

NLP-5x Programming/Verification Board Manual

For FluentChip™ 5 Technologies



S E N S O R Y[®]

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P/N 80-0319-A

Introduction	3
Included in the NLP-5x Programming/Verification Toolkit:	3
Additional Resources	4
Getting Started	5
Step One: Installing USB Drivers	5
Step Two: Installing Sensory Tools	5
Step Three: Programming an NLP-5x packaged chip on the Programming/Verification Board	9
Programming/Verification Board Hardware	11
Default Setting of DIP Switches and Jumper Blocks	12
ON/OFF Switch and the Power Supply Circuit	12
IO Summary and Allocations	13
LEDs and Pushbuttons	14
Serial Memory ICs	14
Parallel Memory IC	14
Audio Outputs	15
Microphone Circuit	15
USB	15
SENSORY Software End User License Agreement	16
The Interactive Speech™ Product Line	18

Introduction

Welcome to the NLP-5x and the world of low-cost, high-performance speech recognition! The **NLP-5x Programming/Verification Toolkit** allows you to program packaged NLP-5x ICs to verify programs developed with the NLP-5x Demo/Emulation (NLP-5x D/E) Toolkit. Since the NLP-5x Demo/Emulation board uses multiple chips to emulate an actual NLP-5x, it is necessary to verify all programs developed on that platform by programming and testing a packaged NLP-5x IC on the NLP-5x Programming/Verification board.

This Toolkit supports the NLP-5x only. It cannot be used to develop products for the RSC-164, 264, 364, 4128 or SVC families of chips.

Included in the NLP-5x Programming/Verification Toolkit:

- ▶ NLP-5x Programming/Verification board (60-0263). Also called a P/V board.
- ▶ USB Cable
- ▶ (2) Speakers
- ▶ Wall-Mount Power Supply (120V) 9VDC
- ▶ *NLP-5x Toolkits Installer* (Download from <ftp://ftp4.sensoryinc.com/software/nlp5x/nlp5xtoolkit.zip>)
 - Complete Documentation including NLP-5x Programming/Verification Manual (80-0319-x) (this manual) — For use as a Quick Start Guide
 - FluentChip™ 5 for NLP-5x Technology (FC5) Library, with speech recognition technologies including T2SI™ speaker-independent (SI), speaker-dependent (SD), speaker-verification (SV), plus speech and music synthesis, MP3 decoding, and a variety of other technologies
 - “QuickSynthesis™ 5” (QS5), which allows speech to be compressed for low data-rate synthesis
 - “SensoryLoader5” (SL5), which is used to download programs to the NLP-5x Programming/Verification Board

The NLP-5x provides the following technology features important for low-cost consumer products:

- ▶ Wide operating voltage range (2.0 to 3.6V)
- ▶ Power-down sleep mode to conserve power
- ▶ Pulse Width Modulator (PWM) to directly drive an 8-ohm speaker
- ▶ Stereo D/A converters (DACs)
- ▶ Integrated microphone amplifiers requiring only a few additional passive components
- ▶ Ability to interface to optional external parallel and serial memories

This toolkit works in conjunction with:

- ▶ ZView Tools for NLP-5x, which includes the ZViewIDE and the ZView C compiler.
- ▶ Quick T2SI™ Toolkit for NLP-5x (sold separately), which can be used to create speaker-independent recognition sets by simply typing the vocabulary into a PC based GUI and downloading it to the NLP-5x Demo/Emulation board.

Developing a product that effectively integrates Sensory’s speech technologies requires hardware platform development, software development, product integration, and human-interaction testing. For the best speech recognition performance, each of these design areas should be error-free. Sensory helps to facilitate successful implementation by providing free design consultations and product reviews. Refer to the [Speech Recognition Hardware Design Guide \(80-0073-x\)](#) for more details.

Check for updates and the most recent versions of the technology libraries on the Sensory website at <http://www.sensoryinc.com>.

Additional Resources

- ▶ [NLP-5x Datasheet \(80-0317-x\)](#)
- ▶ [FluentChip NLP Reference Manual \(80-0316-x\)](#)
- ▶ [Installing the ZViewIDE Installation Guide \(80-0320-x\)](#)
- ▶ [NLP-5x Debugging with the ZViewIDE Quick Start Guide \(80-0328-x\)](#)
- ▶ [Programming the NLP-5x Rapid Prototyping Module \(80-0330-x\)](#)
- ▶ [NLP-5x Demo/Emulation Manual \(80-0314-x\)](#)
- ▶ [NLP-5x Product Brief \(80-0329-x\)](#)
- ▶ Various other Design Notes, Design Guides and Schematics

Getting Started

Step One: Installing USB Drivers

The NLP-5x Programming/Verification board uses the FT232B(L) USB UART IC chip manufactured by Future Technology Devices Int'l (FTDI). In order to interface to a PC, you need to download and install their USB drivers. These drivers make the NLP-5x Programming/Verification board appear as a Virtual COM Port. If you have used other Sensory boards in the past, you may already have drivers installed that will work with the NLP-5x Programming/Verification board.

- ▶ To download the driver, refer to:
<http://www.ftdichip.com/Drivers/VCP.htm>
- ▶ For installation instructions, refer to:
<http://www.ftdichip.com/Documents/InstallGuides.htm>
- ▶ For more information, refer to the Future Technology Devices Int'l website at:
<http://www.ftdichip.com>

In the above installation guides, you will be instructed to “connect the device to a spare USB port on your PC”. In this case, this “device” is the Programming/Verification board. The USB circuit for the PC loader is powered from the USB connector, so you do not need to turn on the Programming/Verification board. Simply connect the USB cable to the USB connector located on the **bottom** of the board near the lower-left corner, which is **labeled “PC LOADER”**. There are three USB connectors near the lower-left corner, so be careful to connect to the correct one.

Note: The port number assigned to the Virtual COM Port may change if you plug the USB cable into a different USB connector on your computer!

Note: If a problem occurs with the USB connection to the NLP-5x Programming/Verification board, try connecting the USB cable to a different connector on your computer. Try to bypass USB hubs if possible.

Uninstalling USB Drivers

If you need to remove the drivers, go to the Windows Control Panel, choose “Add or Remove Programs”, and then remove “FTDI USB Serial Converter Drivers.”

Step Two: Installing Sensory Tools

We recommend that you read all of the documents available in this installer program before attempting to install any software or connect the Programming/Verification board to your PC.

- 1) Navigate to the Main Window in the installer program.
- 2) Click “Install SensoryLoader5.” This tool will allow you to program NLP-5x chips using the Programming/Verification board.

If you are using the Programming/Verification board just as a NLP-5x programmer, these two items are needed to develop new NLP-5x applications:

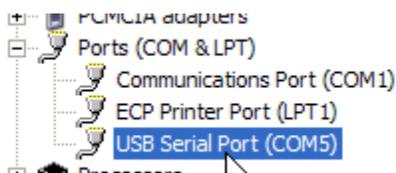
- 3) Click “Install FluentChip™ 5” This will install Sensory’s speech technology libraries.
- 4) Click “Install QuickSynthesis 5”. This will install the tool that allows you to compress speech files for playback.

COM Port Configuration

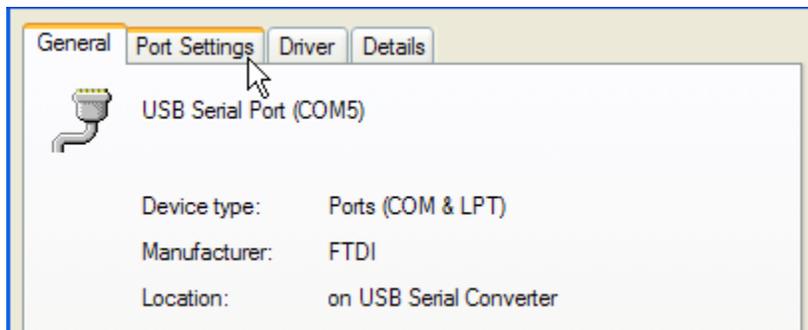
When the NLP-5x Programming/Verification board is connected to your computer, a COM port number is automatically assigned to the Virtual COM Port driver. The Sensory software tools must be configured to use this COM port number. The following screen shots show where to view and/or change the COM port in the Device Manager and the various Sensory tools.

Note: The port number assigned to the Virtual COM Port may change if you plug the USB cable into a different USB connector on your computer!

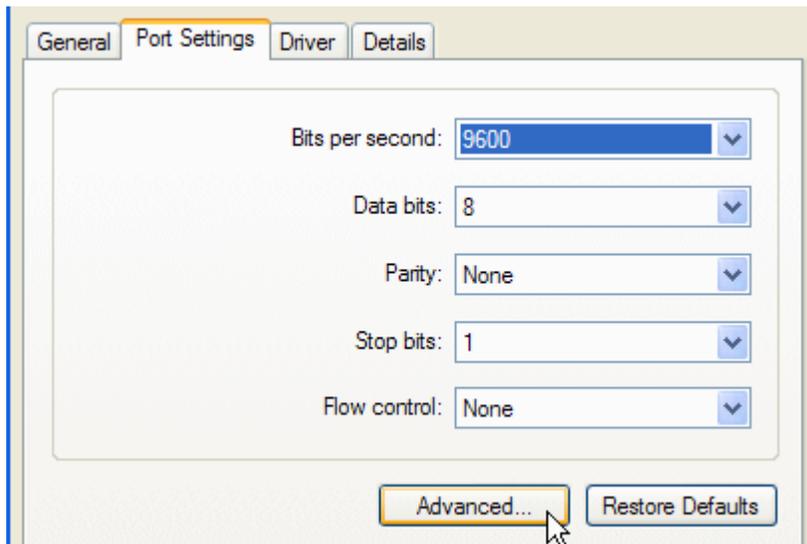
To find out the port number selected for the Virtual COM Port driver, use the Device Manager in your PC's Administrative Tools Control Panel under Computer Management/System Tools—or—System Properties on My Computer. In the Device Manager, the Virtual COM Port will appear in the section for Ports (COM & LPT) as a USB Serial Port. In this example you will see that the USB Serial Port was assigned to COM5.



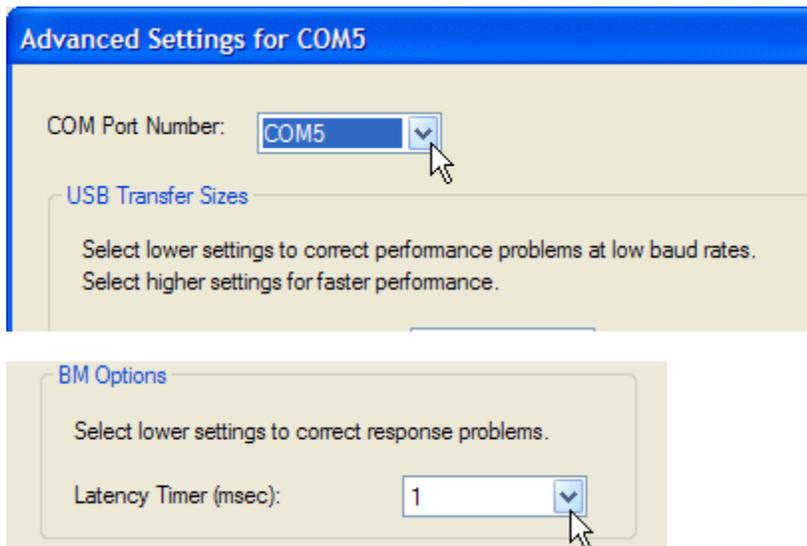
If for some reason you want to change the assigned port number, double-click on the USB Serial Port in the Device Manager list for access to the Properties window for that device, and then click on the Port Settings tab.



On the Port Settings tab, click on Advanced:

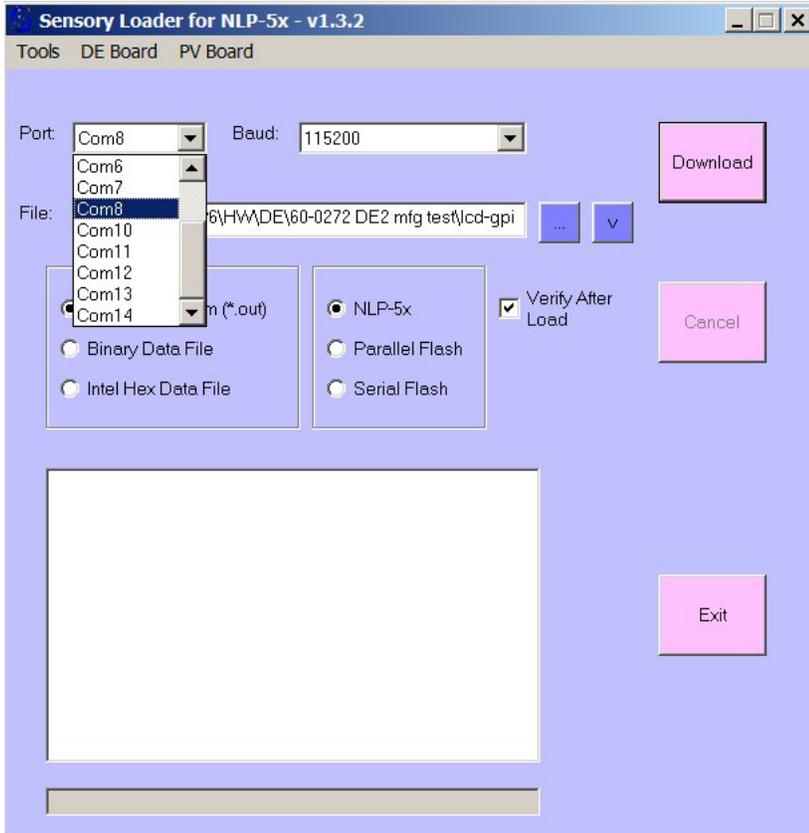


The Advanced Settings window allows you to change the COM Port number. While not necessary, you can also change the latency setting to the minimum value (1) to improve upload performance.



SensoryLoader5 (SL5)

SensoryLoader5 is a utility program for downloading executable and data files to the NLP-5x Program/Verification board. Use the pull-down menu to select the correct COM port number.



QuickSynthesis™ 5 (QS5)

For setting up QuickSynthesis5 (QS5), refer to [NLP-5x Demo/Emulation Toolkit Manual \(80-0314-x\)](#).

Step Three: Programming an NLP-5x packaged chip on the Programming/Verification Board

The Sensory Programming/Verification Toolkit allows developers to quickly grasp how Sensory's speech technologies work. The Toolkit includes samples that use many of the Sensory technology functions.

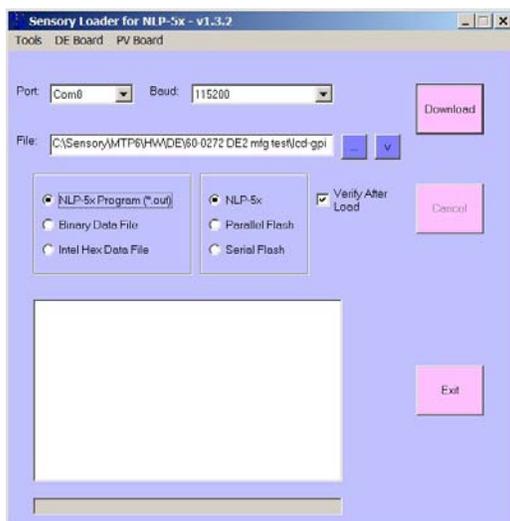
Note: Although most sample programs will run with the default board DIP switch and jumper settings, some sample programs require different settings or additional hardware. Read the accompanying sample instructions before you download the sample program. The default DIP switch and jumper settings are found in the Programming/Verification Hardware section.

1) Setting up the Hardware:

- ▶ Place the On/Off switch (S2) of the Programming/Verification board to the OFF position.
- ▶ Connect the 9VDC power supply to J1 of the Programming/Verification board.
- ▶ Connect a speaker to one of the speaker outputs of the Programming/Verification board. Most samples use the SPKR PWM output. Other samples use two speakers connected to the stereo DAC outputs, SPKR L and SPKR R.
- ▶ If required, connect other hardware to the Programming/Verification board per the sample instructions.
- ▶ Connect the USB connector from the computer to the USB connector on the Programming/Verification board which is labeled as "PC LOADER". When the computer recognizes that a USB device is connected, you will hear the USB device connect sound. If you don't hear this sound, or see the error message on the computer, something went wrong. If this happens, it is probably because the FTDI USB drivers were not installed correctly. Uninstall the FTDI USB drivers, and then install them again.

2) Programming a NLP-5x Chip

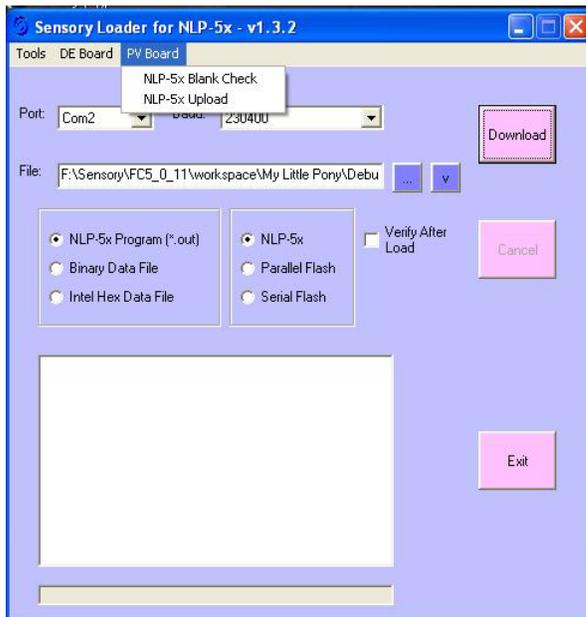
- ▶ Place a blank packaged NLP-5x chip in one of the two sockets on the board (one socket is for PQFP parts, the other for CPGA parts).
- ▶ Place the On/Off switch (S2) in the ON position, and confirm that the green LED "POWER" turns on.
- ▶ Open SensoryLoader5.



- ▶ Make sure that the correct COM port number is selected.
- ▶ In the file type box, click on the button labeled "NLP-5x Program (*.out)".
- ▶ In the destination box, click on the button labeled "NLP-5x".
- ▶ Click "...", then browse and select the desired executable file. Downloadable NLP-5x executable files have a ".out" extension.
- ▶ Click on the "Download" button.
- ▶ If downloading does not start immediately, press the "LOADER RESET" button on PV board.

3) Programming a NLP-5x RPM module (version 60-0268-B)

- ▶ With the Programming/Verification board powered OFF via the ON/OFF switch, connect the RPM via the ribbon cable to the Remote Device connector, JP10.
- ▶ Make sure the TRST jumper (JP3) is in place on the RPM.
- ▶ Make sure the VDD, VPP jumper (CN3-2) on the RPM is in the rightmost position, in line with the TRST jumper.
- ▶ Connect a jumper wire (clip lead) from the left-hand post in CN4 pin VIO (on RPM) to 3.3V on the Programming/Verification board. Good points on the PV are CN2-pin33 (near the upper-left corner of the board), TP3 (VCCB) or TP4 (VCCC).
- ▶ Now turn on the Programming/Verification board via the ON/OFF switch. Verify the REMOTE LED next to JP10 is lit. If not, press LOADER RESET and it should light.
- ▶ Open SensoryLoader5. Use the PV Board pull-down menu, and select Blank Check.



- ▶ If Blank Check passes, press LOADER RESET on the Programming/Verification board, and then press Download.
- ▶ After programming, power-down the Programming/Verification board via the ON/OFF switch prior to disconnecting the RPM.
- ▶ ***Important***: Prior to using the RPM, remove its TRST jumper and restore the VDD, VPP jumper (CN3-2) to the leftmost position.

Note: Some sample programs require an additional data file to be downloaded to external memory, either serial or parallel flash. If this is the case, follow the procedure written in the sample instructions.

Note: If the USB cable was not connected *before* you opened SensoryLoader5, the actual COM port might not be available to select. If this is the case, close SensoryLoader5, and re-open it after you have connected the USB cable.

Programming/Verification Board Hardware

WARNING:

Do NOT change the jumpers while the power is turned on. Before changing any jumpers, turn off the ON/OFF switch (S2).

The first time that you use the Programming/Verification board, confirm that all jumper blocks are installed at the default settings before turning on the power.

On the NLP-5x Programming/Verification board, there are two sockets for the 176 pin LQFP and the 181 pin PGA. There is also a “Remote Device” connector (JP15) which is used to program an NLP-5x RPM module (60-0268). Only one of these devices can be connected at a time.

See Programming the NLP-5x Rapid Prototyping Module(RPM) (80-0330-x) for detailed instructions on how to set up the RPM for programming.

The Programming/Verification board has a NLP-5x (U16), which with the USB interface IC FT232BL (U22), is used for downloading the programs and data from a PC. All components which are not application related are placed on the bottom side of the board.

All ICs and components such as memory ICs, buttons, LEDs, microphones, etc. that allow application developers to create hardware mockups of their final product are located on the top side of the board.

NLP-5x Programming/Verification Board Schematic (70-0078-x) is included in the NLP-5x Programming/Verification Toolkit installation program, but it is not part of this manual.

Default Setting of DIP Switches and Jumper Blocks

DIP Switch Setting

- ▶ All three DIP switches (S3, S8, and S9) at ON position

Jumper Blocks

- ▶ JP3 at CS0
- ▶ JP8 at AUTO
- ▶ JP9 at NC
- ▶ JP11 shorting block in place
- ▶ JP7 at Switched
- ▶ JP2 at INT
- ▶ JP1 at AVCC 3.3V
- ▶ JP4 at Share

Connectors are labeled as CN. They do not need jumper blocks.

ON/OFF Switch and the Power Supply Circuit

The Programming/Verification board can be powered by an external 9VDC power supply. To use the external power supply, connect the adapter plug into J1 located near the upper-right corner of the board.

The On/Off switch (S2) is also located near the upper-right corner of the board. When the power is applied to the board, the green LED (D2) will turn on.

The power supply circuit is located in the upper-right area of the board, and there are 5 power supply outputs with test points:

- ▶ VCCA: 3.3V, powers the application analog circuit
- ▶ VCCB: 3.3V, powers the application digital circuit
- ▶ VCCC: 3.3V, powers supporting circuits
- ▶ VPDD: Powers the audio amplifier IC (U13)
- ▶ VPP: NLP-5x programming voltage

IO Summary and Allocations

Port	NLP-5x IO Functions			NLP-5x Program/Verification Default IO Allocations		
P0.0					LED Green	
P0.1					LED Yellow	
P0.2					LED Orange	
P0.3					LED Red	
P0.4		T3 Gate	Edge Interrupt			LCD Segment
P0.5		T3 Clock	Edge Interrupt			LCD Segment
P0.6		HPI WR				LCD Segment
P0.7		HPI EN				LCD Segment
P0.8		HPI Data	Motor Sensor 0	Motor Sensor 0		
P0.9		"	Motor Sensor 0	Motor Sensor 0		
P0.10		"	Motor Sensor 1			LCD Segment
P0.11		"	Motor Sensor 1			LCD Segment
P0.12		"	Motor Sensor 2			LCD Segment
P0.13		"	Motor Sensor 2			LCD Segment
P0.14		"				LCD Segment
P0.15		"				LCD Segment
P1.0	IO Wake Interrupt	Comparator/ Line Input			Audio Shutdown	
P1.1	"	"	Motor Stop Input			LCD Segment
P1.2	"	"			Button A	
P1.3	"	"			Button B	
P1.4	"	"	Motor PWM 2 Fwd		Button C	
P1.5	"	"	Motor PWM 2 Rev		Button D	
P1.6	"	"	Motor PWM 1 Fwd	Motor PWM 1 Fwd	USB Detect	
P1.7	"	"	Motor PWM 1 Rev	Motor PWM 1 Rev	USB Pull-up	
P1.8	"	Comp. Out	Motor PWM 0 Fwd	Motor PWM 0 Fwd		
P1.9	"	Comp. Out	Motor PWM 0 Rev	Motor PWM 0 Rev		
P1.10	"					LCD Common 0
P1.11	"					LCD Common 1
P1.12	"					LCD Common 2
P1.13	"					LCD Common 3
P1.14	"					LCD Bias 0
P1.15	"					LCD Bias 1
P2.0	SPI / I2S -SS			Serial Flash -CS		
P2.1	SPI / I2S SCLK			Serial Flash SCLK	EEPROM SCL	
P2.2	SPI / I2S MISO			Serial Flash MISO		
P2.3	SPI / I2S MOSI			Serial Flash MOSI	EEPROM SDA	
P2.4	IR RXIR			IR RXIR		
P2.5	IR TXIR			IR TXIR		
P2.6	UART RXD			RS232 RXD		
P2.7	UART TXD			RS232 TXD		

LEDs and Pushbuttons

There are four LEDs and four pushbuttons connected to the NLP-5x's IO ports. Refer to the chart for the IO summary and allocations.

LED SW Default DIP Switch (S8)

The LED SW default DIP Switch (S8) is provided to allow each LED and pushbutton to be disconnected from the NLP-5x IO pins so that the IO pins can be used for a different purpose. To disconnect them, place the switches on the OFF positions.

Connector (CN6)

This connector is provided to interface with the external devices which will be connected to in parallel with LEDs and switches.

Connector (CN5)

This connector is provided to connect different port pins to the LEDs and switches. To do this, place the LED SW default DIP switch to the OFF position, and make connections with hook-up wires to CN8 from the CN3 connector.

Serial Memory ICs

We have provided one 32Mbit Serial Flash IC, AT45DB321D, (U11) and one 128Kbit Serial EEPROM, 24LC128 (U12). Their connections can be disconnected by Serial Memory DIP switch (S9) in the OFF position.

If you are going to connect an external device with a SPI interface:

- ▶ Disconnect the on-board serial flash, or
- ▶ Use a dedicated port pin for –CS signal for the external device.

Parallel Memory IC

We have provided one 32Mbit parallel memory IC, AT49BV322D (U3).

Audio Outputs

The NLP-5x has one PWM audio output and two DAC audio outputs, which can be used for stereo applications. On the Programming/Verification board, we have provided one audio jack for PWM (J4), and two audio jacks for DAC outputs (J5 and J6).

DAC Amplifier and Volume Control

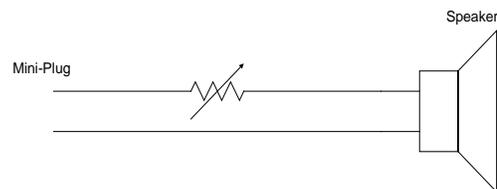
To amplify the NLP-5x's differential DAC outputs, we have provided a fully differential stereo audio amplifier, the TPA6021A4 (U13). Because each channel has differential outputs (bridge-tied loads) there is no common ground connection, so there are separate speaker jacks for each channel. Do not use a Y cable that shorts one of the outputs of each channel together.

The volume of the DAC outputs is controlled with the dial (R45). When a shorting block is placed at Manual at the “Switched” header (JP7), the audio shutdown is controlled with this dial.

Adding Volume Control for PWM

To add volume control to the PWM output of the board:

- ▶ Disconnect the speaker cord from the mini-plug jack on the PCB.
- ▶ Cut into one side of the cord and insert a 200 Ohm potentiometer in series with the wire.



Microphone Circuit

There are two on-board microphones. To use the external microphone, plug the microphone cable into the microphone jack. If you do, the on-board microphone will be disconnected from the circuit.

Microphone Power

The microphones are powered with VCCA. If you can power the microphones with a IO port, remove the shorting block from MIC PWR (JP11), and connect the IO port to pin 2 of JP7.

Microphone Bias Resistors

MIC 1 has a 2.2K Ohms microphone bias resistor (R40), and MIC2 also has a 2.2K Ohms microphone bias resistor (R39). If you need to change the value of microphone bias resistor, replace these resistors. For selecting a microphone and bias resistor, refer to the design note – [NLP-5x Microphone Selection Design Guide \(80-0318-x\)](#).

USB

There are three USB connectors on Programming/Verification board. They are labeled “PC LOADER”, “DEBUG”, and “APP USB”. “PC LOADER” is used to download the code and data into the Programming/Verification board. The one used for the application is “APP USB”. “DEBUG” is reserved for future use.

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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™ 5 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 visual 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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