The NLP-5x is Sensory's new Natural Language Processor targeting consumer electronics. The NLP-5x is designed to offer advanced speech recognition, text-to-speech (TTS), high quality music and speech synthesis and robotic control to cost-sensitive high volume products. Based on a 16-bit DSP, the NLP-5x integrates digital and analog processing blocks and a wide variety of communication interfaces into a single chip solution minimizing the need for external components.

The NLP-5x operates in tandem with FluentChip™ firmware - an ultra-compact suite of technologies that enables products with up to 750 seconds of compressed speech, natural language interface grammars, TTS synthesis, Truly Hands-Free™ triggers, multiple speaker dependent and independent vocabularies, high quality stereo music, speaker verification (voice password), robotics firmware and all application code built into the NLP-5x as a single chip solution.

The NLP-5x also represents unprecedented flexibility in application hardware designs. Thanks to the highly integrated architecture, the most cost-effective voice user interface (VUI) designs can be built with as few additional parts as a clock crystal, speaker, microphone, and few resistors and capacitors. The same integration provides all the necessary control functions on-chip to enable cost-effective man-machine interfaces (MMI) with sensing technologies, and complex robotic products with motors, displays and interactive intelligence.

Features

BROAD RANGE OF FLUENTCHIP™ TECHNOLOGIES

- **WORLD'S FIRST NATURAL LANGUAGE INTERFACE ON AN EMBEDDED PROCESSOR!**
- *Real world* noise-robust Speaker Independent (SI) & Dependent (SD) recognition; up to 75 word sets
- TTS (text-to-speech) for text-based speech playback
- Phrase spotting of up to 30 commands or key words embedded in speech
- Truly Hands-Free triggers (using phrase spotting) alert the recognizer to listen for commands
- Speaker Verification (SV) – Noise robust voice password biometric security
- High quality stereo MP3 decoder
- 24-voice MIDI-compatible stereo music synthesis; allows simultaneous speech synthesis
- High quality, 2.4-64 kbps speech synthesis & sound effects with Sensory "SX" technology
- SonicNet for acoustic data networking
- Support for major EU and Asian languages for VR and TTS

Integrated Single-Chip Solution

- Powerful 16-bit DSP – up to 80MHz clock; single issue/single MAC; nested interrupts; on-chip debug
- 128KBytes One-Time-Programmable (OTP) memory for code and constants
- Three 16-bit ADC channels - two with pre-amps (standard or beam-forming microphones) & one line input for sensors
- Two 16-bit DAC channels - stereo music, speech and sound effects at 48KHz sample rate
- Mono PWM direct speaker drive
- 24 KBytes total RAM, including on chip storage for SD and SV templates
- Five timers (4 GP, 1 Watchdog), plus Real Time Clock and on-chip 128KHz RC oscillator scalable to 32KHz
- LCD control logic and drive - up to 104 icons or pixels SPI for large array driver interfaces

- Motor control logic – up to 3 bi-directional motors
- USB1.1, SPI, UART-Lite and infrared (IR) interface
- Analog comparator unit (4 inputs)
- Power-on Reset and Brown-out Reset
- Low EMI design for FCC and CE requirements
- 40 configurable general purpose I/O lines; 10 mA (typical) output drive and 3.6V tolerance
- External 16 bit data and 23 bit address bus with 3.6V tolerance; configurable as 39 more GPIO

Long Battery Life

- 1.8V +/- 10% operation; includes on-chip regulation of 2-3.6V Vdd input
- 16-36mA typical operating current at 1.8V
- 50μA typical sleep current

NLP-5x Block Diagram
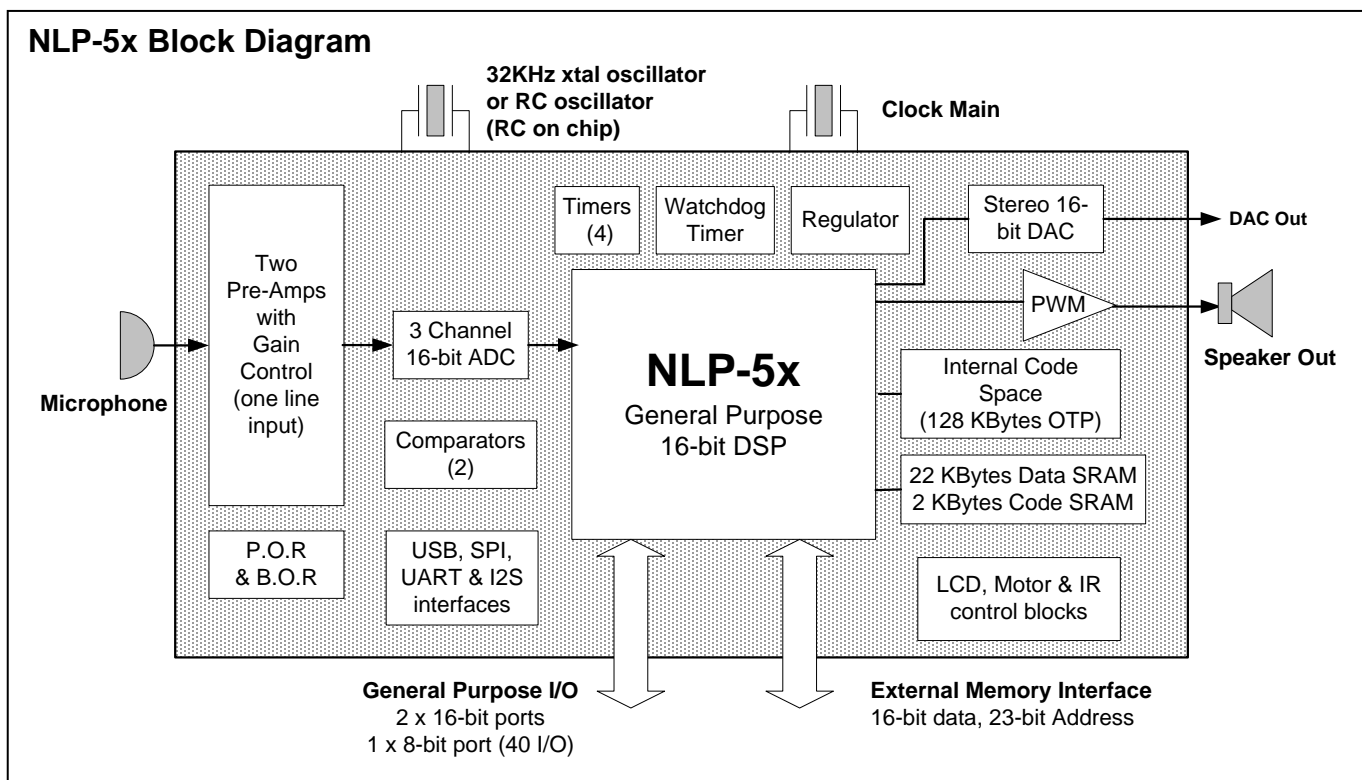
The **NLP-5x** is designed to support Hidden Markov Modeling (HMM) as well as Neural Network (NN) technologies provided in FluentChip™ firmware to perform speaker independent (SI) speech recognition. A brief summary of **Speech Recognition** technologies include:

- **Natural Language Interface** provides the unique ability to understand context-specific user's commands in the natural way the user would like to speak. Order independence allows flexibility in commands and speech prompts can request any missing information (form filling).
- **Speaker Independent** recognition requires no user training. The NLP-5x can recognize up to 75 words in an active set (number of sets is limited only by internal ROM or external memory size). Text-to-SI (T2SI) recognition, based on HMM technology, allows creation of SI recognition sets in seconds.
- **Speaker Dependent** recognition allows the user to create names for products or customize vocabularies. Up to 50 words can be recognized in an active set (number of sets is limited only by internal ROM or external memory size). The NLP-5x can store up to 10 SD words in on-chip SRAM.

- **Truly Hands-Free** phrase spotting allows the chip to continuously listen for triggers or commands, even in the presence of high noise. In phrase spotting mode, the word(s) to be recognized may be spoken in the middle of speech, for Truly Hands-Free™ operation.
- **Speaker Verification** allows the NLP-5x to identify whether a pre-determined and trained word or phrase is spoken by the original speaker, enabling applications that require voice passwords. Up to 10 SV templates can be stored on-chip, or more with external programmable memory.

SPEECH/MUSIC SYNTHESIS & AUDIO FUNCTIONS

The NLP-5x processing power, high-quality 16-bit ADC and stereo DAC support a variety of audio and speech playback technologies:

- Text-to-speech (TTS) is supported for systems requiring text-based speech playback, and requires less than 1MByte of external memory. TTS works well for names or text/phrase reading and is supported in multiple languages.
- Speech compression and playback using state-of-the-art "SX" technology. Data rates vary from 2.4K to 64K bits per second depending on desired quality, frequency response and available memory storage. SX uses on-chip or off-chip ROM to store speech data
- Stereo MP3 with a 5-band equalizer.
- MIDI synthesis for high-quality, 24-voice, stereo wave-table music.
- Record & Playback at various compression levels for voice memo functions
- Pitch Detect, which enables talking and singing in character voices, etc
- LipSync automates animation of a motorized mouth in sync with speech
- BeatPredict automates animation of movement, etc in time with music beat

SENSORS, TOUCH AND GESTURE TECHNOLOGIES WITH SENSORY ANALYSIS

- On chip firmware for HMM's can be used for complex signal analysis and pattern recognition from sensors detecting visible light, IR, electric fields, mechanical changes, capacitive and resistive changes, accelerometers and more.
- DSP processing, mixed signal I/O and a broad variety of communication protocols support interfacing with external sensors and various data conversion and interpretation.
- Sensory and 3rd party developers provide support for presence detection, touch and position sensors, gesture and motion analysis, etc. Combined with voice user interface capabilities, this enables man-machine interface solutions with an unprecedented combination of power and cost-effectiveness.
- SoundSourcing – with 2-3 microphones a product can locate a speaker and turn or move towards the person talking.
- IR Presence Detect – detects up to 6 feet, triggering speech playback, speech recognition, etc.

TELECOMMUNICATIONS

The NLP-5x is capable of implementing voice codecs suitable for cell phone or PDA mobile communications. It can implement this function along with speech recognition, acoustic echo cancellation, DTMF codec, VOIP protocols and on-chip voice compression, easing the addition of speech command and control, and answering machine functions to telephony applications. The NLP-5x can also implement a beam forming microphone array.

TOOLS & SUPPORT

Revolutionary Quick-Text-to-Speaker-Independent (QuickT2SI™) tools enable creation of speaker independent recognition command sets with flexible grammars for international languages in minutes by simply entering text. Quick Synthesis tools allow rapid creation of prompts and music. A full suite of development hardware and software allows fast development and testing of new ideas: C-compiler, assembler, debugger, Demo/Emulation Board, Programming/Verification Board, rapid prototyping modules (RPM) and more.

TARGET MARKETS, PRICING, AND AVAILABILITY

The NLP-5x targets high volume consumer electronic markets including home appliances and electronics, automotive, speech controlled internet devices (SCID's), toys, robots, PSTN/VOIP phones and other general purpose controller/DSP markets. The NLP-5x is priced at $2 in 100K volumes in die form. Packaging is available in 176LQFP.