Automotive Conference Call
London, 10 October 2017

Peter Schiefer
Division President Automotive
Agenda

1. Overview
2. Megatrend 1: ADAS and automated driving
3. Megatrend 2: Clean cars
4. Summary

Please regard the glossary at the end of the presentation.

Disclaimer: This presentation contains forward-looking statements about the business, financial condition and earnings performance of the Infineon Group. These statements are based on assumptions and projections resting upon currently available information and present estimates. They are subject to a multitude of uncertainties and risks. Actual business development may therefore differ materially from what has been expected. Beyond disclosure requirements stipulated by law, Infineon does not undertake any obligation to update forward-looking statements.
Megatrends shaping the automotive market; significantly increasing semi content per car

- **Automated Driving**
  - Enabling safety towards Vision Zero

- **eMobility**
  - Enabling CO$_2$ reduction

- **Connectivity**
  - Enabling the communication of cars

- **Advanced Security**
  - Enabling security in connected cars
Infineon’s automotive business is outgrowing the market since 2010

Infineon automotive market share development*

* Infineon automotive revenue as reported to Strategy Analytics incl. revenue from ATV, IPC and PMM. Adjusted to calendar year.

### Infineon's position in the automotive semiconductor universe

**Automotive semiconductors**  
2016 total market size: $30.2bn

<table>
<thead>
<tr>
<th>Category</th>
<th>Company</th>
<th>Market Share</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sensors</strong></td>
<td>NXP*</td>
<td>14.0%</td>
</tr>
<tr>
<td></td>
<td>Infineon</td>
<td>10.7%</td>
</tr>
<tr>
<td></td>
<td>Renesas</td>
<td>9.8%</td>
</tr>
<tr>
<td></td>
<td>Texas Instr.</td>
<td>7.8%</td>
</tr>
<tr>
<td></td>
<td>STMicro</td>
<td>7.4%</td>
</tr>
<tr>
<td><strong>Microcontrollers</strong></td>
<td>NXP</td>
<td>27.0%</td>
</tr>
<tr>
<td></td>
<td>Texas Instr.</td>
<td>9.7%</td>
</tr>
<tr>
<td></td>
<td>Infineon</td>
<td>8.7% +0.1%-pt</td>
</tr>
<tr>
<td></td>
<td>Microchip</td>
<td>5.7%</td>
</tr>
<tr>
<td><strong>Power</strong></td>
<td>Infineon</td>
<td>25.6% +0.4%-pt</td>
</tr>
<tr>
<td></td>
<td>STMicro</td>
<td>13.4%</td>
</tr>
<tr>
<td></td>
<td>Bosch</td>
<td>9.2%</td>
</tr>
<tr>
<td></td>
<td>NXP*</td>
<td>8.2%</td>
</tr>
<tr>
<td></td>
<td>Texas Instr.</td>
<td>8.8%</td>
</tr>
</tbody>
</table>

#### Market share trend

- Infineon benefits disproportionately from the two mega trends  
  - ADAS/AD  
  - clean cars

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* Divestiture of NXP’s Standard Product business (“Nexperia”) closed on 16 Feb 2017; hence included in the 2016 ranking.  

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**Long-term drivers:**  
- 24 / 77 GHz radar  
- lidar
WW car production growth rate expected to be ~2% for 2017 and 2018; China slowing down

Source: IHS Markit, Technology Group, “Light vehicle production & sales volumes”, September 2017 update
Megatrend 1: advanced driver assistance systems and automated driving

Automated Driving
Enabling safety towards Vision Zero

eMobility
Enabling CO₂ reduction

Connectivity
Enabling the communication of cars

Advanced Security
Enabling security in connected cars
Conceptual overview of an ADAS/AD system

Sense
- Human driver
- Sensor fusion
- Specialized sensor processors
- Sensor fusion decision making

Compute
- Central gateway
- Driving domain controller

Actuate
- Transmission
- Engine
- Braking (ABS)
- Steering

Automated car
- Camera inside
- Radar
- Lidar
- Camera outside
- Ultrasonic
### Average semiconductor content per car by level of automation

<table>
<thead>
<tr>
<th>Level 2 (~2020)</th>
<th>Level 3 (~2025)</th>
<th>Level 4/5 (~2030)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sense</strong></td>
<td><strong>Sense</strong></td>
<td><strong>Sense</strong></td>
</tr>
<tr>
<td><strong>Compute</strong></td>
<td><strong>Compute</strong></td>
<td><strong>Compute</strong></td>
</tr>
<tr>
<td><strong>Actuate</strong></td>
<td><strong>Actuate</strong></td>
<td><strong>Actuate</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Component</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Level 4/5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camera modules</td>
<td>$40</td>
<td>$180</td>
<td>$195</td>
</tr>
<tr>
<td>Radar modules</td>
<td>$90</td>
<td>$190</td>
<td>$230</td>
</tr>
<tr>
<td>Lidar modules</td>
<td>$0</td>
<td>$70</td>
<td>$190</td>
</tr>
<tr>
<td>Sensor fusion</td>
<td>$20</td>
<td>$110</td>
<td>$55</td>
</tr>
<tr>
<td>Actuators</td>
<td>$0</td>
<td>$30</td>
<td>$860</td>
</tr>
<tr>
<td><strong>Total BoM</strong></td>
<td>$150</td>
<td>$580</td>
<td>$860</td>
</tr>
</tbody>
</table>

- L2 vehicles in 2020: ~8m
- L3 vehicles in 2025: ~3m
- L4/L5 vehicles in 2030: ~4m

Source: Strategy Analytics; IHS Markit, Technology Group; Infineon.
Bill of material contains all type of semiconductors (e.g. radar modules include µC).
More sensors required for any next level of automation will lead to sensor cocoon in L4/5

<table>
<thead>
<tr>
<th>Level of automation</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Level 4/5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Automatic emergency brake/ forward collision warning</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parking assist</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lane keep assist</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highway assist</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valet parking</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highway and urban chauffeur</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radar # of modules**</td>
<td>≥ 3</td>
<td>≥ 6</td>
<td>≥ 10</td>
</tr>
<tr>
<td>Camera # of modules**</td>
<td>≥ 1</td>
<td>≥ 4</td>
<td>≥ 8</td>
</tr>
<tr>
<td>Lidar # of modules**</td>
<td>0</td>
<td>≤ 1</td>
<td>≥ 1</td>
</tr>
<tr>
<td>Others</td>
<td>Ultrasonic</td>
<td>Ultrasonic</td>
<td>Ultrasonic</td>
</tr>
<tr>
<td></td>
<td>Interior camera</td>
<td>Interior camera</td>
<td>Interior camera</td>
</tr>
</tbody>
</table>

* Source: VDA (German Association of the Automotive Industry); Society of Automotive Engineers
** Market assumption
Infineon’s radar solutions reduce development efforts on customer side

- SiGe-based radar solutions are the best solutions on the market
- Infineon’s radar solutions facilitate the system integration at customers and reduce their development efforts
- Infineon’s optimized solutions safeguard component interoperability and comply with functional safety requirements

Infineon’s radar chipset
- transceiver
- processor
- safe power supply
- in-vehicle network

Unit shipments doubled in FY17!
Introduction of central computers triggers demand for high-perf., fail operational MCUs

**L0 / L1 / L2 vehicles**

- Temperature
- Pressure
- Position
- Speed

**L3 / L4 / L5 vehicles**

- Camera
- Radar
- Lidar
- GPS

**central computer**

- CPU / GPU
- MCU (AURIX™)

**future ECU = classic ECU**

- + higher performance
- + fail operational
- + secure

**fail operational** systems require redundancy in

- Power switches, power supply
- Sensors
- MCUs

**car security** is achieved through

- Discrete security controller (OPTIGA™)
- Integrated security modules in MCUs (AURIX™)
Vast majority of microcontroller units (MCUs) will be used in ECUs

<table>
<thead>
<tr>
<th>Vehicle segments</th>
<th>Light vehicle production</th>
<th>ECU</th>
<th>CC</th>
</tr>
</thead>
<tbody>
<tr>
<td>luxury/premium</td>
<td><img src="image" alt="Car" /></td>
<td><img src="chart" alt="Graph" /></td>
<td>up to 110 MCUs</td>
</tr>
<tr>
<td>mid-range</td>
<td><img src="image" alt="Car" /></td>
<td><img src="chart" alt="Graph" /></td>
<td>up to 60 MCUs</td>
</tr>
<tr>
<td>economy/low-end</td>
<td><img src="image" alt="Car" /></td>
<td><img src="chart" alt="Graph" /></td>
<td>up to 20 MCUs</td>
</tr>
</tbody>
</table>

Source: Strategy Analytics, Infineon estimates
32-bit MCUs capture the lion share of $-opportunity in automotive applications

Example: 2016 German premium car with ~110 MCUs in total

32-bit MCU market is the place to be

~110 MCUs

100%

~25

~30

~55

by unit

by value

8-bit
16-bit
32-bit

3,570

1,464

839

2016

2017

2018

2019

2020

2021

2022

2023

[USD m]

CAGR\textsubscript{(16-23)}: +5.3%

= 61% market size

= 72% market size

8-bit
16-bit
32-bit

~25%

~60%

~15%

Infineon AURIX™ fits to ~90% of all 32-bit use cases and is clearly gaining market share in 32-bit automotive market, e.g. radar signal pre-processing

Source: Strategy Analytics, „Automotive Semiconductor Demand Forecast 2014 – 2023“, January 2017
AURIX™ microcontroller covers ~90% of all 32-bit control and processing use cases

### 32-bit MCU use cases

- Airbag and safety
- Power steering
- Stability control
- xEV DC-DC & charger
- Powertrain
- xEV inverter control
- Domain control
- Sensor fusion
- 24 GHz radar
- 77 GHz radar
- Advanced lighting
- Vision safe host

### AURIX™ radar controller and chipset

- **Performance**: multi-core microcontrollers supporting latest radar data analysis algorithms
- **Scalability**: portfolio covering basic assist systems up to complex automated driving
- **Safety**: chipset enabling design of safe radar systems up to ISO26262 ASIL-D
- **Security**: Latest crypto-processing technology for protection against hacker attacks

Five major radar system suppliers plan to use AURIX™ 2G radar controller in 2020 onwards.
Megatrend 2: clean cars

Automated Driving
- Enabling safety towards Vision Zero

eMobility
- Enabling CO₂ reduction

Connectivity
- Enabling the communication of cars

Advanced Security
- Enabling security in connected cars
CO₂ emission targets are the key triggering points for increase in semiconductors

National fleet emissions

CO₂ drives three major trends

(1) Higher efficiency of the ‘classic’ ICE:
- EPS (electric power steering)
- start-stop
- dual-clutch
- alternator

(2) Energy efficiency of body applications:
- power distribution
- electric motors for pumps and fans

(3) Electrification of the drivetrain:
- main inverter
- auxiliary inverter
- onboard charger
- battery management

Source: The International Council for Clean Transportation, 2017
Power semiconductor demand for all different levels of electrification

Incremental power semi content for drive train

- BEV, Fuel Cell EV
  - energy recovery
  - onboard charger

- Full HEV
  - start-stop
  - energy recovery
  - coasting, sailing
  - boosting (fun-to-drive)
  - EV mode

- Plug-in HEV
  - start-stop
  - energy recovery
  - coasting, sailing
  - boosting (fun-to-drive)
  - EV mode
  - onboard charger

- Mild HEV, 48 V
  - start-stop
  - energy recovery

- Hybrid

Power of xEV electric motor [kW]
Infineon has unparalleled package expertise for high-power main inverter applications

<table>
<thead>
<tr>
<th>Bare die</th>
<th>Discrettes</th>
<th>Scalable products</th>
<th>Plug-n-Play</th>
</tr>
</thead>
<tbody>
<tr>
<td>Si bare dies</td>
<td>Si IGBT</td>
<td>HybridPACK™ Double-Sided Cooling</td>
<td>HybridPACK™ solutions</td>
</tr>
<tr>
<td>SiC bare dies</td>
<td>SiC MOSFET</td>
<td></td>
<td>Easy modules</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>SiC-optimized package solution</td>
</tr>
</tbody>
</table>
The incremental demand of power semiconductors is a significant opportunity.

### 2017 average xEV semiconductor content by degree of electrification

<table>
<thead>
<tr>
<th></th>
<th>48 V / MHEV</th>
<th>HEV / PHEV</th>
<th>BEV</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sense</strong></td>
<td>$355</td>
<td>$355</td>
<td>$75</td>
</tr>
<tr>
<td><strong>Compute</strong></td>
<td>$5</td>
<td>$15</td>
<td>$5</td>
</tr>
<tr>
<td><strong>Actuate</strong></td>
<td>$20</td>
<td>$20</td>
<td>$20</td>
</tr>
<tr>
<td><strong>total semi BoM</strong></td>
<td>$455</td>
<td>$695</td>
<td>$695</td>
</tr>
</tbody>
</table>

**48 V / MHEV veh. in 2025: ~15m**

**PHEV vehicles in 2025: ~9m**

**BEV vehicles in 2025: ~6m**

Source: Strategy Analytics, “Automotive Semiconductor Content”, May 2017; Infineon

*“power” includes linear and ASIC; “others” include opto, small signal discrete, memory*
With the transition from ICE to xEV the power semi content in powertrain increases by ~15x

Average semiconductor content by type of car

<table>
<thead>
<tr>
<th>Type of Car</th>
<th>Drivetrain Non-Power Semi</th>
<th>Drivetrain Power Semi</th>
<th>Other Features (Power and Non-Power Semi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICE</td>
<td>300</td>
<td>38</td>
<td>17</td>
</tr>
<tr>
<td>HEV / PHEV</td>
<td>300</td>
<td>130</td>
<td>695</td>
</tr>
</tbody>
</table>

Source: Strategy Analytics, “Automotive Semiconductor Content”, May 2017; Infineon
Various market drivers yield a sweet spot for xEV: BEV SUV and PHEV SUV

Consumers
- Diesel uncertainty
- SUV popularity
- Fuel price
- Charging infrastructure

Car Manufacturers
- Profitable premium sport brands
- Electrification (xEV)
- New BEV players/disruptors

Politics / Legislation
- China focus on tech leadership
- CO2 targets
- Diesel ban

Sweet Spot: BEV & PHEV SUV
SiC has some significant advantages over Si but will stay a niche market for some time

### SiC versus Si on application level

<table>
<thead>
<tr>
<th>Onboard charger</th>
<th>Main inverter</th>
</tr>
</thead>
</table>

### Advantages of SiC vs Si

- SiC enables a smaller form factor, less weight and thus lead to CO₂ savings on a “well-2-wheel” basis
- Higher efficiency at high-voltage fast charging
- volume reduction by 50%

### Advantages of SiC vs Si

- High efficiency → higher range; altern.: reduced battery cost for the same range
- Higher power density → higher performance, more flexibility in scalability
- volume reduction by 50% to 80%
- about 5% efficiency gains in real-life driving cycle
Premium cars will adopt SiC first in 2020+; mass market will follow not before 2025

Penetration of SiC in main inverters (qualitative forecast only)

- **As cost for SiC will come down over time, advantages such as performance increase, range extension, and faster charging cycles will be highly adopted for premium BEVs.**

- **Advantages of SiC-based main inverters will pay off case-by-case, e.g. PHEV will benefit from smaller form factor.**

- **Si will be more cost competitive for a long time.**

- **It is unlikely that small xEVs will switch to SiC at a large extend.**

Source: Infineon
Infineon is well prepared for the adoption of SiC power modules in electro-mobility

Infineon demonstrated SiC power module for automotive applications

- 3-phase half-bridge module
- Power density doubled compared to IGBT
- HybridPACK™ Drive compatible
- Target applications:
  - Main inverter (300 kW)
  - High-voltage DC-DC converter

More than 15 leading OEMs and tier-1s are evaluating the Infineon HybridPACK™ Drive CoolSiC™ MOSFET power module
Two types of charging: AC-DC on-board charging and DC-DC off-board charging.

Ultra high-power charging stations will use Infineon CoolSiC™ MOSFET technology

First OEM has chosen Infineon CoolSiC™ MOSFET technology for ultra high-power charging stations to shrink size and weight

The project

› A consortium of German OEMs have signed MoU to create highest-powered charging network in Europe
› Goal: quick build-up of sizable number of stations in order to enable long-distance travel for battery electric vehicle drivers through open-network charging stations along highways
› Roll-out plan:
  › start in 2017
  › initially 400 sites in Europe
  › 1,000s of charging points by 2020

› Ultra high-power charging stations will reduce charging time for 300 km reach from 3 h to 20 min
› Specification: 350 kW; 800 V; 400 A
› Just 5 full SiC power modules (plus 5 driver ICs) are required per station due to extraordinary high performance of the Infineon CoolSiC™ MOSFET
› Infineon starts to deliver in Oct 2017
2022 trends for SiC in xEV: inverter is leading application; modules are leading form factor

2022 total power semiconductor market in xEV: $1,011m*

SiC by application**

<table>
<thead>
<tr>
<th>Year</th>
<th>DC-DC converter</th>
<th>on-board charger</th>
<th>inverter</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>2017</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>2018</td>
<td>11</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>2019</td>
<td>17</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td>2020</td>
<td>34</td>
<td>34</td>
<td>34</td>
</tr>
<tr>
<td>2021</td>
<td>46</td>
<td>46</td>
<td>46</td>
</tr>
<tr>
<td>2022</td>
<td>69</td>
<td>69</td>
<td>69</td>
</tr>
</tbody>
</table>

SiC by product**

<table>
<thead>
<tr>
<th>Year</th>
<th>SiC diodes</th>
<th>SiC FETs</th>
<th>SiC modules</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>2017</td>
<td>23</td>
<td>23</td>
<td>23</td>
</tr>
<tr>
<td>2018</td>
<td>6</td>
<td>6</td>
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</tr>
<tr>
<td>2019</td>
<td>11</td>
<td>11</td>
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</tr>
<tr>
<td>2020</td>
<td>17</td>
<td>17</td>
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</tr>
<tr>
<td>2021</td>
<td>34</td>
<td>34</td>
<td>34</td>
</tr>
<tr>
<td>2022</td>
<td>75</td>
<td>75</td>
<td>75</td>
</tr>
</tbody>
</table>

Si IGBTs: $865m (86%)
SiC: $146m (14%)

* Infineon estimate; incl. discrete IGBTs and IGBT modules, excl. MOSFETs
Megatrends shaping the automotive market; significantly increasing semi content per car
ADAS/AD, clean cars, and adoption of premium features drive growth

Vehicle production

<table>
<thead>
<tr>
<th>Clean cars</th>
<th>ADAS/AD</th>
<th>Comfort, premium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driven by legislation</td>
<td>Today:</td>
<td>Premium cars are early adopters of high-end comfort and safety features</td>
</tr>
<tr>
<td>Improvements of ICE</td>
<td>› crash avoidance</td>
<td>› Trickling down to mid-range</td>
</tr>
<tr>
<td>Higher efficiency of all electric consumers</td>
<td>› ADAS</td>
<td></td>
</tr>
<tr>
<td>Adoption of xEV</td>
<td>› Autonomous Driving</td>
<td></td>
</tr>
<tr>
<td>2% - 3% growth p.a.</td>
<td>Tomorrow:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>› Autonomous Driving</td>
<td></td>
</tr>
</tbody>
</table>

~8% p.a. through-cycle growth
Summary – high confidence in 8% p.a. through-cycle growth

**ADAS/AD:**
- Shipments in radar sensor ICs will double in FY17 y-y
- Infineon has developed strong microcontroller product portfolio for radar systems

**xEV transition:**
- Infineon is the main beneficiary of electro-mobility: power semi content in drivetrain is increasing by ~15x
- Infineon has industry’s broadest package portfolio for xEV applications
- Infineon’s view on SiC:
  - premium cars will adopt SiC first in 2020+; mass market will follow not before 2025
  - modules will be the preferred form factor
Part of your life. Part of tomorrow.
## Glossary

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACC</td>
<td>adaptive cruise control</td>
</tr>
<tr>
<td>AD</td>
<td>automated driving</td>
</tr>
<tr>
<td>ADAS</td>
<td>advanced driver assistance system</td>
</tr>
<tr>
<td>AEB</td>
<td>automatic emergency braking</td>
</tr>
<tr>
<td>BEV</td>
<td>battery electric vehicle</td>
</tr>
<tr>
<td>BoM</td>
<td>bill of material</td>
</tr>
<tr>
<td>CC</td>
<td>central computer</td>
</tr>
<tr>
<td>CPU</td>
<td>central processing unit</td>
</tr>
<tr>
<td>DPM</td>
<td>digital power management</td>
</tr>
<tr>
<td>ECU</td>
<td>electronic control unit</td>
</tr>
<tr>
<td>EPS</td>
<td>electric power steering</td>
</tr>
<tr>
<td>FCW</td>
<td>forward collision warning</td>
</tr>
<tr>
<td>GPU</td>
<td>graphics control unit</td>
</tr>
<tr>
<td>HEV</td>
<td>mild and full hybrid electric vehicle</td>
</tr>
<tr>
<td>ICE</td>
<td>internal combustion engine</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MHA</td>
<td>major home appliances</td>
</tr>
<tr>
<td>micro-hybrid</td>
<td>vehicles using start-stop systems and limited recuperation</td>
</tr>
<tr>
<td>MCU</td>
<td>microcontroller unit</td>
</tr>
<tr>
<td>MHEV</td>
<td>mild hybrid electric vehicle; vehicles using start-stop systems, recuperation, DC-DC conversion, e-motor</td>
</tr>
<tr>
<td>OBC</td>
<td>onboard charger</td>
</tr>
<tr>
<td>PHEV</td>
<td>plug-in hybrid electric vehicle</td>
</tr>
<tr>
<td>SiC</td>
<td>silicon carbide</td>
</tr>
<tr>
<td>SiGe</td>
<td>silicon germanium</td>
</tr>
<tr>
<td>ToF</td>
<td>time-of-flight 3D sensor</td>
</tr>
<tr>
<td>UPS</td>
<td>uninterruptible power supply</td>
</tr>
<tr>
<td>V2X</td>
<td>vehicle-to-everything communication</td>
</tr>
<tr>
<td>V2V</td>
<td>vehicle-to-vehicle communication</td>
</tr>
<tr>
<td>VSD</td>
<td>variable speed drive</td>
</tr>
<tr>
<td>xEV</td>
<td>all degrees of vehicle electrification (EV, HEV, PHEV)</td>
</tr>
</tbody>
</table>