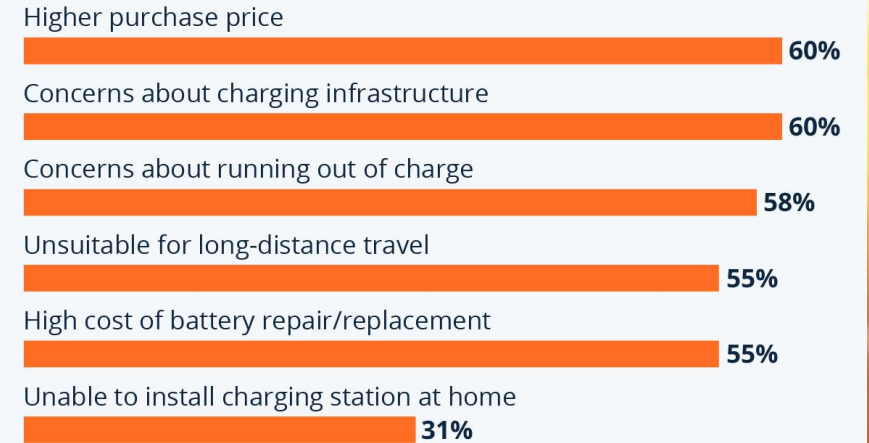
3. Affordability



4. Availability

High Prices, Range Anxiety Holding Back EV Adoption

Share of U.S. adults saying they're unlikely to buy an electric vehicle as their next car for the following reasons



Based on a survey of 1,051 U.S. adults conducted in February 2022
Source: AAA



statista

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BARRIERS TO EV ADOPTION



5. Raw Material Extraction



6. Alternative Fuel Sources



7. Safety

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BATTERY SAFETY



THERMAL RUNAWAY

SAFETY HAZARD



- Overheating battery system resulting in fire
- Mechanical, electrical or chemical failure
- Once event has started cannot be reversed
- OEMs incorporating safety sensors to mitigate risks
- Minimum warning threshold legislation
- Consumer confidence is key – safety net



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BATTERY SAFETY SENSOR TECHNOLOGIES



Specification

Technology	Light scattering (Aerosol PM Sensor)	Monitors absolute pressure
Output type	CAN communication	CAN communication
Detection range	1 $\mu\text{g}/\text{m}^3$ ~ 10000 $\mu\text{g}/\text{m}^3$	50 KPa to 300 KPa
Accuracy	$\pm 15\%$	-2 to +4kPa
Response time	≤ 1 s	30 ms
Operating temperature	-40°C to 85°C	-40°C to 105°C
Modes	ECO & Continuous	ECO & Continuous
Price	\$	\$

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CURRENT SENSING



SELECTING THE CORRECT CURRENT SENSOR

- Sensing range
- Accuracy
- Magnetic interference
- Zero offset
- Ease of installation
(size, connector and mounting)



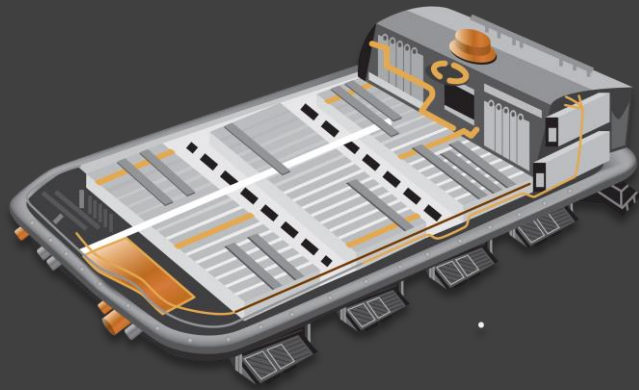
Current Sensing Specifications Engineers Care About



CURRENT SENSING APPLICATIONS

Battery Management System (BMS) in Li-ion Batteries

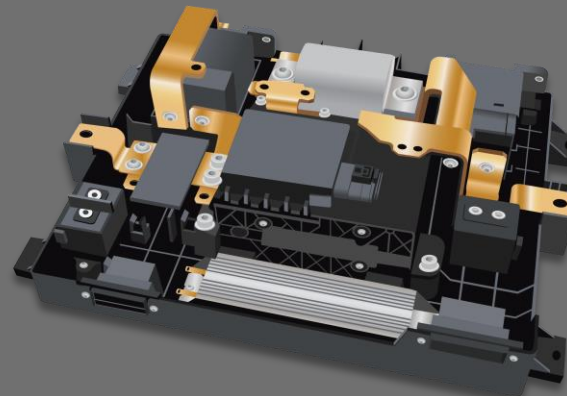
BMS in an electric vehicle keeps the Li-ion battery within the safety of operation during charge and discharge



HON Sensor Application	State of charge estimation (Fuel gauge for EV) and safety
Critical Features	<ul style="list-style-type: none"> • Sensing range • Accuracy over sensing range
Customer Type	<ul style="list-style-type: none"> • Li-ion battery manufacturers • Tier 2 suppliers (CMs) • Electric vehicle OEMs

Battery Disconnect Unit (BDU) in Electric Vehicles

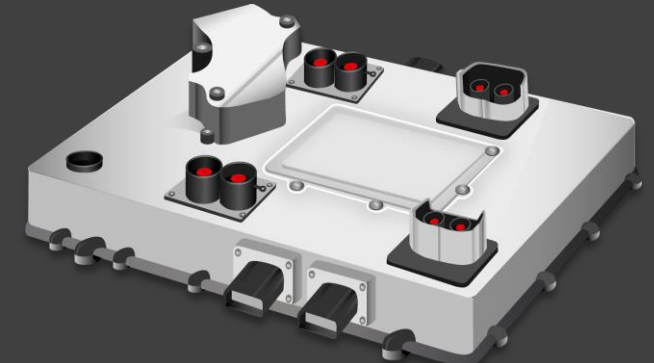
BDUs in an electric vehicle (EV) acts as an on/off switch to the battery for different EV operating modes



HON Sensor Application	Measures current flow into & out of the battery
Critical Features	<ul style="list-style-type: none"> • Accuracy over sensing range • Immunity to stray magnetic fields
Customer Type	<ul style="list-style-type: none"> • Tier 2 suppliers (CMs & Design Houses) • Electric Vehicle OEMs

Power Distribution Unit (PDU) in Electric Vehicles

PDU in an electric vehicle (EV) enables the connections with all HV Units (loads, supply) in a single location in the vehicle



HON Sensor Application	Measures current for vehicle efficiency and safety
Critical Features	<ul style="list-style-type: none"> • Accuracy over sensing range • Immunity to stray magnetic fields
Customer Type	<ul style="list-style-type: none"> • Tier 2 suppliers (CMs & Design Houses) • Electric Vehicle OEMs



CURRENT SENSOR TECHNOLOGIES



Specification

Technology	Flux gate	Hall-effect
Output type	CAN	Analog voltage
Sensed current	±700A	±100 A to ±1500 A ranges
Accuracy (I_p=0, no current flow)	±0.05 A	±1.4 A
Accuracy (full scale)	±0.1 A @ -40°C to 85°C / I _p ≤ 20 A ±0.5 % @ -40°C to 85°C / 20A < I _p ≤ 700 A	I _{pn} * 2%
Response time	CAN Bus (10 millisecond)	6 μsec
Operating temperature	-40°C to 85°C	-40°C to 125°C
Price	\$\$	\$

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Thanks!

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