“Active Safety – Electronic Stability Control (ESC) / Automatic Emergency Braking (AEB)”

Mr Leon Quinn – Senior Sales Manager
### Bosch Key Figures 2014

**Bosch Group**
- 46.1 billion euros in sales
- 360,000 associates
- Ownership structure: charitable foundation
- Spend their profit for a variety of social projects

**Mobility Solutions**
- One of the world's largest suppliers of automotive technology
  - 68% share of sales

**Industrial Technology**
- Leading in drive and control technology, packaging, and process technology

**Energy and Building Technology**
- Leading manufacturer of security technology
- Global market leader of energy-efficient heating products and hot-water solutions
  - 32% share of sales

**Consumer Goods**
- Leading supplier of power tools and accessories
- Leading the field in household appliances
Bosch Automotive Thailand

Foundation
October 1996

Employees
c. 1,100 (Dec 2014)

Bangkok
Sales Office

Amata Plant 1
Main plant
(Chassis Systems Control, Electrical Drives and Diesel Systems production)

Amata Plant 2
Gasoline Systems production
## Bosch Automotive Products

### Diesel Systems
- Common Rail System
- Glow plug / ECU, Vacuum pump
- DeNOx system

### Gasoline Systems
- Engine management system (ECU, Injector, Sensor)
- Fuel supply pump,
- Accel pedal module
- Transmission control system
- HEV/EV components
- CNG system

### Automotive Electronics
- Energy Management System
- Body Computer
- Parking Assist system
- Vehicle Security system

### Car Multimedia
- Low cost navigation system
- Instrumentation systems

### Starters and Generators
- Starter, Generator
- Start Stop System

### Automotive Aftermarket

### Chassis Systems Control
- Active safety: ABS, ESP, Sensors
- Driver assistance: Radar, Multi Purpose Camera, Stereo Video Camera, Ultrasonic Sensors
- Passive safety: Airbag ECU, Sensors
- Brake: iBooster, brake booster, master cylinder

### Electrical Drives
- Wiper, Engine cooling fan
- Window lift motor
- Electric power pump
Safe and comfortable driving for everyone

- “Invented for life”
  - leading with excellent Quality, Agility and Safety
  - supporting “safe and comfortable driving”

- Advanced driver assistance and safety systems
  - sense surrounding conditions,
  - control reaction patterns and use cases,
  - act for improving safety and comfort,
  - connect to mobility networks.
## Accident Research

### Car safety in 2013 – ASEAN

<table>
<thead>
<tr>
<th>Registered Cars¹,³ [Mio]</th>
<th>Road accidents¹ (Total number of accidents, 2013) in Thousands</th>
<th>Fatalities¹ (fatalities within 30 days after accident)</th>
<th>Car fatality per Registered car</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malaysia</td>
<td>11.6</td>
<td>477.2</td>
<td>6 915</td>
</tr>
<tr>
<td>Thailand</td>
<td>13.1</td>
<td>61.3</td>
<td>7 364</td>
</tr>
<tr>
<td>Indonesia</td>
<td>1.1</td>
<td>100.1</td>
<td>26 416</td>
</tr>
<tr>
<td>India</td>
<td>23.2</td>
<td>486.4</td>
<td>137 572</td>
</tr>
</tbody>
</table>

1) Transport partnership (AJTP Information Center), [http://www.ajtpweb.org](http://www.ajtpweb.org)
2) [www.grspiroadsafety.org/sites/](http://www.grspiroadsafety.org/sites/)
3) [https://data.gov.in/catalog/total-number-registered-motor-vehicles-india#web_catalog_tabs_block_10](https://data.gov.in/catalog/total-number-registered-motor-vehicles-india#web_catalog_tabs_block_10), 2013 Projected @ 10% Rate
Active Safety Legislation

ABS and ESP® regulations – status January 2015

ABS 2014
ESP® 2018

ABS 2014
ESP® 2018

ABS-M* 2016-2019

ESP® Nov 2011-2014
ABS-M* 2016-2017

ESP® 2012-2016

ESP® Jan 2010-2012

ESP® Jan 2014-2016
ESP® Oct 2012-2018
ESP® Jan 2012-2015
ESP® Jan 2015

ESP® for trucks & buses

ABS for trucks & buses

*ABS-M = ABS for Motorcycle
Safety Road Map

SUMMARY OF NCAP ROAD MAP
(2013 ~ 2020)


| ASEAN NCAP |
|---|---|---|---|---|---|---|---|---|
| Offset Impact | 60%ile Male | New Rating Scheme | ENCAP Protocol, Combined Score, 5%ile Female | Side AE-MDB, Side Pole World SID |
| Lateral Impact | New Rating Scheme | Child (Q1.5, Q3), New Rating Scheme, ASEAN NCAP Child Seat. |
| Child Occupant | Pre-requisite for 4 or 5 STAR | Pre-requisite for 3 STAR @ MIROS Test Centre |
| ECE R95 | Pre-requisite for 5 STAR | Pre-requisite for 4 STAR |
| ESC | Pre-requisite for 5 STAR | Pre-requisite for 4 STAR |
| SBR | | | |

| ANCAP |
|---|---|---|---|---|---|---|---|
| Frontal Impact, Side Impact, Side Pole, SBR, Mand SAT, Add SAT, Pedestrian Pro, Roof Crush, Whiplash | 31 December 2014 | Transition Period | 1 January 2018 |
| Current policies & protocols | Current policies & protocols (ANCAP Pathway) | Use Euro NCAP results (Euro NCAP Pathway) |
| • Road Map | • Transition Period | • Use Euro NCAP results. |
| • Variant Policy | • Use Euro NCAP results |
| • Niche Policy etc. | Access Euro NCAP results |

| ENCAP |
|---|---|---|---|---|---|---|---|
| Adult Occupant Pro (AOP) | New Rating +Whiplash RR +AEB City | +Frontal FW, Side AE-MDB, Side Pole 75%, 5%female |
| Child Occupant Pro (COP) | +New Impact Lwr leg | | |
| Ped. Pro. (PP) - Head, UL, LL | +New Impact Uppr leg, +AEB-VRU | | |
| Safety Assist (SA) | +SLD | +AEB City, +LDW/LKA |

Remarks:
SBR = Seatbelt Reminder
Mand SAT = Mandatory Safety Assist Tech.
Add SAT = Additional Safety Assist Tech.
ESC = Electronic Stability Control
SLD = Speed Limit Device
AEB = Autonomous Emergency Braking
VRU = Vulnerable Road User / Pedestrian
LDW = Lane Departure Warning
LKA = Lane Keep Assist
AE-MDB = Advanced European - MDB

Source: ASEAN NCAP
Bosch Systems Solutions

Active safety  Passive safety

Actuation | Braking  Driver assistance

Brake system | ESP®  Restraint system  Radar sensors  Video cameras  Ultrasonic sensors
Bosch’s Milestones in Road Safety

- **World’s first ABS**: 1978
- **World’s first TCS**: 1980
- **Predictive emergency braking system**: 1986
- **Lane change assist with MRR**: 1995
- **Fully automated driving**: 2010
- **World’s first airbag control unit**: 2013
- **World’s first ESP®**: 2014
- **Regenerative braking with ESP® hev**: 2016
- **Active pedestrian protection with stereo video camera**: 202x
- **iBooster**:
Electronic Stability Control (ESC) / ESP®
Active Safety Components

Active Safety product portfolio covers vehicle dynamics and stabilization functions from motorcycles up to light commercial vehicles.

- ABS
- Motorcycle ABS
- ESP®
- Inertial sensor
- Steering-angle sensor
- Wheel-speed sensor
Active Safety System Milestones

- 1978: World’s first ABS
- 1986: World’s first TCS
- 1995: World’s first ESP®
- 2003: 25 years ABS and Bosch 100 millionth ABS and 10 millionth ESP®
- 2006: Bosch 20 millionth ESP®
- 2007: Bosch 150 millionth ABS
- 2009: Bosch 200 millionth ABS
- 2010: 15 years ESP®
- 2012: Bosch 75 millionth ESP®
- 2014: Bosch 100 millionth ESP®
ESP® Features and Benefits

- Increases driving stability actively in all driving situations
- Vehicle stabilization by individual wheel braking and engine management control

Customer benefits

- Reduced risk of skidding
- Maneuverability maintained even in extreme situations
- Significant decrease of severe and fatal accidents
Video: Working Principle of ESP®
Technical Evolution of ESP®

Technical evolution of ESP®
weight [kg]

<table>
<thead>
<tr>
<th>Year</th>
<th>ESP®</th>
<th>Weight [kg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>ESP® 5.0</td>
<td>4.3 kg</td>
</tr>
<tr>
<td>1997</td>
<td>ESP® 5.3</td>
<td>3.7 kg</td>
</tr>
<tr>
<td>1998</td>
<td>ESP® 5.7</td>
<td>3.1 kg</td>
</tr>
<tr>
<td>2002</td>
<td>ESP® 8.0</td>
<td>2.3 kg</td>
</tr>
<tr>
<td>2007</td>
<td>ESP® 9.0</td>
<td>1.6 kg</td>
</tr>
</tbody>
</table>

ESP® installation rate
by production worldwide [%]

- 1995: 0%
- 1997: 0.4%
- 1998: 1%
- 2002: 10%
- 2005: 20%
- 2007: 31%
- 2010: 41%
ESP® Product Range and Value Added Functions

Bosch product line up covers all market demands
ESP® Value Added Functions

Hydraulic Brake Assist (HBA)
Reduces stopping distance increasing brake pressure at fast brake pedal application

Roll Over Mitigation (ROM)
Mitigates dangerous rollover e.g. motorway exit

Hill Hold Control (HHC)
Automatic hold of vehicle on hills, facilitated drive-off on slopes without roll-back

Load Adaptive Control Mode (LAC)
Adjusts ESP® interventions based on loading level (actual weight, center of gravity)

Hill Descent Control (HDC)
Cruise Control for functionality for downhill driving at low speed
Automatic Emergency Braking (AEB)
Functional Portfolio

Predictive Emergency Braking System

- Continuous analysis of traffic situation ahead & driver reaction
- Early detection of impending rear-end collisions
- Triggering of collision avoidance/mitigation

Predictive Collision Warning (PCW)

preparation of braking system: pre-fill and parameter adaptation of hydraulic brake assist

pre-warning (acoustic / visual), acute-warning (brake-jerk) in case of imminent front collision

Emergency Braking Assist (EBA)

extension of PCW functionality:

automatic amplification of brake-force (target braking) if driver reaction is given, but insufficient

Automatic Emergency Braking (AEB)

AEB — partial braking (AEB-P):
- gain more reaction time
- induce driver triggered emergency braking process

AEB — full brake (AEB-F):
- if collision unavoidable to reduce injury risk

AEB — low speed (AEB-L):
- collision avoidance braking at speeds < ~30 km/h

Equivalent FCW
## Functional Portfolio

<table>
<thead>
<tr>
<th>Description</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Brake preparation</strong></td>
<td>driver has full braking power available valuable hundredths of a second earlier</td>
</tr>
<tr>
<td>pre-fill &amp; parameter adaptation of hydraulic brake assist</td>
<td>driver is made aware of acute threat and can react earlier to potentially avoid a rear-end collision</td>
</tr>
<tr>
<td><strong>Collision Warning</strong></td>
<td>provide additional time for the driver to react</td>
</tr>
<tr>
<td>pre-warning (audible / visual), acute-warning (brake-jerk) in case of imminent front collision</td>
<td>effective braking support for the driver and assistance in potentially avoiding rear-end collisions</td>
</tr>
<tr>
<td><strong>Partial Braking</strong></td>
<td>effective amplification of brake force (target braking) if driver reaction is given, but insufficient</td>
</tr>
<tr>
<td>automatic partial braking to induce driver triggered emergency braking process</td>
<td>brakes the vehicle to the maximum extent</td>
</tr>
<tr>
<td><strong>Braking Support</strong></td>
<td>avoid collision or reduce impact speed and risk of injury</td>
</tr>
<tr>
<td>automatic amplification of brake force (target braking) if driver reaction</td>
<td></td>
</tr>
<tr>
<td>is given, but insufficient</td>
<td></td>
</tr>
<tr>
<td><strong>Emergency Braking</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>scalable safety functions for predictive collision mitigation/avoidance</td>
</tr>
</tbody>
</table>

Scalable safety functions for predictive collision mitigation/avoidance
Functions and Sensors

Predictive Emergency Braking

- ESP®
- Long-Range Radar (LRR)
- Mid-Range Radar (MRR)
- Multi Purpose Camera (MPC)
- Stereo Video Camera (SVC)
Predictive Collision Warning (PCW)

**Features**
- Continuous analysis of traffic situation ahead and driver reaction
- Early detection of impending rear-end collisions
- Pre-fill of brake system
- Parameter adaptation of Hydraulic Brake Assist
- Pre-warning (audible/visual)
- Acute-warning (brake-jerk and/or tightening of the reversible seat-belt)

**Customer benefits**
- Early driver warning for collision avoidance / mitigation
- Reduction of braking distance through immediate braking action

**System requirements**
- MRR, LRR or SVC
- ESP®
Emergency Brake Assist (EBA)

**Features**

- Driver triggered target emergency braking
- Calculation of required deceleration for collision avoidance
- Automatic amplification of brake force (target braking) if driver reaction is insufficient

**Customer benefits**

- Reduced stopping distance in case of emergency braking due to automatic braking action
- Adapted and improved brake assist function

**System requirements**

- MRR, LRR or SVC
- ESP®
Automatic Emergency Braking (AEB)

**Features**
- AEB – low speed (AEB-L): automatic collision avoidance braking below 30 kph
- AEB – partial (AEB-P): automatic partial braking to reduce velocity and gain more reaction time for the driver to avoid the collision
- AEB – full (AEB-F): automatic full emergency braking if collision is unavoidable to reduce injury risk

**Customer benefits**
- Reduced stopping distance in case of emergency braking due to automatic braking action
- Adapted and improved brake assist function

**System requirements**
- MRR/LRR + Video camera (for AEB-F)
- ESP®
Real world accident data show that 31% of drivers who caused a rear-end crash did not brake at all prior to the collision.

- 49% performed a partial braking and 20% a full braking, however too late.

Base: GIDAS 2001-2005/6 1160 weighted, reconstructed and relevant rear end crashes
Avoidable Rear End Crashes With Casualties

- Predictive Collision Warning: -38%
- Emergency Braking Assist: -55%
- Automatic Emergency Braking: -72%

Source: Bosch Analysis of GiDAS Database (2001-2005), modeled under idealized conditions

Note: Normal driver behaviour. 100% penetration of AEB in the field