I. Overview

The Sensory NLP-5x has on-board control logic which can drive an external static or multiplexed Liquid Crystal Display (LCD) of up to 104 icons or pixels without the need for a separate LCD driver. This design note describes and documents an example of an LCD daughter board which can be connected directly to Sensory's NLP-5x Demo/Evaluation board, running the 'lcd' sample code provided with Sensory's FluentChip 5 API.

II. NLP-5x LCD Driver and Interface

Note: For complete details on the NLP-5x LCD, refer to the “NLP-5x Datasheet” (80-0317).

The NLP-5x LCD driver has these features:

- Configurable outputs, up to 26x4
- Programmable drive control handles display refreshing without software intervention and allows operation (maintaining a display with unchanging information) while the processor is stopped
- Programmable refresh rate
- Static, 1/2, and 1/3 LCD bias
- Low 80 μA current consumption

The LCD interface consists of circuitry to generate pulse sequences of varying amplitude supplied to a programmable number of outputs over a period of programmable duration. Each pixel in the LCD is supplied by two pulse sequences, a “common” and a “segment”. Pixels in the LCD that are to be “on” (dark) are driven by a pair of pulse sequences that produce a large AC voltage; pixels that are to be “off” (transparent) are driven by a pair of pulse sequences that produce a small-or-zero AC voltage. To protect the LCD itself, no pixel may have a net DC voltage. The application software needs only to control the on/off state of each pixel; the pulse sequences are generated automatically by the LCD interface.

The LCD interface circuitry includes:

- Configuration control and I/O assignment registers
- 128-bit LCD pixel memory
- Programmable refresh clock
- State machine to control timing waveforms
- External connections through I/O to segments, commons, and bias voltages

Using the LCD interface requires dedicating some number of I/O pins for that purpose. The largest configuration requires all 32 bits of P0 and P1. Any or all of port 0 and port 1 pins can be used to directly drive an LCD display. If a LCD mode other than static drive is selected, P1.15 and P1.14 will be connected to an off-chip resistor divider to generate intermediate voltages for the LCD driver. In static mode, P1.15 is the common output. In other modes, two, three, or four of P1.13-P1.10 will become common outputs, depending on the number of common pins configured. All remaining P1 and P0 pins can be individually configured as LCD segment outputs.

All GPIO pins used as LCD inputs should be configured as open (Hi-Z) inputs. Otherwise GPIO inputs with internal pullup resistance and GPIO outputs will be connected through the LCD display, which will be distorted or obliterated.
III. The LCD Daughter Board

The Sensory LCD Daughter board implements a sample clock LCD display which is a 4 common, 11 segment matrix consisting of 3.5 digits of 7-segment numerics, along with 23 separate icons: “CHIME”, “ALARM”, “MONTH”, “DAY”, “M”, “S”, “AM”, “PM”, “MON”, “TUE”, “WED”, “THU”, “FRI”, “SAT”, “SUN”, “F”, “C”, “°”, (temperature) “:” (colon) and “/” (slash), and special picture icons to represent recording, snooze, and low battery level.
IV. The LCD Sample program

The FluentChip 5 API includes an LCD sample application which is compatible with the LCD daughter board. It does the following:

1. Display the digits “00:00”, then “11:11”, “2:22”, etc up to “9:99”.
2. Cycle through all the icons
3. Repeat steps 1-2 eight times, then enter a low-power sleep mode.
The Interactive Speech™ Product Line

Sensory’s Interactive Speech™ product line makes consumer electronics more intelligent by enabling them to talk, hear, move and interact with the external world using naturally sounding spoken commands—all without training and even in noisy environments! Sensory offers both chip and software solutions that offer advanced speech recognition with hands-free functionality, biometric speaker verification, text-to-speech (TTS) synthesis, high quality stereo music and sound effects, robotics and LCD controls, and interactive sensing capabilities. These technologies are designed for integration into cost-sensitive consumer electronic applications such as home appliances, smart toys, music players and personal communication devices. The hardware line includes the NLP-5x Natural Language Processor, the RSC-4x family of mixed signal processors, and the SC-691 music and speech synthesis slave processor. Embedded software options include the FluentSoft™ Recognizer, which offers speech recognition technologies for non-Sensory processors and DSPs. Sensory’s BlueGenie™ Voice Interface, the first speech recognition, TTS and synthesis option for BlueTooth® enabled devices, offers hands-free control of headsets, music players and other BlueTooth® devices.

NLP-5x Natural Language Processor and Development Tools

The NLP-5x features a high-performance 80MHz 16-bit DSP with on-chip ADC, hi-fidelity stereo DAC, microphone preamplifiers, RAM, OTP code and constant memory, and many kinds of peripheral interfaces and control blocks. With Sensory’s FluentChip™ firmware, it provides a single chip solution capable of accurate speech recognition; text-to-speech (TTS) synthesis with morphing; compressed speech; high fidelity music; motor and LCD control; and man-machine interfaces (MMI) with interactive sensors. Sensory offers a complete suite of evaluation and development tools that include the ability to create complex grammars with a natural language interface in multiple languages.

RSC-4x Family of Microcontrollers and Developer Tools

The RSC-4x (Recognition, Synthesis and Control) product family contains low-cost 8-bit speech-optimized microcontrollers that are fully integrated and include A/D, pre-amplifier, D/A, RAM, and ROM circuitry. With Sensory’s FluentChip™ firmware, the RSC family offers speech recognition, speaker verification, speech and music synthesis, voice recording and playback, and an entire suite of interactive robotic and sonic networking technologies. The family is supported by a complete suite of evaluation and development toolkits that include the ability to quickly create speaker independent recognition sets in many languages.

SC6 Slave Processor and Tools

The SC-691 is a standard slave synthesizer that accepts compressed speech data from other microprocessors or microcontrollers and converts it to speech. The chip operates up to 12.32 MIPS, and provides high-quality, low data-rate speech compression and MIDI music synthesis, with unlimited speech duration using external memory. Sensory offers hardware and software tools for analyzing speech files, editing speech data and generating coded speech.

FluentSoft™ Recognizer

The FluentSoft™ Recognizer is the engine powering the FluentSoft™ SDK. It provides a noise-robust, large-vocabulary, speaker-independent solution with continuous digit recognition and word-spotting capabilities. This small-footprint software recognizes thousands of words and runs on non-Sensory processors including Intel XScale, TI OMAP, and ARM9, and supports operating systems such as MS Windows, Linux, and Symbian.

BlueGenie™ Voice Interface

The BlueGenie Voice Interface software suite runs on CSR’s BC-5 MM Kalimba DSP, and enables manufacturers of Bluetooth products to integrate full voice control and synthetic speech output without the need for displays or complex user interfacing. It frees designers to pack functionality onto small form factor Bluetooth devices and answers consumer demand for a “Truly Hands-Free” experience.

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