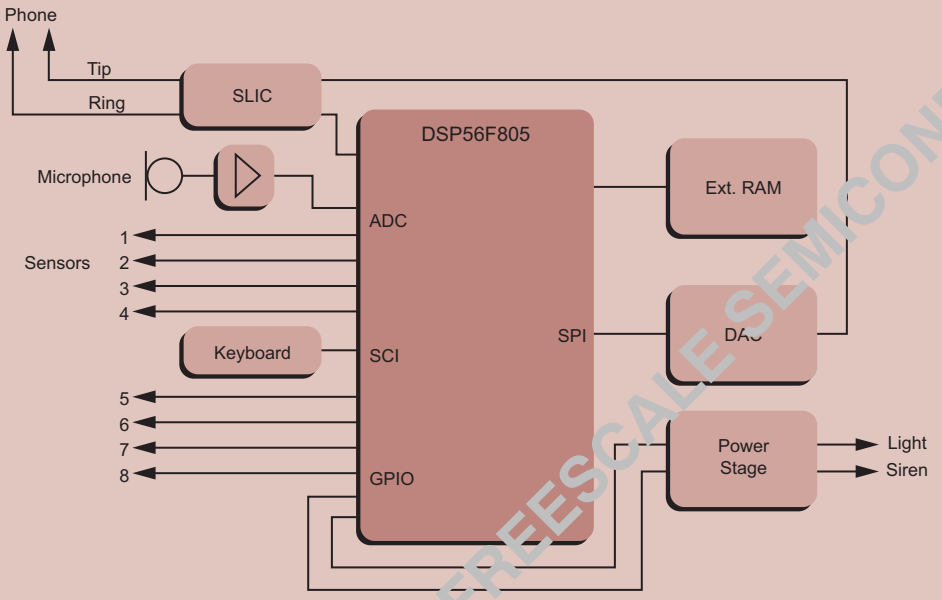
Home Appliances Voice Control

Overview

Control of a device with voice commands is now possible using an architecture that combines a microcontroller (MCU) with a digital signal processor (DSP).

BLOCK DIAGRAM OF LIGHT AND HEATING CONTROL USING DSP56F805 WITH INTEGRATED SIMPLE VOICE CONTROL



Key Benefits

> Controls home appliances using voice commands

> Accesses system functions by voice command, manual switch, or keypad input

> Controls heating by phone using voice commands

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

freescale semiconductor

Freescale Ordering Information

Part Number	Product Highlights	Additional Information
DSP56F800 Family	80 MHz, 40 MIPS, up to 31.5KB Flash, 6K words RAM and Off-Chip Memory, SCI, SPI, ADC, PWM, Quadrature Decoder, Quad Timer, CAN, GPIO, MCU-friendly instruction set, JTAG/OnCE for debug	www.freescale.com
DSP56F820 Family	80 MHz, 40 MIPS, up to 68K words Flash, 5K words RAM and Off-Chip Memory, SCI, SPI, SSI, ADC, Quad Timer, GPIO, TOD, MCU-friendly instruction set, JTAG/OnCE for debug	www.freescale.com
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
MC56F8100 Family	40 MHz, 40 MIPS, up to 544KB Flash, 32KB 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	www.freescale.com

Design Challenges

The digital processing capabilities of a hybrid MCU allow voice control to penetrate to embedded systems. Practically any new product containing a hybrid MCU can be controlled by voice. A system for control of lights and heating (see the block diagram on page 1) can be generalized for controlling any device with a voice command set. Algorithms are based on hidden Markov models (HMM) adapted to the hybrid MCU.

Freescale Semiconductor Solution

Speech Signals in Real Time

The hardware for voice control can be produced right now because the DSP56F805 device has 32.5K Flash program memory, allowing the recognition algorithm to be upgraded easily.

The pivotal feature for speech processing is the ability to parameterize speech signals in real time. This is provided in the SDK library.

Voice Command Set Capability

The voice command set must be designed with respect to speaker dependence. Assuming the proposed system will be used by two people, the command set could be the following words: *light, dark, heat, cold* (recorded four times individually for each speaker), *0* through *9*, time, and temperature (recorded by one authorized person). The speaker dependence characteristic is advantageous when controlling devices.

3 Ways to Access Functionality

All proposed system-controlling functions are accessible by voice command, manual switch, or by keypad input (in a noisy environment). Each microphone has a corresponding switch or button and a corresponding lamp unit. The arbitration process, or choosing the controlled device, is solved by software.

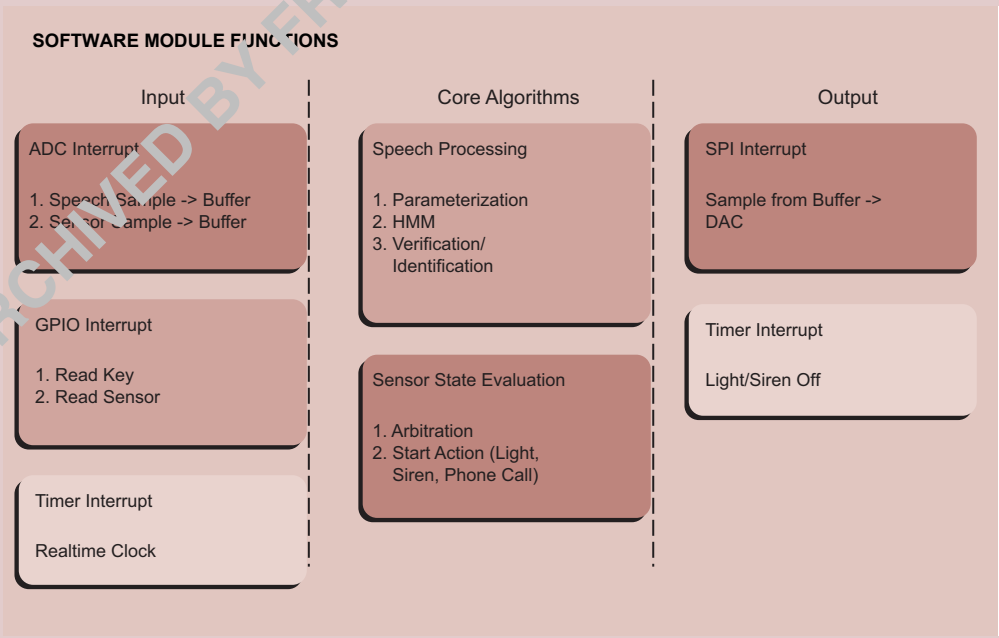
The controller continuously samples all analog-to-digital converter (ADC) inputs, the affiliated software process determines if there is a speech or input, and the processor assigns an actual device. The ADC on the DSP56F805 has two modules, each multiplexed to four pins; a total of eight sources of analog signal. Optionally, one ADC pin can be connected to a phone through a subscriber line interface circuit (SLIC); one pin is connected to a temperature sensor. The remaining six pins can be connected to microphones. The ADC resolution is 12-bit, and maximum sampling frequency is 800 kHz, time-multiplexed sampling of all eight ADC channels. To minimize memory requirements, a sampling frequency of 8 kHz is recommended for all speech channels.

Optional Phone Control of Heating

As an option, heating can be controlled by phone. The recognition process is the same. If the speech reference is recognized, the processor returns it as an audio signal to confirm the validity of the recognition. The controller is connected to a phone through a SLIC. Internal ADC is used at the input side and an external digital-to-analog converter (DAC) is used at the output side. The DAC and the DSP are connected through a serial peripheral interface (SPI).

Software Module Functions

Module functions are provided by software and should be programmed in C language. Proposed layering of the software and interrupt usage are shown in the figure below.



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 processors.
Software	CWDSP56800	Freescale Semiconductor	CodeWarrior Software Development Tools for 56800 (Metrowerks)
Software	VRLite-1	Freescale Semiconductor	VRLite-1 is a memory-optimized, isolated-word, speaker-dependent speech recognition system.
Hardware	56F800DEMO	Freescale Semiconductor	56F800 Demonstration Kit
Hardware	DSP56F801EVM	Freescale Semiconductor	Evaluation Module for the 56F801 and 56F802
Hardware	DSP56F803EVM	Freescale Semiconductor	Evaluation Module for the 56F803
Hardware	DSP56F805EVM	Freescale Semiconductor	Evaluation Module for the 56F805
Hardware	DSP56F807EVM	Freescale Semiconductor	Evaluation Module for the 56F807
Hardware	DSP56F826EVM	Freescale Semiconductor	Evaluation Module for the 56F826
Hardware	DSP56F827EVM	Freescale Semiconductor	Evaluation Module for the 56F827
Hardware	MC56F8300DSK	Freescale Semiconductor	56F8300 Developers Start-Kit
Hardware	MC56F8323EVM	Freescale Semiconductor	Evaluation Module for the 56F8322 and 56F8323
Hardware	MC56F8367EVM	Freescale Semiconductor	Evaluation Module for the 56F834x, 56F835x, 56F836x

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.
For more information about Freescale products, please visit **www.freescale.com**.

SG2041
REV 3
6/2005

June2005