

Electronic Transmission Control/ Continuously Variable Transmission Control

Overview

Automatic transmissions simplify car driving and for most users, offer smoother vehicle operation.

Transmission systems allow the relatively narrow range of engine torque to efficiently and properly power a vehicle over its much wider speed range. The transmission changes the gear ratios between the engine torque and the requested road speed.

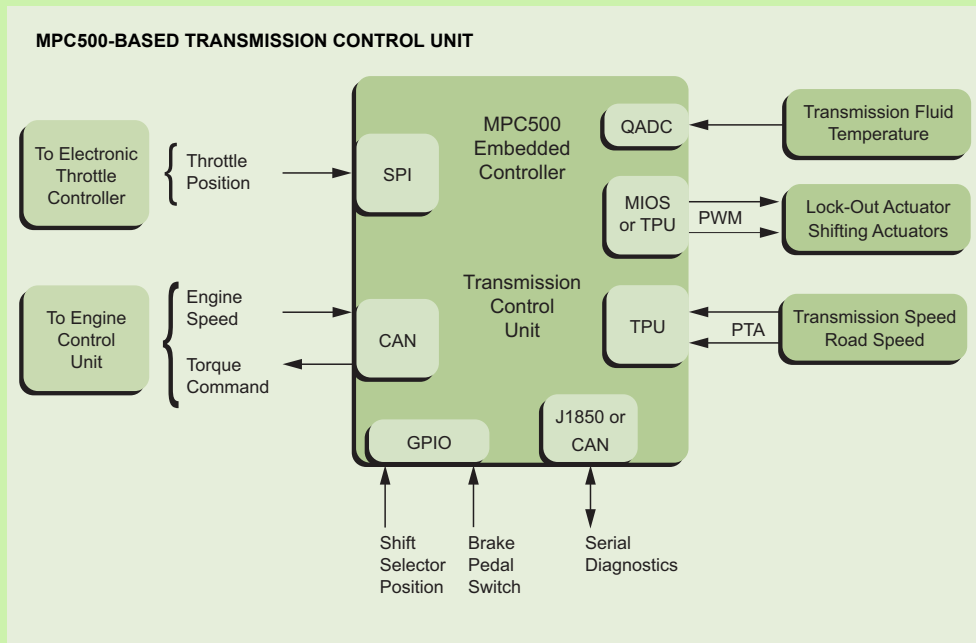
A modern automatic transmission has a microcontroller (MCU)-based electronic

module to control the shift points of the gears by monitoring engine load, engine and road speed, as well as throttle.

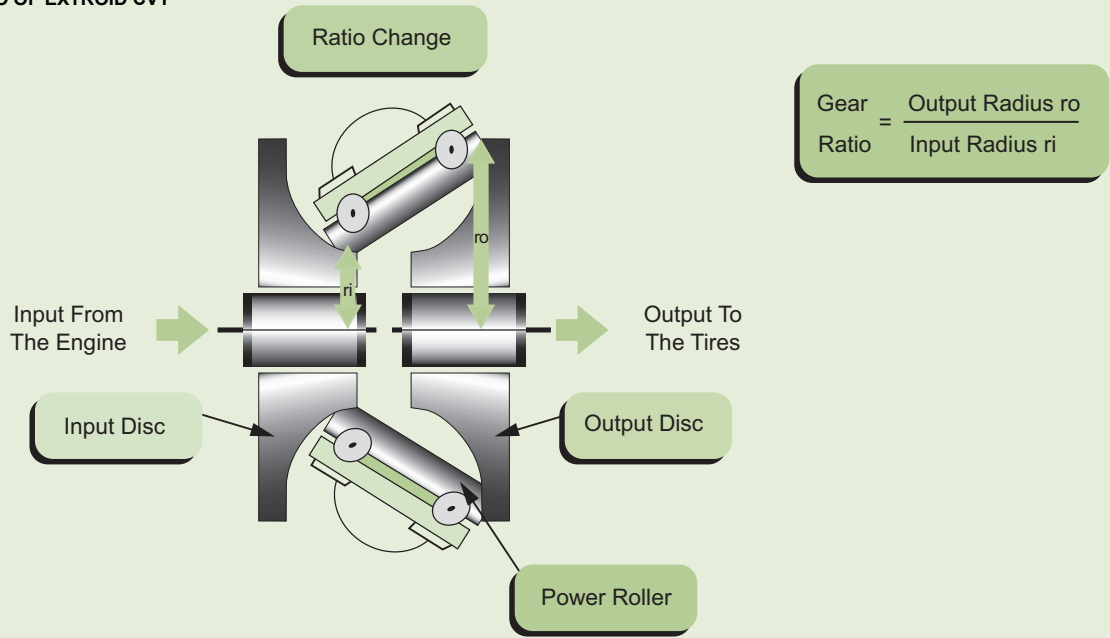
The MCU allows more advanced control algorithms to be implemented and networked with other control modules in the vehicle. The MCU enables the cost-effective implementation of alternate transmission technologies such as continuously variable transmission (CVT) and electronic clutch transmissions.

Key Benefits

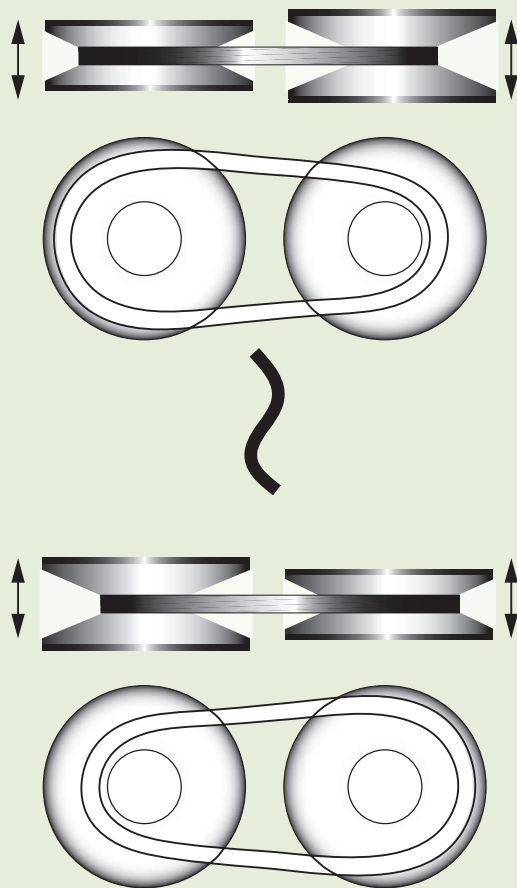
- > Offers highly integrated functionality for electronic transmission control systems using the MPC500 microcontrollers that are based on the PowerPC instruction set architecture
- > Simplifies development time and eases software migration between different devices through seamless migration between different variants of MCUs in the MPC56x family
- > Meets automotive operating environment and reliability requirements demanded by electronic transmission control systems



GEAR RATIO OF EXTROID CVT



BELT-DRIVEN CVT SYSTEM



Freescale Ordering Information

Part Number	Product Highlights	Additional Information
MPC500 family	<ul style="list-style-type: none">> Floating point unit> 40 MHz or 56 MHz CPU> Compatible with the PowerPC ISA> Available with code compression> Up to 1MB of Flash memory	www.freescale.com ^{Note}
MC56F834x	<ul style="list-style-type: none">Quad Timers, FlexCAN, Off-Chip Memory Expansion, an MCU-friendly instruction set, Enhanced OnCE for debug, and temperature sensor with> 144KB Flash> 12KB RAM	Industrial (-40°C to 105°C) and Extended (-40°C to 125°C) Temperature Ranges with up to 76 GPIOs in a 128, 144 or 160-pin LQFP
MC56F835x	<ul style="list-style-type: none">Quad Timers, FlexCAN, Off-Chip Memory Expansion, an MCU-friendly instruction set, Enhanced OnCE for debug, and temperature sensor with> 280KB Flash> 20KB RAM	Industrial (-40°C to 105°C) and Extended (-40°C to 125°C) Temperature Ranges with up to 76 GPIOs in a 128, 144 or 160-pin LQFP
MC56F836x	<ul style="list-style-type: none">Quad Timers, FlexCAN, Off-Chip Memory Expansion, an MCU-friendly instruction set, Enhanced OnCE for debug, and temperature sensor with> 576KB Flash> 64KB RAM	Industrial (-40°C to 105°C) and Extended (-40°C to 125°C) Temperature Ranges with up to 76 GPIOs in a 128, 144 or 160-pin LQFP

Note: Search on the listed part number.

Design Challenges

For all transmissions, designers face all of the following design challenges:

Cost Reduction and Miniaturization of the Control Module

Transmissions are one of the most space conscious modules within the vehicle. They are also required to withstand rugged behavior due to rapidly changing temperatures as well as environments with consistently high temperatures.

Migration Between Different MCUs for Cost Performance Trade-Offs

At times, the module manufacturer wants to implement a variant of an existing module and retain the same software and development tools. This is a major investment that requires a cohesive MCU roadmap.

High Reliability Between -40°C to +125°C Ambient Temperature

Module manufacturers are striving to develop highly integrated mechatronic solutions that invariably result in higher operating temperatures for the electronic components.

Flexibility to Satisfy Many Different Configurations of a Transmission System

Module manufacturers want to maximize the reuse of their investment in the product and the tools needed to support it.

Electromagnetic Compatibility (EMC) Regulatory Compliance

Because the transmission control module operates in a system that contains other electronic modules (e.g., radios, mobile phones, ABS systems), it is important that the transmission module does not generate electromagnetic interference that could disrupt the operation in the other modules.

Diagnostic Capability to Meet Current and Planned OBD and European Regulations

Industry standards require that each electronic control module provides diagnostic information to service personnel.

Automatic Transmission

The control module in an automatic transmission requires more performance from the embedded processor and memory to support new algorithms that emulate the desirable behaviors of manual transmission systems, provide better shift quality, and reduce fuel consumption.

Some of the desirable behaviors include downshifting automatically when going downhill to control speed and reduce wear on the brakes, upshifting when braking on a slippery surface to reduce the braking torque applied by the engine, and inhibiting the upshift when going into a turn on a winding road.

Continuously Variable Transmission (CVT)

Lack of tension control on the CVT belt causes excessive wear on the belt and limits the maximum engine size available for CVTs. The “rubber band” effect, where the engine speeds up rapidly out of proportion to car acceleration, feels disconcerting to the average driver. Fixed gear ratios are not available to emulate manual transmission operation.

Freescale Semiconductor Solution

The following solutions specifically address the system challenges outlined above:

Cost Reduction and Miniaturization of the Control Module

The MPC56x family of microcontrollers provides price improvements because of its high level of on-chip integration. The MPC56x devices feature on-chip ADCs, timer systems, GPIO, Flash and RAM memory, and industry standard serial communication protocols. This largely eliminates many off-chip devices and the external interfaces to these devices, which reduces PCB space that would otherwise be used for bus routing and for external components.

Freescale Semiconductor is a leader in known good die (KGD) production and quality. The KGD devices address the need for miniaturization of the control module.

Migration Between Different MCUs for Cost Performance Trade-Offs

The members of the MCP56x family use the same PowerPC ISA-compatible instruction set architecture and range of on-chip modules. This simplifies development time and eases software migration between different devices.

High Reliability Between -40°C to +125°C Ambient Temperature

Freescale Semiconductor's products are qualified to meet industry standard automotive operating conditions and quality levels.

Flexibility to Satisfy Many Different Configurations of Transmission Systems

On-chip Flash and design tools from leading vendors enable production line customization of the transmission module.

Electromagnetic Compatibility (EMC) Regulatory Compliance

The high level of on-chip functionality enables the elimination of the external bus interfaces that are traditionally a large contributor to EMC issues.

Diagnostic Capability to Meet Current and Planned OBD and European Regulations

The MPC56x family contains on-chip serial communication systems such as J1850, Nexus, SCI, SPI, and CAN to permit a wide range of options for diagnostics and calibration. The MPC56x family's on-chip standby RAM provides key-off storage for diagnostic codes.

Automatic Transmission

The 1MB of on-chip memory and 36K of SRAM allow:

- > Implementation of the complex algorithms that improve transmission response time and characteristics
 - > Adaptive control for different road conditions and engine wear
 - > Emulation of manual gear changing
- Torque convertor lock-up strategies can be implemented on the MPC56x to improve fuel consumption.

The serial communications modules enable networking with other in-car modules such as:

- > The electronic throttle control to provide smoother shifting
- > The engine control module to provide traction control
- > The ABS system to help reduce skidding caused by engine braking

Networking with the engine control module also enables implementation of cost effective and efficient electronic clutch transmission systems.

Continuously Variable Transmission (CVT)

The large number of analog measurement channels on the MPC56x family solves the problem of monitoring the numerous torque and speed sensors required in next generation CVT systems. The high-speed and high-resolution timer systems of the MPC56x devices are used to control the actuators required to emulate fixed gear ratio manual transmissions and prevent the "rubber band" effect.

Development Tools

Vendor	MPC555	MPC561	MPC562	MPC563	MPC564	MPC565	MPC566	MC56F8300	TPU
Metrowerks									
CodeWarrior for Embedded PowerPC ISA	•	•	•	•	•	•	•		
CodeWarrior for OSEK RTOS	•	•	•	•	•	•	•		
CodeWarrior Development Systems	•							•	
OSEKturbo (RTOS)	•	•		•		•		•	
TPU Low-Level Driver Library									•
Flash Programming — CodeWarrior for Embedded PowerPC ISA	•			•	•	•	•	•	
Flash Programming — CodeWarrior for OSEK RTOS	•			•	•	•	•	•	
Wind River Systems									
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	•	•	•	•	•	•	•		
Lauterbach									
BDM Debugger Trace32	•	•	•	•	•	•	•	•	•
Nexus Debugger Trace32		•	•	•	•	•	•		•
Code Trace (with Bus access)	•	•	•	•	•	•	•		
Code Trace (Nexus)	•	•	•	•	•	•	•		
Axiom Manufacturing									
Low-Cost Evaluation Board	•	•							
Mid-Range Evaluation Board	•	•							
Full-Feature Evaluation Board	•	•	•	•	•	•	•		
Ashling Microsystems									
BDM Debugger — Opella, Genia, and Vitra	•	•	•	•	•	•	•		
Nexus Debugger — Vitra (w/trace)		•		•			•		•
Nexus Debugger — Opella, Genia		•		•			•		
Green Hills Software									
IDE, Debugger — Multi	•	•		•			•		
Compiler — C/C++/EC++	•	•		•			•		
P&E Microcomputer Systems									
Low-Cost Debugger	•	•		•			•		
Flash Programming Tools	•			•			•		
GNU									
Compiler/Debugger	•	•		•			•		
ASH WARE									
TPU Simulator									•

Development Tools (continued)

Vendor	MPC555	MPC561	MPC562	MPC563	MPC564	MPC565	MPC566	MC56F8300	TPU
ETAS									
ErCOSEK	•	•		•		•			
Calibration Tools (ETK)	•	•		•		•			
Calibration Tools (ETK) Nexus	•	•		•		•			
LabCar Calibration	•	•	•	•	•	•	•		•
LabCar Autocode	•	•	•	•	•	•	•		•
Simulink Hardware in the Loop	•	•	•	•	•	•	•		•
Simulator – Hardware in the Loop	•	•	•	•	•	•	•		•
MicroAutobox Calibration (Nexus)	•	•	•	•	•	•	•		•
dSPACE									
TargetLink	•	•		•		•			
dli									
Logic Analyzer	•	•		•		•			
Agilent Technologies									
Logic Analyzer	•	•		•		•			
Inverse Assembler, Source Correlation	•	•		•		•			
Emulation Probe (BDV)	•	•		•		•			
Tektronix									
Logic Analyzer	•	•		•		•			
Abatron AG									
BDM Support	•	•		•		•			
Accelerated Technology									
Nucleus (RTOS)	•	•		•		•			

Third Party Support

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

Online Topics

Description	Location
MPC500	www.freescale.com
Automotive	www.freescale.com
TPU Microcoding Made Easy	www.amtpublishing.com
MPC500 User Group	groups.yahoo.com/group/mot-mpc500-apps

Notes

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