Automotive MCU Overview

AA108

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Product Management - 8/16-bit Auto and 32-bit for Body Applications
Agenda

► Automotive Electronics Trends

► Leading-edge Powertrain Solutions

► Innovation in Chassis and Safety

► Wide Body Electronics Offering

► Wrap-Up
Automotive Electronic System Trends

Going Green

- Stringent emissions regulation
- Hybrids, gasoline direct injection
- Electronics replacing hydraulics

Safety

- Active safety systems proliferating
- Intelligence driving performance
- Higher standards of reliability required

Connectivity/Infotainment

- “Standard” convenience features
- Wireless inside and out
- Regulations: Telematics/eCall systems may become mandatory

The Affordable Vehicle

- 30M cars in emerging markets by 2009
- Ultra-low-cost vehicles

*source: IMS Research
Powertrain Solutions
Diesel Engine Management Solutions

- Analog / Digital Inputs
  - Cylinder Pressure
  - Accelerator
  - Air Mass Flow
  - Battery
  - Temperatures
  - Rail Pressure
  - Oxygen Sensors

- Injectors Feedback
- Timed Inputs
  - Crank Speed
  - Cam position
  - Clutch / Brake
  - Speed

- On Board Diagnostic

- Signal Conditioning

- Main Micro
  - MPC56xx
  - DMA
  - Ext Bus
  - COM
  - eTPU
  - I/O
  - FLASH / RAM

- Power Supply
  - MC33730
  - MC33905

- Safety Micro
  - S08SG

- DC/DC

- Injectors
  - Driver MC33810

- High Current Driver
  - EGR Positioner
  - Valves Control
  - Turbo Control

- HBridge
  - Driver MC33899
  - MC33926
  - MC33997

- Output Drivers
  - MC33800
  - MC33810

- COM ICs
  - HS CAN
  - LIN
  - FLEXRAY™
  - ETHERNET

- Microun

- Injectors (3 to 12)

- Glow Plugs (3 to 12)

- Relays

- Tachout Counter

- Oxygen Heaters

- Fuel Pump

- Dashboard Lamps

- Fan Control

- Rail Pressure Control

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Automatic Manual Transmission Solutions

- Battery Voltage
- Brake Pedal Position
- Vehicle Speed
- Clutch Speed
- Clutch Position
- Gear Position
- Shift Position
- Hydraulic Pressure
- Gear Selection
- Cranking
- Cranking Relay
- AUTO Switch
- Door Switch

Signals Conditioning

Switch Detection

MC3902
CAN Transceiver

MC3905
Voltage Reg CAN/LIN Transceiver

MPC5634M / MPC5644A

DMA

COM
eTPU
I/O
FLASH /RAM

MC9S08SG
Optional Safety MCU

MC33902

MC33905

MC33800
Multiple Low-Side Switch & Driver

MC33811
Solenoid Monitor

Main Power Relay
Hydraulic Pump Relay
Buzzer
Shift Valve 1
Shift Valve 2
Gear Valve 1
Gear Valve 2
Clutch Valve
Power Architecture, More Than Just MHz

► Greatest throughput / MHz of any powertrain MCU
  • MPC5674F has 623 DMIPS at 264 MHz (2.4 DMIPS / MHz)
  • Other similar class devices offer 1 – 1.5 DMIPS / MHz

► More than just DMIPS
  • MPC5674F has multiple enhanced eTPU2 modules which run faster than eTPU (200 MHz vs. 132MHz)
    ▪ Each eTPU can deliver up to 1MIP/MHz in C90, CPU offers 1.5 MIPS/MHz
  • Parallel processing: smart DMA, crossbar architecture and cache
  • Advanced fetch accelerator, virtual single cycle flash up to 264 MHz

► Combined CPU, optimized architecture and smart peripherals
  • Gives greatest throughput, system level performance
  • Offload tasks, run slower, reduce power
  • Opportunity for customers to add value via software
    ▪ eTPU2 as smart watchdog
    ▪ eTPU2 running transmission module
Performance Roadmap

36x more performance increase over 6 product generation

- MPC5554
- MPC5566
- one-z6-200MHz
- MPC5674F 264-300MHz
- MPC57xx dual z6 200 MHz

- In Production
- Available
- Planned
- Proposed

- highest ever EEMBC results, 114
- benchmarked as 200MIPS
- MPC5554 2M Flash, 64 kB SRAM 128MHz
- MPC5566 3M Flash, 128 kB SRAM 144MHz
- MPC5674F 4M Flash, 256 kB SRAM 264MHz
- MPC7xx 6M Flash, 384 kB SRAM 2 x 200MHz

- dual core, 3 eTPU, 3x perf MPC5554
- single core, 2 eTPU, 2x perf MPC5554

- Fully compatible products
- Dedicated automotive peripherals
- Single and dual-core options
- Covers performance needs to 2020
Introducing the S12XE Family:
- Enables higher system integrity at the ECU level (MPU, ECC Supervisor Mode)
- XGATE coprocessor
- Higher memory sizes & new package options
- Improved advantages
  - Low current consumption, EMC, Code size density
- Higher performance:
  - Max speed 50MHz, 12-bit ATD, More peripherals, More I/Os
- TIM Timer Modules (TIM subset of ECT, downwards compatible)
- Additional periodic interrupt timer for internal time bases
- Enhanced XGATE allows one level of interruptability
  - Increase performance to 100MHz operation

Use XGATE to implement a software DSP filter for engine knock detection. This solution eliminates the need for an external Knock ASIC and results in an overall reduction of system cost and complexity.
8-bit S08 Watchdogs for Powertrain

- Single wire background debug mode (BDM) allows non-intrusive debug in multi-MCU systems
- Various communication methods are available: SPI, SCI, IIC, LIN and CAN
- Internal clock source supporting up to +/- 2% accuracy across temperature and voltage
- Flash memory, 16-bit timers and 10-bit ADCs available on all families
Chassis and Safety Solutions
Chassis & Safety Application Space

Steering
- Electric power steering
- Active front steering
- Steering Torque Sensors

Driver Assistance
- Front & rear radar
- Multifunction Camera
- Blindspot detection
- Ultra-sonic park assist

Brake Systems
- Anti-lock braking
- Vehicle stability control
- Electric parking brake

Passive Safety
- Front airbag
- Side airbag
- Seatbelt Pretensioner

Suspension
- Semi active suspension
- Fully active suspension
32-bit Chassis, Advanced Driver Assistance and Safety MCU Roadmap

Legend

- Available
- In Design
- Planned
- Proposed

**Power Steering**
- MPC551x
  - 1M Flash, 64K RAM, FlexRay
  - e200z1 core, 48-80 MHz

**High End Chassis Products**

- **MPC564xL**
  - e200z4 Dual issue
  - Up to 120MHz
  - Dual Core
  - 512k to 1M Flash

- **MPC5643L**
  - Dual core
  - 1M Flash, 128K RAM, Flexray
  - e200z4 core, 60-120 MHz

**Cross Triggering, FCCU, SPI, Flexray; Power Steering, Airbag, Braking**

- **MPC5604P**
  - 512K Flash, 40K RAM, Flexray
  - e200z0h core, 64MHz

- **MPC5603P**
  - 384K Flash, 36K RAM, Flexray
  - e200z0h core, 64MHz

**Steering, Braking, Low-cost radar, domain control**

- **MPC5664xL**
  - Dual core
  - 512K Flash, 64K RAM
  - e200z4 core, 60-80 MHz

**Motor Control, Airbag**

- **MPC5602P**
  - 256K Flash, 20K RAM
  - e200z0h core, 64MHz

- **MPC5601P**
  - 192K Flash, 12K RAM
  - e200z0h core, 64MHz

**Camera Applications**

- **Camera, Radar**

**Camera, Radar**

- **MPC5664P**
  - e200z0
  - Up to 64MHz
  - 192k to 512k Flash

- **MPC5601P**
  - e200z0h core, 64MHz

**In Design**

- **MPC5561**
  - 1M Flash, 192K RAM, FlexRay
  - e200z6 core, 80-132MHz

- **MPC5561 light**
  - 512K Flash, 98K RAM
  - e200z6 core, 80-132MHz

**Available**

- **MPC5567**
  - 2M Flash, 80K RAM, FlexRay
  - e200z6 core, 80-132MHz

**Proposed**

- **MPC55611**
  - 1M Flash, 192K RAM, FlexRay
  - e200z6 core, 80-132MHz

**Planned**

- **MPC55672**
  - 2M Flash, 80K RAM, FlexRay
  - e200z6 core, 80-132MHz

**32-bit 130nm**

**90nm**
MPC560xP Family – For Safety and Actuation

Safety Features:

Safety Port
- Allows CRC signed communication to slave MCU (if needed) may be used as 2nd CAN

CRC Unit
- Application Signature

Fault Collection Unit
- Detects when errors have occurred and the source and sets a flag independant of software operation

Actuation (e.g Steering, ABS Braking)

FlexPWM
- Optimized for 3ph motor control
- Includes dead time insertion, fault channels, center/edge alignment, distortion correction

Cross Triggering Unit
- Enables deterministic control of events and offloads CPU of expensive context switches

Timer Module:
- 2xBUS frequency → high resolution for accurate motor control
Body Electronics Solutions
Enabling More Integration

Benefits:
- Fewer modules
- Reduced manufacturing costs
- Better quality

Body Controller (interior features + lighting)

CAN Gateway

Fuses Box Replacement

Central Body Domain Controller

RF Receiver (key, tires)
e200z Core Roadmap

**Powertrain & Chassis**
- e200z6
  - 144MHz
  - 7-stage pipeline
  - Up to 32k cache
  - FPU
  - SIMD

**Body Electronics**
- e200z7
  - 264MHz
  - 10-stage pipeline
  - Up to 32k cache
  - Dual Issue / VLE
  - FPU
  - SIMD

- e200z6
  - 200MHz
  - 7-stage pipeline
  - VLE
  - Up to 32k cache
  - FPU
  - SIMD

- e200z4
  - 120MHz
  - 5-stage pipeline
  - Dual Issue / VLE
  - Up to 16k cache
  - FPU
  - SIMD

- e200z1
  - 80MHz
  - 4-stage pipeline
  - VLE Only

- e200z0
  - 80MHz
  - 4-stage pipeline
  - FPU
  - SIMD

- e200z3
  - 80MHz
  - 4-stage pipeline
  - FPU
  - SIMD

This document contains forward-looking statements based on current expectations, forecast and assumptions of Freescale that involve risk and uncertainties. Forward looking statements are subject to risk and uncertainties associated with Freescale business that could cause actual results to vary materially from those stated or implied by such forward-looking statements.
The Crossbar Architecture, a Turbo for Gateways

- Platform = cores + crossbar + system support functions (INTC, debug, timers, semaphores…)

- The crossbar switch allows concurrent accesses between masters and slaves resources

- Widening the memory bottleneck:
  - Separate SRAM blocks
  - Flash controller with separate page buffers to emulate dual-ported flash

- Peak data bandwidth of the MPC5668G crossbar architecture is 3.5 Gbytes/sec at 116 MHz clock speed
The Whole Dual-Core Solution

Scalable Power Architecture Platforms

Professional Services to migrate your application

Reuse of Existing Tool Flows

3rd party support (GHS TimeMachine, ETAS)

Reference Design Software Framework

Freescale Dual-core Autosar OS and MCAL

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MPC5606S – Single Chip Cluster Example

- 6 Stepper Motor Drivers with patented stall detection
- GP I/O
- 2x CAN
- 2x LIN
- PWMs
- QuadSPI
- 48kb RAM
- EEPROM
- 160kb RAM
- 1MB FLASH
- 40x4 LCD seg driver
- Serial Flash
- LEDS
- TFT DISPLAY

DCU on MPC5606S enables direct drive of Quarter VGA and WQVGA.

PDI allows cheap video input (no buffer) eg to display reversing camera image on dashboard TFT.

SEE "MPC5606S" DEMO ON YouTube
MPC5121e / MPC5123 SoC Architecture

- **VIU** Video Input
- **Parallel ATA**
- **NFC** NAND flash
- **LPC** NOR Flash, RAM, ROM
- **DIU** 66Mpixel/sec, 24-bit 3-Plane Blend
- **e300 Power Architecture™** 32KB I-Cache / D-Cache Double Precision FPU
- **AXE Multimedia Core** 8KB I-Cache Audio Optimizations
- **Graphics Core**
- **DMA** 64-channels
- **128K SRAM** 4-way banked
- **AHB Bus (32-bits)**
- **Processor Bus (64-bits)**
- **IP Bus (32-bits)**

**External Memory Bus**

**Display**

**DRAM Memory**

**PCI 2.3**
- **Watch Dog**
- **Timers 8x**
- **GPIO**
- **RTC**
- **CAN 4x**
- **J1850**
- **SDHC**
- **SPDJF**
- **I²C 3x**
- **PSC 12x**
- **Temp Sensor**
- **Unique ID 128-bit OTP**

**J1850**

**SDHC**

**SPDJF**

**I²C 3x**

**PSC 12x**

**Temp Sensor**

**Unique ID 128-bit OTP**

**FEC 10/100 BaseT**

**USB2.0 + PHY**

**USB2.0 ULPI**

**Serial ATA + PHY**

**NFC**

**NAND flash**

**LPC** NOR Flash, RAM, ROM

**External Memory Bus**

**Arrow show mastering direction**
MPC5121e – Powerful Graphics Capability

One example from QNX showcasing the graphics capability of the MPC5121e

► QNX(R) Neutrino(R) RTOS
► Aviage(R) HMI Suite running on the Freescale MPC5121e processor
► Integrates OpenGL ES and Adobe Flash to provide a rich graphics experience
Global Ecosystem of mobileGT® Alliance Partners
Why is FSL the Automotive 16-bit Market Leader?

- Wide portfolio of compatible and scalable products
- Optimized feature sets for cost sensitive applications
- On-chip EEPROM solutions to reduce system cost
- Low-power solutions
- Simple yet powerful debug and emulation tools
### S12/ S12X Family Lineup

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<th>Flash Package</th>
<th>48QFN</th>
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<th>80QFP</th>
<th>112LQFP</th>
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*1= package subject to confirmation.
All proposed parts features subject to change with out notice.

**Flexibility in package and memory to meet changing demands**
Quality
Freescale Quality Vision

### Vision

**It's impossible. Zero = Zero**

### Mission

- Zero Defects for the Automotive Market
- Safe Launch on New Product Introductions

### Strategy

**Defects**
- Containment
- Analysis
- Improvement

**Spill Elimination**

**Safe Launch**
- New Technology Introduction
- New Product Development
- Technology and Product Transfers
Wrap-Up
Our Vision, Mission and Message

► Freescale Automotive provides enabling technologies that drive next-generation solutions for safer, more fuel-efficient and environmentally friendly vehicles.

► This is made possible through three core principles:

1. Our *leadership* in driving innovative technologies for automotive applications
2. Our continued efforts to deliver high *quality* products through quality-driven processes
3. Our desire to build the *trust* of our customers through “Customer First” initiatives
Freescale Introduces Product Longevity Program

► The embedded market needs long-term product support, which allows OEMs to provide assurance to their customers.
► Freescale has a longstanding track record of providing long-term production support for our products.
► Freescale is pleased to introduce a formal product longevity program for the market segments we serve.
  • For the automotive and medical segments, Freescale will manufacture select devices for a minimum period of 15 years.
  • For all other market segments in which Freescale participates, Freescale will manufacture select devices for a minimum period of 10 years.
► A list of applicable Freescale products is available at www.freescale.com.
Thank you for attending this presentation. We’ll now take a few moments for the audience’s questions and then we’ll begin the question and answer session.