

NUE-PSK Digital Modem



Software Development Kit

Technical instructions and guidance for modifying the application software running on the NUE-PSK Digital Modem, or for developing new applications on this platform.

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1) Introduction

This Software Development Kit (“SDK”) is intended for software programmers wishing to modify the existing NUE-PSK digital modem application, and for those wishing to develop entirely new applications based on the NUE-PSK hardware platform.

We shall not attempt to instruct on basics of software programming, Microchip development tools, or dsPIC hardware. Those attempting to use this SDK may refer to the plethora of good documentation and instructional material provided by Microchip at www.microchip.com.

2) Minimum Requirements

In order to effectively use this SDK as intended, one must have ...

- a) **MPLAB** – The latest version of this Integrated Development Environment from Microchip is v8.01, as of this writing. You can download MPLAB for free from www.microchip.com/MPLAB
- b) **C30** – The latest version of the C compiler from Microchip is v3.02 Student Edition. The download is free, and although the Microchip web page states that the optimization engine expires after 30 days’ use, the compiler may continue to be used effectively without the optimization well after this time period. You can download the latest version of C30 from www.microchip.com/C30
- c) **ICD2** – The most capable (and simultaneously low cost) programming/debugging pod available for this platform is the In Circuit Debugger 2 (“ICD 2”), available from a variety of sources including Microchip and Digi-Key.
- d) **Windows PC** – The tools described thus far only operate on Windows and the PC becomes your development workstation. We know the tools operate on Windows XP with Service Pack 2. They may also work on the newer Windows Vista operating system, or on the older Windows operating systems, but we have not tried them. As is most often the case when using a PC as development workstation, the best experience will be achieved using a powerful PC -- fast processor, much RAM, lots of hard disk space.

3) Installing the Development Environment

- a) Install the latest version of MPLAB.
- b) Install the latest version of the C30 compiler.
- c) Run MPLAB. (It takes almost a full minute for MPLAB to fully load in and start up.)
- d) Plug in the ICD2 programming pod to the computer’s USB port. Follow any instructions that might appear for loading the driver into the Windows OS.
- e) In the Configure menu ... Select “Select Device”, and then use the pull-down menu to select the dsPIC MPU used for the NUE-PSK project: “dsPIC33FJ128MC706”.
- f) In the Configure menu, select Settings ...
 - 1) Select the tab for Program Loading and uncheck the box for "Clear program memory upon loading a program". All other boxes except the top one should be unchecked.
 - 2) In the Projects tab, uncheck "Use one-to-one project-workspace model"
- g) Plug in the USB connection to the ICD2 programming pod. The system (and MPLAB) will automatically recognize the device.

- h) Under the Programmer menu, select “Select Programmer” and specify “MPLAB ICD2”
- i) Plug the ICD2 cable into the target hardware (NUE-PSK modem).
- j) Apply power to the target hardware.
- k) In the Programmer menu, select Connect. You should see text appear in the Output window indicating that the ICD2 was able to successfully connect to the target hardware.

4) Setting Up MPLAB Build Options

A cumbersome-yet-important configuration item must be done when starting a new project, or when starting to work with the NUE-PSK modem application: setting the build options to point the MPLAB environment to the proper folders containing the project. For this explanation, we will use the NUE-PSK project as the example.

a) File ... Close Workspace.

- b) File ... Open Workspace**, and then navigate to the **nuepsk_boot.mcw** file in the top level of your project folder and open it. This will bring up the workspace window on the left with various **mcp** folder(s) containing the application(s), and the corresponding subfolders for Source Files, Header Files, Object Files, Library Files, Linker Script, and Other Files.

*NOTE: In the case of the NUE-PSK project, two programs are actually contained within the same workspace: the Boot Loader program, and the Modem program. This can be seen by the two **mcp** files shown in the workspace window. In effect, we will compile and build each of these programs independently, and their object file images will be loaded into the same file that ultimately gets programmed into the dsPIC controller. As we will see later in this SDK, the modem program starts at address 0x402 and the Boot Loader starts at 0x15000.*

- c)** Adjust the **Workspace** window size so it takes up the full left half of the display screen. Then adjust the size of the **Output** window so it takes up the full right half of the display screen

d) Set MPLAB environment pointers for the Modem Program

- 1) **Set the Modem Program as active** – Right-click the top-level folder called “NUE_PSK.mcp”, hereafter called the Modem Program”. Right-clicking will produce a pop-up menu, from which you will select the “Set Active” item.
- 2) Right-click again NUE_PSK.mcp and this time select “**Build Options ...**”
- 3) In the Directories tab, pull down the menu for “Show directories for:” and select the **Output Directory**.

The highlighted pathname in the larger window below this is the current path to the Output folder, which may or may not be correct. Click on the right end of that highlighted line to see a new control representing the navigation icon “...”. Clicking on this control will bring you to a folder structure on your PC through which you will use to navigate to the proper Output folder. Starting at the top of your C: drive, locate the top-level folder where your project files reside (C:_NUEPSK). Continue to navigate down in the folder structure until you see the first level of folders showing Assembler, C Source, C Header, etc. Select the Output folder and you will see this folder name below in the “Folder:” field. Click OK.

- 4) In the Directories tab, pull down the menu for “Show directories for:” and select the **Assembler Include Search Path**.

In a manner similar to how you navigated to the previous folder, navigate to the C Source folder. Select this one, see it appear in the “Folder:” field, and click OK.

- 5) In the Directories tab, pull down the menu for “Show directories for:” and select the **Include Search Path**.

In a manner similar to how you navigated to the previous folder, navigate to the C Header folder. Select this one, see it appear in the “Folder:” field, and click OK.

- 6) In the Directories tab, pull down the menu for “Show directories for:” and select the **Library Search Path**.

For this one, you need to ensure that the path is pointing to the C30 “lib” folder on your system. If not already there, start at the top to navigate to C:\Program Files\Microchip\MPLAB C30\lib. Once pointed there, click OK.

e) Set MPLAB environment pointers for the Boot Loader

- 1) **Set the Boot Loader as active** – Right-click the first top-level folder called “16-bit Flash Programmer.mcp”, hereafter called the Boot Loader”. Right-clicking will produce a pop-up menu, from which you will select the “Set Active” item.
- 2) Right-click again on 16-bit Flash Programmer.mcp and this time select “Build Options ...”
- 3) In the Directories tab, pull down the menu for “Show directories for:” and select the **Output Directory**.

This time you’ll need to navigate to the Output folder in the dsPIC_Boot folder and select it. The folder structure you should be in is C:_NUEPSK\NUEPSK_v1-12\dsPIC_Boot\Output. With this Output folder highlighted and showing in the Folder field below, click OK.

- 4) In the Directories tab, pull down the menu for “Show directories for:” and select the **Assembler Include Search Path**.

Navigate to the very same dsPIC_Boot folder and select it. (Do not go any lower to any other folder.) The folder structure you should be in is C:_NUEPSK\NUEPSK_v1-12\dsPIC_Boot. With this dsPIC_Boot folder highlighted and showing in the Folder field below, click OK.

- 5) In the Directories tab, pull down the menu for “Show directories for:” and select the **Include Search Path**.

In a manner identical to above, navigate to the dsPIC_Boot folder and select it again for this search path. The folder structure you should be again in is C:_NUEPSK\NUEPSK_v1-12\dsPIC_Boot. Select this one, see it appear in the “Folder:” field, and click OK.

- 6) In the Directories tab, pull down the menu for “Show directories for:” and select the **Library Search Path**.

For this one, you just need to ensure that the path is correctly pointing to what you previously used for the Library Search path. It should already be set to C:\Program Files\Microchip\MPLAB C30\lib.

f) Click APPLY to end this part of the process.

- g)** In the MPLAB menu bar along the top of the screen, select **Project** and move your mouse down to **Build Configuration** item. Click Release if a checkmark is not already on that item.

h) All done!

5) Compiling & Building with MPLAB

If all the paths were set correctly in Build Options, you should experience a successful compilation and build process in this section. (That is, for a known-good program such as the distribution files for the NUE-PSK Digital Modem.)

NOTE: For those familiar with the terms “build” and “make”, we specifically will instruct you to “make” these files here. “Build all” is a term that forces a compile and linking of everything in the project

folder, whereas we need to compile and link selectively (i.e., “make”) for the two programs being combined into one object file image.

a) Make the Boot Loader

Right-click the top-level folder **16-bit Flash Programmer.mcp**, and make it active. (In the pop-up window select Set Active.)

Right-click the mcp file again and select Make. Numerous lines will be displayed in the Output window on the right, indicating the compile and linking processes happening. If successful, it will terminate with SUCCEEDED.

b) Make the Modem Program

Right-click the top-level folder **NUE_PSK.mcp**, but do not make it active ... just select Make. Again, numerous lines will be displayed in the Output window on the right, indicating the compile and linking processes happening. If successful, it will again terminate with SUCCEEDED.

c) View Program

You can easily see the entire memory image of what was just compiled and linked. This is a convenient way to check for a successful process before you attempt to burn the whole program into the dsPIC device.

- 1) From “View” on the MPLAB menu bar, select Program Memory.
- 2) If not already selected, click on the Symbolic tab at the bottom of the Program Memory window.
- 3) At the line for Address 00000 at the very top, you should see the instruction “goto 0x015000”
- 4) From Address 00003 to 001FE, you should see _DefaultInterrupt. (There will be a few instances of nopr or T1Interrupt.)
- 5) At Address 00400 you should see 00000A in the opcode column. This data value is used as the timer in the boot loading process for the NUE-PSK modem.
- 6) At the very next address (00402), you should see the start of the Modem Program with instruction “mov.w #0x2f0c,w15”, followed by a long series of instructions extending down to close to address 076FE.
- 7) You should see a small blob of code placed around address 00C8D6.
- 8) At address 15000, you should see the Boot Loader program start with 20E02F in the opcode column.
- 9) The Boot Loader program instructions end around address 154BA.
- 10) Close the Program View window.

6) Programming with MPLAB + ICD2

You are now ready to program the target hardware.

- 1) If not already in place, make sure the ICD2 module is plugged into the USB port of your computer, and its target cable is connected to the NUE-PSK Digital Modem.
- 2) In the MPLAB menu bar, select Programmer and then select **Connect**. You should see some text display in the Output window on the right of your screen, ending with “...Passed. MPLAB ICD2 Ready”. You might also see the LCD on the modem come alive with residual text from the last time it was programmed and used.

- 3) Pull down the Programming menu item from the MPLAB menu bar, and this time select **Program**. You should see the following sequence of events displayed in the Output window while the target hardware is programmed ...

```
Programming Target...
...Validating configuration fields
...Erasing Part
...Programming Programming Executive
...Verifying Programming Executive
...Programming Program Memory (0x0 - 0x154FF)
Verifying...
...Program Memory
...Verify Succeeded
...Programming User IDs
...User ID Memory
...Programming Configuration Bits
.. Config Memory
Verifying configuration memory...
...Programming succeeded
18-Feb-2008, 13:30:25
```

MPLAB ICD 2 Ready

During the programming sequence, which normally takes several minutes, you will see a green progress bar moving in the lower portion of the overall MPLAB window.

- 4) Disconnect the cable connecting the ICD2 to the modem, and the modem will power-up with its normal boot sequence, displaying the splash screen followed by a display clear and a display of the audio signal spectrum.
- 5) All done!

7) Programming Another Device

If you will be programming multiple devices, for example in a production environment, you only need to repeat a small subset of everything done so far.

- 1) If PC hasn't been powered down and you are still in MPLAB.
 - a) Just connect the ICD cable to the next target board (modem), and apply power to the hardware.
 - b) You must **Connect** the ICD programmer (under Programming, select Connect), and then select **Program** again.
- 2) If the PC power has been cycled (e.g., coming back the next day to program more boards)
 - a) Launch MPLAB again, and your previous workspace for this project will automatically be loaded.
 - b) Set the Boot Loader program as **Active** (right-click 16-bit Flash Programmer.mcp and select Set Active), and then **Make** this program (right-click the mcp file and select Make.)
 - c) Highlight the Modem program and **Make** it too. (Right-click the NUE_PSK.mcp folder and select Make). Caution: Do not set the Modem mcp folder as active!
 - d) **Connect** the ICD programmer (under Programming, select Connect), and then select **Program** again.

8) Field Loading of Software Application

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9) Hardware Architecture

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10) Software Architecture

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11) Memory Usage

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12) Hardware Port Usage

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13) Display Memory Usage

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14) Schematic

