

# Electromechanical Braking (Brake By-Wire)

## Overview

Electromechanical braking systems (EMB), also called brake by-wire, replace conventional hydraulic braking systems with a completely “dry” electrical component systems by replacing conventional actuators with electric motor-driven units. This move to electronic control eliminates many of the manufacturing, maintenance, and environmental concerns associated with hydraulic systems.

Because there is no mechanical or hydraulic back-up system, reliability is critical and the system must be fault-tolerant. Implementing EMB requires features such as a dependable power supply, fault-tolerant communication protocols (i.e., TTCAN and *FlexRay*™), and some level of hardware redundancy.

As in electrohydraulic braking (EHB), EMB is designed to improve connectivity with other vehicle systems, thus enabling simpler integration of such higher-level functions as traction control and vehicle stability control. This integration may vary from embedding the function within the EMB system, as with ABS, to interfacing to these additional systems using communication links.

Both EHB and EMB systems offer the advantage of eliminating the large vacuum booster found in conventional systems. Along with reducing the dilemma of working with increasingly tighter space in the engine bay, this elimination helps simplify production of right- and left-hand drive vehicle variants. When compared to those of EHB, EMB systems offer increased flexibility for the placement of components by totally eliminating the hydraulic system.

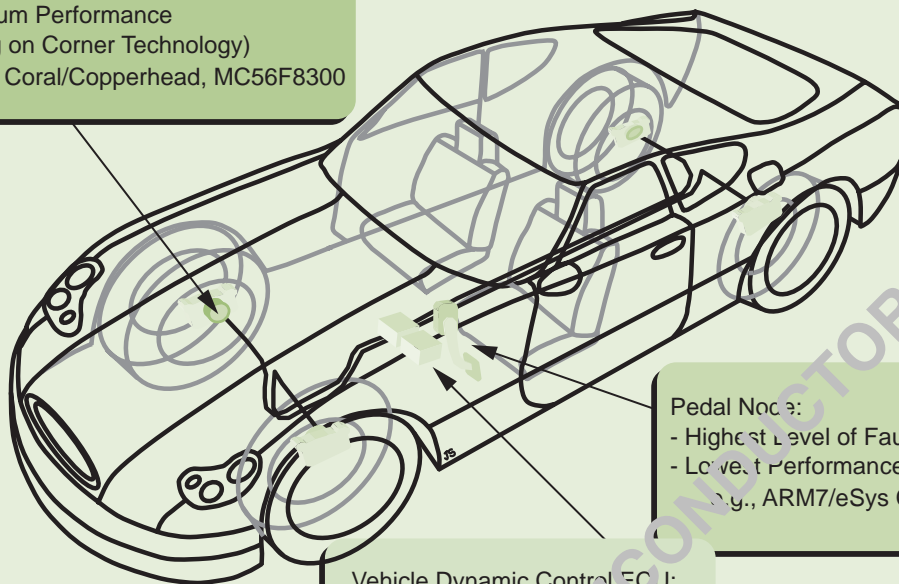
## Key Benefits

- > Connects with emerging systems, such as adaptive cruise control
- > Reduces system weight to provide improved vehicle performance and economy
- > Assembles the system into the host vehicle simpler and faster
- > Reduces pollutant sources by eliminating corrosive, toxic hydraulic fluids
- > Removes the vacuum servo and hydraulic system for flexible placement of components
- > Reduces maintenance requirements
- > Supports features such as “hill hold”
- > Removes mechanical components for freedom of design
- > Eliminates the need for pneumatic vacuum booster systems

**CONTROL PACKAGE**

**Wheel or Corner Node:**

- Fail Safe
- Low to Medium Performance  
(Depending on Corner Technology)
- e.g., eSys Coral/Copperhead, MC56F8300



**Pedal Node:**

- Highest Level of Fault Tolerance
- Lowest Performance
- e.g., ARM7/eSys Coral/MC56F8300

**Vehicle Dynamic Control (VDC):**

- Fail Safe or Fault Tolerant
- Highest Performance
- e.g., eSys Cobra

**Freescale Ordering Information<sup>1</sup>**

Part Number	Product Highlights	Additional Information
MPC500	32-bit microcontrollers	<a href="http://www.freescale.com">www.freescale.com</a> <sup>2</sup>
HC512	16-bit microcontrollers	<a href="http://www.freescale.com">www.freescale.com</a> <sup>2</sup>
MC56F8300 Family	60 MHz, 60 MIPS, up to 176KB Flash, 36KB RAM and Off-Chip Memory, SCI, SPI, ADC, PWM, Quadrature Decoder, Quad Timer, FlexCAN, GPIO, COP/Watchdog, PLL, MCU-style software stack support, JTAG/OnCE for debug, temperature sensor	<a href="http://www.freescale.com">www.freescale.com</a>

**Notes:**

1. Contact your Freescale Semiconductor sales representative for complete information about existing products and custom solutions.
2. Search on the part number list.

### **Design Challenges**

EMB systems represent a complete change in requirements from previous hydraulic and electrohydraulic braking systems. The EMB processing components must be networked using high-reliability bus protocols that ensure comprehensive fault tolerance as a major aspect of system design.

The use of electric brake actuators means additional requirements that include motor control operation within a 42 V power system and high temperature and high density to the electronic components.

In addition to supporting existing communications standards such as CAN and K-line, EMB systems require the implementation of deterministic, time-triggered communications, such as those available with *FlexRay*<sup>™</sup>, to assist in providing the required system fault tolerance. The EMB nodes may not need to be individually fault tolerant, but they

help to provide fail-safe operation and rely on a high level of fault detection by the electronic components.

These new system requirements must be met using high-end components at very competitive prices to replace established, cost-effective technology, while maintaining strict adherence to the automotive qualification.

Delivering the large current requirements to stop a large SUV may cause limited adoption initially. The first implementation will be on small car platforms.

### **Freescale Semiconductor Solution**

A multiple microcontroller unit (MCU) EMB system requires components such as high-performance MCUs from the MPC500 family for the vehicle control node, mid-range performance 56F8300 hybrid controllers or MPC500 microcontrollers for the wheel nodes,

and HCS12 microcontrollers or 56F8300 hybrid controllers for brake pedal nodes.

Freescale Semiconductor has vast experience developing many of the specific aspects required for the implementation of EMB systems. Freescale Semiconductor has a strong background in fault-tolerant communications from previous development of fail-safe microcontrollers, braking specific modules such as the wheel speed timer, a dedicated motor control lab, and a software center that develops drivers, tools, and operating systems. Freescale Semiconductor is also a core team member in the *FlexRay*<sup>™</sup> consortium and has been instrumental in the development of this protocol. With this strong foundation, Freescale Semiconductor has the knowledge to develop the right solutions in partnership with its customers.

ARCHIVED BY FREESCALE SEMICONDUCTOR INC.

## Development Tools

Vendor	MPC555	MPC561	MPC562	MPC563	MPC564	MPC565	MPC566	MC56F8300	TPU
<b>Freescale Semiconductor</b>									
56F8300 Developers Starter Kit								•	
<b>Metrowerks</b>									
CodeWarrior™ Development Studio	•	•	•	•	•	•	•	•	
CodeWarrior for OSEK RTOS	•	•	•	•	•	•	•		
CodeWarrior Development Systems	•					•	•	•	
OSEKturbo (RTOS)	•	•		•		•		•	
TPU Low-Level Driver Library									•
Flash Programming — CodeWarrior	•			•	•	•	•		
Flash Programming — CodeWarrior for OSEK RTOS	•			•	•	•	•	•	
Processor Expert Plug-in for CodeWarrior								•	
<b>Wind River Systems</b>									
BDM Debugger — SingleStep	•	•		•		•			
BDM Debugger — SingleStep with Vision	•	•		•		•			
Flash Programming — SingleStep	•			•		•			
BDM Debugger — VisionCLICK	•	•		•		•			
Nexus Debugger — VisionCLICK		•		•		•			
Nexus Debugger — SingleStep with Vision		•		•		•			
Flash Programming — VisionCLICK	•			•		•			
Compiler — DiabData	•	•	•		•	•	•		
MATRIX	•	•		•		•			
Simulator — SingleStep	•	•	•	•	•	•	•		
<b>Lauterbach</b>									
BDM Debugger Trace32	•	•	•	•	•	•	•	•	•
Nexus Debugger Trace32		•	•	•	•	•	•		•
Code Trace (with Bus access)	•		•	•	•	•	•		
Code Trace (Nexus)	•		•	•	•	•	•		
<b>Axiom Manufacturing</b>									
Low-Cost Evaluation Board	•	•							
Mid-Range Evaluation Board	•	•							
Full-Feature Evaluation Board	•	•	•	•	•	•	•		
<b>Ashling Microsystems</b>									
BDM Debugger — Opella, Genia, and Vitra	•	•	•	•	•	•	•		
Nexus Debugger — Vitra (w/ trace)		•		•		•			•
Nexus Debugger — Opella, Genia		•		•		•			
<b>Green Hills Software</b>									
IDE, Debugger — Multi	•	•		•		•			
Compiler — C/C++/EC++	•	•		•		•			

### Development Tools (continued)

Vendor	MPC555	MPC561	MPC562	MPC563	MPC564	MPC565	MPC566	MC56F8300	TPU
<b>P&amp;E Microcomputer Systems</b>									
Low-Cost Debugger	•	•		•		•			
Flash Programming Tools	•			•		•			
<b>GNU</b>									
Compiler/Debugger	•	•		•		•			
<b>ASH WARE</b>									
TPU Simulator									•
<b>ETAS</b>									
ErCOSEK	•	•		•		•			
Calibration Tools (ETK)	•	•		•		•			
Calibration Tools (ETK) Nexus	•	•		•		•			
<b>dSPACE</b>									
TargetLink	•	•		•		•			
<b>dli</b>									
Logic Analyzer	•	•		•		•			
<b>Agilent Technologies</b>									
Logic Analyzer	•	•		•		•			
Inverse Assembler, Source Correlation	•	•		•		•			
Emulation Probe (BDV)	•	•		•		•			
<b>Tektronix</b>									
Logic Analyzer	•	•				•			
<b>Abatron AG</b>									
BDM Support	•	•		•		•			
<b>Accelerated Technology</b>									
Nucleus (RTOS)	•	•		•		•			

ARCHIVED BY FREESCALE SEMICONDUCTOR INC.

### Third Party Support

Vendor	Contact Information
Metrowerks	800-377-5416 ( <a href="http://www.metrowerks.com">www.metrowerks.com</a> )
Axiom Manufacturing	972-926-9303 ( <a href="http://www.axman.com">www.axman.com</a> )
Wind River Systems	800-872-4977 ( <a href="http://www.windriver.com">www.windriver.com</a> )
Green Hills Software	805-965-6044 ( <a href="http://www.ghs.com">www.ghs.com</a> )
Lauterbach	508-303-6812 ( <a href="http://www.lauterbach.com">www.lauterbach.com</a> )
Accelerated Technology	800-468-6853 ( <a href="http://www.acceleratedtechnology.com">www.acceleratedtechnology.com</a> )
Ashling Microsystems	408-732-6490 ( <a href="http://www.ashling.com">www.ashling.com</a> )
ASH WARE	503-533-0271 ( <a href="http://www.ashware.com">www.ashware.com</a> )
GNU	617-542-5942 ( <a href="http://www.gnu.org">www.gnu.org</a> )
ETAS	888-382-7462 ( <a href="http://www.etasinc.com">www.etasinc.com</a> )
dSPACE	248-567-1300 ( <a href="http://www.dspace.com">www.dspace.com</a> )
P&E Microcomputer Systems	617-353-9206 ( <a href="http://www.pemicro.com">www.pemicro.com</a> )

### Online Topics

Description	Location
M68HC12	<a href="http://www.freescale.com">www.freescale.com</a>
MPC500	<a href="http://www.freescale.com">www.freescale.com</a>
Analog and Mixed Signal	<a href="http://www.freescale.com">www.freescale.com</a>
MC56F8300	<a href="http://www.freescale.com">www.freescale.com</a>

### Related Product

Product Number	Product Name	Contact Information
MC33253	Full bridge pre-driver with AOP for boost electronic application	<a href="http://www.freescale.com">www.freescale.com</a> <sup>Note</sup>

Note: Search on the listed part number.

**Learn More:** Contact the Technical Information Center at +1-800-521-6274 or +1-480-768-2130. For more information about Freescale products, please visit [www.freescale.com](http://www.freescale.com).