Agenda

→ Cypress Automotive HMI One-Stop-Shop

→ Automotive HMI Trends – CapSense & TrueTouch

→ Automotive HMI Trends – Functional Safety/ISO 26262

→ Automotive HMI Trends – MagSense

→ Question & Answers
Cypress is Your One-Stop-Shop for Automotive HMI Systems

- **Door Control**
  - Lincoln Continental (PSoC® 4)

- **Buttons/Sliders**
  - Honda Odyssey (PSoC 1)

- **Touchpads**
  - Mercedes Benz C-Class (Gen 1)

- **Touchscreens**
  - Audi A8 (Gen 6)

- **Optical Navigation**
  - Mercedes Benz E-Class (ONS)

- **Capacitive Navigation**
  - Cypress Engaged

- **Biometrics and Navigation**
  - Cypress Engaged

- **Hands-On Detection**
  - Cypress Engaged
HMIs for Steering wheels

- **Steering Wheel Instrument Cluster/HMI Control**
  - Multiple OEM’s are looking into the integration of touch buttons, (small) touchpad(s) into the steering wheel
  - For a further refined user experience force touch and haptic feedback implementations are under development
  - New HMI requirements such as functional safety (ASIL-A/B/C) for cruise control button, communication interfaces such as CXPI (driven by Japanese OEM)

- **Hands-on detection / Grip sensing**
  - Autonomous driving: steering wheel grip-detection becoming an integral part of the HMIs in vehicles for driver/passenger’s safety
  - Current technology: based on capacitive-sensing (touch-sensing / force-sensing)
  - Multiple challenges: impact of environmental conditions (such as temperature, humidity etc.,), EMC issues, functional safety (based on ISO 26262)

- Cypress is engaged with several tier-1’s for such HMI designs, with some of them in production and several designed-in
HMI systems for automotive exterior

- **Door handles and trunk openers**
  - Touch buttons on the door handles for lock and unlock functions: traditional mechanical buttons being replaced by capacitive-touch buttons
  - Reliable touch performance is difficult: grounded-water or detergents (Windex) may cause false touch, EMI/EMC issues as well as glove operation
  - Achieving high sensitivity and maintaining ultra-low power (as they need to stay awake even when the car is turned off)

- **Door Panel touch**
  - Door / window panels become touchscreens / touchpads for exterior HMI control
  - HMI Functions supported such as door lock/unlock with a PIN#, operations like turning on/off engine and lights, can also open trunk

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1 The photograph shown here is only for representation
From Touchpads to Touch Anything

- **Touchpads (Center Console)**
  - Primarily driven by German premium OEM’s so far, but the future is not decided yet based on the introduction of touchscreens
  - Raising interest for touchpads by some Asian OEM’s – on-top of the already existing touchscreen
  - Touchpads are integrating features such as character/handwriting recognition, force-touch and haptic feedback as well

- **Touchpads (Steering Wheel)**
  - The photo shows the Daimler E Class navigation system in the steering wheel, which received quite positive reviews
  - Multiple OEM’s are looking into the integration of (small) touchpad(s) into the steering wheel, some based on capacitive-sensing to reduce costs

- **Interactive Surfaces (Air Outlets & Loudspeaker Covers)**
  - Air Outlets with gesture control, e.g. swipe left/right for temperature changes and up/down for air flow or volume control for loudspeakers

- **Sleek & Gapless Surfaces with Touch (Door Panels)**
HMI with authentication: Fingerprint Sensing

Fingerprint sensing makes it way to cars!

- **HMI authentication**
  - Fingerprint sensing makes its way to automotive: European OEMs already working on designing it in their next generation infotainment systems
  - Use cases: driver/passenger authentication, personalize settings for infotainment system, air-conditioning, seat adjustment etc.,
  - Main technology is based on capacitive sensing, as it seems to be the proven technology in the consumer market
  - Cypress is working with tier-1s and OEMs to design fingerprint modules (sensor + match controllers)
  - Challenges include reliable sensing (high accuracy), fast response, security, robust performance

- **Fingerprint + Navigation**
  - Fingerprint sensor can also enable navigation function (like a small touchpad)
  - Use cases: steering wheels where driver’s fingerprint is used to authenticate, and then the same sensor used to navigate a menu on the infotainment system
Next generation of “MBR”: Reconfigurable HMI systems

MBR = Mechanical Button Replacement

- **Reconfigurable HMI systems** –
  - Small displays (2” – 4”) in cars with integrated reconfigurable touch buttons
  - Use cases:
    - Current systems with different color and texture and functional variants leading to a lot of mechanical parts ⇒ could be replaced by small displays that have HMI functions integrated that blends with the interior of the car
    - OEMs could sell a function after the car has been sold (kind of “in app purchase” concept) and hence needs an additional button
    - Smart keys: integrated display + touch
  - End systems could be: door control panels, seat control buttons etc.,
  - Challenges/requirement: small-sized “display + touch” integrated controllers and Cypress is currently investing in developing such a solution where even AUTOSAR + HMI could be integrated in a one-chip solution
Smart surfaces with integrated HMI

- **Smart surfaces:**
  - Today’s automotive interior and exterior designs are being driven by intuitive HMI systems being integrated on several surfaces called as “smart surfaces” blending with the design of the car.
  - Some trends include curved surfaces, different materials as overlays such as Aluminum, Carbon, plastic, wood, sheet metal, etc., and integrating several types of feedback such as visual, haptic and audio.
  - Primary challenges include achieving reliable performance/operation with thick overlays, different type of surfaces, water rejection, operating over an extended range of temperature while also meeting automotive compliance requirements such as functional safety and EMC.
  - Cypress is working with several partners in this area and offers solutions based on various technologies such as CapSense (capacitive-sensing), MagSense (inductive sensing), force-sensing, fingerprint sensing, impedance measurement, optical navigation.
OEMs starting to put in functional safety (ISO 26262/ASIL) requirements for capacitive HMI systems as they get more integrated with crucial functions where reliable functioning (or safe operation) is necessary in order to not impact the health of the driver/passenger.

**HMI applications that need functional safety**
- Steering wheel touch buttons – where 1-2 buttons (or a small touchpad) used for cruise control -> requiring ASIL-B/C
- Steering wheel grip detection – Autonomous driving feature that requires to reliably detect the presence/absence of hand -> requiring up to ASIL-B typically
- Sunroof control module buttons/sliders – some standards such as FMVSS (Federal Motor Vehicle Safety Standards) ask for specific use-cases to reject a 40mm steel ball (equivalent to a kid’s knee) as false-touch and one way of handling this requirement is having some safety mechanisms like in an ASIL system; so some tier-1’s want to treat it like an ASIL-A system

Cypress is developing sufficient collaterals such as application notes for safe touch button systems, Design FMEAs, safety manuals FMEDAs, and also offering training services on developing safe HMI systems for automotive.
Human machine interface (HMI) systems using capacitive buttons (CapSense) to control functional safety (ISO 26262) relevant functions as e.g. activation/deactivation of: Advanced driver assistance systems in the steering wheel, stability control in the dashboard or around the gear shift, hazard light switch or movement of the car spoiler

- **Self- (CSD) and Mutual-Capacitance (CSX) CapSense buttons supported**
- **CapSense Button Functional Safety**
  - Demonstrator allows the injection of various failure modes, which could lead to either no touch or a false touch detection, if not being detected properly by the hardware/firmware design
  - Failure injection options include break, short to GND or VCC for: CSD sensor, shield sensor, Cmd/CTank capacitor, CSX RX or TX sensor as well as CintA/B capacitors
  - On-board DDS\(^1\) based sinusoidal signal generator to inject noise into CSD/CSX RX sensors
  - External input jack for noise injection into CSD/CSX RX sensors and power supply path

- **Collateral**
  - Application Note Functional Safety support for CapSense Button Applications
  - Hardware Safety Manual for Automotive PSoC 4 Family
  - FMEDA\(^2\) (PSoC 4200M, 4100S Plus, additional devices on request)
  - Design FMEA for CapSense Button Applications
  - PSoC 4 CapSense Button/ISO 26262 Workshop

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1. Direct digital synthesis
2. Failure modes, effects, and diagnostics analysis
3. Failure mode and effect analysis
## Automotive Portfolio:
### PSoC® Functional Safety (ASIL / ISO 26262) Support

<table>
<thead>
<tr>
<th>Category</th>
<th>Product</th>
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<td>Collaterals</td>
<td>Application Note</td>
<td>Functional Safety support for CapSense Button Applications</td>
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<td></td>
<td>Safety Manual</td>
<td>Hardware Safety Manual for Automotive PSoC 4 Family</td>
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<td>FMEDA(^1)</td>
<td>PSoC 4200M and PSoC 4100S Plus product FMEDA</td>
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<td>DFMEA(^2)</td>
<td>Design FMEA for CapSense button application</td>
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<td>Training Services</td>
<td>Training on detailed CapSense architecture, functional safety with CapSense</td>
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<td></td>
<td>Firmware</td>
<td>BIST(^3) library</td>
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<td></td>
<td>Software tools</td>
<td>PSoC 4 Software: Workflow, Processes &amp; Quality presentation</td>
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\(^1\) Failure modes, Effects and Diagnostic analysis  
\(^2\) Design Failure Mode Effects Analysis  
\(^3\) Built-in Self Test
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Inductive sensing basics

- What is Inductive sensing?

**Source: Magnetic Field Lines**

- Driving an AC signal into an Inductive Coil creates a magnetic field.
- Moving a metal target close to the field induces eddy currents in the target, changing the field.

\[ \Delta L = L - L' \]
Why Inductive Sensing?

- **Inductive sensing detects metal objects**
  - Inductive sensing has been around for over 50 years
  - Introduced in 1958 to replace mechanical contacts that would wear out or were dangerous in explosive environments due to arcing

- **Inductive sensing enables:**
  - Metal deflection (Metal Buttons/Keypads)
  - Proximity detection
  - Angular detection
  - Flow detection

- **Why does Inductive sensing matter?**
  - Effective for Metal over Touch (MoT) applications
  - Insensitive to dirt/oil
  - Insensitive to moisture
  - Works effectively with grounded or ungrounded (floating) metal
  - Intrinsically safe requiring no electrical connection to the metal
  - Large distance range for proximity detection of metallic objects
Recent Press Announcement¹

Infineon To Acquire Cypress, Strengthening And Accelerating Its Path Of Profitable Growth

Last Updated: June 02, 2019

- Infineon to pay US$23.85 per Cypress share, equivalent to a total enterprise value of €9.0 billion
- Transaction expected to yield €180 million in cost synergies per annum by 2022 and more than €1.5 billion annual revenue synergies in the long-term
- Transaction expected to be accretive to earnings beginning in the first full year after closing and to close by end of calendar year 2019 or early 2020
- Future target operating model after integration: 9+ percent revenue growth, 19 percent segment result margin and 13 percent investment-to-sales ratio

For questions, please contact AskCY@cypress.com

Cypress is Embedded in Critical Automotive Systems

**Instrument Cluster¹**
- Virtual and Hybrid Clusters
- Head-Up Display

**Infotainment**
- Navigation with Security
- Central Information Display
- Satellite/Audio Systems
- Rear-Seat Entertainment
- Touch/Character Recognition

**ADAS/Safety**
- TPMS
- Air Bag
- Telematics
- Surround Camera
- Radar System

**Body Electronics**
- HVAC
- Gateway
- Body Control
- Comfort
- Lighting

Cypress’ Embedded-Systems Product Portfolio

Cypress Body Electronics solutions cover a wide variety of applications inside and outside the automobile cockpit

Cypress’ Automotive Track Record
- A comprehensive portfolio of AEC-Q100-qualified embedded system products
- Over 30 years of experience supporting automotive quality requirements
- Cypress is the third-largest supplier of automotive MCUs and memories
- Cypress has earned preferred supplier status from the Top 25 automotive OEMs

Scalable MXS40 Technology Platform
- High-performance 40-nm process
- Based on single ARM® Cortex®-M4F/-M7F and dual Cortex®-M7F
- Pre-verified IP and core systems improve quality and constancy
- Strong hardware-based security Crypto IP blocks
- Flexible Smart I/O interfaces
- Faster, cost-effective and flexible derivatives
- Script-driven chip implementations
- Proven system software support


Company Positioning