

User's Manual

78K0 UZ Stick

ZigBee™-ready

Wireless Network Evaluation Module

Using the UZ2400 RF chip

and the 78K0/KE2 Microcontroller

Tutorial

Date published: Mar 2008

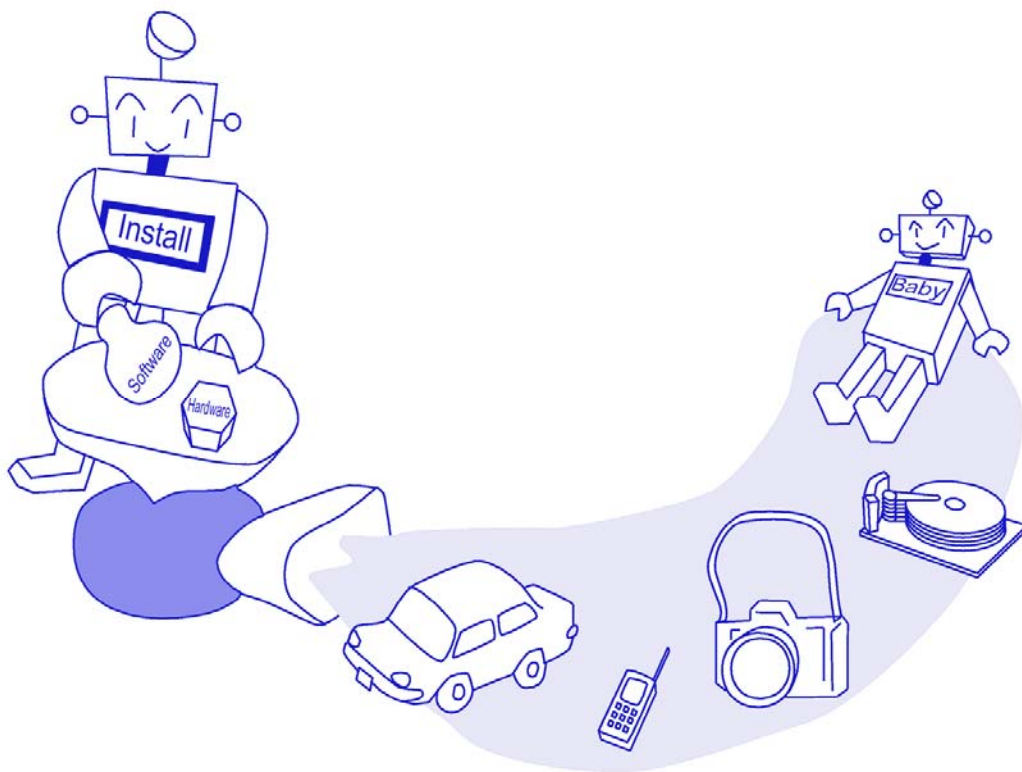
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Welcome to the world of 78K0 UZ Stick.

You are now being navigated to the design environment of the 78K0 microcontroller for developing wireless network applications. Please follow the tutorial step by step.



[NOTES]

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[CAUTION]

This equipment should be handled like a CMOS semiconductor device. The user must take all precautions to avoid build-up of static electricity while working with this equipment. All test and measurement tool including the workbench must be grounded. The user/operator must be grounded using the wrist strap. The connectors and/or device pins should not be touched with bare hands.

Contents

1	INTRODUCTION.....	7
2	PREPARATIONS.....	8
2.1	Development Tools, Sample Programs, and the MAC Library.....	9
2.1.1	Integrated Development Environment PM plus V5.21	9
2.1.2	Device file DF780547 V2.10	9
2.1.3	C Compiler CC78K0 W3.70: Code size limited version	9
2.1.4	Assembler RA78K0 W3.80: Code size limited version.....	9
2.1.5	USB driver.....	9
2.1.6	Flash EEPROM Programmer PG-FPL3	9
2.1.7	Parameter File	9
2.1.8	The RF Test Program.....	10
2.1.9	IEEE 802.15.4 MAC Library.....	10
2.1.10	The MAC Sample Program: Text Chat Program.....	10
2.1.11	Option to add debug interface	11
2.1.12	Conformance to local EMI regulation	11
2.2	Installation of Software Development Tools.....	12
2.2.1	Start-up of the installation CD-ROM	12
2.2.2	Installation of the software development tools.....	12
2.2.3	Uninstall	18
2.2.4	File Configuration in PC.....	19
2.3	Sample Environment.....	20
2.3.1	Installation of the sample programs.....	21
2.3.2	File Configuration of the sample program	23
2.4	USB Driver	24
2.4.1	Installation of the USB driver	24
2.4.2	Confirmation of the installation	33
2.4.3	Uninstall of the USB driver.....	34
3	EXPERIENCES.....	36
3.1	Starting PM plus	38
3.2	Introduction to PM plus.....	39
3.3	Loading Workspace (Project)	41

3.4	Configuration of Compiler Option	43
3.5	Configuration of Linker Option.....	48
3.6	Configuration of Object Converter Option	50
3.7	Build Mode and Compiler Option	51
3.8	How to make hex files	53
3.9	How to modify the source code and define a new build mode	56
4	HOW TO USE PG-FPL3.....	60
4.1	Installation of PG-FPL3	60
4.2	How to use PG-FPL3	60
5	RF TEST PROGRAM	66
5.1	Procedure for one to one transmit/receive test.....	67
5.2	PER test / receiver	76
5.3	Continuous TX / Pseudo Noise.....	76
5.4	Continuous TX / Raw carrier.....	76
5.5	RX Mode	76
5.6	IDLE MODE.....	76
5.7	Sleep MODE	76
5.8	Standby MODE.....	76
5.9	Set RF channel.....	77
5.10	Manually set UZ2400 register	77
5.11	Resetting RF	77
6	IEEE 802.15.4 MAC SAMPLE PROGRAM	78
6.1	Programming to the 78K0 UZ Stick.....	79
6.2	Setting up 78K0 UZ Stick to your PC	79

6.3	Designation of a coordinator	81
6.4	Network Association	81
6.5	Text Chat	82
7	MODE SETTING OF THE 78K0 UZ STICK.....	84
8	REVISION HISTORY	85

1 Introduction

Target Reader Software development engineers who wish to become familiar with the development environment of the 78K0 microcontrollers. It is assumed that the readers have been familiar with basics of microcontrollers, C and assembler languages, and the Windows™ operating system.

Purpose For readers to become familiar with the design environment and the application examples of wireless networks.

Organization This manual consists of the following contents

[Chapter 1 Preparations](#)

→ Introduction of soft tools, and sample programs and installation

[Chapter 2 Experience](#)

→ Guide to the basic operations of PM plus and the integrated debugger using sample programs.

[Chapter 3 How To Use PG-FPL3](#)

→ How to program Flash EEPROM

[Chapter 3 IEEE 802.15.4 MAC Sample Programs](#)

→ Learn sample programs, which utilize the MAC library

[Chapter 5 Mode setting of the 78K0 UZ Stick](#)

→ Explanation of switch setting

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2 Preparations

This chapter introduces the development environment and describes how to install the sample programs. The sample program works on the 78K0 UZ Stick.

2.1 Development Tools, Sample Programs, and the MAC Library

This section outlines the development tools, sample programs and the MAC library used in this tutorial.

2.1.1 Integrated Development Environment PM plus V5.21

This is a project manager, where you work for editing the source code, compiling it, and initiating the debugger. The project manager works on MS Windows 2000 or XP.

2.1.2 Device file DF780547 V2.20

A device file contains an MCU specific information. It instructs the development tools what kind of an MCU the tools shall work for.

2.1.3 C Compiler CC78K0 W3.70: Code size limited version

This is a free compiler for the 78K0 microcontrollers. The object code size is limited to 32 Kbytes. It works on MS Windows 2000 or XP.

2.1.4 Assembler RA78K0 W3.80: Code size limited version

This is a free assembler for the 78K0 microcontrollers. The object code size is limited to 32 Kbytes. It works on MS Windows 2000 or XP. The RA78K0 Assembler Package contains Structured Assembler Preprocessor, Assembler, Linker, Object Converter, Librarian, and List Converter.

2.1.5 USB driver

This is a software driver for PC to access to the USB interface of the 78K0 UZ Stick.

2.1.6 Flash EEPROM Programmer PG-FPL3

PG-FPL3 is a software Flash EEPROM programmer, working on MS Windows. PG-FPL3 enables you to program your application program file of hex format in the Flash EEPROM, embedded on the 78K0/KE2 microcontroller on the 78K0 UZ Stick, via the USB interface of the stick. You do not need any hardware, additionally to your PC and the 78K0 UZ STICK, to make the programming.

2.1.7 Parameter File

A parameter file is required to inform PG-PFL3 of device specific parameters of Flash EEPROM. Please do not mix it up with a device file.

2.1.8 The RF Test Program

This program supports generation of basic radio waves for RF conformance test for IEEE 802.15.4, EU directive, or EMI regulation in various countries. This program also supports settings for sleep/standby modes of the RF chip. The RF test program is provided in the form of the hex file, as well as the C source code.

The hex file, allows you to immediately program to your 78K0 UZ STICK using the PG-FPL3 Flash EEPROM programmer, and start RF testing.

Or, if you wish to tailor the RF test program to meet your specific needs, you can edit the source code, re-compile it with release build to achieve a new hex file, on the project manager PM plus. For debugging, you need an option of the debugger interface for MINICUBE.

2.1.9 IEEE 802.15.4 MAC Library

The IEEE 802.15.4 MAC Library offers an executable object-code library of the MAC stack specified in the IEEE 802.15.4. Please refer to the MAC Library manual for further details.

2.1.10 The MAC Sample Program: Text Chat Program

The MAC Sample program was developed to provide with a simple example to construct a star network utilizing the IEEE 802.15.4 PHY/MAC standard.

The MAC Sample Program offers,

- 1). Designation of a network coordinator in a star configuration
- 2). Text chat between a coordinator and an end device

To use the MAC Sample Program, you need to prepare at least two PC with a USB interface and two 78K0 UZ Sticks.

The MAC Sample Program is provided in the form of the hex file, as well as the C source codes.

The hex files allow you to immediately program to your 78K0 UZ Sticks using the PG-FPL3 Flash EEPROM programmer, and start the sample application. The hex files are available at
C:/TK78K0/SAMPLE_UZSTICK/78K0UZSTICK_MAC_Sample/Release

Or, if you wish to tailor the sample program to meet your specific needs, you can edit the source code, re-compile it with release build to generate a hex file, then, you can load the hex file on to the 78K0 UZ stick using the Flash programmer PG-FPL3.

2.1.11 Option to add debug interface

Though the standard specification of the 78K0 UZ Stick does not support debugging capability, you can place an order of an option to provide with the debugger interface, SICA2P20S, for connection to a MINICUBE debugger, QB-78K0MINI, or QB-MINI2. You need to purchase an adapter, SICA10I2P, at the same time.

2.1.12 Conformance to local EMI regulation

As a general remark, please respect your local regulation of electro-magnetic emission. In general, it is suggested to use the 78K0 UZ STICK in a radio anechoic chamber.

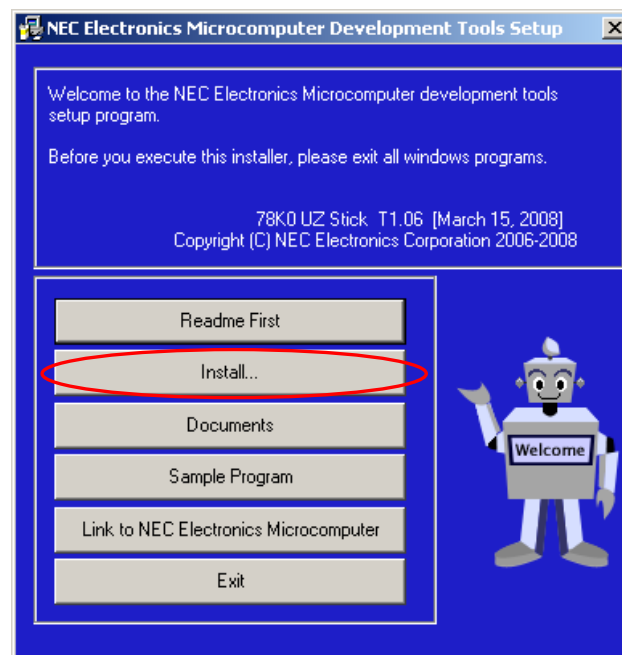
2.2 Installation of Software Development Tools

2.2.1 Start-up of the installation CD-ROM

The Attached CD-ROM contains Development Tools, document and sample soft. You can install it using an installer. (Expect for FPL3 and Parameter file.)

2.2.2 Installation of the software development tools.

Please insert the CD-ROM in the drive. The installer will show up automatically. If it does not start automatically, please initiate it by double clicking the SETUP.EXE.



<1> Readme First

The contents of the CD-ROM, and some notes are available. Please read it at first.

<2> Install...

Click "Install" to start installation of development tools. For details, please refer to the next section.

<3> Documents

Manuals of development tools and the evaluation kit are available in PDF files.

When this button is clicked, the WWW browser will start.
Adobe® Acrobat® Reader is available in the CD-ROM.

<4> Sample Program

Click this button to start the WWW browser for the sample program and the tutorial.

<5> Link to NEC Electronics Microcontrollers

Click this button to start the WWW browser display the link to the NEC Electronics Microcontroller web site
(http://www.necel.com/micro/index_e.html)

The NEC Electronics Microcontroller web page provides with the latest product/tool information and FAQs.

<6> Exit

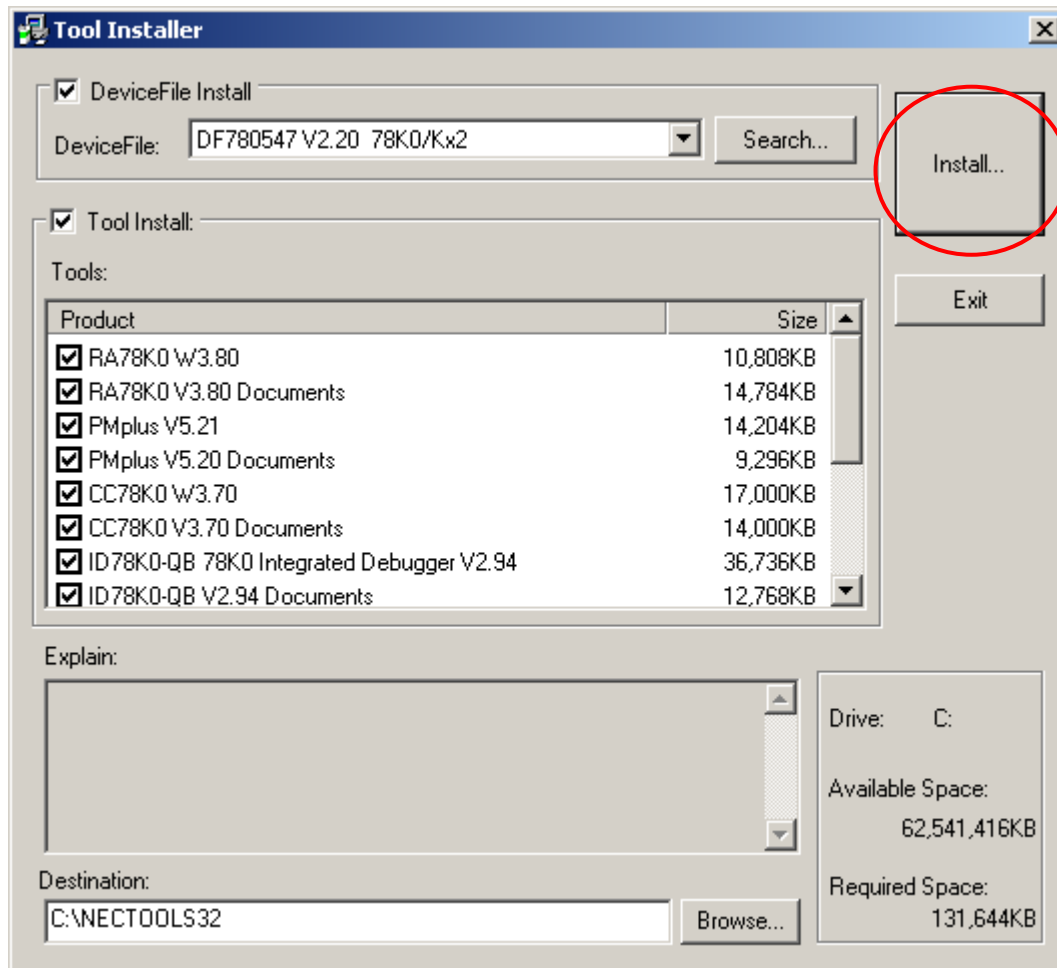
Terminate the setup.

<1> Select [Install] in the set-up menu with the welcoming robot.
Check the box for “Tool Install”, check/clear the product to be installed in the boxes.

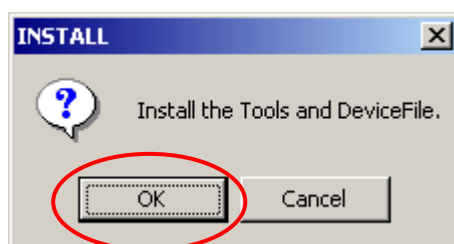
“Explain” displays an explanation of the selected product.

To change the installation destination, click [Browse...].

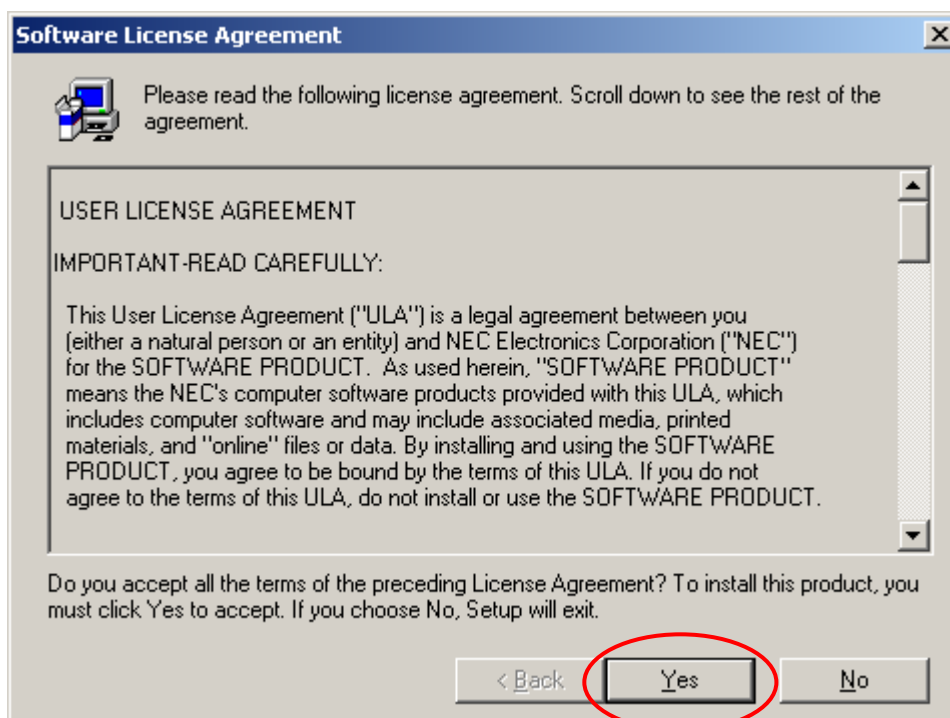
When all the settings are completed, click [Install...].



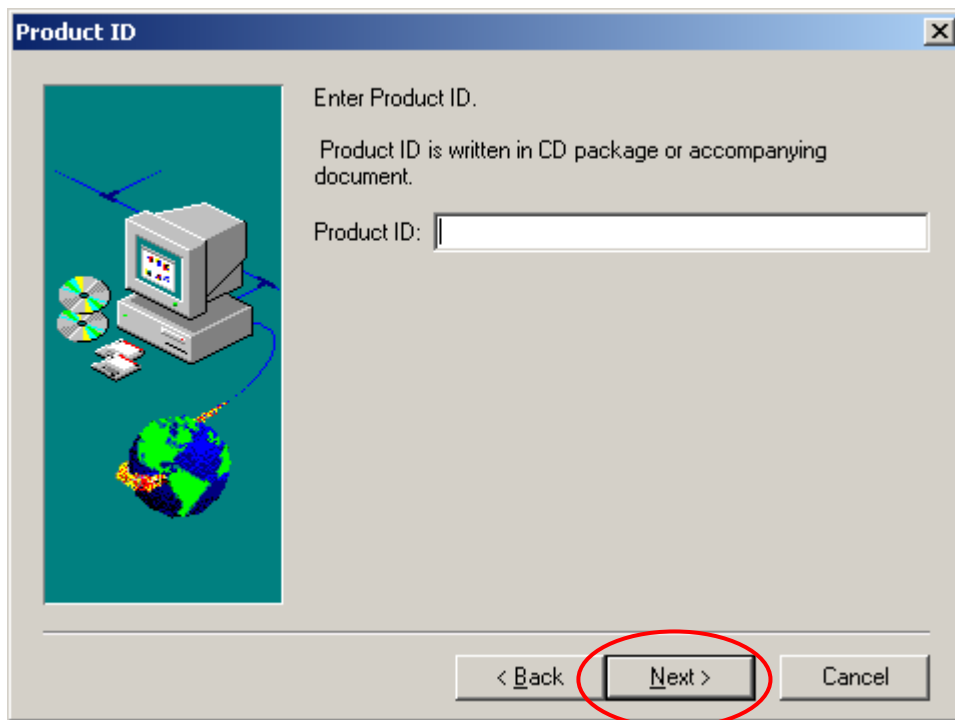
<2> To install each development tool, click **OK** when the install confirmation screen is displayed. To stop installation, click **Cancel**.



<3> To install a product, click **Yes** when the software license agreement screen is displayed. To stop installation, click **No**. To return to the previous screen, click [**< Back**].

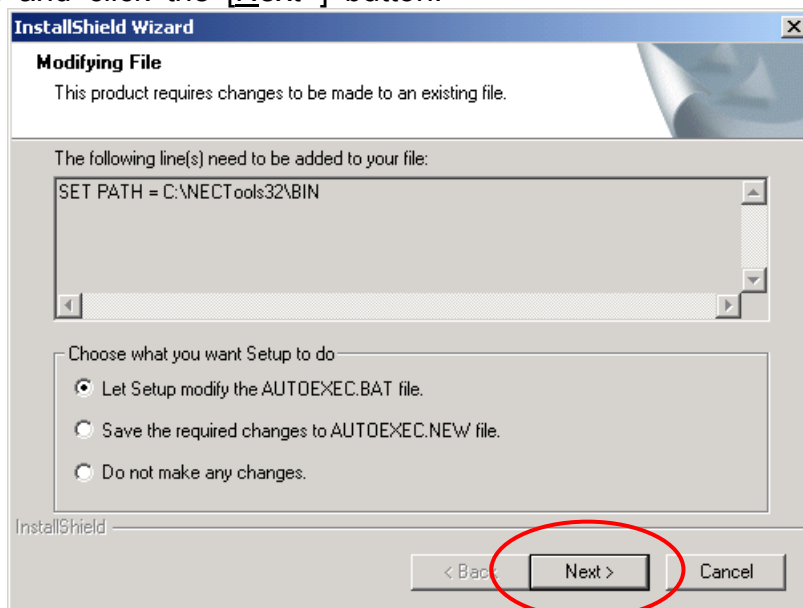


<4> Enter the product ID. The product ID is available on the CD-ROM package.



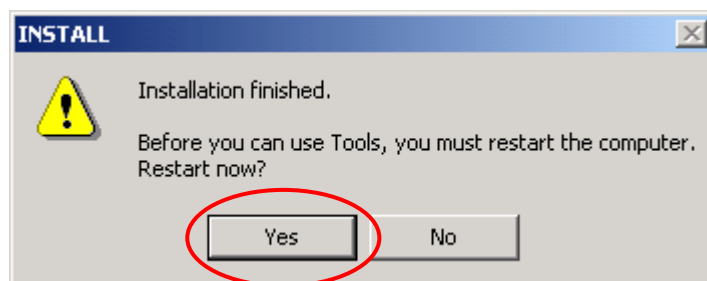
<5> Copying the files is started.

<6> When the files have been completely copied and if AUTOEXEC.BAT must be corrected, the following dialog box is displayed. Select an option and click the [Next>] button.

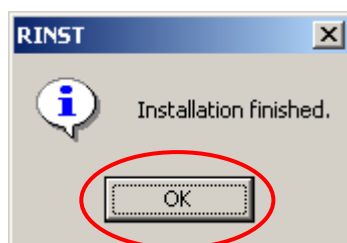


<7> If it is necessary to restart the computer, the following dialog box is displayed.

Click [Yes] to restart the computer.



<8> If the computer does not have to be restarted, a dialog box indicating completion of setup is displayed. Click the [OK] button. This completes installation of each development tool.



Notes on the about installation authority

To install this tool in Windows 2000 or XP, the authority of an administrator is necessary. Therefore, please login as an administrator.

Notes on the install-directory

Please do not use 2-byte characters, such as umlaut in the directory name, where the product is to be installed.

Note on the version of Windows

If the language of the Windows is not English, a file transfer error during installation might be observed. In this case, please abort the installation in the language, and re-install it in an English version of Windows.

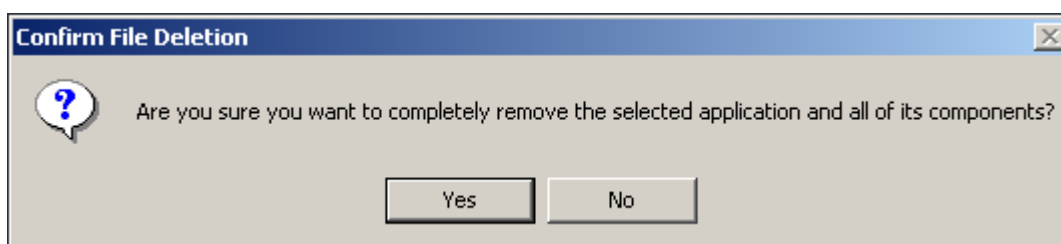
The identical problem may be observed, if a language other than English is specified as the system language in the “Regional Settings Properties” tab.

2.2.3 Uninstall

- <1> Start "Add /Remove Programs" in the Control Panel.
(Example here is based on Windows2000)



- <2> Select the tool that you want to uninstall from the list displayed in "Install/Uninstall" and click [Add/Remove...].
- <3> A dialog box for confirming deletion of files will be displayed. Click Yes. Deleting of the files will be started.



- <4> When the completion message is displayed, click .

Caution:

Deletion of some files may be asked during uninstallation. Normally, deletion of these files causes no problem.

- <5> This completes uninstalling this tool.

2.2.4 File Configuration in PC

Software Development Tools are installed in "C:/NECTOOLS32" on default setting.

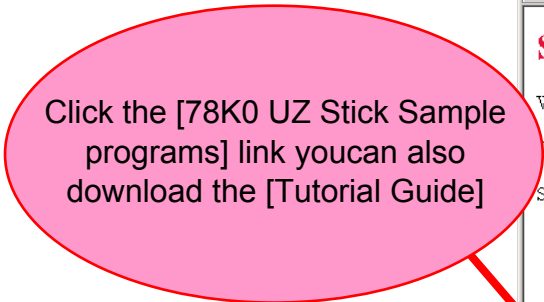
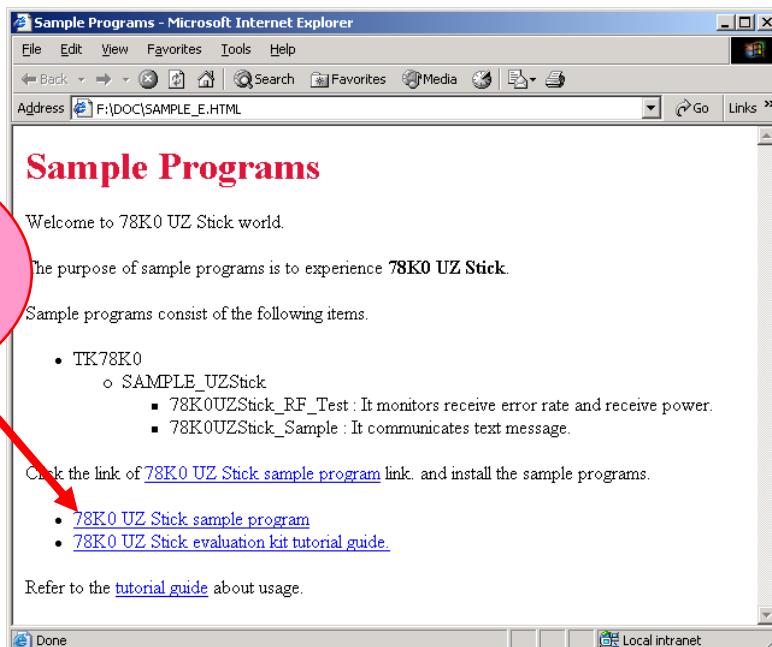
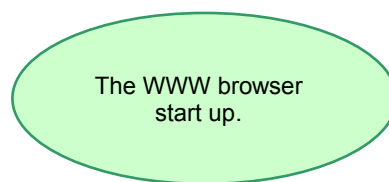
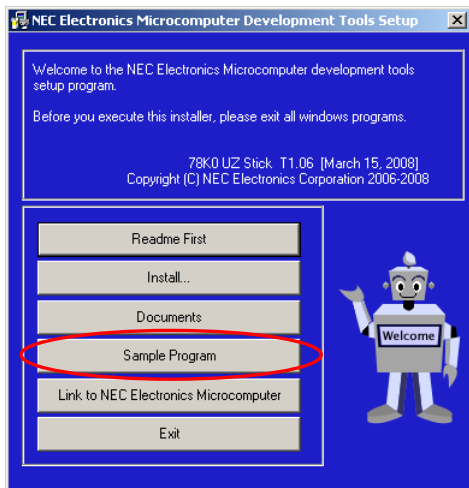
When you use the tools, please open the tools from [Start menu] -> [Programs]->[NEC Tools32].

2.3 Sample Environment

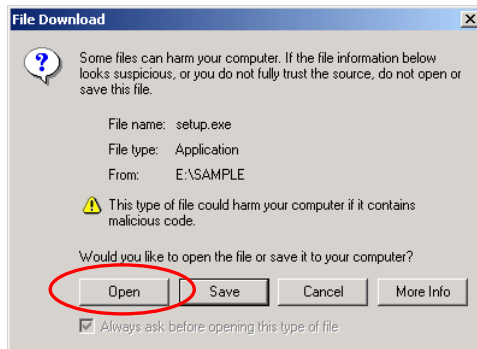
2.3.1 Installation of the sample programs

Insert the CD-ROM disk in the CD-ROM drive of your PC. The [NEC Electronics Microprocessor Development Tools Setup] screen automatically appears.(if this screen does not appear automatically, start setup.exe from Explorer. etc.)

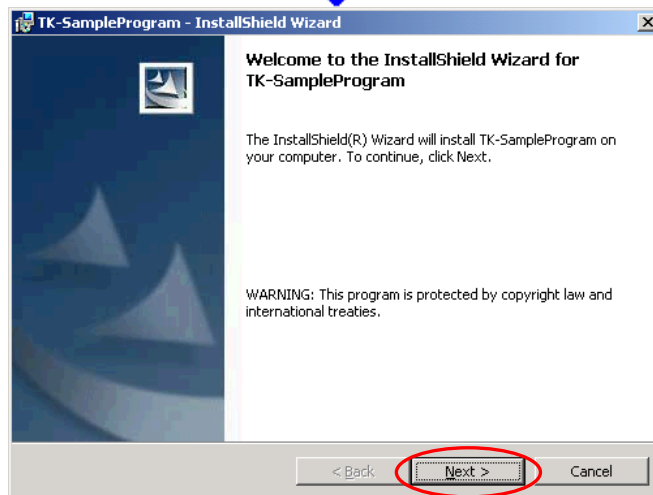
Press the **Sample Program** button to start the WWW browser, and then click the [78K0 UZ Stick Sample Programs] link.



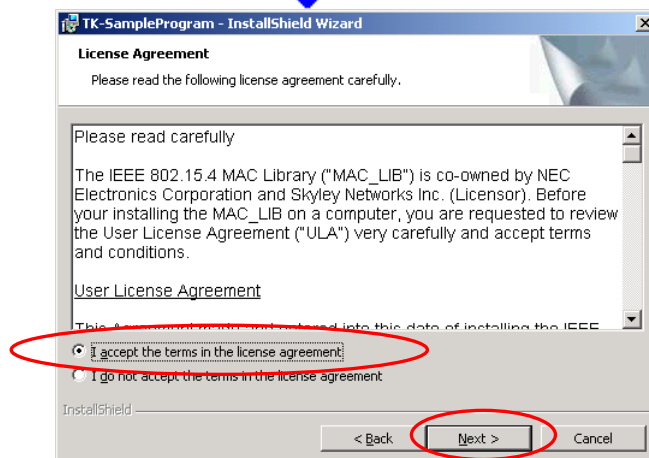
When[78K0 UZ Stick Sample Programs] is clicked, the following download confirmation window appears.



Please click the **Open** button.
In case of windows 2000,
you will see the [Security Warning] window. Please click **Run**.

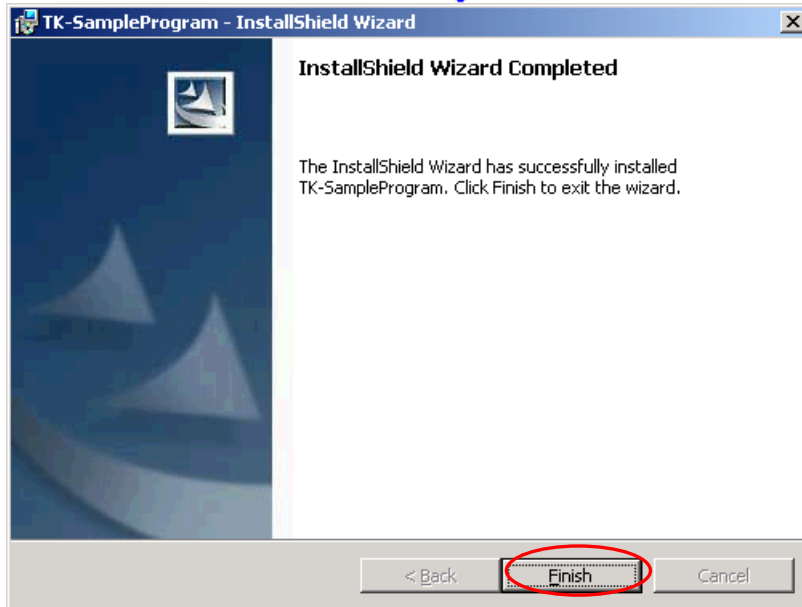


InstallShield wizard for TK-Sample Program starts up
Please click the **Next**.



License agreement screen is displayed.

please select "I accept the terms in the license agreement".and click **Next**.



Please click **Finish**.

The sample programs are installed.

Installed files

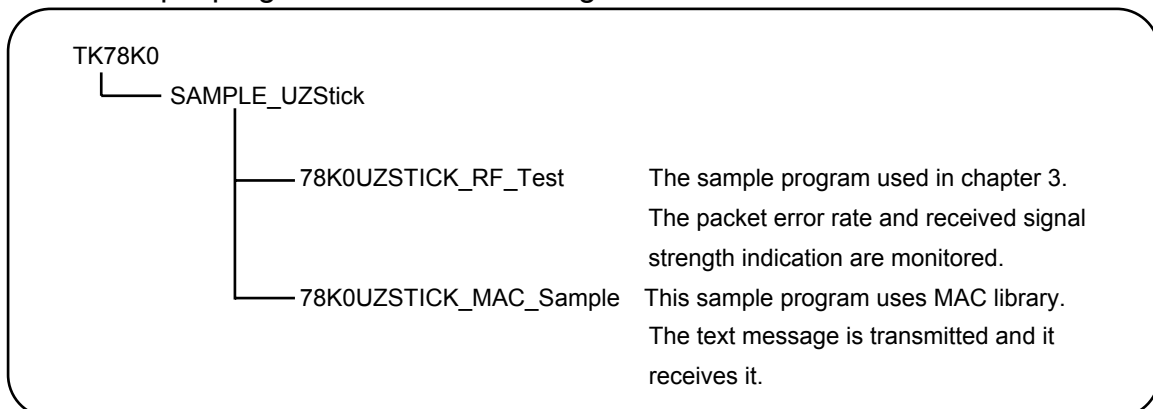
- TK78K0 folder ----- sample programs
- 78K0UZSTICK.exe ----- execute file

When you uninstall the sample program.

Please use "Add /Remove Programs" in the Control Panel.

2.3.2 File Configuration of the sample program

The sample program ware the following folders.



2.4 USB Driver

You need to install “USB Serial Converter” and “USB Serial Port” in your PC.

When 78K0 UZ Stick is used, it is necessary to install “USB Serial Converter” and the “USB Serial Port” driver in the host machine. Please install the driver according to the following procedures with appending CD in the drive.

Attention Please do not connect 78K0 UZ Stick by way of the USB hub. It is likely not to operate normally.

2.4.1 Installation of the USB driver

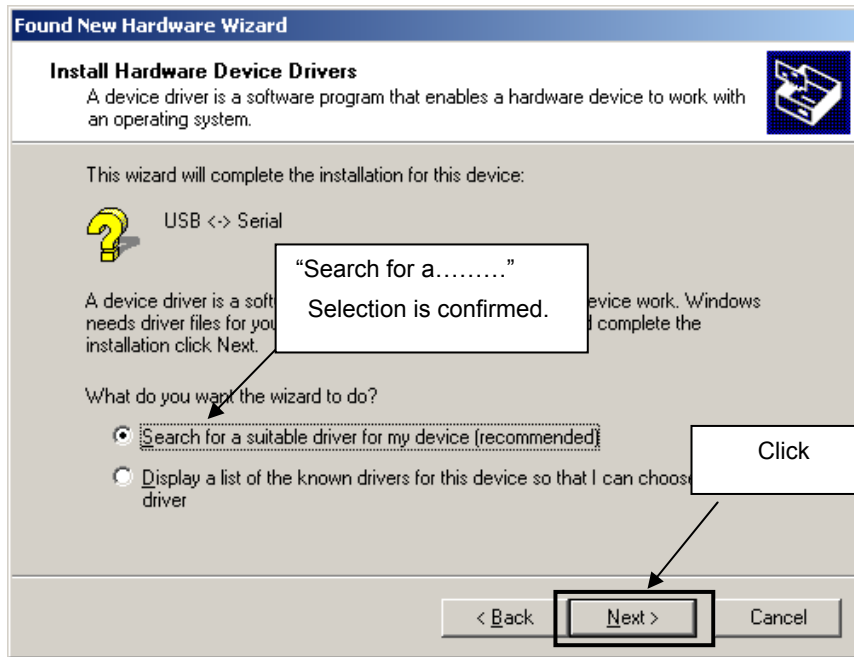
Install to Windows2000

1. Once the 78K0 UZ Stick is inserted to the PC USB terminal, a wizard will be initiated by the MS Windows.



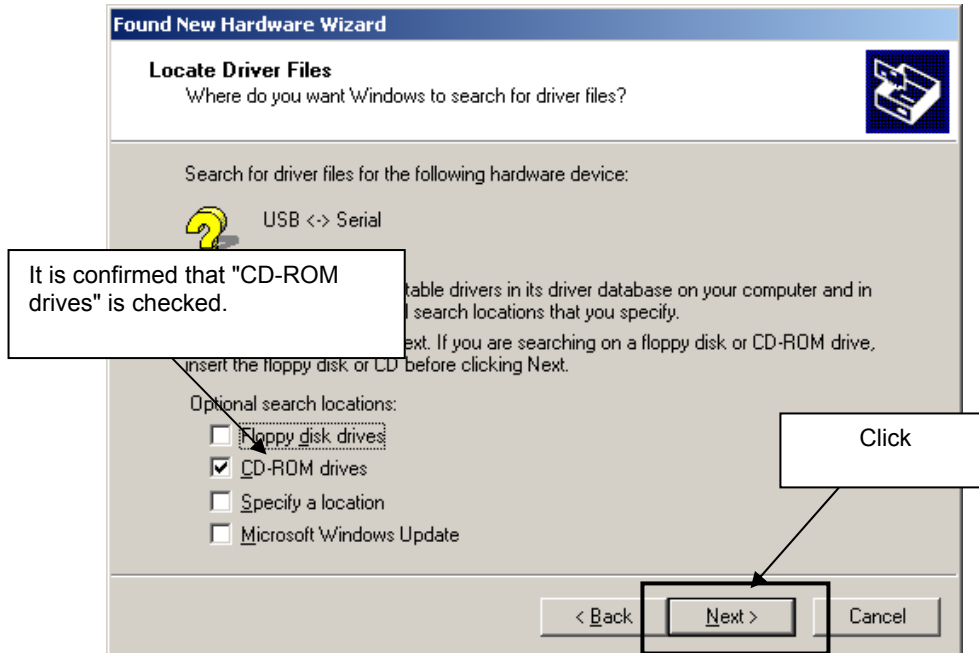
2. The following window is displayed, please click “search for a suitable driver

Method 1 (Windows2000)



3. Please select the “CD-ROM drives” only. and click **NEXT(N)>**.

driver file 1 (Windows2000)

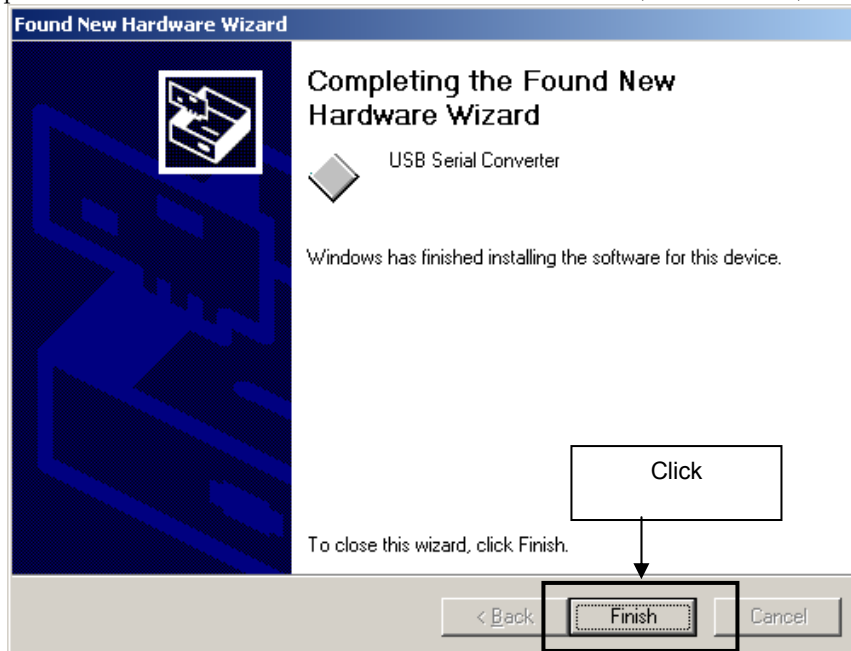


4. Please click **NEXT(N)>**

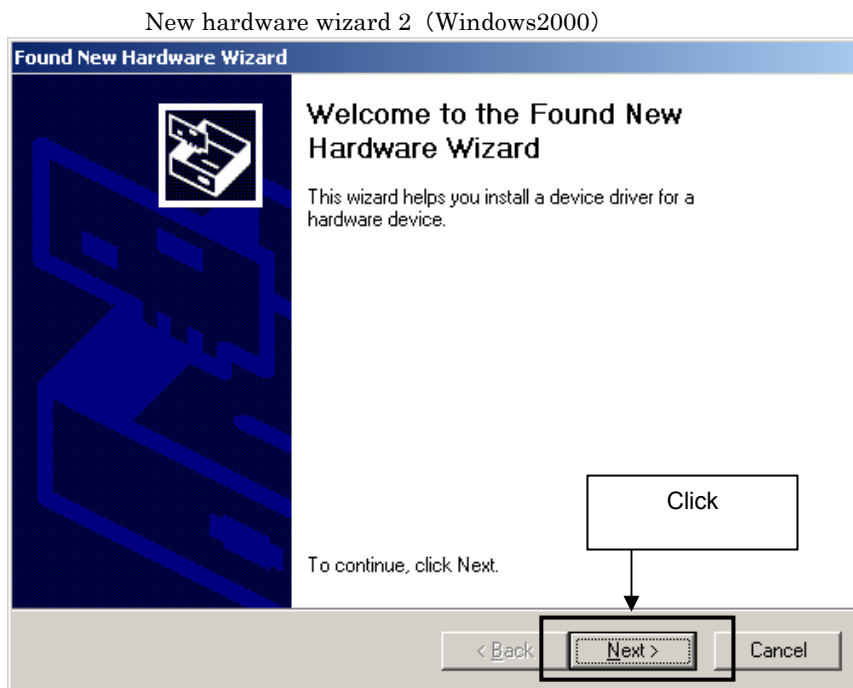


5. The "USB Serial Converter" driver's installation is completed. Click **Finish**.

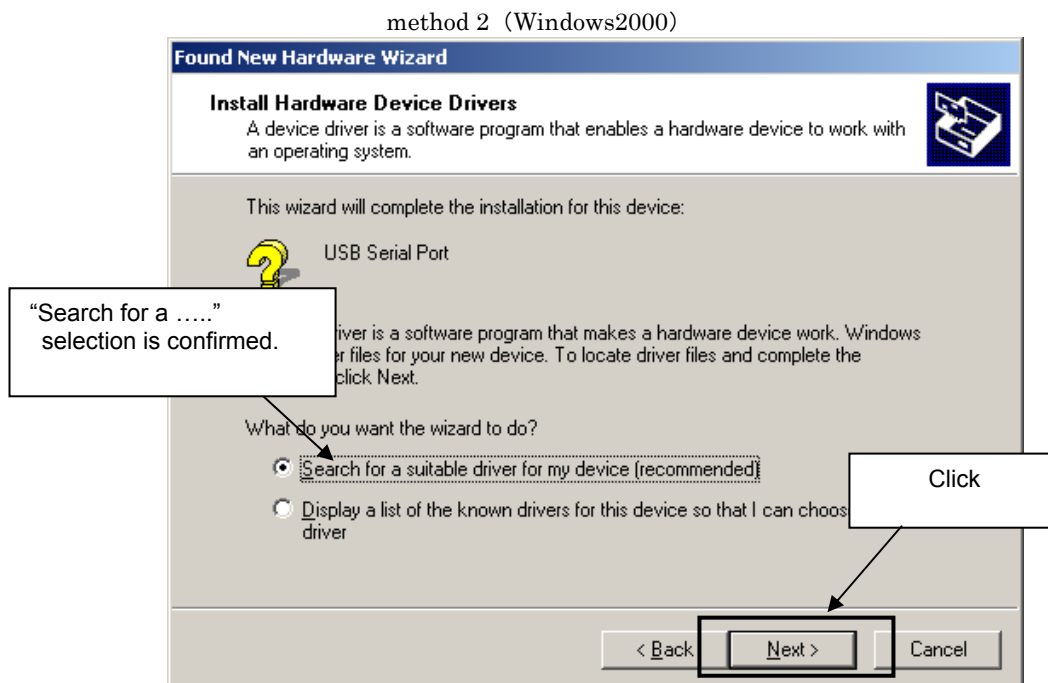
Completion of the USB Serial Converter driver installation 1 (Windows2000)



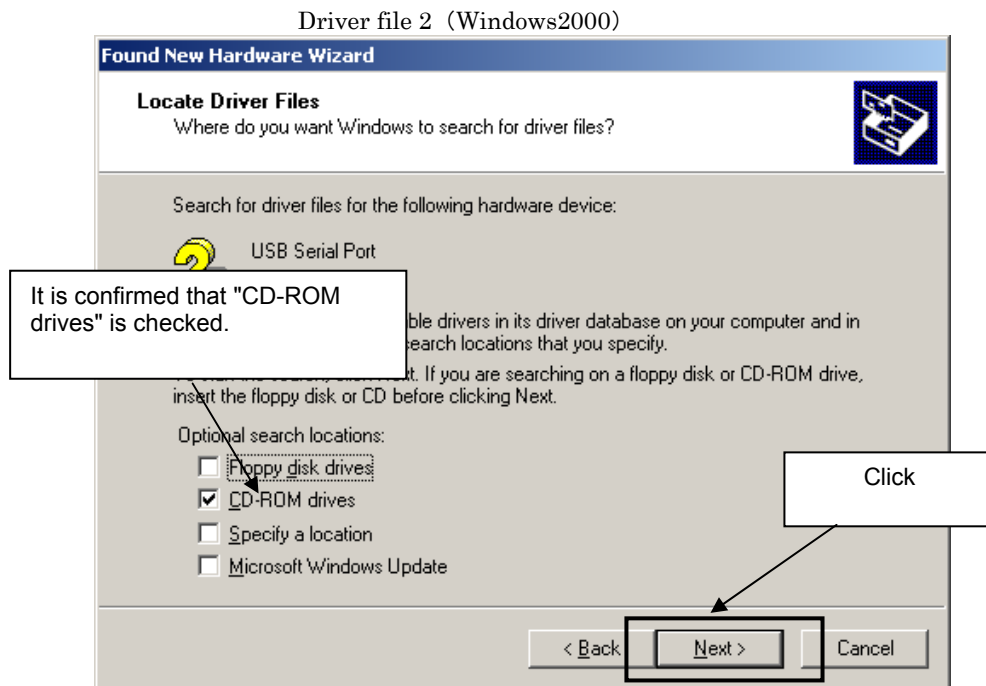
6. The "USB Serial Port" driver's installation begins continuously. Click **NEXT(N)>**.



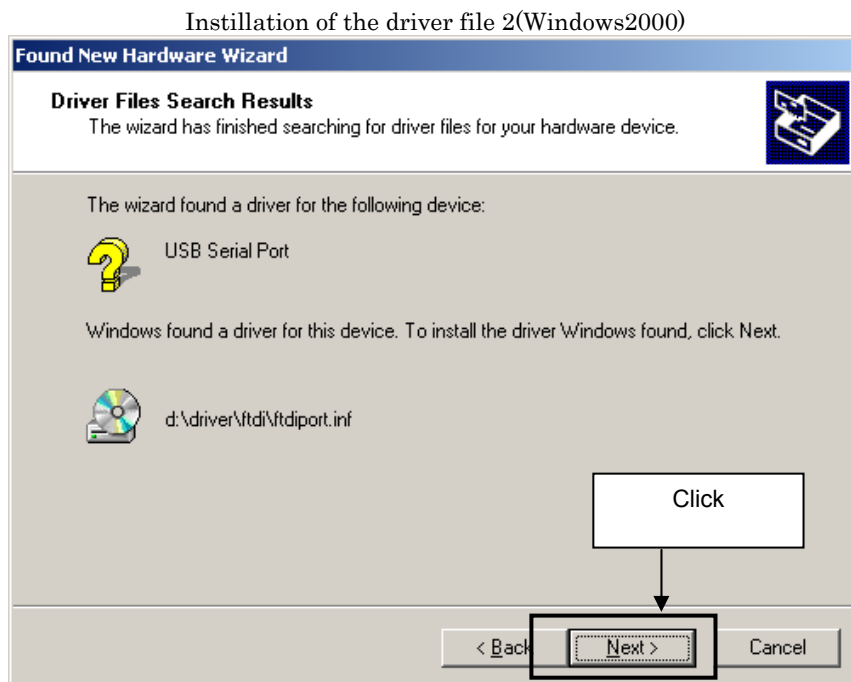
7. The following window is displayed. Select "Search for a suitable driver for my device" . and click **NEXT(N)>**.



8. Please select the "CD-ROM drives" only. And click **NEXT(N)>**.

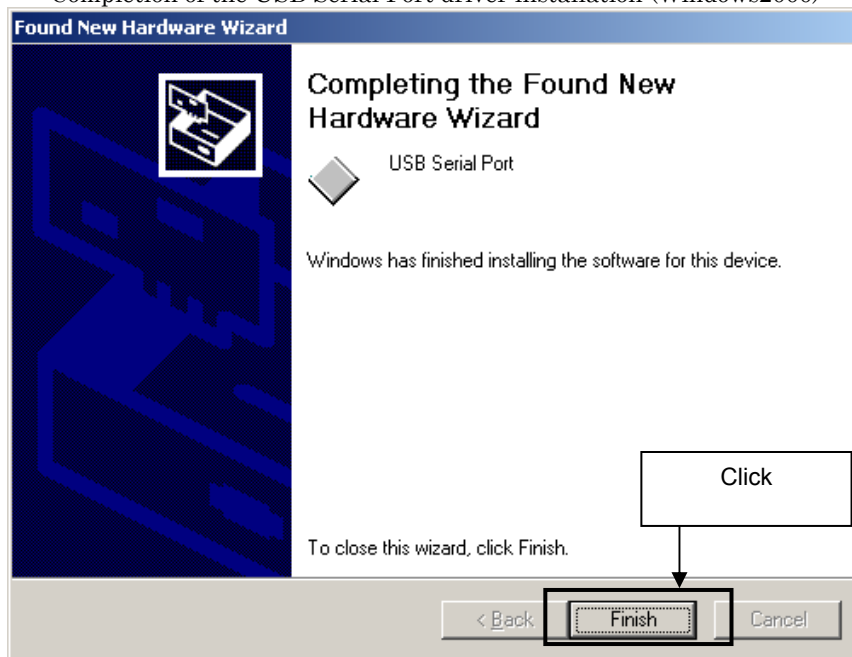


9. Please Click **NEXT(N)>**.



1 0. The “USB Serial Port” driver’s installation is completed. Click **Finish**.

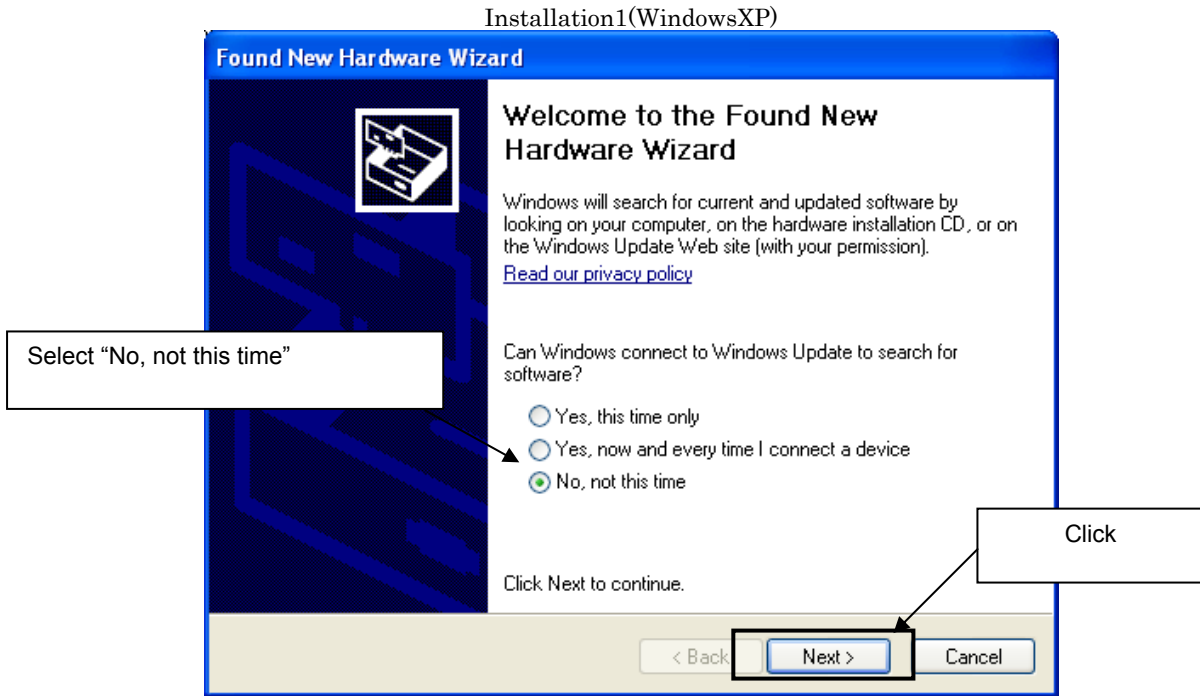
Completion of the USB Serial Port driver installation (Windows2000)



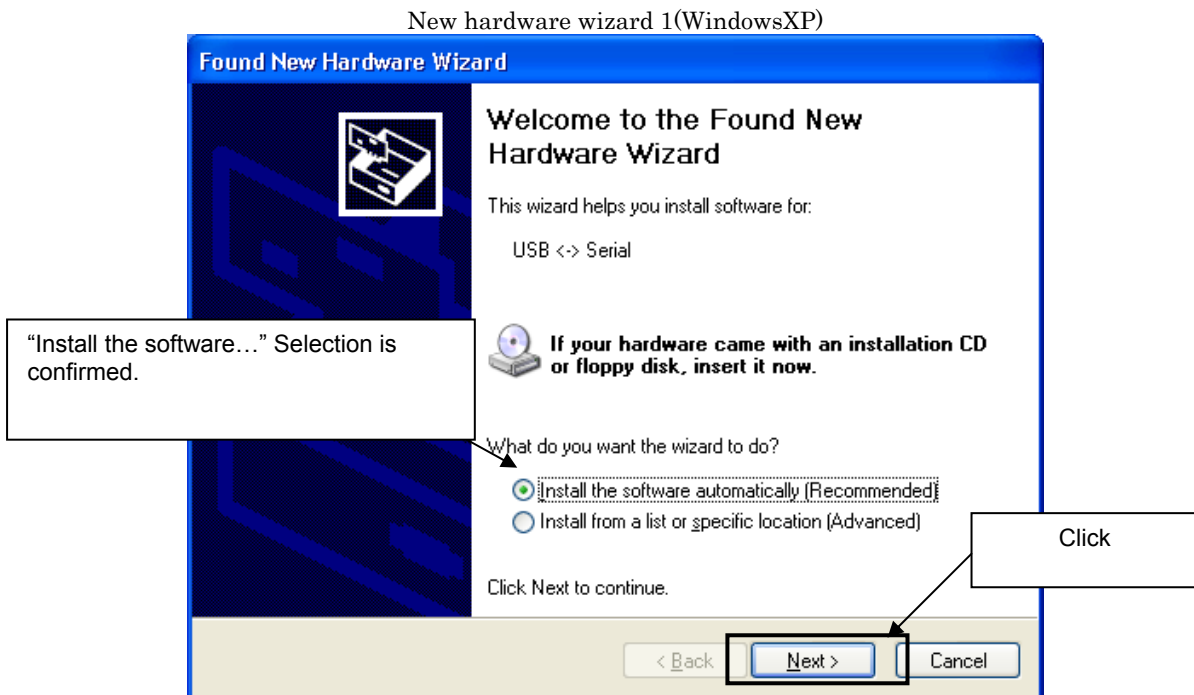
1 1. Driver Install was finished.

Install to Windows XP

1. Once the TK-78K0/KF2+UZ board is inserted to the PC USB terminal, a wizard will be initiated by the MS Windows.



2. Select the "Install the software automatically ..." has been selected, and click **NEXT(N)>**.



3. The "USB Serial Converter" driver's installation is completed. Click **Finish**.

Completion of the USB Serial Converter driver installation 1 (WindowsXP)

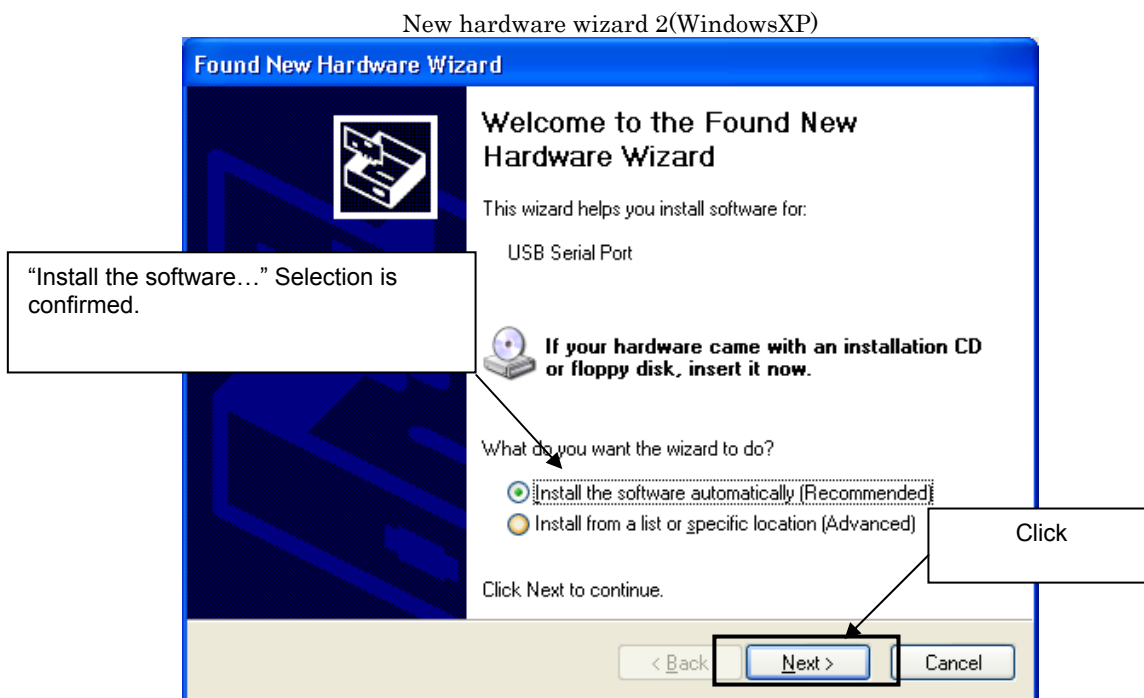


4. The "USB Serial Port" driver's installation begins continuously. Click **NEXT(N)>**.

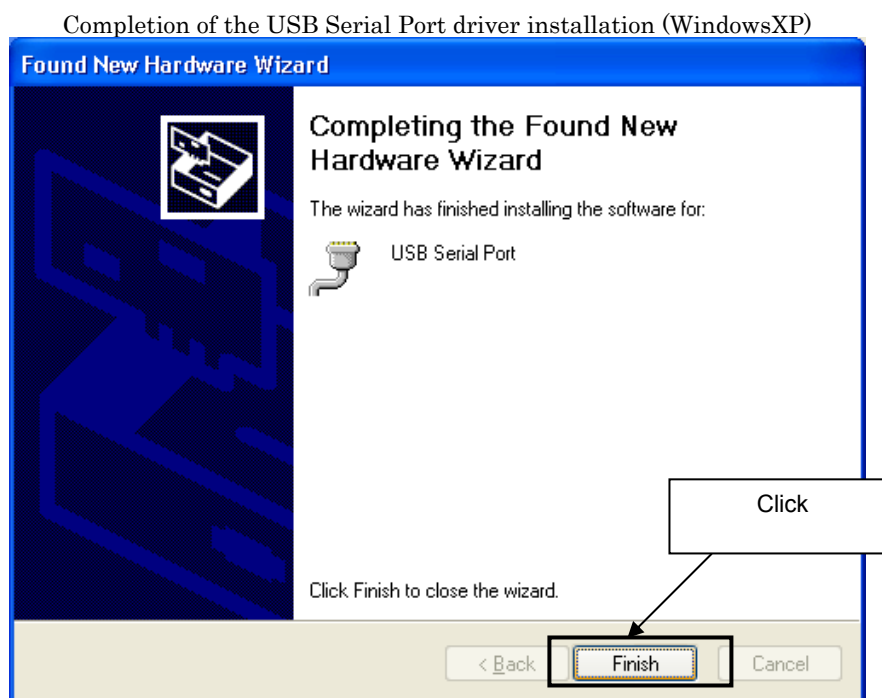
Installation2(WindowsXP)



5. The "USB Serial Port" driver's installation begins continuously. Click **NEXT(N)>**



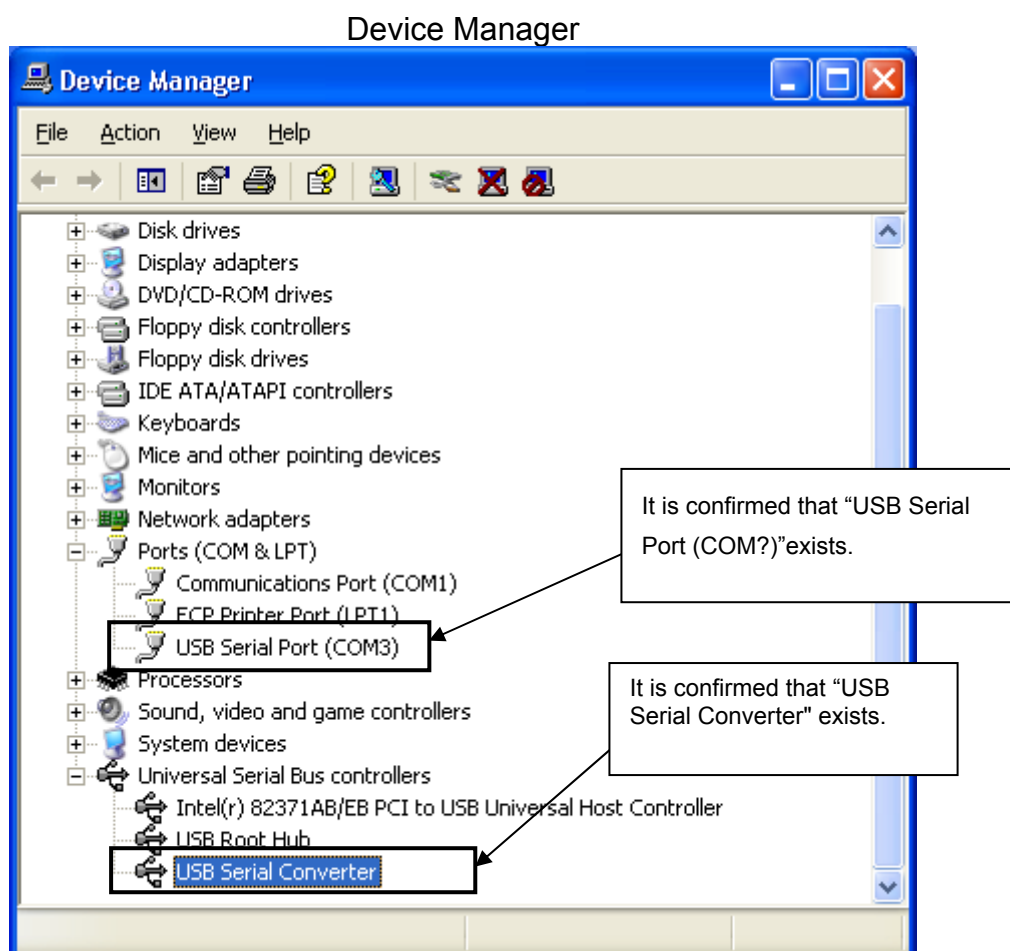
6. If the following window is displayed, the USB driver's installation is completed. Click **Finish**.



7. Driver Installation has been finished.

2.4.2 Confirmation of the installation

Please confirm “USB Serial Port (COM?)” in the device manager of system in the control panel of the MS Windows. Then, please confirm “USB Serial Converter”.



※Attention

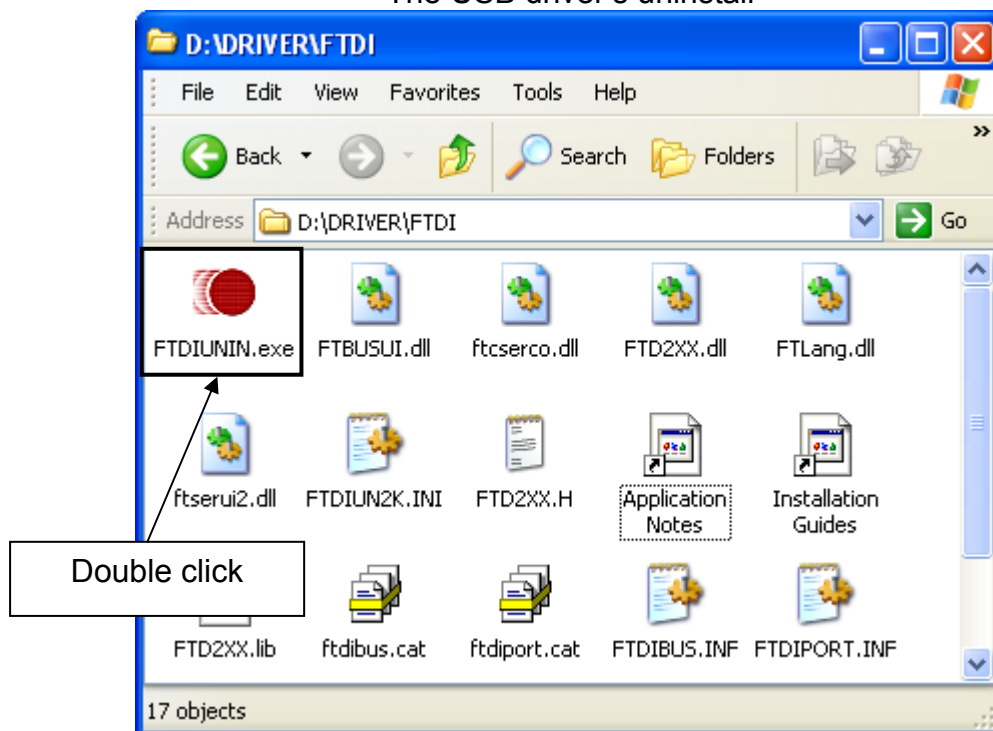
Windows2000/XP

Please do not do “Hardware Modification Scan” when you communicate with the target device.

2.4.3 Uninstall of the USB driver

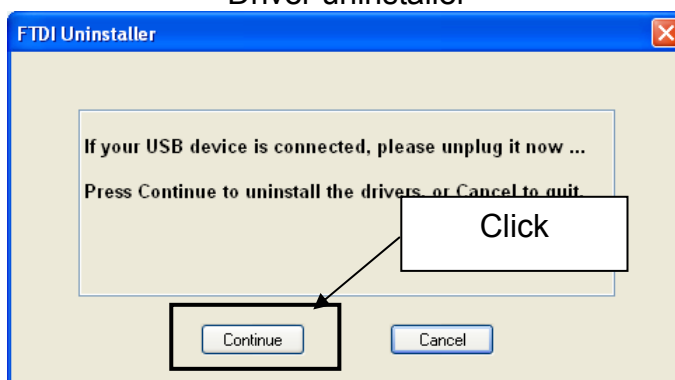
The uninstall program, Ftdiunin.exe, is available at “/DRIVER/FTDI”. Please log on as an administrator, then, execute the Ftdiunin.exe

The USB driver’s uninstall



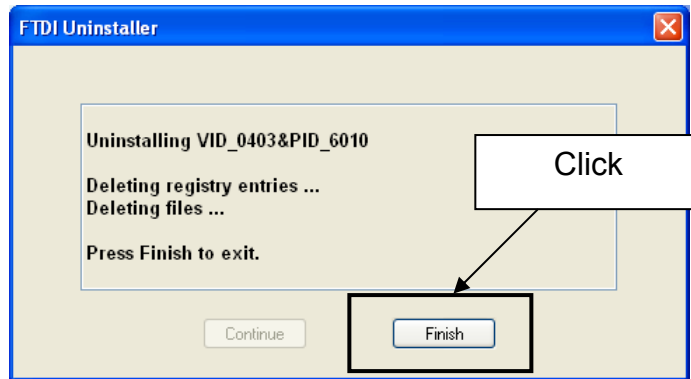
After 78K0 UZ STICK is detached, please click is **Continue** .

Driver uninstaller



Please click **Finish**.

The driver's uninstall completion



3 Experiences

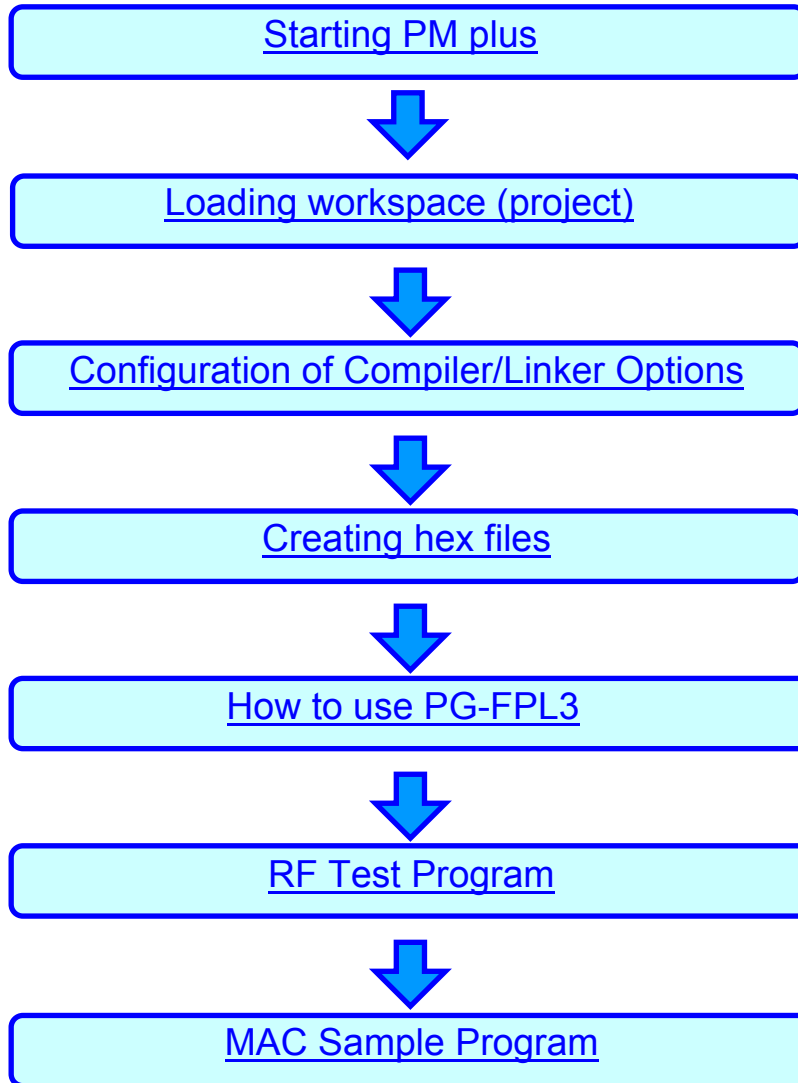
Now you are ready to experience the operation of the 78K0 UZ Stick using the integrated development environment, PM plus.

Here, we use RF test program [78K0UZSTICK_RF_Test] as an example.

This chapter is designed to provide with an understanding of how to work on PM plus, how to generate a hex file, and how to use the Flash programmer.

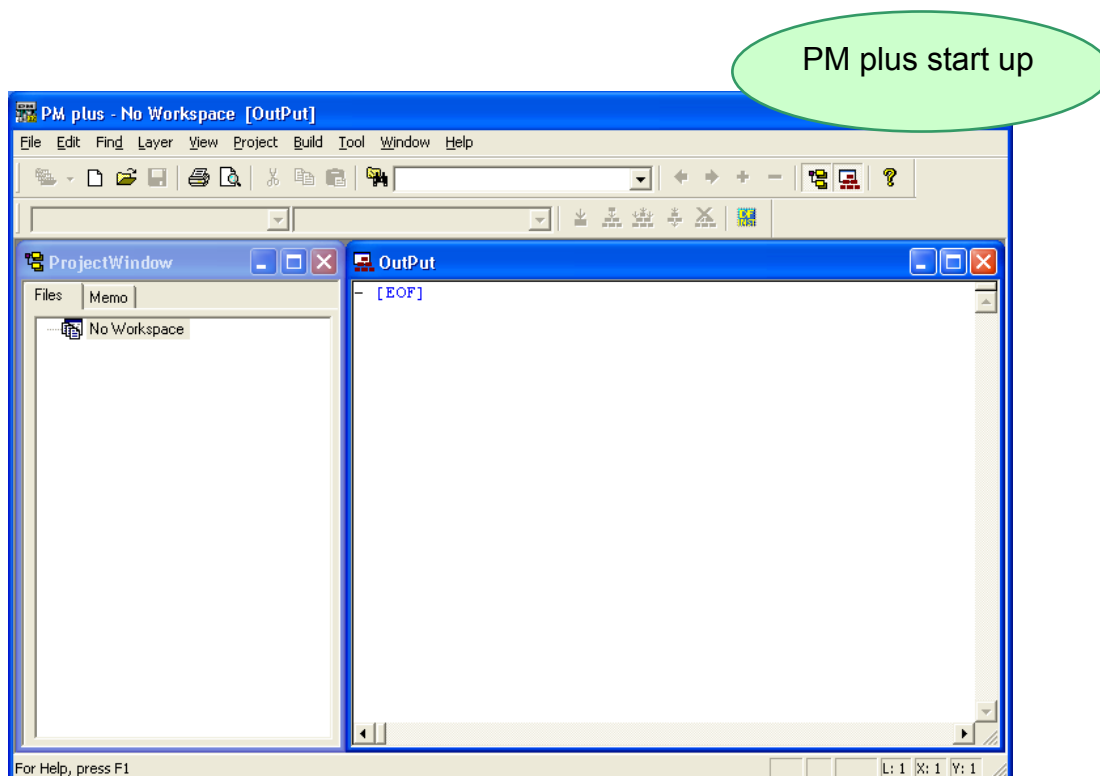
Though the standard specification of the 78K0 UZ Stick does not support debugging capability, you can place an order of an option to provide with the debugger interface, SICA2P20S, for connection to a MINICUBE debugger, QB-78K0MINI, or QB-MINI2. You need to purchase an adapter, SICA10I2P, at the same time.

The overall flow is as follows.



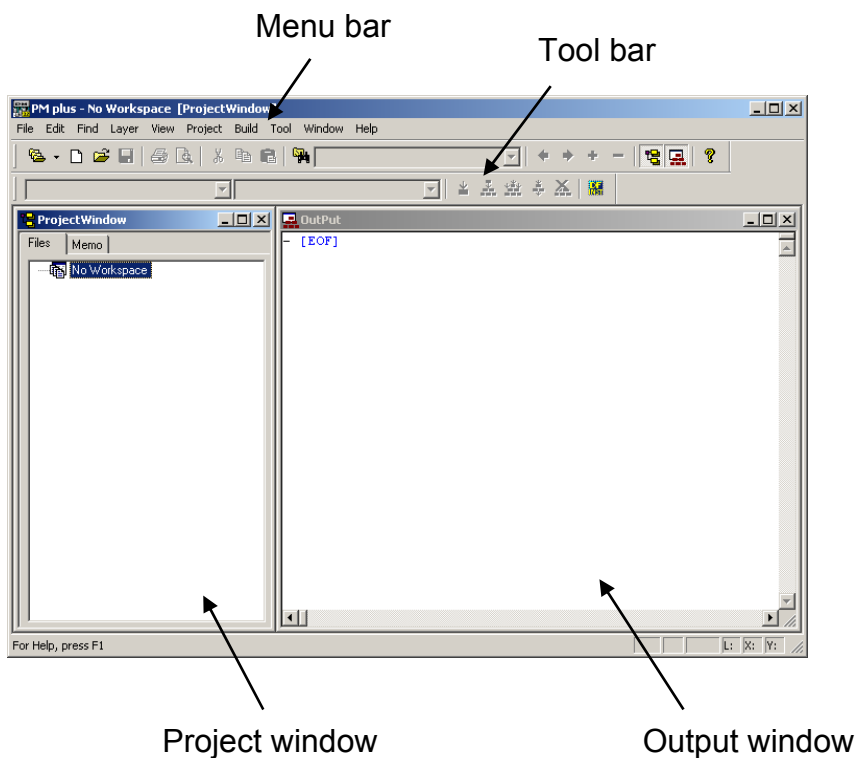
3.1 Starting PM plus

In the Windows Start menu, select [Programs]->[NEC Tools32]->[PM plus]



3.2 Introduction to PM plus

In PM plus, application programs and environment setting are handled as a single [Project](#), and series of actions such as program creation using the editor, source management, build, and debugging are managed. Also, one or more project files is managed together as a workspace.



Project window A window in which project names, source files, and include file are displayed using a tree structure.

Output window A window in which the [build](#) execution status is displayed.

➡ For details regarding menu bars and tool bars, refer to the PM plus User's Manual.

What is a project?

A project is the unit in which PM plus executes management, and refers to an application system and environment development based on PM plus.

PM plus compiles project information and saves it in a “project file”, from which it is then referenced.

What is a project file?

A project file is a file to which information such as the source file to be used in the project, the device name, the tool options for compiling, and the editor and debugger to be used have been saved as “project information”.

The file name format is “`△△△△prj`”.

Project files are created in folders that are set when creating new workspaces.

What is a project group?

A project group is a group comprised of a number of projects in an application system.

The target devices of each project that can be registered to one project group must be the same.

What is a workspace?

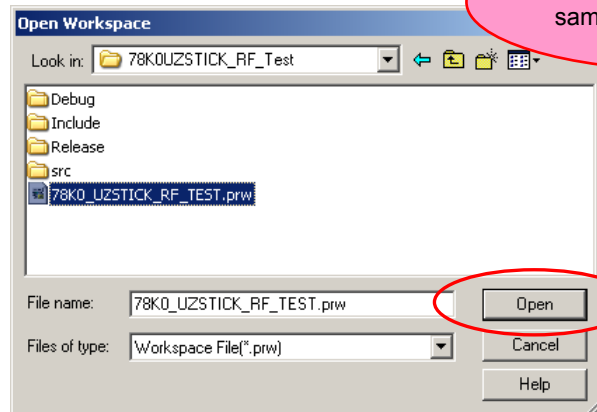
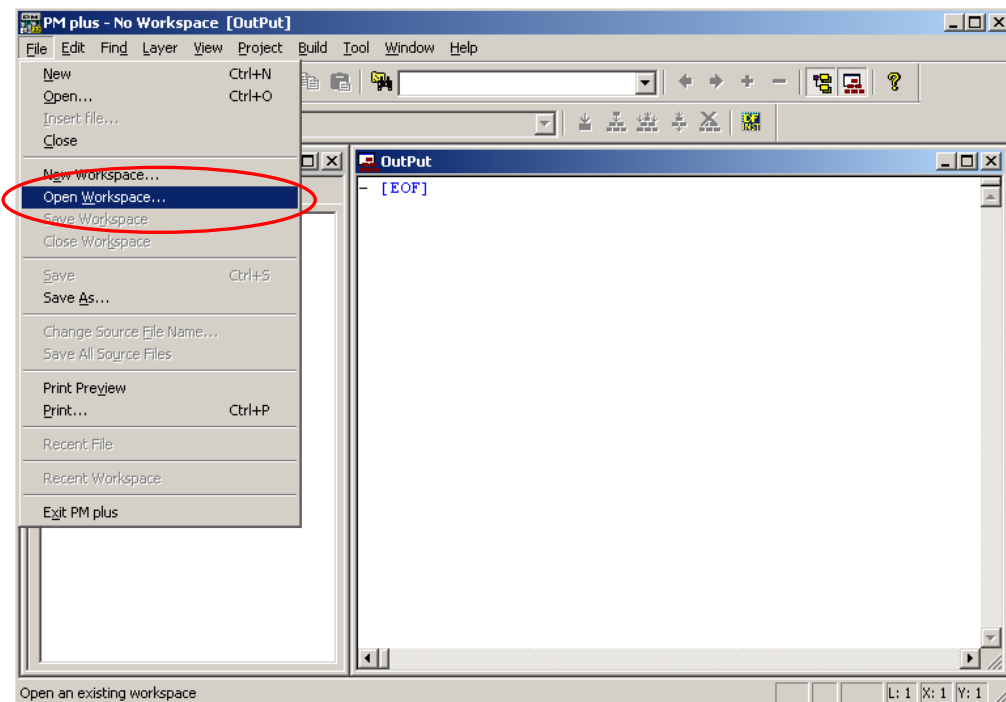
A workspace is the unit used to manage all the projects or project group required for one application system.

The file name of multiple project files is saved to a workspace file for referencing.

The file name format is “`△△△△prw`”.

3.3 Loading Workspace (Project)

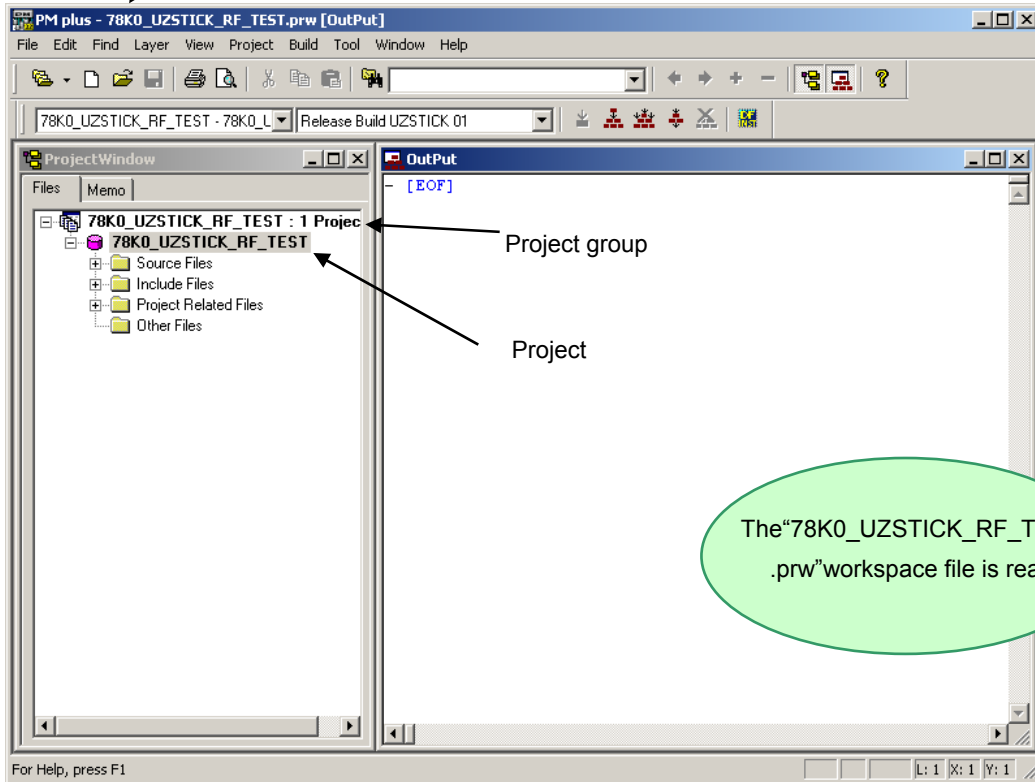
Please place the file “78K0_UZSTICK_RF_TEST.prw” at
C:\TK78K0\78K0_UZSTICK__RF_Test\78K0_UZSTICK_RF_TEST
Please start PM plus from [All Programs] -> [NEC Tools32] -> [PM plus]
Then, please select “Open Workspace” as shown below.



“78K0_UZSTICK_RF_TEST.prw” and then press the **Open** button.

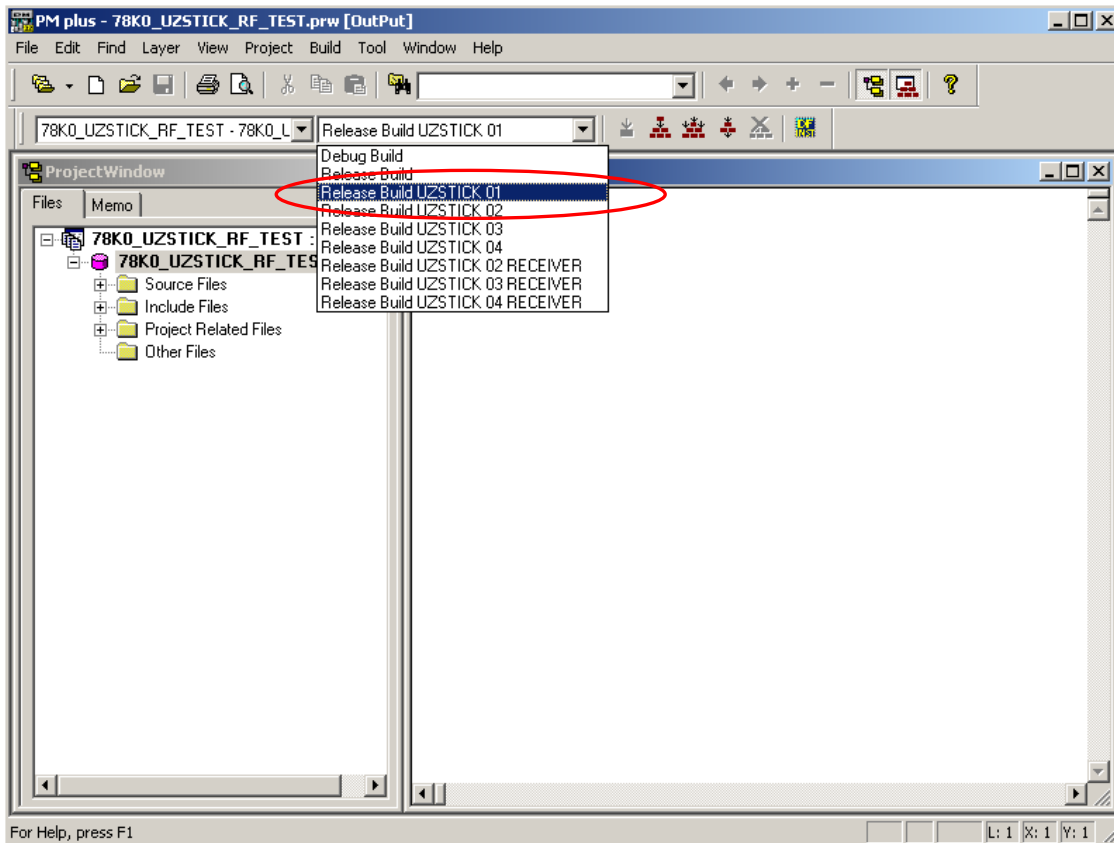


Workspace file name :78K0_UZSTICK_RF_TEST.prw

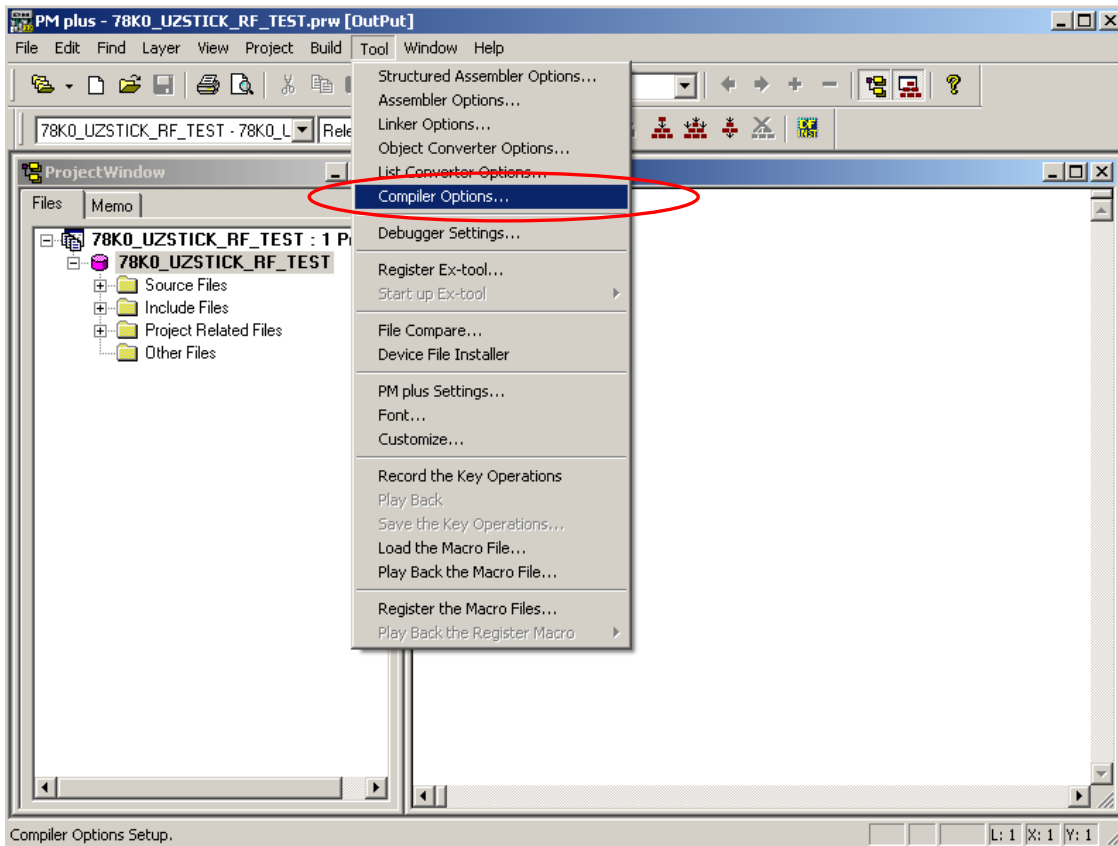


3.4 Configuration of Compiler Option

Please select “Release Build UZSTICK 01” at the pull-down menu of the build mode selection, as shown below.



Please choose [Tools] -> [Compiler Options] at the pull-down menu.



In the opening tab, Macros and path to include files are defined, as shown below.

You will find three defined macros of “CPU78K0”, “F053764”, and “MAC_ADDR=0x0001”. The meanings of the macros are as follows,

“CPU78K0”: The target CPU is 78K0.

“F053764”: The target MCU is UPD78F0537, and the MCU has 64 pins.

“MAC_ADDR=0x0001”: This code is for a node with MAC short address of 0001.

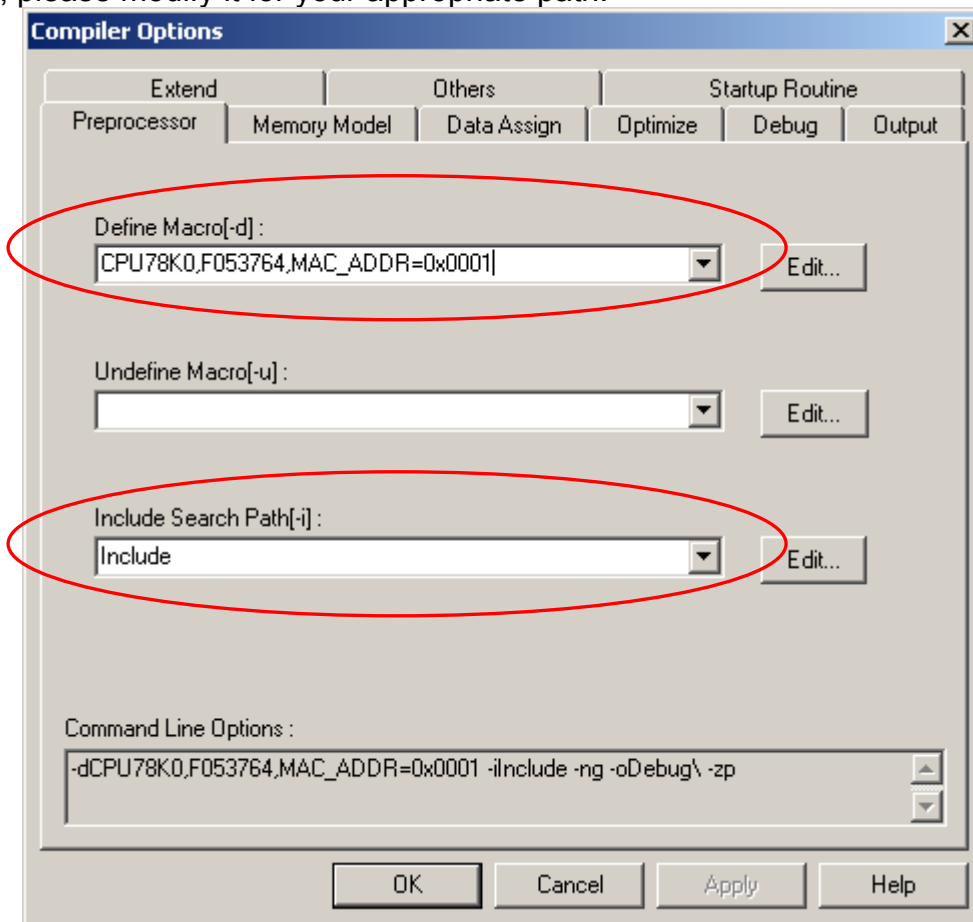
This RF test program supports the MAC short addresses of 0002, 0003, and 0004.

The code for the MAC short address of 0002 is compiled by “Release Build UZSTICK 02” with the defined macro of “MAC_ADDR=0x0002”, the code for the MAC

short address of 0003 by “Release Build UZSTICK 03” with the defined macro of “MAC_ADDR=0x0003”, and the code for the MAC short address of 0004 by

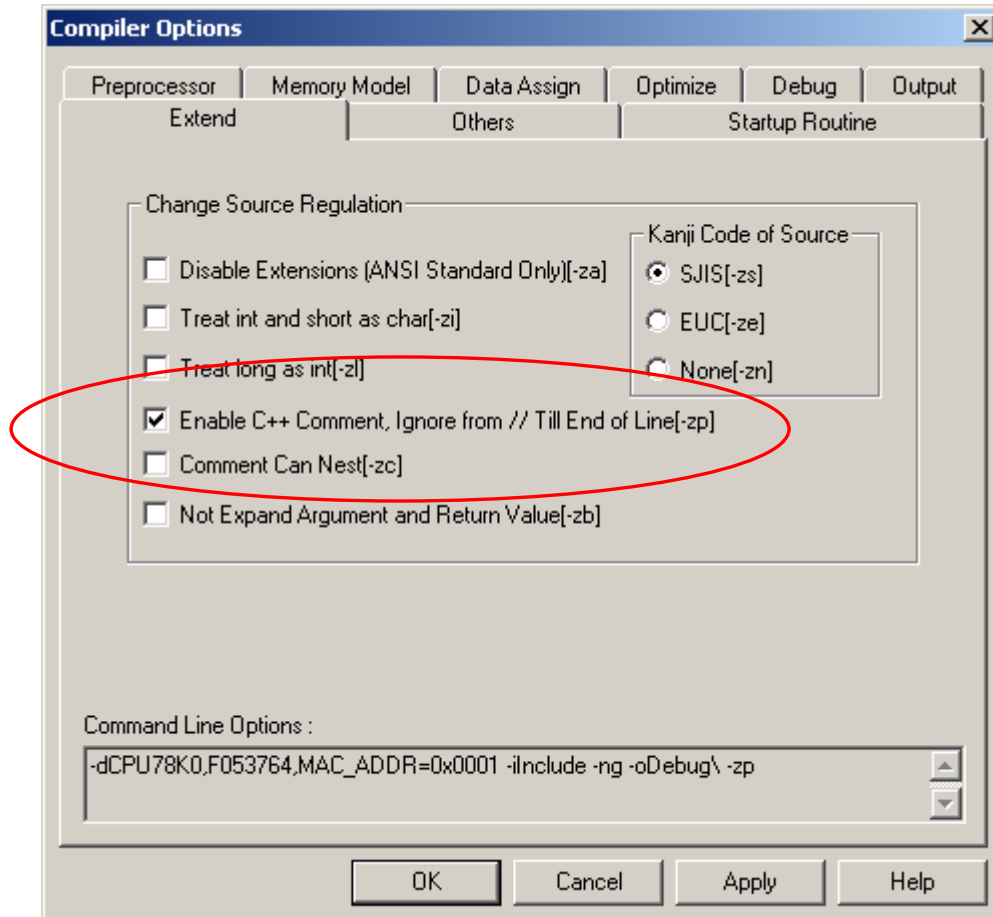
“Release Build UZSTICK 04” with the defined macro of “MAC_ADDR=0x0004”.

Include Search Path will be, “Include”,
if you install the project file at this location.
If not, please modify it for your appropriate path.



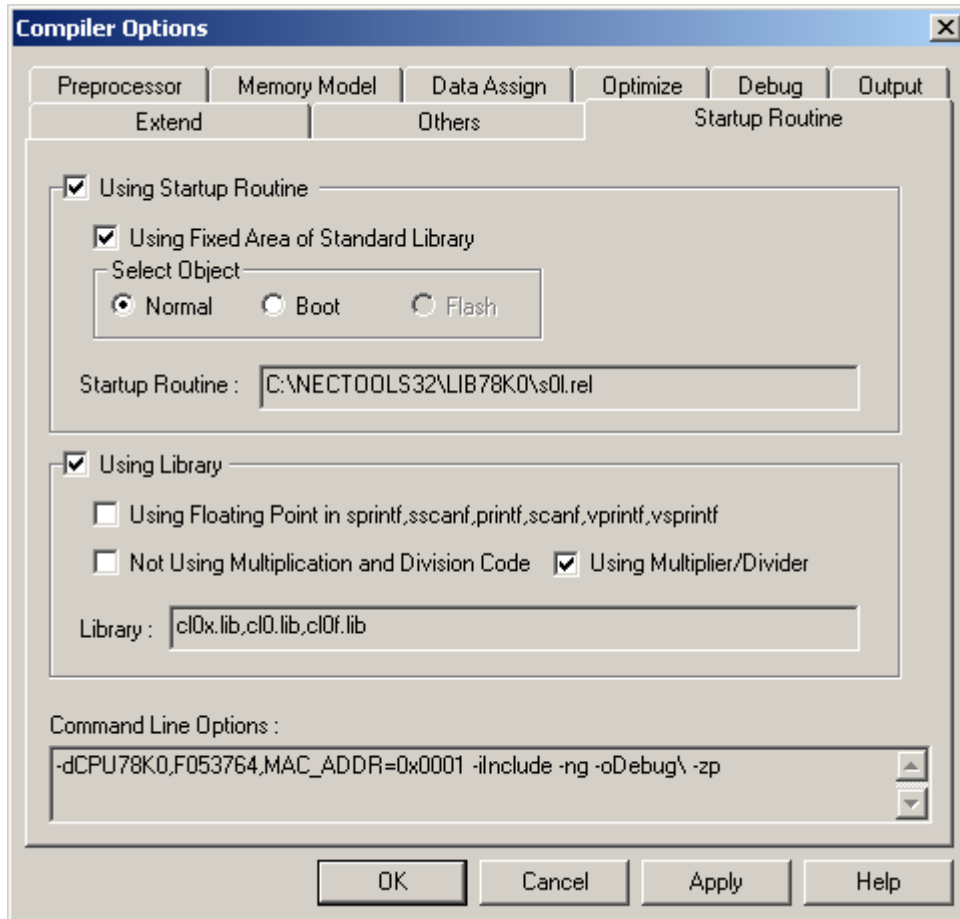
Please select the “Extend” tab.

You will allow the comment in a way supported by C++, using “//”.



Then, you will check the “Startup Routine”. The “Multiplier/Divider” library is supported at the Startup Routine tab.

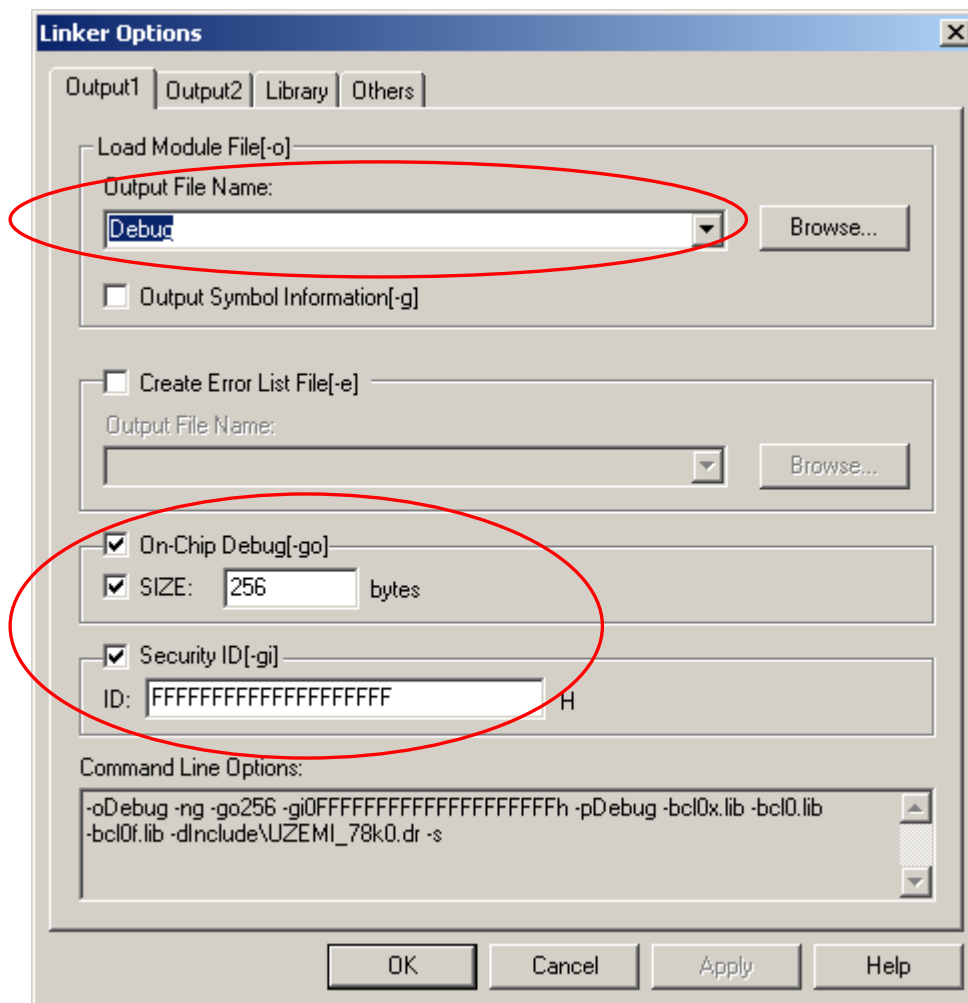
Please note the “Multiplier/Divider” library has been newly introduced in the CC78K0 v3.7/W3.7. If you try to use library created by using the older versions of the CC78K0 compiler, you will find an error message.



In that case, you have a good chance to solve the problem by clearing the check at “Using Multiplier/Divider”.

3.5 Configuration of Linker Option

Then, please open the “Linker Options” window from the pull down menu of [Tools] -> [Linker options]. Please set the “Load module file”, “On Chip Debug”, and “Security ID”, as shown below.



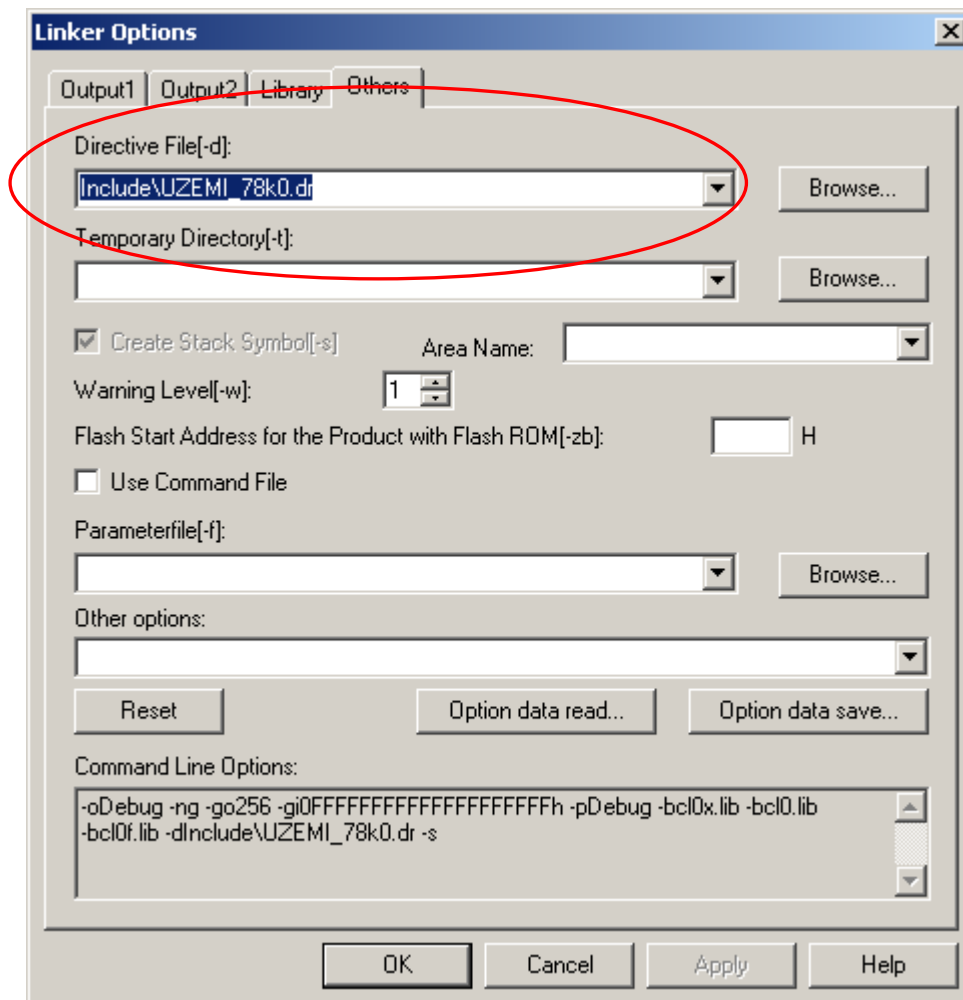
The Load Module File is required for debugging.

The Security ID in all of the sample programs is “FFFFFFFFFFFFFFFFFFFFh”. You can change the ID code by writing a new ID code in the ten bytes starting at 85H.

The intention of using the unique ID code is to prevent an unwelcome third party from debugging and modifying your source code. To enable the ID code, you have to write non-zero value at 84H.

In the sample programs, “84H” is set to a non-zero value, “2”, by the “option.asm” file. If you set “0” at 84H, the ID code is ignored. If you forget your unique ID code, or mistakenly over-write 0x00(value) at the address of 0x84, the debugger ID78K0-TK is unable to access to the CPU via OCD interface. In this case, you have to start over from erasing all data in the Flash EEPROM. Then, after your defining a new ID Code, you can load the hex file using PG-FPL3 with the new ID code. How to use “PG-FPL3” will be explained later.

In the “Others” tab, please confirm the path for the directive file as, “Include\UZEMI_78k0.dr”



3.6 Configuration of Object Converter Option

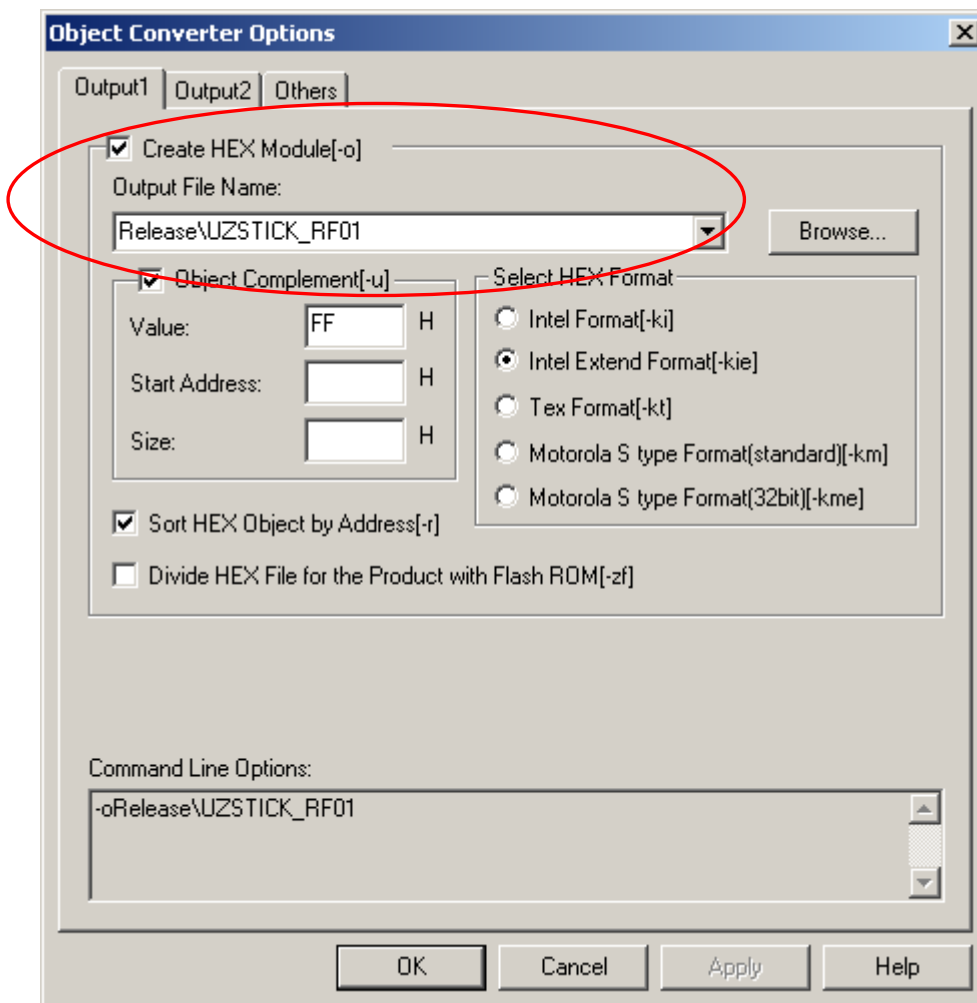
Please choose [Tools] -> [Object Converter Options] at the pull-down menu.

Please confirm the output of the hex object module file is set. The path of the output and the name of the hex file is,

Release\UZSTICK_RF01,

The hex format is the format to load an executable object code on to Flash EEPROM using the Flash programmer, PG-FPL3.

“01” in the name of the hex file, “UZSTICK_RF01” means the hex file was generated with the compiler option of MAC_ADDR=0x0001. Therefore, the stick, on which the UZSTICK_RF01.hex was loaded, carries the MAC short address of 0001.

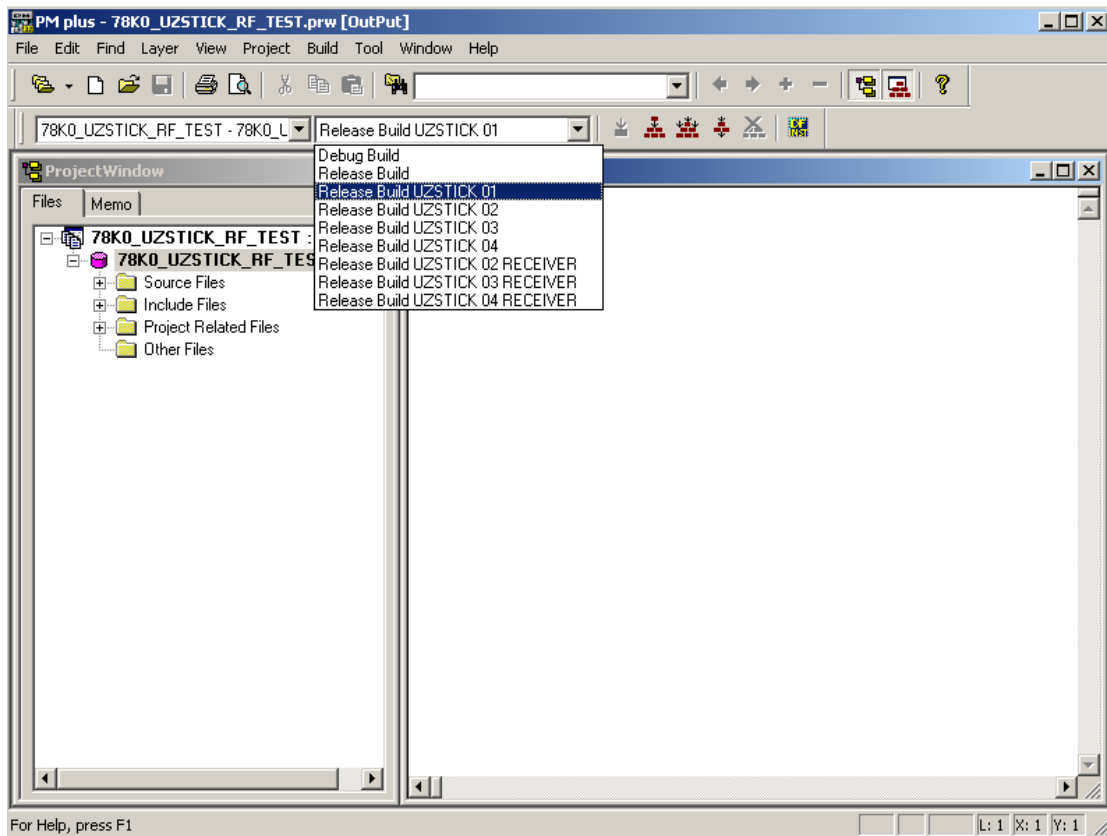


3.7 Build Mode and Compiler Option

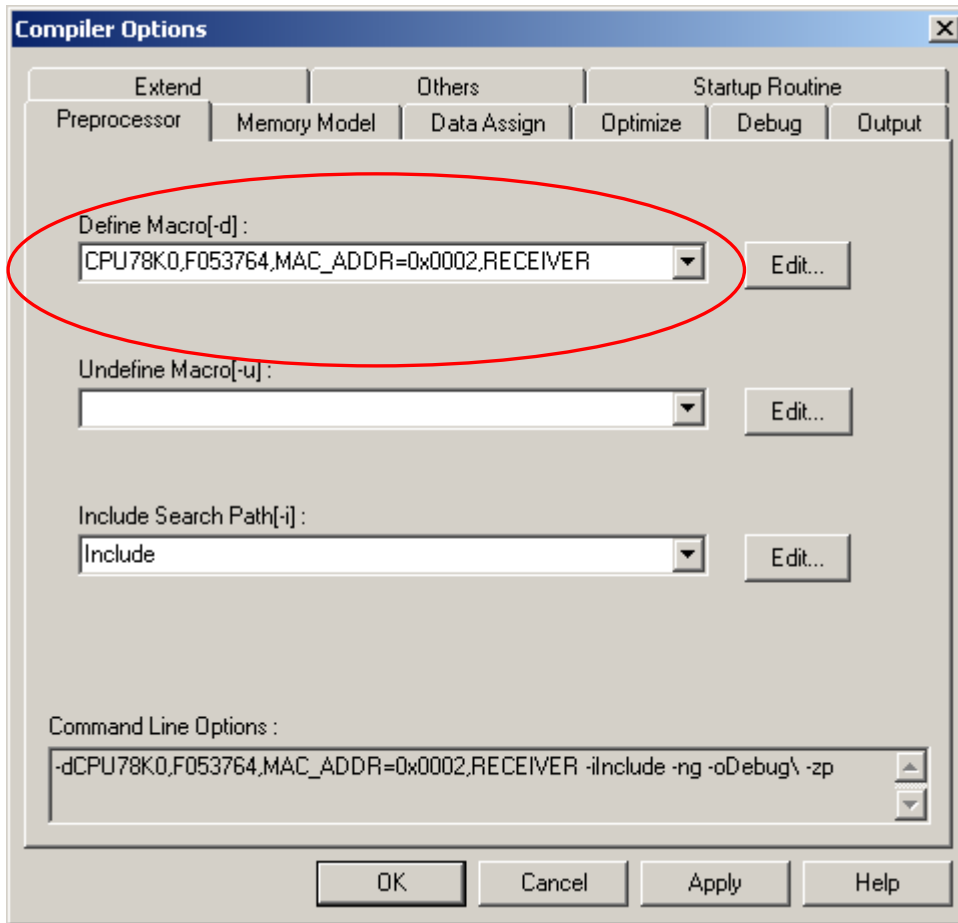
Please click the build mode tab as shown below.

You will find, in addition to “Release Build UZSTICK 01”, “Release Build UZSTICK 02”, “Release Build UZSTICK 03”, “Release Build UZSTICK 04”, “Release Build UZSTICK 02 RECEIVER”, “Release Build UZSTICK 03 RECEIVER”, and “Release Build UZSTICK 04 RECEIVER”. As previously explained, the numbers indicate MAC short addresses.

“RECEIVER” means the generated hex file is for a receiver. Operation of the RF Test program will be explained later.



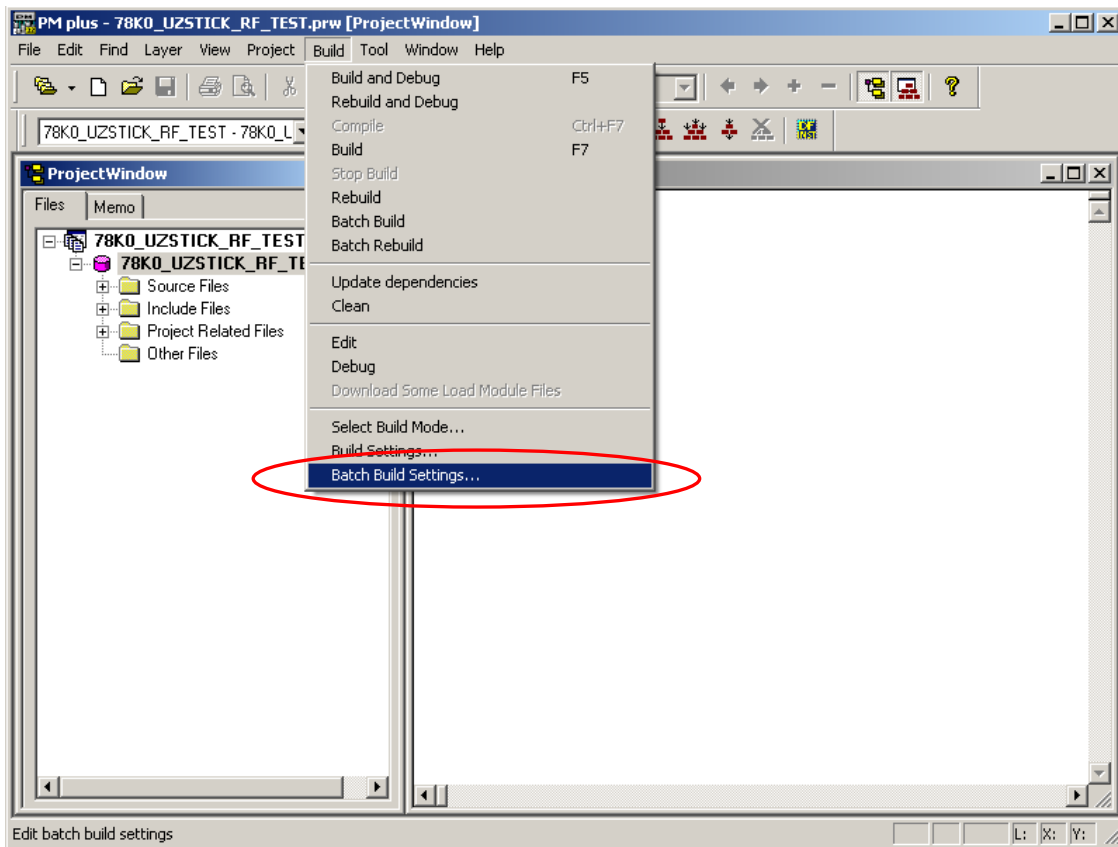
Each build mode is linked to its unique compiler option and hex file. For instance, if you choose “Release Build UZSTICK 02 RECEIVER”, you will find “CPU78K0,F053764,MAC_ADDR=0x0002,RECEIVER” as the defined macro of the compiler option, and “Release/UZSTICK_RF02_RECEIVER” at the output path of the hex file in the Object Converter Options. as shown below.



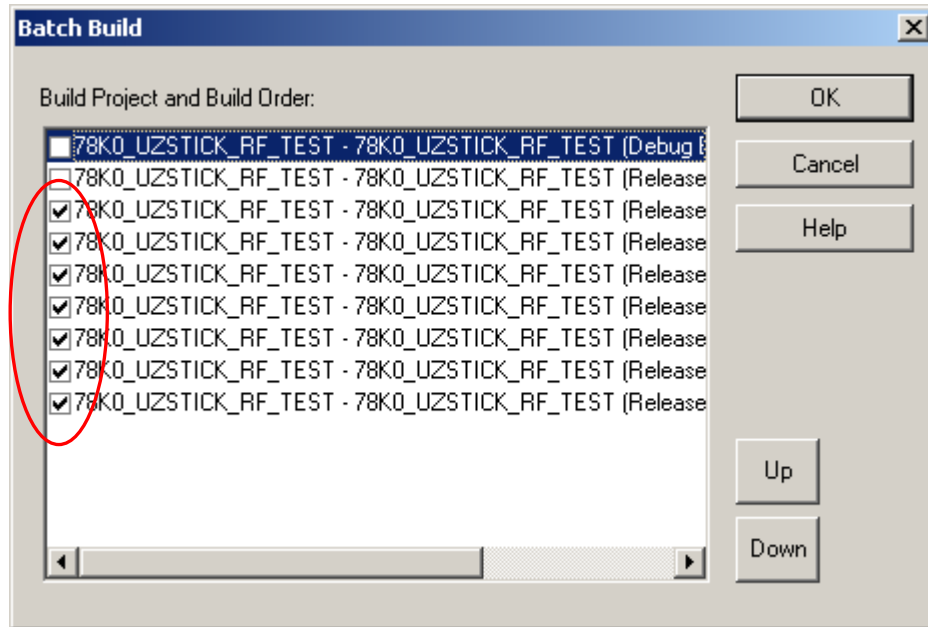
3.8 How to make hex files

If you modify the source code and wish to make new hex files, please follow steps explained here.

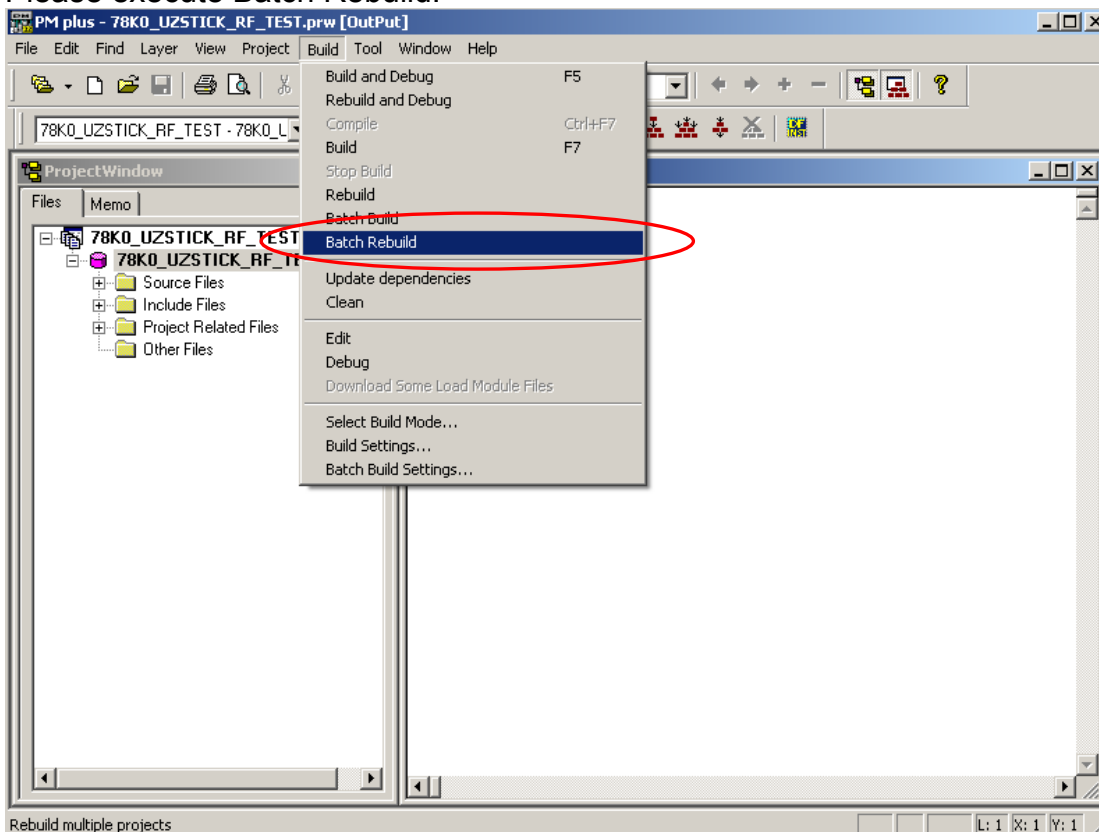
Please click the “Build” menu, and select “Batch Build Setting”.



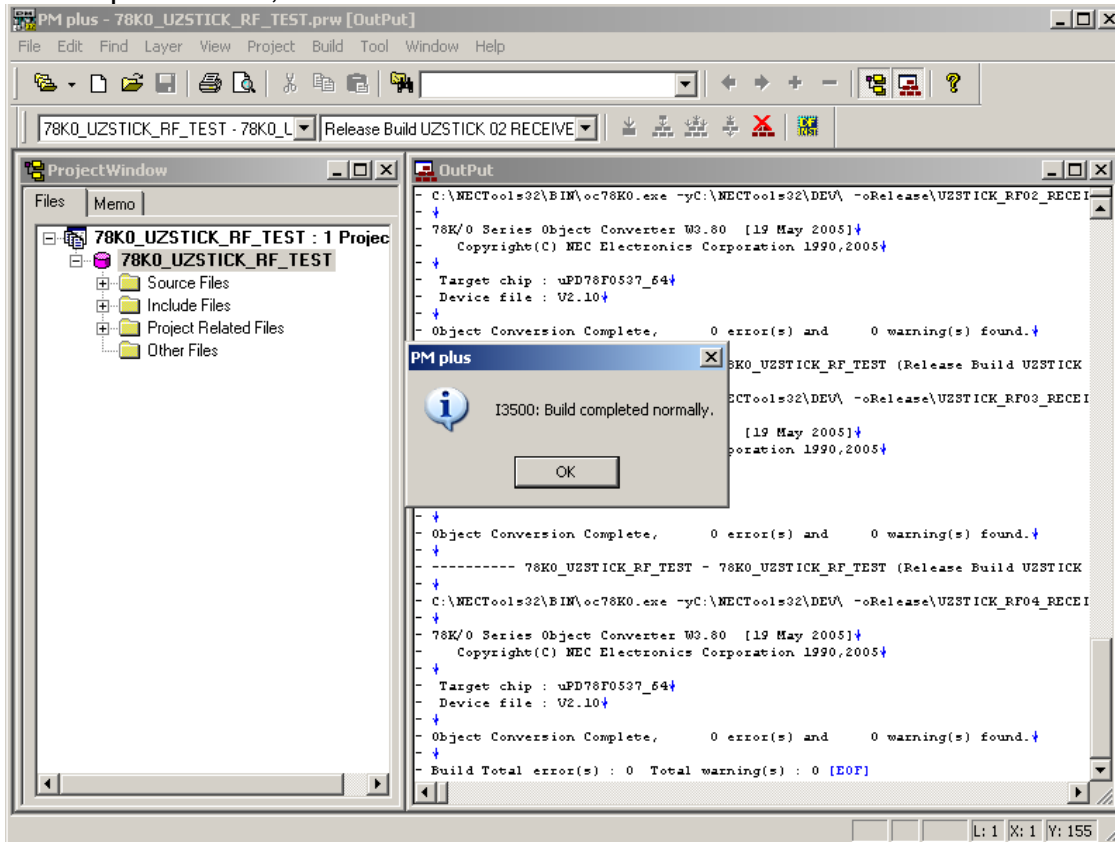
Please select the seven build modes, in which you want to make hex files, as shown below.
(Release Build UZSTICK 01~04、 Release Build UZSTICK 02~04 RECEIVER)



Please execute Batch Rebuild.



After a while, Batch Rebuild will be completed. Please confirm no build errors in the Output window, as shown below.

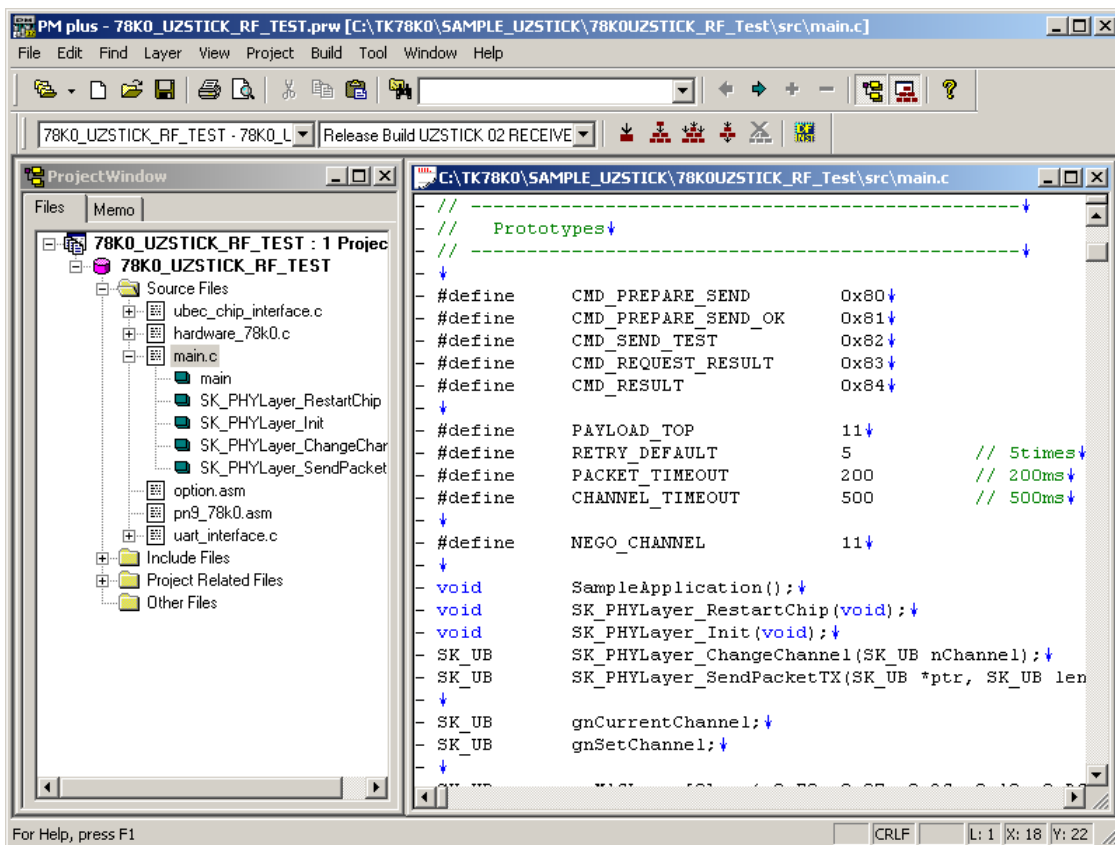


In this example, please find the 7 hex files at the directory of C:\TK78K0\SAMPLE_UZSTICK\78K0_UZSTICK_RF_Test\Release as shown below.

- UZSTICK_RF01.hex
- UZSTICK_RF02.hex
- UZSTICK_RF02_RECEIVER.hex
- UZSTICK_RF03.hex
- UZSTICK_RF03_RECEIVER.hex
- UZSTICK_RF04.hex
- UZSTICK_RF04_RECEIVER.hex

3.9 How to modify the source code and define a new build mode

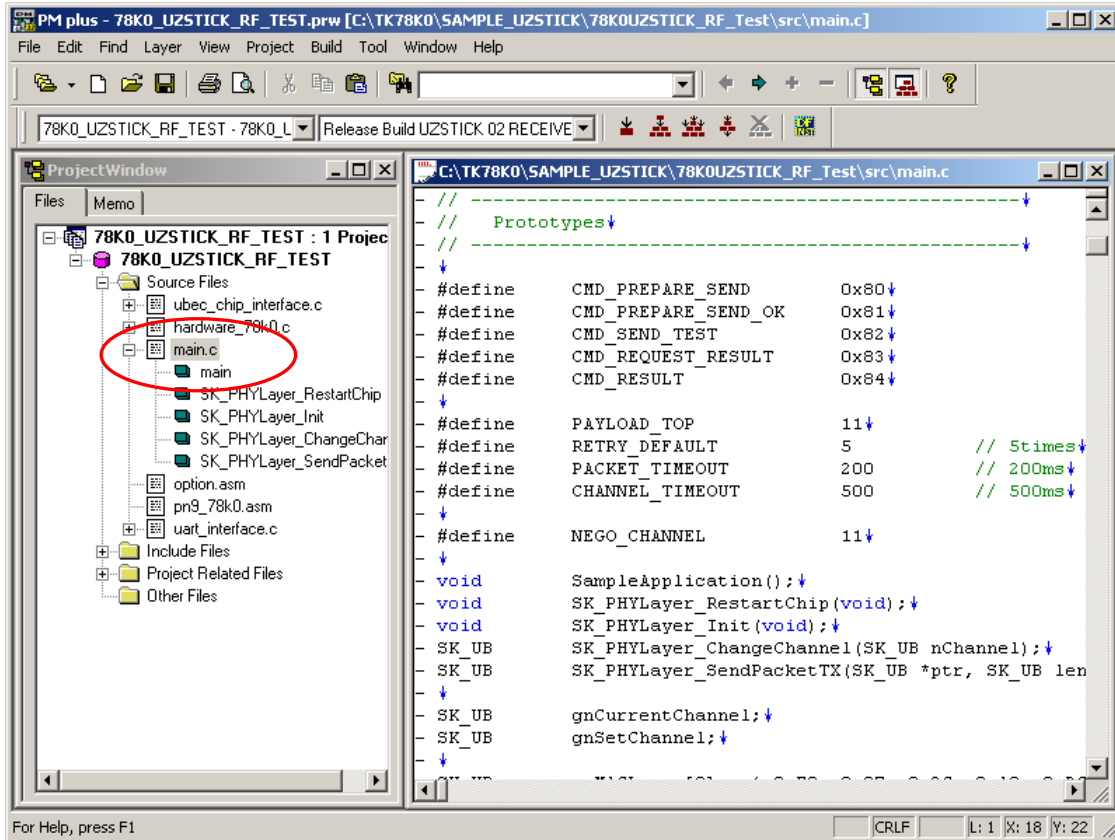
Please click “Source File” in the Project Window. You will see the list of C source files, as shown below.

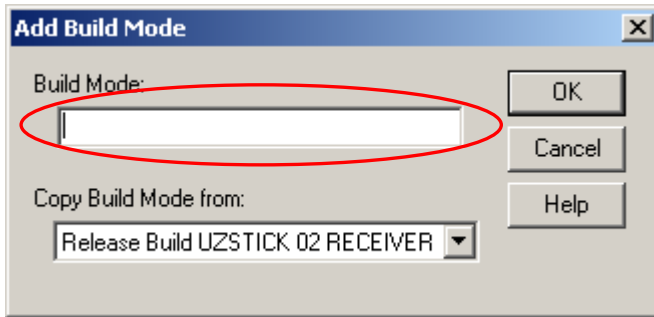


Please double click the C source file, which you intend to modify. You will see the new text window of the C source file, as shown below.

Please edit it with your favorite text editor, and, then, save it to the original location at

“C:\TK78K0\SAMPLE_UZSTICK\78K0UZSTICK_RF_Test\src” with the original name.





Please input the name of the new build mode.
Then, for the new build mode, please set the options in the compiler, linker, and object converter with the new name of the new hex file. Then, you will execute the new build to create the new hex file.

4 How to use PG-FPL3

PG-FPL3 is a software Flash EEPROM programmer, working on MS Windows. PG-FPL3 enables you to program your application program file of hex format in the Flash EEPROM, embedded on the 78K0/KE2 microcontroller in the 78K0 UZ Stick, via the USB interface of the stick. You do not need any hardware, additionally to your PC and the 78K0 UZ Stick, to make the programming.

4.1 Installation of PG-FPL3

Please set the CD-ROM in your PC.

Please find "setup.exe" at "/FPL3/FPL3_V110", then, execute it.

4.2 How to use PG-FPL3

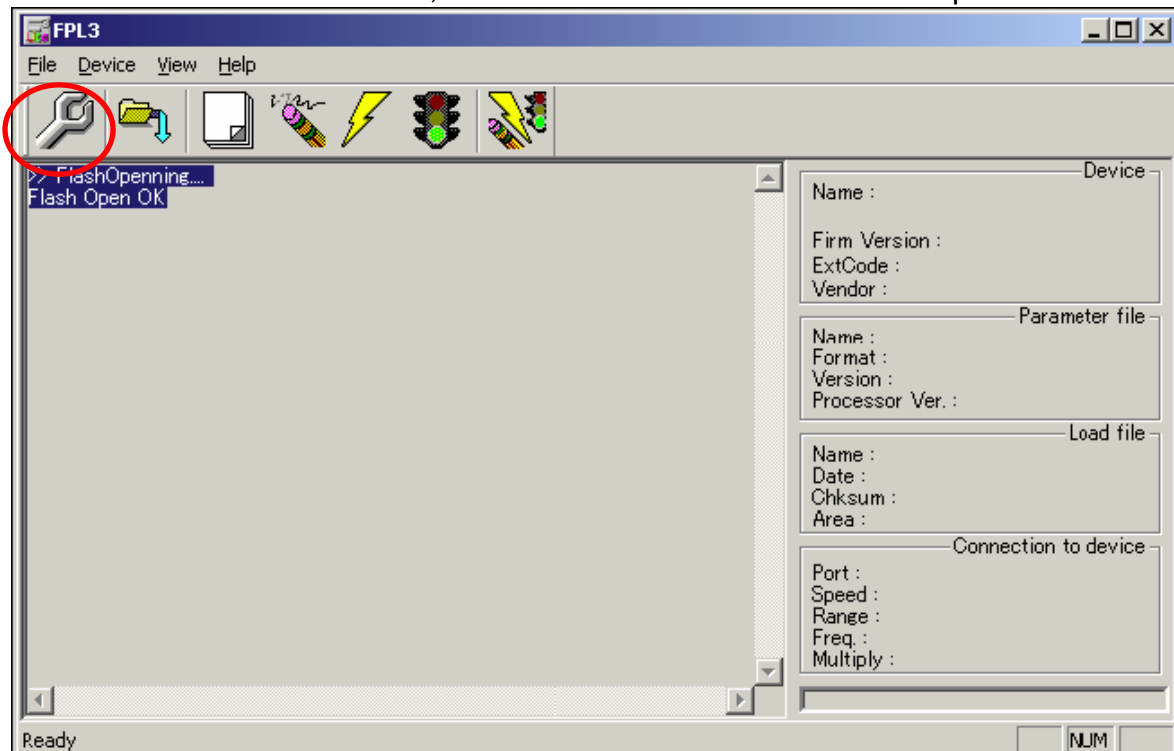
Please keep the CD-ROM in your PC.

Please remove the expansion connector from the 78K0 UZ Stick, set the power switch to USB, set the FLMD0 switch to H.

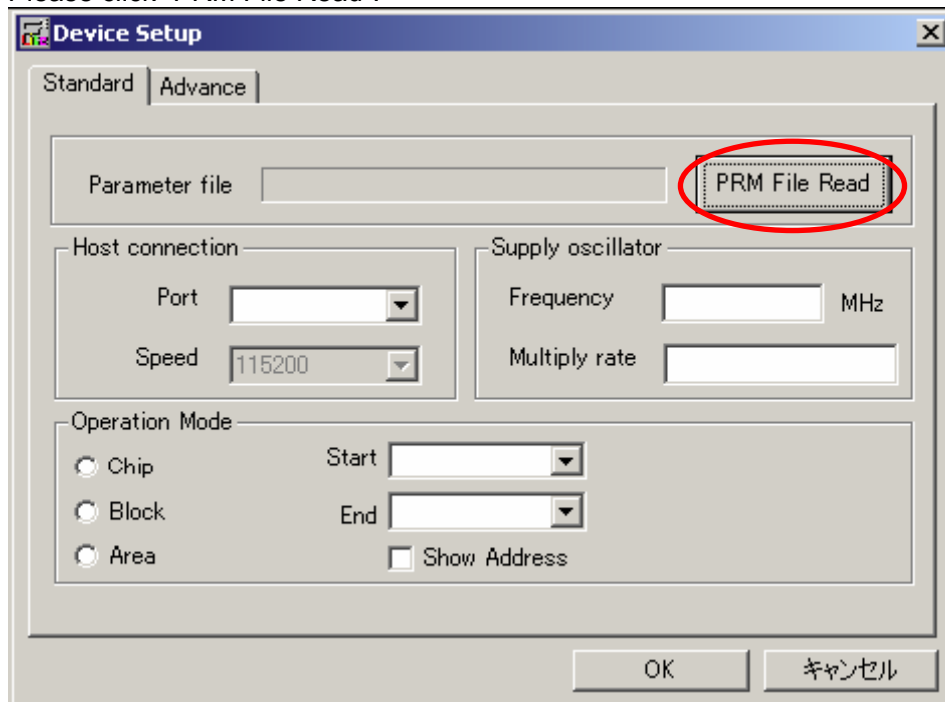
Now, you insert the 78K0 UZ Stick to your PC. Then, confirm the green LED.

Please select PG-FPL3 at [Programs] -> [NEC Tools32] -> [PG-FPL3].

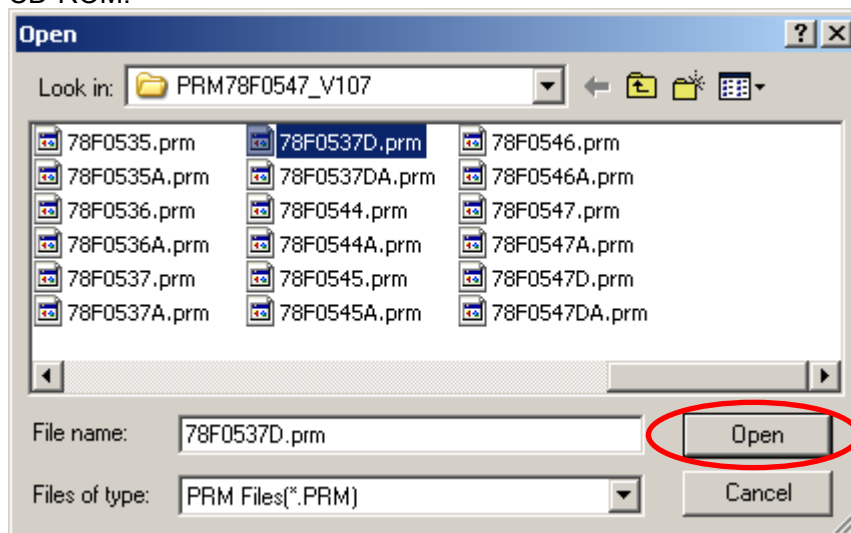
You will see the main window, as shown below. Please click "Setup".



You will see the setup window, shown below.
Please click “PRM File Read”.



Please select “78F0537D.prm” in the directory of “PRM/PRM78F0547_V107” in the CD-ROM.

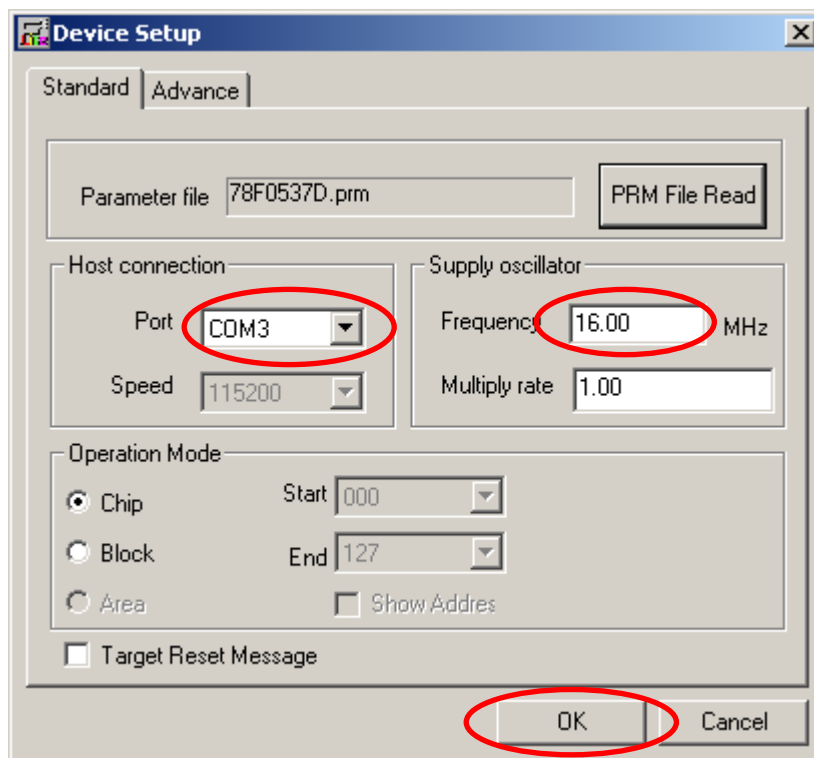


Then, "Port" is to be selected. You will choose the number of the COM port, where the 78K0 UZ Stick is inserted. If you do not know the COM port number, please go to Control Panel -> System -> Device Manager to find something like "USB Serial Port (COMx)".

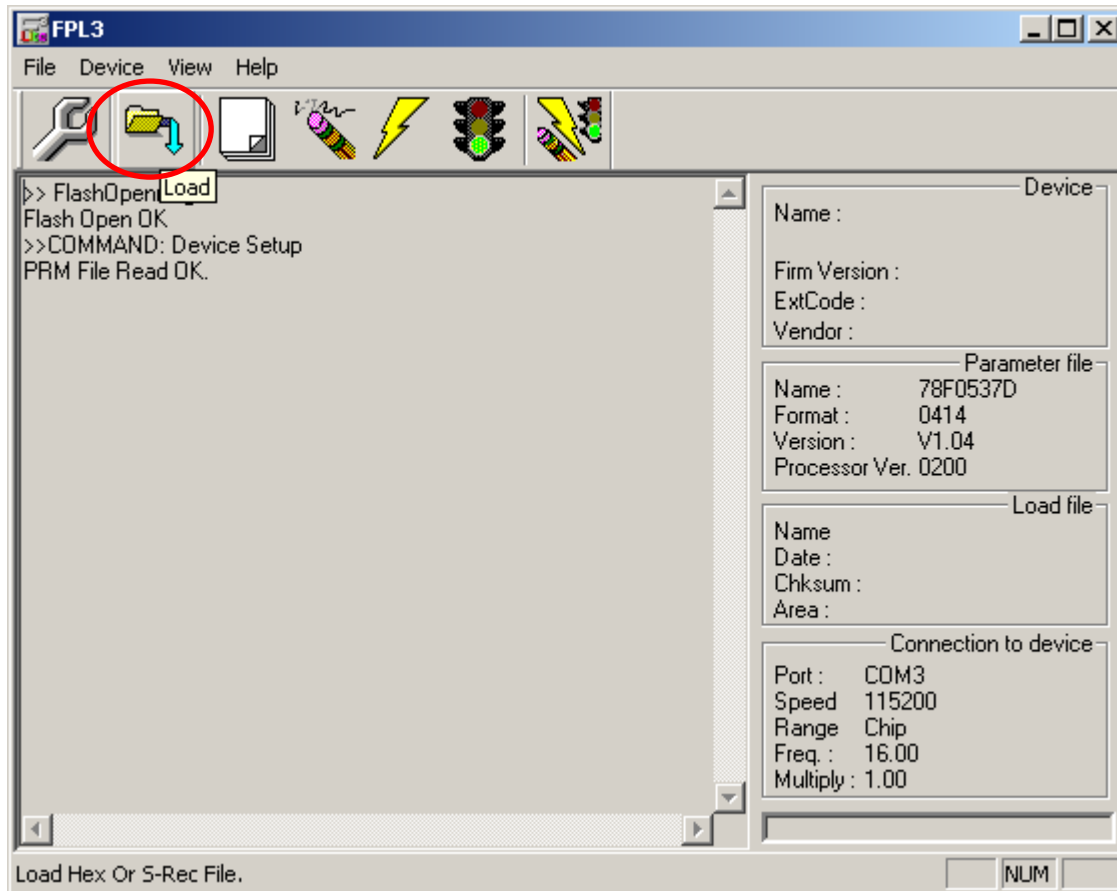
In this particular case, it is "3". The number may be another one, depending on a PC or a USB terminal.

Please select your COM port number in the pull-down menu. The pull-down menu displays all of available COM ports in your PC.

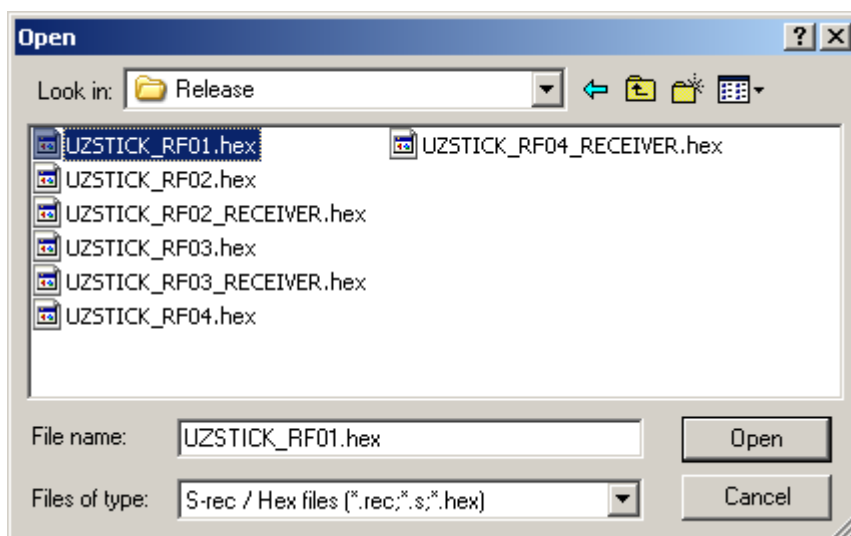
Please set "16.00" in the "Frequency", then, press OK.



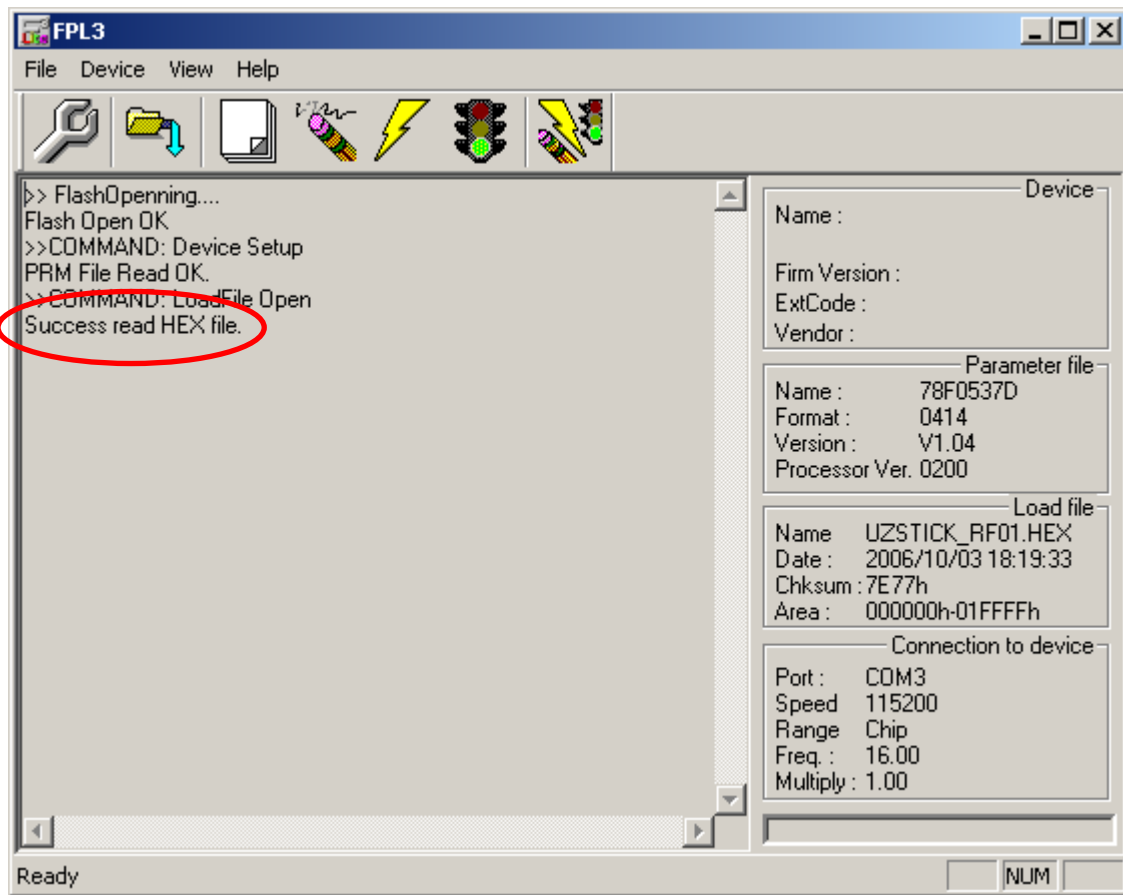
The next action is the loading of the hex file to the PG-FPL3. Please click “Load”.



In this example, “UZSTICK_RF01.hex”, found at “C:¥TK78K0¥SAMPLE_UZSTICK¥78K0UZSTICK_RF_Test¥Release”, is loaded.



If everything goes well, you will see a message of “Success read HEX file”, as shown below.

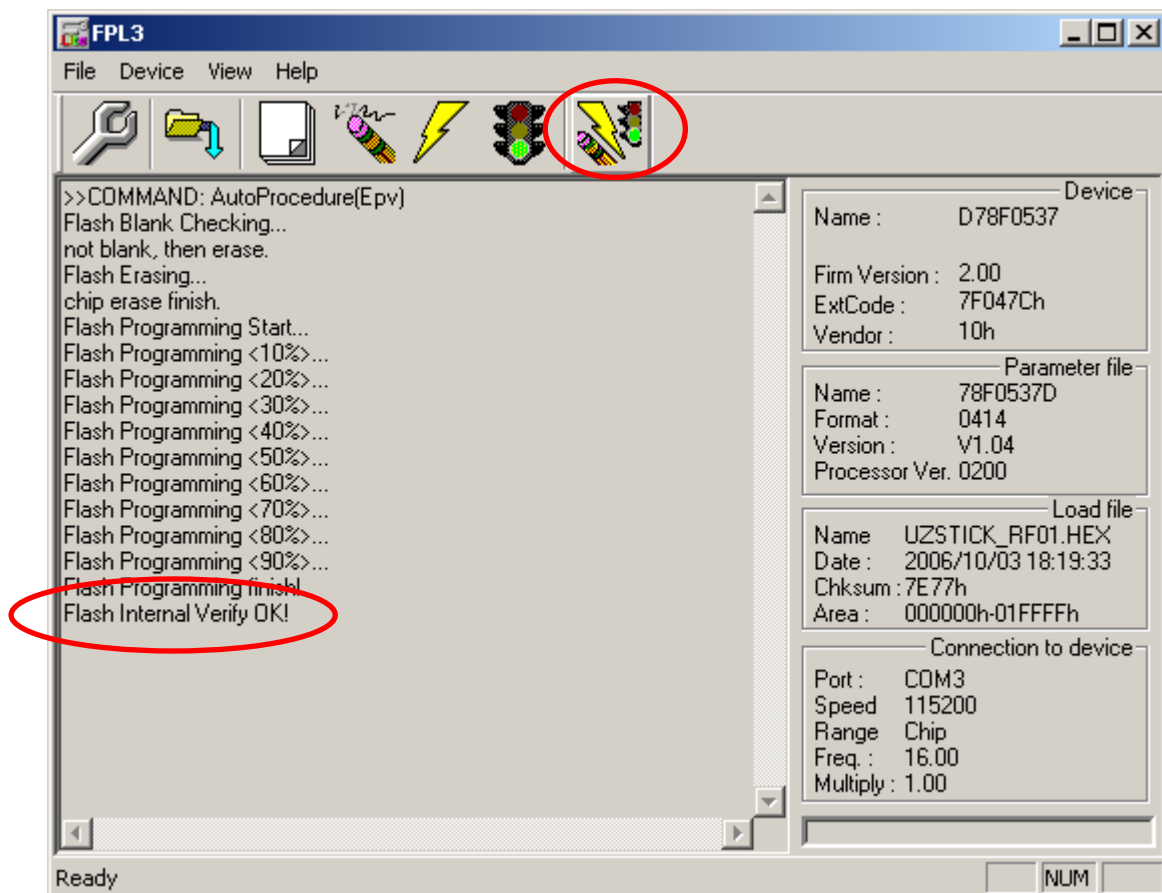


Then, if you click “Auto procedure”, erasing, programming, and verification are executed. Alternatively, you can execute erasing, programming, and verification, one by one by clicking the three buttons located at the left of the “Auto procedure” button.

If you see “Flash internal Verify OK!”, your program has been successfully loaded in the Flash EEPROM.

Then, you can disconnect the 78K0 UZ Stick from your PC.

Now, you will program the hex file in the second, or possibly third, and more sticks.



5 RF Test Program

The RF test program is developed to provide with functions to support conformance tests to the IEEE 802.15.4 PHY standard and regulations, such as, ETSI EN 300 328, and Japan's radio regulation 38-2-1-1-5/ Table 42. 2-1-19.

The RF test program supports,

1. The transmitter mode in the PER, Packet Error Rate, test with RSSI MAX/MIN values
2. The receiver mode in the PER test with a hex file for a receiver.
3. Continuous emission of modulated RF
4. Continuous emission of the carrier RF
5. Setting the RF chip to the receive mode
6. Setting the RF chip to the IDLE mode
7. Setting the RF chip to the sleep mode
8. Setting the RF chip to the standby mode
9. Setting a RF channel
10. Setting register values manually
11. Reset of the RF chip

To utilize the RF test program, you need to prepare at least one PC with a USB interface and two 78K0 UZ Sticks.

5.1 Procedure for one to one transmit/receive test

1). Assumption here in this section is, you have two 78K0 UZ Sticks. In one of them, the “UZSTICK_RF01.hex” file was programmed.

This is a transmitter.

In the other one, the “UZSTICK_RF02_RECEIVER.hex” file was programmed.

This one is a receiver. Additionally you have one PC with USB interface and hyper-terminal, and one 006 type 9V battery.

2). The latter stick, you designated as a receiver, sends back the test result to the transmitter.

The receiver can work without PC, but with a battery to power up the stick.

Please set the FLMD0 switch to “L”, and the POWER switch to “BAT”.

Then, please connect the expansion connector with a battery cable.

Then, please connect a 006P battery to the battery cable.

Please confirm green light of an LED, which indicates availability of power.

Now the receiver is ready waiting for an instruction from the transmitter for the one to one test.

3). Now, please pick up the stick, you designated as a transmitter.

Please set the FLMD0 to L, and the POWER switch to USB.

Then, please insert it into USB connector of your PC.

Please confirm the POWER LED being green.

Then, please identify the COM port number of the USB connector in your PC at [Control Panel] → [System]

4). Hyper Terminal

On MS-Windows in your PC, please select [All Programs] -> [Accessory] -> [Communication] -> [HyperTerminal]

Setting of Hyperterminal

Bits per second	19200
Data bits	8
Parity	None
Stop bits	1
Flow control	None

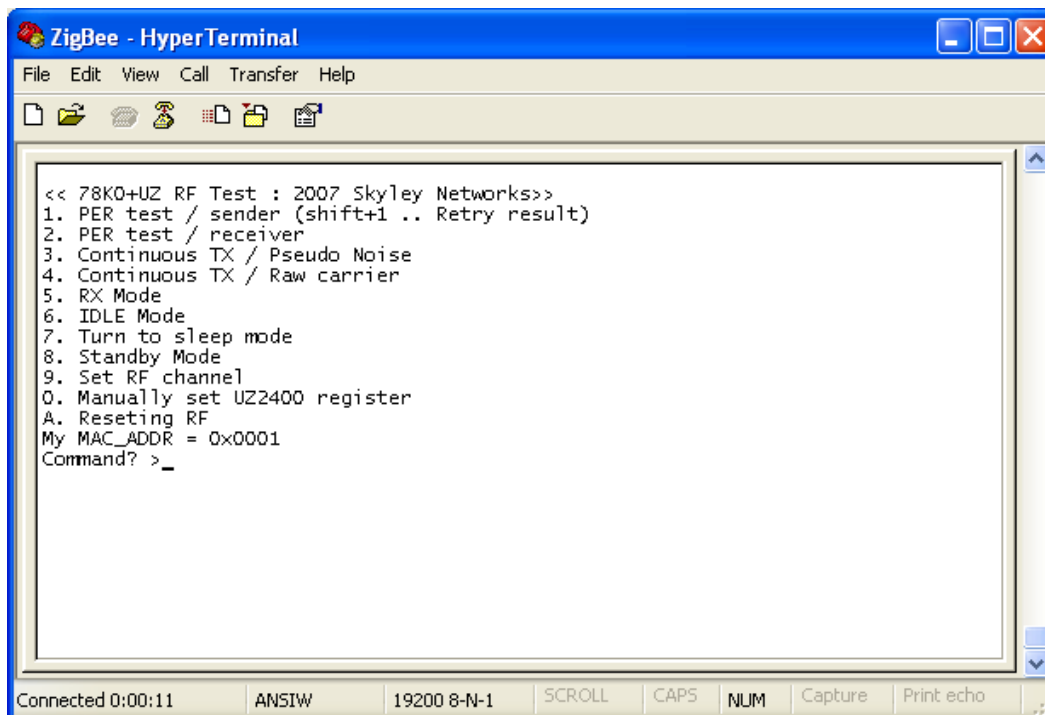
(Property -> Setting -> ASCII)

Local Echo OFF

No Line Feed

Press [ENTER] on your keyboard.

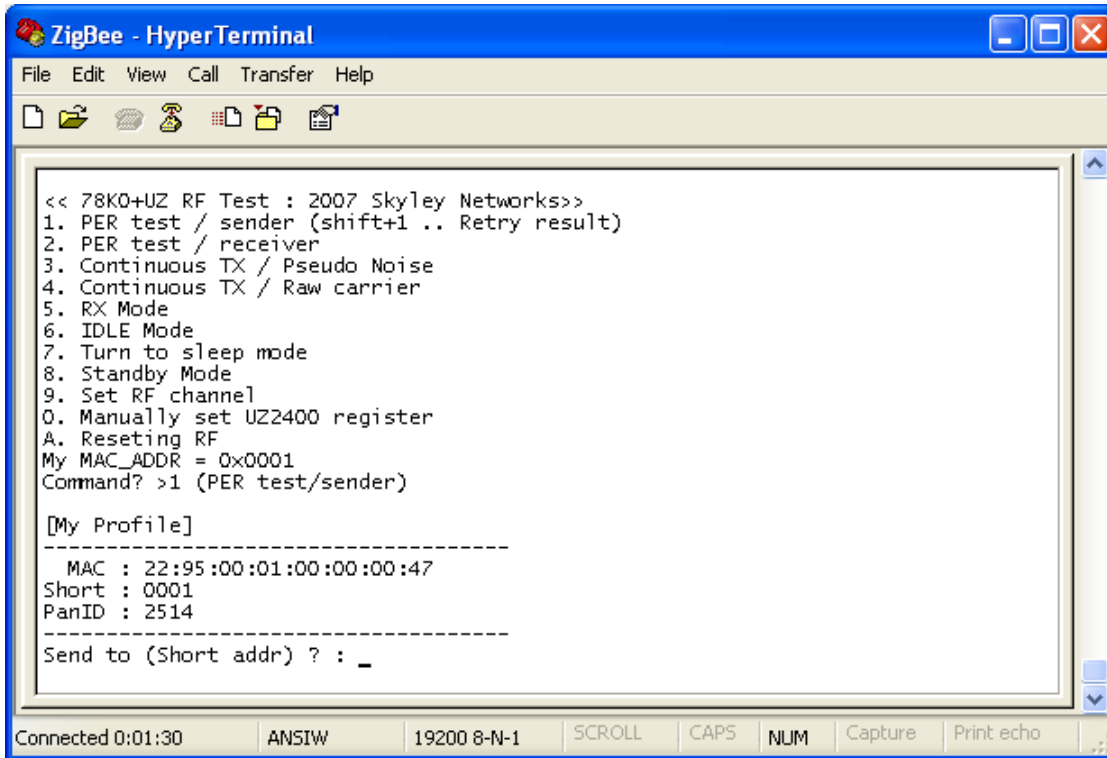
Now you will find the following opening menu in the window.



```
<< 78K0+UZ RF Test : 2007 Skyley Networks>>
1. PER test / sender (shift+1 .. Retry result)
2. PER test / receiver
3. Continuous TX / Pseudo Noise
4. Continuous TX / Raw carrier
5. RX Mode
6. IDLE Mode
7. Turn to sleep mode
8. Standby Mode
9. Set RF channel
0. Manually set UZ2400 register
A. Resetting RF
My MAC_ADDR = 0x0001
Command? >_
```

5). Execution of the Transmit/Receive Test

To initiate the PER test, please press 1 in the menu. You will see [My Profile], then, be asked for the destination of the PER test, as shown below.



```
<< 78K0+UZ RF Test : 2007 Skyley Networks>>
1. PER test / sender (shift+1 .. Retry result)
2. PER test / receiver
3. Continuous TX / Pseudo Noise
4. Continuous TX / Raw carrier
5. RX Mode
6. IDLE Mode
7. Turn to sleep mode
8. Standby Mode
9. Set RF channel
0. Manually set UZ2400 register
A. Resetting RF
My MAC_ADDR = 0x0001
Command? >1 (PER test/sender)

[My Profile]
-----
MAC : 22:95:00:01:00:00:47
Short : 0001
PanID : 2514
-----
Send to (Short addr) ? : _
```

Now, please input "0002".

Then, you will be asked how many packets you wish to consume in the PER test.

You may input "1000".

Then, you will be asked the interval of packets in msec.

You may input 10 msec.

Then, the PER test will be executed.

You will see,

the number of packets sent, that is, 1000 as you input,

the number of the received packets,

the calculated PER in %

and the maximum and minimum RSSI values in the PER test.

[Note] PER= Packet Error Rate, RSSI= Received Signal Strength Indication

```
ZigBee - HyperTerminal
File Edit View Call Transfer Help
PanID : 2514
-----
Send to (Short addr) ? : 0002
Send count (dec) ? : 1000
Interval (dec/msec) ? : 3
[Set channel to 11 (Cmd)]
Prepare to send..OK
[Set channel to 11 (Current)]
Request to result..OK

[Results]
-----
From : 0001
To : 0002
-----
Sent : 1000
Recieved : 1000
PER : 0.0000%
RSSI : max FF / min FF
-----
Press any key to the menu
-
Connected 0:00:57  ANSIW  19200 8-N-1  SCROLL  CAPS  NUM  Capture  Print echo
```

RSSI is expressed in the hexagonal value of 256 levels, which indicates the signal strength in the received signal. For more details of the RSSI value, please refer to the datasheet of the UZ2400 RF chip.

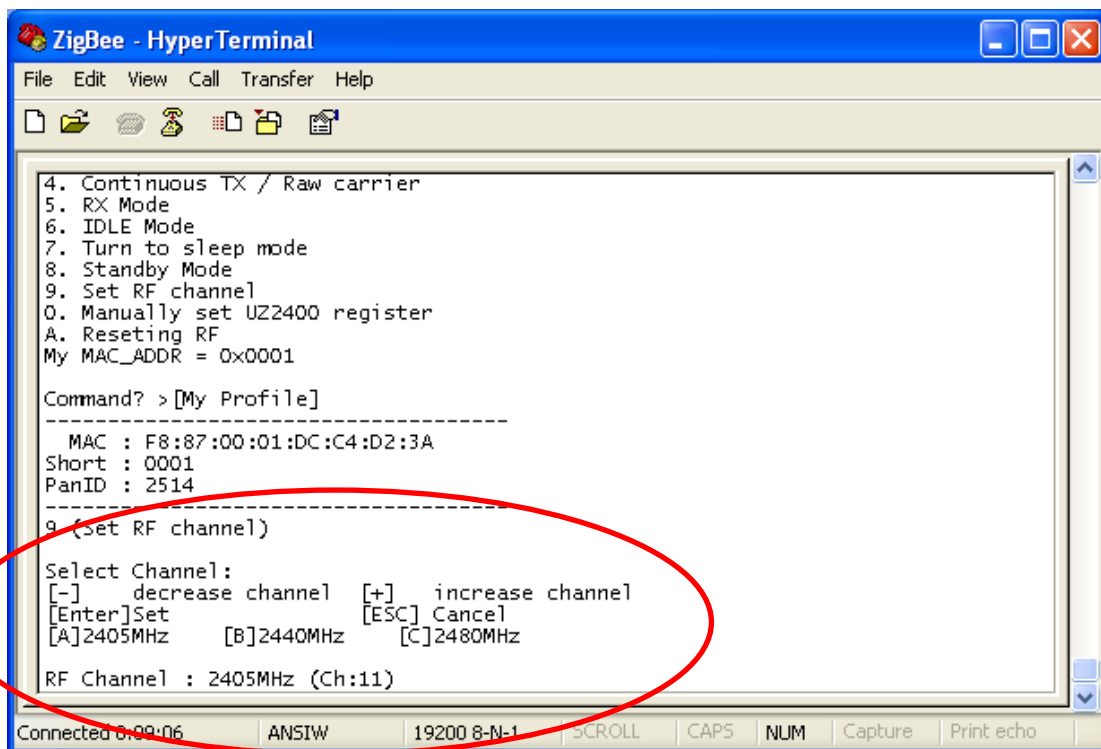
Please note the PER and the RSSI are measured at the receiver side. The receiver does not send back the test packets, but only the test result.

6). Channel setting

In the previous example, you may have also found the RF channel used in this test is the Channel 11. The channel is specified by the IEEE 802.15.4 specification.

The channel 11 is assigned at 2405 MHz. The default setting is the channel 11. You can change the channel in the PER test in 5MHz step to the maximum channel of 26th at 2480 MHz.

To do it, please press “9” in the command prompt. Then, please choose the channel by [+], [-], [A], [B], or [C]. In the example below, the channel 23th, 2465 MHz, was selected.



```
ZigBee - HyperTerminal
File Edit View Call Transfer Help
-----
4. Continuous TX / Raw carrier
5. RX Mode
6. IDLE Mode
7. Turn to sleep mode
8. Standby Mode
9. Set RF channel
0. Manually set UZ2400 register
A. Resetting RF
My MAC_ADDR = 0x0001

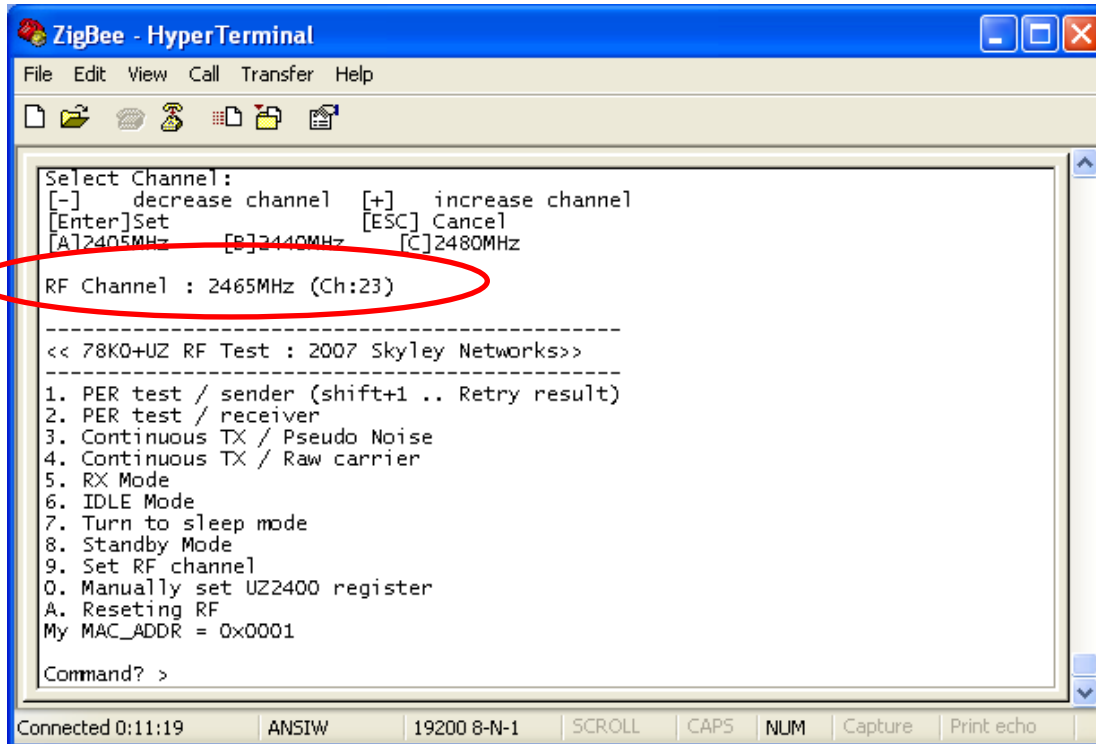
Command? > [My Profile]
-----
MAC : F8:87:00:01:DC:C4:D2:3A
Short : 0001
PanID : 2514
-----
9 (Set RF channel)

Select Channel:
[-] decrease channel  [+] increase channel
[Enter]Set           [ESC] Cancel
[A]2405MHz          [B]2440MHz          [C]2480MHz

RF Channel : 2405MHz (Ch:11)

Connected 0:09:06  ANSIW  19200 8-N-1  SCROLL  CAPS  NUM  Capture  Print echo
```

To execute the PER test at the channel 23, press [Enter] in your keyboard, then, choose "1" to initiate the PER test mode. Then, you may input 1000 packet in 5 msec interval to see the following example. Please confirm the channel used is 23th in the display. Please note the receiver will learn which channel is to be used for the test automatically.



```

ZigBee - HyperTerminal
File Edit View Call Transfer Help
[Icons]
Select Channel:
[-] decrease channel [+] increase channel
[Enter]Set [ESC] Cancel
[A]2405MHz [B]2440MHz [C]2480MHz
RF Channel : 2465MHz (Ch:23)
-----
<< 78K0+UZ RF Test : 2007 Skyley Networks>>
-----
1. PER test / sender (shift+1 .. Retry result)
2. PER test / receiver
3. Continuous TX / Pseudo Noise
4. Continuous TX / Raw carrier
5. RX Mode
6. IDLE Mode
7. Turn to sleep mode
8. Standby Mode
9. Set RF channel
0. Manually set UZ2400 register
A. Reseting RF
My MAC_ADDR = 0x0001
Command? >
-----
Connected 0:11:19 ANSIW 19200 8-N-1 SCROLL CAPS NUM Capture Print echo
```

7). Adjusting the output power

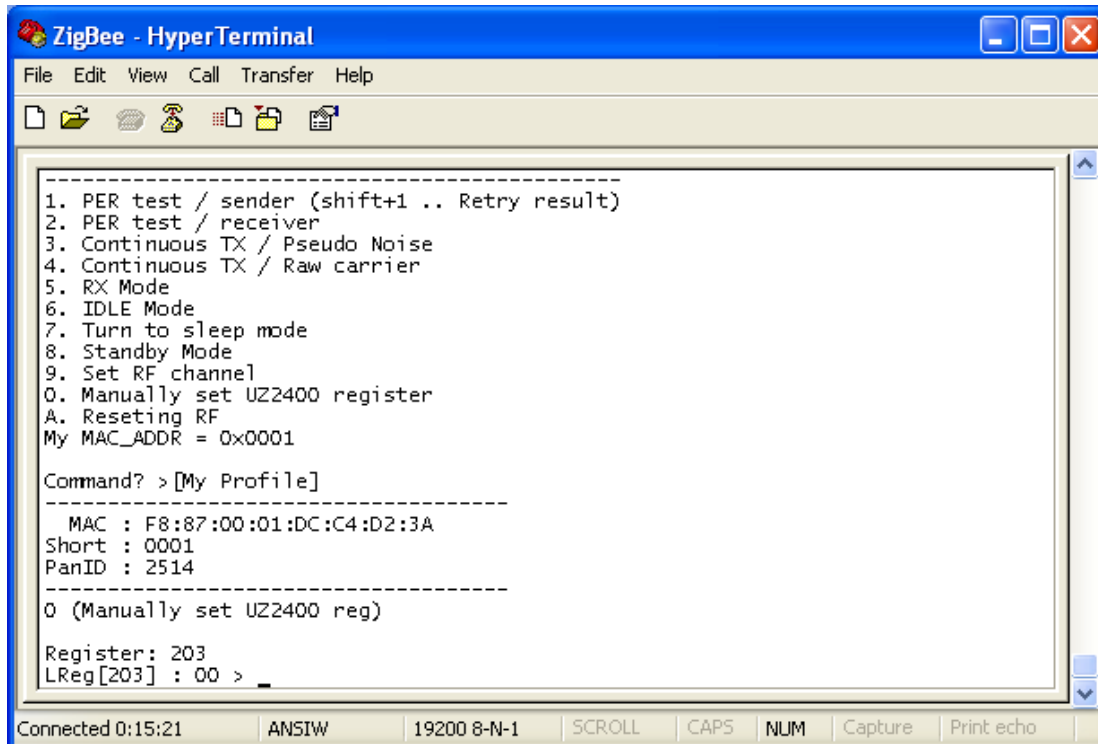
You may wish to control the output power in the PER test.

For it, please select “0” in the menu.

You will be asked the register ID. Please input “203”.

Then you will see, “LREG[203] : 00 >”.

It means the current value at the register [203] is 0x00h, which means 0 dB. 0x00h is the reset default.



```
ZigBee - HyperTerminal
File Edit View Call Transfer Help
-----
1. PER test / sender (shift+1 .. Retry result)
2. PER test / receiver
3. Continuous TX / Pseudo Noise
4. Continuous TX / Raw carrier
5. RX Mode
6. IDLE Mode
7. Turn to sleep mode
8. Standby Mode
9. Set RF channel
0. Manually set UZ2400 register
A. Resetting RF
My MAC_ADDR = 0x0001

Command? > [My Profile]
-----
MAC : F8:87:00:01:DC:C4:D2:3A
Short : 0001
PanID : 2514
-----
0 (Manually set UZ2400 reg)

Register: 203
LReg[203] : 00 > _
-----
Connected 0:15:21  ANSIW  19200 8-N-1  SCROLL  CAPS  NUM  Capture  Print echo
```

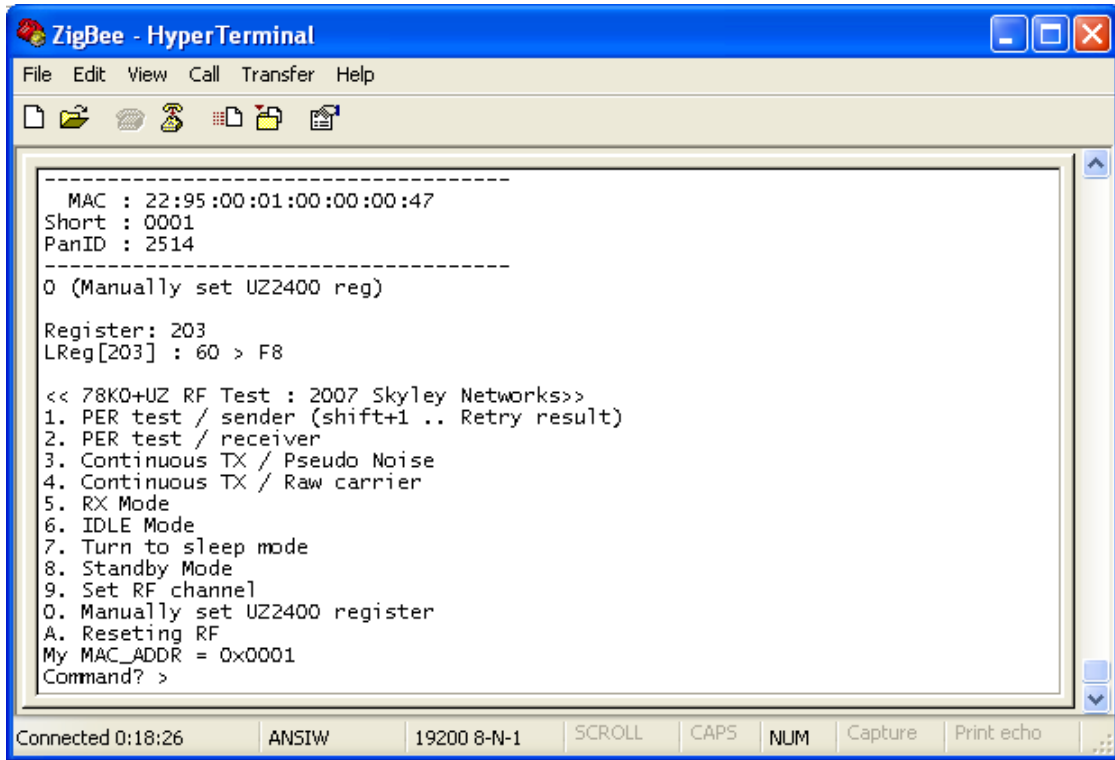
The register bits are defined as follows,
LREG[203]:

[7:6] -> large scale tuning
00: 0 dB
01: -10 dB
10: -20 dB
11: -30 dB
[5:3] -> small scale tuning
000: 0 dB
001: -1.25 dB
010: -2.5 dB
011: -3.75 dB
100: -5 dB
101: -6.25 dB
110: -7.5 dB
111: -8.75 dB
[2:0] -> 000

For instance, if you wish -15 dB, please input "60", as follows,
"LREG[203] : 00 > 60"
Then, you will start the PER test.

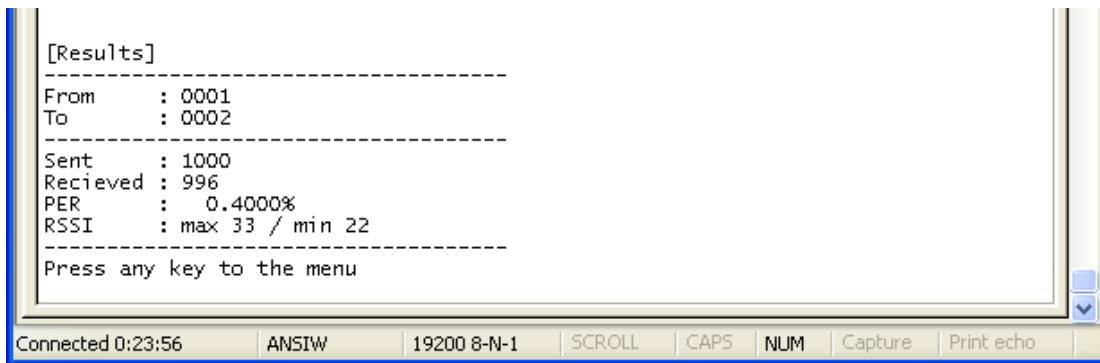
```
MAC : 22:95:00:01:00:00:47
Short : 0001
PanID : 2514
-----
0 (Manually set UZ2400 reg)
Register: 203
LReg[203] : 00 > 60
<< 78K0+U2 RF Test : 2007 Skyley Networks>>
1. PER test / sender (shift+1 .. Retry result)
2. PER test / receiver
3. Continuous TX / Pseudo Noise
4. Continuous TX / Raw carrier
5. RX Mode
6. IDLE Mode
7. Turn to sleep mode
8. Standby Mode
9. Set RF channel
0. Manually set UZ2400 register
A. Resetting RF
My MAC_ADDR = 0x0001
Command? >_
```

The minimum output power is set by “F8”.



```
ZigBee - HyperTerminal
File Edit View Call Transfer Help
-----
MAC : 22:95:00:01:00:00:47
Short : 0001
PanID : 2514
-----
O (Manually set UZ2400 reg)
Register: 203
LReg[203] : 60 > F8
<< 78K0+UZ RF Test : 2007 Skyley Networks>>
1. PER test / sender (shift+1 .. Retry result)
2. PER test / receiver
3. Continuous TX / Pseudo Noise
4. Continuous TX / Raw carrier
5. RX Mode
6. IDLE Mode
7. Turn to sleep mode
8. Standby Mode
9. Set RF channel
O. Manually set UZ2400 register
A. Resetting RF
My MAC_ADDR = 0x0001
Command? >
Connected 0:18:26 ANSIW 19200 8-N-1 SCROLL CAPS NUM Capture Print echo
```

You may find larger PER value with smaller RSSI value in this case.



```
[Results]
-----
From : 0001
To : 0002
-----
Sent : 1000
Recieved : 996
PER : 0.4000%
RSSI : max 33 / min 22
-----
Press any key to the menu
Connected 0:23:56 ANSIW 19200 8-N-1 SCROLL CAPS NUM Capture Print echo
```

Please note this adjustment is applied only to the transmitter. The receiver always sends back the test results with the 0 dB output power using the channel 11th.

5.2 **PER test / receiver**

The Menu 2 sets the board to the receiver in the PER test. If you have two PCs, you can connect two sticks to PCs, then, you will apply this mode to one of them..

5.3 **Continuous TX / Pseudo Noise**

The Menu 3 initiates the modulated RF transmission. The data carried are pseudo random numbers. You can define the channel using the menu 9, and the output power using the menu 0.

5.4 **Continuous TX / Raw carrier**

The Menu 4 initiates the carrier transmission. The output power is not 0 dB as a reset default. You can define the channel using the menu 9.

5.5 **RX Mode**

The Menu 5 initiates the receiver mode.

5.6 **IDLE MODE**

The Menu 6 sets the UZ2400 into the IDLE mode.

5.7 **Sleep MODE**

The Menu 7 sets the UZ2400 into the Deep Sleep mode.

5.8 **Standby MODE**

The Menu 8 sets the UZ2400 into the Standby mode.

5.9 Set RF channel

The Menu 9 allows you to set the RF channel.

5.10 Manually set UZ2400 register

The Menu 0 allows you to set the UZ2400 registers.
Please refer to the datasheet of the UZ2400 RF chip for the definition of registers.

5.11 Resetting RF

The Menu A allows you to reset the UZ2400 registers.

6 IEEE 802.15.4 MAC Sample Program

The MAC Sample program was developed to provide with a simple example to construct a star network utilizing the IEEE 802.15.4 PHY/MAC standard.

The MAC Sample Program offers,

- 1). Designation of a network coordinator in a star configuration
- 2). Text chat between a coordinator and an end device

To use the MAC Sample Program, you need to prepare at least two PC with a USB interface or a PC with two USB interface and two 78K0 UZ Sticks.

The hex files allow you to immediately program to your 78K0 UZ Sticks using the PG-FPL3 Flash EEPROM programmer, and start the sample application. The hex files are available at

`"C:\TK78K0\SAMPLE_UZSTICK\78K0UZSTICK_MAC_Sample\Release"`

Or, if you wish to tailor the sample program to meet your specific needs, you can edit the source code, re-compile it with release build to generate a hex file, then, you can load the hex file on to the 78K0 UZ stick using the Flash programmer PG-FPL3.

It supports text chat for one coordinator and 4 end devices at the maximum, if you prepare 5 sticks and 5 PCs.

6.1 Programming to the 78K0 UZ Stick

For chatting, please prepare minimum 2, or maximum 5 78K0 UZ Sticks.
You need identical numbers of PCs.

Some laptop PCs do not support full functionality of hyperterminal.
This software has been confirmed at
NEC MATE MY25XCZEG
and, NEC VERSAPRO VY10F/BH-M

Please program the hex files of 78K0_UZSTICK_MAC_Sample_01.hex,
_02.hex, _03.hex, _04.hex and _05.hex to each of your 78K0 UZ Sticks using
PG-FPL3.

The hex files are stored at 78K0_UZSTICK_MAC_SAMPLE/Release.

6.2 Setting up 78K0 UZ Stick to your PC

- 1). Please pick up one of your sticks.
- 2). Please set FLMD0 to L, and POWER to USB, then, please insert it to the PC.
You will see a green LED.
Then, please identify the COM port number of the USB in your PC
at [Control Panel] → [System]

- 3). Hyper Terminal

On MS-Windows in your PC, please select [All Programs] -> [Accessory] ->
[Communication] -> [HyperTerminal]

Setting of Hyperterminal

Bits per second	19200
Data bits	8
Parity	None
Stop bits	1
Flow control	None

(Property -> Setting -> ASCII)

Local Echo OFF

No Line Feed

Press [ENTER] on your keyboard.
You will find the following opening menu in the window.

```
-----  
78K0 UZ Stick MAC Application  
-----  
2006 Skyley Networks  
  
My MAC extended address  
= 123478019ABC0001  
  
Command? >
```

Then, press Enter,

```
[Help] -----  
My MAC extended address  
= 123478019ABC0001  
-----  
S: Send Message  
M: MLME Associate test  
C: Start Coordinator test  
-----  
Command? >
```

Please do the same for every pair of your sticks and PCs.

6.3 Designation of a coordinator

Now, you must decide which stick is a coordinator.
Go to a pair of PC and stick, which you wish to assign the coordinator tasks,
and press C.

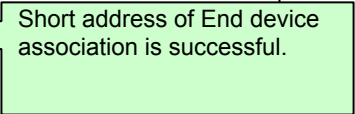
```
Command? >C  
  
> MLME-START.request  
> MLME-START.confirm  
> Status:00  
  
Command? >
```

Now the coordinator has started.

6.4 Network Association

For other PCs for other sticks, please press M.

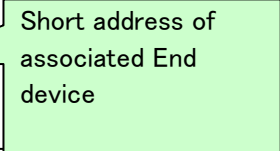
```
Command? >M  
  
> MLME-ASSOCIATE.request  
> MLME-ASSOCIATE.confirm  
> Associated ShortAddr:4321  
> Status:00  
  
Command? >
```



Now, this particular 78K0 UZ Stick was associated to the network as an end device with the short address of 4321.
Please repeat this step for your third, fourth, and possibly fifth 78K0 UZ Stick.

On the coordinator side, you will find the following message, if the association is successful.

```
Command? >
> MLME-ASSOCIATE.indication
> from 123478029ABC0001 associated to 4321
```



Short address of associated End device

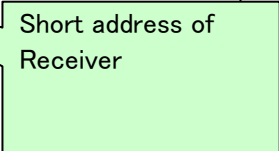
6.5 Text Chat

Now the network is prepared for you to start text chat between an end device and the coordinator.

At first, you may start with the coordinator.

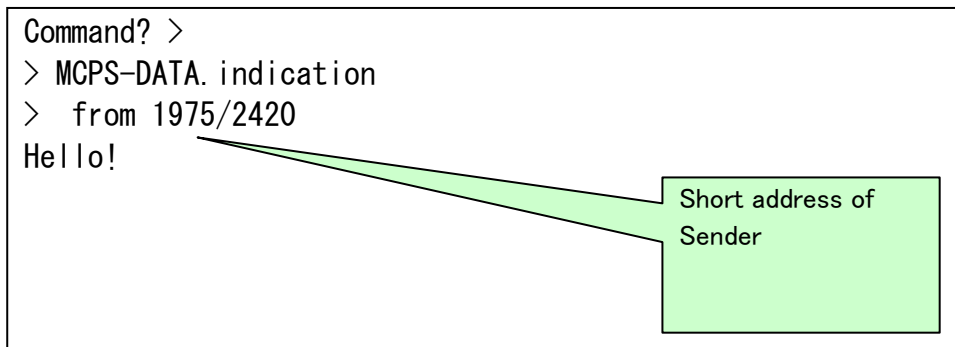
Press S, then input the short address of an end device, 4321 in this example, then, input your text message, up to 102 bytes.

```
Command? >S
> MCPS-DATA.request
> Send to (short address) ? 4321
> Message ? Hello!
Command? >
```



Short address of Receiver

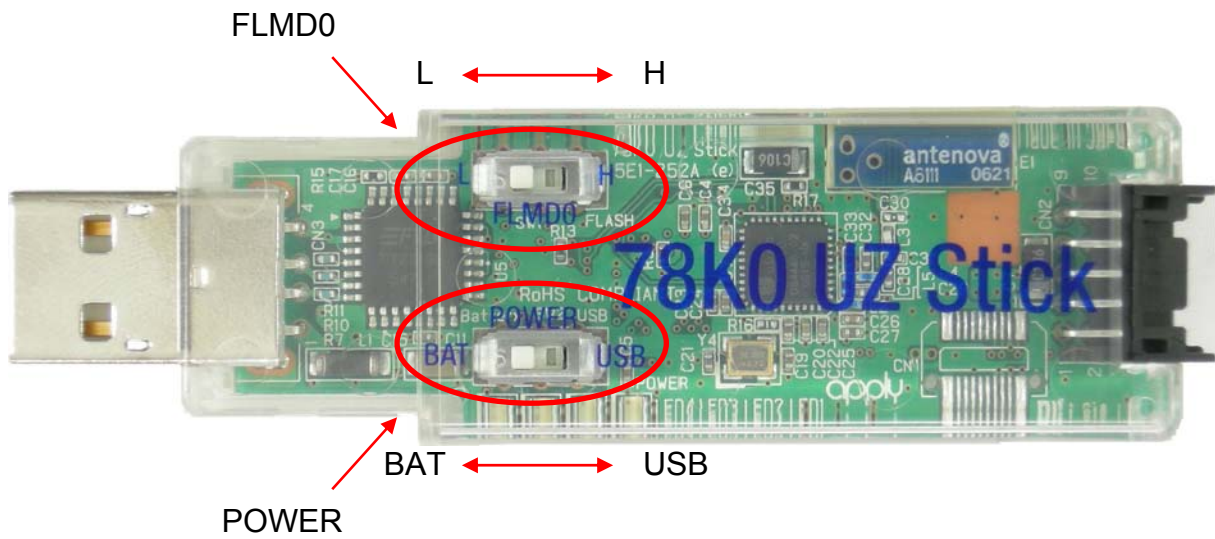
You will find the following message on the end device, 4321.
The sender's short address is "1975", and the PAN ID is 2420 in this example.



Now, you can reply from the end device "4321" to the coordinator "1975" by inputting S, 1975, and your reply text.

7 Mode setting of the 78K0 UZ Stick

The combination table of 78K0 UZ Stick is shown.



Usage case / Switch	Normal (USB Power Supply)	Normal (Battery Power Supply)	Flash memory writing
FLMDO	L	L	H
POWER	USB	BAT	USB

8 Revision History

Revision	Contents	Date
Rev. 1.0	Initial Version	September 25, 2006
Rev. 1.1	Correction	January 20,2007
Rev. 2.0	Corrections	March 1, 2007
Rev. 3.0	Correction about the sample program change.	July 3, 2007
Rev. 3.1	Correction about the operation procedure.	August 8, 2007
Rev. 4.0	Modification on IEEE 802.15.4 MAC Library	November 15, 2007
Rev. 5.0	Modification on IEEE 802.15.4 MAC Library	March 15, 2008