

Embedded Connectivity Summit 2004

FlexRay Protocol Overview and Applications Demonstration with 56F8300

10/05/2004

Slide 1

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Agenda

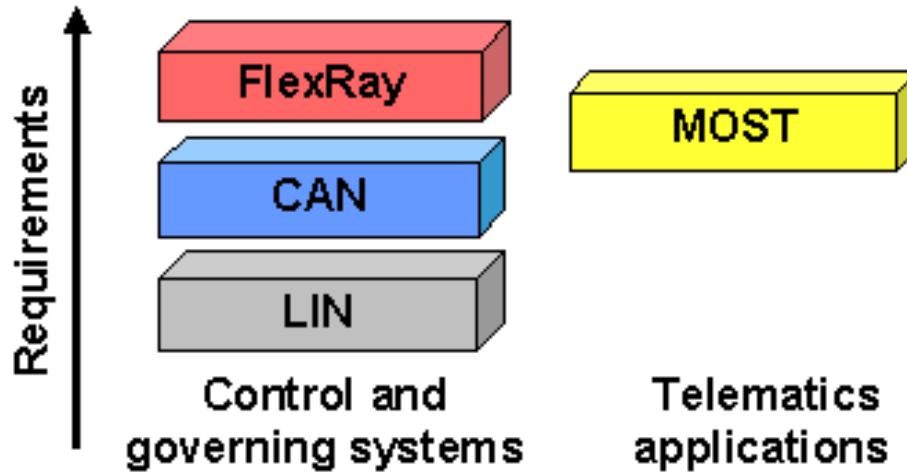
- **Overview of FlexRay**
- **Overview of 56F8300**
- **Overview of 56F8300 Development Tools**
- **Description of 56F8300 FlexRay Developer's Kit**
- **56F8300 FlexRay Demo**
- **Summary**

FlexRay Overview

Slide 3

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Major In-vehicle Networking Standards



FlexRay is designed to meet key automotive requirements like dependability, availability, flexibility, and a high data rate to complement the major in-vehicle networking standards - CAN, LIN, and MOST.

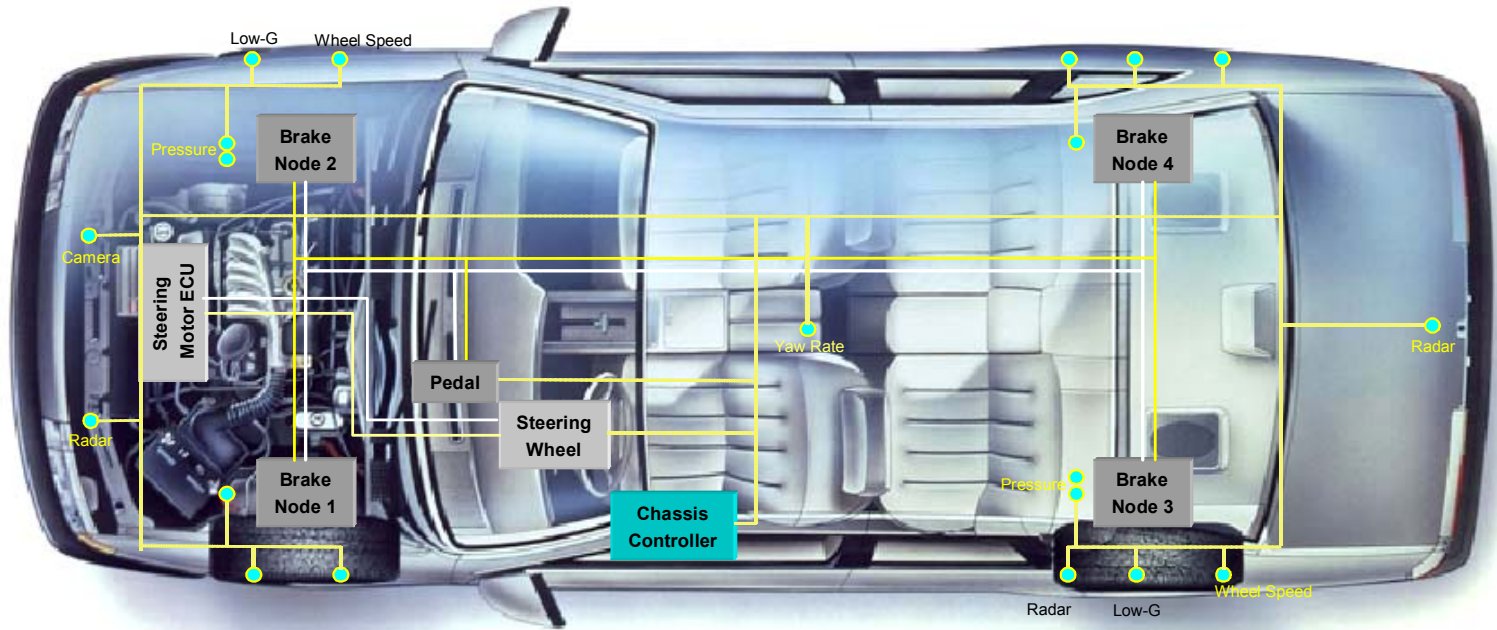
FlexRay History

- 1998 – Analysis
- 1999 – Realized future requirements are not fulfilled by existing protocols
- 1999 – Start of Cooperation (BMW, DaimlerChrysler)
- 2000 – Common requirements specification (first version)
- 9/2000 – Motorola (Freescale) and Philips join FlexRay Consortium
- 10/2000 – Bosch joins FlexRay Consortium
- 09/2001 – General Motors joins Consortium
- 03/2002 – Update of requirements specification
- 04/2002 – 10/2002 – Ford Motor Company, Mazda, and Fiat join as Primary Associate members
- Since 04/2002 – More than 25 Associate and Development Members join Consortium

FlexRay Consortium Membership

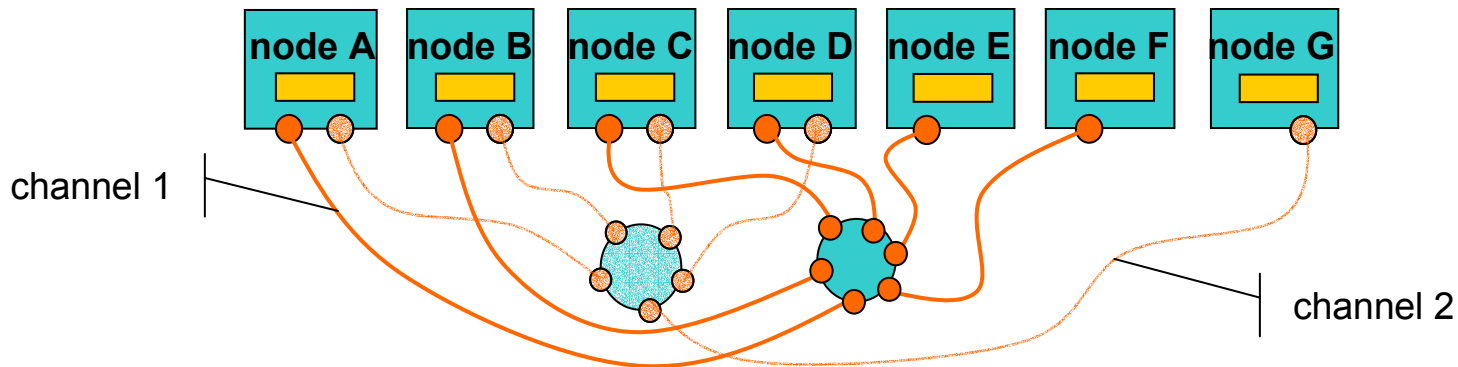
Core Members	Premium Associate Members	Associate Members	Development Members
BMW Group BOSCH DaimlerChrysler General Motors Freescale Semiconductor Philips Volkswagen	ContiTeves Denso Fiat Ford Motor Honda Hyundai Kia Mazda Nissan Toyota Tyco Volvo	Avidyne Berata Elmos ESG Esterel Fujitsu Hella Hyundai Autonet Mitsubishi NEC Nidec Pacifica RWTÜV Siemens VDO SP ST Micro TI Visteon ...	Cadence CapeWare Cardec CRST DECOMSYS dSpace IXXAT MicroSys NSI 3SOFT SystemA TZM Vector Informatik Volcano Weise GmbH ...

What is FlexRay?



- FlexRay is a fault-tolerant, deterministic, time triggered communication protocol
- Intended to be a global standard for advanced automotive control
- Required to enable next generation, “by-wire” applications
- See www.flexray.com for more information

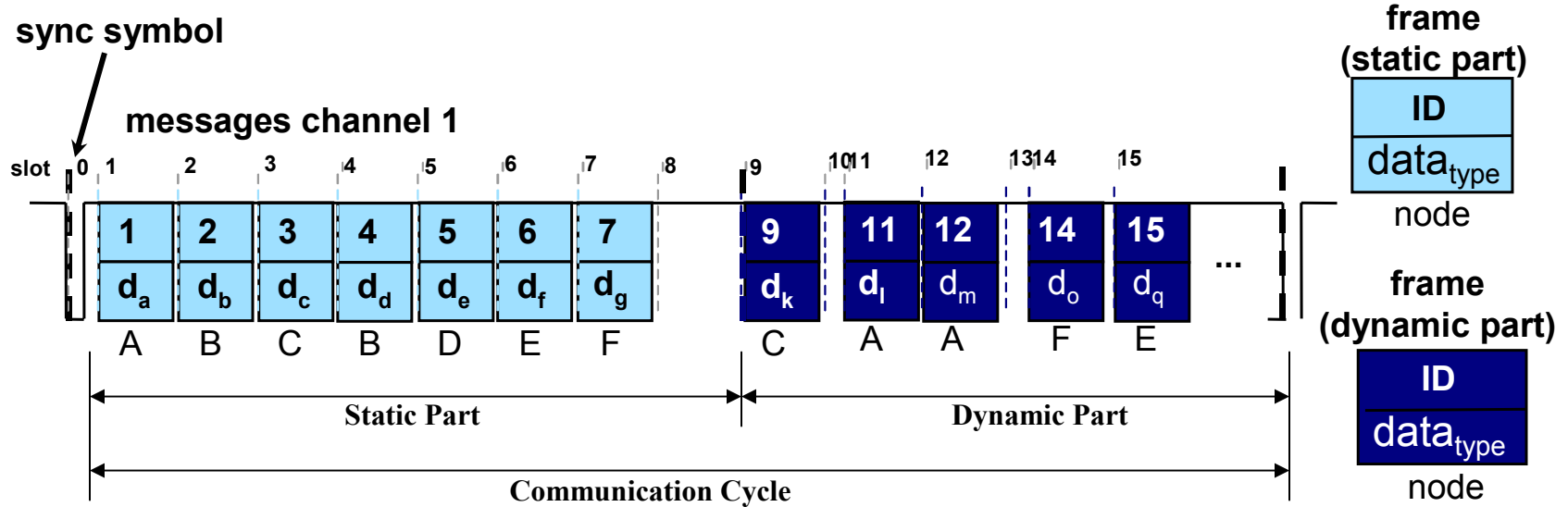
Integration Flexibility



FlexRay controller network in mixed connectivity, "active star" configuration

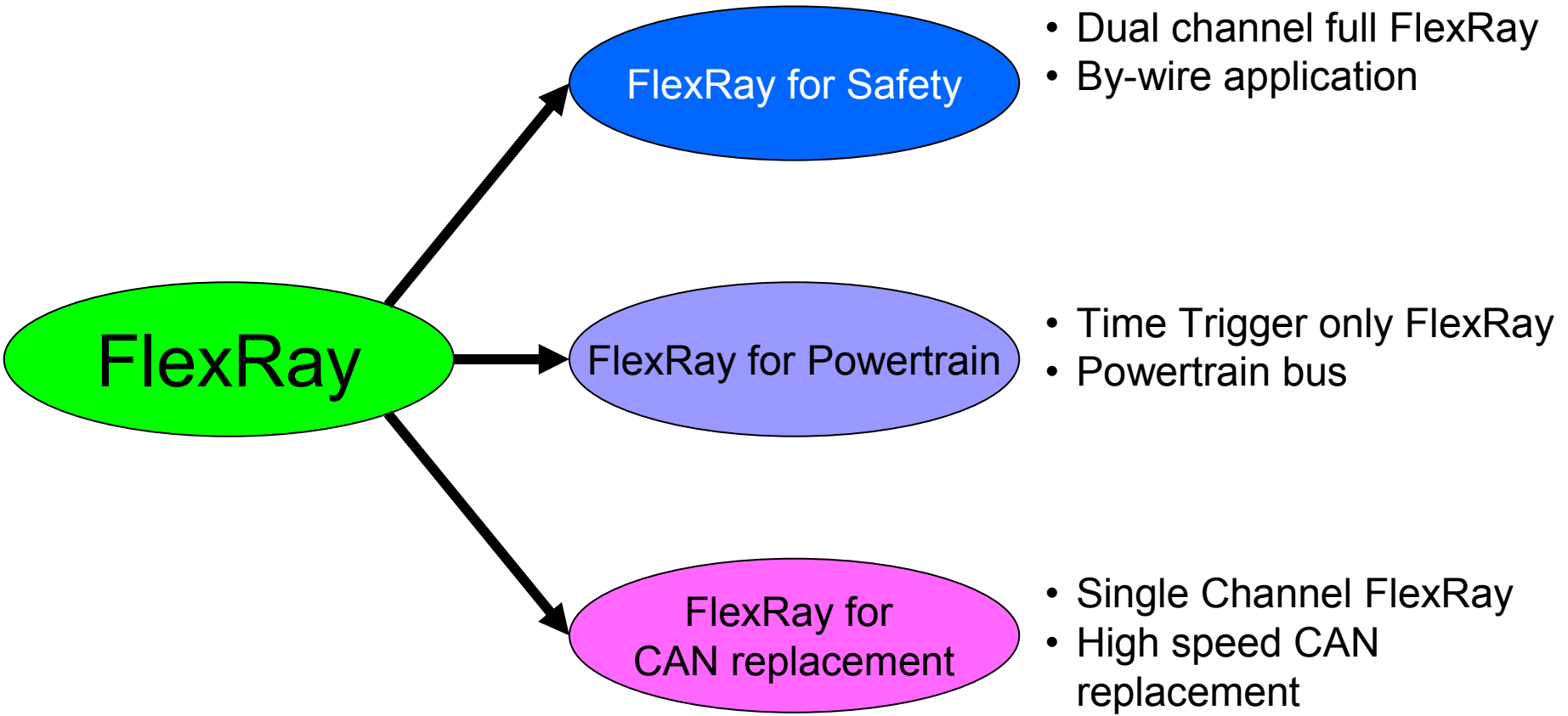
- **Multiple operating modes**
 - Single channel, dual (redundant) channel, or mixed connectivity
- **Supports bus, star, and multiple star topologies**
 - Active, passive, or mixed
- **Fault-tolerant and time triggered services implemented in hardware**
- **Can be used with optical and/or electrical physical layers**
- **Supports system integration at vehicle manufacturer level**

FlexRay Protocol Basics



- Data rate of 10 Mbit/sec per channel
- Scalable communication system, allowing synchronous and asynchronous data transmission
- Configurable to provide a mix of deterministic and dynamic data transmission
- Fast error detection and signalling
- Support of a fault tolerant synchronized global time base
- Error containment on the physical layer through an independent “Bus Guardian”
- Arbitration free transmission

FlexRay – One Protocol, Many Solutions



FlexRay for Safety

- Applications
 - By-Wire Systems
 - Braking Systems (i.e. Electro-Mechanical Braking)
 - Steering Systems (i.e. Electronic Power Assisted Steering)
 - Traction Control Systems (i.e. Electronic Stability Program, Inertial Sensor)
 - Airbag
- Why FlexRay?
 - Redundant Channels
 - Fault Tolerant
 - Deterministic

FlexRay for Powertrain

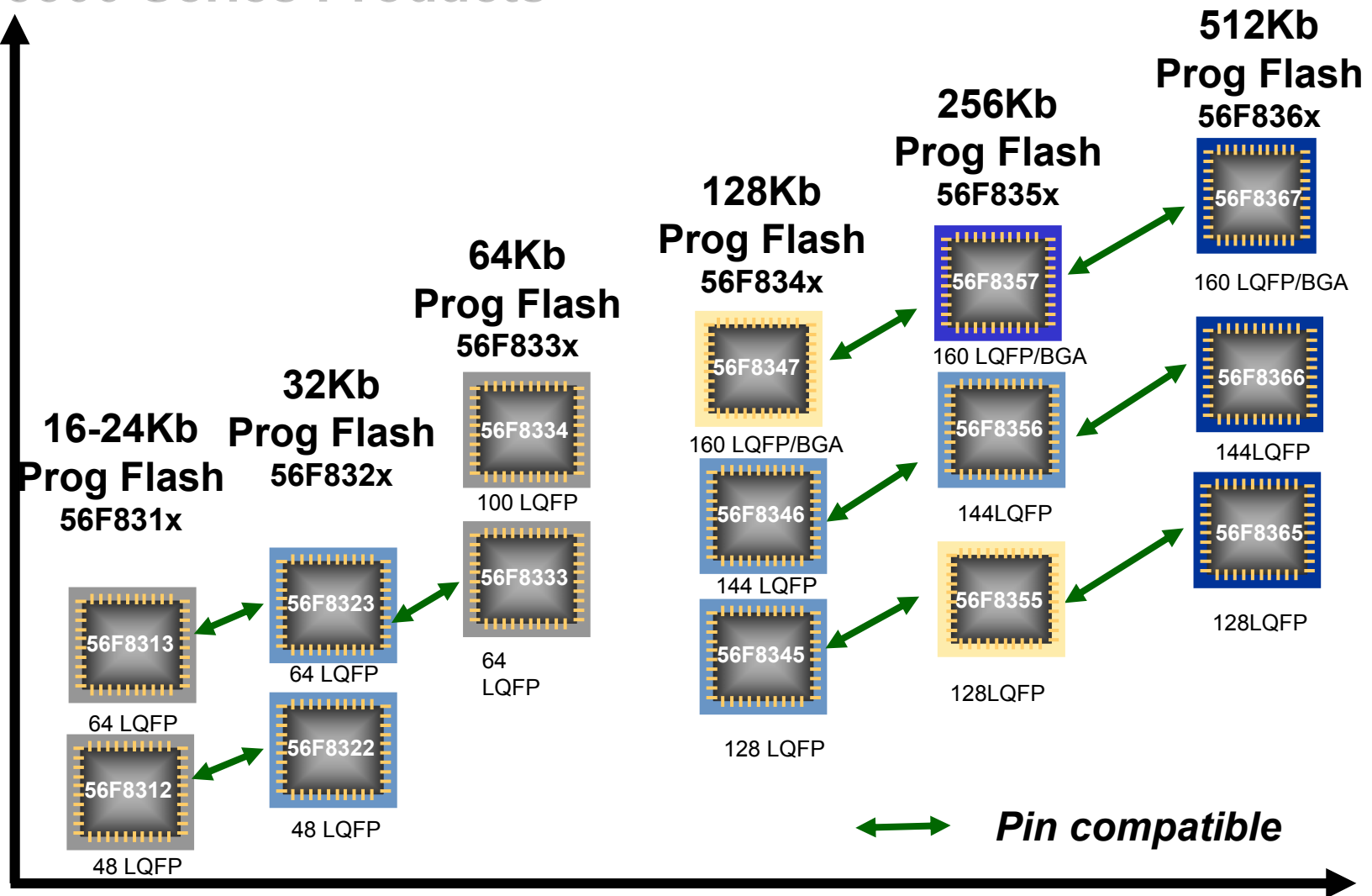
- Applications
 - Electronic Transmission Control
 - Continuously Variable Transmission Control
 - Adaptive Cruise Control
 - Electronic Valve Control
 - Diagnostics
- Why FlexRay?
 - High Bandwidth
 - Deterministic

FlexRay for CAN Replacement

- Applications
 - Any automotive application currently using CAN
 - The Industrial market is starting to show some interest as well
- Why FlexRay?
 - High bandwidth (10 Mbps vs 1 Mbps)
 - Two independent channels (replace two CAN peripherals)
 - Arbitration free transmission

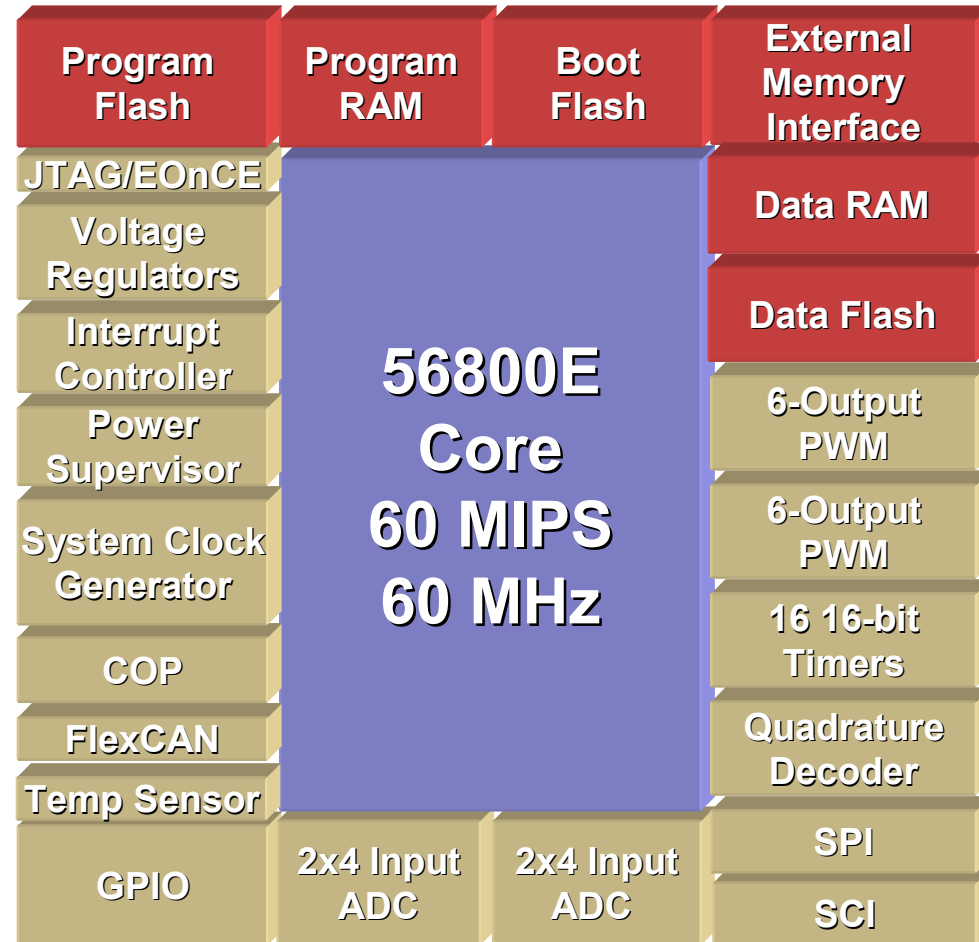
56F8300 Overview

Peripheral Integration



Pin compatible

56800E



48 - 160 Pins

- ✓ 60MIPS Harvard Architecture Core
- ✓ 32K-512K Bytes Program Flash, 4K Bytes Program RAM
- ✓ 8K-32K Bytes Data RAM, 8K-32K Bytes Data Flash
- ✓ 8K-16K Bytes BootFLASH™
- ✓ Code Security Interlock feature for Flash Memory
- ✓ External Memory Interface with 24 Address Lines, 16 Data Lines and 8 Programmable Chip Selects
- ✓ On chip Voltage regulator and ADC reference
- ✓ System Clock Generator - Dynamically Program System Clock Frequency
- ✓ Power Supervisor – Power on Reset and Low Voltage detection.
- ✓ Computer Operating Properly Timer
- ✓ Up two FlexCAN Module – CAN 2.0 A/B Compliant
- ✓ Up to two 6-Output PWM Modules
- ✓ Up to four 4-Input 12-bit ADC
- ✓ Up to two Quadrature Decoders
- ✓ Up to sixteen 16-Bit General Purpose Timers
- ✓ Multiple Serial Ports – SCI & SPI
- ✓ Up to 77 GPIO
- ✓ JTAG/EOnCE™ Debug Port
- ✓ **10Ku Pricing \$7.20-\$22.00 suggested resale**

56F8300 Safety Features and Benefits

Power Supervisor – Power on Reset (POR)

- ✓ Facilitates graceful system shutdown and restart in the event of a power supply failure

Power Supervisor – Low Voltage Interrupt (LVI)

- ✓ Monitors input voltage and generates an interrupt to allow shutdown of the chip if it falls below pre-defined levels. This helps to prevent continued operation that results in damage or incorrect results due to low-voltage levels.

On-chip Clock Synthesis (OCCS)

OCCS - Loss of Clock (LOC) Detection

- ✓ Enables systems to pass the “Cut Crystal Test”. This insures graceful shutdown if something happens to the crystal (physical damage, EMC, etc) during normal operation

OCCS – Loss of PLL Lock (LOL) Detection

- ✓ Monitors the stability of the generated clock to insure it is in sync with the reference clock.

OCCS – Generates an Interrupt on LOC,LOL, or both

- ✓ Each of the above conditions notifies the processor so that it can respond appropriately if the condition occurs, i.e. gracefully shutdown the system.

OCCS – Safety shutdown feature available in the event the PLL Reference clock disappears

- ✓ As in each of the above, enables graceful shutdown to prevent damage to the system.

56F8300 Safety Features & Benefits

Temperature Sensor – Device temperature monitoring using ADC channel

Measures temperature of die & using an ADC informs system that the temperature has exceeded limits.

- ✓ This enables the processor to adjust operations and or shutdown operations as appropriate when warning or excessive temperature levels are detected.
- ✓ Allows engineers to more closely identify actual operating temperature ranges enabling system cost savings through optimized thermal designs and component selection.

Computer Operating Properly (COP) – run-away code recovery

- ✓ Insures recovery from runaway code conditions to prevent incorrect results and/or resulting damage to the system.

Quad Decoder – Zero speed watchdog

- ✓ Detects that the motor has stopped spinning so that an alert may be generated or adjustments made.
- ✓ Also monitors the connection between the controller and the encoder to insure that position information is being transferred

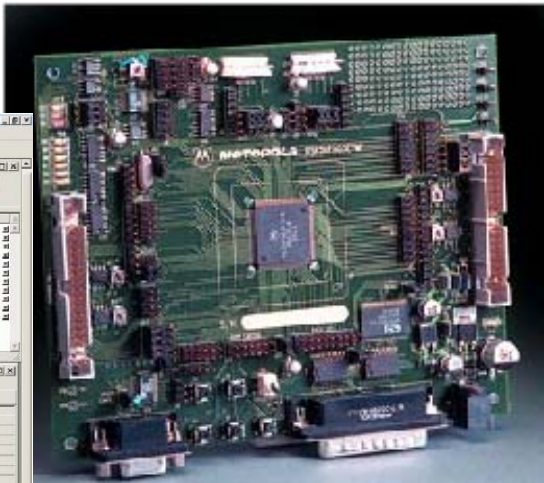
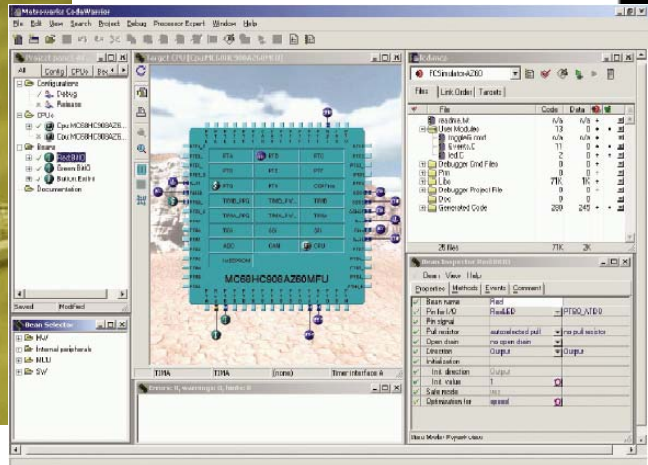
FLASH Security

56F8300 Development Tools Overview

Slide 18

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The Complete Development Environment



CodeWarrior™ for 56800/E

CodeWarrior for Freescale 56800/E is a windows based visual IDE that includes an optimizing C compiler, assembler and linker, project management system, editor and code navigation system, debugger, simulator, scripting, source control, and third party plug in interface.

Processor Expert™

Processor Expert (PE) provides a Rapid Application Design (RAD) tool that combines easy-to-use component-based software application creation with an expert knowledge system. PE is fully integrated with the CodeWarrior for 56800/E.

Hardware Tools

The 56800/E solutions are supported with a complete set of evaluation modules which supply all required items for rapid evaluation and software and hardware development. In addition several command converter options exist for customer target system debugger connection.

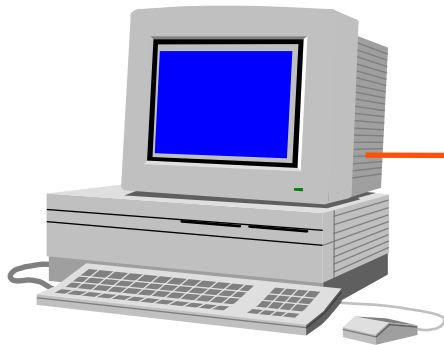
56800/E Evaluation Board (EVB)

Evaluation Board (EVB) Kit

The EVB kit includes everything required to start developing code immediately. It includes the evaluation board, all documentation, required cabling, power supply, CodeWarrior IDE, Processor Expert, and the training CD.

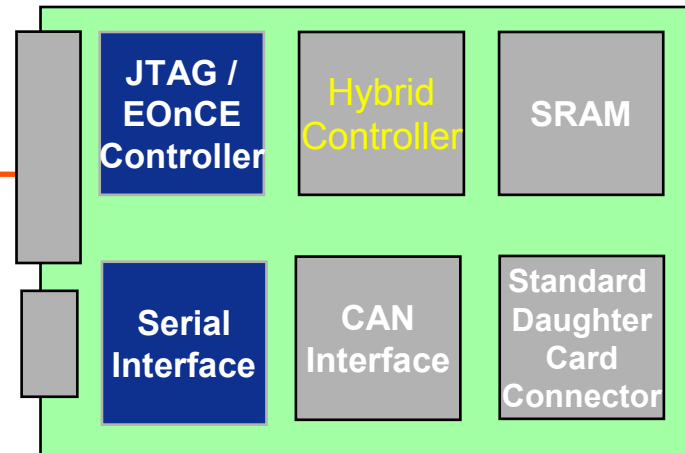
Standard Features:

- ✓ Parallel port Connection to Host PC
- ✓ Non intrusive debug via OnCE/EOnCE port
- ✓ JTAG Connector
- ✓ RS232 Serial connector
- ✓ Expansion Memory
- ✓ Standard daughter card connection
- ✓ CAN PHY layer
- ✓ Universal Power Supply
- ✓ Code Warrior CD w/30 day evaluation license
- ✓ Processor Expert
- ✓ Hands on training CD



Windows Host System

Parallel cable



EVB

56F8300 Developer's Starter Kit

- Everything required to start developing code immediately
- All documentation, required cabling, power supply and more
- Parallel port connection to host PC
- JTAG connector
- CAN PHY layer
- Non-intrusive debug via EOnCE port
- On-board MC33794 E-Field sensor
- Universal power supply
- CodeWarrior CD with Processor Expert



56800/E Demos and Reference Designs

Vehicle

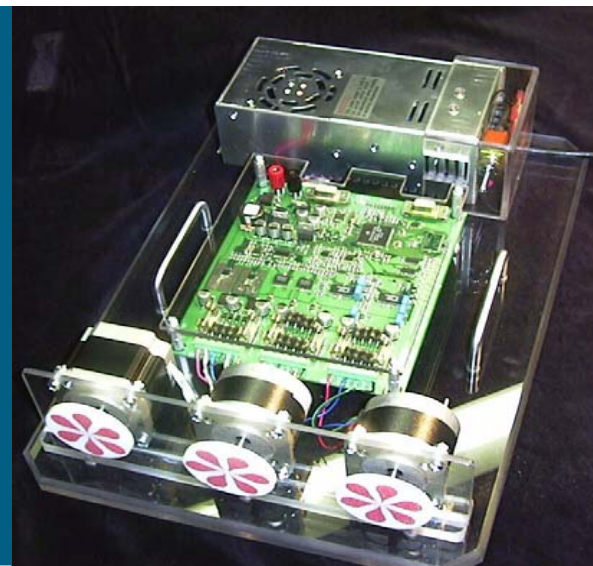
- Electronic Power Assisted Steering (EPAS) Demo
 - 56F805 Version and 56F8345 Version
- Hybrid Braking Demo

Industrial

- UPS Reference Design in Development
- Powerline Modem
 - Switch Mode Power Supply in Definition
 - Low Cost 56F800
- Motor Control Demos
 - BLDC
 - Switch Reluctance
 - Sensorless ACIM
 - Stepper Motors

Voice

- Speaker Feature Phone
- Hands-free (AEC/NS)
- Voice Recognition



56F8300 FlexRay Developer's Kit

Slide 23

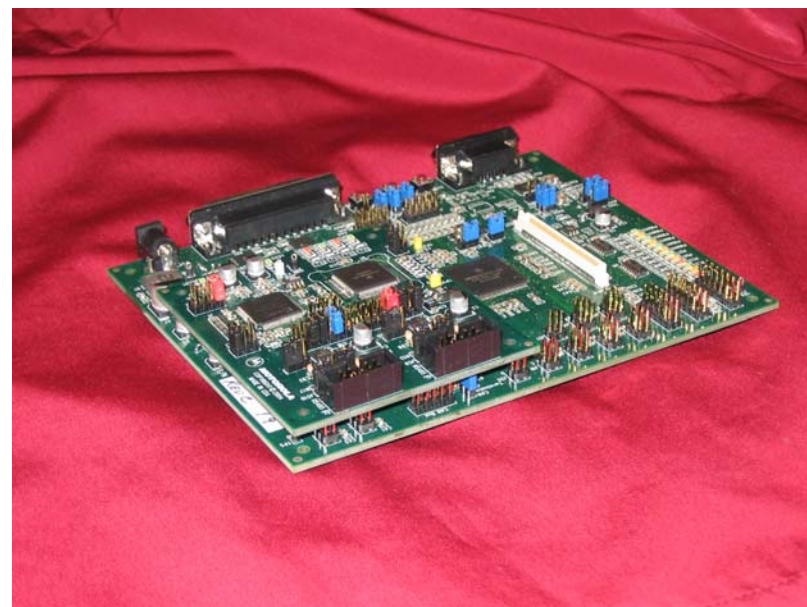
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FlexRay Developer's Kit

FlexRay Developer's Kit



FlexRay Daughter Card & 56F8300 EVB



FlexRay Developer's Kit Advantages

- **Prototype Now!!!**
 - **Allows customers to prototype their 56F800E FlexRay applications today using a 56F8300 EVB and a FlexRay Daughter Card**
- **Hands-On Experience**
 - **Allows customers to get “hands-on” experience with FlexRay and with FlexRay development tools**
- **Provide Input**
 - **Allows customers to provide input to Freescale Semiconductor prior to the release of the 56F800E FlexRay devices and the development of the Titan devices**
- **Develop Custom Hardware**
 - **Customers can develop their own custom hardware to interface with the FlexRay Daughter Card**
 - **Freescale Semiconductor is here to help!!!**

FlexRay Developer's Kit Contents

FlexRay Daughter Card

- **Connects to MC56F8300 EVBs**
 - Daughter card connector connects directly to the MC56F8300 family of EVBs, thus no external wiring is required
- **Uses MFR4200 FlexRay Communications Controller**
- **Two versions of the card available**
 - One version uses dual **RS-485** transceiver
 - One version uses dual **Philips FlexRay** transceiver
- **Power-On LED**

FlexRay Developer's Kit Contents

Low-Level and High-Level Software Drivers

- Software Drivers will be integrated into Processor Expert (PE) RAD tool
- HIS – PE will be compliant by end of 2004
- Autosar – MetroWerks is a member, PE will be compliant

Documentation

- FlexRay Developer's Kit Installation Guide
- FlexRay Daughter Card Schematic
- FlexRay Developer's Kit User's Manual
 - Describes Software Drivers
 - Describes Demo Applications
- Description of FlexRay
- Description of FlexRay Tools

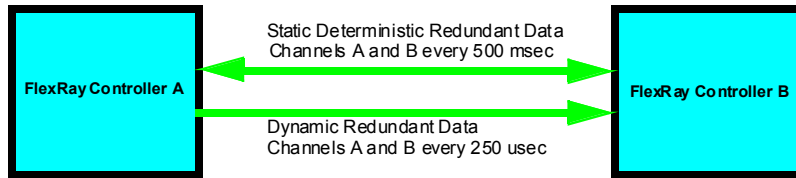
Application that demonstrates FlexRay capabilities

56F8300 FlexRay Demo

Slide 28

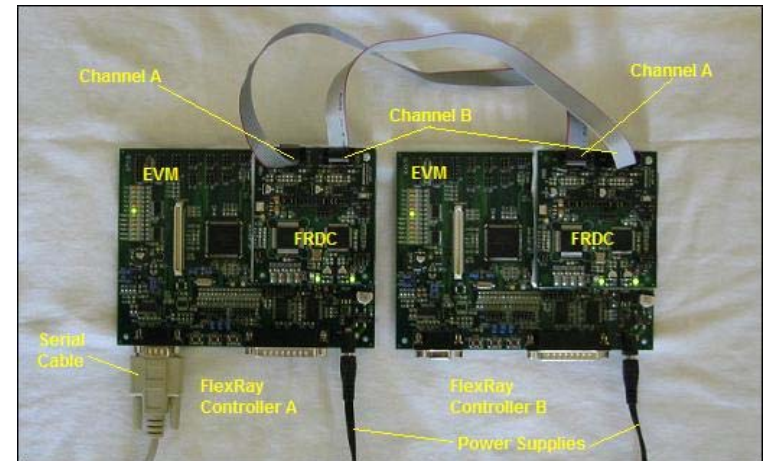
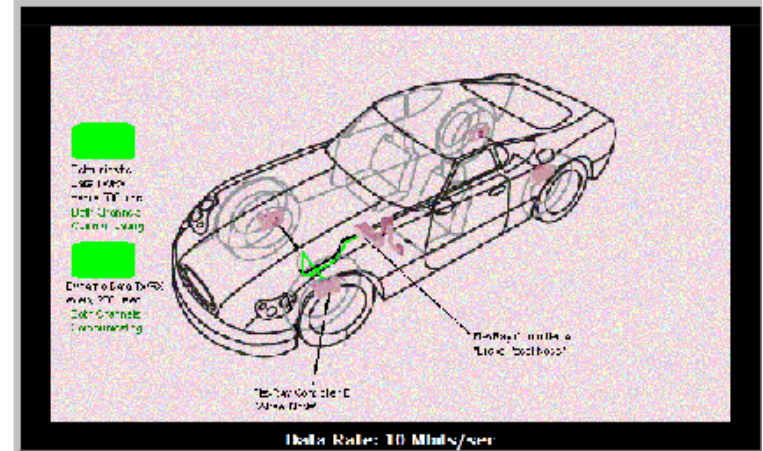
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FlexRay Demo Application



Features of the demo

- Utilizes MC56F8300 EVBs and FlexRay daughter cards
- Utilizes in-house developed FlexRay low-level driver
- Redundant data transmission on two channels
- Deterministic as well as dynamic data transmission
- Data rates at 10 Mbits/sec per channel
- Visual feedback of communication between two FlexRay controllers via PC Master software



Summary

Slide 30

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Summary

- **FlexRay is the next generation communication protocol for the automotive market**
- **Freescale Semiconductor is a leader in the development of FlexRay silicon and software**
- **Freescale Semiconductor has the Processors and Tools suited for applications using FlexRay (i.e. Electro-Mechanical Braking)**
- **Freescale Semiconductor has plans for integrating the FlexRay controller with the its processors**
- **FlexRay support is available now for the 56F8300**
 - Low-Level and High-Level Software Drivers
 - FlexRay Daughter Card
 - FlexRay Demo

Thank You!