User's Manual

78K0R UZ Stick

ZigBee™-ready
Wireless Network Evaluation Board
Using the UZ2400 RF chip
and the 78K0R/KE3 Microcontroller

Tutorial

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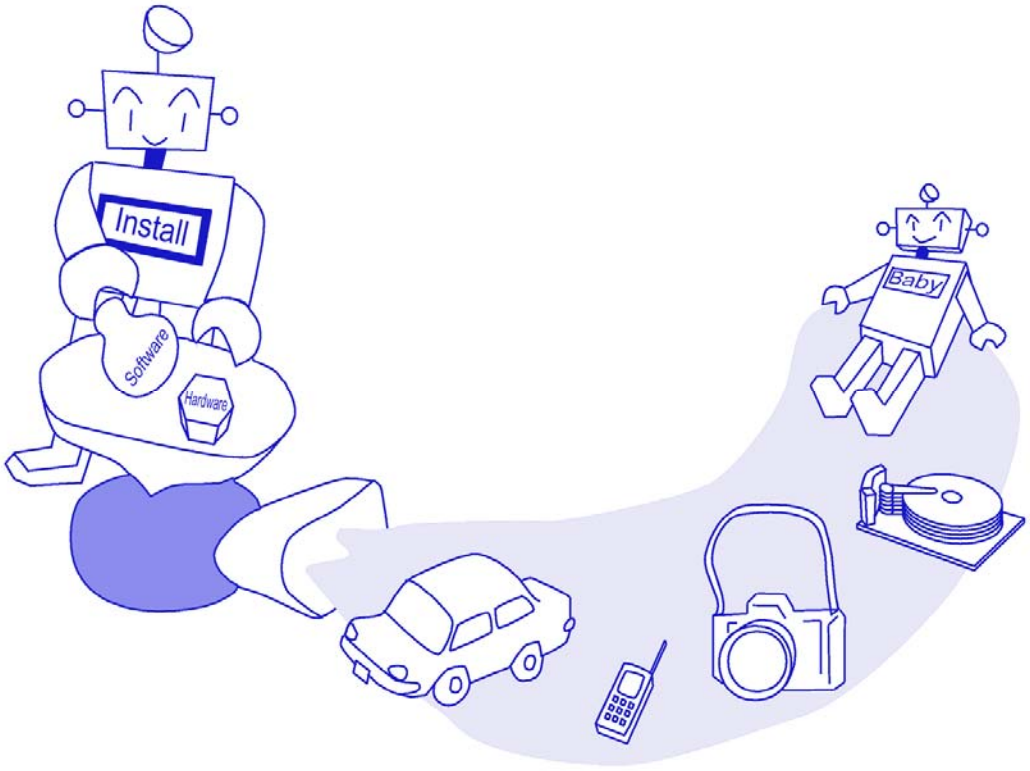
Welcome to the world of 78K0R UZ Stick.

You are now being navigated to the design environment of the 78K0R 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

Target Reader	Software development engineers who wish to become familiar with the development environment of the 78K0R 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.

Overview This manual consists of the following contents

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2 Preparations

This chapter introduces the development environment and describes how to install the sample programs. The sample program can be tested on this hardware platform of the evaluation kit.

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 + V6.30

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 DF781188 V3.00

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 CC78K0R W1.20 : Code size limited version

This is a free compiler for the 78K0R microcontrollers. The object code size is limited to 64 Kbytes. It works on MS Windows 2000 or XP.

2.1.4 Assembler RA78K0R W1.10 : Code size limited version

This is a free assembler for the 78K0R microcontrollers. The object code size is limited to 64 Kbytes. It works on MS Windows 2000 or XP. The RA78K0R Assembler Package contains Structured Assembler Preprocessor, Assembler, Linker, Object Converter, Librarian, and List Converter.

2.1.5 78K0R integrated debugger ID78K0R-QB V3.40

The Integrated Debugger ID78K0R-QB offers a debug environment on your PC, where the MS Windows 2000 or XP runs, if the 78K0R UZ Stick is connected to the PC with USB. The USB I/F accesses to the OCD, On Chip Debug, interface on the microcontroller.

2.1.6 78K0R Starter Kit Setting

If you forget about the security ID or if you set On-Chip Debug Option Byte to “disable on-chip debug function”, you can erase the flash memory by using this starter kit.

2.1.7 USB driver

This is a software driver for PC to access to the USB interface of the 78K0R UZ Stick.

2.1.8 The RF Test Program

The RF Test Program is used in [chapter 2 Experiences].

The RF Test Program is provided in the form of the C source codes.

If you wish to tailor the RF Test Program to meet your specific needs, you can edit the source code, re-compile it with debug build to generate a load module file, then, start the debugger to load the tailored execution code on to the microcontroller for further debugging on the project manager PM +.

Alternatively, if debugging is not required, you can make a release build to achieve a new hex file, on the project manager PM +.

As a general remark, please respect your local regulation of electro-magnetic emission. In general, it is suggested to use the 78K0R UZ Stick in a radio anechoic chamber.

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 is 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 78K0R UZ Stick.

The MAC Sample Program is provided in the form of the C source codes.

If you wish to tailor the sample program to meet your specific needs, you can edit the source code, re-compile it with debug build to generate a load module file, then, start the debugger to load the tailored execution code on to the microcontroller for further debugging on the project manager PM +. However, because the USB connection to instruct operation to the program is occupied for the debugging purpose,

alternatively, you can make a release build to achieve a new hex file, on the project manager PM +.

As a general remark, please respect your local regulation of electro-magnetic emission. In general, it is suggested to use the 78K0R UZ Stick in a radio anechoic chamber.

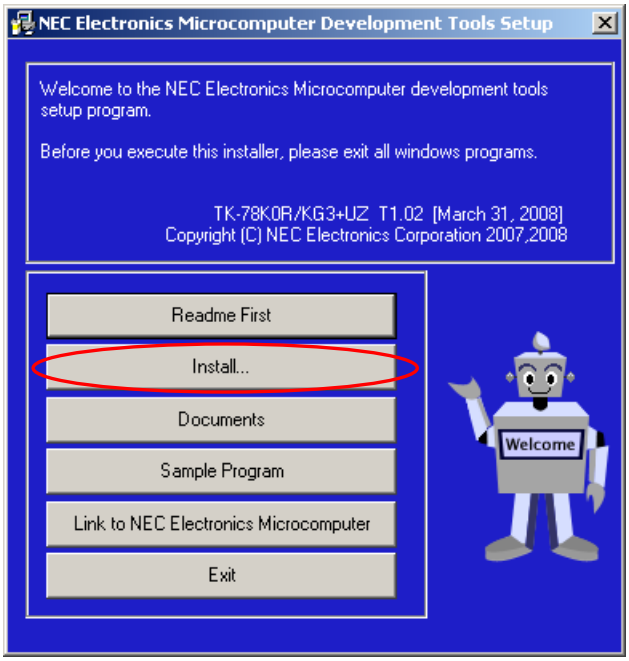
2.2 Installation of Software Development Tools

2.2.1 Start-up of the installation CD-ROM

The attached CD-ROM contains Development Tools, documents and sample soft ware.
You can install it using an installer.

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.

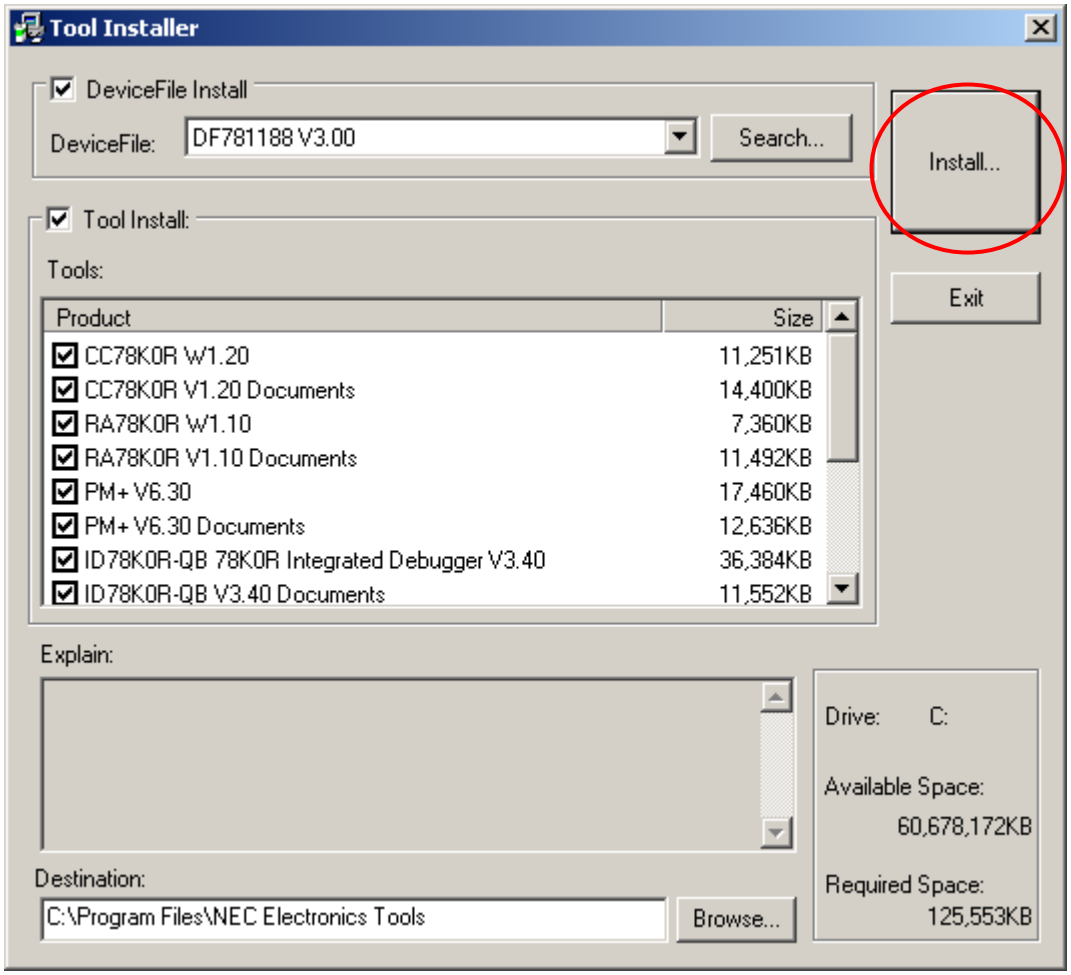
<6> Exit

Terminate the setup.

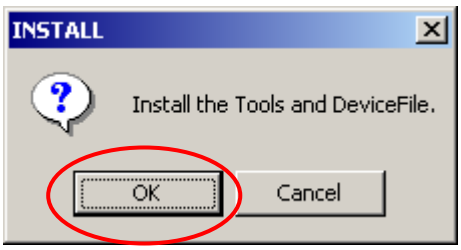
① Select products that you need to install.
(as default, all the products that you need to use the demostration kit are selected.)
"Explain" area displays an explanation of the selected product.
To change the installation destination, click Browse··· .

When all the settings are completed, click Install··· .

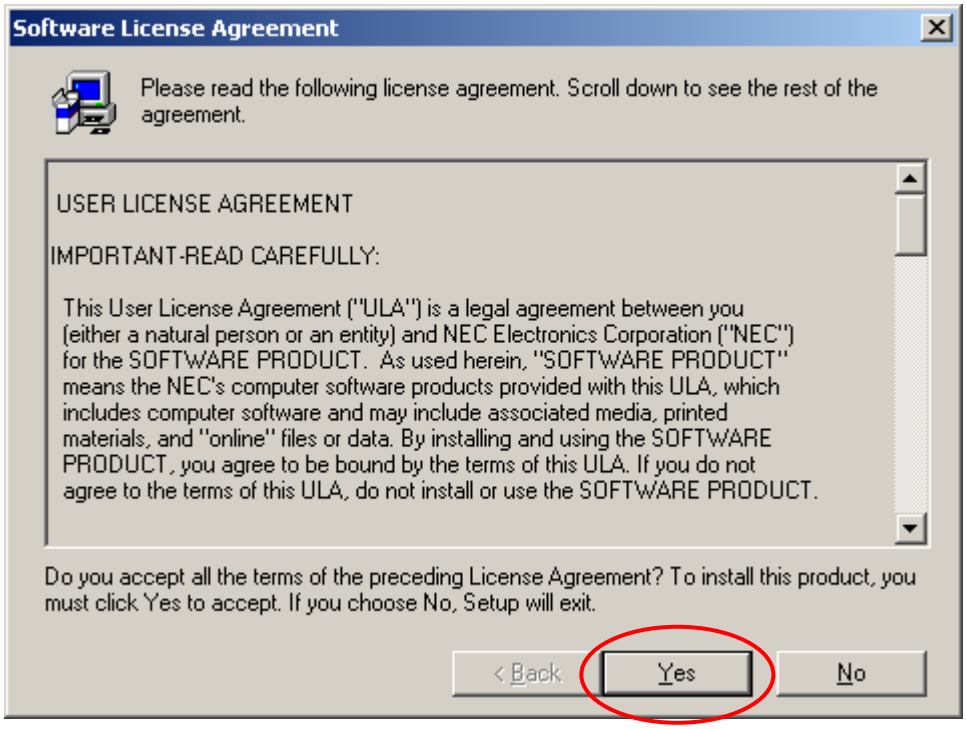
* In this document, it is assumed that users install the programs under "NEC Electronics Tools" directory (default installation directory). Users can find the tools by selecting “Start Menu” -> "Programs" -> "NEC Electronics Tools".



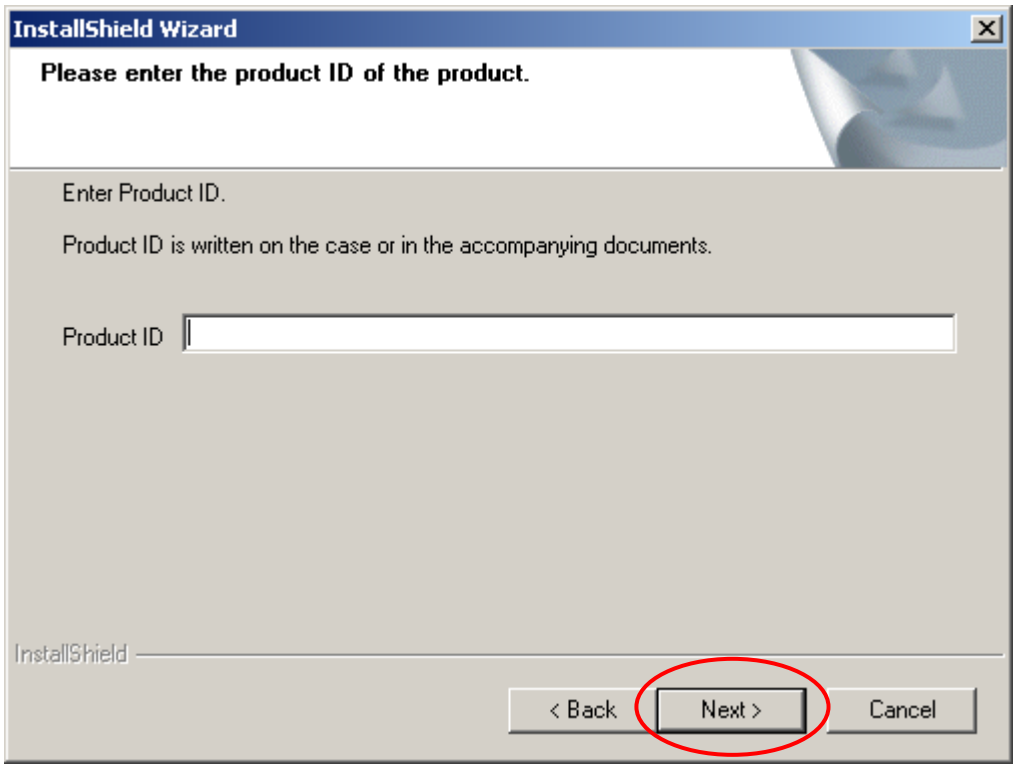
② Click OK when "Install" confirmation dialog box is opened.



③ Read "software license agreement" and click Yes for continuing the installation. To stop the installation, click No .

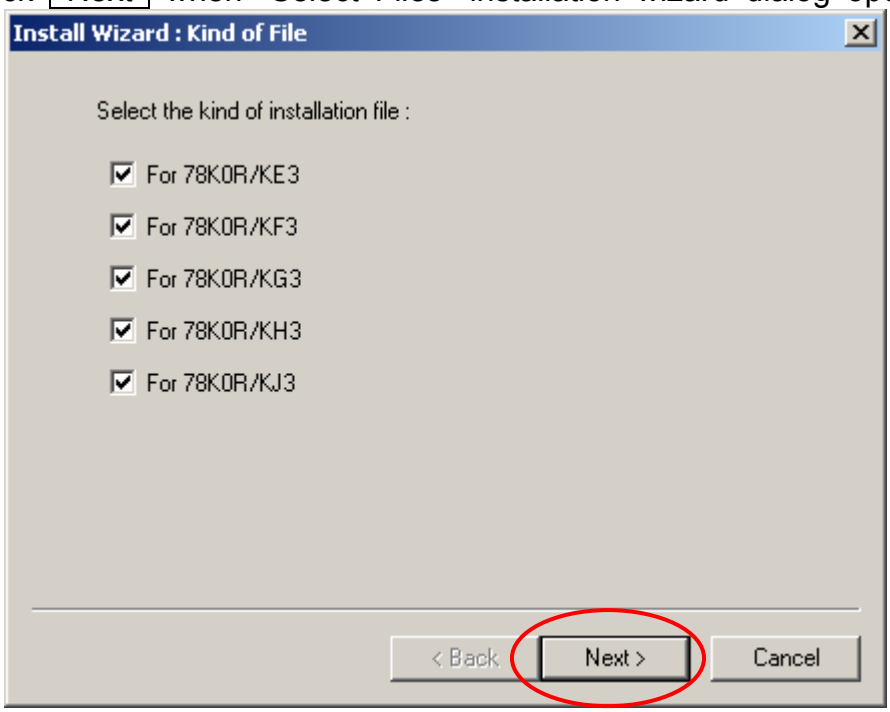


④ Enter the product ID, and click Next .
∗ The product ID is available on the“README.HTML” or the other sheet.

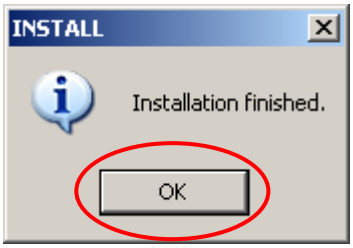


⑤ It starts copying the files.

⑥ Click [Next] when "Select Files" installation wizard dialog opened.



⑦ When the installation is completed, the following dialog opens. Click [OK] .



⑧ "NEC Electronics Starter Kit Virtual UART" USB driver must be installed on PC before you connect to 78K0R UZ Stick.

Install the USB driver by referring "2.4 USB Driver".

Notes on the installation authority

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

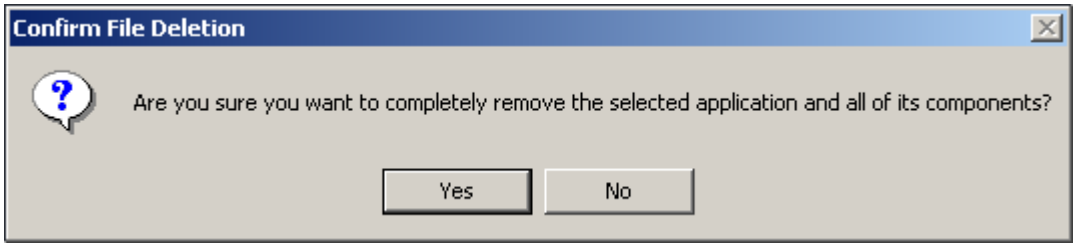
The identical problem may be observed, if a language other than English is specified as the system language in the “Regional Settings Properties” tab.

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 OK.

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:¥Program Files¥NEC Electronics Tools" on default setting.
When you use the tools, please open the tools from [Start menu] -> [Programs]->[NEC Electronics Tools].

2.3 Sample Environment

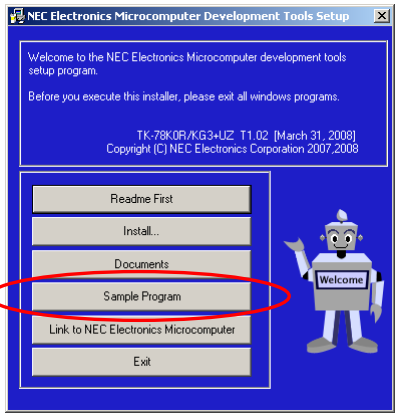
This section explains the overview and preparation of sample programs.

You need to install the sample programs on your system first before using them.

How to install the sample programs and where they should be intalled on your system will be explained.

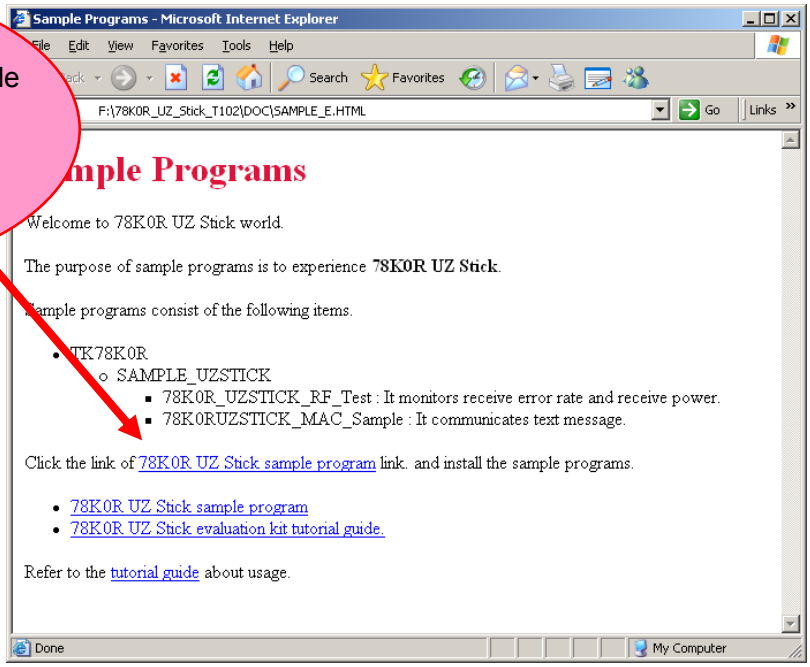
2.3.1 Installation of the sample programs

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 [78K0R UZ Stick Sample Programs] link.

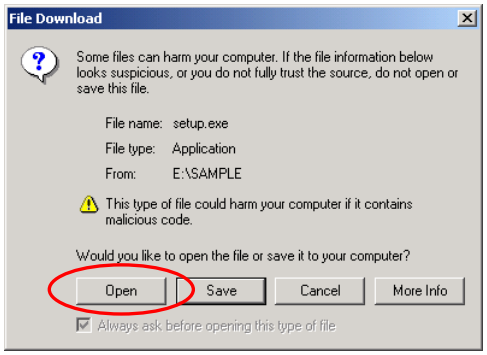


The WWW browser starts up.

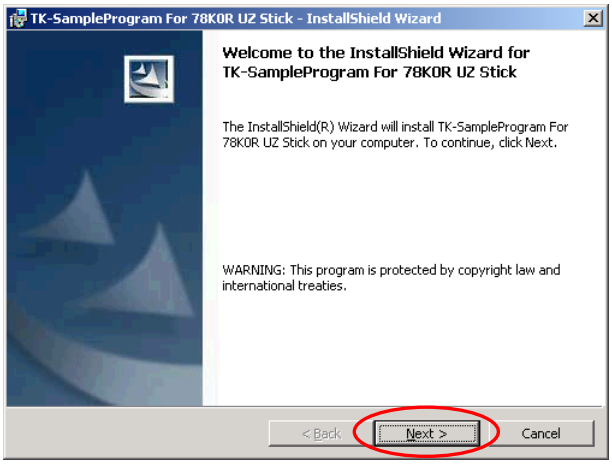
Click the [78K0R UZ Stick Sample programs] link you can also download the [Tutorial Guide]



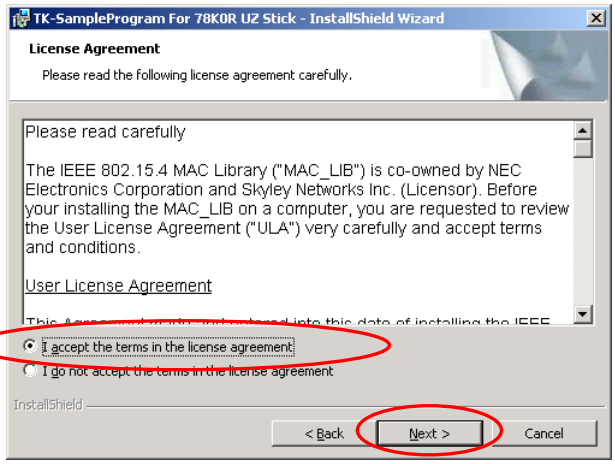
When[78K0R UZ Stick Sample Programs] is clicked, the following download confimation window appears.



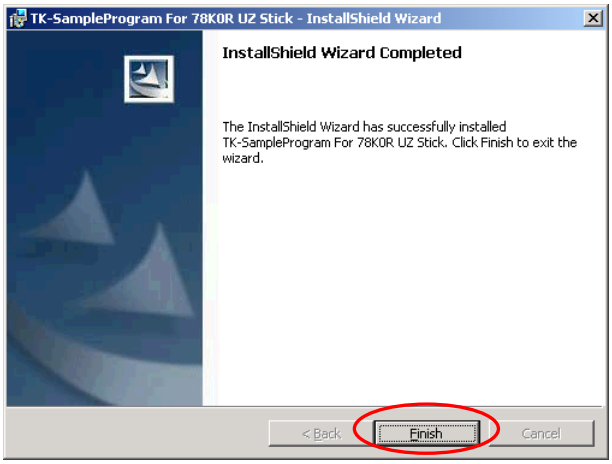
Please click the Open button.
In case of windows 2000,
you will see the [Security Warning] window. Please click Run.



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



License agreement screen is displayed.
Please select "I accept the terms in the license agreement".and click Next.



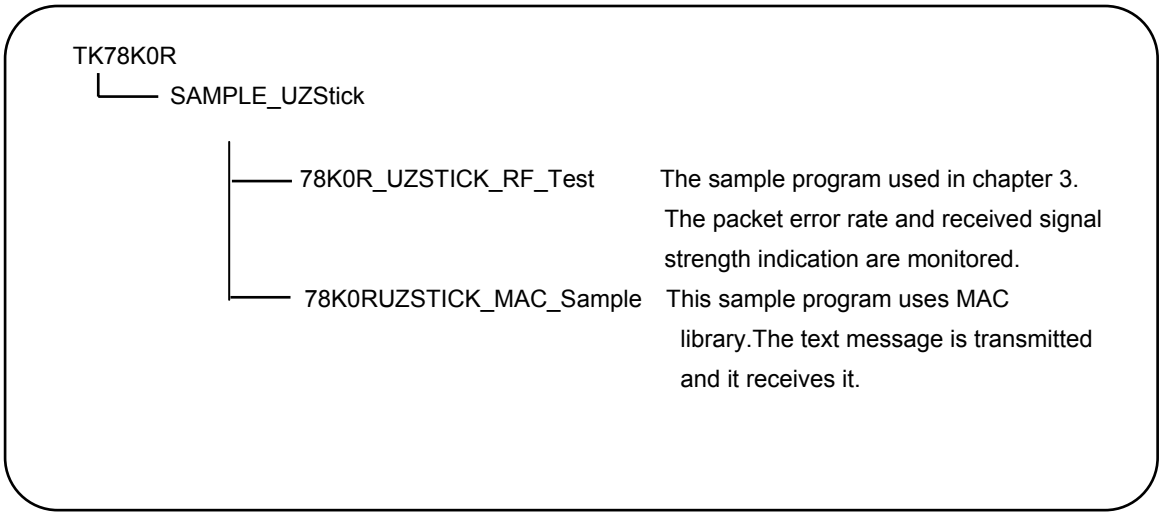
Please click Finish.

The sample programs are installded.
The sample program "TK78K0R.EXE" with self-extract file is also intalled. When you need to use the original sample programs, you can extract the file "C:¥TK78K0R.EXE".

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 programs ware the following folders.



2.4 USB Driver

You need to install “NEC Electronics Starter Kit Virtual UART” in your PC.

When 78K0R UZ Stick is used, it is necessary to install the “NEC Electronics Starter Kit Virtual UART” driver in the host machine. Please install the driver according to the following procedures with appending CD in the drive.

"Starter Kit USB Driver" must be installed on the PC. If not, please refer to "2.2 Installation of Development Tools" to install the driver first.

Attention **Do not use a USB hub for connecting 78K0R UZ Stick.**

Depending on the version of Windows OS, the installation will be differed.
Please check your Windows version, and follow the instructions

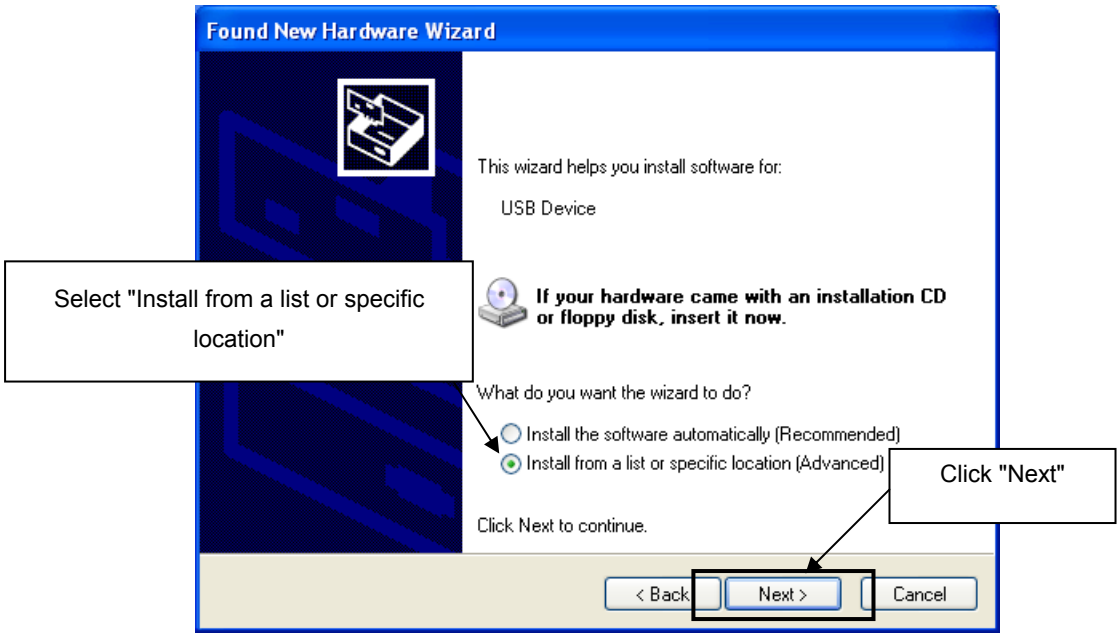
- Windows XP -> "2.4.1 Installation on Windows XP"
- Windows 2000 -> "2.4.2 Installation on Windows 2000"

After the installation, go to "2.4.3 Confirmation of the installation"

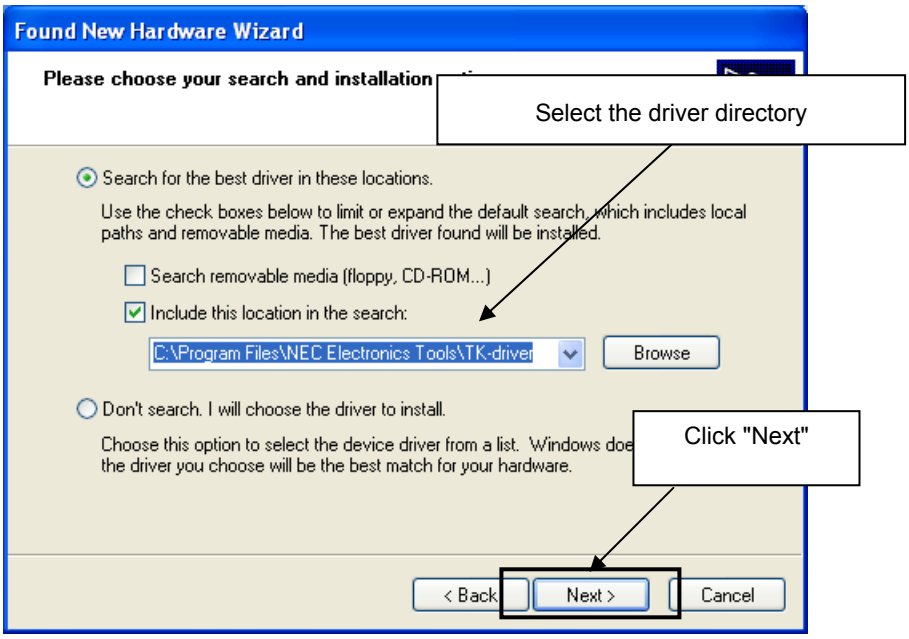
2.4.1 **Install to Windows XP**

1. Once the 78K0R UZ Stick is connected with USB, the "Found New Hardware Wizard" will be started. Select "No, not this time" and click Next > .

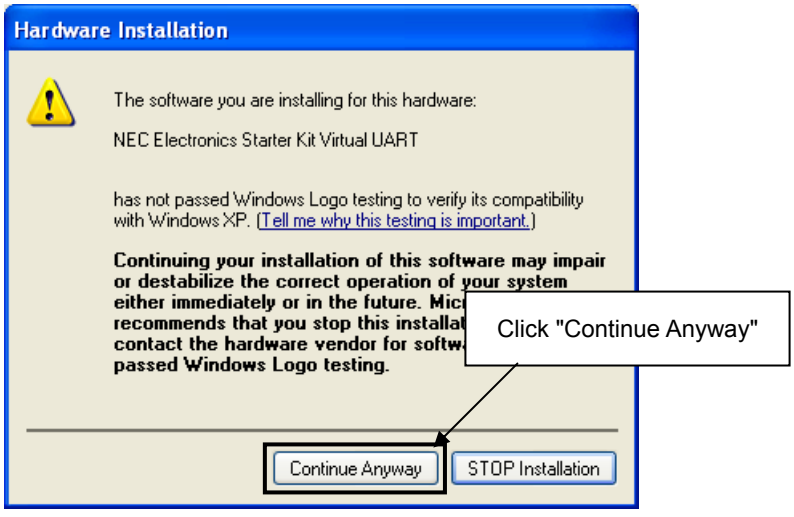
2. Select "Install from a list or specific location" and click Next > .



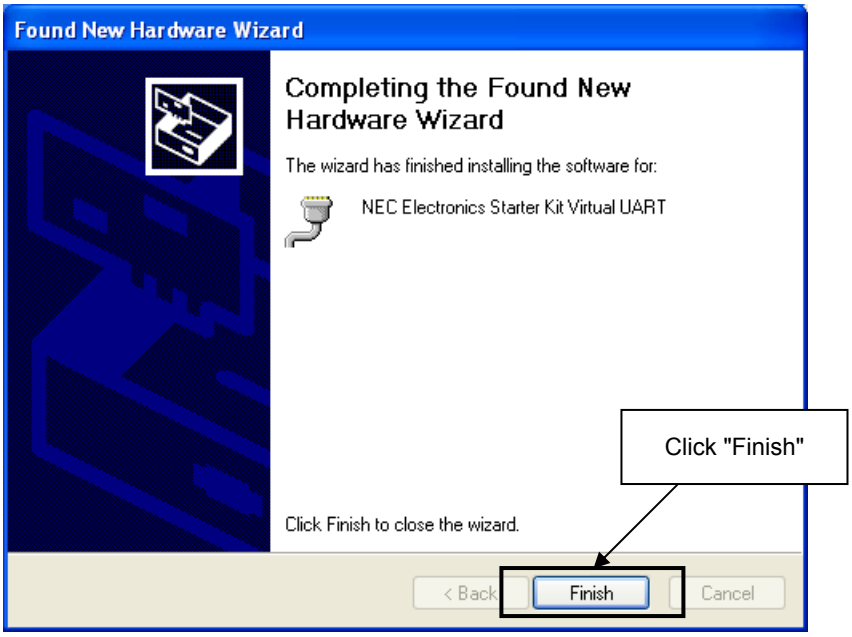
3 . Select "Search for the best driver in these locations." , check "Include this location in the search:", and then click "Browse..." to select the driver directory path. The path should be "C:¥Program Files¥NEC Electronics Tools¥TK-driver" as default installation. If the installation directory is not default, then select "TK-driver" under the installation directory.
Click Next > .



4 . If the following dialog is opened, click Continue Anyway .



5. The installation of "NEC Electronics Starter Kit Virtual UART" driver is completed.
Click Finish .

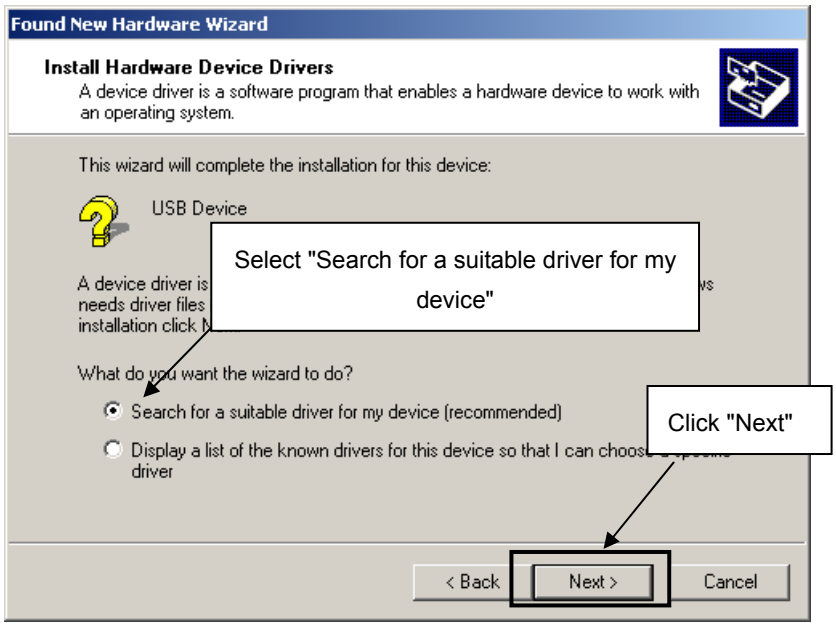


6. Go to "2.4.3 Confirmation of the installation".

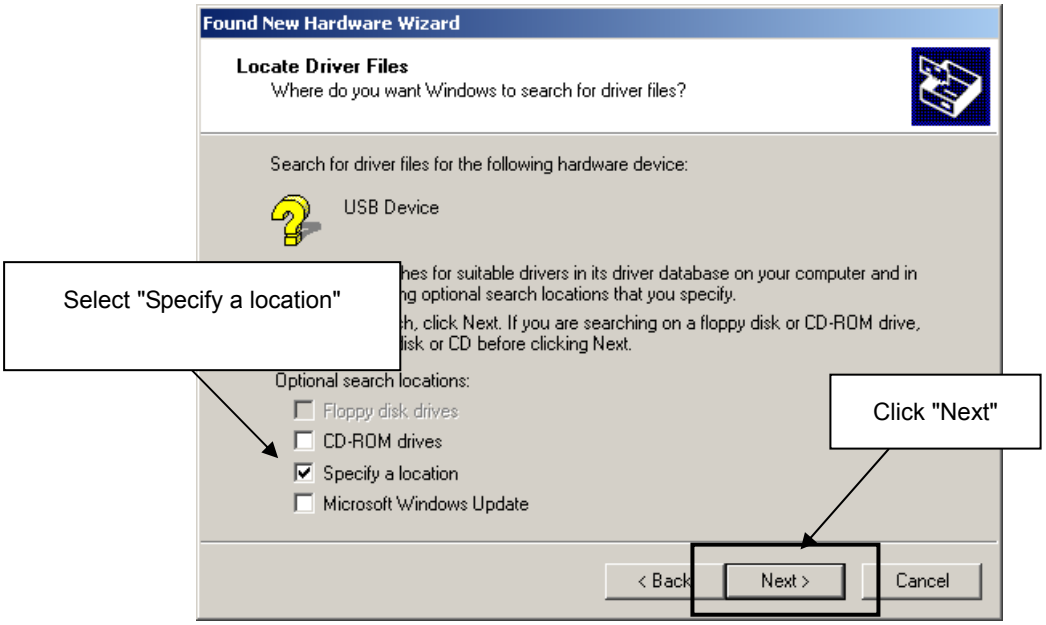
2.4.2 **Install to Windows2000**

1. Once the 78K0R UZ Stick is connected with USB, the "Found New Hardware Wizard" will be started.
   Select "No, not this time" and click [Next >] .

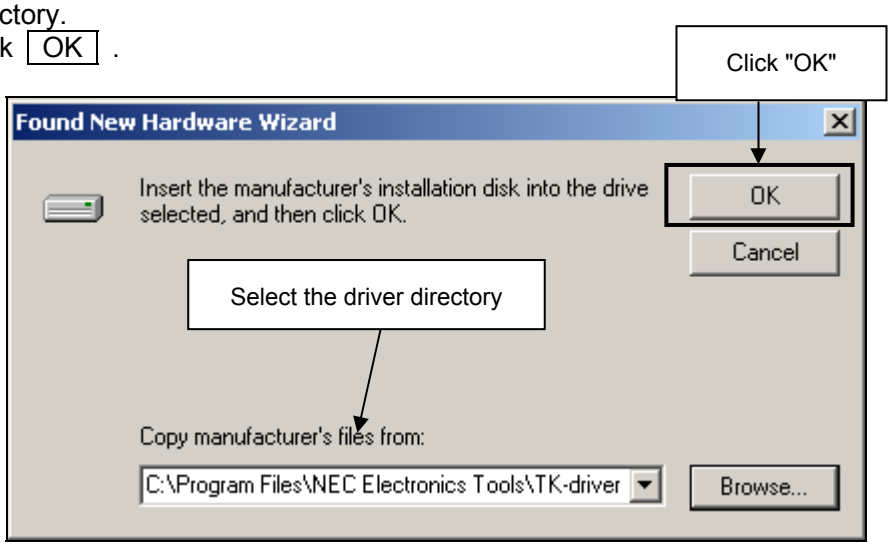
2 . Select "Search for a suitable driver for my device".
Click Next > .



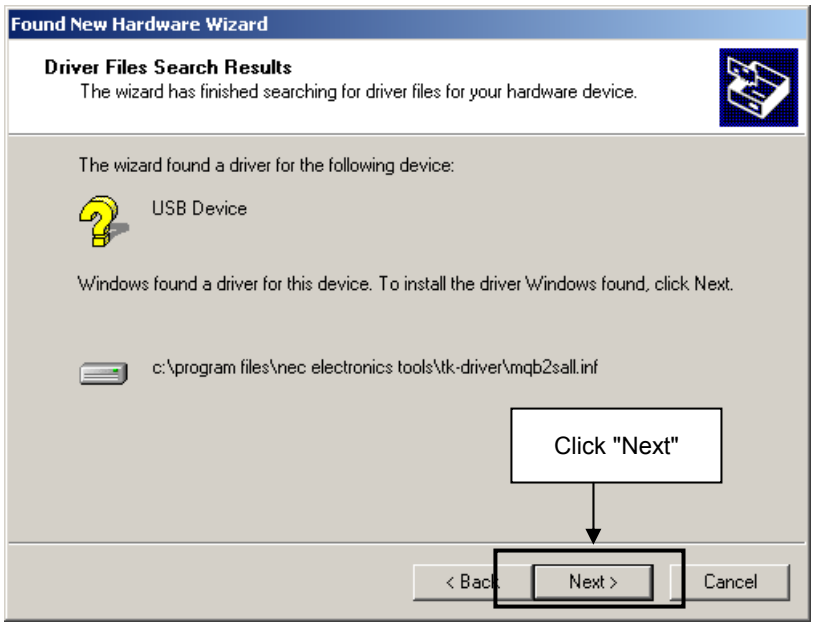
3 . Select "Specify a location".
Click Next > .



4. Select the driver directory path. The path should be " C:¥Program Files¥NEC Electronics Tools¥TK-driver " as default installation.
If the installation directory is not default, then select "TK-driver" under the installation directory.
Click [OK] .



5. Click [Next >] .



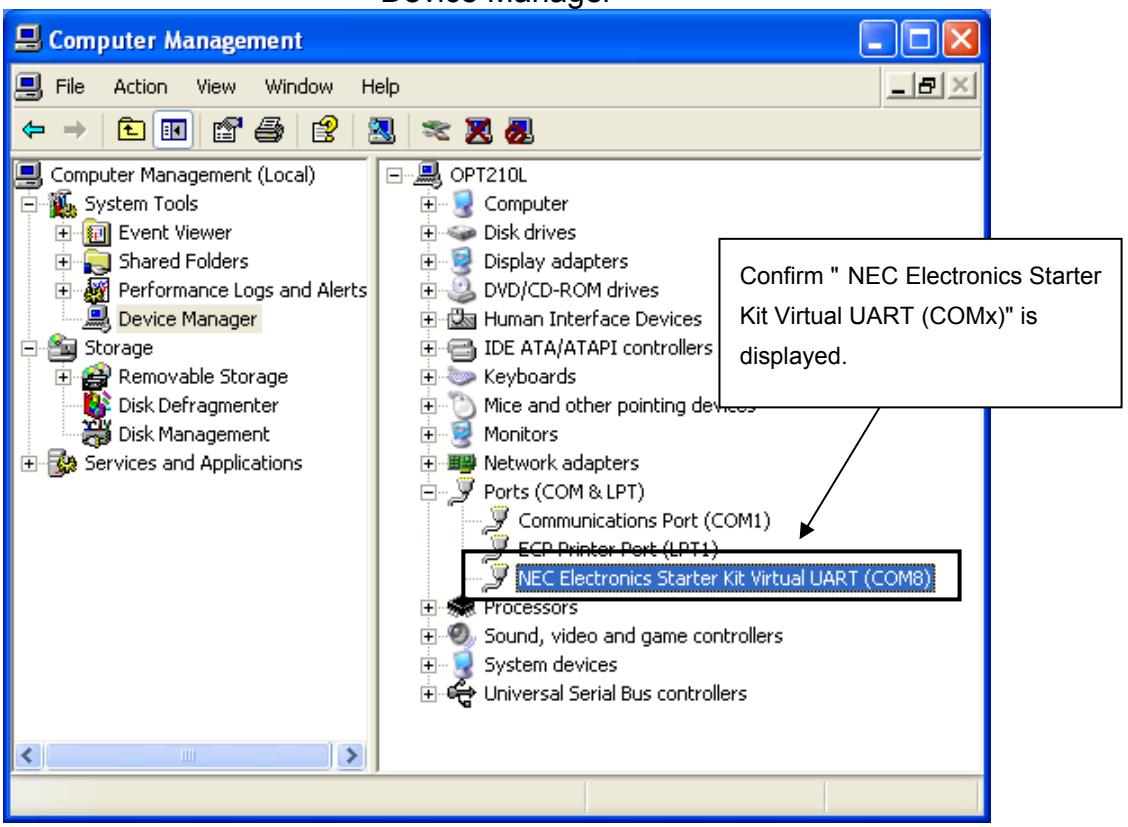
6. The installation of "NEC Electronics Starter Kit Virtual UART" driver is completed. Click [Finish] .

7. Go to "2.4.3 Confirmation of the Installation".

2.4.3 Confirmation of the installation

Please confirm “NEC Electronics Starter Kit Virtual UART(COMx)” in the device manager of system in the control panel of the MS Windows.

Device Manager



The screen above shows that the COM port number is "COM8". If ID78K0R-QB is not in use, you can use this port number for connecting 78K0R UZ Stick.
When you change the USB port Connection, the COM port number will be changed as well.

CAUTION

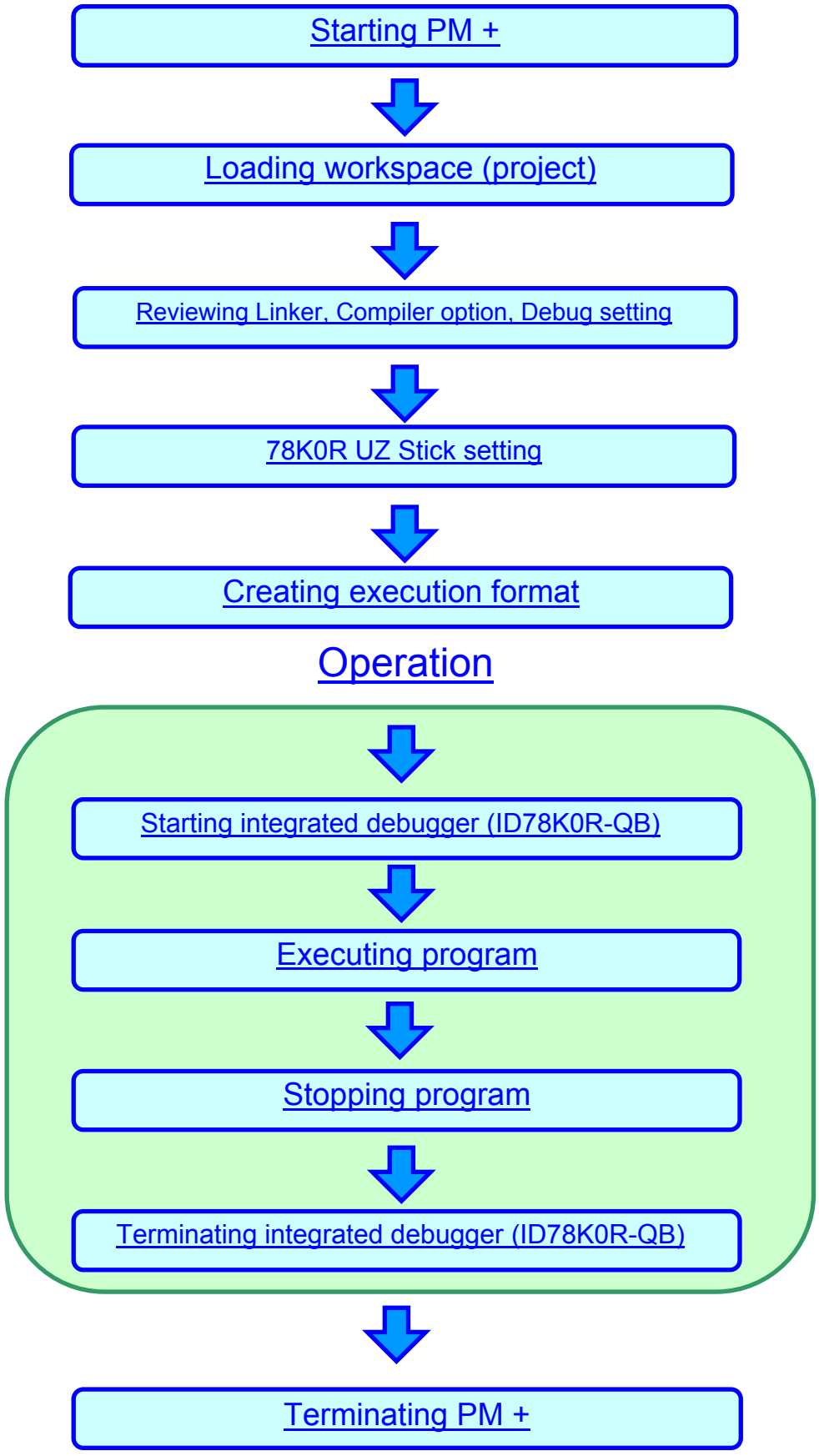
・Do not do “Hardware Modification Scan” when you communicate with the target device.

3 Experiences

Now you are ready to experience the operation of the 78K0R UZ Stick using the integrated development environment, PM +.

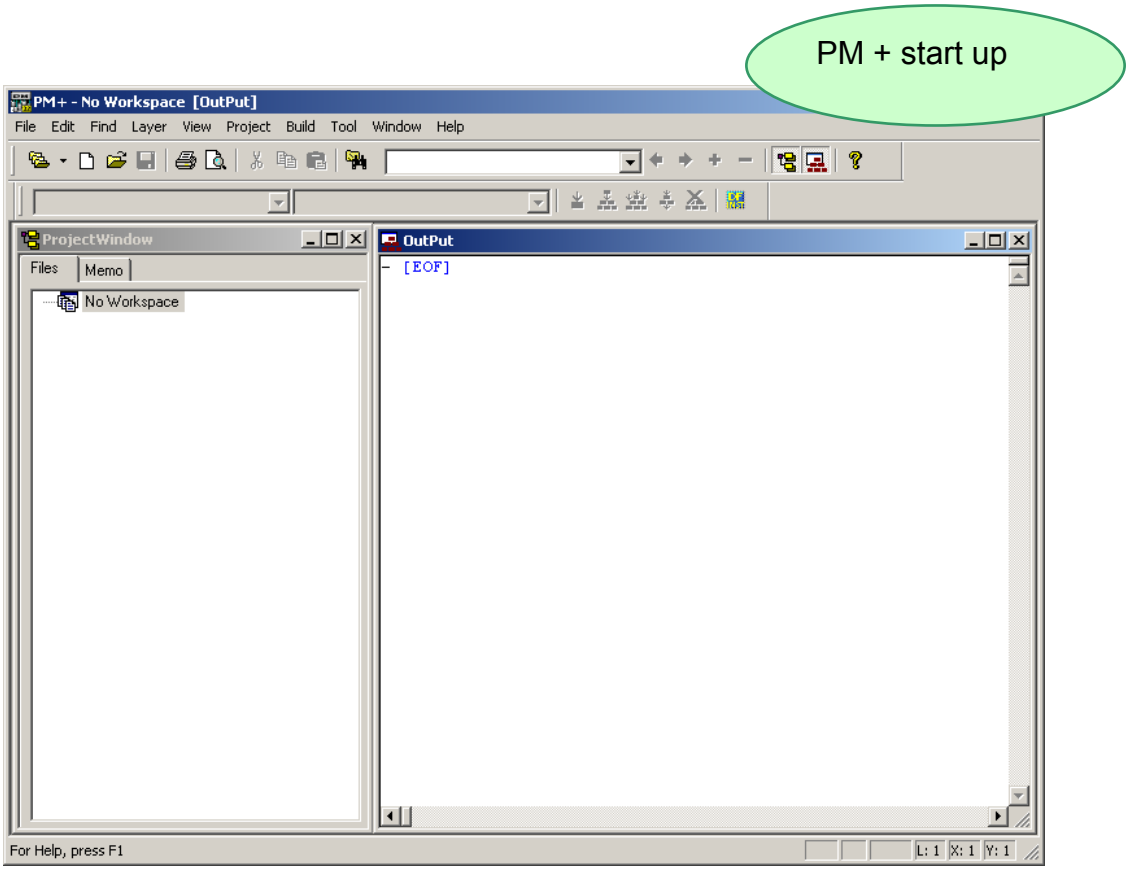
As a program for the 78K0R/KE3, the RF test program (RF_Test) which you installed in "2.3.1 Installation of the sample programs" is used.
You use two of 78K0R UZ Stick. One is the stand-alone system with USB power supply. Another is connected to the debugger and run user programs. By building the sample programs and operating with ID78K0R-QB, you can understand the basic operation of the development tools (PM+, ID78K0R-QB) and the basics of the project files that you need when you develop application programs.

The overall flow is as follows.



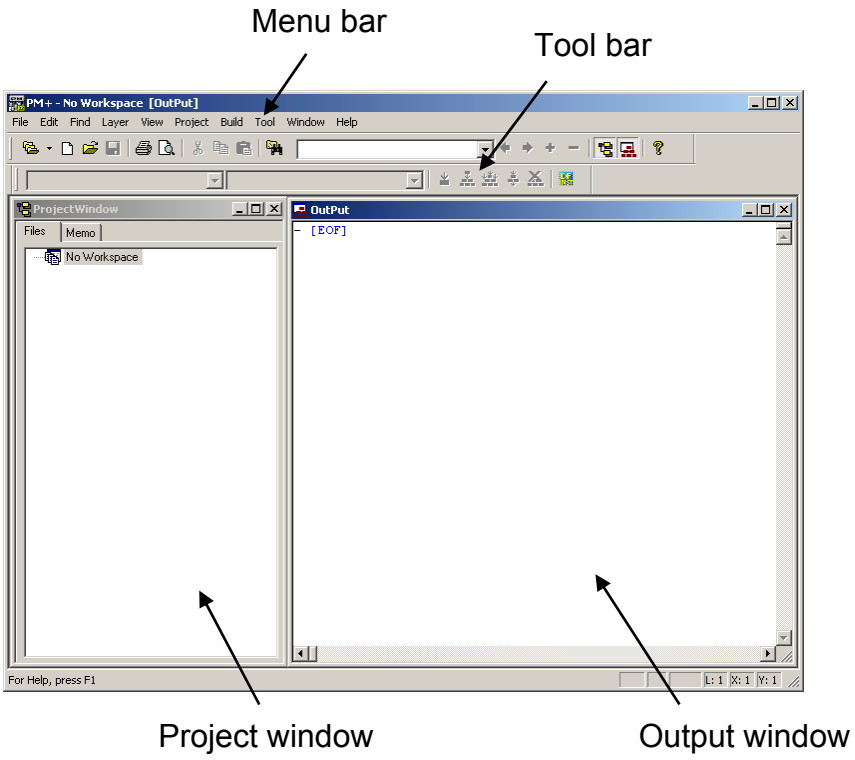
3.1 Starting PM +

In the Windows Start menu, select [Programs]->[NEC Electronics Tools]->[PM + V6.30]



3.2 Introduction to PM +

In PM +, 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 of 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 + User's Manual.

What is a project?

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

PM + complies 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 complying, and the editor and debugger to be used have been saved as “project information”.

The file name format is “ΔΔΔΔprj”.

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?

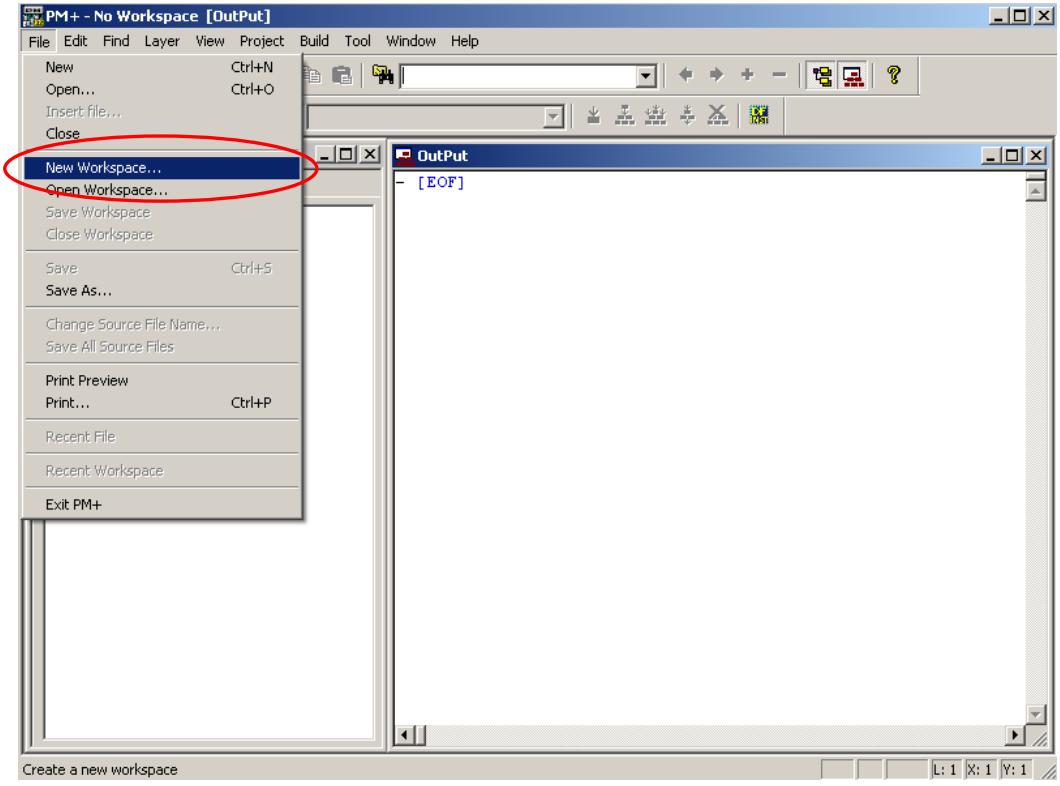
A workspace is the unit used to manage all the projects or project group required for one application system.

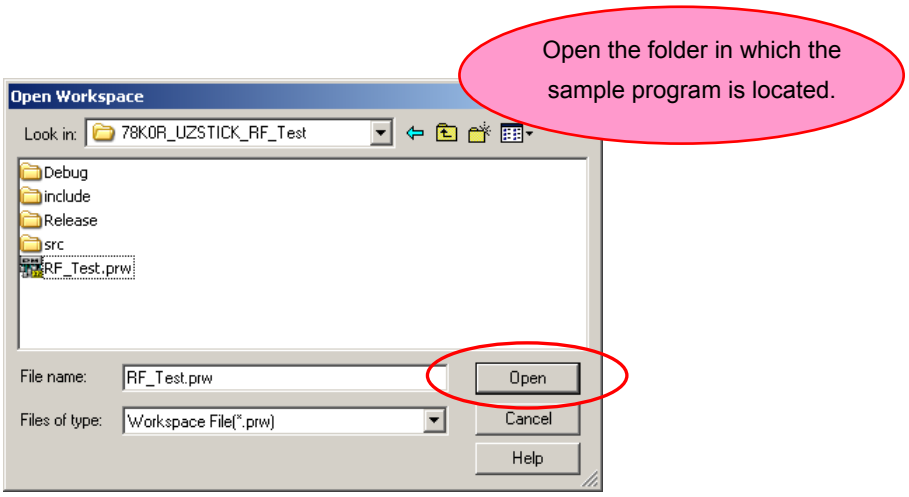
The file name of multiple project files is saved to a workspace file for referencing.

The file name format is “ΔΔΔΔprw”.

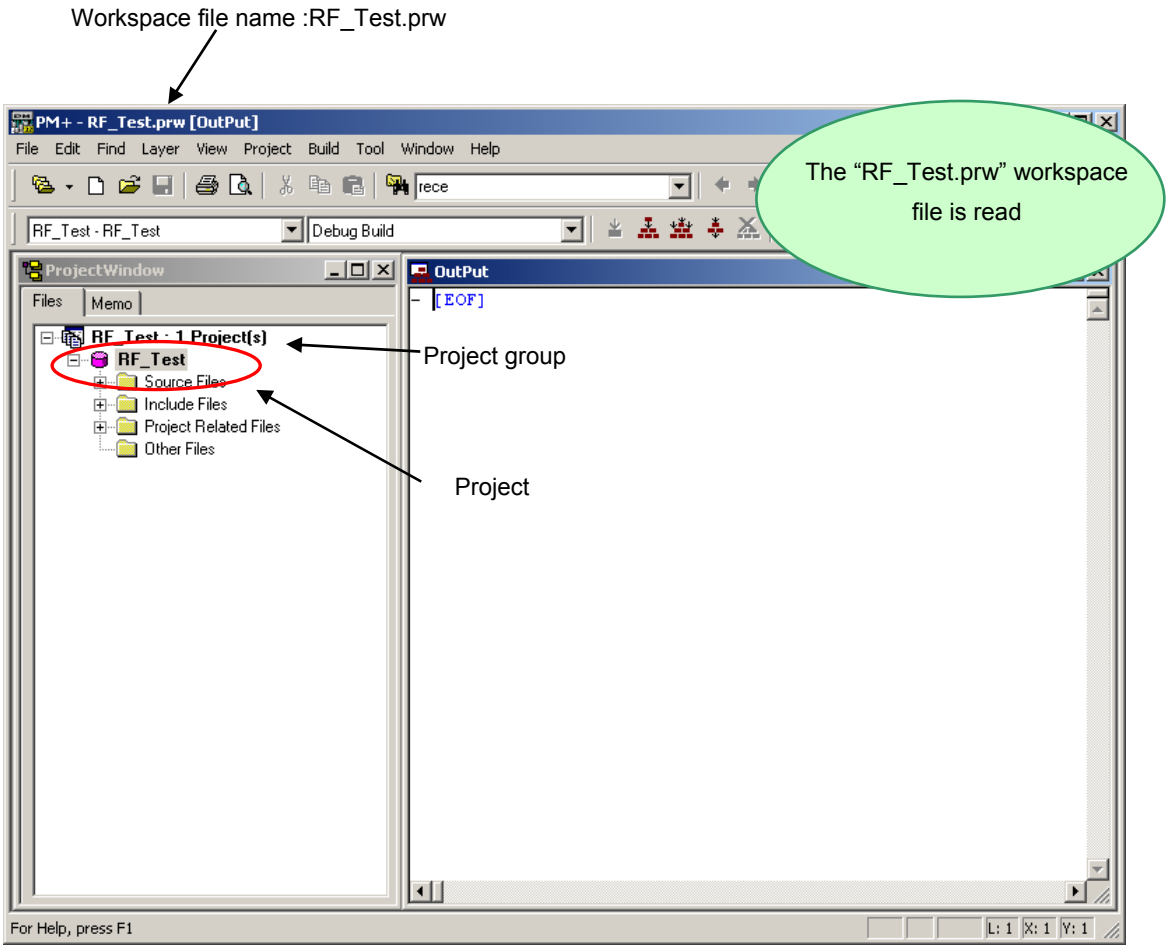
3.3 Loading Workspace (Project)

In this section, you will use the workspace that you created in "2.3.1 Installation of the sample programs"
For creating a new workspace, refer to "3.15 Creating a new PM + workspace (project)".
The workspace has information about the build environment for the sample programs.
Select "File" on menu bar and "Open Workspace…".
Then, select
“C:¥TK78K0R¥SAMPLE_UZStick¥78K0R_UZSTICK_RF_Test¥RF_Test.prw”.





"RF_Test.prw"and then press the Open button.



3.4 Configuration of Linker Option

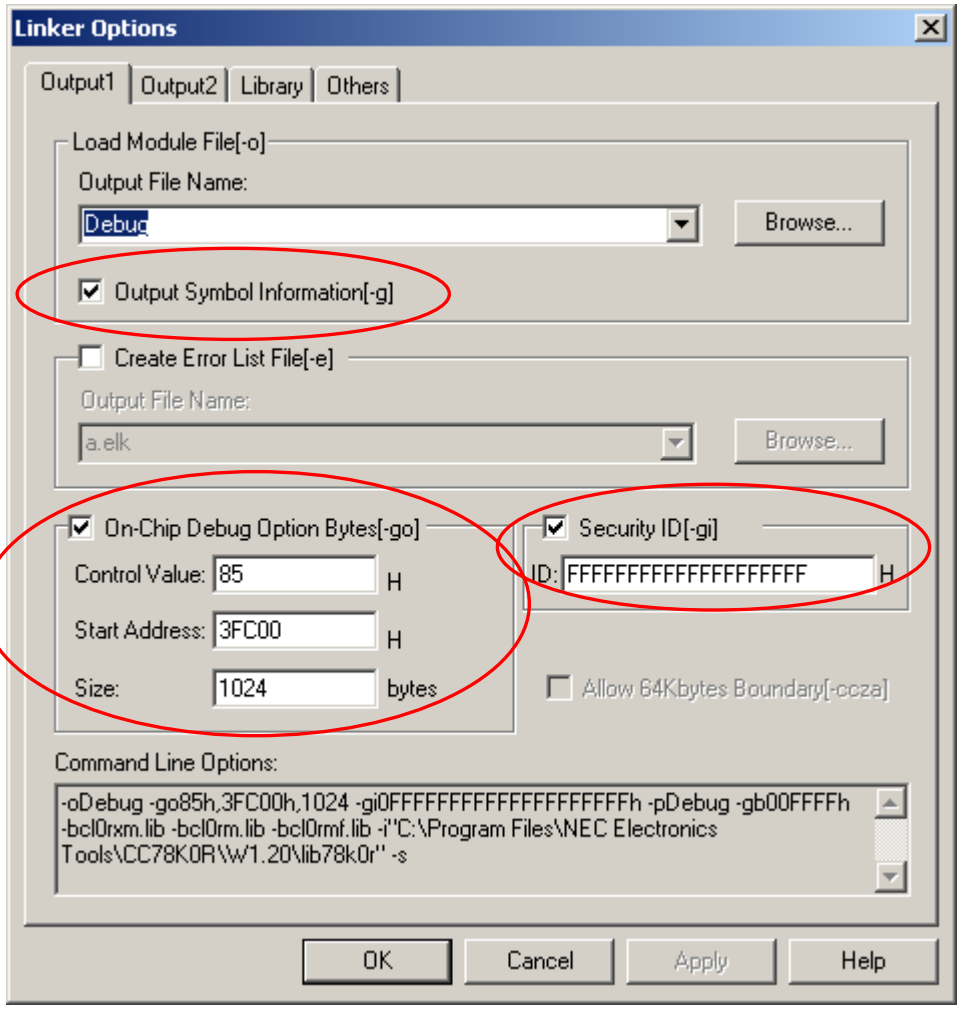
The linker options have been set by the project file. However, some option settings will be covered in this section because the linker option settings are important for debugging. Following three settings are covered specifically.

- Outputs from debugging
- On-chip debug (bytes, security ID)
- Watchdog timer

Select "Tools" on menu bar, then "Linker options".

3.4.1 "Output1" Tab

Select "Output1" tab on "Linker Options" window, and see following settings.



- Load Module File settings

Check "Output Symbol Information".

This enables to do source level debugging (setting break points, monitoring variables in watch window, etc).

Also, you can specify the load module file name.

- On-Chip Debug Option Byte

Check "On-Chip Debug Option Byte". Enter "85" in "Control value". This setting enables the on-chip debugging function of the microcontroller.

For details of "Control value", refer to the user's manual of 78K0R/KE3 (U17854E).

See "Start address" is set to "3FC00", and "Size" is set to "1024".

These settings reserve the memory address area for the monitor program (the flash memory area that the debugger uses for on-chip debugging).

In this case, the "Control value" is allocated to the address of C3H in flash memory, and FFH is set to the next address. Because of this, the following areas could not be set the segments.

<Address area that reserved by on-chip debugging>

- 2H, 3H
- CEH-D7H
- From the address set in "Start address" to the byte set in "Size"

- Security ID

Check "Security ID", and enter the security ID which is a unique ID code (10 bytes) to authenticate when the debugger is launched.

The security ID is stored in the flash memory (C4H-CDH), and checked if it is the same as the code entered in Linker options dialog when the debugger is launched.

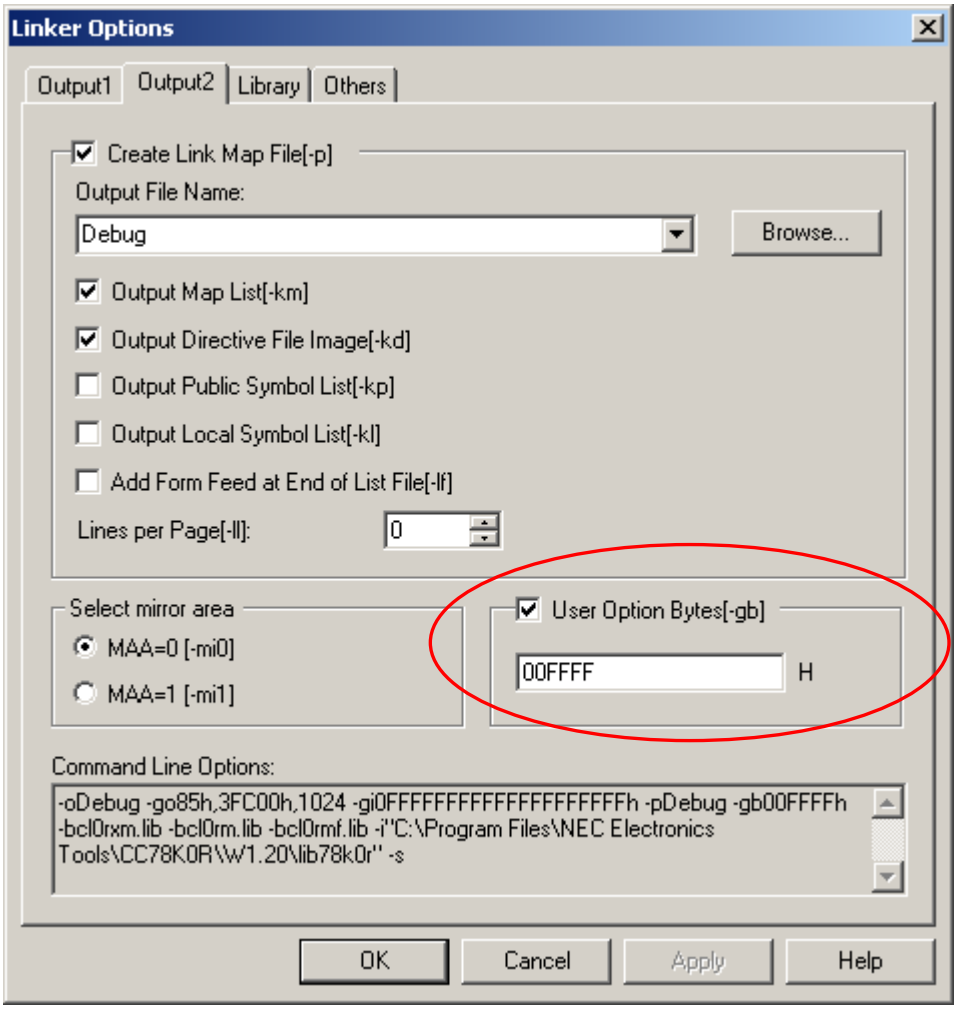
The debugger will not be launched when the security ID is unmatched. By using this function, you can secure the programs from leaks.

If you do not need to set the security, it is recommended to set the security ID "FFFFFFFFFFFFFFFFFFFF" as this is the initial code.

If you forget about the security ID (stored in the address of C4H-CDH) or if you set wrong on-chip debug option byte, you will not be able to use the debugger (ID78K0R-QB).
To solve this, you can use the "78K0R Starter Kit Setting" for changing the setting to initialize the flash memory at the time debugger launched.
For details, refer to "3.9 Starting integrated debugger (ID78K0R-QB)".

3.4.2 "Output2" Tab

Select "Output2" tab on "Linker Options" window, and see following settings.



- User Option Byte

  Check "User Option Byte", and then enter "00FFFF". Here, you can do the setting of watchdog timer, low-voltage detector, and system reserved memory area. The 3 bytes you entered are stored at C0H-C2H on flash memory:

  - C0H: setting for watchdog timer
  - C1H: setting for low-voltage detector
  - C2H: setting for system reserved memory area (must be set as FFH)

  This time, you disabled the watchdog timer and the default start function of low-voltage detector.

  For details, refer to the user's manual, 78K0R/KE3 (U17854E).

3.5 Configuration of Compiler Option

The compiler options have been set by project file. However, because some compiler options are useful, following three settings are covered specifically in this section.

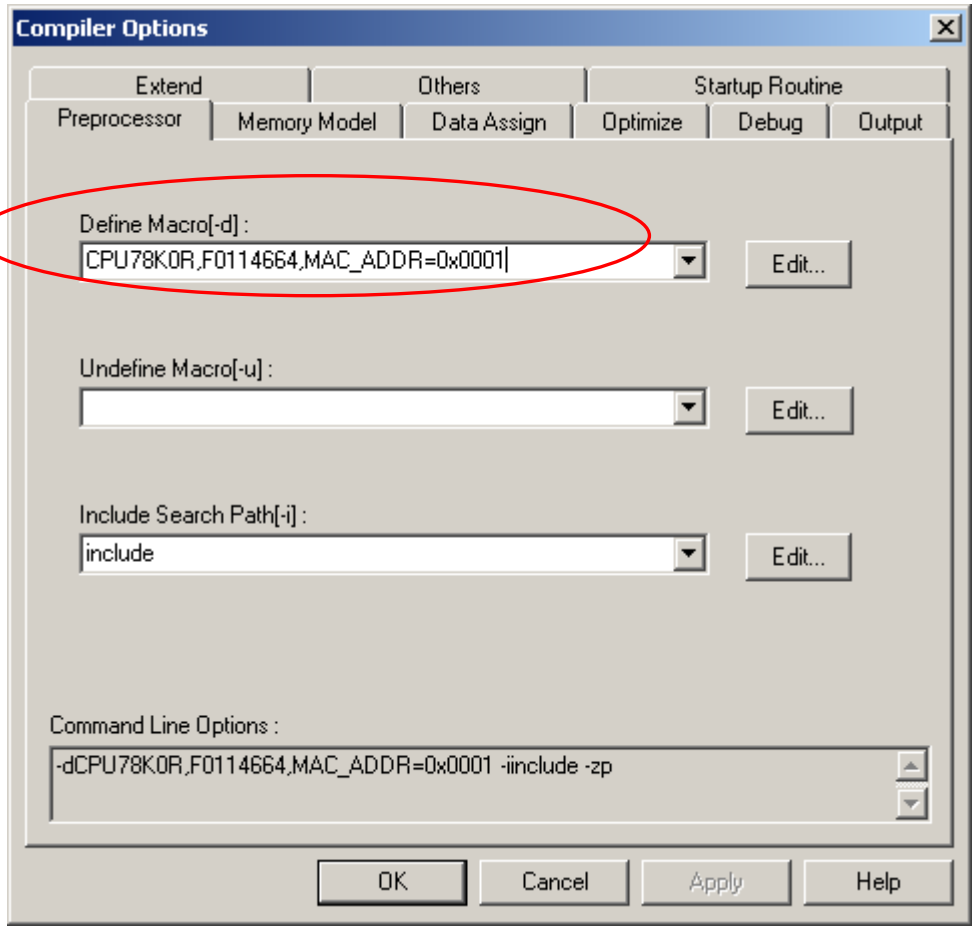
- Setting for Define Macro
- Enable C++ comments
- Use multiplier and divider

Select "Tools" on menu bar, then "Compiler options".

3.5.1 “Preprocessor” Tab

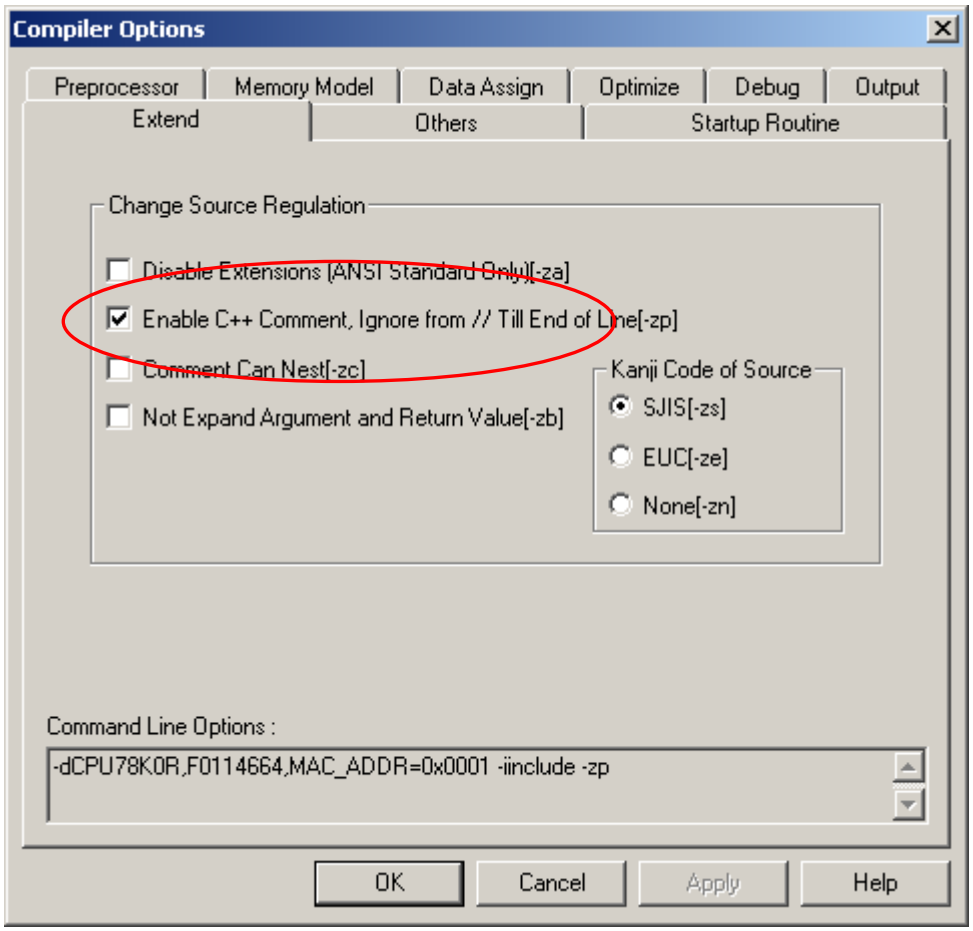
As "Define Macro", three macros, CPU78K0R, F0114664, and MAC_ADDR=0x0001, are set. These regard to "ifdef" statement in the source code.
"MAC_ADDR=0x0001" indicates that the MAC short address is "0001" as the wireless node. (Also the 3rd - 4th byte of extended address from the upper side is set to 0x0001.)

Enter "include" in "Include Search Path" field.



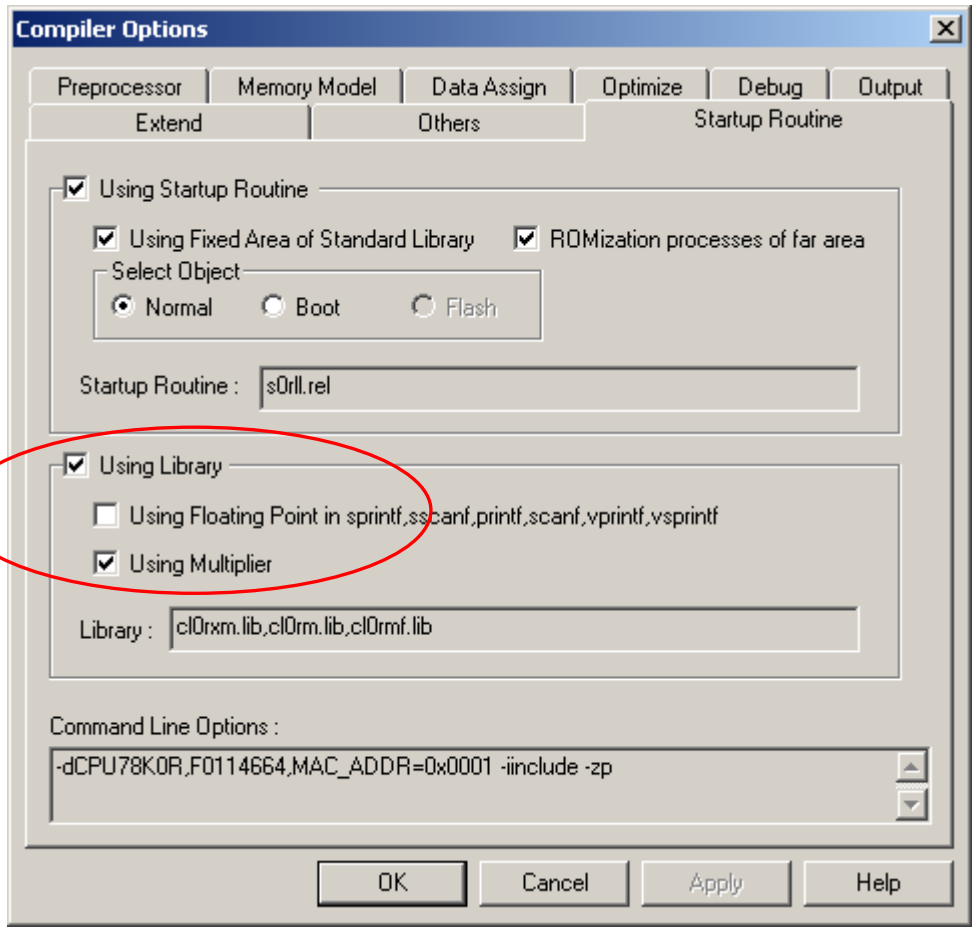
3.5.2 "Extend" Tab

Select "Extend" tab, and check "Enable C++ Comment".
This setting allow you to use the C++ comment using "//".
It is useful feature when developing code.



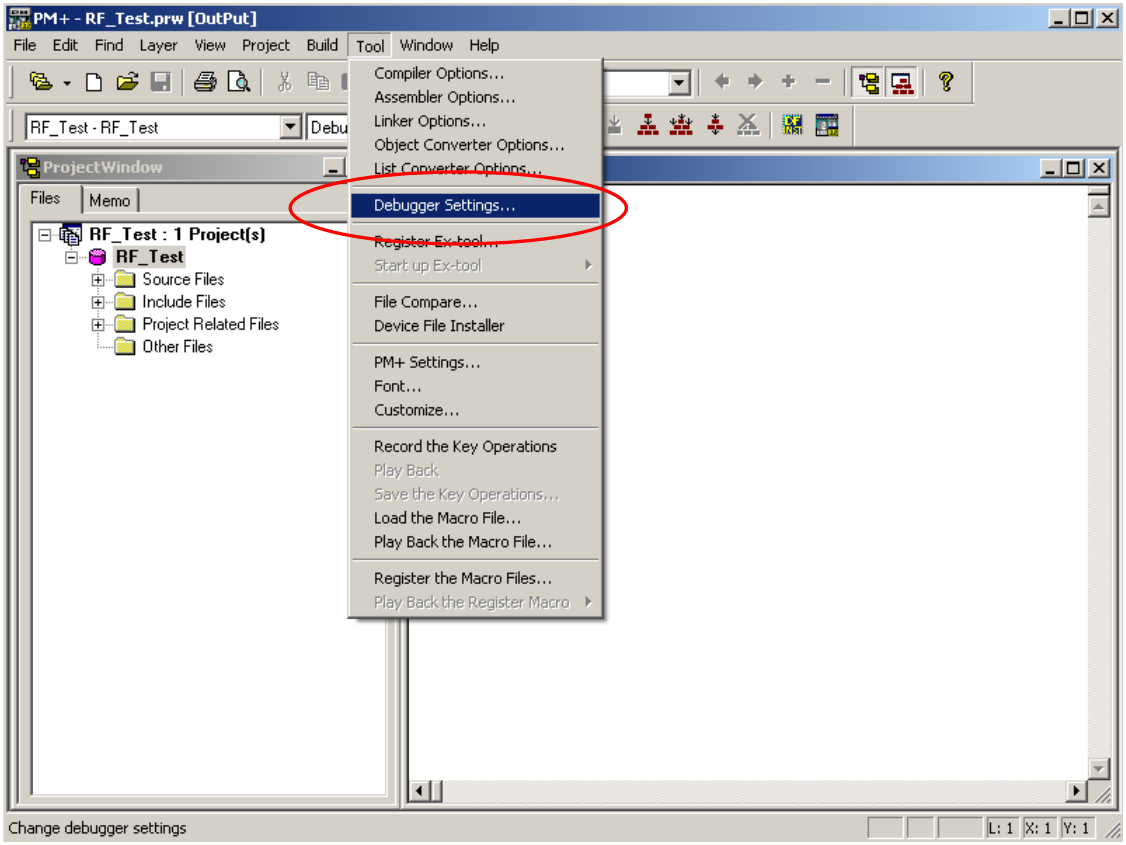
3.5.3 "Startup Routine" Tab

Select "Startup Routine" tab, and check "Using Library" and "Using Multiplier/Divider". The 78K0R/KE3 has feature of multiplier/divider to increase those calculation speed.

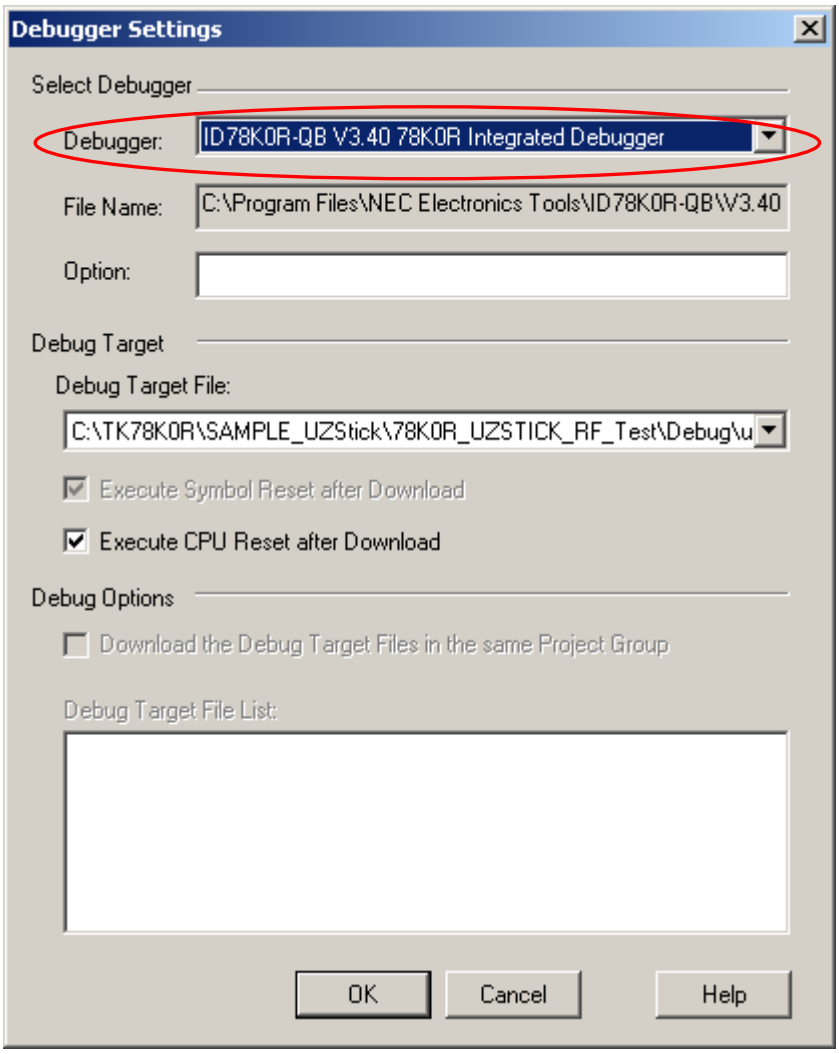


3.6 Configuration of Debugger setting

Please Choose [Tool] -> [Debugger Setting] at the pull-down menu.

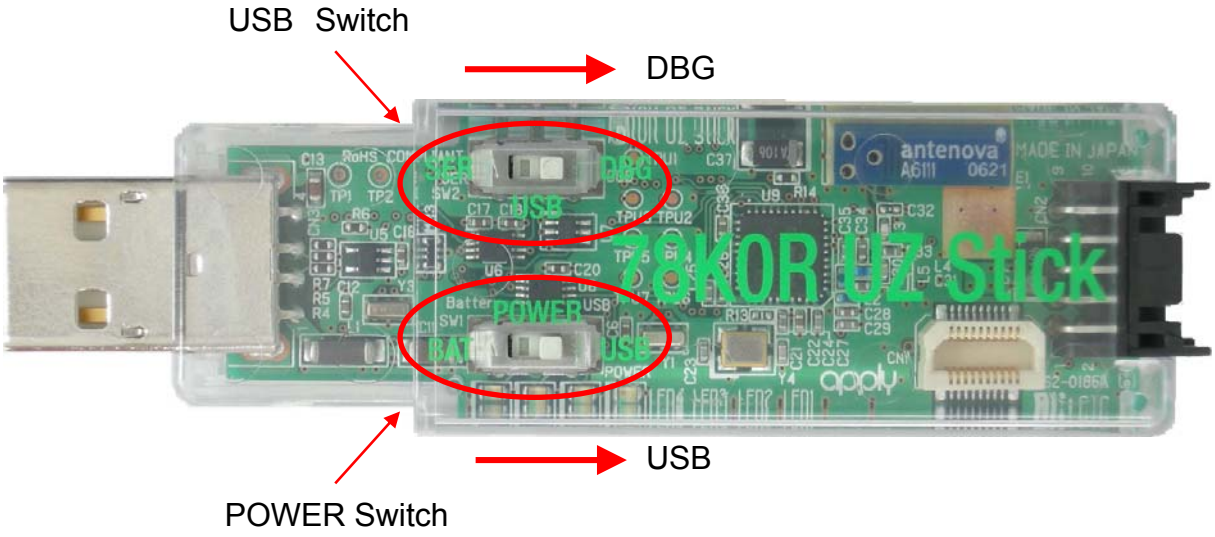


Check if "ID78K0R-QB V3.40 78K0R Integrated Debugger" is selected on "Debugger".



3.7 78K0R UZ Stick Settings

Please set the switches on the 78K0R UZ Stick as follows.



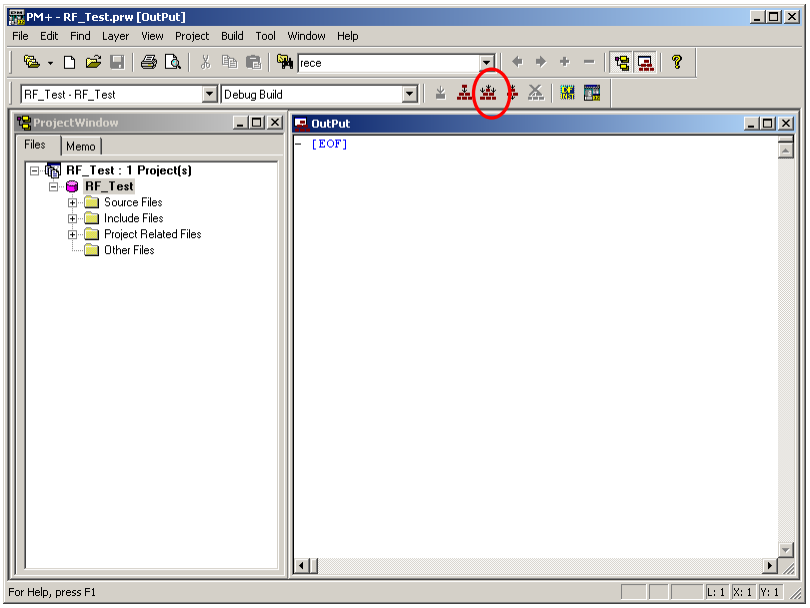
Switch	Setting
USB	DBG
POWER	USB

After the switch settings are completed, connect the PC to USB connector on 78K0R UZ Stick with USB cable. If the "Found New Hardware Wizard" is started, install USB driver with referring "2.4 USB Driver"".

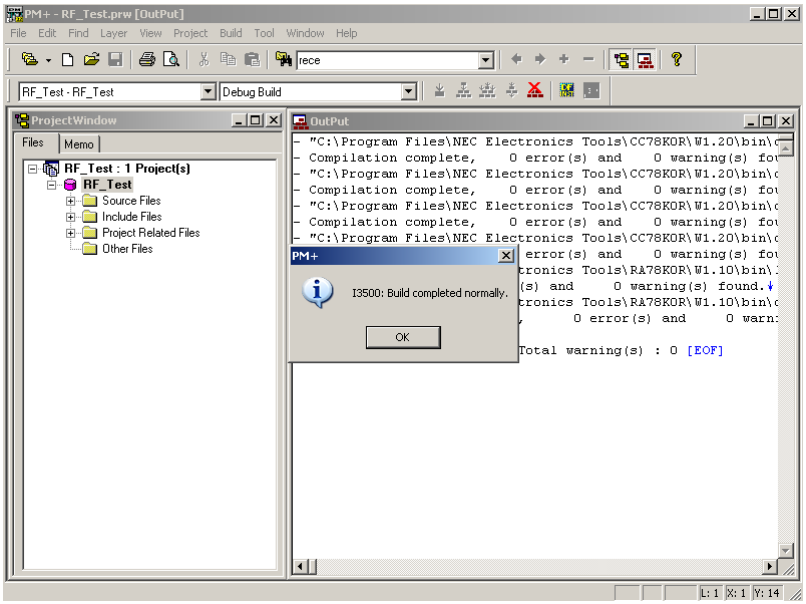
3.8 Creating execution format

Please go back to PM +.

Please re-compile the project by clicking the  button at the menu bar.



Build process is executed



Build has been completed successfully.

What is build ?

Build is a function that creates an executable file, etc., from a source file registered to a project.
PM + automatically performs compiling, linking, and other processing actions.
On the second and subsequent build, PM + also automatically delects files that have been updated from the previous build processing, and complies and assembles only the relevant files, thereby reading the time required for build processing.

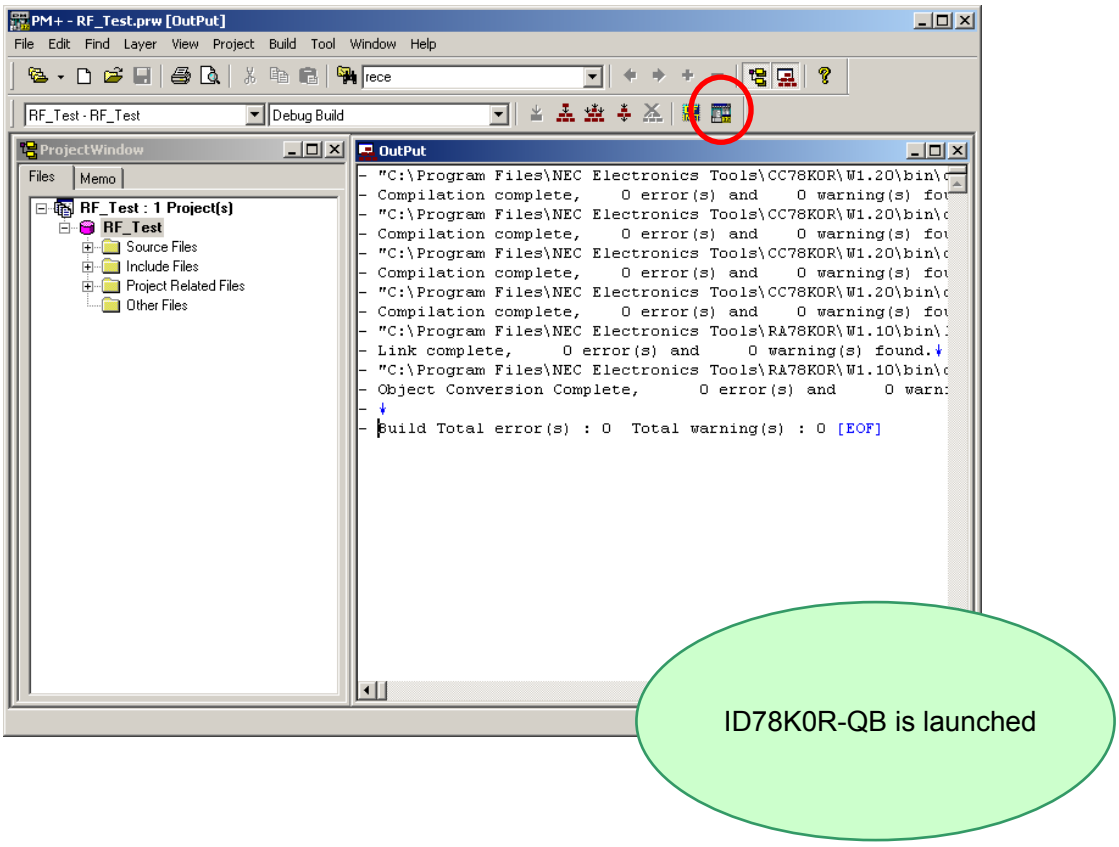
What is rebuild ?

Build compiles and assembles only the source files that have been updated since the previous time, whereas rebuild compiles and assembles all the source files.
When setting, such as compiler options, have been changed, not build, but rebuild, must be Selected.

3.9 Starting integrated debugger (ID78K0R-QB)

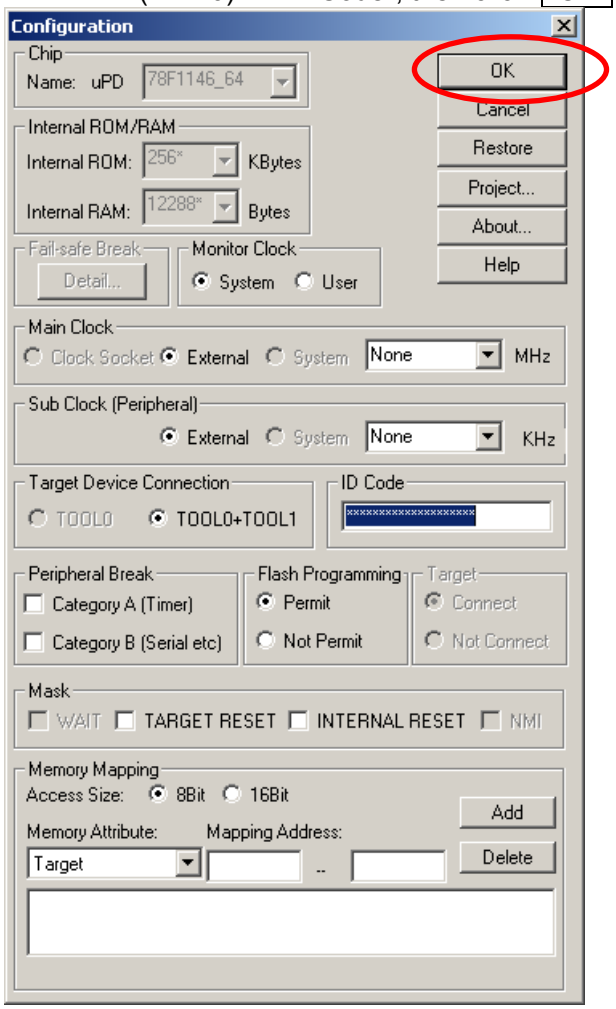
Please select the Debug button  , of PM +, or in the menu, select [Build(B)] →[Debug(D)].

If the debug button is not displayed, in the menu, select [Tool]→[Debugger Setting...]“ID78K0R-QB V3.30 78K0R Integrated Debugger”

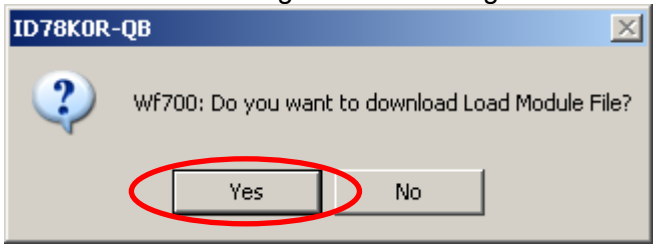


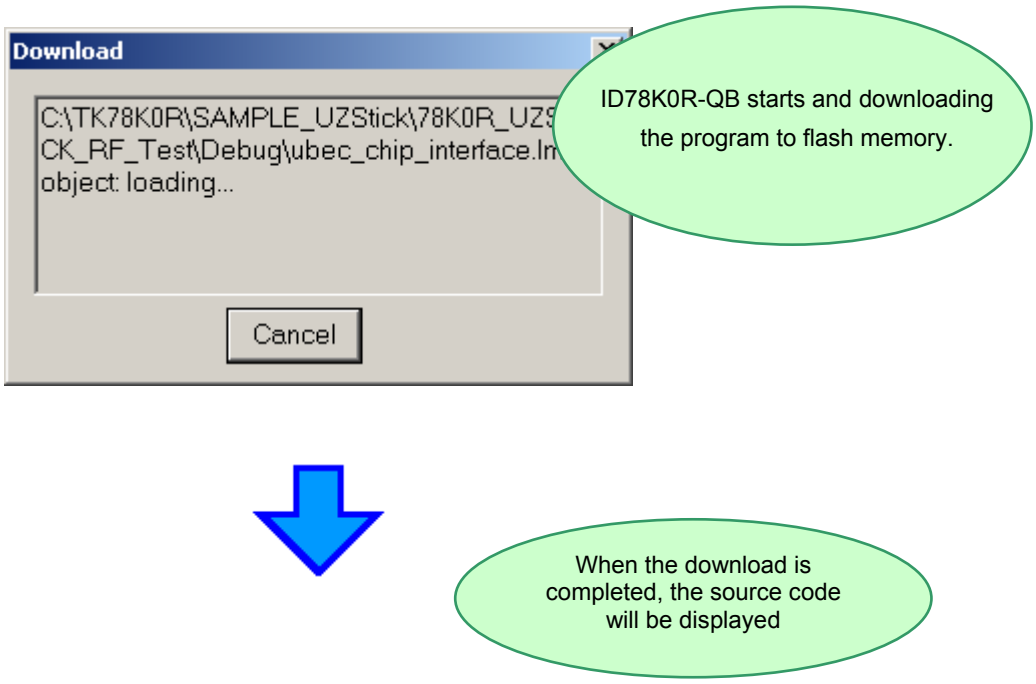
"Configuration" dialog is opened.

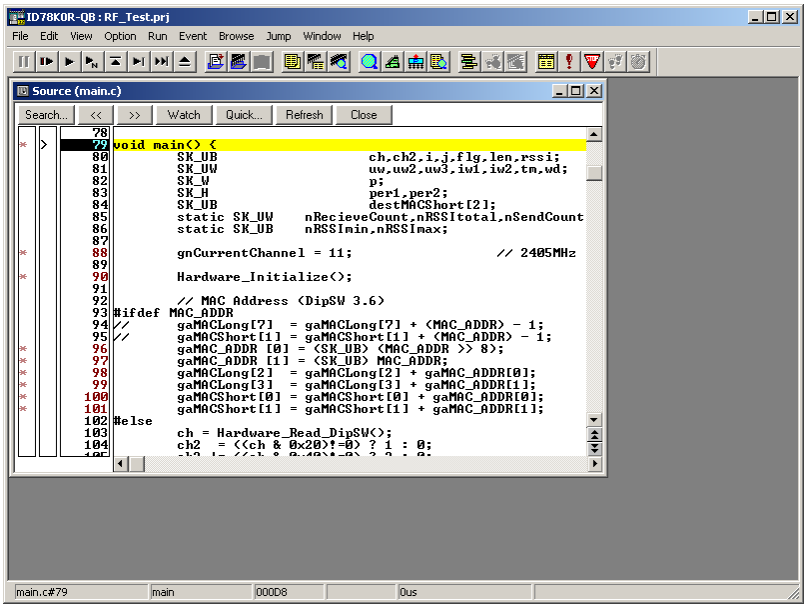
Enter "FFFFFFFFFFFFFFFFFFFF" (F x 20) in "ID Code", then click OK .



Click Yes when the confirmation dialog for downloading load module file is opened.



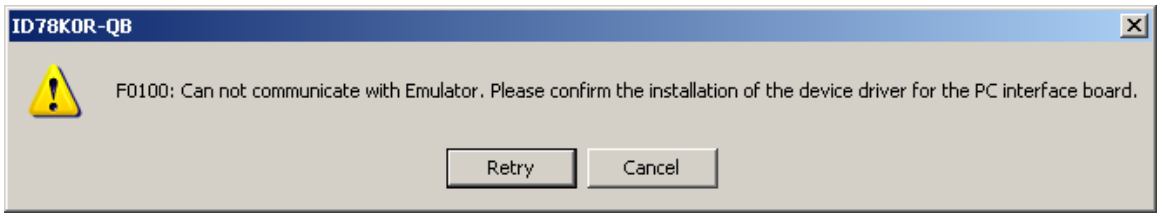




NOTE:

Completion of the download does not mean running the programs.
To run the sample programs, go to "3.11 Executing program".

Normally, if communication with the CPU fails, the following error messages are output.



If you observe the message please confirm the following items.

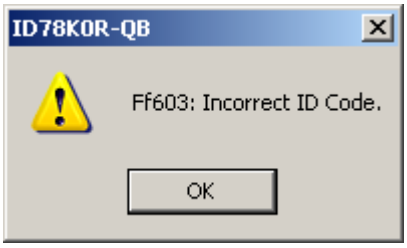
1. Please confirm the switch on the 78K0R UZ Stick is set as follows.

Switch	Setting
USB	DBG
POWER	USB

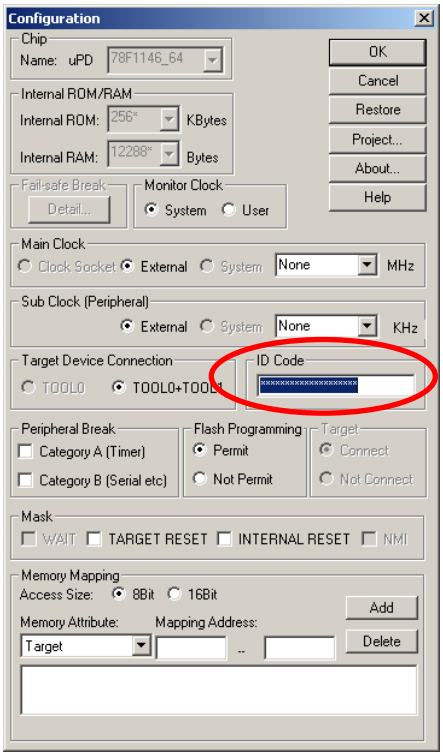
2. Please confirm the power LED1 is lighted.

After checking the above items, start ID78K0R-QB again.

If the ID code is wrong, you may find the following messages on the display.



The following "Configuration" screen is displayed when OK is pushed and input a correct ID code, please.

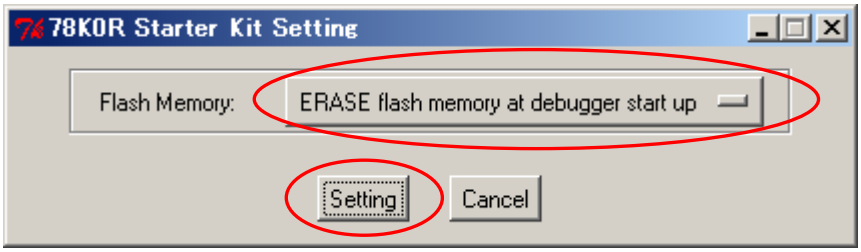


If the setting of On-Chip Debug Option Byte is "Does not erase data of flash memory in case of failures in enabling on-chip debugging" and if you forget the security ID, you need to erase the CPU built-in flash memory.

To erase the data in flash memory, do following steps.

Double-click to open the file "exk0r32ocfg.exe" under the directory "C:¥Program Files¥NEC Electronics Tools¥TK-driver" (as the installation directory is default).

"78K0R Starter Kit Setting" starts.
Set "Flash Memory" to " Erase flash memory at debugger start up ", then click "Setting".



Restart the integrated debugger (ID78K0R-QB).

When you could confirm the debugger is working, open "exk0r32ocfg.exe" again. This time, select "KEEP flash memory at debugger start up", then click Setting. (Because there is a limit of erasing times for flash memory, it is recommended to try not to erase flash memory many times)

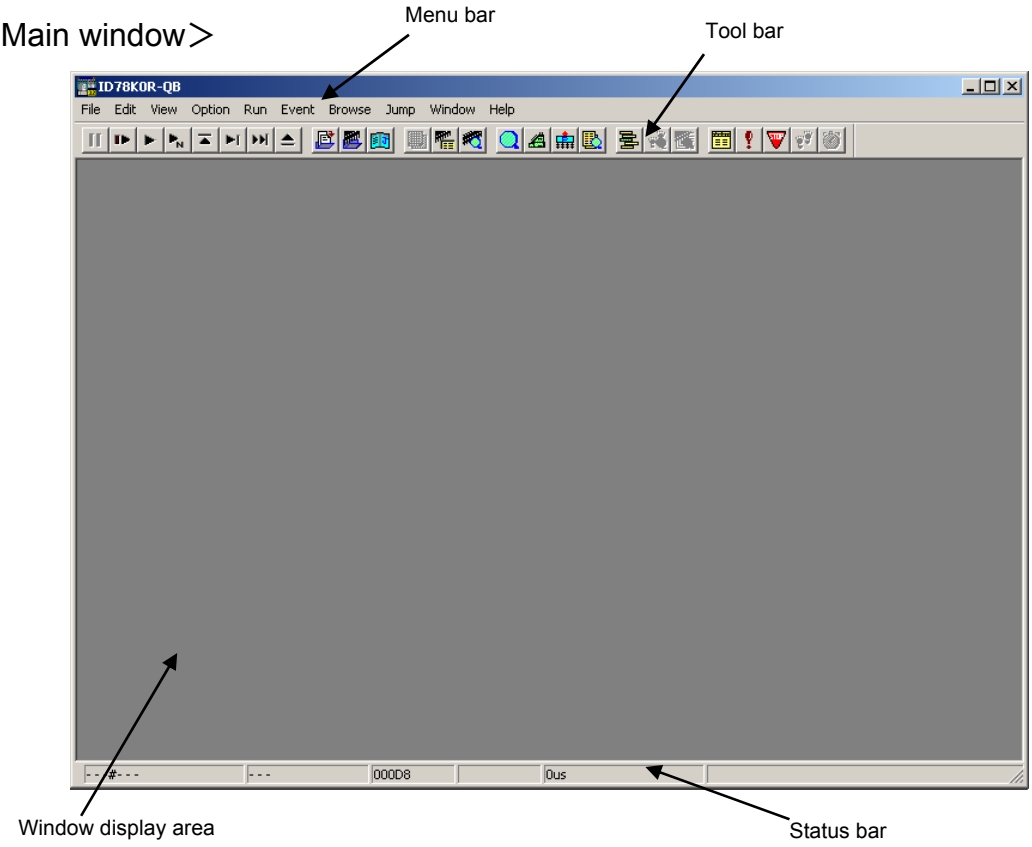
※ ID Code

The ID Code is a mechanism to prevent an unwelcome third party from accessing your source code by initiating the debugger. Therefore, it is recommended to modify the ID Code from the default value to secure your original source code. However, once you modify it, then, if you forget the security ID or mistakenly over-write 0x00(value) to the address of 0xC3, the debugger ID78K0R-QB 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, you can define the new ID Code. You may load your source code from the debugger with a load module file.

3.10 Introduction of integrated debugger（ID78K0R-QB）

ID78K0R-QB displays the internal status of the CPU and controls monitor functions in the main window.
The initial screen of ID78K0R-QB is as follows.

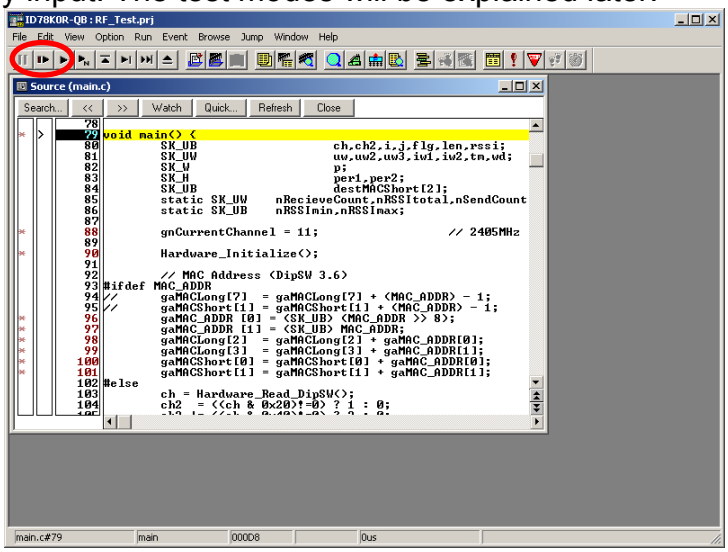
< Main window＞



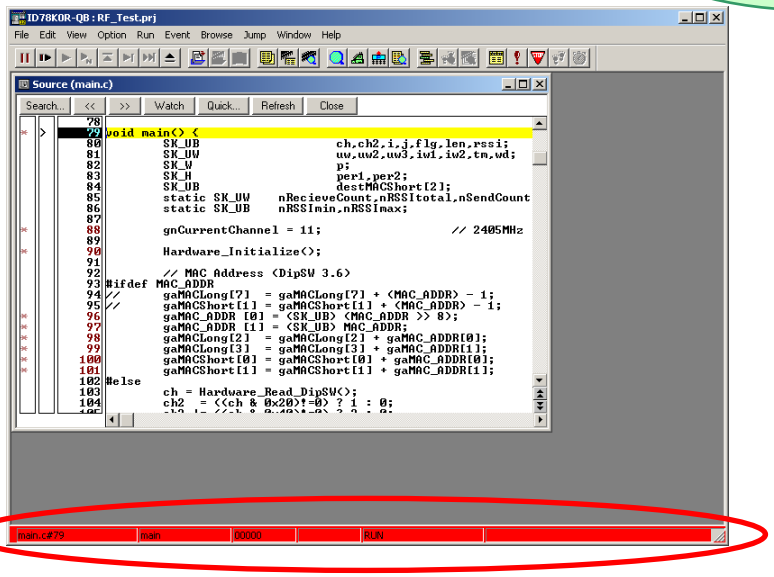
For more details, please refer to the user's manuals of ID78K0R-QB.

3.11 **Executing program**

If you click “GO”  , the execution of the code will start.
You can know it by the red bar at the bottom.
However, because this RF Test Program requires a key input from HyperTerminal to set a test mode, the program is waiting for the key input, while the USB connection to PC is occupied with the debugger interface. To debug the each test mode of operation, you may modify the source code to specify a test mode by skipping the key input. The test modes will be explained later.



Execute the program

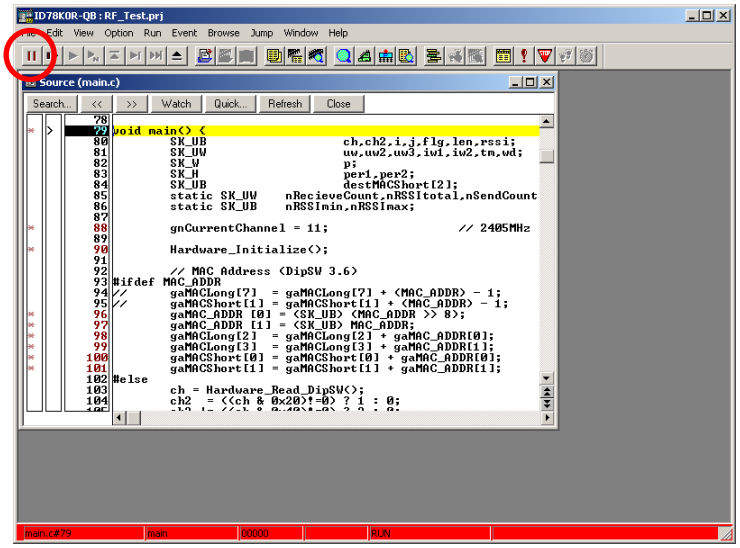


When programs are running, the status bar will be red.

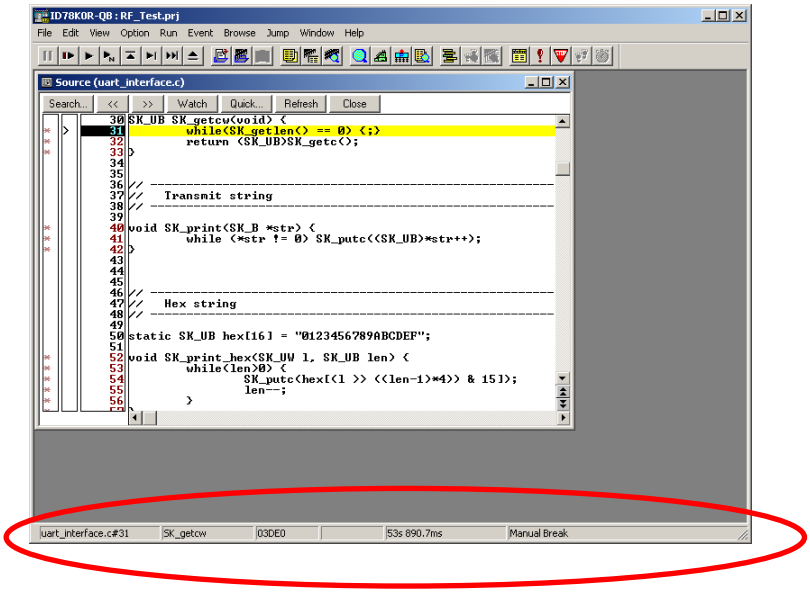
3.12 **Stopping program**

Now, you are going to stop the program.

Press the ID78K0R-QB's stop button , or in the menu, select [Run]→[Stop].



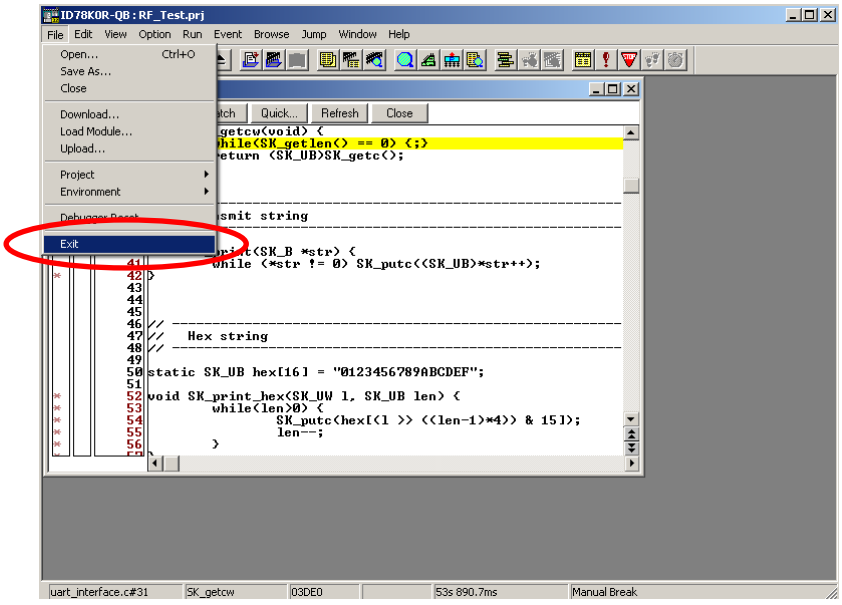
Stop the program



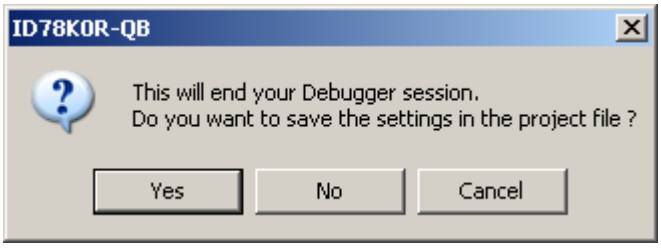
When the program stops, the status bar changes back to the original color.

3.13 Terminating integrated debugger (ID78K0R-QB)

Select "File" on menu bar, then "Exit".



The Exit confirmation dialog box is displayed.



If you push the “Yes”, ID78K0R-QB is terminated after preserving a present environment.
If you push the “No”, ID78K0R-QB is terminated without preserving a present environment.

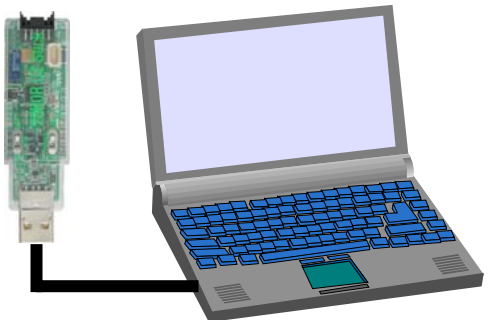
3.14 RF Test Program

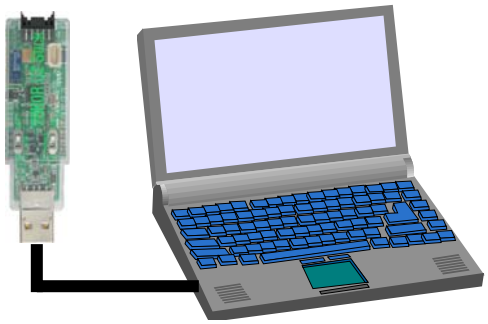
3.14.1 Procedure for one to one transmit/receive test

1). Assumption here in this section is, you have two 78K0R UZ Stick. and you need identical number of PCs or one PC with more than one USB interface, Hereinafter, the 78K0R UZ Stick, which you have loaded programs to, is referred as to the "**transmitter**" and the other one with USB interface to the second PC for debugging is referred as to "**receiver**", which send back the test result to the Transmitter. The receiver can work without PC, but now, you set this 78K0R UZ Stick to the debug mode.

Transmitter use as Stand alone.
Execute terminal software.

Receiver Debugger use.
Execute ID78K0R-QB.





Short address : 0001

Short address : 0002

2). Preparation for Receiver

Start PM+ with referring to Chapter 2, then open "C:¥TK78K0R¥SAMPLE_UZStick¥78K0R_UZSTICK_RF_Test¥RF_Test.prw".

Select "Tool" on menu bar, then "Compiler options..." to open "Compiler Options" window.
Select "Preprocessor" tab.
The statement "CPU78K0R,F0114664,MAC_ADDR=0x0001" is in "Define Macro" field.
Change the statement to "

CPU78K0R,F0114664,**MAC_ADDR=0x0002,RECEIVER**".

By defining "MAC_ADDR=0x0002", the MAC short address of the receiver is set to "0002".
By defining "RECEIVER", the receiver is set to “receiver mode” as soon as the program starts.

Click the rebuild button  or select "Build", then "Rebuild", to rebuild.
Set the switches on the Receiver "78K0R UZ Stick" as shown below.

Switch	Setting
USB	DBG
POWER	USB

Start the debugger, load the module file, and then run the program on the debugger, with referring to "3.9 Starting integrated debugger".
Now, the receiver "78K0R UZ Stick" is standing by for receiving commands with wireless data from the transmitter.

3). Preparation for Transmitter

Next, you need to set for the transmitter "78K0R UZ Stick" and the PC.

Set the switches on the transmitter "78K0R UZ Stick" as shown below.

Switch	Setting
USB	SER
POWER	USB

Connect USB cable to the second PC, which you do not use for debugging.
Confirm the power LED is lighted.

4). Hyper Terminal

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

Setting of HyperTerminal

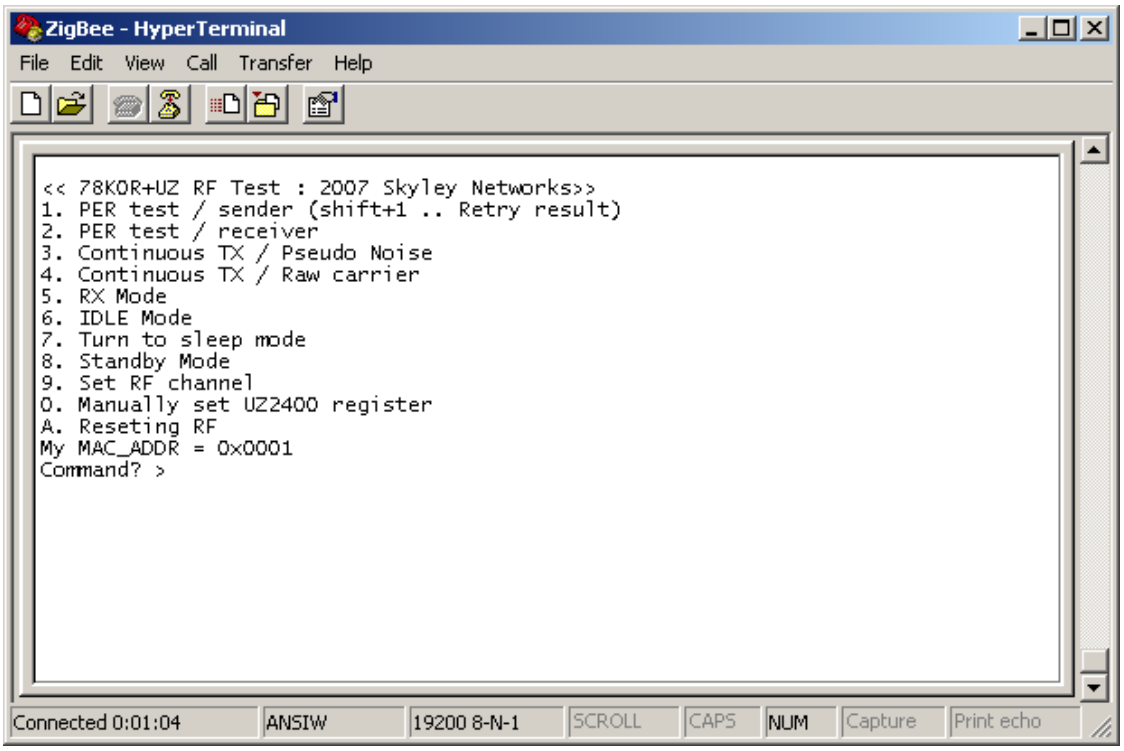
Bits per second	115200
Data bits	8
Parity	None
Stop bits	1
Flow control	None

(Property -> Setting -> ASCII)
Local Echo OFF
No Line Feed

If you are not sure about the COM port number, click "Start" -> "Settings" -> "Control Panel" -> "System" -> "Hardware" -> "Device Manager" and check the number at NEC Electronics Starter Kit Virtual UART" under "Ports (COM & LPT)".

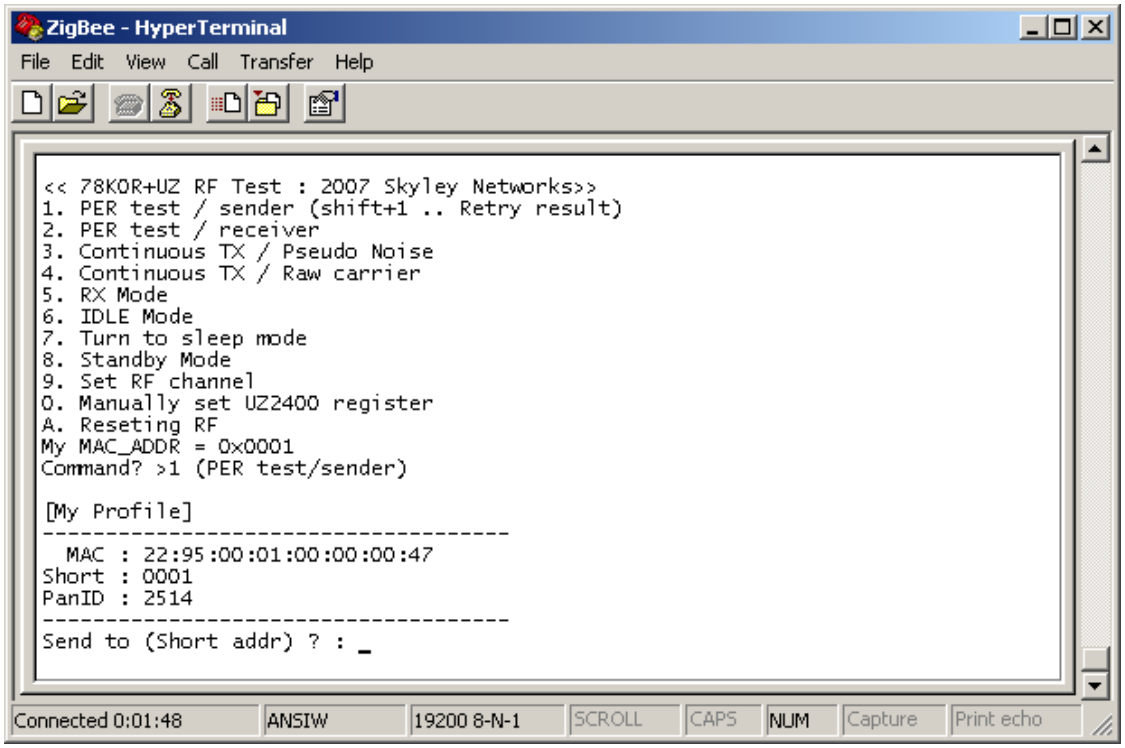
Press [ENTER] on your keyboard.
Now you will find the following opening menu in the window.

If the window is not displayed, check followings.
- Set the power switch of the transmitter "78K0R UZ Stick" to "BAT" once, then set back to "USB" again.
- Re-confirm the setting for the COM port of hyper terminal is correct.



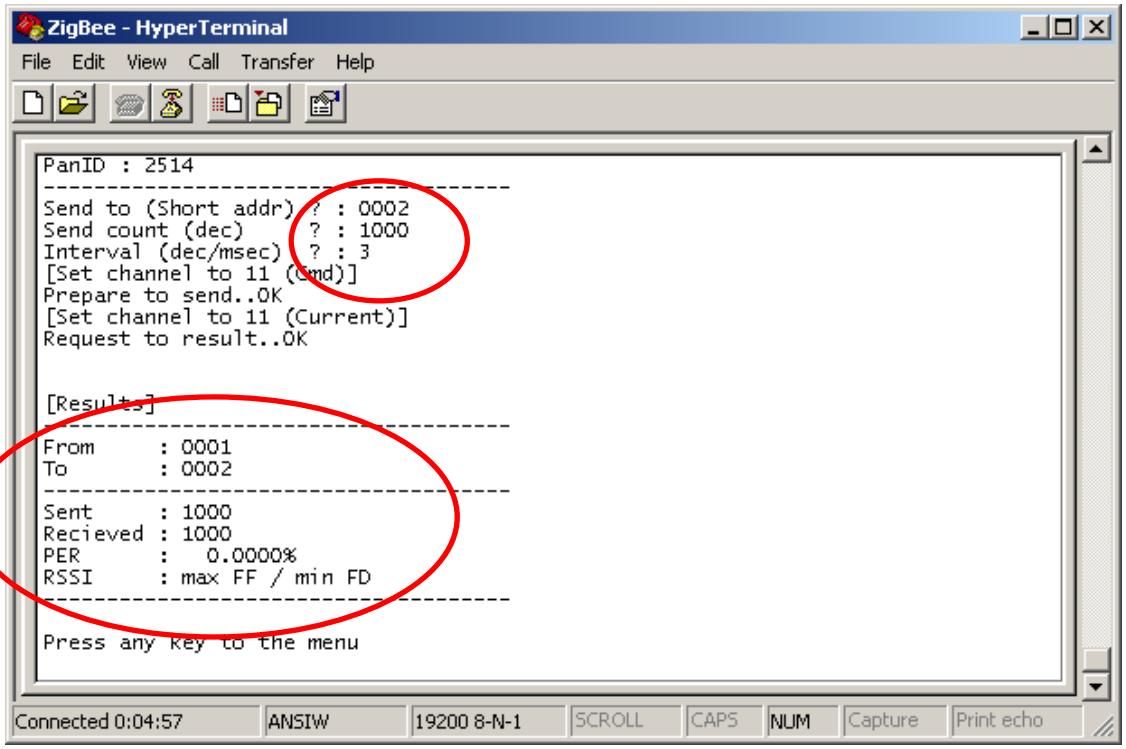
5). Execution of the Transmit/Receive Test

To initiate the PER, Packet Error Rate, 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.



Now, you may 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 3 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

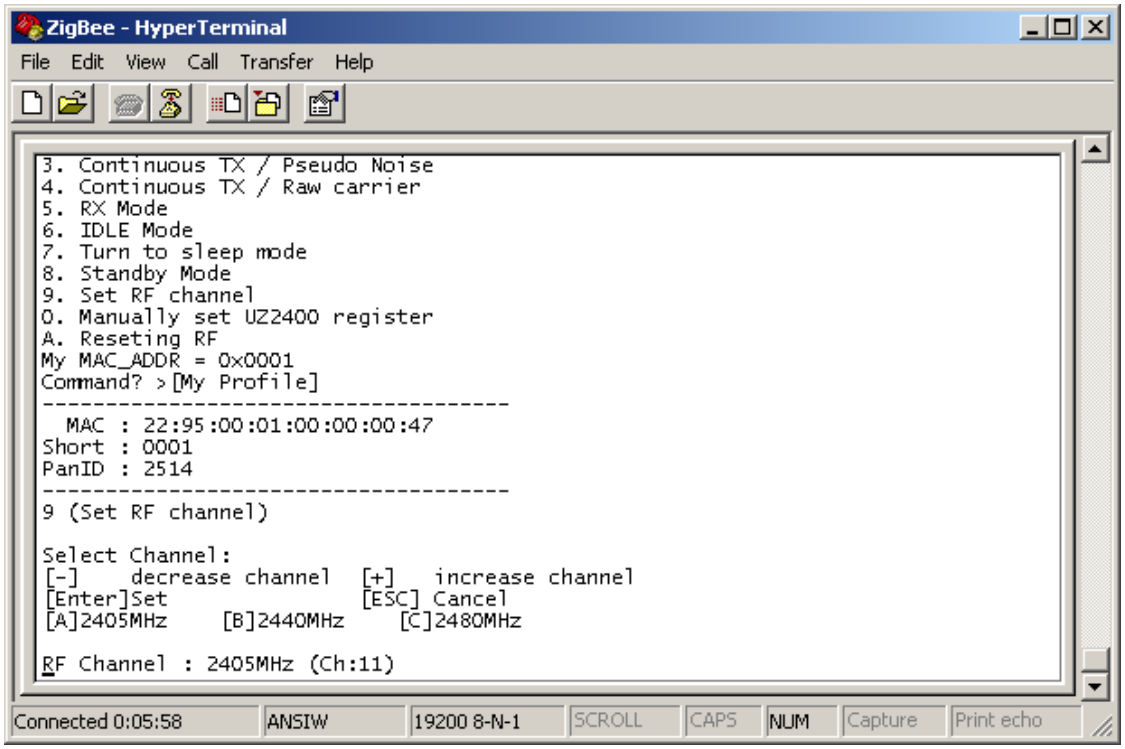


RSSI is expressed in the hexagonal value of 256 levels, which indicates the signal strength in the received signal. For more details of the RSSI value, please refer to the datasheet of the UZ2400 RF chip.

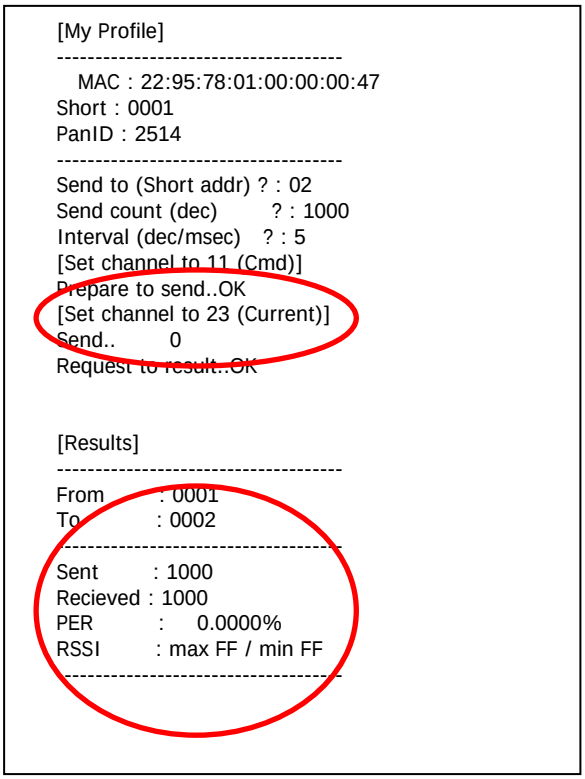
Please note the PER and the RSSI are measured at the receiver side.
The receiver does not send back the test packets, but only the test result.

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. 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.

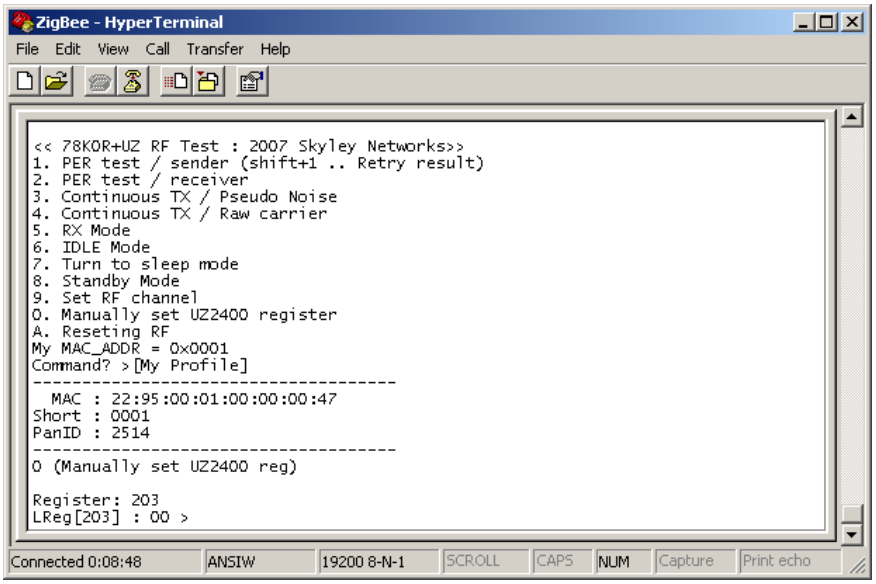


To execute the PER test at the channel 23, press [Enter] in your keyboard, then, choose “1” to initiate the PER test mode. Then, you may input 1000 packet in 5 msec interval to see the following example. Please confirm the channel used is 23th in the display. Please note the receiver will learn which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



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.



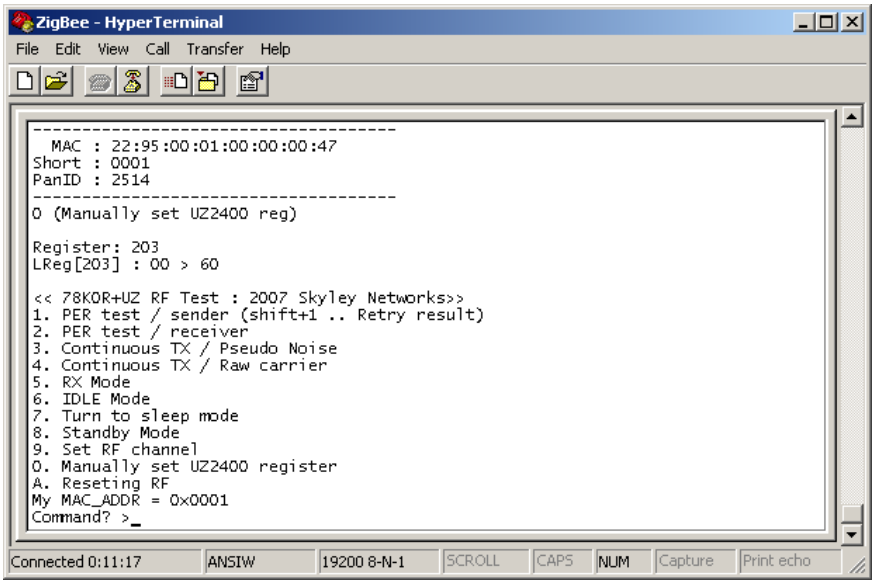
The register bits are defined as follows,

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

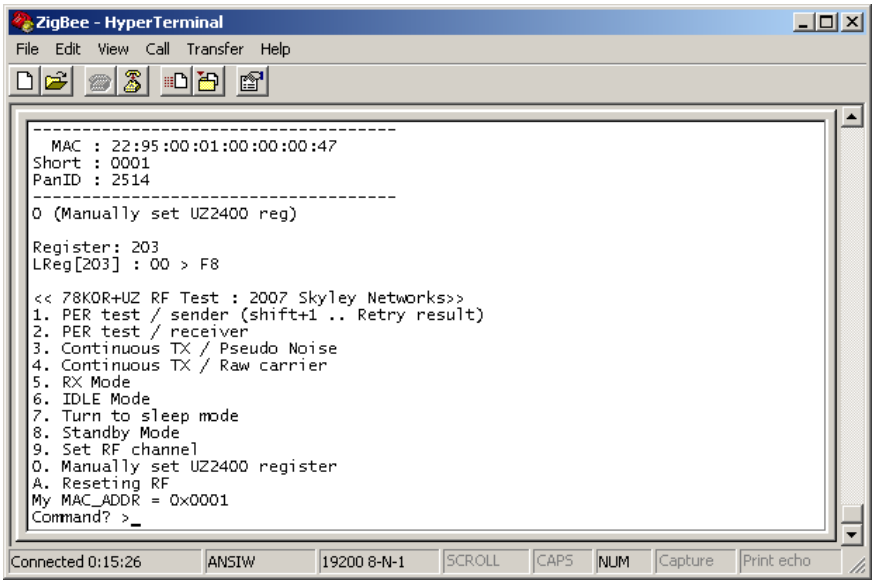
For instance, if you wish -15 dB, please input “60”, as follows,

“LREG[203] : 00 > 60”

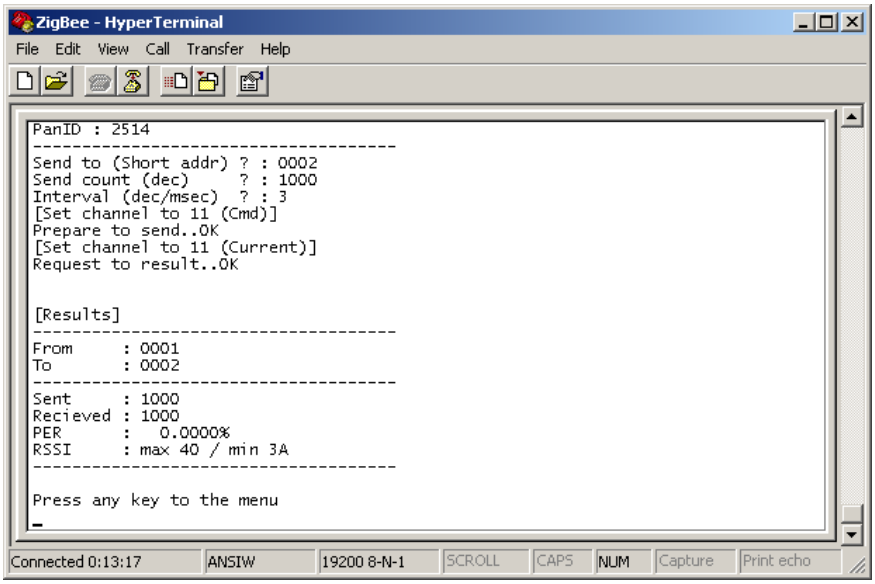
Then, you will start the PER test.



The minimum output power is set by “F8”.



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



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.

3.14.2 PER test / receiver

The Menu 2 sets the 78K0R UZ Stick to the receiver in the PER test.
If you have two PCs, you can connect two 78K0R UZ Stick to each of two PCs, then, you will apply this mode to one of them.
In your current case, your receiver board is now being connected to the debugger. Therefore, you cannot access to these menu to utilize this mode setting. Alternatively, you have set the receiver 78K0R UZ Stick to the receiver mode by setting the compiler option.

3.14.3 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.

3.14.4 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.

3.14.5 RX Mode

The Menu 5 initiates the receiver mode.

3.14.6 IDLE MODE

The Menu 6 sets the UZ2400 into the IDLE mode.

3.14.7 Sleep MODE

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

3.14.8 Standby MODE

The Menu 8 sets the UZ2400 into the Standby mode.

3.14.9 Set RF channel

The Menu 9 allows you to set the RF channel.

3.14.10 Manually set UZ2400 register

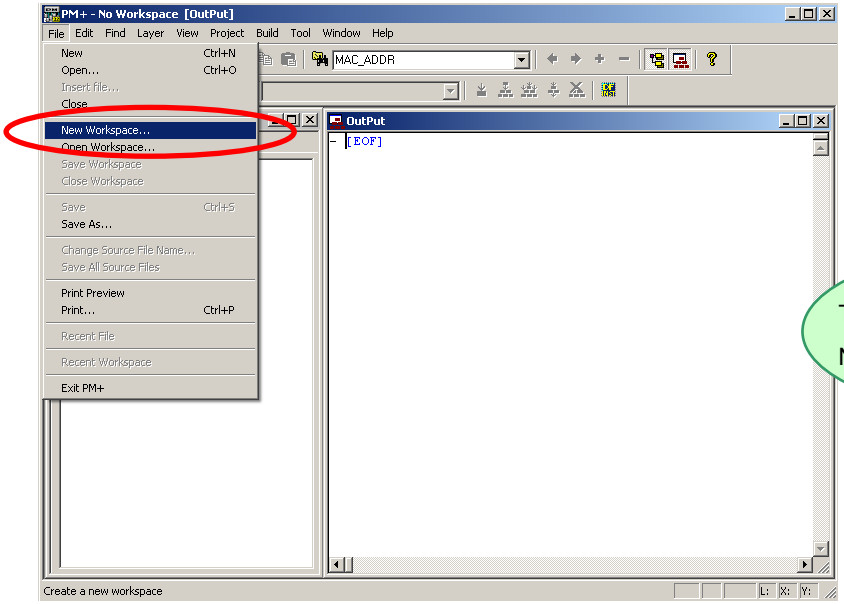
The Menu 0 allows you to set the UZ2400 registers.
Please refer to the datasheet of the UZ2400 RF chip for the definition of registers.

3.14.11 Resetting RF

The Menu A allows you to reset the UZ2400 registers.

3.15 Creating a new PM + workspace (project)

You may wish to create a new work space in the PM + to initiate a new project. Please select select [File]→[New Workspace...] in the pull-down menu of the PM +.



The dialog box for creating New workspace is displayed

<Description of items>

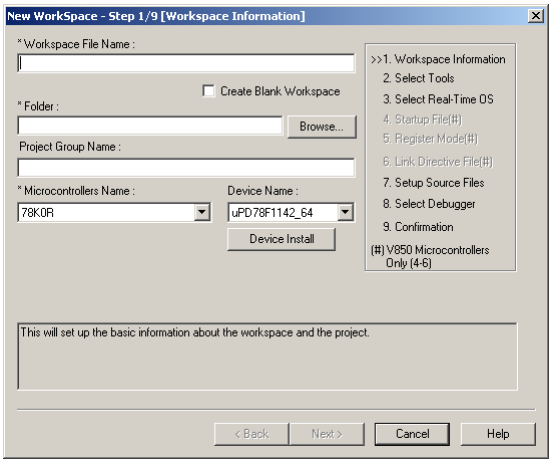
Workspace File Name:
-> Specify the name of the workspace file that manages the project files.
.prw is automatically suffixed as the file type.
A project file (.prj) of the same name is simultaneously created.

Folder:
-> Specify the folder for saving the workspace file by writing its absolute path.
This item can be selected from a reference dialog box by pressing the Browse... button.

Project Group Name:
-> Specify this item if wishing to manage multiple projects together in function units. If nothing is specified, this item is the same as the workspace file name.

Series Name:
-> Specify the series name of the device to be used.

Device Name:
-> Specify the name of the device to be used.



The concrete information set here is described on the following pages

Input the workspace information setting as follows.

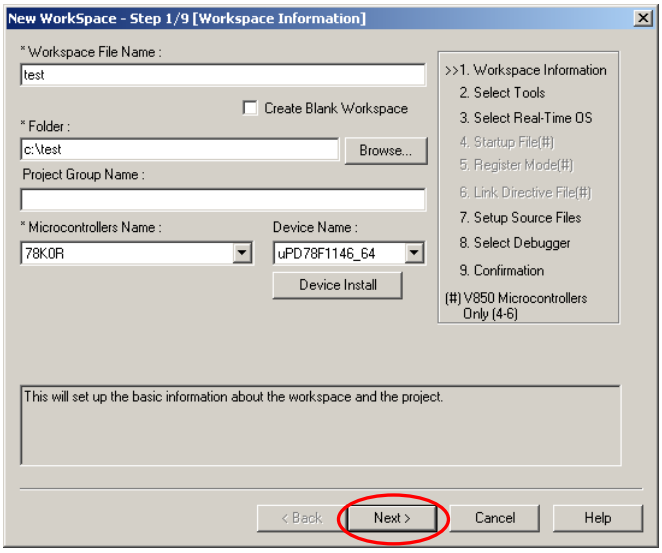
Workspace file name
→ test

Folder
C:¥test

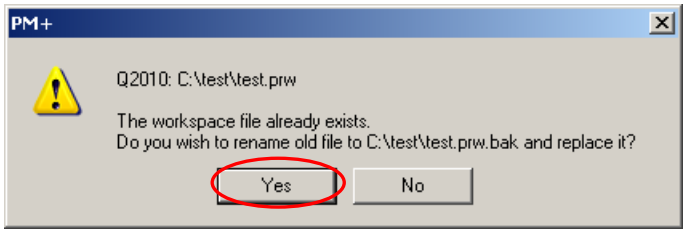
Project Group Name
→ Don't input this item.

Series Name
→ 78K0R

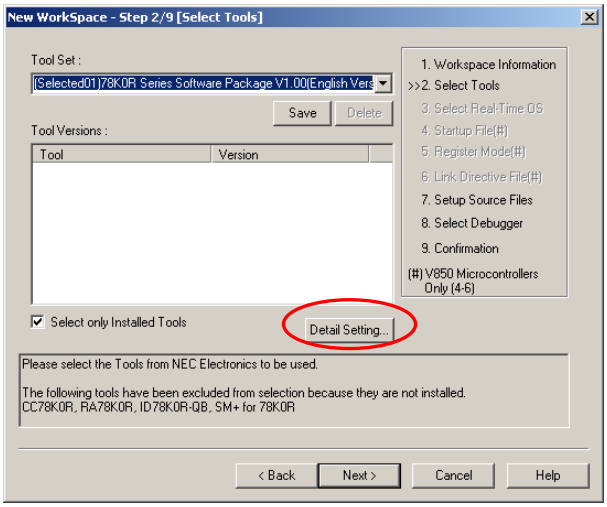
Device Name
→ uPD78F1146_64



Push the Next > button.

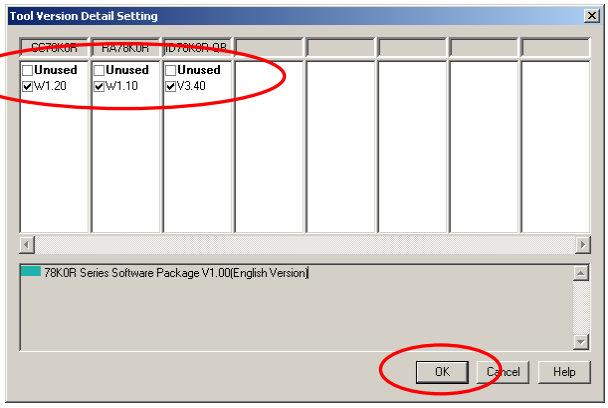


Push the Yes button.

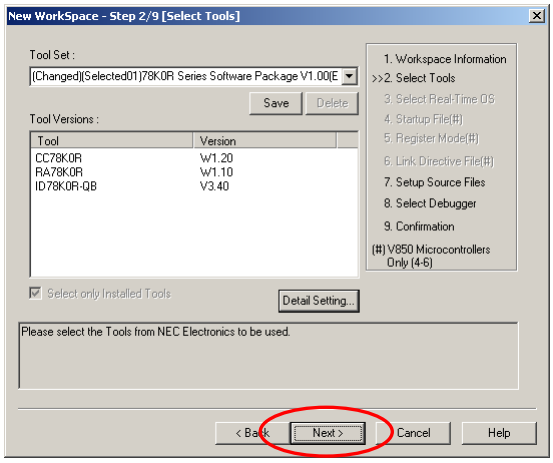


Push the Detail setting button

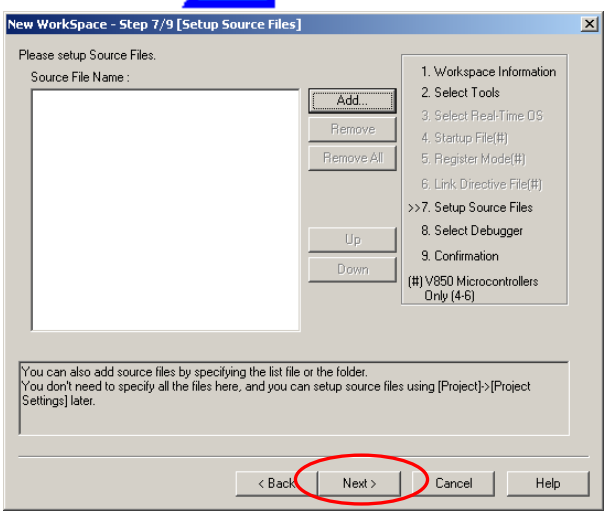
Set the version of tools as follows.
CC78K0R : W1.20
RA78K0R : W1.10
ID78K0R-QB : V3.40



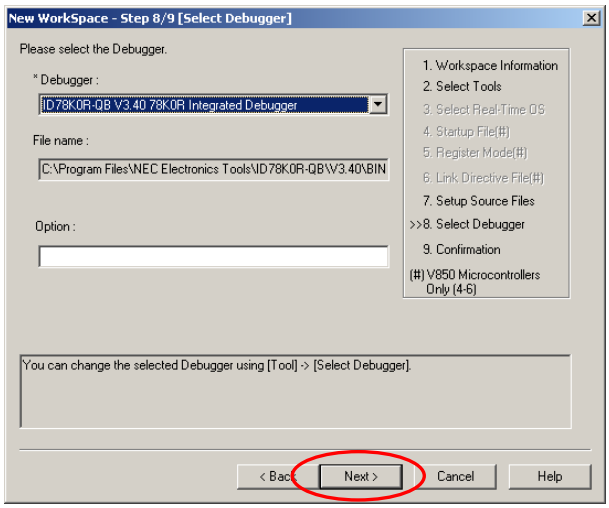
Select tools as above screenshot, then click OK .



Click Next >

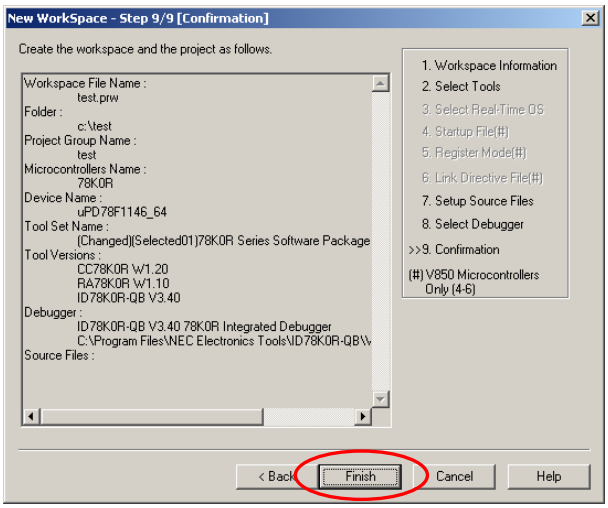


Click Next >



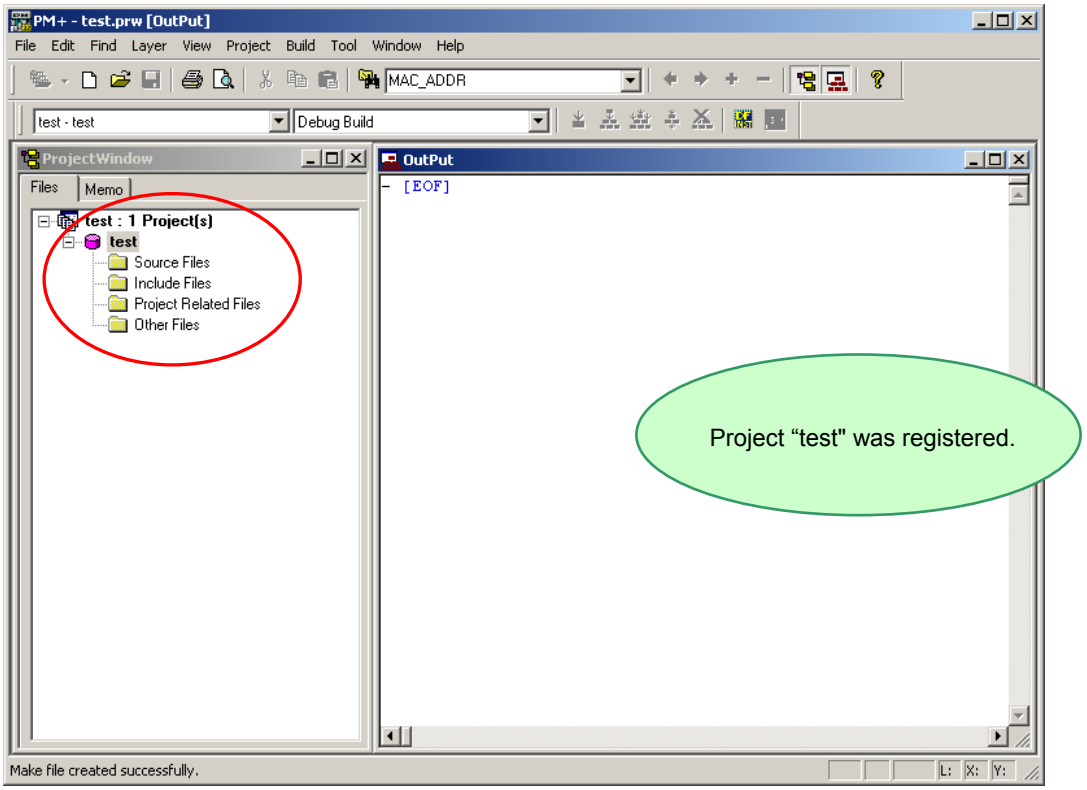
Select ID78K0R-QB V3.40

Click Next >



Check the project information setting contents.

Click Finish



This completes workspace and project creation.

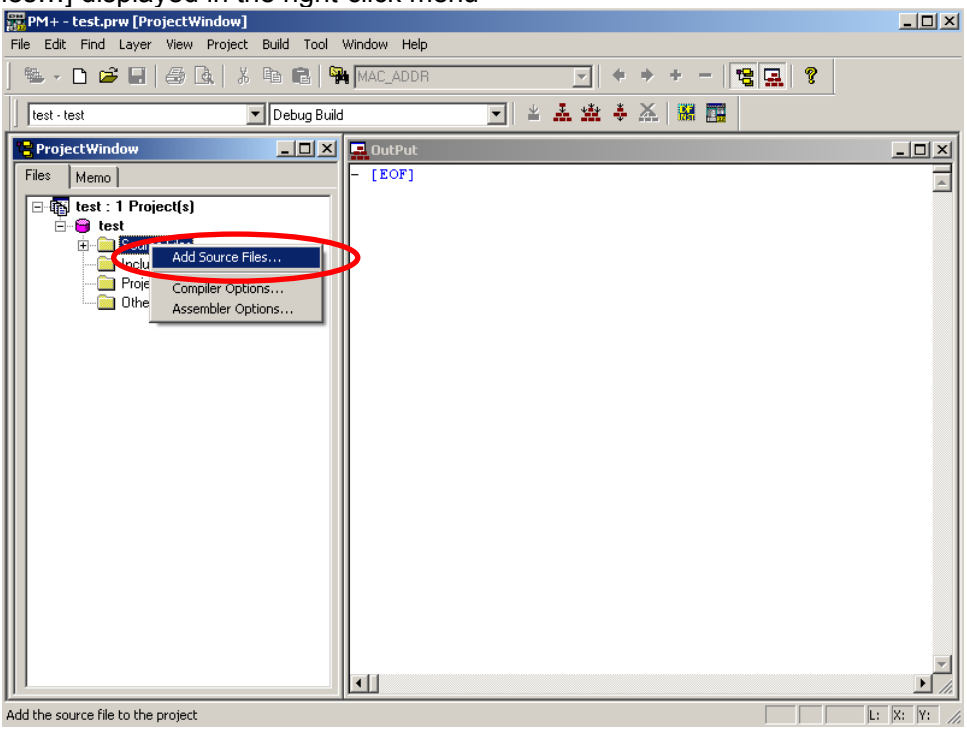
Additional source files can be registered at any time thereafter.

For details, refer to ”Registering additional source file”

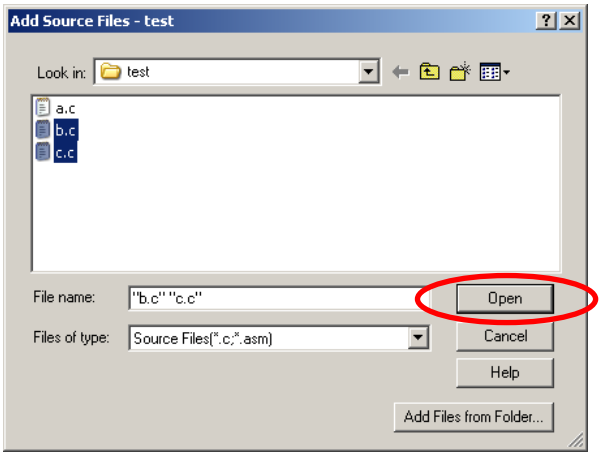
Also, you need to do the settings for on-chip debug. Please refer to "2.4 Set Linker Options", "2.5 Set Compiler Options", and "2.7 Check Debugger Settings".

3.16 Registering additional source file

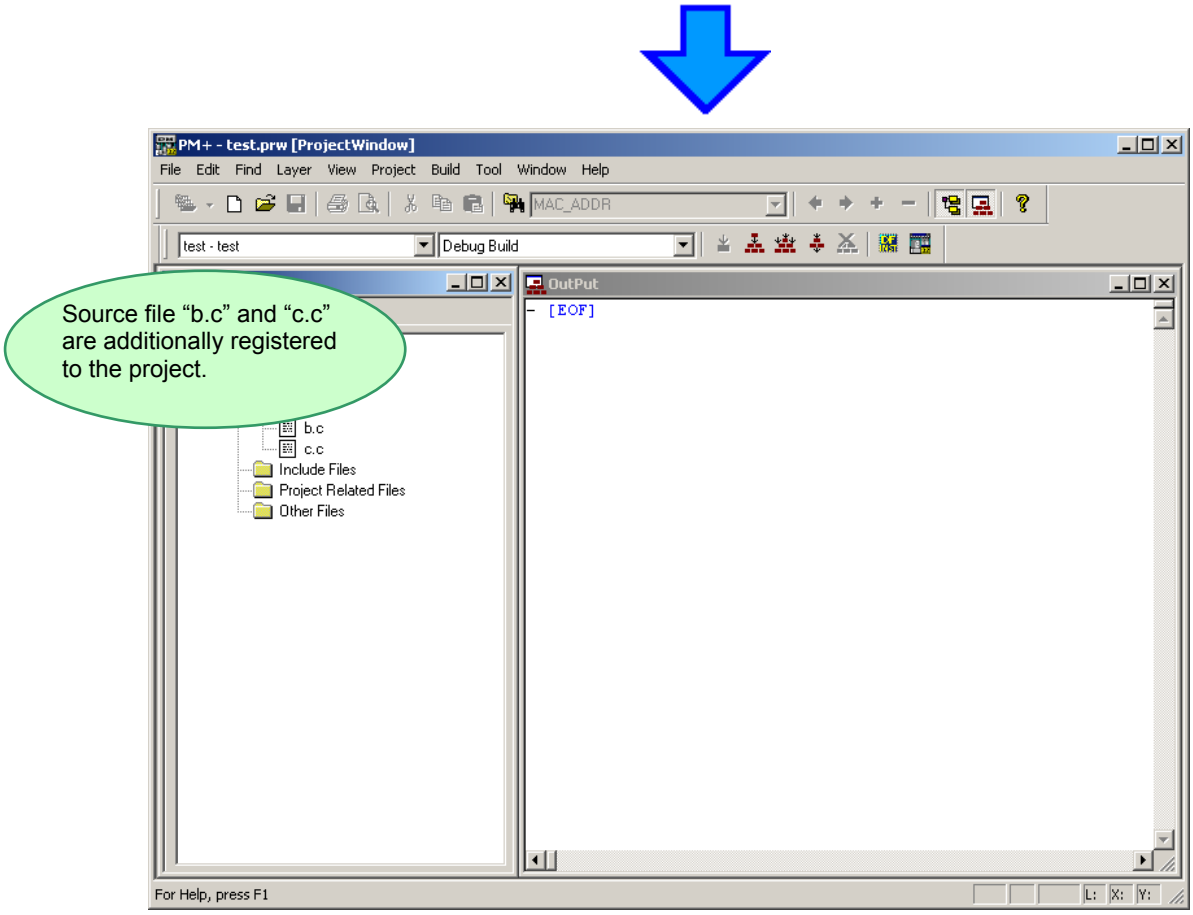
The method for registering additional source files to a project is described below.
The following example shows the additional registration of source files “b.c” and “c.c” with source file “a.c” already registered.
Place the cursor on the source file in the Project window of PM +, and select [Add Source Files…] displayed in the right-click menu



Select source files “b.c” and “c.c” and then press the Open button.



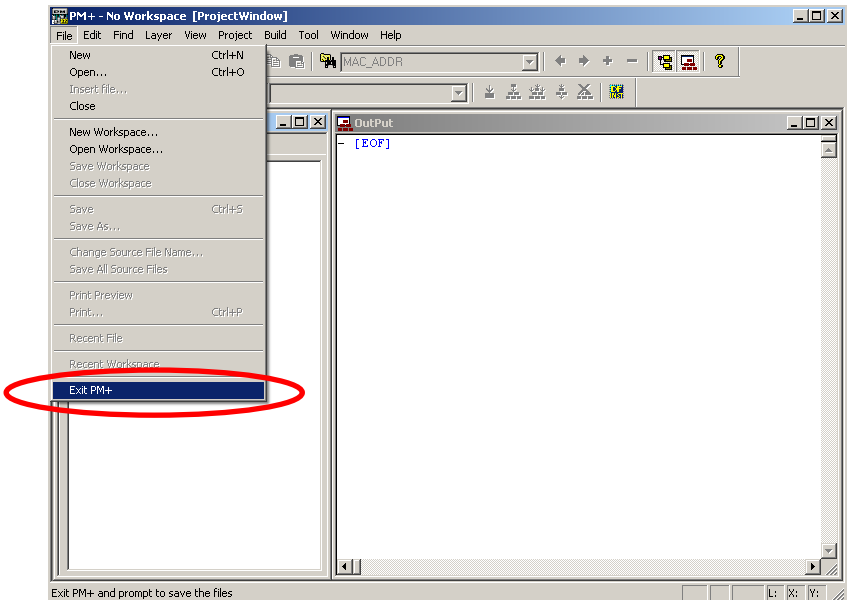
Multiple source files can be selected by clicking the desired source files where pressing Ctrl key.


PM+ - test.prw [ProjectWindow]
File Edit Find Layer View Project Build Tool Window Help
MAC_ADDR
test - test
Debug Build
OutPut
[EOF]
b.c
c.c
Include Files
Project Related Files
Other Files
For Help, press F1
Source file “b.c” and “c.c” are additionally registered to the project.

3.17 Terminating PM +

In the PM + menu, select [File]→[Save Workspace].
Then, select [File]→[Close Workspace].

In the PM + menu, select [File]→[Exit PM +].



PM + ends.

4 IEEE 802.15.4 MAC Sample Program

The sample implementations utilizing the MAC stack are offered in this evaluation kit.

The MAC Sample program :TextChat

This chapter introduces the usage of MAC application

The MAC Sample program is 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 one PC with more than one USB interface, and two 78K0R UZ Stick.

The MAC Sample Program 1 is provided in the form of the C source codes.

If you wish to tailor the sample program to meet your specific needs, you can edit the source code, re-compile it with debug build to generate a load module file, then, start the debugger to load the tailored execution code on to the microcontroller for further debugging on the project manager PM +. In this procedure, the Flash programmer is not required. However, because the USB connection to instruct operation to the program is occupied for the debugging purpose, alternatively, you can make a release build to achieve a new hex file, on the project manager PM +.

As a general remark, please respect your local regulation of electro-magnetic RFssion. In general, it is suggested to use the 78K0R UZ Stick in a radio anechoic chamber.

It supports text chat for one coordinator and 4 end devices.

4.1.1 Programming to the 78K0R UZ Stick

For chatting, please prepare minimum 2, or maximum 5 78K0R UZ Stick.
You need identical numbers of PCs. or one PC with more than one USB interface,

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

One 78K0R UZ Stick will be "Coordinator". Other 1-4 78K0R UZ Stick will be "End device".
You use the same project files for both "Coordinator" and "End device".

Start PM+, and open the file
"C:¥TK78K0R¥SAMPLE_UZStick¥78K0RUZSTICK_MAC_Sample¥78K0RUZSTICK_MAC_Sample.prw".

Select "Tool" on menu bar, then "Compiler options..".
Select "Preprocessor" tab on "Compiler Options" window.
To write programs to the first 78K0R UZ Stick, enter "CPU78K0R,F114664,MAC_ADDR=0x0001" on "Define Macro". For the second and third 78K0R UZ Stick, enter "CPU78K0R, F114664,MAC_ADDR=0x0002" and "CPU78K0R, F114664,MAC_ADDR=0x0003". The number "x" of " MAC_ADDR=x" must be a unique number.

Click rebuild button on PM+ or select "Build" -> "Rebuild" on menu bar to rebuild.

Start the debugger from PM+, then write different programs to each 78K0R UZ Stick (for the information about how to write programs, refer to "3.1 Starting PM+" through "3.9 Starting integrated debugger").)

4.1.2 **Setting up the 78K0R UZ Stick to your PC**

Set the 78K0R UZ Stick as shown below. Then, connect to USB interface on the PC.

Switch	Setting
USB	SER
POWER	BAT

Start Hyper Terminal with referring to "3.14 RF Test Program".

Settings of the Hyper Terminal should be set as follows

Bits per second	115200
Data bits	8
Parity	None
Stop bits	1
Flow control	None

When the Hyper Terminal starts, run the sample application by setting the POWER switch to USB.

In the same way, connect the other 78K0R UZ Stick to PC, and start Hyper Terminal. If the PC has more than one USB ports, you can connect to more than one 78K0R UZ Stick, and you can start more than one Hyper Terminals for those COM ports on each 78K0R UZ Stick.

4). Hyper Terminal

Now you will find the following opening menu in the window.
If not, please try Power On Reset by switching the POWER switch to BAT, and, then, back to the USB position.

```
<< 78K0R+UZ Sample Application: Skyley Networks >>
My MAC extended address
= 22950000100000047

  Command >
```

Then, press Enter,

```
[Help] -------------------------
S: Send Message
M: MLME Associate test
C: Start Coordinator test
--------------------------------

Command? >
```

Please do the same for your other 78K0R UZ Stick and PCs.

4.1.3 Designation of a coordinator

Now, you must decide which 78K0R UZ Stick is a coordinator.
Go to the PC of the coordinator, and press C.

```
Command? >C

> MLME-START.request
> MLME-START.confirm
>  Status:00

Command? >
```

Now the coordinator has started.

4.1.4 Network Association

For other PCs for other 78K0R UZ Stick, please press M.

```
Command? >M

> MLME-ASSOCIATE.request
> MLME-ASSOCIATE.confirm
>  Associated ShortAddr:4321
>                Status:00

Command? >
```

Now, this particular 78K0R 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 78K0R UZ Stick.

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

```
> MLME-ASSOCIATE.indication
>  from 2295000200000047 associated to 4321

[Help] ------------------------
S: Send Message
--------------------------------

Command? >
```

4.1.5 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? >
```

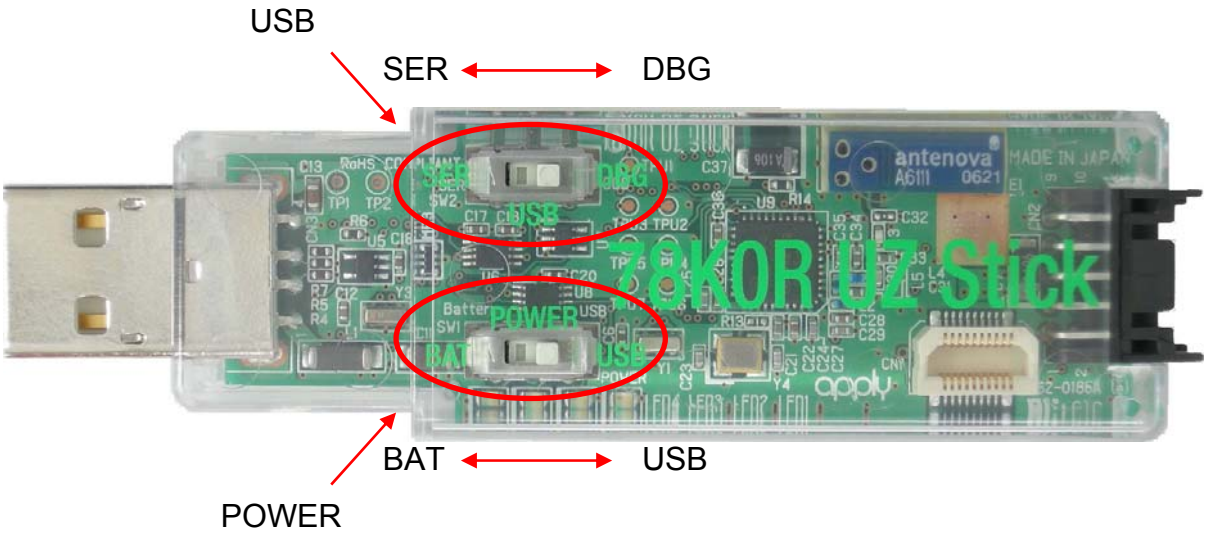
You will find the following message on the end device, 4321.
The sender's short address is "1975", and the PAN ID is 2420 in this example.

```
Command? >
> MCPS-DATA.indication
>  from 1975/2420
Hello!
```

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

5 Mode setting of the 78K0R UZ Stick

The combination table of the switch of the 78K0R UZ Stick is shown.



Usage case / Switch	Normal (USB Power Supply)	Normal (Battery Power Supply)	Debug (USB Connection)
USB	SER	SER	DBG
POWER	USB	BAT	USB

CAUTION

Disconnect the USB cable from the PC when you need to change to Normal use, after Debug use.

6 Revision History

Revision	Contents	Date
Rev. 1.0	Initial Version	April 7, 2007
Rev. 2.0	Correction with the sample program change.	May 29, 2007
Rev. 3.0	Correction with the sample program change.	March 31, 2008
Rev. 3.1	Manufacturer change	June 20, 2008
Rev. 4.0	Correction with the sample program change.	March 09, 2009