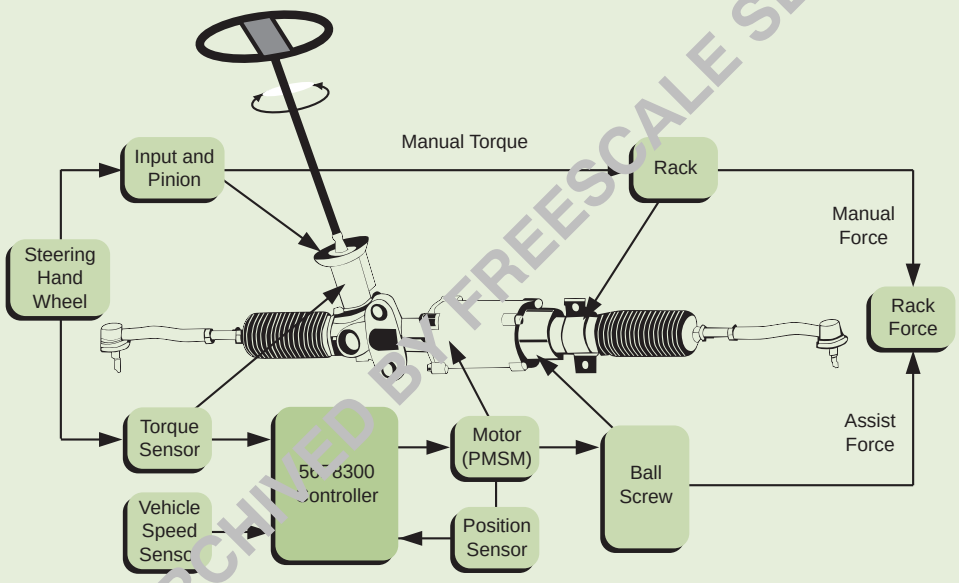
Electric Power Steering

Overview

Traditional hydraulic power steering systems have provided remarkable performance for many years in terms of handling, cost, and comfort. However, these systems have the drawback of adding drag on the engine equal to a decrease of 5 horsepower. The hydraulic pump runs regardless of whether steering assistance is required. In fact, the power cost of the pump is highest at high speed, when steering assistance is least needed.

Automotive manufacturers are moving to Electric Power Steering (EPS) to provide the convenience of steering assist without the cost in engine size and fuel consumption. EPS systems are available today and, by 2006, up to 50% of new vehicles sold in Europe will have electric instead of hydraulic power steering.

PRACTICAL SYSTEM BLOCK DIAGRAM—RACK TYPE



Key Benefits

> EPS provides a more flexible and less expensive steering system than a conventional hydraulic system

> Supports a single-device solution using an integrated peripheral set

> Combines MCU functionality and DSP processing power for high-speed sensor input processing

> Supports automotive environments (-40°C to +125°C)

> Offers a low-cost device and system solution with wider market application availability

> Out-of-the-box software frameworks designed to expedite time-to-market and reduce development costs

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Freescale Ordering Information

Part Number	Product Highlights	Additional Information
MC56F834x	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	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	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

Design Challenges

The steering assistance possible for any EPS system is limited by the maximum current available from the vehicle. Typical 12 V systems can provide a peak maximum current of 80 amps, limiting peak power to only 1 Kilowatt, so current applications of EPS are limited to smaller vehicles, such as the compact or smaller medium class of cars. However, once 42 V electrical systems are available, EPS can be easily applied to larger vehicles, even trucks.

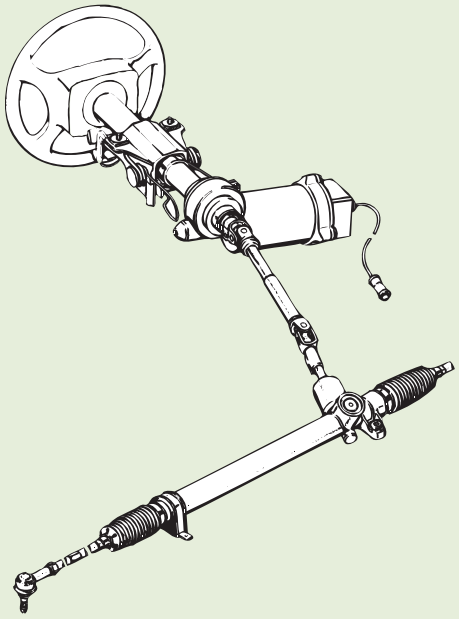
Another challenge is minimizing system cost and maximizing robustness, safety, and flexibility. Choosing the right components is key to success.

EPS is also a cheaper and more flexible solution than a hydraulic pump. Besides providing a five percent improvement in fuel efficiency, EPS is lighter (4 Kgs to 6 Kg or 8 lbs to 13 lbs), and mechanically simpler (no pump, fan belt, fluid reservoir). The same EPS system can provide high-performance driving for a sports car and smooth, safety-assisted steering for the family sedan simply by changing the controller's software.

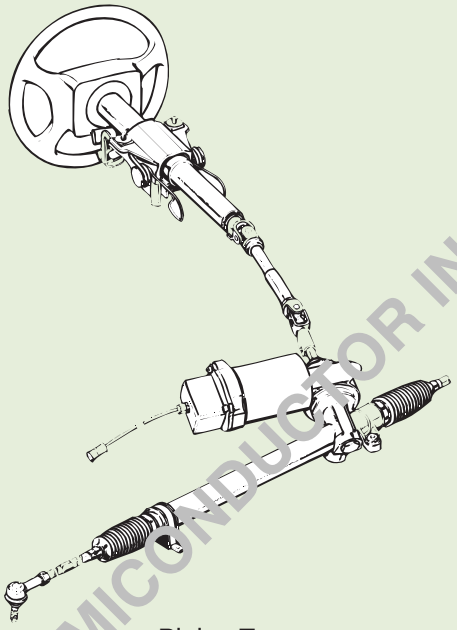
The Figure on page 1 shows a rack-type EPS system block diagram for both the mechanical design and the high-level design of the overall system.

Differing EPS solutions can be separated into categories by the location of the electric motor that provides steering assistance. The Figures on page 3 show the various motor locations possible: Column, Pinion, Rack, and Double Pinion.

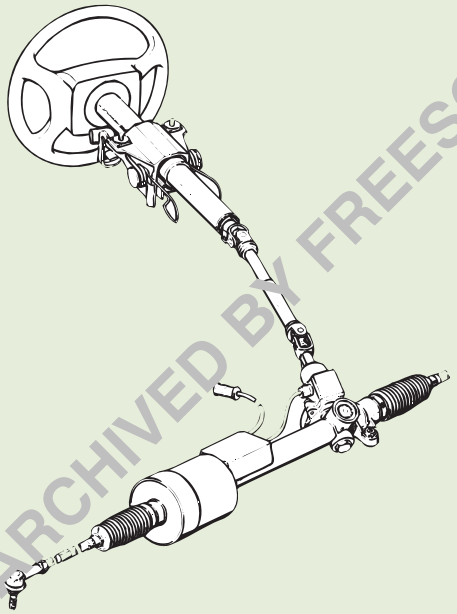
ELECTRIC MOTOR LOCATION TYPES



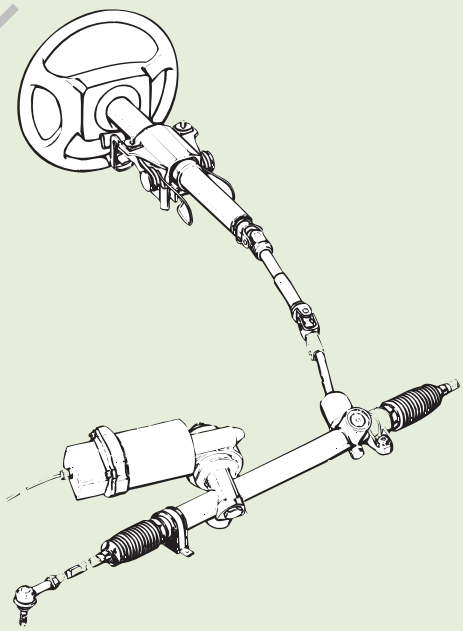
Column Type



Pinion Type



Rack Type



Double Pinion Type

Freescale Semiconductor Solution

The 56F8300 series of hybrid controllers provides the best match of processing throughput and smart peripherals to support successful EPS solutions. This series provides 60 MIPS performance at automotive temperatures with the right peripherals to support EPS.

Enhanced System-on-a-Chip (SOC) integration, which includes the needed safety-enabling features, minimizes overall system cost. Loss of reference clock, loss of voltage, and protection of mission-critical memory are all supported on-chip. Hardware support for fault inputs is provided, with the flexibility to run the system at reduced functionality instead of just shutting it down when faults occur.

Dedicated Boot Flash memory and the on-chip CAN bus peripheral facilitates easy integration of EPS systems into larger subsystems by supporting in-situ reprogramming via the CAN bus. Built-in Flash security protects the intellectual property of the EPS designer.

Freescale Semiconductor provides an EPS software framework to help EPS engineers concentrate on adding features, rather than learning how to spin motors. The Freescale Semiconductor Czech Systems Laboratory (MCSL) in Roznov, Czech Republic, stands ready to help with any advanced questions that arise during system design.

Development Tools

Tool Type	Product Name	Vendor	Description
Software	Processor Expert	Freescale Semiconductor	Software infrastructure that allows development of efficient, high-level software applications that are fully portable and reusable across all 56800/E family processors.
Hardware	MC56F8300DSK	Freescale Semiconductor	56F8300 Developers Start Kit
Hardware	56F800DEMO	Freescale Semiconductor	56F800 Demonstration kit
Software	CW568X	Freescale Semiconductor	CodeWarrior Development Studio for Freescale Semiconductor DSC 56800/E Controllers (Metrowerks)
Hardware	MC56F8323EVM	Freescale Semiconductor	Evaluation Module for the MC56F8323 and MC56F8322
Hardware	MC56F8367EVM	Freescale Semiconductor	Evaluation Module for the MC56F834x, MC56F835x and MC56F836x
Hardware	MMA2260D	Freescale Semiconductor	1.5g X-Axis Accelerometer for Consumer Applications

Disclaimer

This document may not include all the details necessary to completely develop this design. It is provided as a reference only and is intended to demonstrate the variety of applications for the device.

Learn More: Contact the Technical Information Center at +1-800-521-6274 or +1-480-768-2130.
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