June, 2010

Solutions for Body and Comfort Applications
FTF-AUT-F0701

Axel Streicher
Global Automotive Marketing
Agenda

► Body Systems Market and Challenges

► Freescale Body Systems Solutions
  • Microcontroller Overview
  • Analog Components Overview
  • Intelligent Distributed Control (IDC)

► Review and Wrap-up
Body Systems Market and Challenges
Body and Comfort Systems Overview

- **Driver Comfort**
  - Door Module
  - Window Lift
  - Seat Module
  - HVAC
  - Electric Roof
  - Tailgate

- **Vehicle Networking**
  - Central Body Control Module
  - Central Gateway

- **Safety Related**
  - Rain Light Sensor
  - Advanced Front Light Systems
  - Advanced Rear Light Systems

- **Security**
  - Immobilizer
  - Keyless Entry

- Body systems embrace a broad variety of applications inside the cabin
  - Cost drivers: Comfort, safety, security
    - High user value – look and feel
  - Performance drivers: Vehicle networking
    - Little user value - invisible

- Body systems cover the widest range of performance requirements
  - Small 8-bit controllers and watchdogs
  - General purpose 16-bit controllers
  - High performance 32-bit compute engines
Fuel Efficiency – Not Exclusive to Engine Management

Weight Reduction

- Electrification of the car
- In-vehicle networking
- Greater integration

50 kg = 0.1 L/100km

Energy Efficiency

- Efficient engine control
- System optimization
- Power reduction

100W = 0.1 L/100km
In-Vehicle Networking Evolution

► Today
  • Up to 80 individual ECUs
  • Local and proprietary network structures
  • Increasing interaction between ECUs
  • Increasing software complexity
  • Increasing cabling weight
  • Increasing ... everything

► Tomorrow
  • Domain controllers
  • Reduced number of ECUs
  • High performance multi-core controllers
  • Intelligent satellite modules
  • Reduced wiring
  • Domain specific networking
  • Software standardization (Autosar)
Why Multicore in Embedded Applications?

- Frequency scaling constraints
  - FM frequency band
  - External component cost
  - Package cost
- Multicore processors viewed as most viable approach to achieve required performance gains within power budgets

- Networking Multicore
- Automotive Multicore

- New challenge: Software for multicore processors

\[ P_d = CV^2 F \]
Body and Comfort Challenges

Market Dynamics
Cost pressure and globalisation force platform designs
Going Green: the dominating theme
Standardization vs. diverging OEM car network architectures

Designers’ Challenges
Scalability of hardware and software
Reduced time to market
Increasing MIPS while saving energy requires architectural changes
Multicore MCU architecture and software enablement
Increasing network complexity: CAN, LIN, FlexRay, Ethernet, MOST...
Freescale Body Systems Solutions
Microcontroller Overview
Automotive Core Architectures

<table>
<thead>
<tr>
<th>Performance/Features</th>
<th>Applications</th>
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<tr>
<td>S08 (8-bit)</td>
<td>Powertrain Electronics</td>
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<tr>
<td>S12(X) (16-bit)</td>
<td>Engine control</td>
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<td>Transmission control</td>
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<td>Power Architecture®</td>
<td>Chassis and Safety</td>
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<td>MPC55xx and</td>
<td>Central Body Electronics</td>
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<tr>
<td>MPC56xx (32-bit)</td>
<td>Body Control Module</td>
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<td></td>
<td>Gateway</td>
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<td></td>
<td>(Instrument Cluster)</td>
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<td>i.MX ARM™ (32-bit)</td>
<td>Peripheral Body Electronics</td>
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<td>Door Modules, Window Lift, Lighting, HVAC, Sunroof, Occupant Detection, Keyless Entry</td>
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<td>Telematics &amp; Infotainment Navigation</td>
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<td>High-performance DIS</td>
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Power Architecture
MPCC55xx and MPC56xx (32-bit)
Freescale Body Electronics MCU Roadmap

**Complex Gateways**
- MPC5510
  - 32bit RISC
  - e200z1, edMA
  - e200z0 optional
  - 48-66-80MHz
  - 130nm

**Highly integrated Central Body Controller**
- MPC5516/15/14x
  - Up to 1M Flash, 64KB RAM
  - Up to 6 CAN
  - FlexRay optional

**MPC56xx 90nm**
- E200z6+z0, 2MB Flash, 128KB RAM

**S12-S12X**
- 16bit CISC
- XGATE optional
- Up to 50MHz
- 180nm

**S12XH**
- Up to 512K Flash
- XGATE for TFT display
- Stepper Motors

**S12P**
- Up to 128K Flash
- 4KB SRAM, 1 CAN

**S12XS**
- no XGATE, data flash
- 256/128K Flash
- 12/8 KB SRAM
- 1 CAN

**S12X**
- XGATE, EEE
- 1M/512/256K Flash
- 64/32/16 KB SRAM
- Up to 5 CAN

**MPC560xB/C**
- E200z0, Up to 1.5MB Flash
- 3/6 CAN, 96KB RAM

**MPC560xG**
- E200z6+z0, 2MB Flash, 592KB RAM
- FlexRay, Ethernet, MediaLB

**MPC566x**
- E200z6+z0, 2MB Flash, 128KB RAM

**S12xx – 90nm**
- 50 MHz, XGATE, MPU, ECC
- Up to 512k Flash
- Linear Address Space

**Application Midrange**
- Main Body Controller
- CAN Gateways
- Legacy Applications
- Body Peripherals
- Body Controller in Emerging Markets
- Safety Micro / Watchdog

**LIN Slaves**
- Monolithic S12 ASSPs
  - Window Lift
  - Motor Control
  - HVAC
  - etc

**Single CAN**
- 8-bit CISC
- Up to 32KB Flash
- 4KB SRAM, 1 CAN

**CAN Gateways**
- S12C/Q
  - Up to 128K Flash
  - 4KB SRAM, 1 CAN

**Central Body**
- S12-S12X
  - 16bit CISC
  - XGATE optional
  - Up to 50MHz

**Instrument Cluster**
- S12XH
  - Up to 512K Flash
  - XGATE for TFT display
  - Stepper Motors

**General Purpose**
- **NOW**
- **2010/2011**

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Freescale Body Systems Solutions
Analog Components Overview - SBCs
System Basis Chip – SBC

- **Ballast Regulator (Vaux)**
- **Power Sharing (Vdd ballast)**
- **MCU Regulator (Vdd)**
- **Internal CAN Regulator (Vcan)**
  - **Low Power Modes**
  - **Flexible (I/O)**
    - Wake / INH
    - SPI
    - Adv W/D
  - **Secured State Machine**
  - **HS CAN Physical Layer**
  - **LIN Physical Layer**

**Energy Management**
- Flexible power supply for the main MCU and others for auxiliary loads
- Innovative cranking pulse management
- Scalable hardware design for 8/16/32-bit body applications

**Functional Safety**
- Enhanced fail safe protection
- Monitoring of critical pins
- Programmable fail safe default status
- Energy savings in low power modes

**Robust In-vehicle Networking**
- Standard and interoperable transceivers for
  - High-speed CAN
  - Single or multiple LIN
- High EMC/ESD immunity and low emission
## Customer Concerns and Freescale Solutions

Help customers meet their design challenges by providing associated benefits

<table>
<thead>
<tr>
<th>Customer Concerns</th>
<th>SBC Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased electrical content can increase battery discharge in parked mode or increase CO2 emission</td>
<td>Freescale SBCs save energy by minimizing current consumption and optimizing wake up events</td>
</tr>
<tr>
<td>Customer platforms can require multiple semiconductors or increase bill of materials</td>
<td>Freescale SBCs offer an ideal scalable (pin-to-pin compatible) power management solution for our MCUs to address multiple applications</td>
</tr>
<tr>
<td>Need ability to improve determinism during failure modes</td>
<td>Freescale SBCs offer flexible safety solutions and documentation to support application safety integrity level (SIL) assessment</td>
</tr>
<tr>
<td>A wide range of networked electronic systems mean car environments need to be less sensitive to external noise and highly robust (less sensitive to power injection)</td>
<td>Freescale SBCs integrate fully certified CAN and LIN according to latest electrical/ESD/EMC market requirements</td>
</tr>
</tbody>
</table>
MCU – SBC System Fit

Entry SBC
- MC33902, MC33903
- Current below 60mA
- Linear regulator only (LDO)
- Cost-driven solution
- Low pin count packages

Complex Gateways
Highly integrated Central Body Controller
Central Body Cluster
CAN Gateways
Single CAN
LIN Slaves
General Purpose

S12-S12X
16bit CISC XGATE optional
Up to 50MHz

S12X
Up to 512 Flash
XGATE for TFT display
Stepper Motors

S12C/Q
Up to 128K Flash
4 KB SRAM, 1 CAN

S08D
Up to 128K Flash
1 CAN, 32-100 pin

S08E
Up to 32K Flash
32-48pin

S08EL/S
Up to 32K Flash
SLIC for LIN, 20-28 pin

S08SG
Up to 32K Flash
8-28 pin

S08
8bit CISC
Up to 20MHz

S12H
Up to 512 Flash
XGATE for TFT display
Stepper Motors

S12XE, EEE
1M/512/256K Flash;
64/32/16 KB SRAM

S12XS
no XGATE, data flash
256/128K Flash,
12/8 KB SRAM

S12P
Up to 128K Flash
4 KB SRAM, 1 CAN

S122xx – 90nm
50MHz, XGATE, MPU, ECC
Up to 512K Flash
Linear Address Space

S12G – 180nm
EEEPROM, no XGATE
Up to 240K Flash,
25 MHz

Monolithic S12 ASSPs
Window Lift
Motor Control
HVAC
etc

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Next generation SBC

- Current range: 250 mA - 1A
- Energy savings through innovative power efficiency solutions (DC/DC converters)
- Product to be announced
MCU – SBC System Fit

**Complex Gateways**
- MPC5510
  - 32bit RISC
e200z1, edMA
e200z0 optional
  - 48-66-80MHz
  - 130nm

**Highly integrated Central Body Controller**
- MPC5517x
  - 1.5M Flash, 80 KB RAM
  - Up to 6 CAN, FlexRay, MLB

**Central Body**
- S12-S12X
  - 16bit CISC
XGATE optional
  - Up to 50MHz
  - 180nm

**Instrument Cluster**
- S12E
  - XGATE, EEE
1M/512/256K Flash, 64/32/16 KB SRAM
  - Up to 5 CAN
- S12X
  - no XGATE, data flash
256/128K Flash, 12/8 KB SRAM
  - 1 CAN

**CAN Gateways**
- S12C/Q
  - Up to 128K Flash
  - 4 KB SRAM, 1 CAN

**Single CAN**
- S08D
  - Up to 128K Flash
  - 1 CAN, 32-100pin

**LIN Slaves**
- S08E/SL
  - Up to 32K Flash
  - SLIC for LIN, 20-28pin

**General Purpose**
- S08S
  - Up to 32K Flash
  - 8-28pin

**Monolithic S12 ASSPs**
- Window Lift
- Motor Control
- HVAC
- Etc.

**Integrated SBC Functionality**

**NOW**

**2010/2011**

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Freescale Body Systems Solutions
Analog Components Overview – Power Switches
Energy Distribution in Automotive

► Today
  • Traditional BCM modules use fuses and relays

► Tomorrow (SOP2012 and beyond)
  • Regulation: CO2 emission, weight
  • Warranty extension: Robust design
  • Comfort: No changing of fuses
  • Fuse box no longer accessible to the driver
  • Solid state switches replace fuses and relays

Freescale solution: eXtreme Switch
eXtreme Switch: Three Innovations in One Product

► SMARTMOS
- Protection and diagnostic
  - Over temperature
  - Over current
  - Over/under voltage
  - Short circuit
  - Reverse battery
  - Loss of ground/Vbat
  - Energy discharge protection
- SPI Interface
  - Easy connection to the µC
  - Programmability
  - Daisy chain using SPI
  - Programmable over current trip level
  - Watchdog

► Power MOSFETs
- Low Rds(on) MOSFETs
  - 1.7mOhm typ. at 25°C
  - 3.4mOhm typ at 150°C
- Protection in the power stage
  - Temperature sensor
  - Current sensor

► PQFN
- Design flexibility
- Al power wirebonds
  - Low series resistance
- Low cost power package
  - 0.5 mm thick leadframe
  - Solder die attach
  - Rthj-c < 0.5°C/W
  - Current capability > 200A
- High reliability

eXtreme Switch
Intelligence - Power - Protection

14 patents filed since 2003
eXtreme Switch Application: Lighting Module

Vbat
CAN
CAN Slaves
LIN Slaves
Switch Inputs
Analog Inputs

System Basis Chip
16-/32-bit Microcontroller

High Side Driver
High Side Driver
High Side Driver
High Side Driver
Low Side Driver

Switch Monitoring
LIN I/F
CAN I/F

Power distribution
Relays

High beam left
High beam right
Rear break left
Rear break right
Interior 1 and 2
Front side marker left
Front side marker right
Low beam left
Low beam right
Center mount break light
Fog lamp left
Fog lamp right
Rear, turn and hazard left
Rear, turn and hazard right
Freescale Body Systems Solutions
Intelligent Distributed Control (IDC)
Market Trend: CAN/LIN Modes

Source: Strategy Analytics

16% CAAGR

Includes NAFTA, Europe, Japan, S.Korea, China, India

<table>
<thead>
<tr>
<th>Year</th>
<th>Proprietary</th>
<th>Multimedia</th>
<th>Flexray</th>
<th>Safety Bus</th>
<th>LIN/J2602</th>
<th>J1850</th>
<th>CAN</th>
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What Is IDC?
Intelligent Distributed Control

The Ingredients

- Microcontroller
- System basis chip
  - LIN / CAN PHY
- Analog application layer

System In Package Solution
IDC Products: Destined for Distributed Systems
Example: Door Architecture

Typical IDC Use Cases: Half Centralized and Distributed Systems
IDC Summary

- Integration of standard microcontroller, analog function and network interface
- System In Package solution: Two dies in one package or monolithic integration
- Utilization of most optimized technology node
- ASSPs for set of applications, e.g. window lift, sunroof, light leveling, EC mirror, keypad, steering wheel, HVAC, motor control, etc.
- Designed for distributed LIN/CAN systems

Customer Benefits
- Space and weight saving
- Fewer external components
- 100% MCU-analog compatibility
- Improved system level reliability
- Reduced development cycles
- Reduced logistic costs

Example: High-end EC mirror application

IDC system level advantage vs. discrete IC solution

Source: EC mirror application, discrete devices are sampled from various major vendors (anonymous)
Review and Wrap-up
Body Systems – Freescale Solutions

**FSL Solutions**

- Wide portfolio of 8, 16 and 32 bit microcontrollers
  - S08 – S12 – MPC56xx
- Wide portfolio of standard analog devices
  - SBC, power switches, network interfaces, H-Bridge, etc.
- Growing portfolio of System-In-Package solutions
  - Door module, lighting, motor control, interior lighting, etc.
- AutoSar for 16-bit and 32-bit microcontrollers

**Key Differentiators**

- S12 microcontroller family is established de-facto 16-bit automotive standard
  - Shipping >130M units per year
- System-in-package solutions based on S12 controller architecture
  - Software and tool re-use
- Standardizing 32-bit solutions on Power Architecture
  - Body, powertrain, chassis and safety, infotainment
- Joint Development Program (JDP) with STMicroelectronics
## Dedicated Product Sessions at FTF

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<th>Session ID</th>
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<th>Time</th>
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<td>Low Power System Techniques</td>
<td>MCUs</td>
<td>Tuesday</td>
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<td>Automotive Network Protocol Overview</td>
<td>LIN, CAN, FR, MOST, etc</td>
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<td>Analog and Power</td>
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<td>FTF-AUT-F0741</td>
<td>Speed up SBC product selection cycle</td>
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Body & Comfort

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