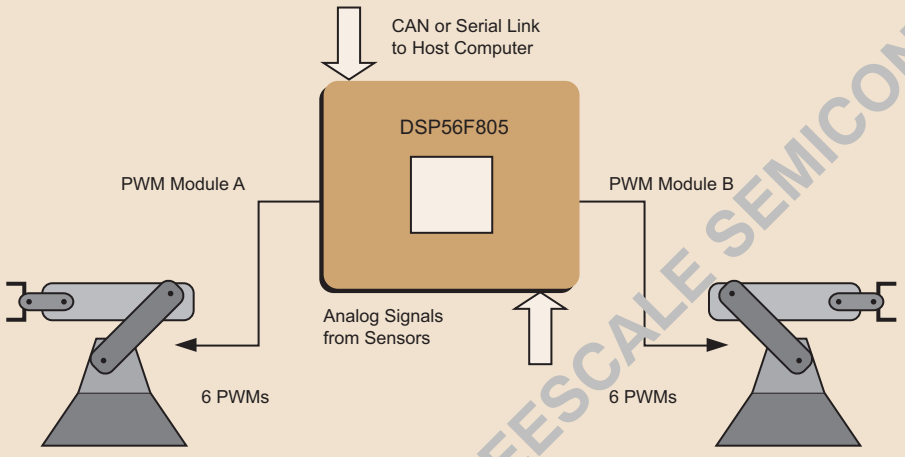
One DSP Controlling Two Robot Manipulators

Overview

In recent years, the increasing power and ease of use of digital signal processors (DSPs) have made them a viable alternative in a variety of applications that previously used low-cost 8- and 16-bit microcontrollers. This document details the use of Freescale Semiconductor's DSP56F805 in robot manipulators.

ONE DSP56F805 CONTROLLING TWO MANIPULATORS



Key Benefits

> Single-chip solution reduces system cost and board space for industrial control applications

> On-chip CAN bus connects several applications to each other or to a host computer

> Two on-chip SCIs connect to other microcontrollers or to sensor nodes

> Large on-chip Flash memory for system software updates

> Powerful DSP core runs at up to 40 MIPS to accommodate a variety of digital filtering algorithms

> Easy C language programming without specific DSP experience

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

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Freescale Ordering Information

Part Number	Product Highlights	Additional Information
DSP56F805	80MHz, 40MIPS, CAN, SCIs, SPI, ADC, PWMs, Quadrature Decoder, Quad Timer and > 31.5K Program Flash > 512K Program RAM > 4K Data Flash > 2K Data RAM	MCU-friendly instruction set, OnCE for debug, on-chip relaxation oscillator, 2K BootFLASH, external memory expansion, and up to 32 GPIO available in a 144-pin LQFP.
DSP56F807	80MHz, 40MIPS, CAN, SCIs, SPI, ADCs, PWMs, Quadrature Decoder, Quad Timer and > 60K Program Flash > 2K Program RAM > 8K Data Flash > 4K Data RAM	MCU-friendly instruction set, OnCE for debug, on-chip relaxation oscillator, 2K BootFLASH, external memory expansion, and up to 32 GPIO available in both a 160-pin LQFP and 160 MAPBGA.
MC56F8300 Family	60 MHz, 60 MIPS, up to 576KB 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	www.freescale.com

Design Challenges

For successful use in generic control applications, a processor must fill general purpose functions and the core must provide both microcontroller functions and an appropriate set of peripherals, including timers, interfaces, analog-to-digital converters (ADCs) and digital-to-analog converters (DACs), and memory modules.

Freescale Semiconductor Solution

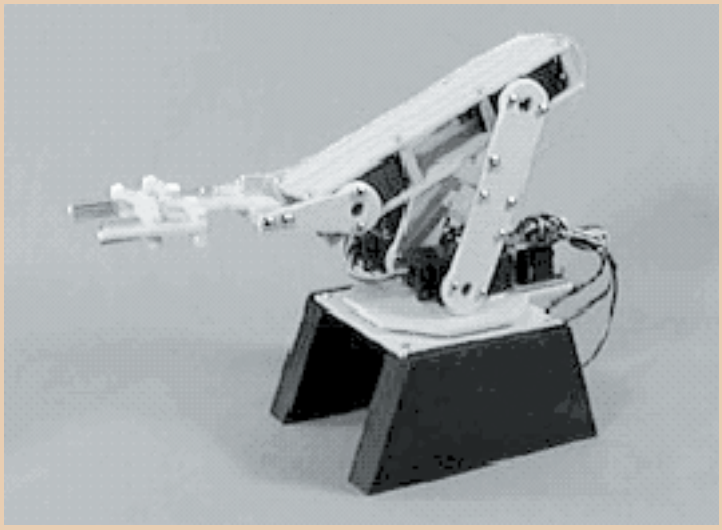
The figure below shows the Lynxmotion robot manipulator. The Lynxmotion is an affordable introductory system if neither high-positioning accuracy nor heavy loads are required. The Lynxmotion uses six servo motors for controlling four axes (four degrees of freedom) and to open and close the gripper.

Each servo motor is independently controlled by a pulse width modulation (PWM) signal. The DSP56F805 is ideally suited for the control of two robot manipulators, because the device features two unique PWM modules for motor control (see figure on page 1). Each PWM module can be configured to deliver six independent PWM signals. A PWM module has a resolution of up to 15 bits, ensuring a high precision of the pulse width.

Other features that make the DSP56F805 the ideal choice for this task are:

- **On-chip controller area network (CAN) module.** The CAN bus has become very popular as a network standard in industrial control. It is often used as a field bus to connect several applications to each other or to a host computer.
- **Two on-chip serial communication interfaces (SCIs).** These SCIs can connect the control system to other microcontrollers or to sensor nodes.
- **Large on-chip Flash memory.** The DSP56F805 features a 32K × 16-bit internal Flash program memory. Therefore, the whole control application can be implemented as a single-chip solution, saving cost and board space. Because the Flash memory is reprogrammable in application, the industrial control system's software can easily be updated.
- **On-chip ADCs.** All derivatives of the DSP56F80x family contain at least two independent 12-bit ADCs. Here, various sensors can be connected to the control system and can be sampled with high resolution.
- **Powerful core.** All derivatives of the DSP56F80x series contain a 16-bit fixed-point DSP core running with a calculating power of up to 40 million instructions per second (MIPS). Thus, not only can all required control tasks be fulfilled easily, but various digital filtering algorithms can also be implemented. This makes the design simpler and saves components and cost.
- **Easily programmed.** DSP56F80x devices are optimized to be programmed in C language. Therefore, it is easy for a typical microcontroller (MCU) design engineer to write code for these devices, as no special DSP experience is required. Freescale Semiconductor's embedded Software Development Kit (SDK) makes it even easier to develop high-quality software.
- **Software.** Out-of-the-box software components for all on-chip peripherals, in combination with software libraries to motor control, communication, and signal processing, make it easy to develop the most demanding real-time embedded applications.
- **Factory-installed boot loader.** DSP56F80x devices support reprogramming over ANSCI port. Boot loader can also be adapted to work over CAN bus.

LYNXMOTION ROBOT MANIPULATOR



Development Tools

Tool Type	Product Name	Vendor	Description
Software	CW568X	Freescale Semiconductor	CodeWarrior™ Development Studio for 56800/E Controllers with Processor Expert (Metrowerks)
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 of processors.
Software	CWDSP56800	Freescale Semiconductor	CodeWarrior Software Development Tools for 56800 (Metrowerks)
Hardware	56F800DEMO	Freescale Semiconductor	56F800 Demonstration Kit
Hardware	DSP56F805EVM	Freescale Semiconductor	Evaluation Module for the 56F805
Hardware	DSP56F807EVM	Freescale Semiconductor	Evaluation Module for the 56F807
Hardware	MC56F8300DSK	Freescale Semiconductor	56F8300 Developers Start Kit
Hardware	MC56F8367EVM	Freescale Semiconductor	Evaluation Module for the 56F834x, 56F835x, 56F836x
Development Kit	DSPOSRTOS	Freescale Semiconductor	Emulation Support for 56F80xx Processors (Requires Ethernet Network)

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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