User's Manual

TK-78K0R/KG3+UD

ZigBee™-ready
Wireless Network Evaluation Board
Using the UZ2400 RF chip
and the 78K0R/KG3 Microcontroller

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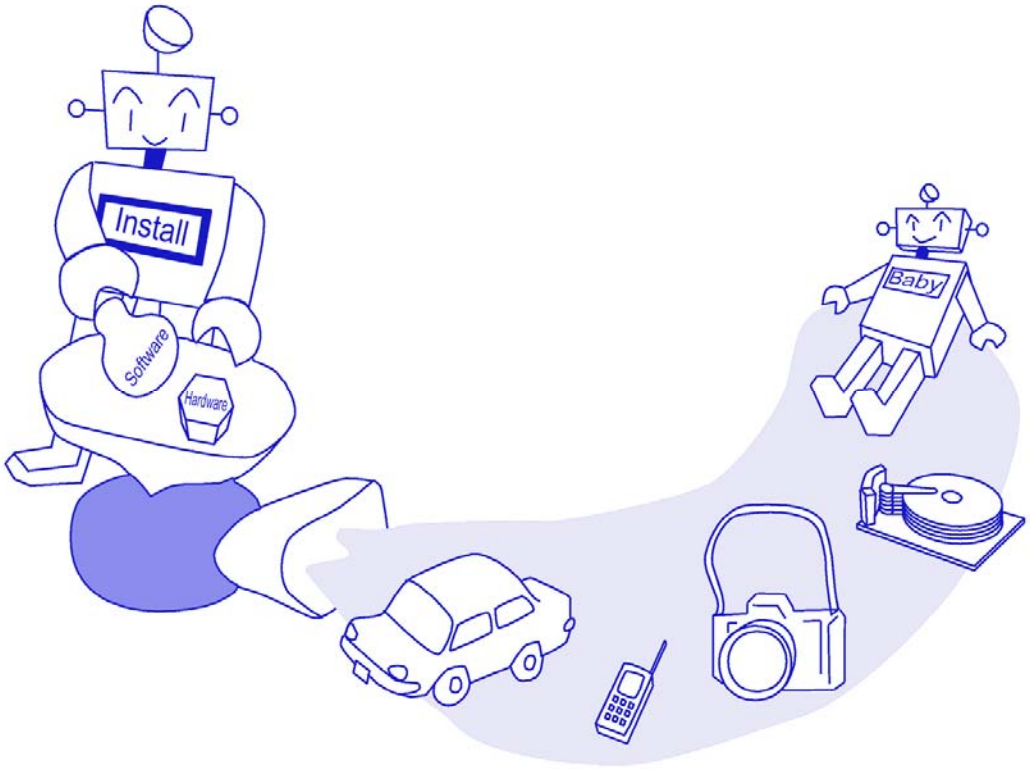
Welcome to the world of TK-78K0R/KG3+UD.

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.

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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

Chapter 1 Introductions
→Overview of this manual

Chapter 2 Preparations
→Introduction of soft tools, and sample programs and installation

Chapter 3 Experiences
→ Guide to the basic operations of PM + and the integrated debugger using sample programs.

Chapter 4 Hardware Specifications
→Explain the hardware of TK-78K0R/KG3+UD

Chapter 5 IEEE 802.15.4 MAC Sample Programs
→ Learn sample programs, which utilize the MAC library

Chapter 6 Troubleshooting
→Describe how to solve troubles you may face, such as errors when starting the integrated debugger (ID78K0R-QB)

Chapter 7 Other Information
→Introduce other information, such as how to create a new workspace (project) on integrated development environment (PM+), how to register additional source file, and some useful tips of the integrated debugger.
The circuit diagrams of demonstration kit are included in this chapter.

Chapter 8 Mode Setting of the Board
→ Explanation of switch setting.

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 + V6.31

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 W2.12 : 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 W1.33 : 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 V3.60

The Integrated Debugger ID78K0R-QB offers a debug environment on your PC, where the MS Windows 2000 or XP runs, if the TK board 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 “Does not erases data of flash memory in case of failures in enabling on-chip debugging”, you can erase the flash memory by using this starter kit.

2.1.7 Starter kit USB driver

This is a software driver for PC to access to the USB interface of the TK-78K0R/KG3+UD board.

2.1.8 The RF Test Program

The RF Test Program is used in [chapter 3 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 TK-78K0R/KG3+UD board 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 Program1 : Text Chat Program

The MAC Sample program 1 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 1 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 1, you need to prepare at least two PC with a USB interface and two TK-78K0R/KG3+UD boards.
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 +.

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 TK-78K0R/KG3+UD board in a radio anechoic chamber.

2.1.11 The MAC Sample Program2 : LED Control

The MAC Sample program 2 is developed to provide with another simple example to construct a star network utilizing the IEEE 802.15.4 PHY/MAC standard.

The MAC Sample Program 2 offers,

1). Designation of a network coordinator in a star configuration
2). LEDs on the coordinator board indicate which switch on which end device is pressed.

To use the MAC Sample Program 2, you need to prepare one PC with a USB interface and two TK-78K0R/KG3+UD boards or more boards, up to 5.
The MAC Sample Program 2 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 is occupied for the debugging interface, the USB connection is not available for applications. Alternatively, you may 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 TK-78K0R/KG3+UD board in a radio anechoic chamber.

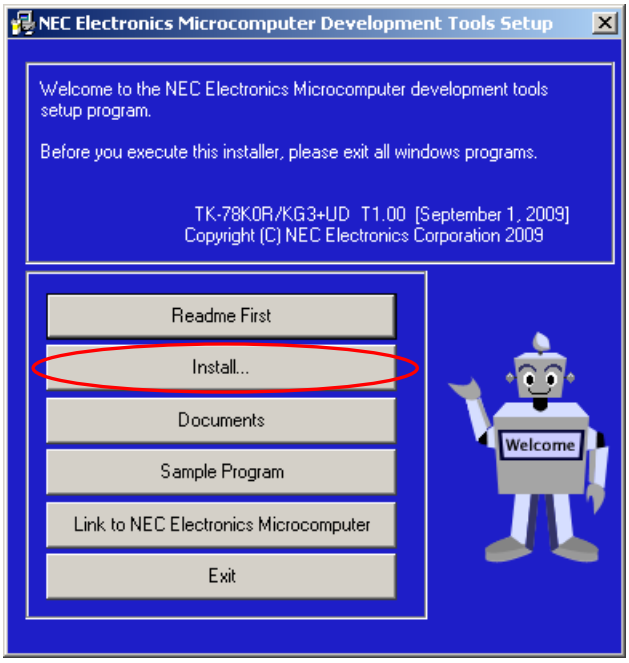
2.2 Installation of Software Development Tools

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.

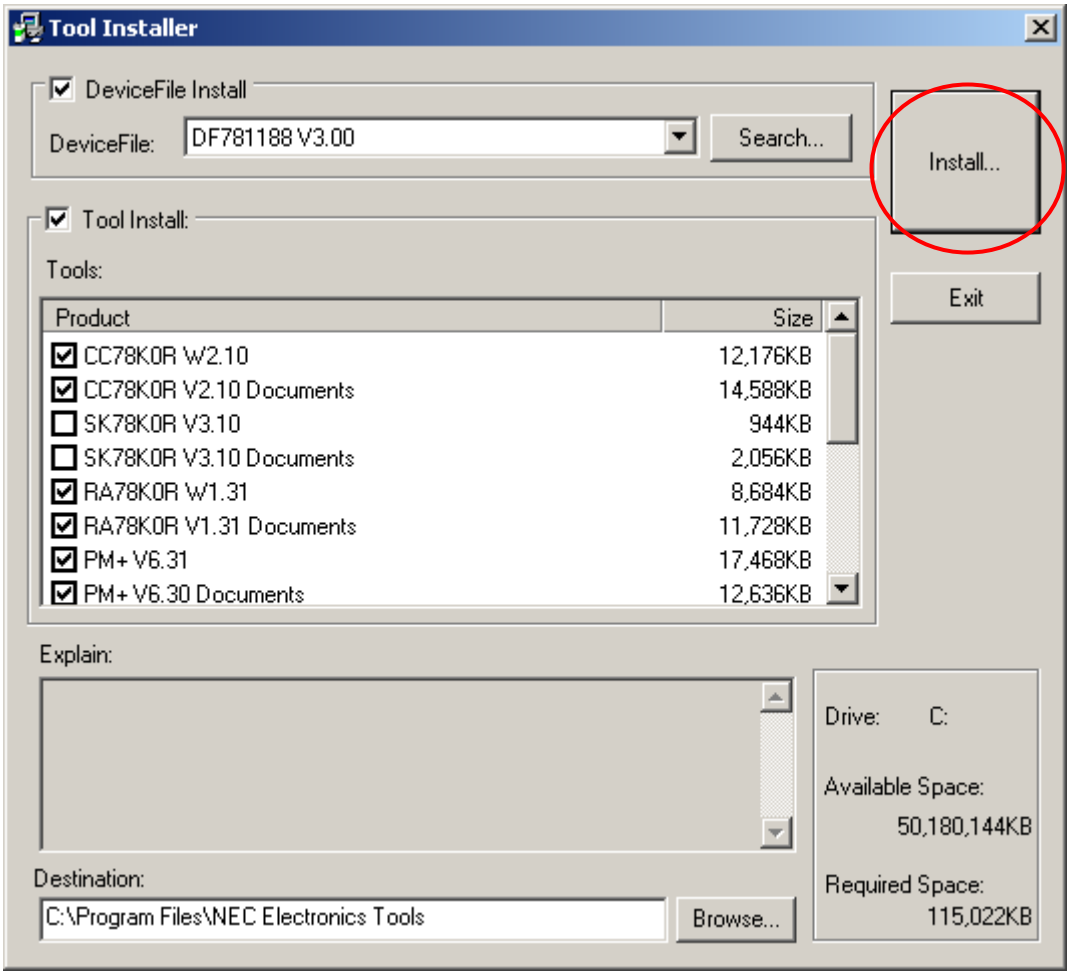
<6> Exit

Terminate the setup.

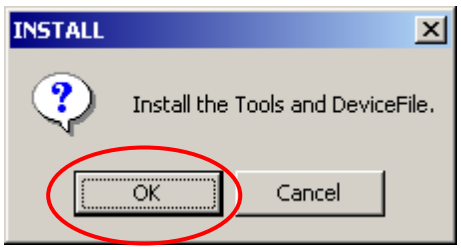
① Select products that you need to install.
(as default, all the products that you need to use the demostration kit are selected.)
"Explain" area displays an explanation of the selected product.
To change the installation destination, click Browse··· .

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

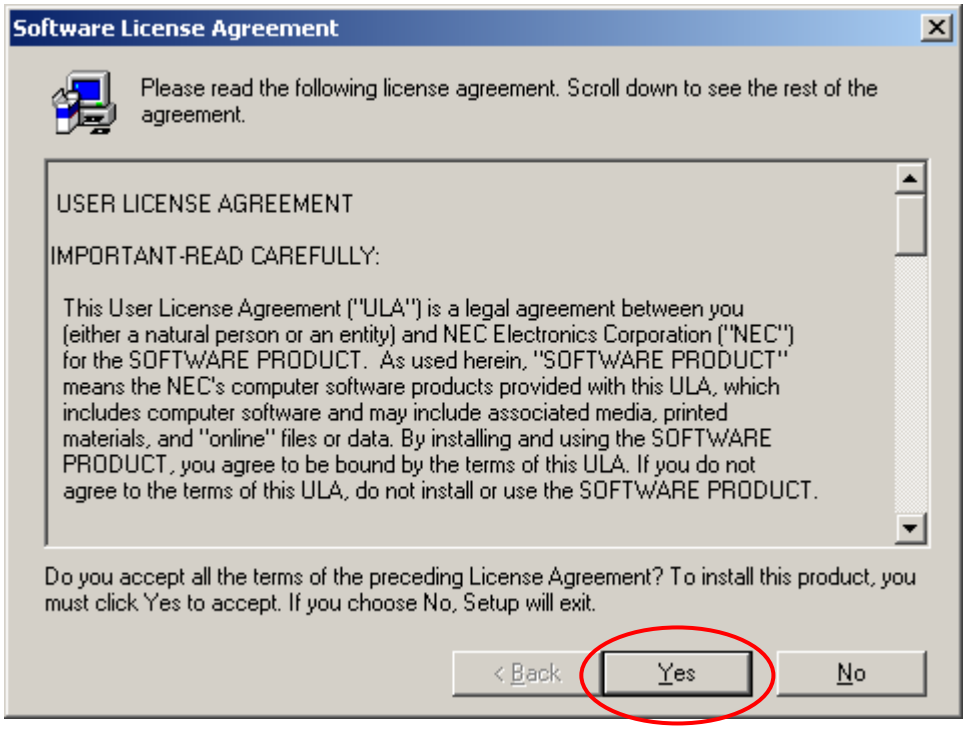
* In this document, it is assumed that users install the programs under "NEC Electronics Tools" directory (default installation directory). Users can find the tools by selecting “Start Menu” -> "Programs" -> "NEC Electronics Tools".



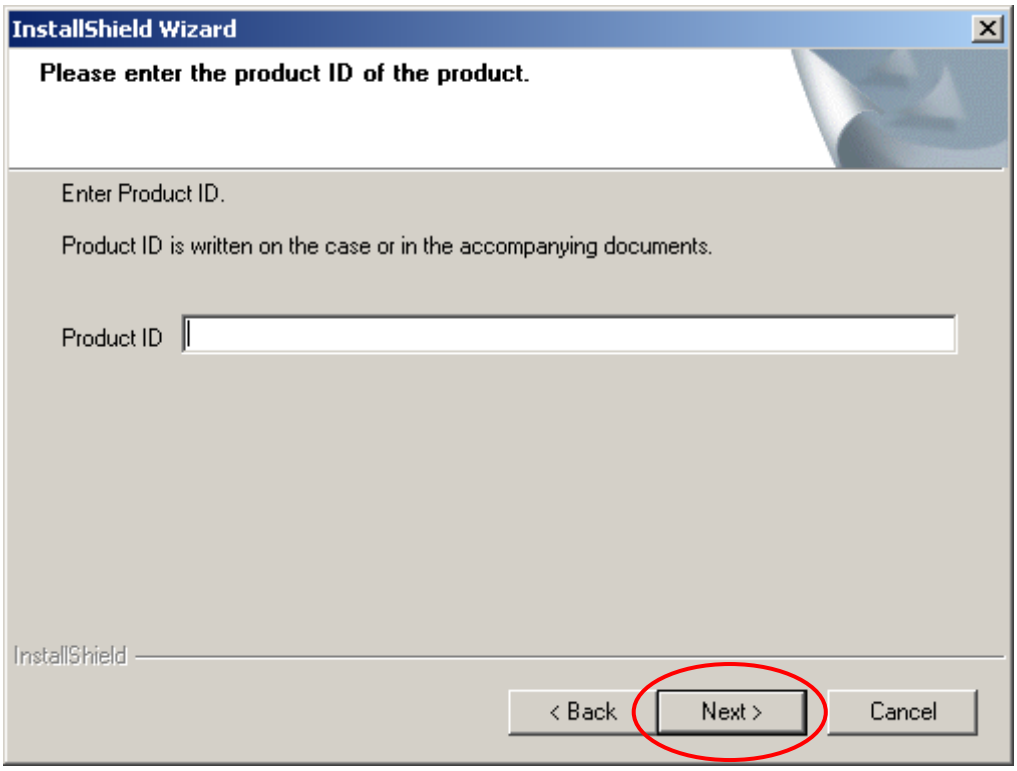
② Click OK when "Install" comfirmation dialog box is opened.



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

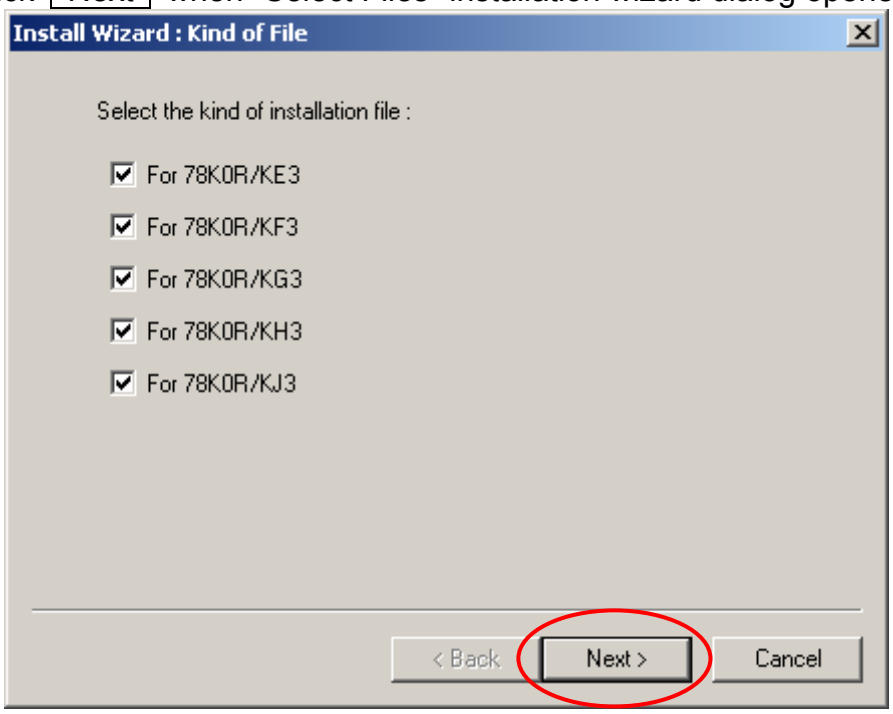


④ Enter the product ID, and click Next .
* The product ID is available on the “README.html” the other sheet.

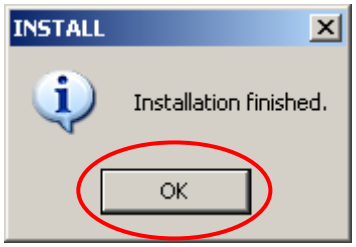


⑤ It starts copying the files.

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 TK-78K0R/KG3+UD. Install the USB driver by referring "2.3USB 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 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.

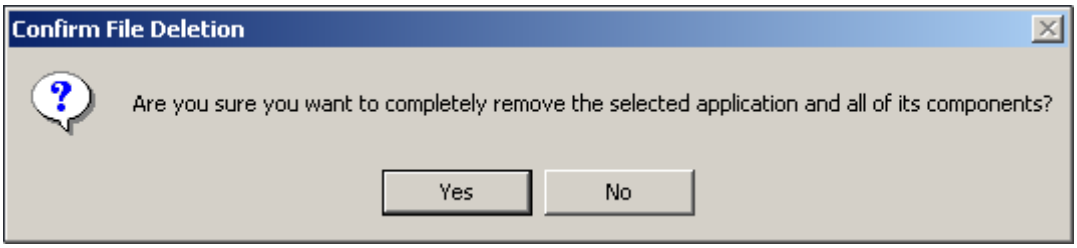
The identical problem may be observed, if a language other than English is specified as the system language in the “Regional Settings Properties” tab.

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 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 USB Driver

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

When TK-78K0R 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 Software Development Tools" to install the “Starter Kit USB Driver” first.

Attention **Do not use a USB hub for connecting TK-78K0R/KG3+UD.**

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

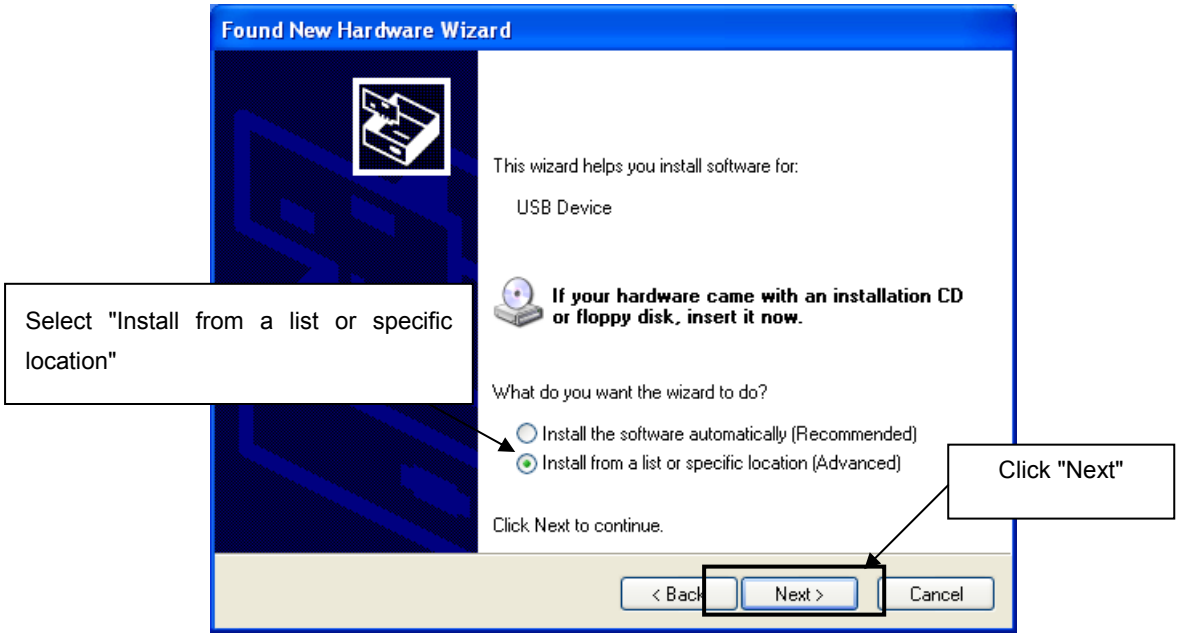
- Windows XP -> "2.3.1Install to Windows XP"
- Windows 2000 -> "2.3.2Install to Windows2000"

After the installation, go to "2.3.3Confirmation of the installation"

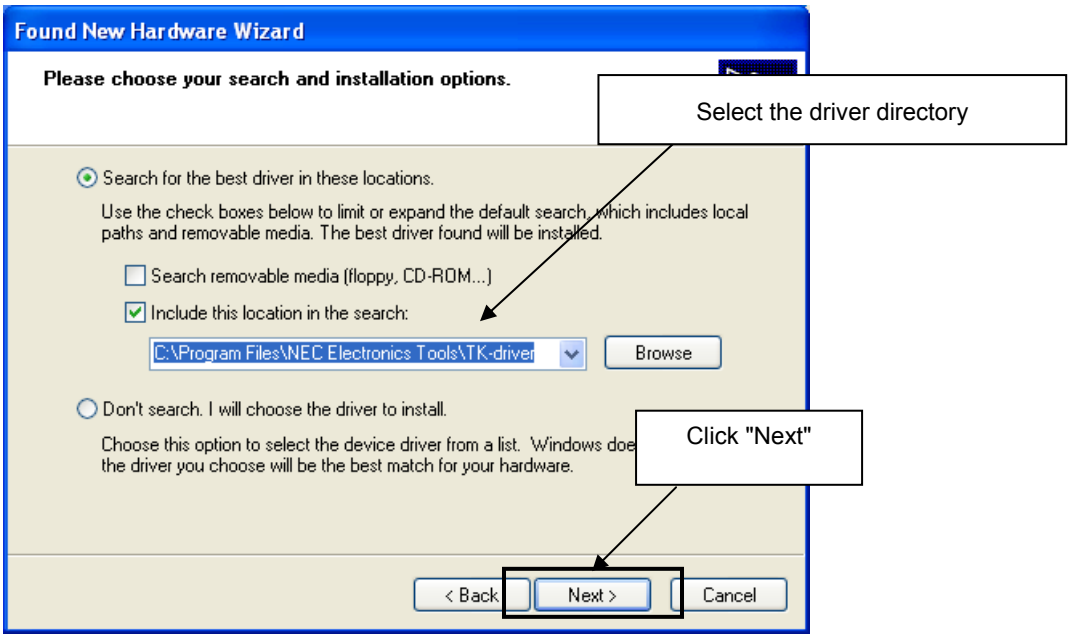
2.3.1 **Install to Windows XP**

1. Once the TK-78K0R/KG3+UD is connected with USB, the "Found New Hardware Wizard" will be started. Select "No, not this time" and click [Next >] .

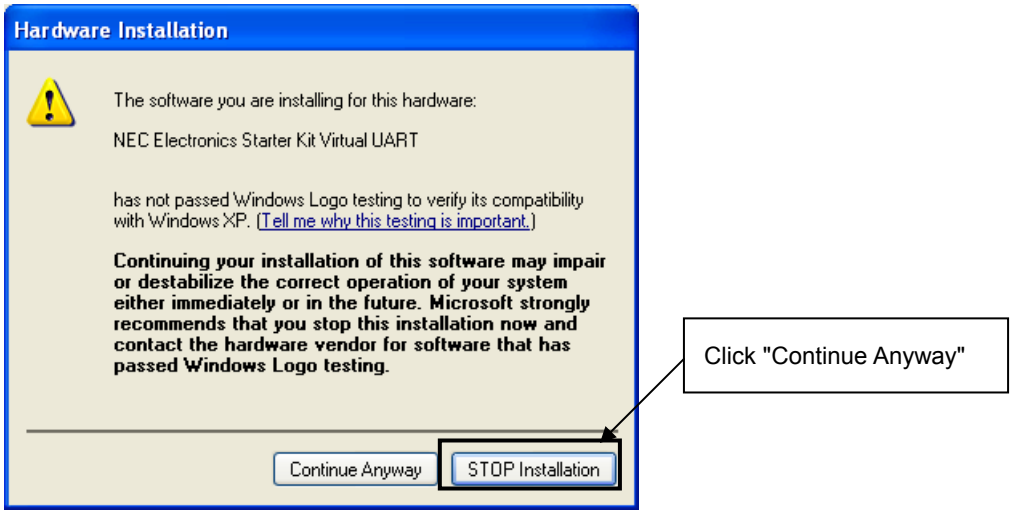
2. Select "Install from a list or specific location" and click [Next >] .



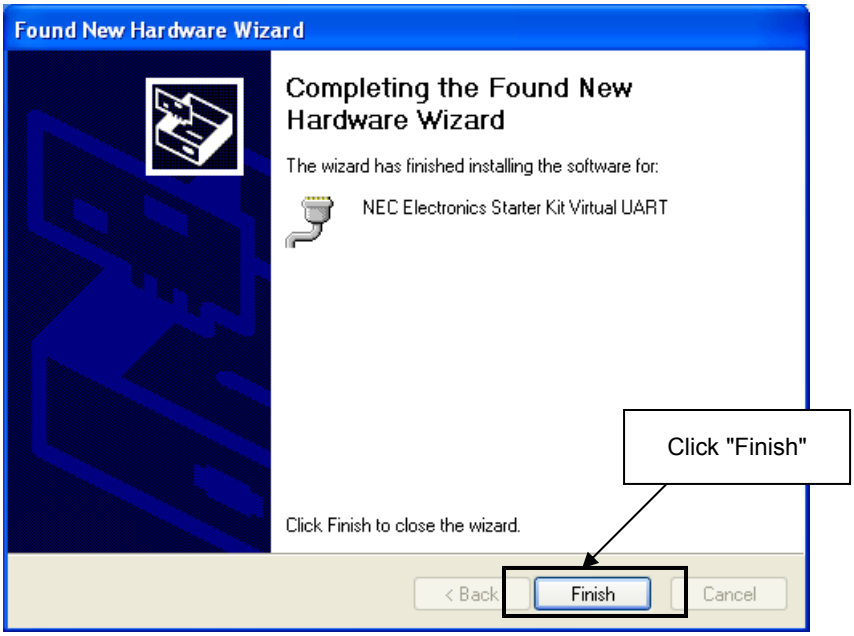
3 . Select "Search for the best driver in these locations." , check "Include this location in the search:", and then click "Browse..." to select the driver directory path. The path should be "C:¥Program Files¥NEC Electronics Tools¥TK-driver" as default installation. If the installation directory is not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

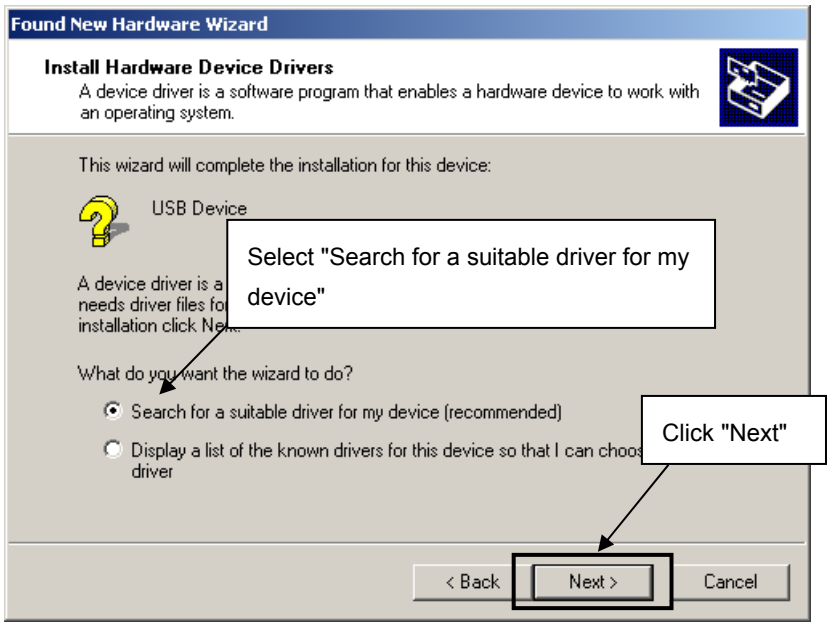


6. Go to "1.3.3 Completion of the installation".

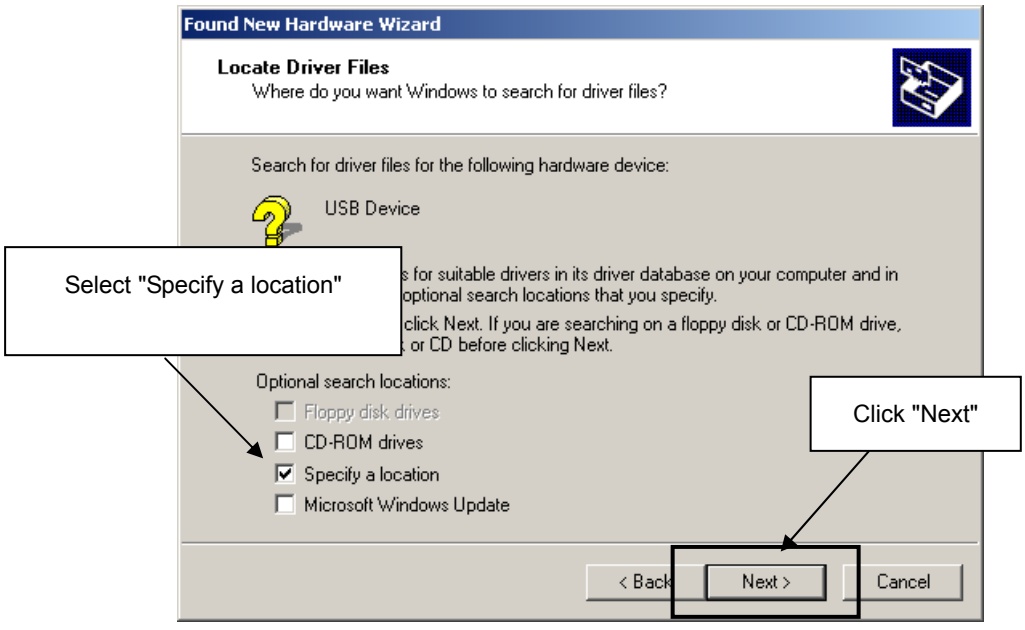
2.3.2 **Install to Windows2000**

1. Once the TK-78K0R/KG3+UD is connected with USB, the "Found New Hardware Wizard" will be started.
   Select "No, not this time" and click [Next >] .

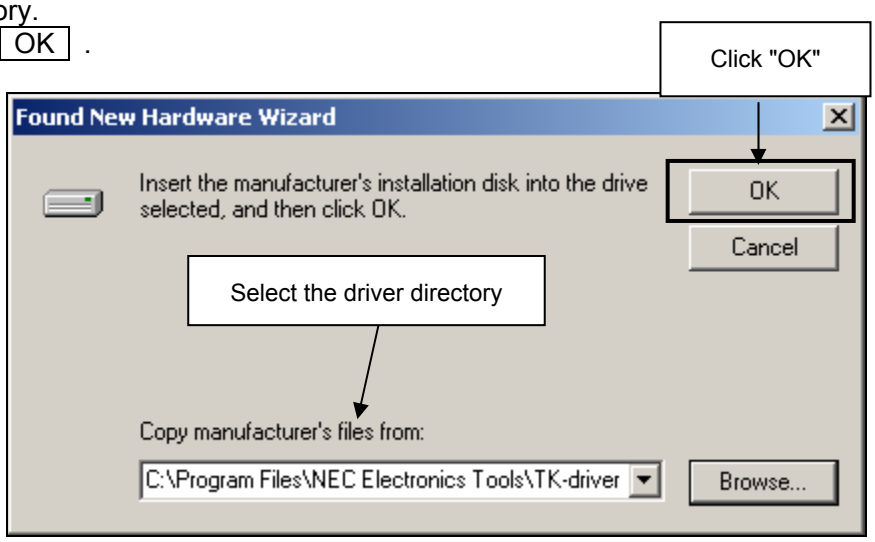
2. Select "Search for a suitable driver for my device".
Click Next > .



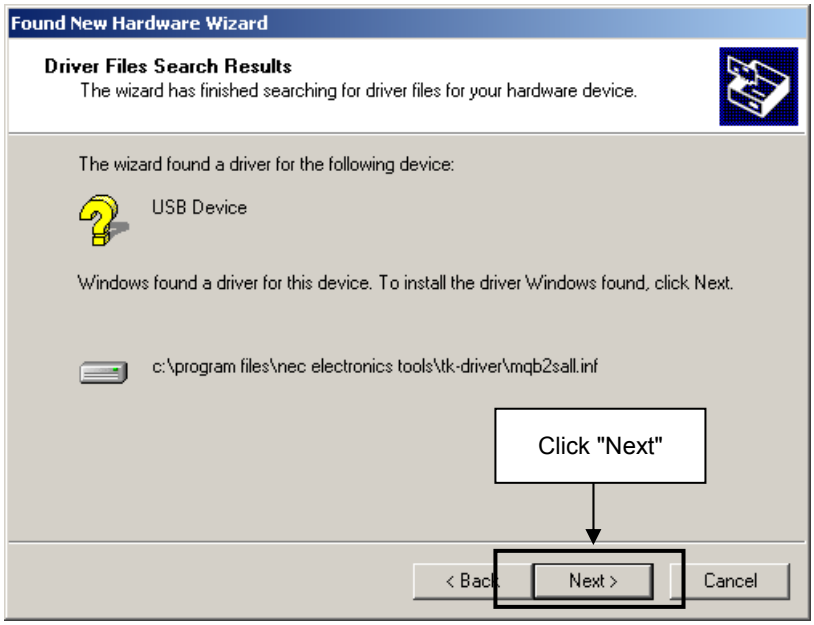
3. Select "Specify a location".
Click Next > .



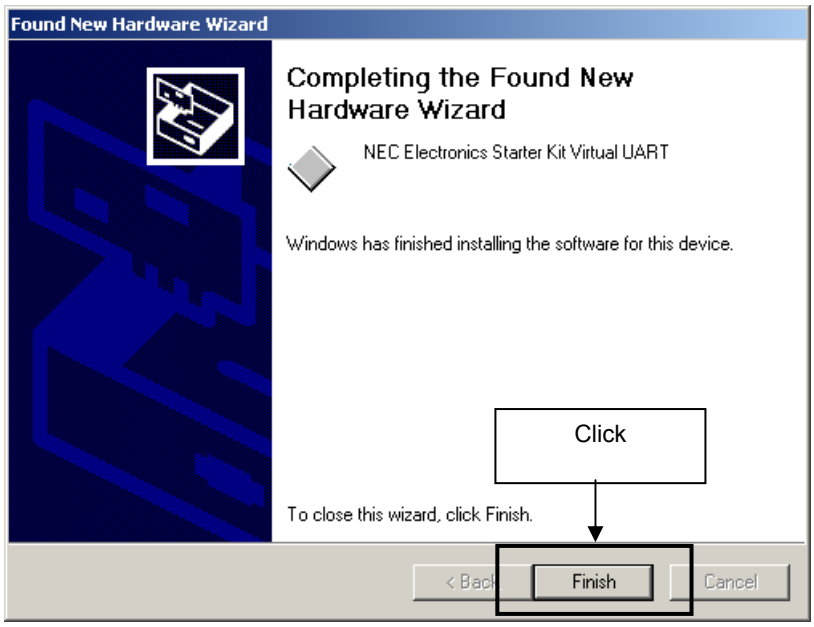
4. Select the driver directory path. The path should be "C:¥Program Files¥NEC Electronics Tools¥TK-driver" as default installation.
If the installation directory is not default, then select "TK-driver" under the installation directory.
Click OK .



5. Click Next > .



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

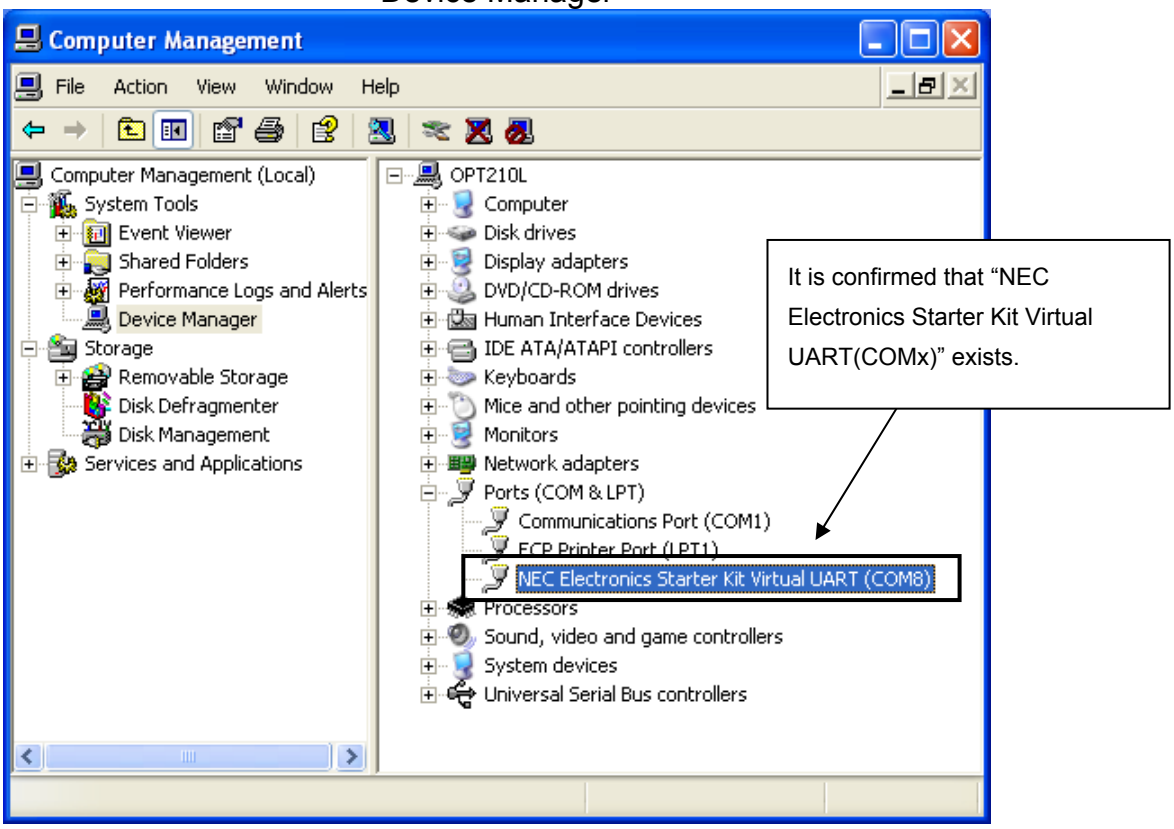


7 . Go to "1.3.3 Confirmation of the installation".

2.3.3 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 TK-78K0R/KG3+UD. 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.

2.4 Sample Environment

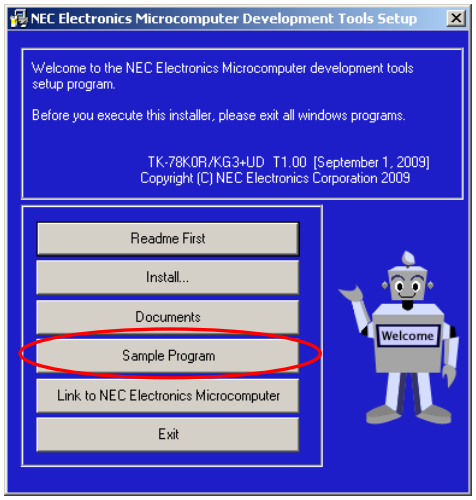
This section explains the overview and preparation of sample programs.
You need to install the sample programs on your system first before using them.

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

2.4.1 Installation of the sample programs

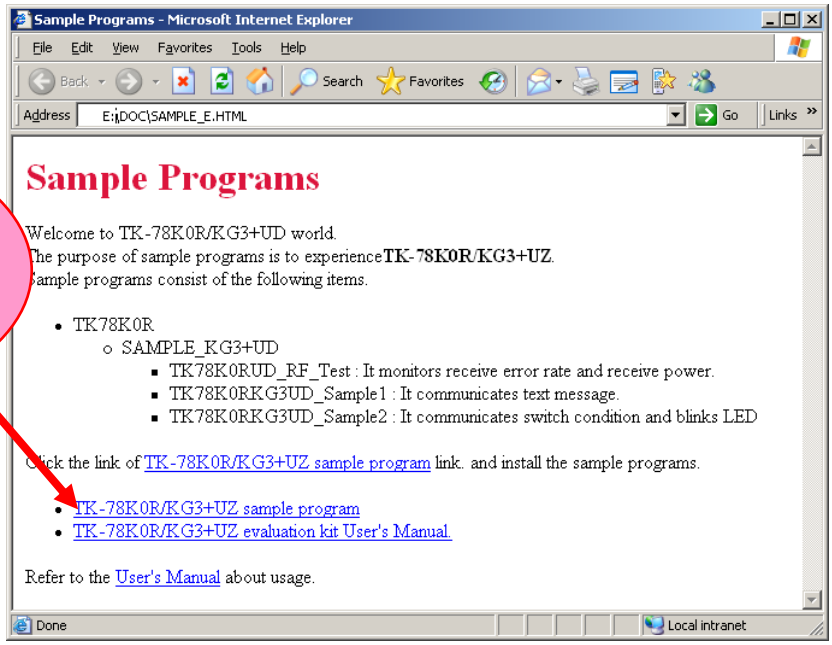
Insert the CD-ROM disk in the CD-ROM drive of your PC. The [NEC Electronics Microprocessor Development Tools Setup] screen automatically appears.(if this screen does not appear automatically, start setup.exe from Explorer. etc.)

Press the Sample Program button to start the WWW browser, and then click the [TK-78K0R/KG3+UD Sample Programs] link.

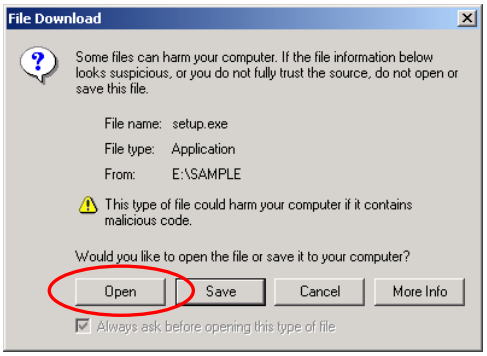


The WWW browser starts up.

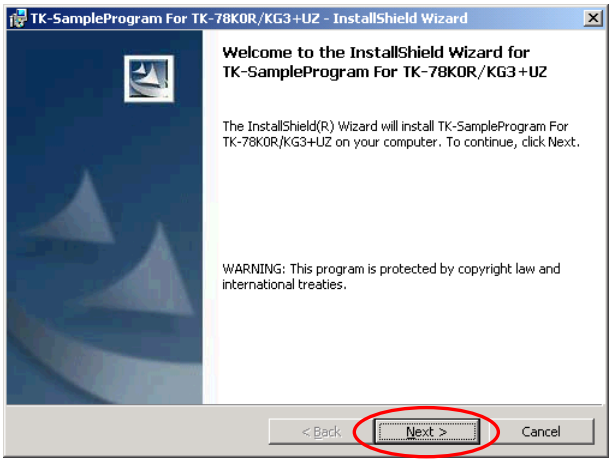
Click the [TK-78K0R/KG3+UD Sample programs] link you can also download the [User's Manual]



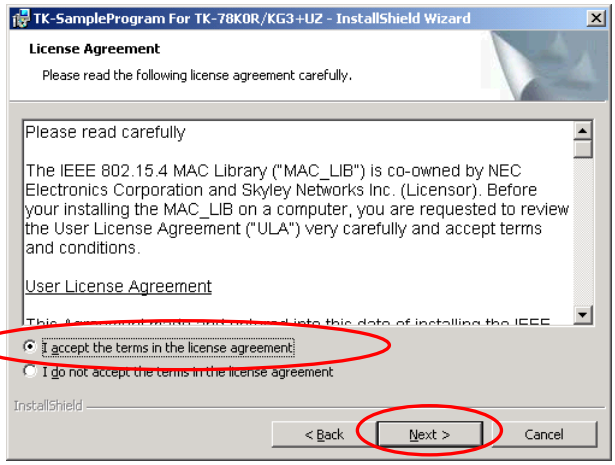
When[TK-78K0R/KG3+UD Sample Programs] is clicked, the following download confimation window appears.



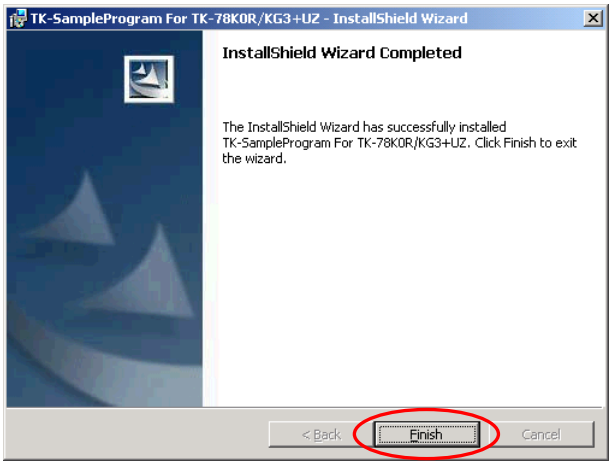
Please click the Open button.
In case of windows 2000,
you will see the [Security Warning] window. Please click Run.



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.

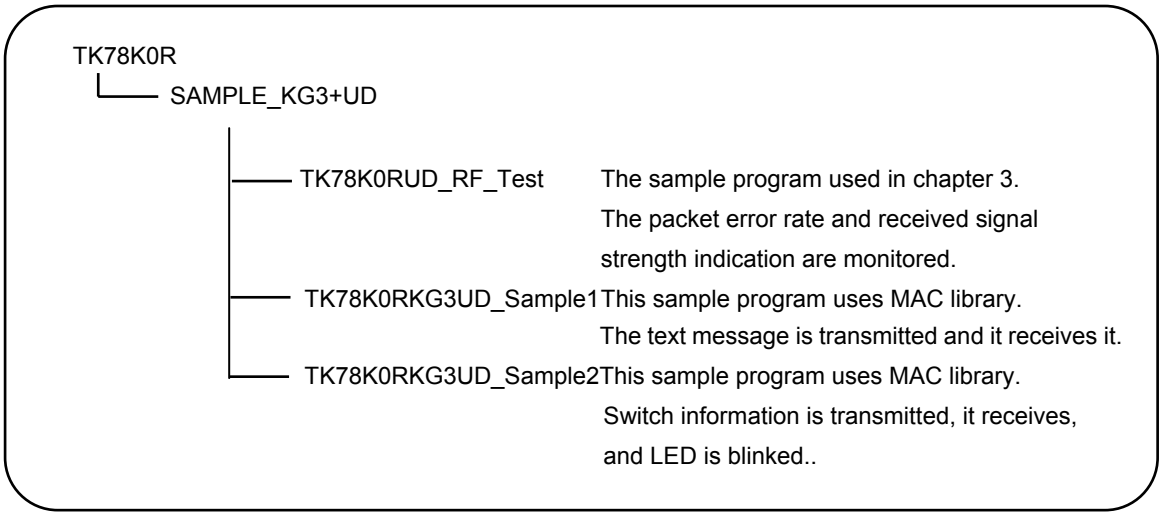
The sample programs are installded under "C:¥" now.

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.

2.4.2 File Configuration of the sample program

The sample programs ware the following folders.

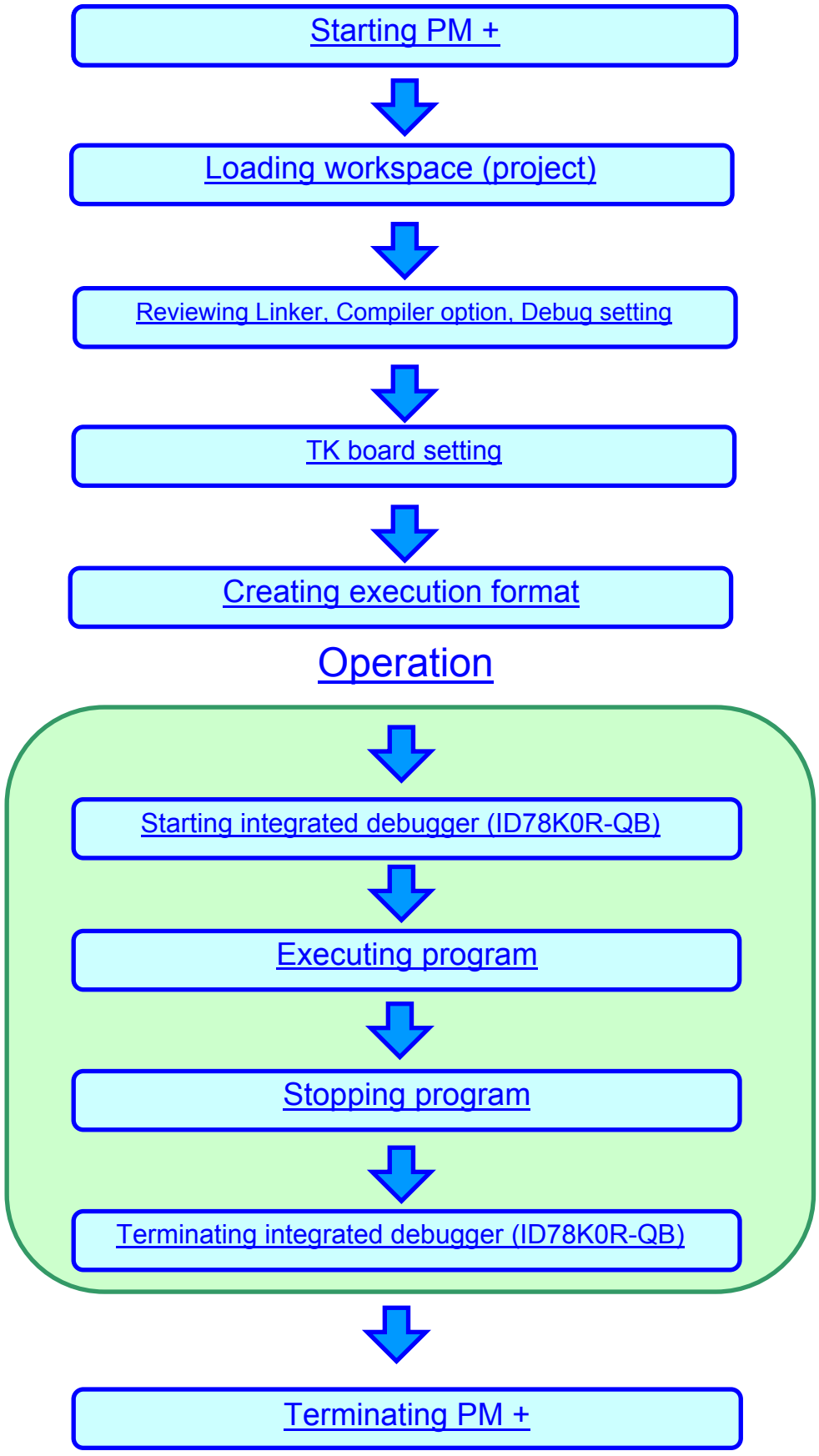


3 Experiences

Now you are ready to experience the operation of the TK-78K0R/KG3+UD using the integrated development environment, PM +.

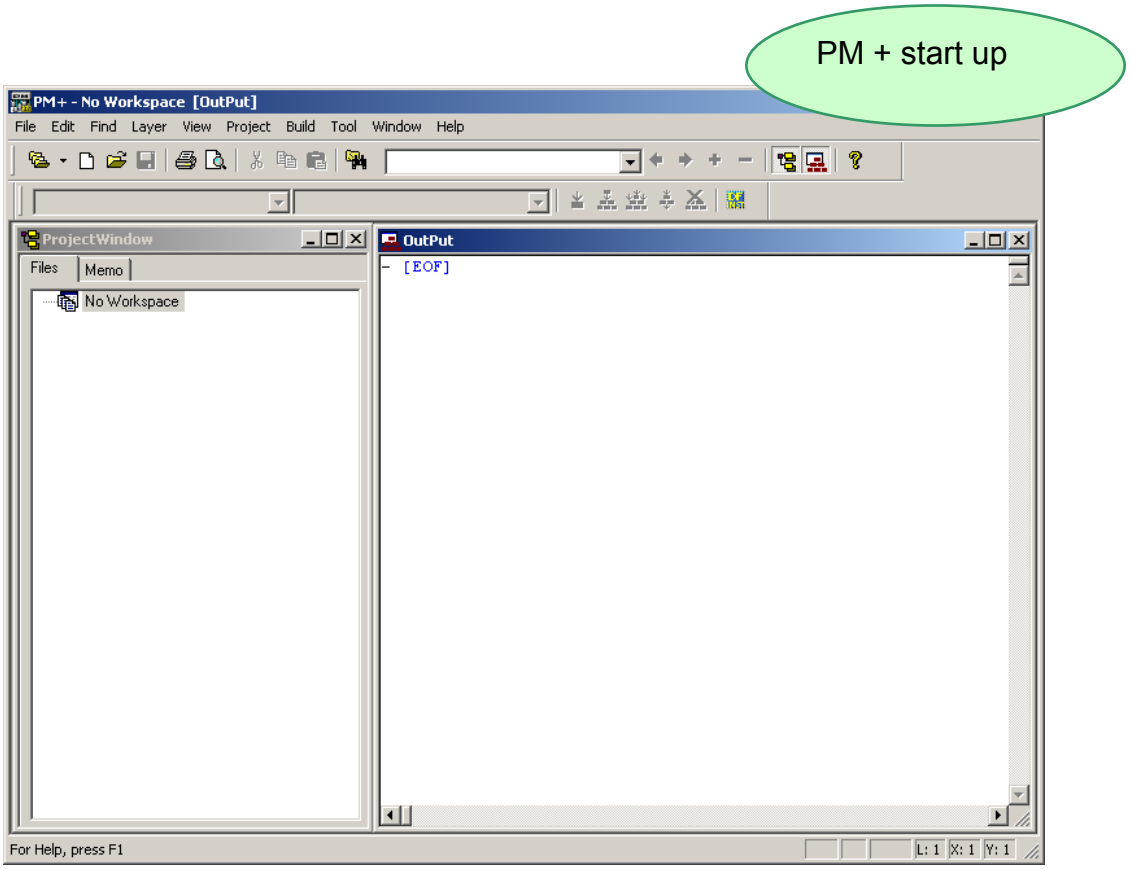
As a program for the 78K0R/KG3, the RF test program (RF_Test) which you installed in "2.4.1Installation of the sample programs" is used.
You use two of 78K0R/KG3. One is the stand-alone system with USB power supply. Another is connected to the debugger and run user programs. By building the sample programs 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.



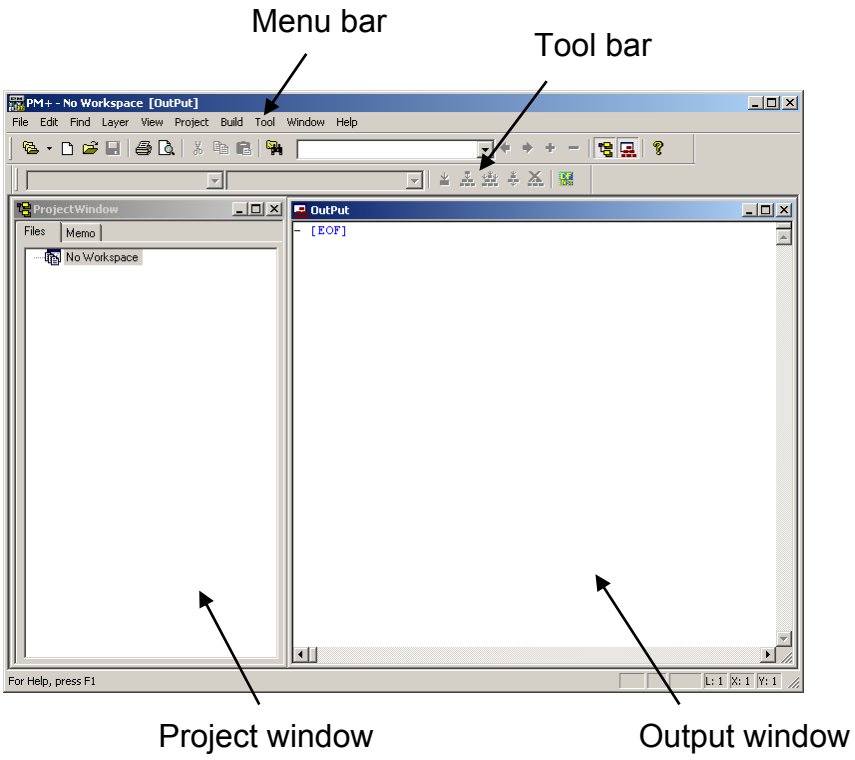
3.1 Starting PM +

In the Windows Start menu, select [Programs]->[NEC Electronics Tools]->[PM + V6.31]



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?

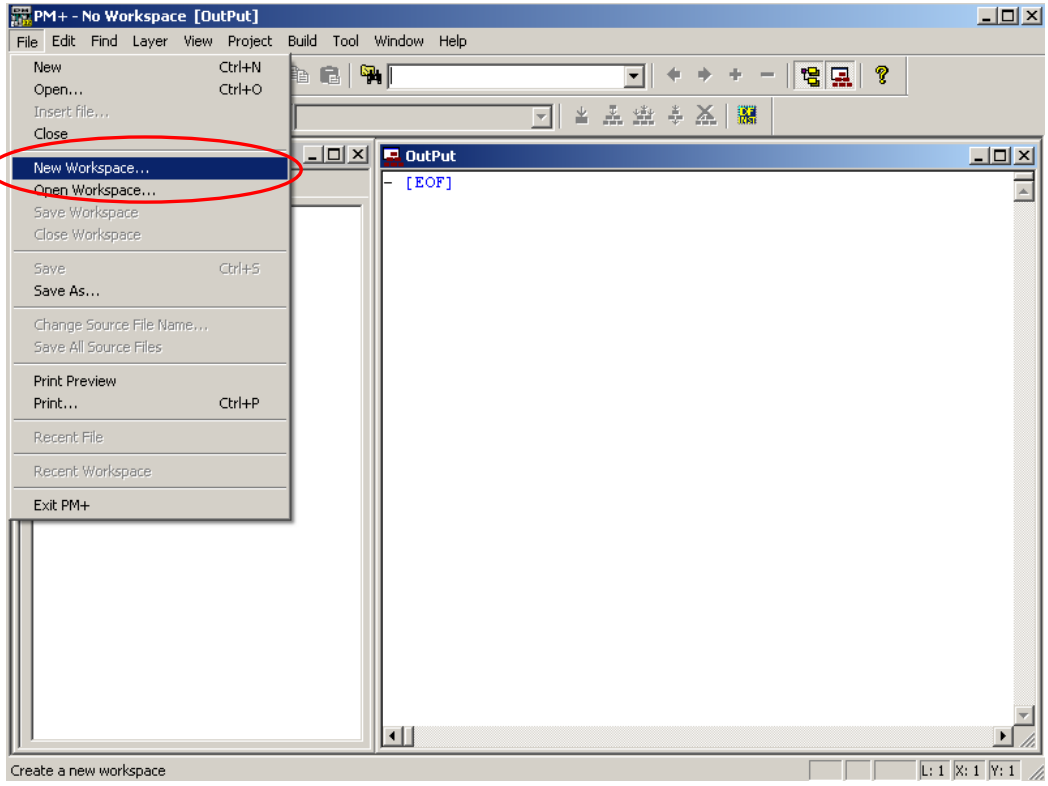
A workspace is the unit used to manage all the projects or project group required for one application system.

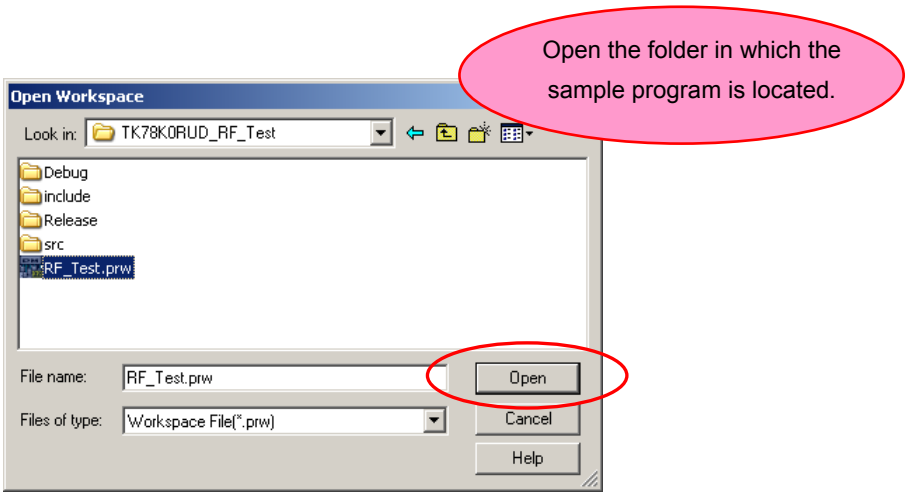
The file name of multiple project files is saved to a workspace file for referencing.

The file name format is “ΔΔΔΔprw”.

3.3 Loading Workspace (Project)

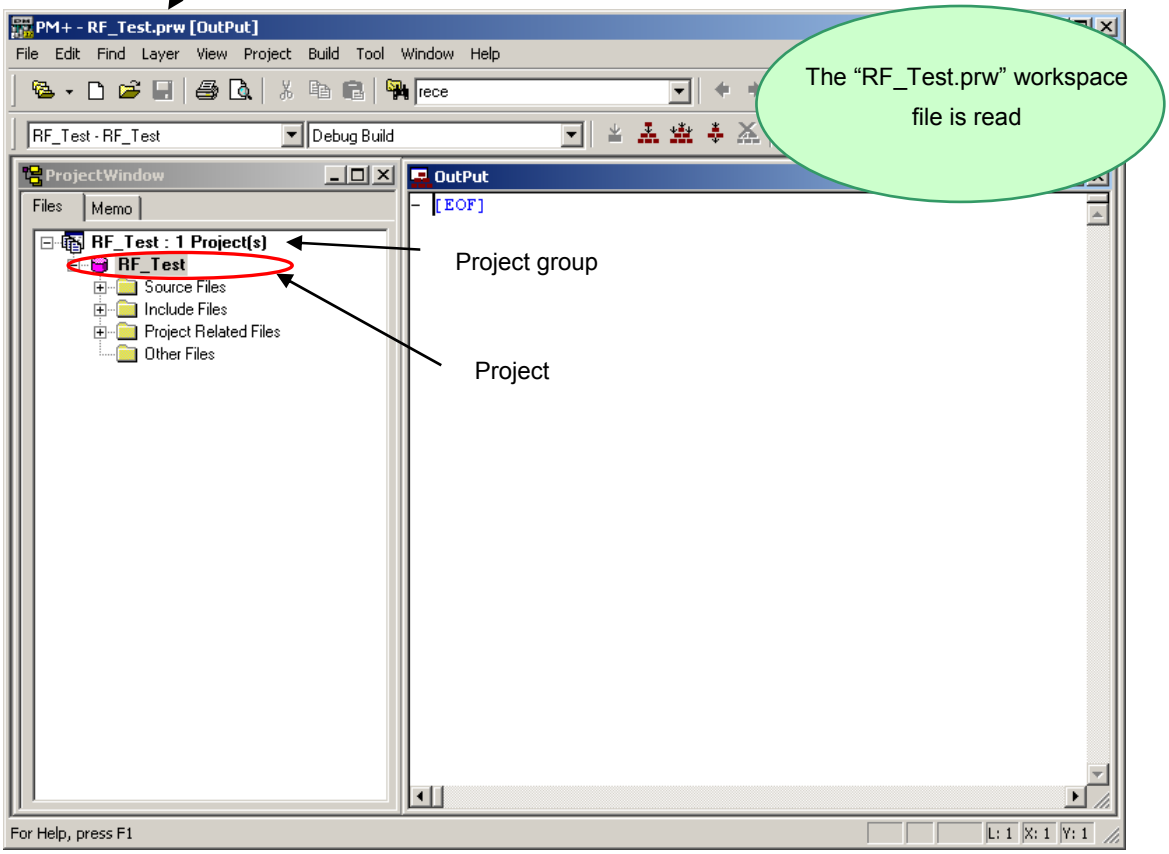
In this section, you will use the workspace that you created in "2.4.1Installation of the sample programs"
For creating a new workspace, refer to "7.1Create a new workspace".
The workspace has information about the build environment for the sample programs.
Select "File" on menu bar and "Open Workspace…".
Then, select
“C:¥TK78K0R¥SAMPLE_KG3+UD¥TK78K0RUD_RF_Test¥RF_Test.prw” .





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

Workspace file name :RF_Test.prw



3.4 Configuration of Linker Option

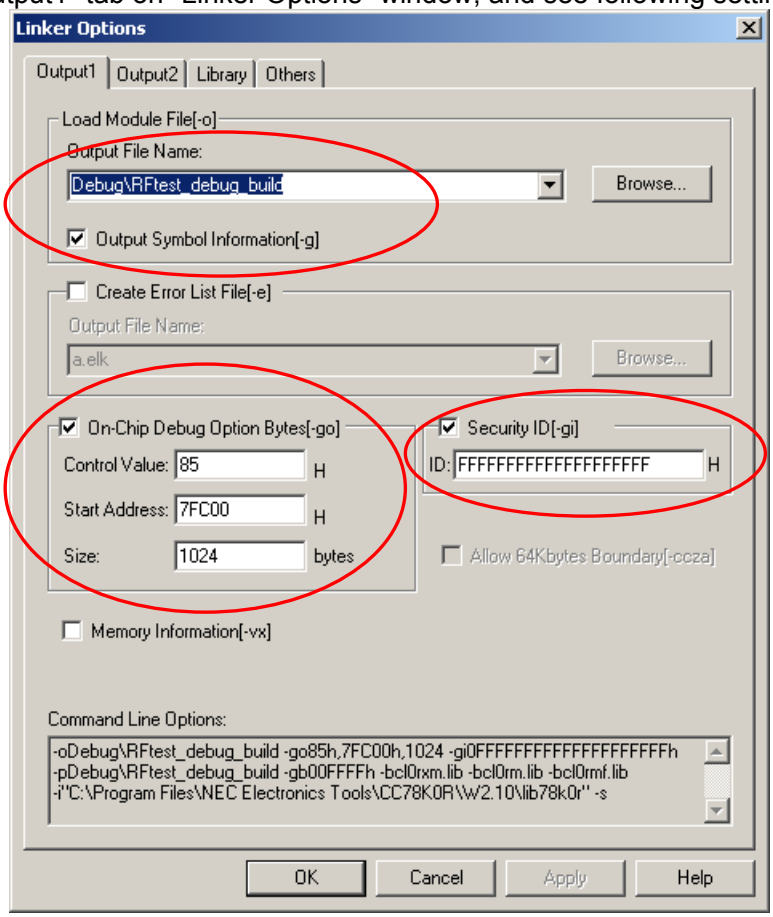
The linker options have been set by the project file. However, some option settings will be covered in this section because the linker option settings are important for debugging. Following three settings are covered specifically.

- 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/KG3 (U17894E).

See "Start address" is set to "7FC00", 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.

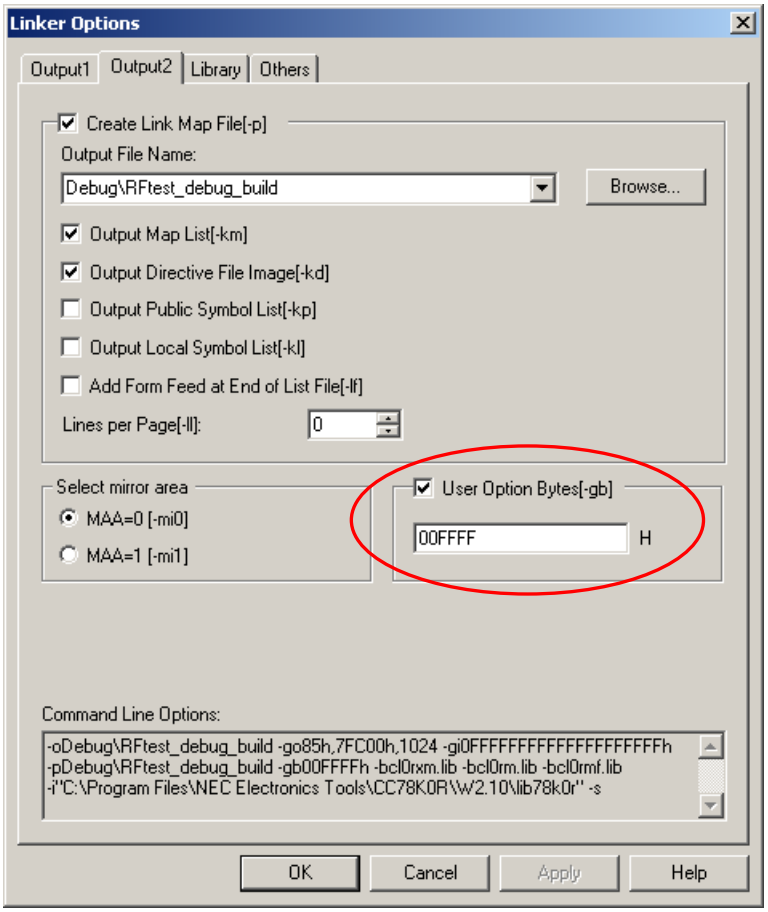
The debugger will not be launched when the security ID is unmatched. By using this function, you can secure the programs from leaks.

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 "7.4Erase of flash memory".

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/KG3 (U17894).

3.5 Configuration of Compiler Option

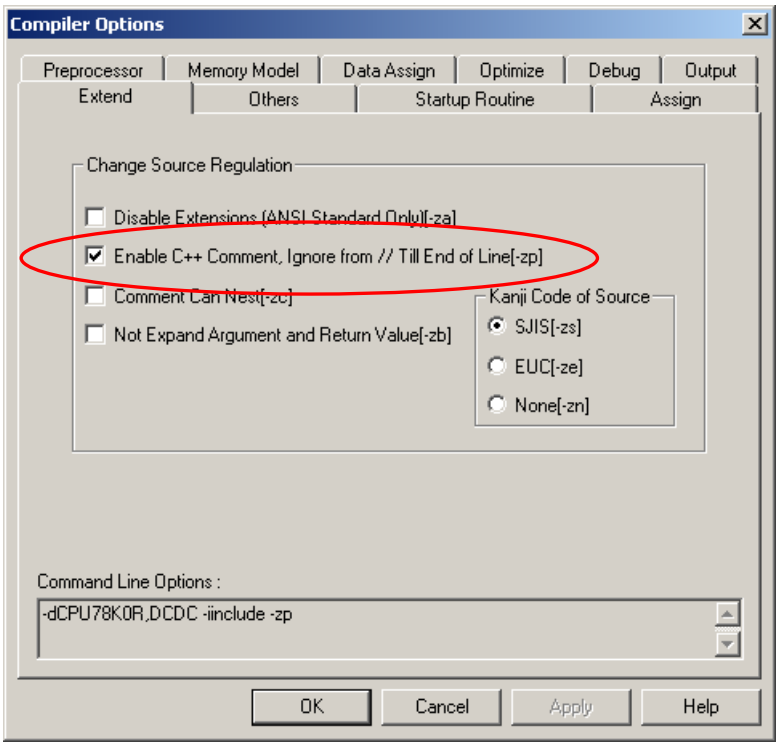
The compiler options have been set by project file. However, because some compiler options are useful, following two settings are covered specifically in this section.

- Enable C++ comments
- Use multiplier and divider

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

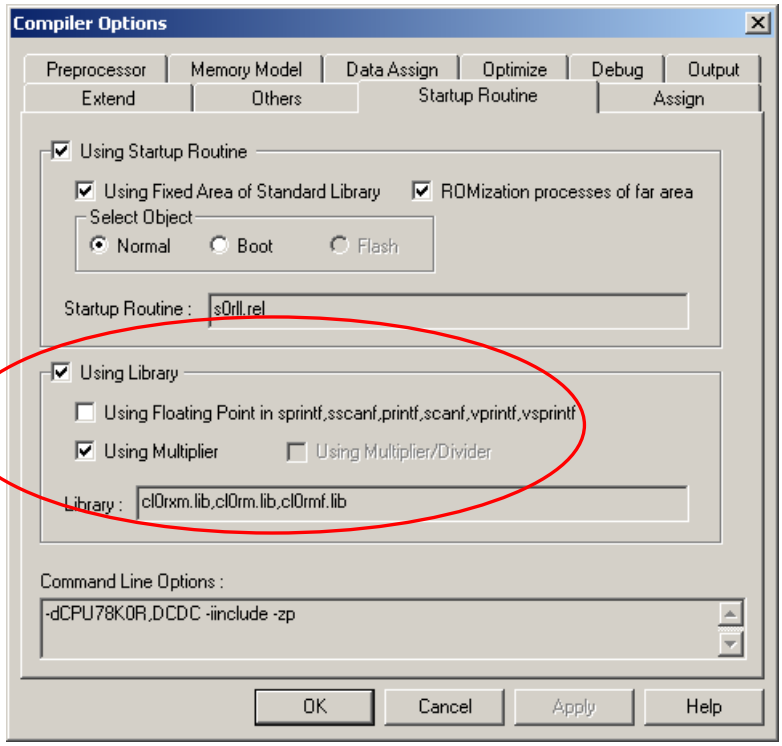
3.5.1 "Extend" Tab

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.



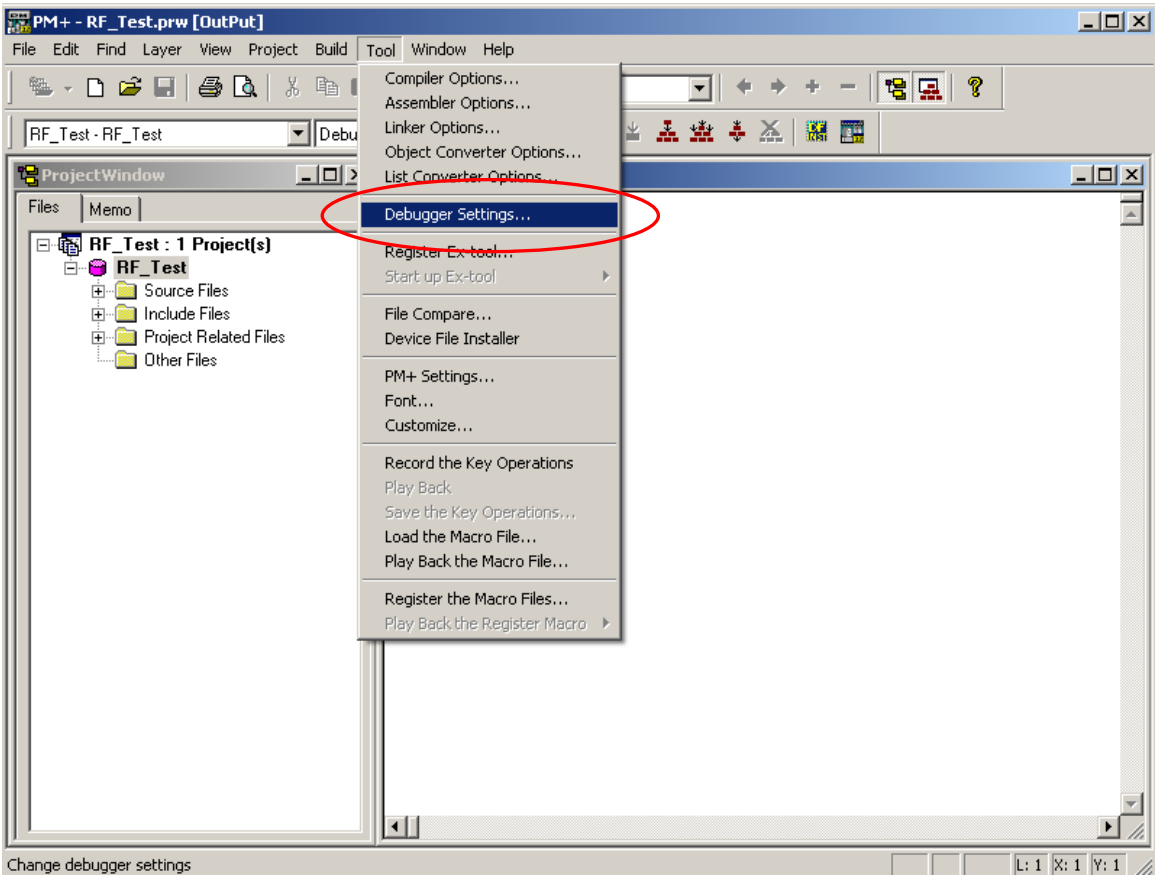
3.5.2 "Startup Routine" Tab

Select "Startup Routine" tab, and check "Using Library" and "Using Multiplier/Divider". The 78K0R/KG3 has feature of multiplier/divider to increase those calculation speed.

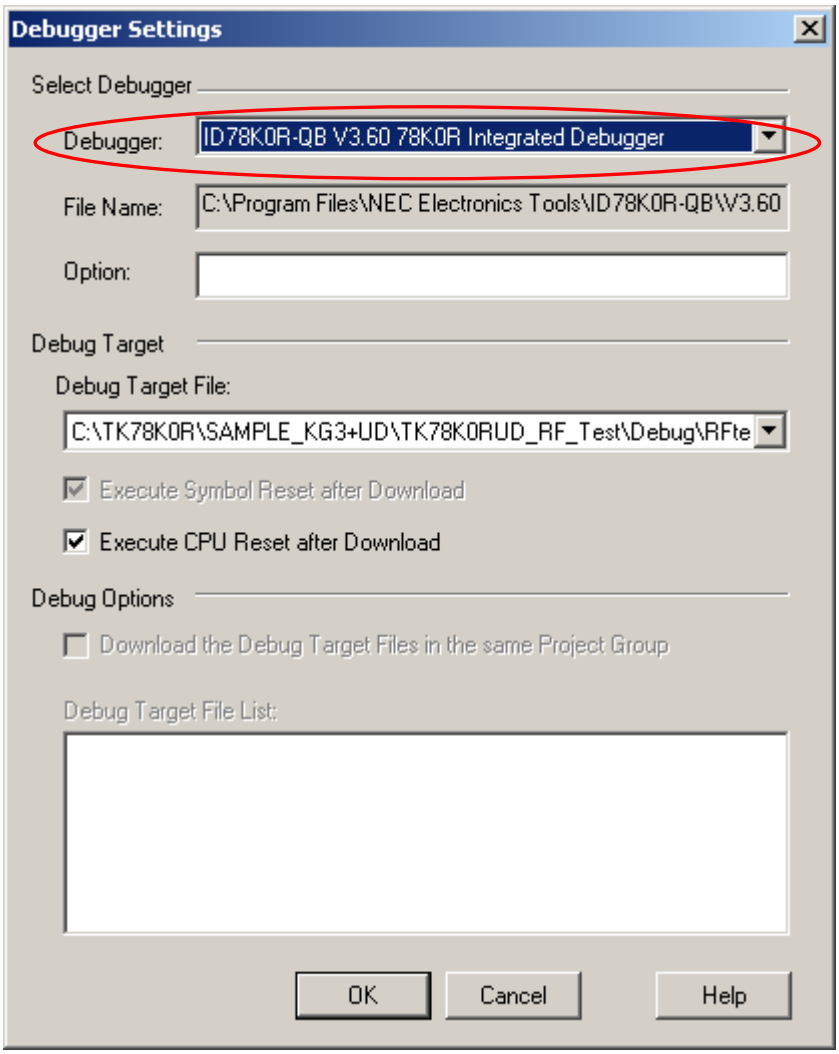


3.6 Configuration of Debugger setting

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



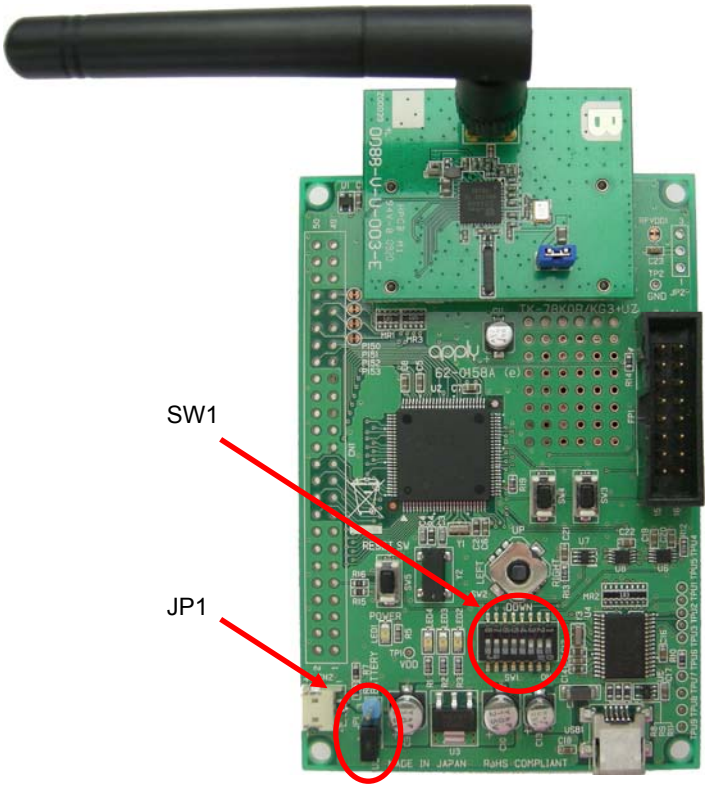
Check if "ID78K0R-QB V3.60 78K0R Integrated Debugger" is selected on "Debugger".



3.7 TK board setting

Please set the switches on the TK-78K0R/KG3+UD board as follows.

JP1		1-2 short (USB side)
SW1	Bit1	ON
	Bit2	ON
	Bit3	ON
	Bit4	OFF
	Bit5	OFF
	Bit6	OFF
	Bit7	OFF
	Bit8	OFF

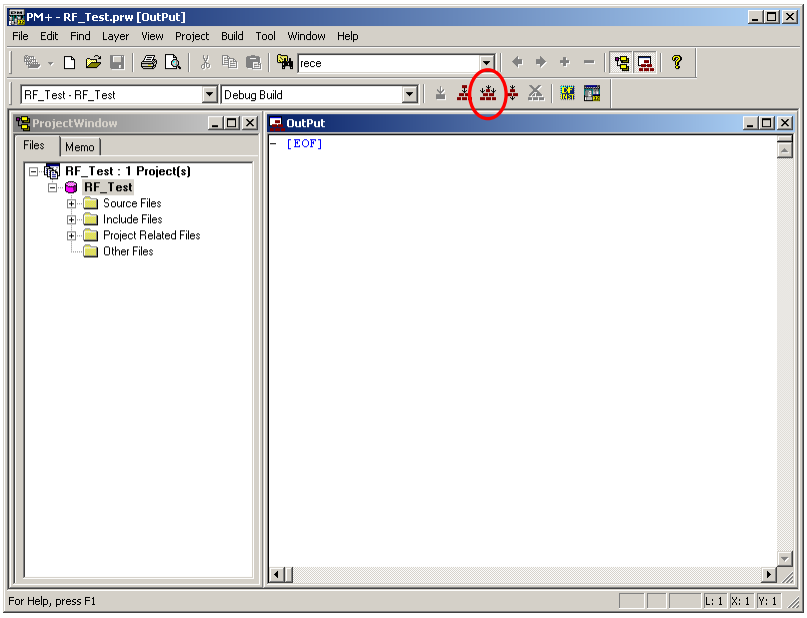


After the switch settings are completed, connect the PC to USB1 on TK-78K0R/KG3+UD with USB cable.If the "Found New Hardware Wizard" is started, install USB driver with referring "2.3USB Driver".

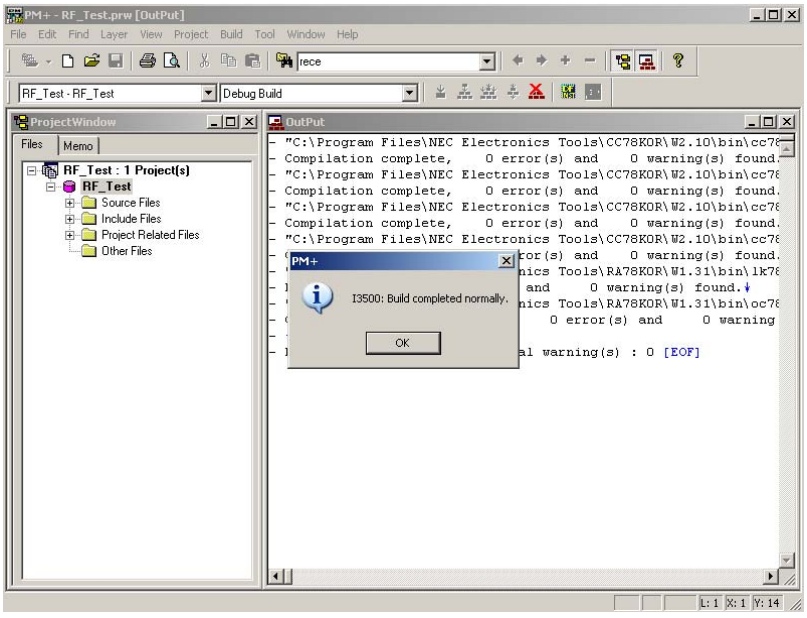
3.8 Creating execution format

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.

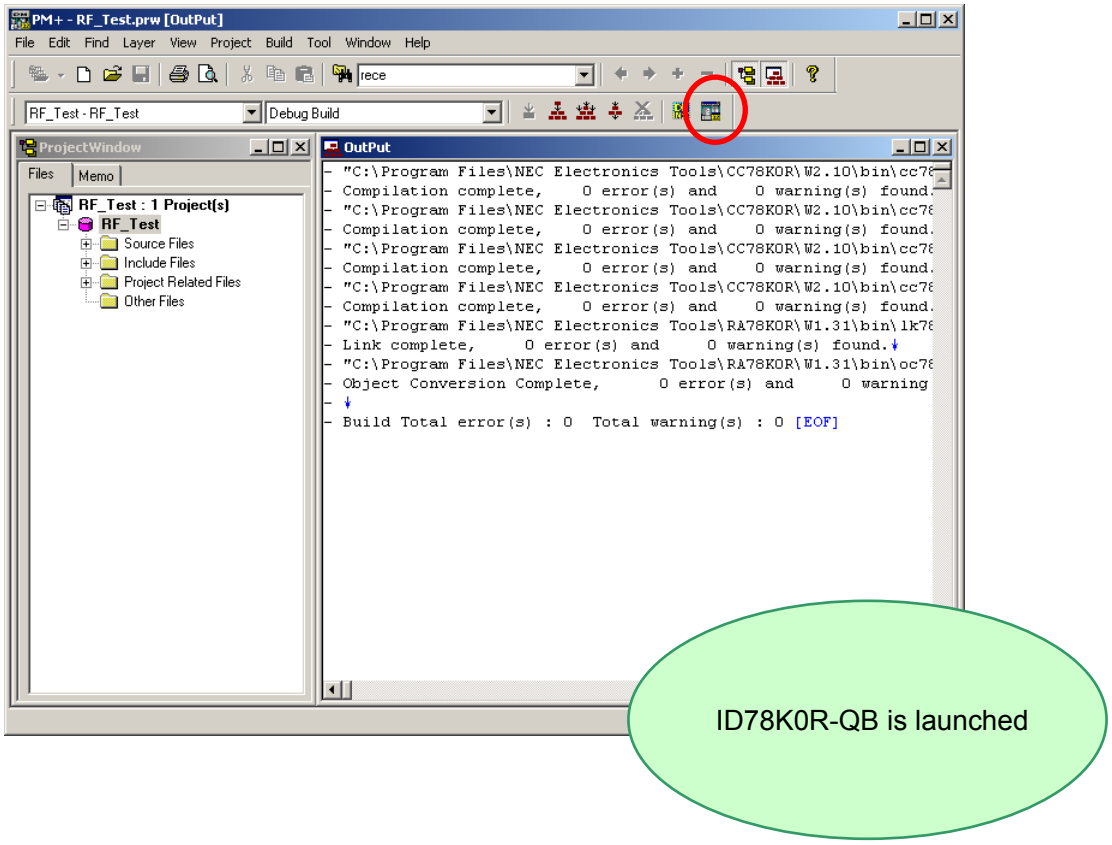
What is rebuild ?

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)

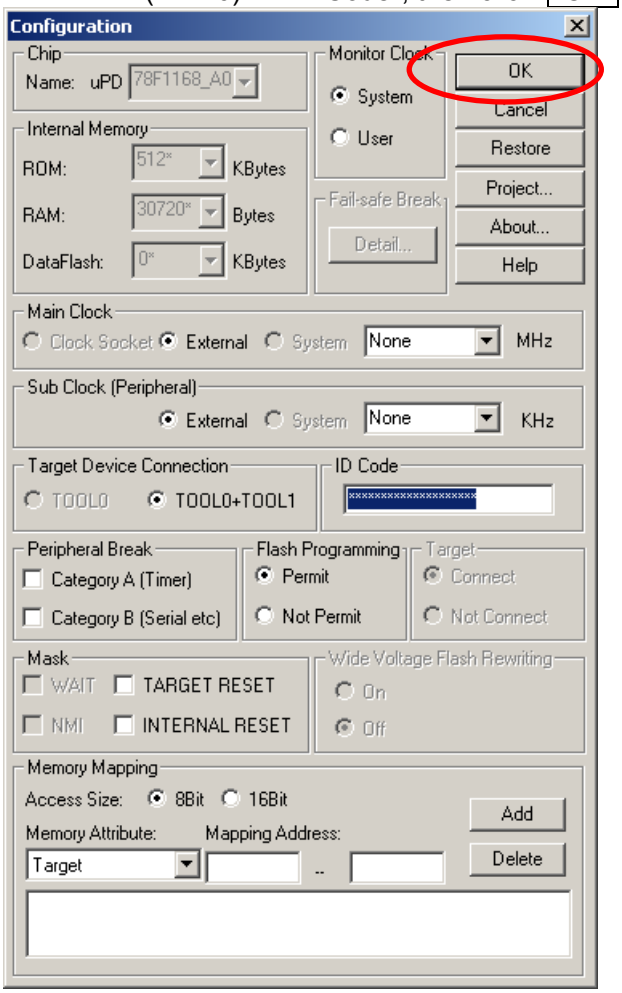
Please select the Debug button  , of PM +, or in the menu, select [Build(B)] →[Debug(D)].

If the debug button is not displayed, in the menu, select [Tool]→[Debugger Setting...]“ID78K0R-QB V3.60 78K0R Integrated Debugger”

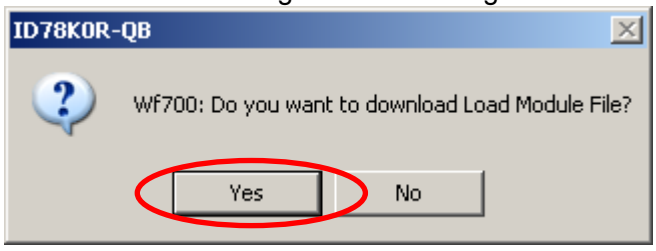


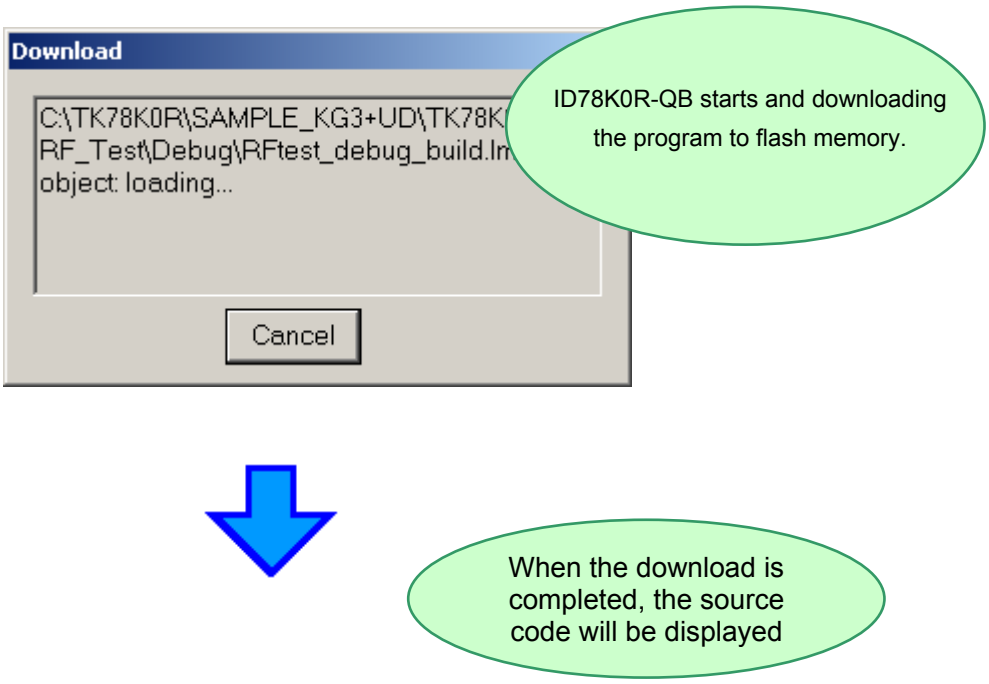
"Configuration" dialog is opened.

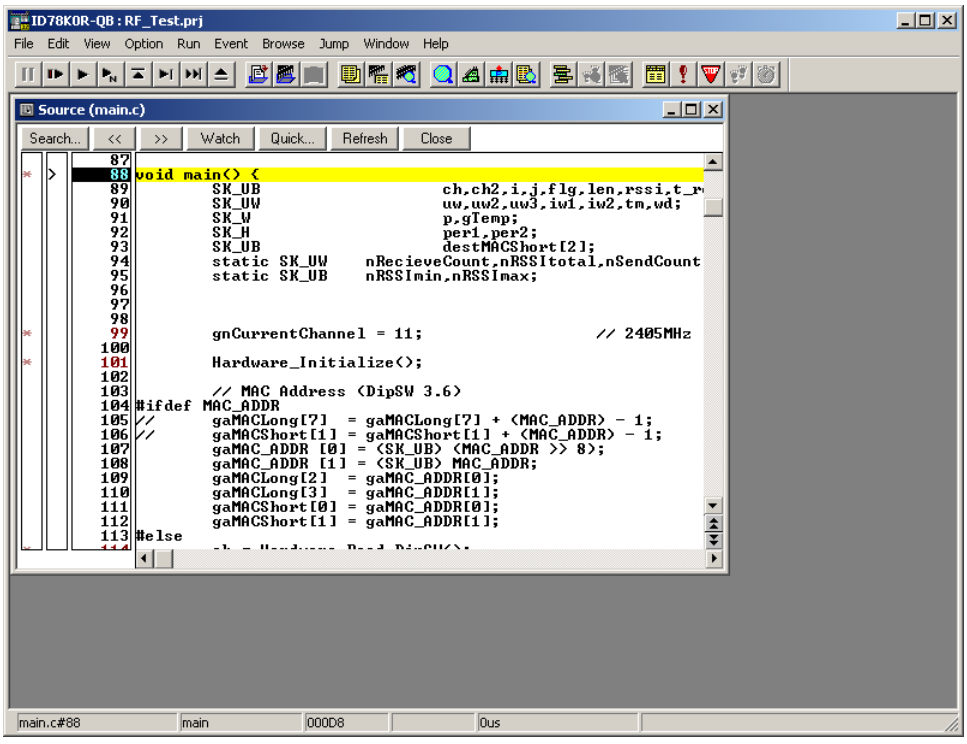
Enter "FFFFFFFFFFFFFFFFFFFF" (F x 20) in "ID Code", then click [OK] .



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



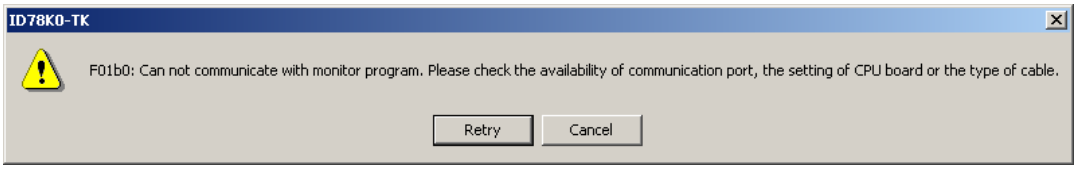




NOTE:

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.

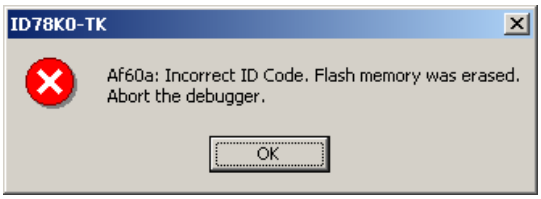
1. Please confirm the switch on the board is set as follows.

JP1		1-2 short (USB side)
SW1	Bit1	ON
	Bit2	ON
	Bit3	ON
	Bit4	OFF
	Bit5	OFF
	Bit6	OFF
	Bit7	OFF
	Bit8	OFF

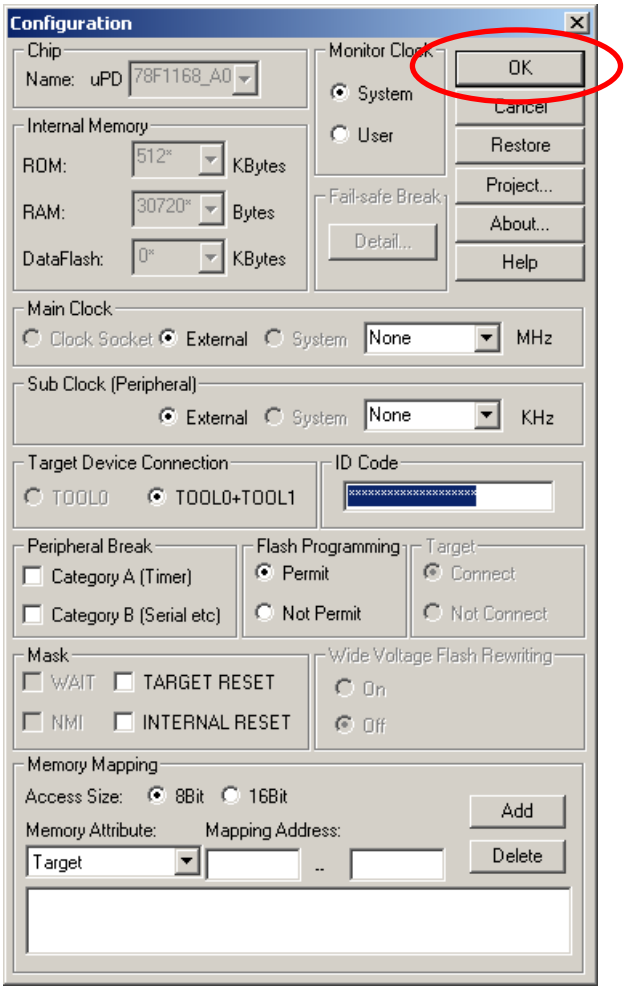
2. Please confirm the power LED1 is lighted.

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.



The default setting of the ID code is ”0xFFFFFFFFFFFFFFFFFFFF”. You can set an alternative ID code on the linker option tab.

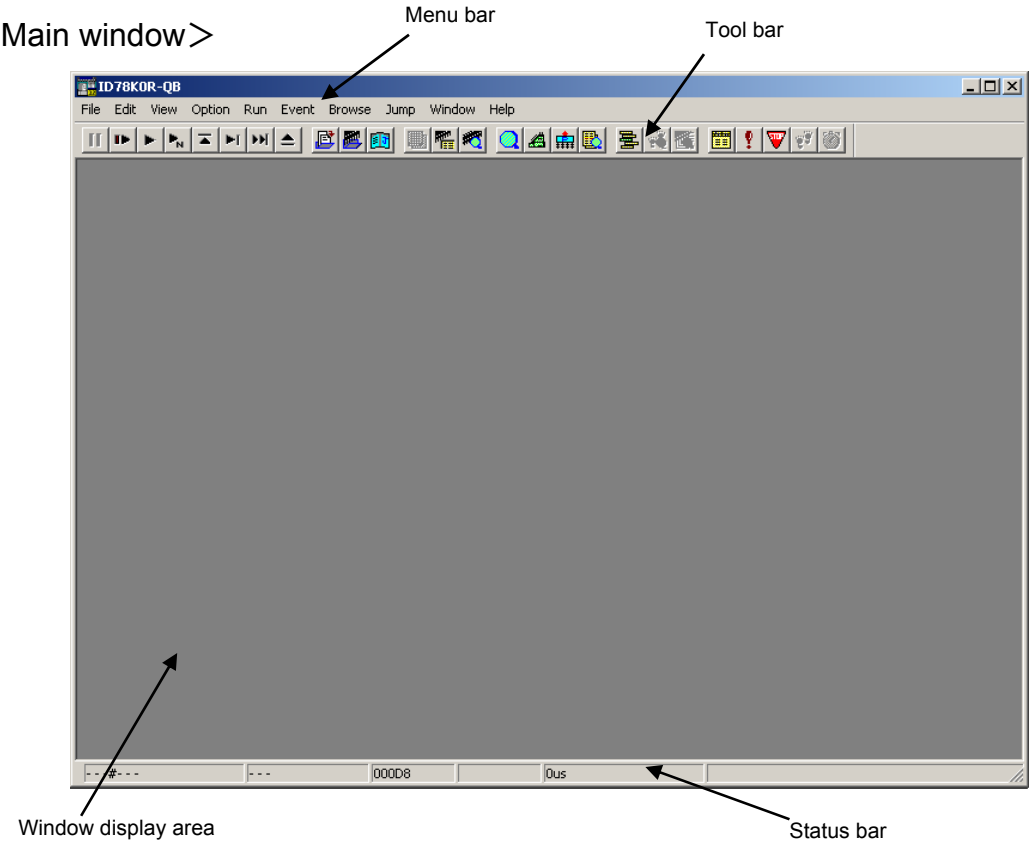
If the setting of On-Chip Debug Option Byte is "Does not erase data of flash memory in case of failures in enabling on-chip debugging" and if you forget the security ID, you need to erase the flash memory completely.

To erase the flash memory, please refer to the section 7.4, “Erasing the Flash Memory”.

3.10 Introduction of the 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.

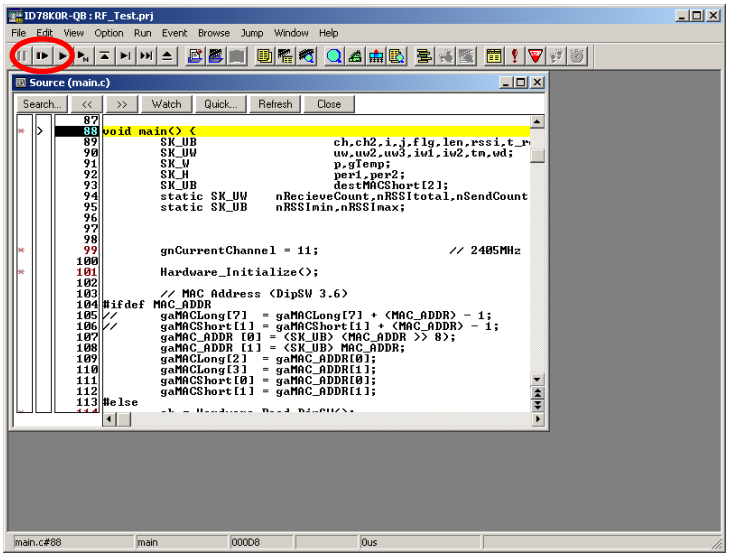
< Main window>



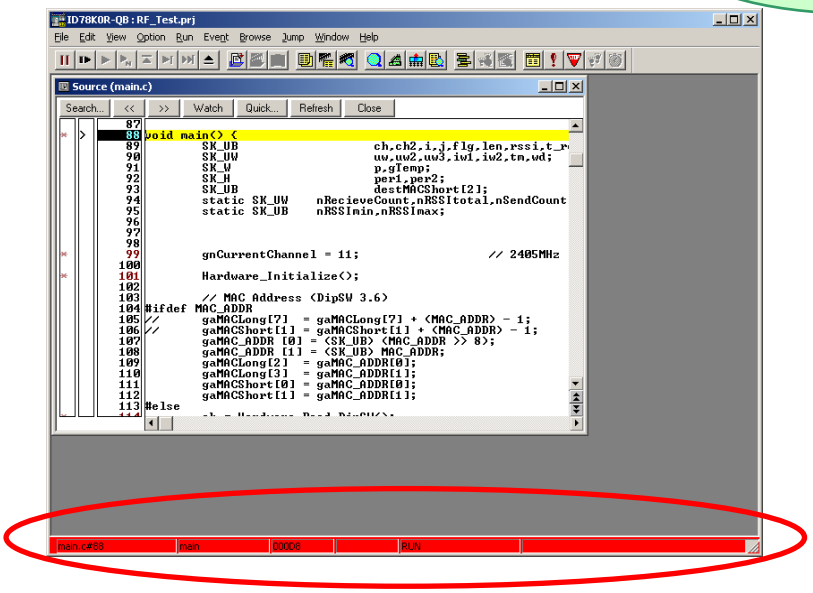
For more details, please refer to the user's manuals of ID78K0R-QB.

3.11 Executing a program

If you click “GO”  , the execution of the code will start.
You can know it by the red bar at the bottom.



Execute the program

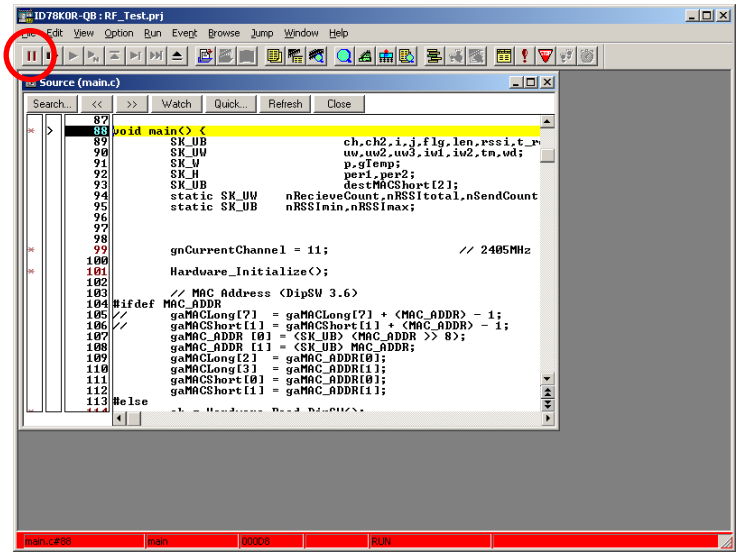


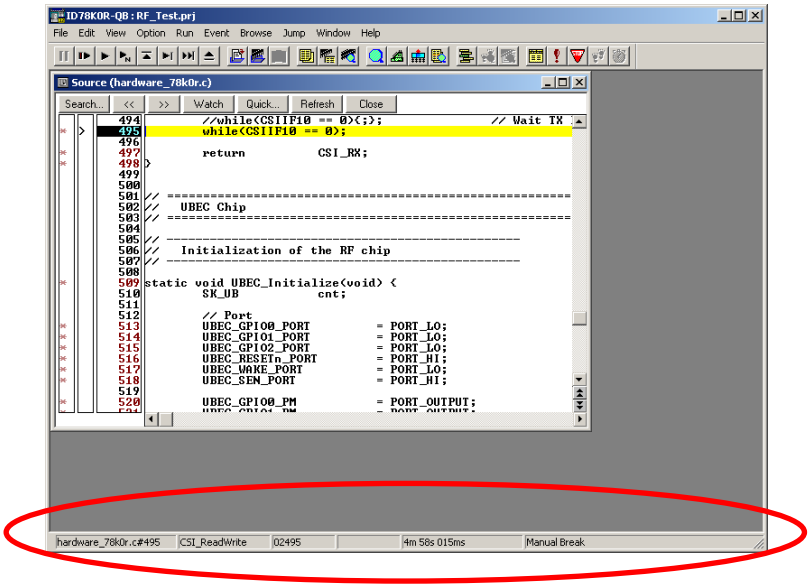
While a program is running, the status bar will be red.

3.12 Stop a program

Now, you are going to stop the program.

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

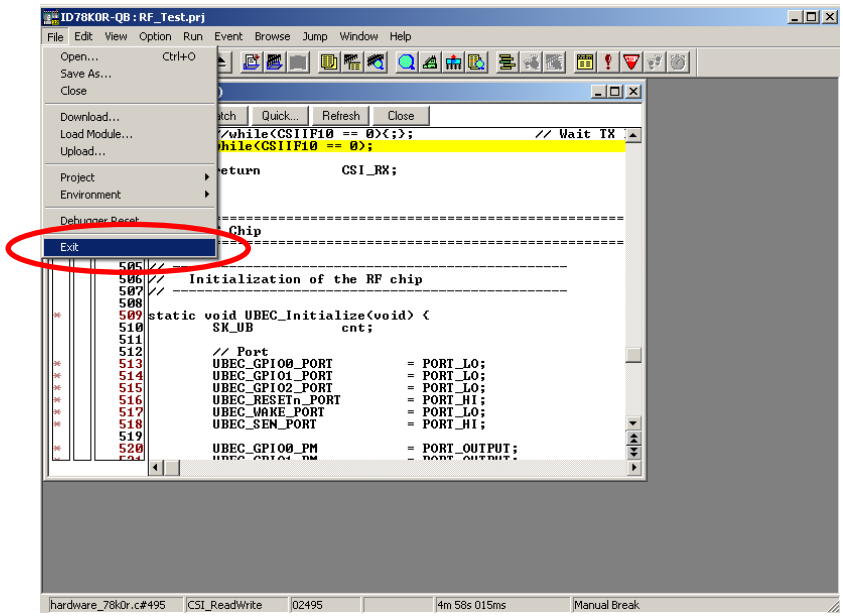




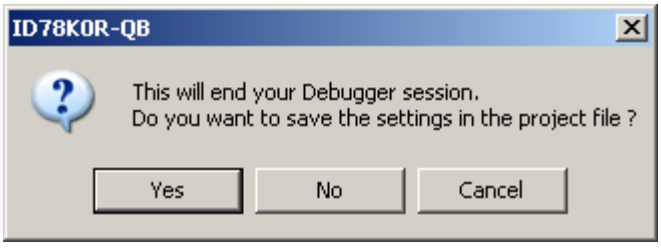
When the program stops, the status bar changes back to the original color.

3.13 Terminating integrated debugger (ID78K0R-QB)

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



The Exit confirmation dialog box is displayed.

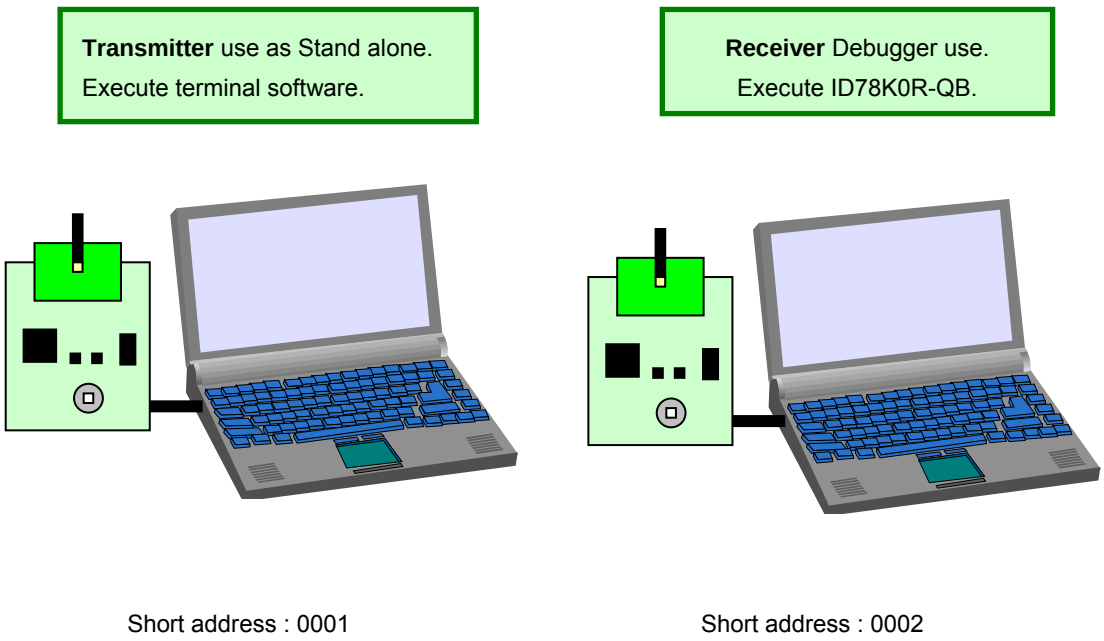


If you push the “Yes”, ID78K0R-QB is terminated after preserving a present environment.
If you push the “No”, ID78K0R-QB is terminated without preserving a present environment.

3.14 The RF Test Program

3.14.1 Procedure for one to one transmit/receive test

1). Assumption here in this section is, you have two TK-78K0R/KG3+UD boards, in one of which the execution code for the “RF_TEST” was programmed by the debugger. You also prepare two PCs or one PC with more than one usb interface.
one PC with USB interface and hyper-terminal to control the transmitter side of the board, and the other one with USB interface to the second PC for debugging at the receiver board.



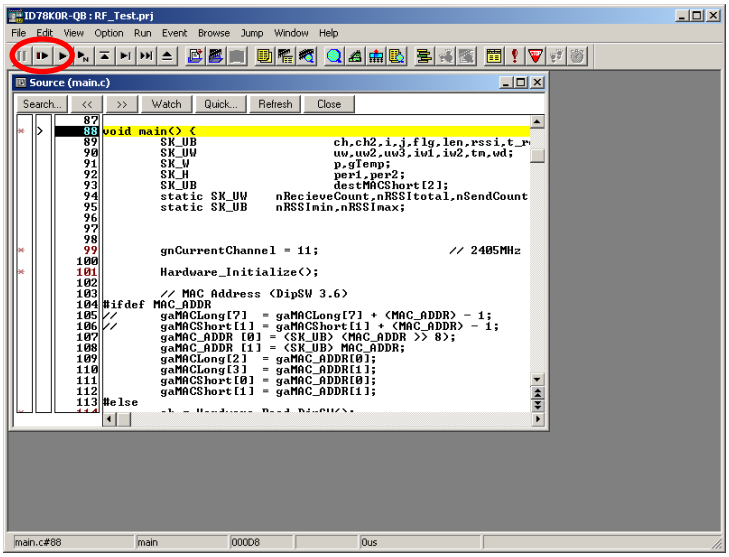
2). Now, you designate one TK-78K0R/KG3+UD board loaded with the execution code in the previous procedure as a transmitter. Another board, which is not loaded with the execution code is now designated as a receiver, which send back the test result to the sender. The receiver board can work without PC, but now, you set this board to the debug mode. Please set the switches on the receiver board as follows.

JP1		1-2 short (USB side)
SW1	Bit1	ON
	Bit2	ON
	Bit3	ON
	Bit4	OFF
	Bit5	OFF
	Bit6	ON for address setting
	Bit7	OFF for address setting
	Bit8	ON for the receive mode

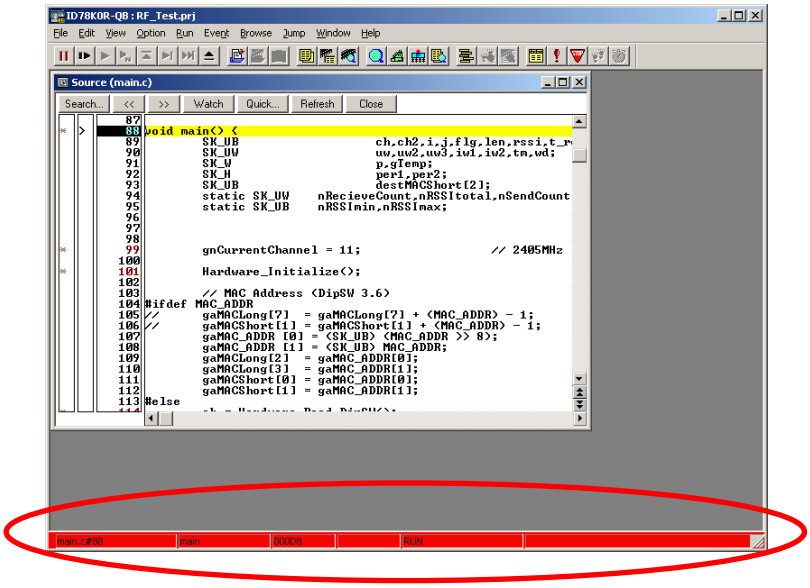
The above example is for the short address of 0002.
There are four ways of the address setting as follows,

		Short Address			
		0001	0002	0003	0004
SW1	Bit6	OFF	ON	OFF	ON
	Bit7	OFF	OFF	ON	ON

Please connect the receiver board to your first PC with a USB cable.
Now, please repeat the procedures described in the section “3.9 Starting integrated debugger”.
You will see the C-source window, as shown below.



Now, please click “GO” to run the program.



You will see the red bar at the bottom.

Now the receiver board is ready.

3). Please set the transmitter board as follows,

JP1		1-2 short (USB side)
SW1	Bit1	OFF
	Bit2	OFF
	Bit3	OFF
	Bit4	ON
	Bit5	ON
	Bit6	OFF for address setting
	Bit7	OFF for address setting
	Bit8	OFF for the Hyperterminal mode

This example is for the short address of 0001.
This board is designated as the transmitter.

Then, please connect it to your second PC with a USB cable.

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

4). Hyper Terminal

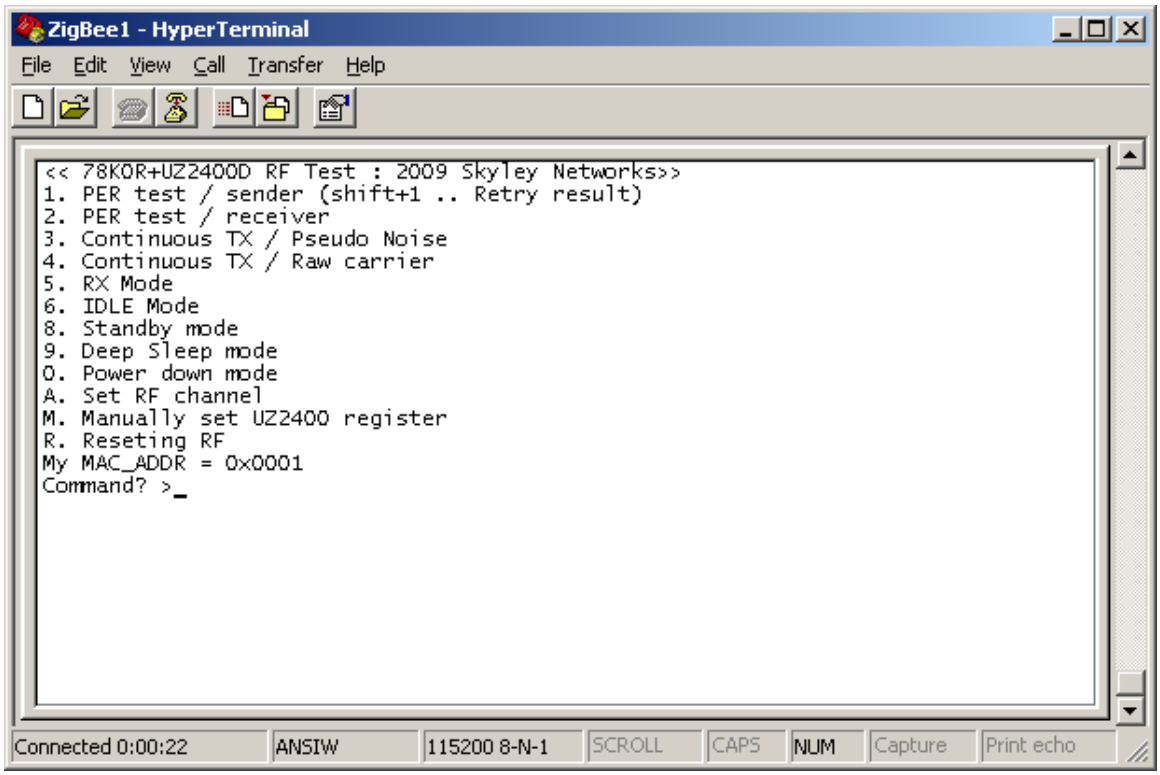
On MS-Windows in your PC, please select [All Programs] -> [Accessory] -> [Communication] -> [HyperTerminal]

Setting of Hyperterminal

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

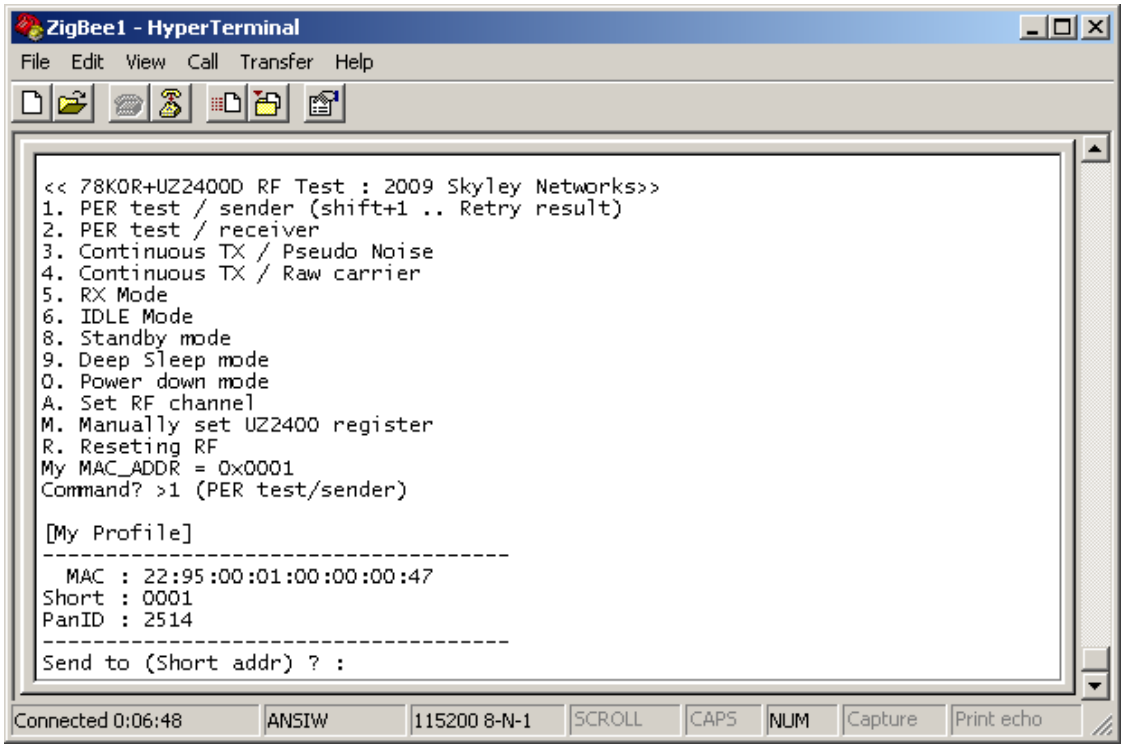
(Property -> Setting -> ASCII)
Local Echo OFF
No Line Feed

Now you will find the following opening menu in the window.
If not, please try the RESET button on the board.



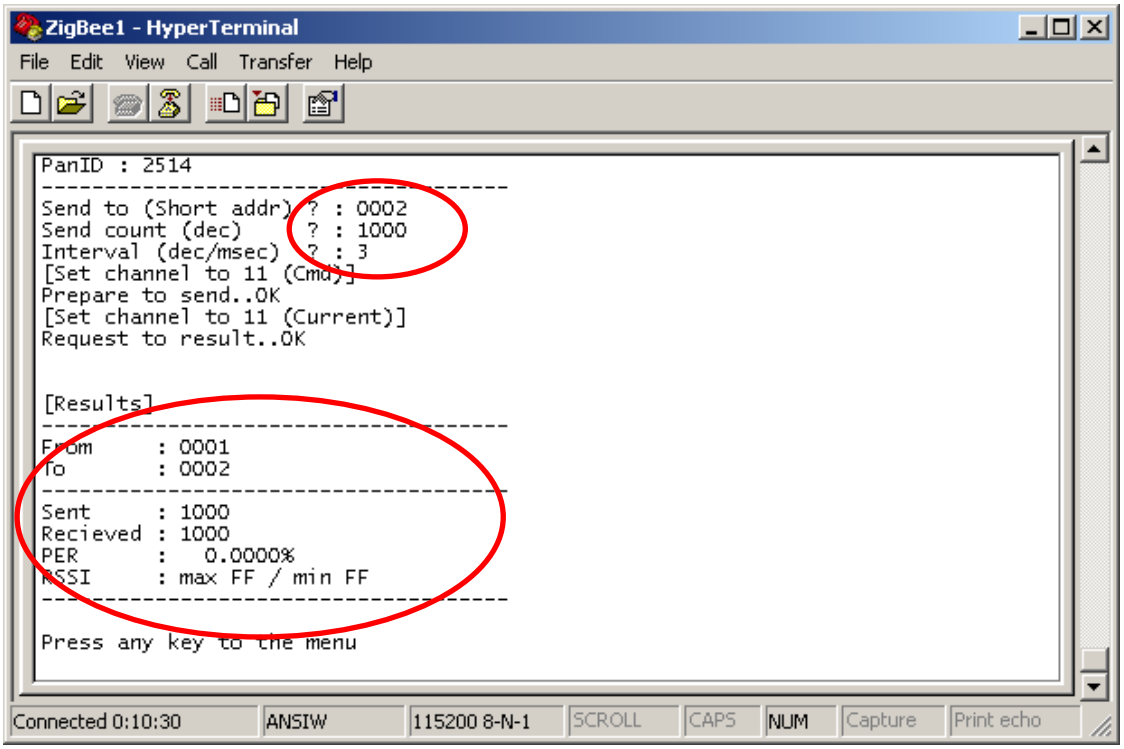
5). Execution of the Transmit/Receive Test

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

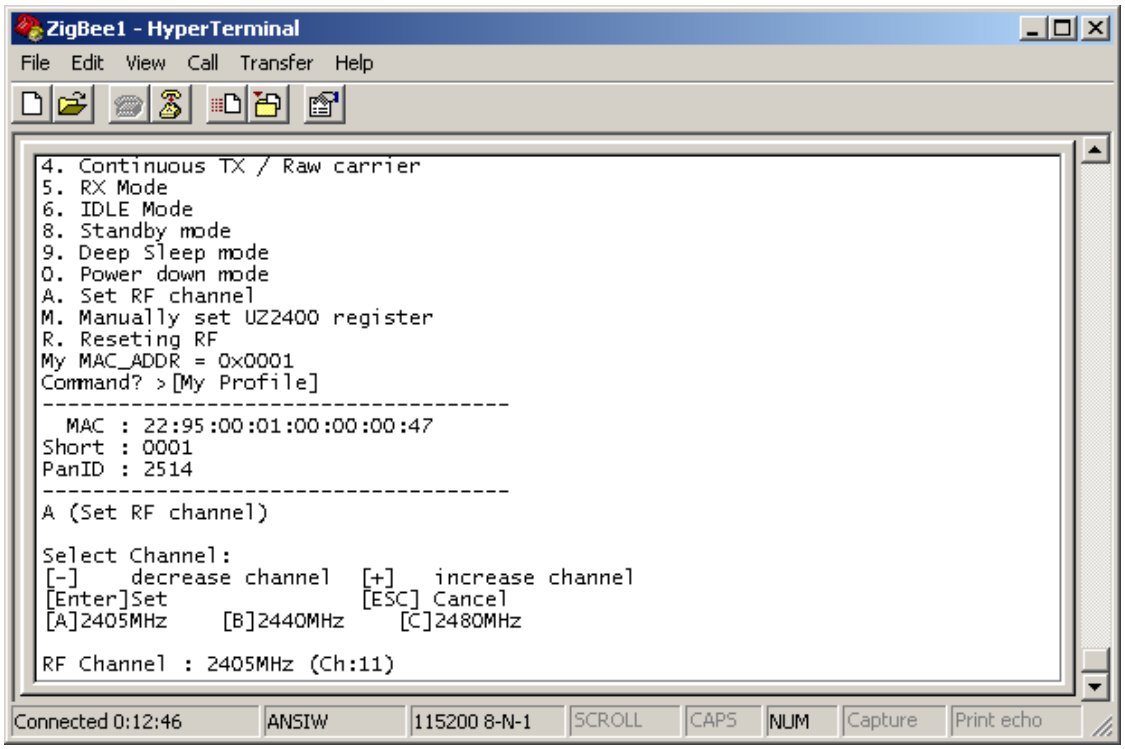


RSSI is expressed in the hexagonal value of 256 levels, which indicates the signal strength in the received signal. For more details of the RSSI value, please refer to the datasheet of the UZ2400 RF chip.

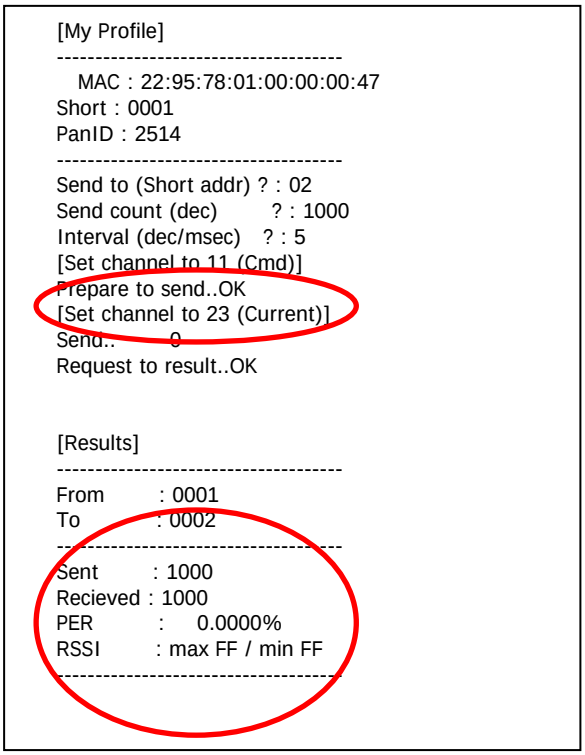
Please note the PER and the RSSI are measured at the receiver side.
The receiver does not send back the test packets, but only the test result.

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 “A” 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.

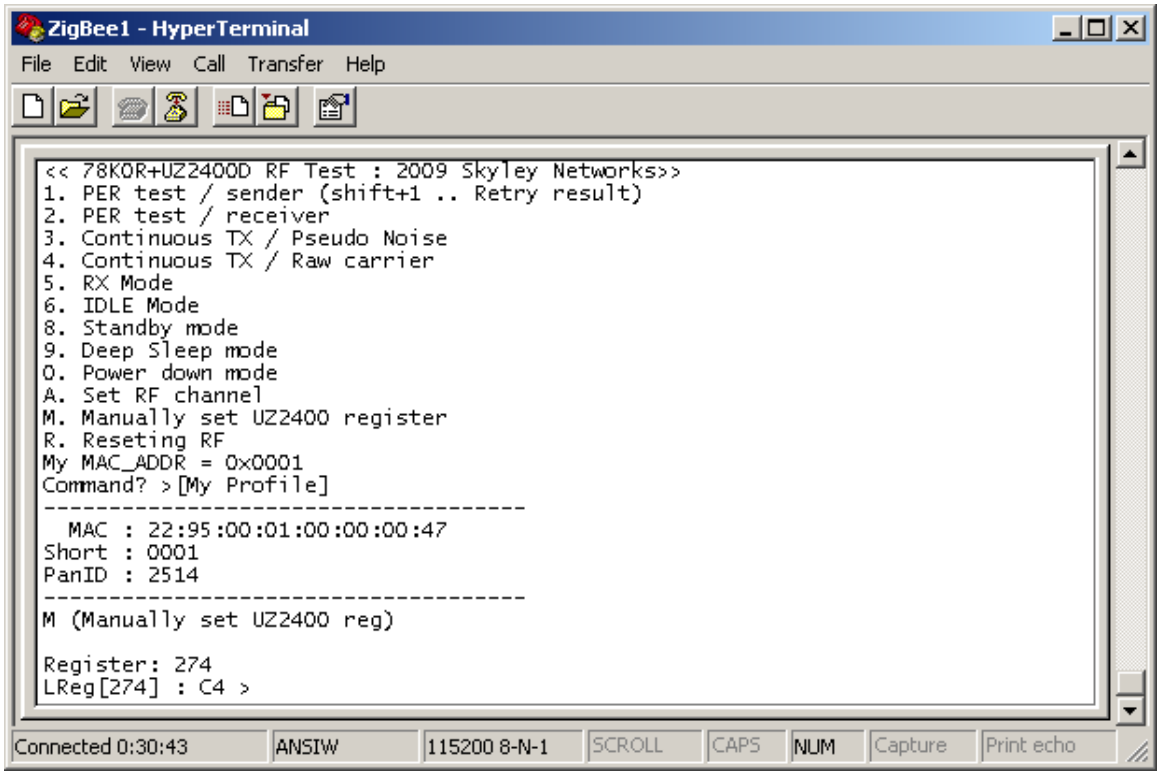


To execute the PER test at the channel 23, press [Enter] in your keyboard, then, choose “1” to initiate the PER test mode. Then, you may input 1000 packet in 5 msec interval to see the following example. Please confirm the channel used is 23th in the display. Please note the receiver will learn which 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 “M” in the menu.
You will be asked the register ID. Please input “274”.
Then you will see, “LREG[203] : 00 >”.
It means the current value at the register [274] is 0xC4h, which means 0 dB.
0xC4h is the reset default.



The register bits are defined as follows,

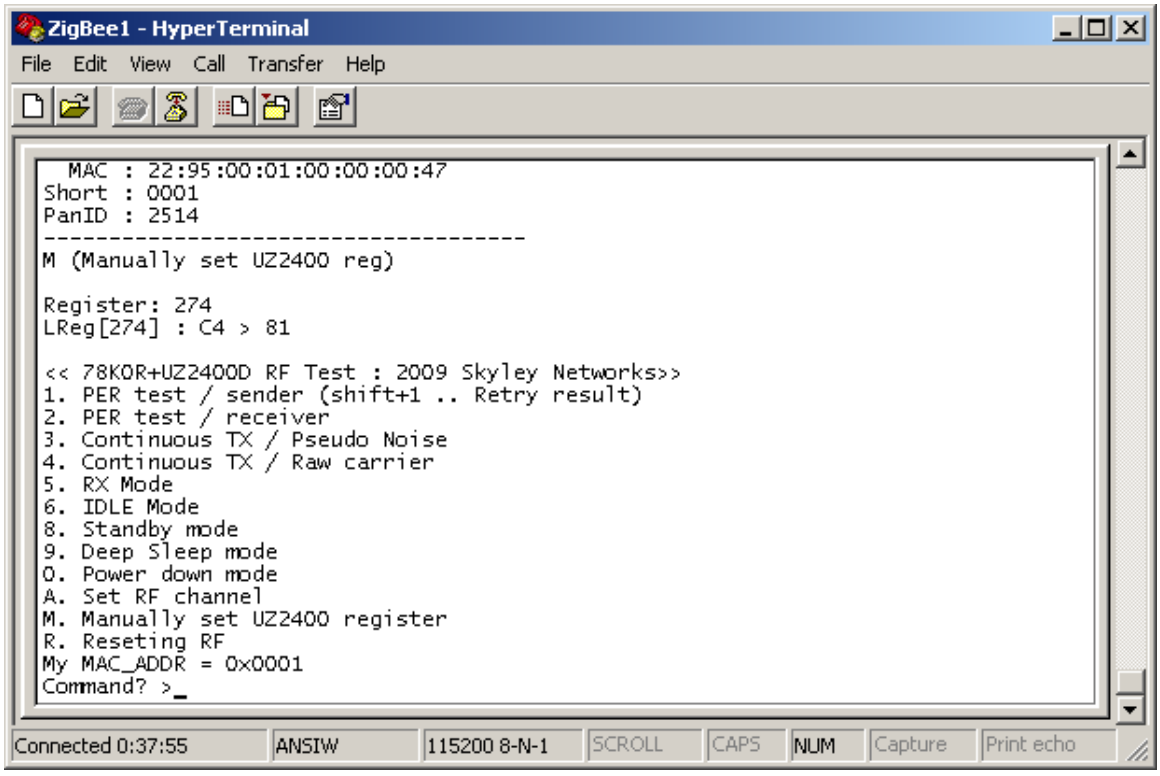
LREG[274]: [7:6] -> large scale tuning
C4: 0 dB
81: -8 dB
09: -16 dB
01: -24 dB

LREG[203]: [7:3] -> small scale tuning
000000: 0 dB
000001: -0.1dB
|
111111: -8.00 dB

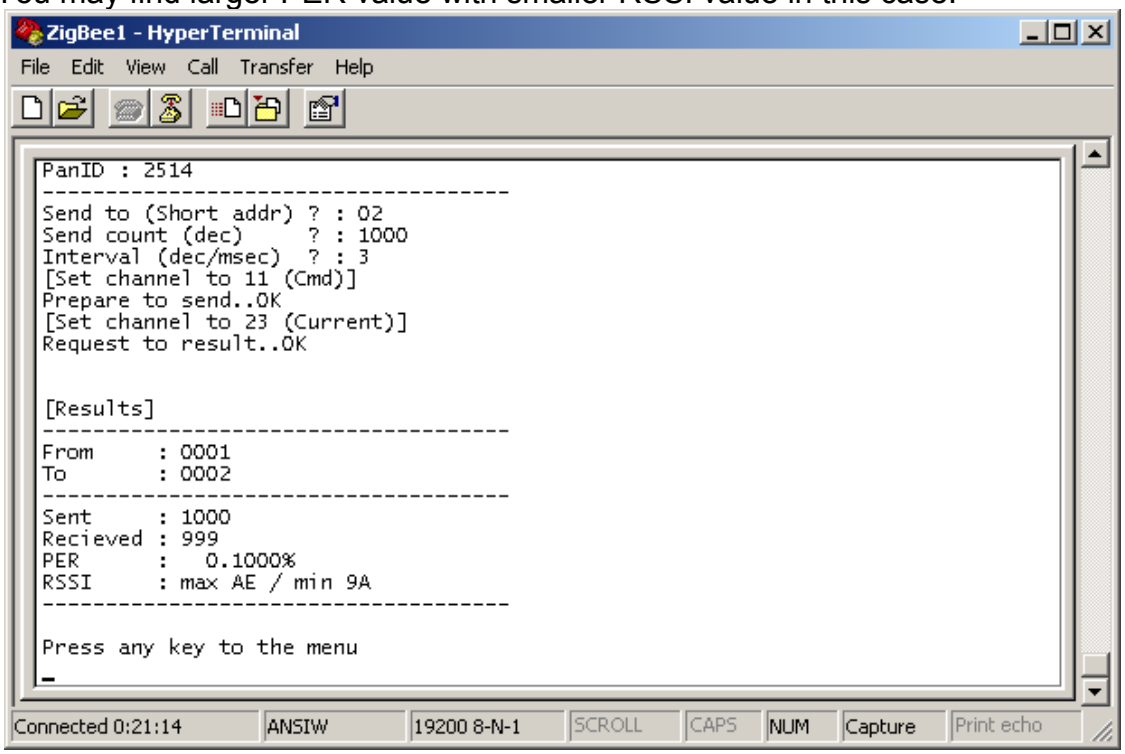
For instance, if you wish -8 dB, please input “81”, as follows,

“LREG[274] : C4 > 81”

Then, you will start the PER test.



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 board to the receiver in the PER test.
If you have two PCs, you can connect two boards 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 board to the receiver mode by setting the switch 1-8.

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 Standby MODE

The Menu 8 sets the UZ2400 into the Standby mode.

3.14.8 Deep Sleep mode

The Menu 9 sets the UZ2400 into the Deep Sleep mode.

3.14.9 Power down mode

The Menu 0 sets the UZ2400 into the Power down mode.

3.14.10 Set RF channel

The Menu A allows you to set the RF channel.

3.14.11 Manually set UZ2400 register

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

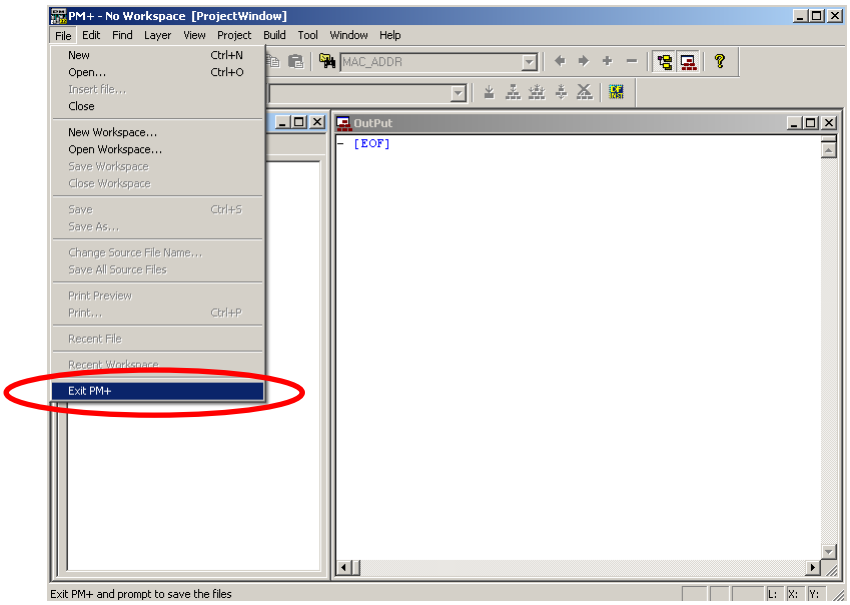
3.14.12 Resetting RF

The Menu R allows you to reset the UZ2400 registers.

3.15 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.

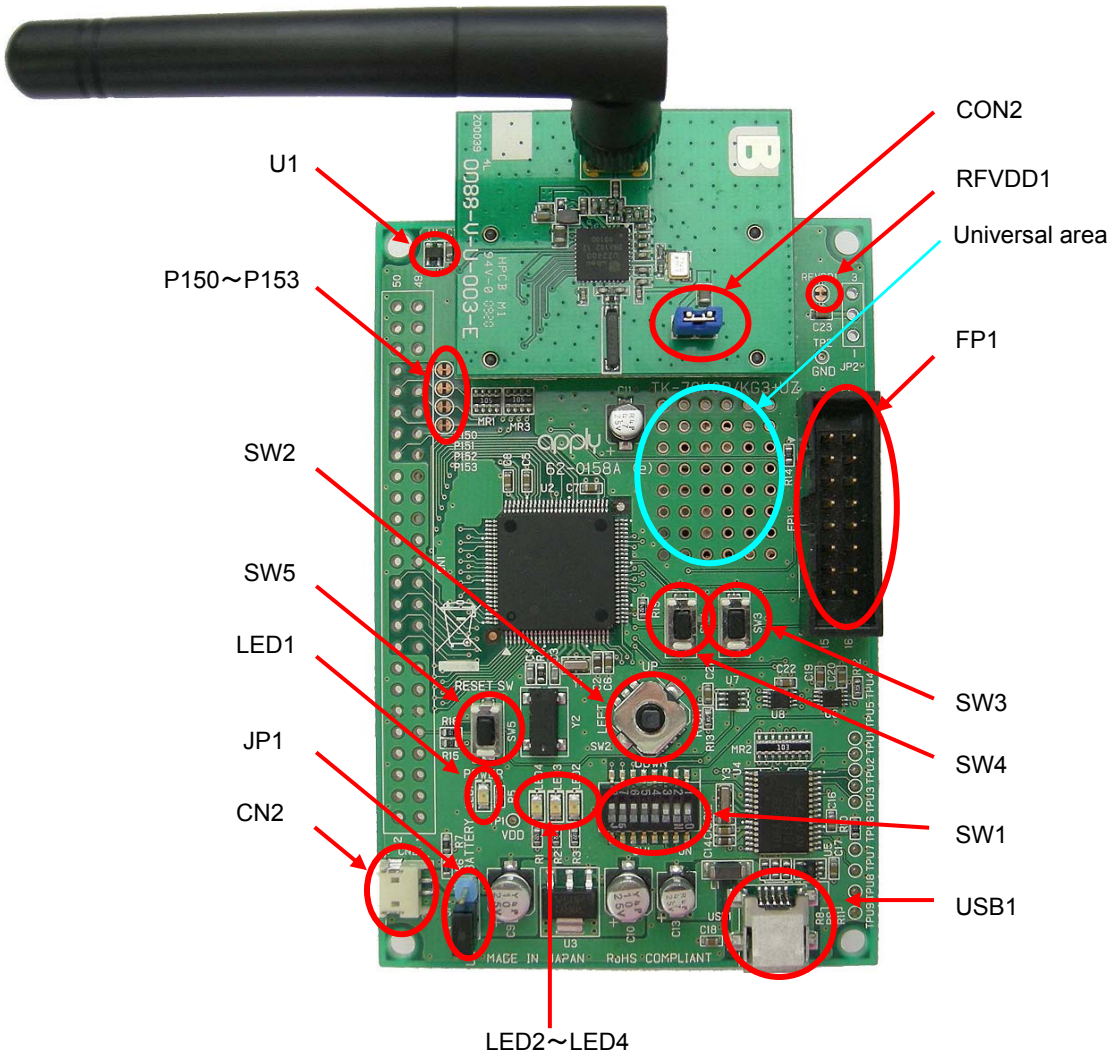
4 Hardware Specifications

In this chapter, the hardware of TK-78K0R/KG3+UD will be explained.

Microcontroller	μPD78F1168 ※78K0R/KG3
Clock	External main system clock: 20MHz Subsystem clock: 32.768KHz Internal high-speed oscillation : 8MHz
Interface	USB (Mini B connector) RF connector (SMA) Connector of board in surrounding (CN1: not mounted) Connector for battery(9.0V-4.8V) MINICUBE2 connector
Power supply voltage	5.0V(Supply from USB)、 9.0V(Supply from a battely,Min.6.5V)
Input/output for operation check use	・7LED x3 ・Push switch (SW3,SW4) ・Dip switch (SW1) ・Reset switch (SW6) ・Temprature sensor (U1)
Other hardware	・Mode switch(SW1) ・Power LED(LED1)

* The name with bracket is the name printed on the board.

4.1 Layout of hardware functions



4.2 Hardware Functions

4.2.1 SW1

Bit1-5 of SW1 is Dip switch for operation mode setting.
Bit6-8 are the Dip switch for general-purpose ports that connected to P80-P82.

- For the use of ID78K0R-QB, use following settings.

SW1

Bit 1	ON/OFF ※1
Bit 2	ON
Bit 3	ON
Bit 4	OFF
Bit 5	OFF

※1 **ON:** The microcontroller stays being reset until ID78K0R-QB is started.
OFF: The microcontroller runs the programs stored in the flash memory as soon as it gets power supply.

※2 If you use ID78K0R-QB, it uses P40 and P41 for communicating with host machine. Therefore, you cannot use P40 and P41.

- To run the programs stored in built-in flash memory without using ID78K0R-QB, use following settings and re-supply USB power.
  You can use the On-chip debug function with connecting a MINICUBE2.

SW1

Bit 1	OFF
Bit 2	OFF
Bit 3	OFF
Bit 4	OFF
Bit 5	OFF

● For use of P13 (TXD3) and P14 (RXD3) connecting to μPD78F0730 as general-purpose ports without using ID78K0R-QB, set SW1 as follows and re-connect the USB to re-supply power.
You can use the On-chip debug function with connecting a MINICUBE2.

SW1

Bit 1	OFF
Bit 2	OFF
Bit 3	OFF
Bit 4	ON
Bit 5	ON

● Bit6-8 are connected to following CPU pins
It becomes “Low” if the switch is pushed, and it becomes “Open” if it separates.
Please turn on pull-up resistor (PU8) with built-in CPU when using it.

SW1

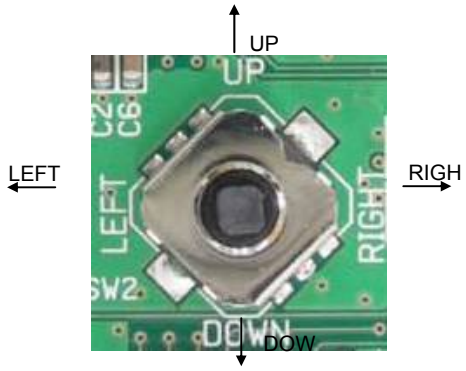
Bit 6	P80
Bit 7	P81
Bit 8	P82

4.2.2 SW2

SW2 is a 4 directional switch with center push. If it is directed or pushed, the input is set to GND. Otherwise the circuit is open. Therefore please set the on-chip pull-up resistors (PU7) during initializing routine of your program code.
(For more detail, please refer to the User's manual(U17894) of the μPD78F1168 CPU.)

SW2 terminal list (ALPS SKRHADE010)

SW2	Signal name	Terminal CPU name at connection destination	Notes
1	P72	P72/EX18/KR2	UP
2	P73	P73/EX19/KR3	CENTER PUSH
3	P74	P74/EX20/KR4/INTP8	LEFT
4	P75	P75/EX21/KR5/INTP9	RIGHT
5	GND	GND	
6	P76	P76/EX22/KR6/INTP10	DOWN



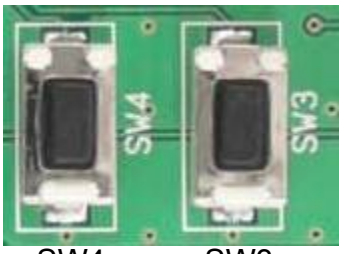
SW2 Directional switch

4.2.3 SW3,SW4

SW3 and SW4 are tact switches. The port inputs are short-circuited to ground, while they are being pushed, and kept open otherwise. Therefore please set the on-chip pull-up resistors(PU7) during initializing routine of your program code. (For more detail, please refer to the User's manual(U17894) of the μPD78F1168CPU.)

SW3 and SW4 terminal list (ALPS SKQMBBE010)

	Signal name	Terminal CPU name at connection destination	Notes
SW3	P70	P70/EX16/KR0	
SW4	P71	P71/EX17/KR1	



SW4 SW3

4.2.4 SW5

SW5 is the reset switch. CPU can be reset by pushing.

SW6

4.2.5 JP1

This switches the power supply for CPU.

1-2 short	supply power from USB connected to USB1
2-3 short	supply power from batteries connected to CN2

4.2.6 LED1

This is the POWER LED. It is lighted when it gets power supply.

4.2.7 LED2, LED3 and LED4

LED2, LED3, and LED4 are available for applications. To make an LED on, please set the output port LOW.

LED2, LED3 and LED4 Terminal list

	Signal name	Terminal CPU name at connection destination	Notes
LED2	P62	P62	
LED3	P61	P61/SDA0	
LED4	P60	P60/SCL0	

LED4 LED3 LED2

4.2.8 FP1

The connector for MINICUBE2.

MINICUBE2 switch setting

M1, T

4.2.9 CON2

Usually the jumper is short-circuited. If you want to measure the current consumed on the RF boards, you can measure it here.

4.2.10 U1

U1 is a temperature sensor.
The temperature sensor is being connected to the MCU pin of "P27/ANI7". Therefore you can measure the output of the sensor using the analogue to digital converter, embedded in the MCU. You can convert the measured output voltage to a tempareture, referring to the conversion formul, available in the datasheet of the sensor, SII S-80120CNB. Please download the datasheet of the sensor from the internet web site of Seiko Instruments.

4.3 Universal Area

The kit has the universal area. Users can use this to develop custom circuit.

4.4 Solder-short pad

With using the solder-short pad to cut the circuit, users can customize the circuit.
The solder-short pad looks like the picture below.
To open, use cutter to cut the dent part. To short, put solder on the pad.

Solder-short pad (Open)

Solder-short pad (Short)

Solder-short pad name	Before Shipment	Connection
P150～P153	Short	1MΩ Pull-down Open when P150～P153 on CN1 is used.

4.5 Power supply

There are two choices to supply power to the board, USB or a 006P battery via CN2. Please refer to 2.5 JP1 for the jumper setting.
Please replace the battery with a new one, if the voltage level goes down to 4.8V.
Below the voltage level of 4.8V, functions of the board are not guaranteed.
The battery voltage can be checked at the port as shown below.

9.0V Battery check

Signal name	Terminal CPU name at connection destination	Notes
BT_MONI	P26/ANI6	33.8% of the battery output is available at ANI6 For instance, If the battery level is 9 V, the level of the BT_MONI = 0.338 × 9.0 V = 3.042 V If the battery level is 6.5 V, the level of the BT_MONI = 0.338 × 4.8 V = 1.622 V

5 The IEEE 802.15.4 MAC Sample Program

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

5.1 The MAC Sample program 1 :TextChat

This chapter introduces the usage of MAC application 1

The MAC Sample program 1 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 1, you need to prepare at least two PC with a USB interface or one PC with more than one USB interface, and two TK-78K0R/KG3+UD boards.

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 emission. In general, it is suggested to use the TK-78K0R/KG3+UD board in a radio anechoic chamber.

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

5.1.1 Programming to the TK boards

For chatting, please prepare minimum 2, or maximum 5 TK-78K0R/KG3+UD boards. 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
NEC VERSAPRO VY10A/C-4,
and, NEC VERSAPRO VY10F/BH-M

Start PM+, and open the file "C:¥TK78K0R¥SAMPLE_KG3+UD¥TK78K0RKG3UD_Sample1¥TK78K0RKG3UZ_Sample1.prw".

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

Select "Preprocessor" tab on "Compiler Options" window.

To write programs on the first TK-78K0R/KG3+UD, enter "CPU78K0R,DCDC,MAC_ADDR=0x0001" on "Define Macro". For the second and third TK-78K0R/KG3+UD, enter "CPU78K0R,DCDC,MAC_ADDR=0x0002" and "CPU78K0R,DCDC,MAC_ADDR=0x0003". The number "x" of " MAC_ADDR=x" must be a unique number.

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

Start the debugger from PM+, then write different programs to each TK-78K0R/KG3+UD (for the information about how to write programs, refer to "3.1 Starting PM+" through "3.9 Starting integrated debugger (ID78K0R-QB)").)

5.1.2 **Setting up the board to your PC**

Set the TK-78K0R/KG3+UD as shown below.
Connect it to PC with USB cable.
Confirm the power LED on TK-78K0R/KG3+UD is lighted.

JP1		1-2short (USB side)
SW1	Bit1	OFF
	Bit2	OFF
	Bit3	OFF
	Bit4	ON
	Bit5	ON
	Bit6	OFF
	Bit7	OFF
	Bit8	OFF

Start Hyper Terminal with referring to "3.14The 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

Press SW5 (RESET SW) once after Hyper Terminal is started. The sample application starts after resetting.

In the same way, connect the other TK-78K0R/KG3+UD board to PC, and start Hyper Terminal. If the PC has more than one USB ports, you can connect to more than one TK-78K0R/KG3+UD boards, and you can start more than one Hyper Terminals for those COM ports on each board.

4). Hyper Terminal

Now you will find the following opening menu in the window.
If not, please try the RESET button on the board.

```
 << 78K0R+UZ Sample Application: Skyley Networks >>
 My MAC extended address
 = 123412349ABC0001


Command? >
```

Then, press Enter,

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

Command? >
```

Please do the same for your other boards and PCs.

5.1.3 Designation of a coordinator

Now, you must decide which board is a coordinator.
Go to the PC of the coordinator board, and press C.

```
Command? >C

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

Command? >
```

Now the coordinator has started.

5.1.4 Network Association

For other PCs for other boards, please press M.

```
Command? >M

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

Command? >
```

Now, this particular board 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 board.

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

```
> MLME-ASSOCIATE.indication
>  from 123400019ABC0001 associated to 4321

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

Command? >
```

5.1.5 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.

5.2 The MAC Sample Program2 : LED Control

The MAC Sample program 2 is developed to provide with another simple example to construct a star network utilizing the IEEE 802.15.4 PHY/MAC standard.

The MAC Sample Program 2 offers,
1). Designation of a network coordinator in a star configuration
2). If you push a switch on the n th end device, an LED on the coordinator board blinks on and off n times.

To use the MAC Sample Program 2, you need to prepare one PC with a USB interface and two TK-78K0R/KG3+UD boards or more boards, up to 5.
The MAC Sample Program 2 is provided in the form of the C source codes with the MAC library.

If you wish to tailor the sample program to meet your specific experiment, 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 is occupied for the debugging interface, the USB connection is not available for applications. In this application example, Hyperterminal with USB connection offers information on the network association. However, the LED operation can be made without Hyperterminal. Therefore, you can use the USB connection for debugging for the LED operation. Alternatively, you may 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 TK-78K0R/KG3+UD board in a radio anechoic chamber.

5.2.1 Programming to the TK boards

Prepare TK-78K0R/KG3+UD boards (2 to maximum of 6 boards).
You also need at least one PC to write programs, however no PC is needed when running the programs.

One TK-78K0R/KG3+UD board will be "Coordinator". Other 1-5 boards 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_KG3+UD¥TK78K0RKG3UD_Sample2¥TK78K0RKG3UZ_Sample2.prw".

Click the build button  or select "Build" on menu bar, then "Build" to build.
Start the debugger from PM+ and write programs to each TK-78K0R/KG3+UD board.
(for the information about how to write programs, refer to "3.1 Starting PM+" through "3.9 Starting integrated debugger (ID78K0R-QB)")

The address of each board will be set by pressing SW2 when the boards start up (when power is supplied). Therefore, you use the same programs to all boards.

5.2.2 Starting up a coordinator

By connecting the TK-78K0R/KG3+UD which takes the role of "Coordinator", you can monitor those programs running (you can monitor the output itself with LED without PC).
When you wish to connect PC, set the TK-78K0R/KG3+UD as follows. Then, connect USB cable to PC. Confirm the power LED is lighted after connecting the USB cable.

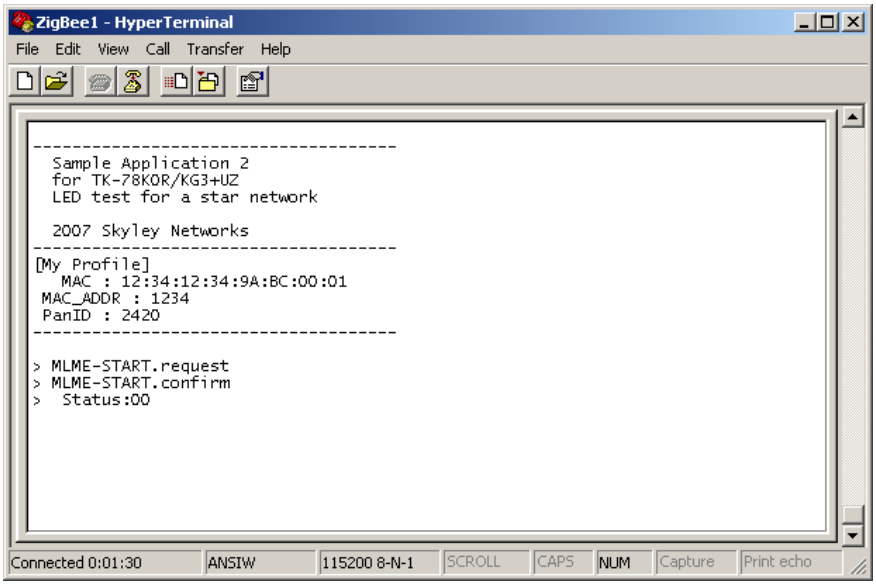
JP1		1-2 short (USB side)
SW1	Bit1	OFF
	Bit2	OFF
	Bit3	OFF
	Bit4	ON
	Bit5	ON
	Bit6	OFF
	Bit7	OFF
	Bit8	OFF

Start Hyper Terminal with referring to "3.14The 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

6). After you open the window of the HyperTerminal, please push the reset button on the board. Now you will find the following opening message in the window.
If not, please reconfirm the COM port number of the USB connection.



Now the coordinator has started up successfully.

5.2.3 Starting up end devices

Set TK-78K0R/KG3+UD settings as follows when you use PC connected to TK-78K0R/KG3+UD which takes the role of "End device". Then, connect USB cable to PC. Confirm the power LED is lighted after connecting the USB cable.

JP1		1-2 short (USB side)
SW1	Bit1	OFF
	Bit2	OFF
	Bit3	OFF
	Bit4	ON
	Bit5	ON
	Bit6	OFF
	Bit7	OFF
	Bit8	OFF

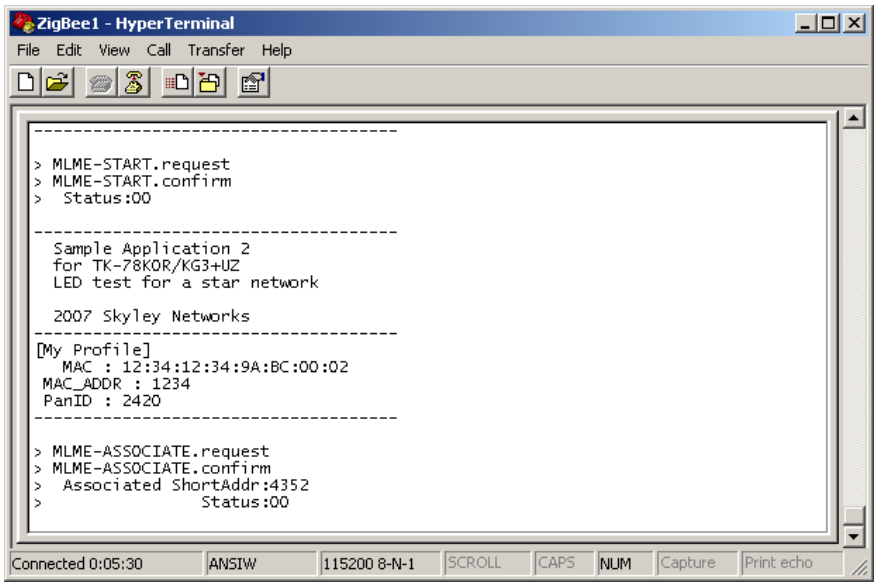
When you wish to use TK-78K0R/KG3+UD as itself, set JP1 to BATTERY side (2-3short) and SW1 to all OFF, then connect battery.

You must set the position of SW2 when you supply power to TK-78K0R/KG3+UD.
The TK-78K0R/KG3+UD board functions of each SW2 position are described as follows.

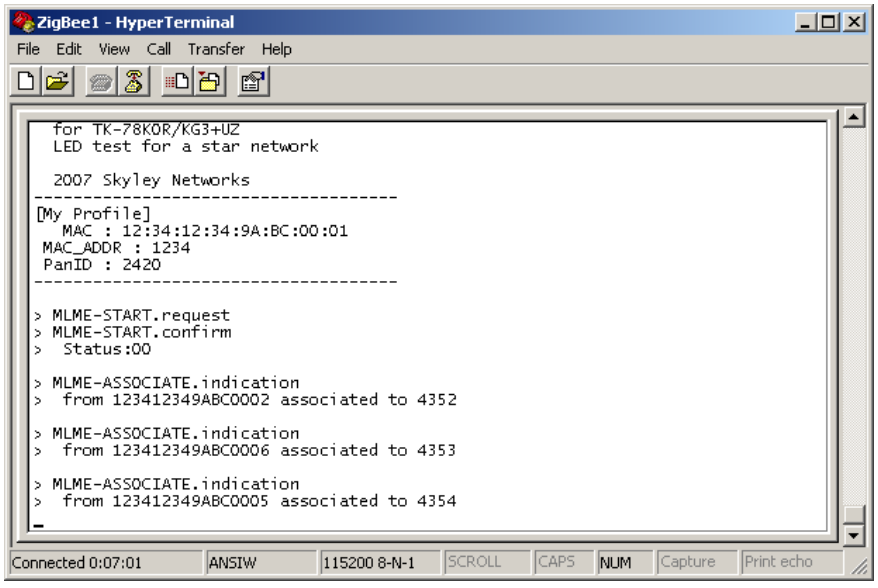
Position of Joy Stick during start-up	Function	Extended Address
Default	Coordinator	0x1234XXXX9ABC0001
Up	End Device	0x1234XXXX9ABC0002
Center	End Device	0x1234XXXX9ABC0003
Left	End Device	0x1234XXXX9ABC0004
Right	End Device	0x1234XXXX9ABC0005
Down	End Device	0x1234XXXX9ABC0006

※The “XXXX”of Extended Address filled with”MAC_ADDR=0xXXXX” that configured at “Compiler Options” -> “Defined Macro”.

If you start-up a board while keeping the Joy Stick up, you will see the following message on the HyperTerminal.



A short address of “4352” was assigned to the board.
A short address is assigned sequentially, independent from the long address.
Then, if you start-up the third board while keeping the Joy Stick center, you will see the following message on the HyperTerminal.



5.2.4 Operation

The coordinator generates beacon at channel 11 of 2405 MHz.
LED4 on the board is ON.

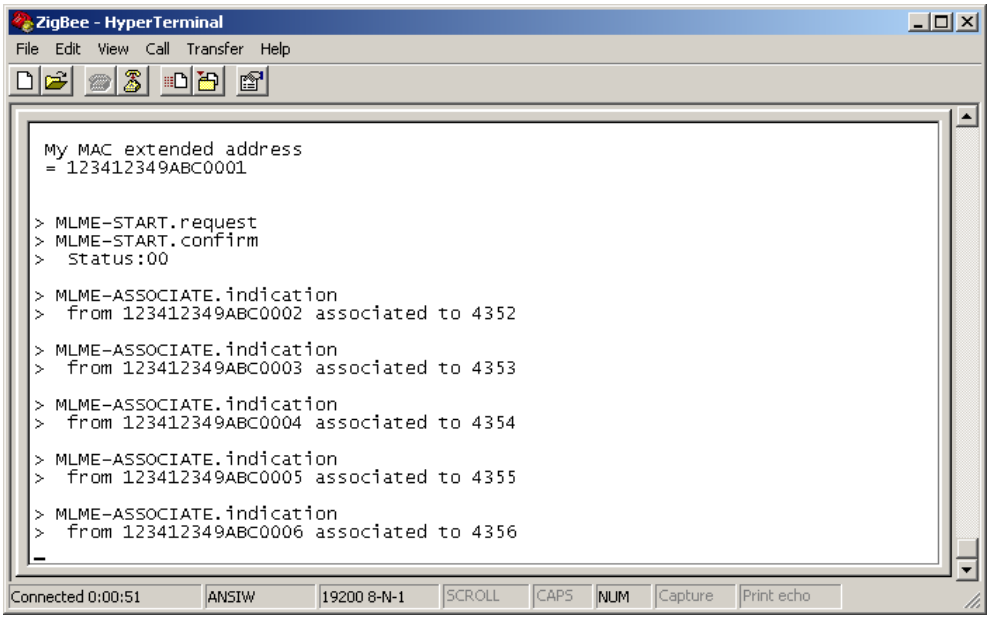
An end device makes a network association. If successful, LED2 on the board is ON.

If you push SW3 on an end device, LED4 on the coordinator blinks.
And, if you push SW4 on an end device, LED3 on the coordinator blinks.

The number of times of blink depends on the sequence the end device joined in the network. For instance, if an end device is the third end device for the network, the LED will blink three times.

LED on Coordinator	SW on End Device
LED2	SW3
LED3	SW4

The following example shows, the SW3 on the fifth end device, “4356”, was pushed. You will see the LED2 on the coordinator will blink 5 times.
The default PAN ID of this network is “2420”.



6 Troubleshooting

This chapter describes how to solve troubles you may face.

6.1 If you cannot find USB driver when you connect PC to the kit

Check Point 1

If you use USB hub, do not use it. (USB hub is not supported)

Check Point 2

Check if you installed "Starter Kit USB Driver" in "1.2 Installation of Development Tools". If not, install the driver.

Check Point 3

Check if the settings of the switch on the kit are correct with referring to "1.3 Installation of USB Driver".

Check Point 4

If above 3 check points are confirmed, disconnect the USB cable from PC and re-connect again. It should show the "Found New Hardware Wizard" wizard. Operate the installation with referring to "1.3 Installation of USB Driver". After the installation, make sure you go through "1.3.3 Completion of USB Driver Installation" to confirm the USB driver installation.

6.2 Error when you start the debugger

There could be several reasons to make errors happen.
The solving processes differ depending on errors. Please check the error message first.
The solving processes for each error are as follows.

6.2.1 "Can not communicate with Emulator..." (F0100 or A0109)

Check Point 1

If you use USB hub, do not use it. (USB hub is not supported)

Check Point 2

Check if the settings of the switch on the kit are correct with referring "1.3 Installation of USB Driver".

Check Point 3

Confirm the USB driver installation with referring to "1.3.3 Completion of USB Driver Installation".

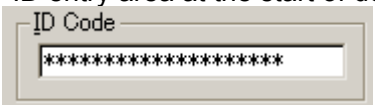
Check Point 4

If above 3 check points are confirmed, close the debugger and disconnect the USB cable from PC. Re-connect USB cable properly to both the PC and the kit, and then re-start the debugger.

6.2.2 "Incorrect ID Code." (Ff603)

This error occurs when the security ID stored on microcontroller built-in flash memory is different from the ID code you entered at the start of debugger.

Security ID entry area at the start of debugger



Check Point 1

Enter correct security ID and click OK on the configuration window.

Check Point 2

If you forgot the security ID, you have to erase the microcontroller built-in flash memory. Before erasing, check if you actually set the security ID with referring to "3.4Configuration of Linker Option". Also remember the code you set for the security ID.
After this, erase the flash memory with referring to "7.4Erase of flash memory".

6.2.3 "The on-chip debug function had been disabled in the device." (F0c79)

This error occurs when the value at address C3H (On-chip debug option byte) in microcontroller built-in flash memory is incorrect. You need to erase the flash memory.

Check Point 1

Check if you actually set the correct on-chip debug option byte with referring to "3.4Configuration of Linker Option". If it is not correct, then set correctly.

Check Point 2

Erase the flash memory with referring to "7.4Erase of flash memory".

6.2.4 "Disabling the on-chip debug function is prohibited." (F0c33)

Basically, this error occurs when you start (download) the debugger without doing the settings described at "3.4Configuration of Linker Option". Do the same checking processes as"4.2.3 The on-chip debug function had been disabled in the device. (F0c79)".

7 Other Information

This chapter explains some useful operation techniques of development tools and circuit diagram of the kit for developing of user programs.

7.1 Create a new workspace (project)

7.2 Register additional source file

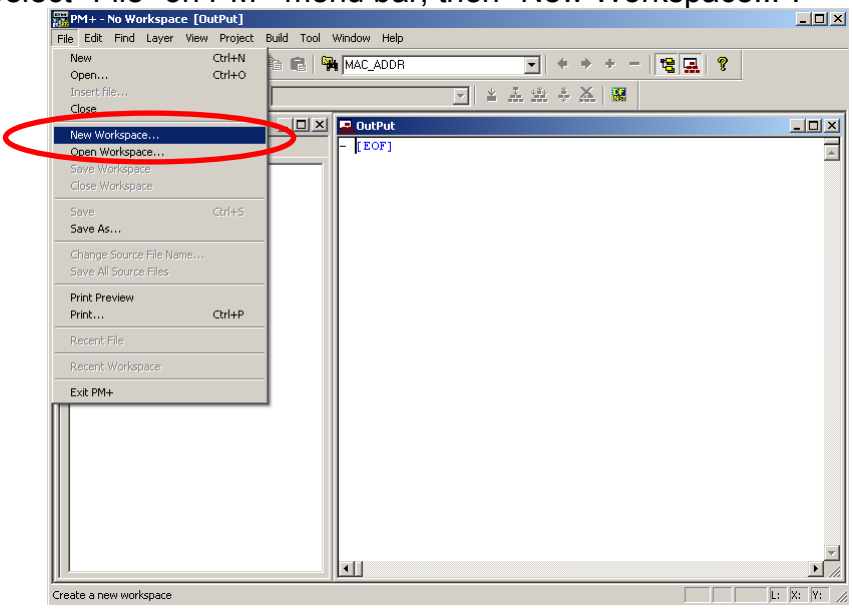
7.3 Debugger tips

7.4 Erase microcontroller built-in flash memory

7.5 Circuit diagram

7.1 Create a new workspace

Now, create a new workspace and project.
PM+ allows you to create a new workspace with following "New WorkSpace" dialog.
Select "File" on PM+ menu bar, then "New Workspace...".



"New WorkSpace" dialog opens

<Description of items>

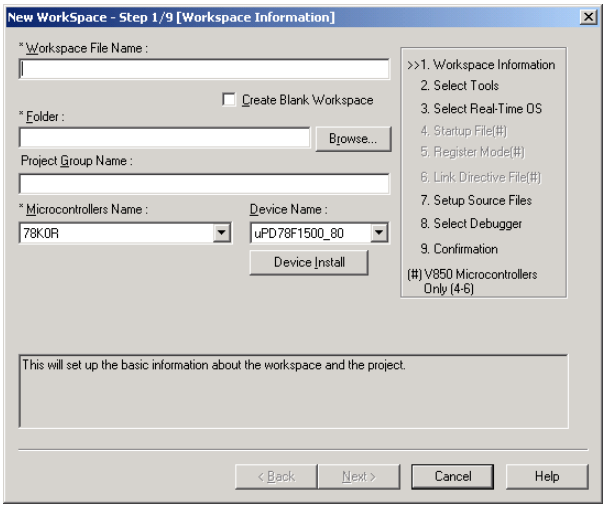
Workspace File Name:
-> Specify the name of the workspace file that manages the project files.
.prw is automatically suffixed as the file type.
A project file (.prj) of the same name is simultaneously created.

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.

Microcontroller Name:
-> Specify the name of the microcontroller 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.

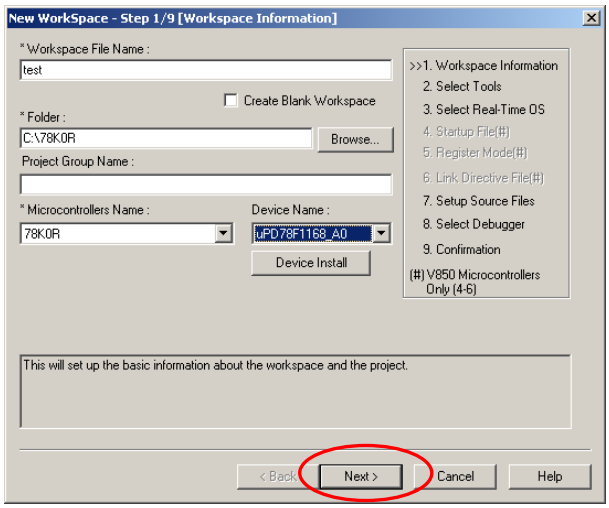
Workspace file name
→ test

Folder
→ C:¥78K0R

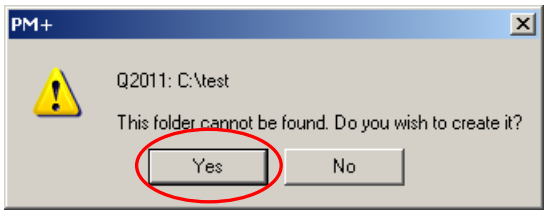
Project Group Name
→ (no input)

Microcontroller Name
→ 78K0R

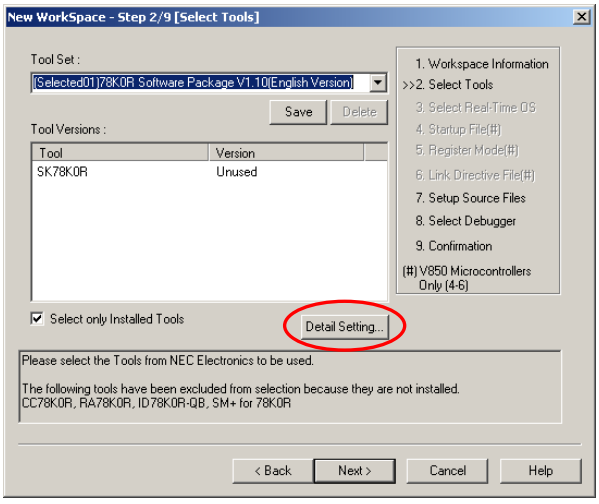
Device Name
→ uPD78F1168_A0



Click Next > button

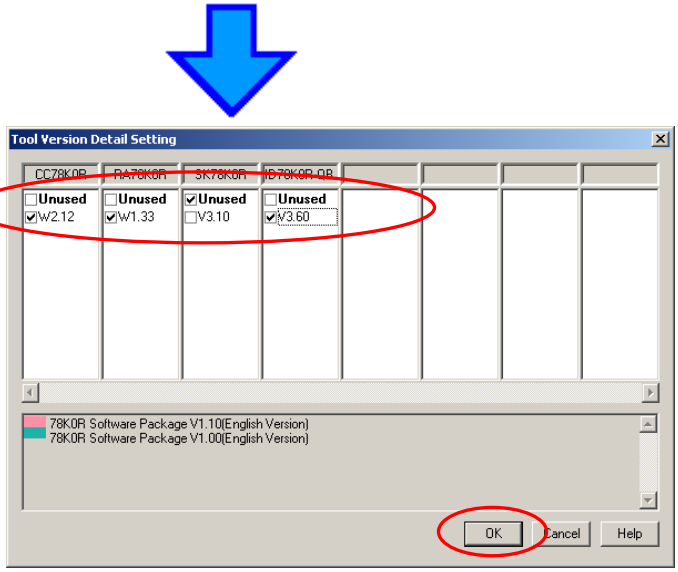


Click Yes button

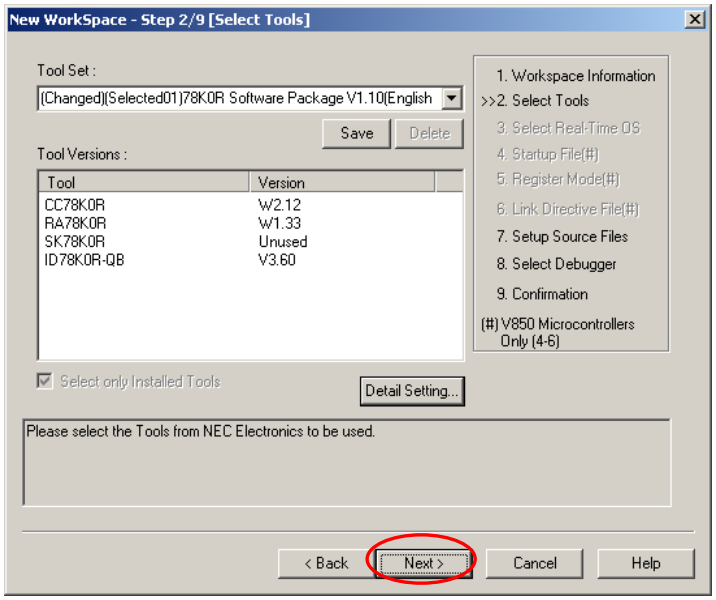


Click Detail Setting button

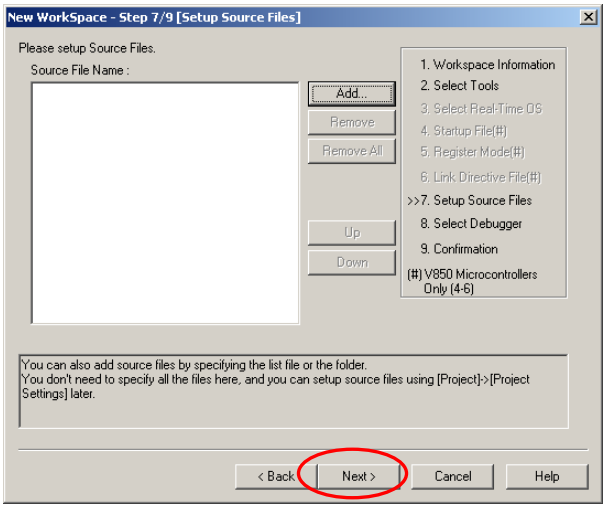
Set the version of tools as follows.
CC78K0R : W2.12
RA78K0R : W1.33
ID78K0R-QB : V3.60



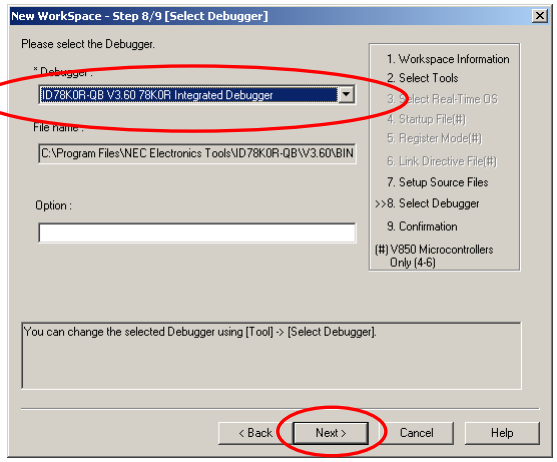
Select tools as above screenshot, then click OK .



Click Next >



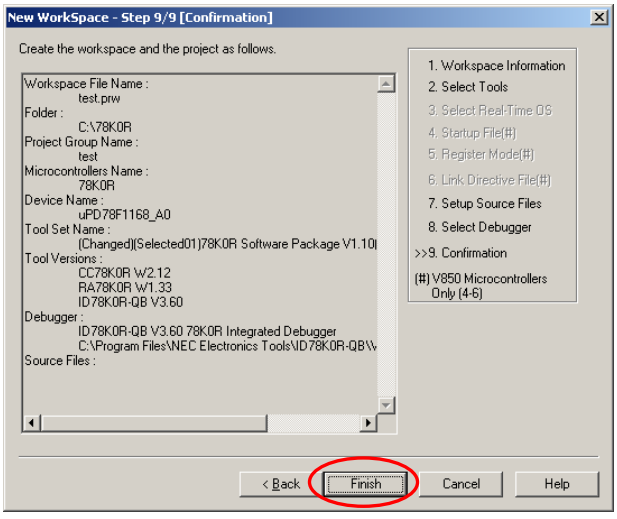
Click Next >



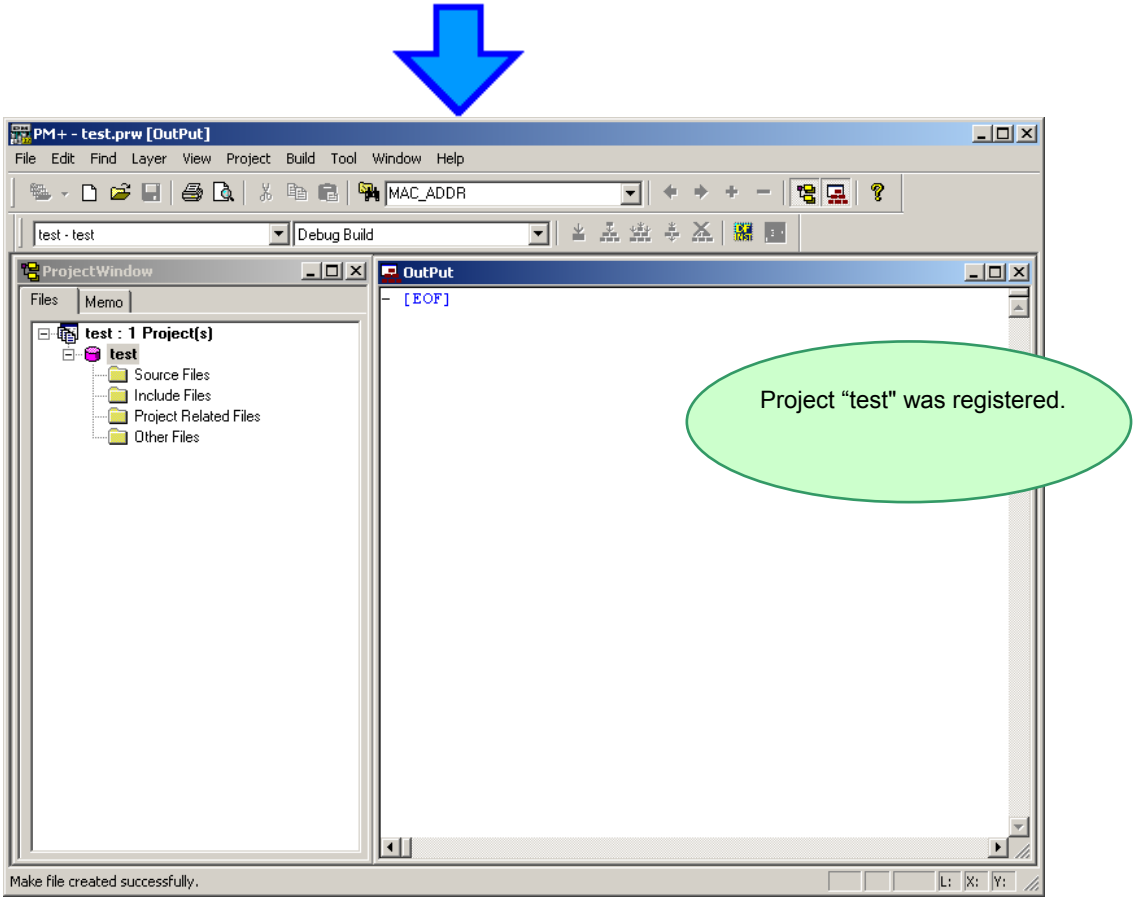
Click Next >

Select ID78K0R-QB V3.60

Check the project information settings



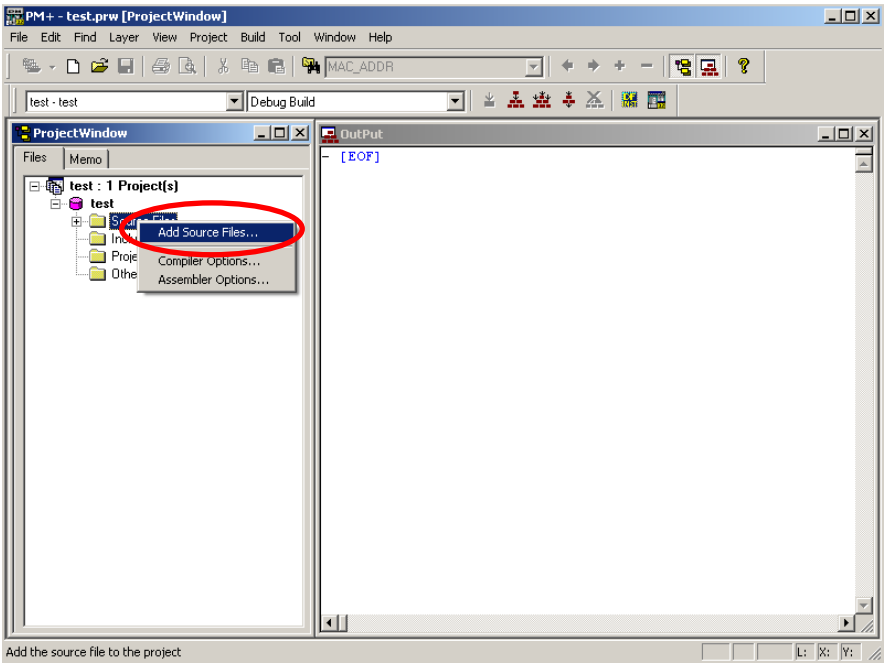
Click Finish



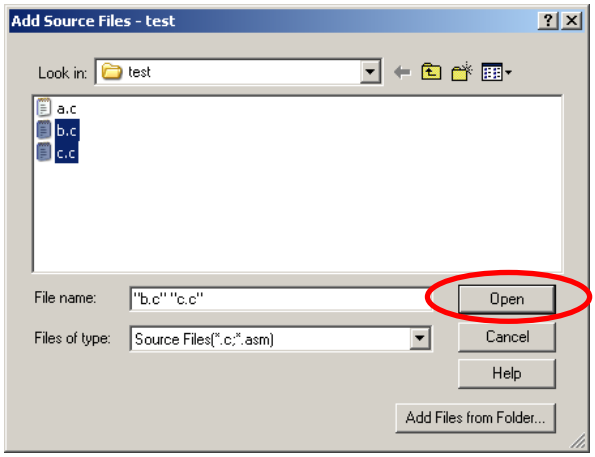
This completes workspace and project creation.
Additional source files can be registered at any time thereafter.
For details, refer to "7.2 Register additional source file".
Also, you need to do the settings for on-chip debug. Please refer to "3.4 Set Linker Options", "3.5 Set Compiler Options", and "3.7 Check Debugger Settings".

7.2 Registration of new source files

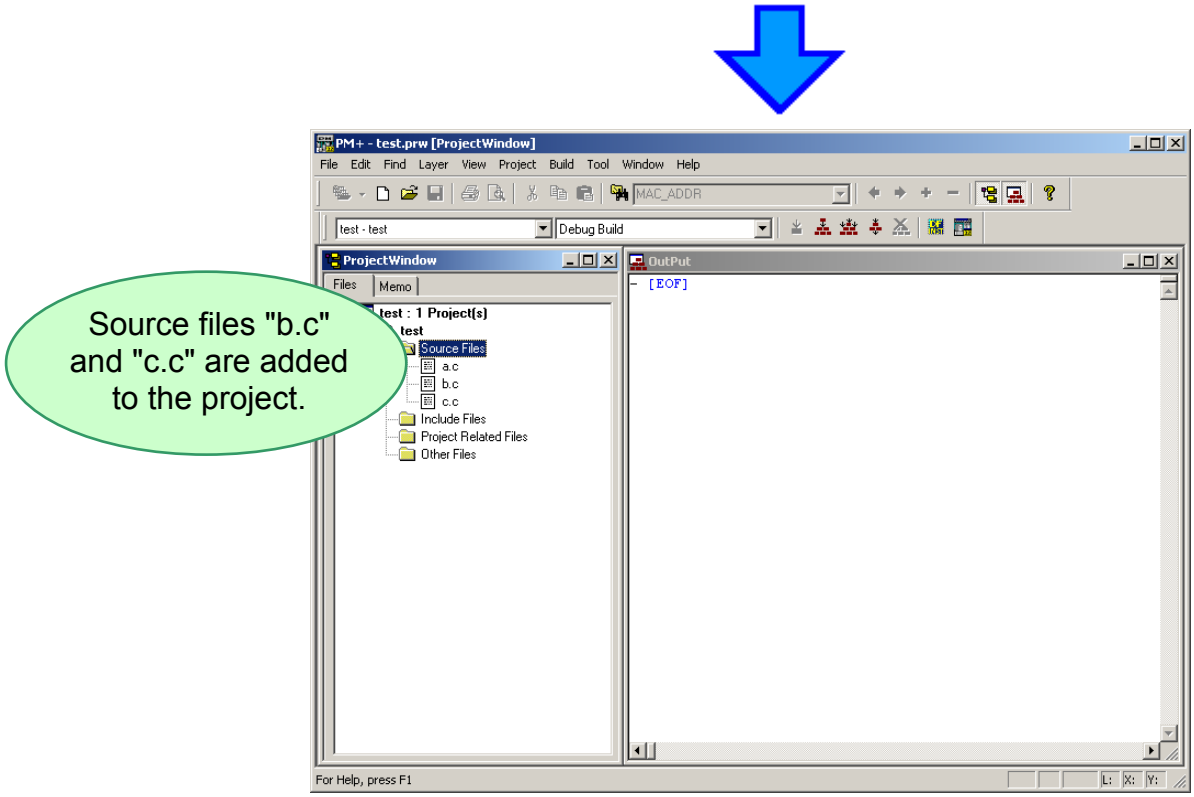
Now, we learn how to register new source files.
The following example shows how to register two additionalsource files of “b.c” and “c.c” with source file “a.c” already registered.
Place the cursor on a source file in the Project window of PM+, and select [Add Source Files…] displayed in the right-click menu.



Select source files "b.c" and "c.c", then click Open



Multiple source files can be selected by clicking them while keep pressing Ctrl key.


Source files "b.c" and "c.c" are added to the project.
PM+ - test.prw [ProjectWindow]
File Edit Find Layer View Project Build Tool Window Help
MAC_ADDR
test - test
Debug Build
ProjectWindow
Files
Memo
test : 1 Project(s)
test
Source Files
a.c
b.c
c.c
Include Files
Project Related Files
Other Files
OutPut
[EOF]
For Help, press F1

7.3 Debugger tips

This section describes some useful techniques for the debugger (ID78K0R-QB).

7.3.1 Change display of buttons

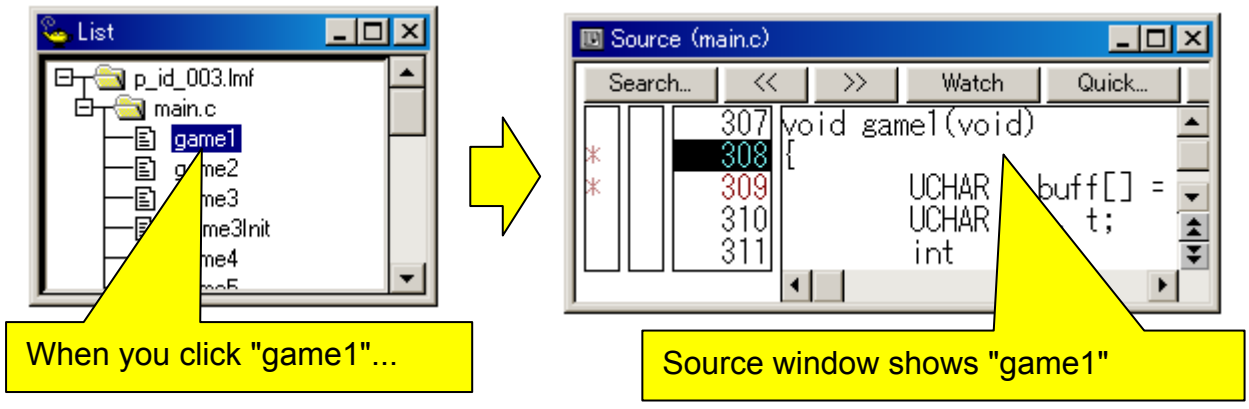
Execution controls (run, stop, step-in debugging, reset, etc) and opening functional window can be made by below buttons. However, it could be difficult to know which button does what.

In this case, select "Options" on menu bar, then "Debugger Options". Check "Pictures and Text" on setting area.

With this setting, the buttons display the text as well, so that it is easier to know what they are.

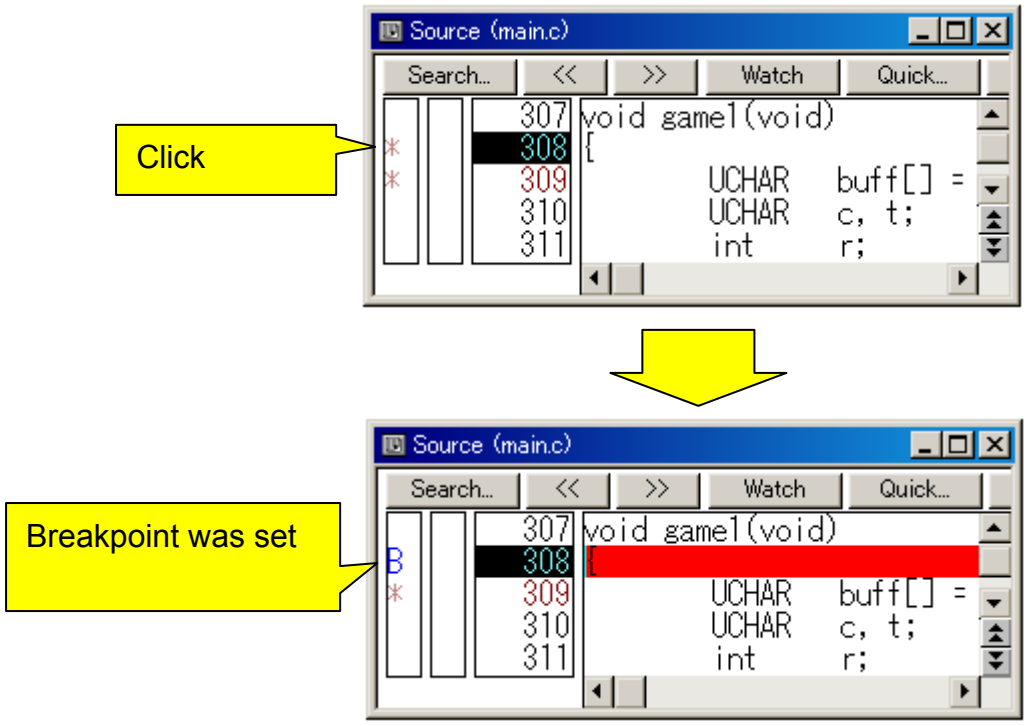
7.3.2 Display source list and function list

When you wish to see source file list or function list, select "Browse" on menu bar, then "Other" -> "List" to open the list window. The information in the windows is synchronized. Therefore, it is not just for referring to the list, but it is useful when you wish to update files or functions.



7.3.3 Set/delete breakpoints

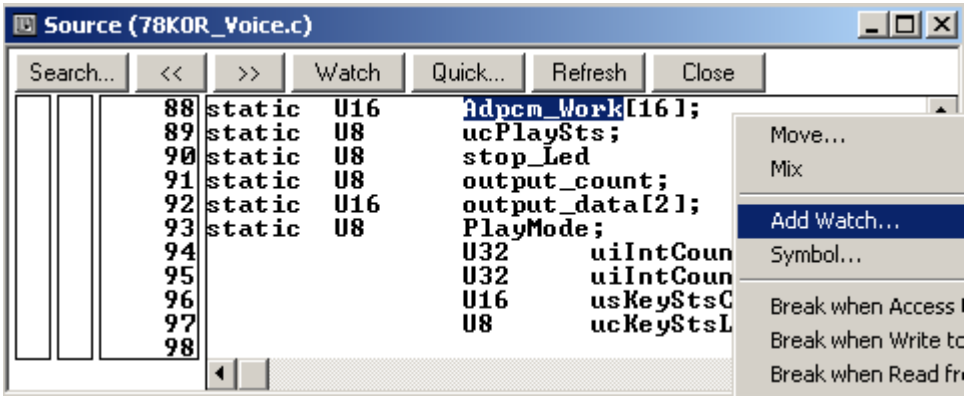
Breakpoints are executed by clicking lines in which ″ * ″ is displayed
″B″ is displayed in the line where a breakpoint is set.
Breakpoints are deleted by clicking ″B″.



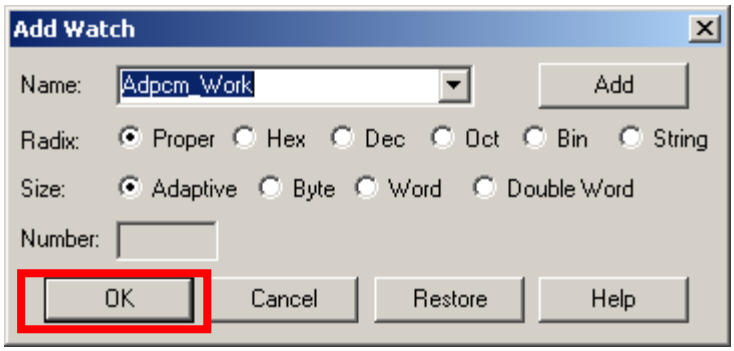
7.3.4 Display global variables

With using Watch Window, you can display global variables. There are several ways to register global variables to watch window. In this section, how to register from source window is described.

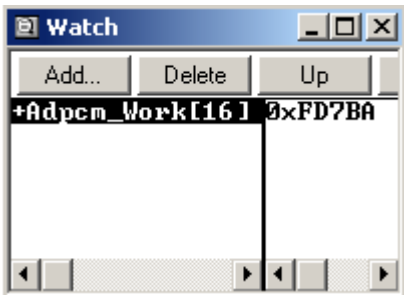
①Right-click the variable on source window, then select "Add Watch..."



②Add Watch dialog opens. Click [OK] .

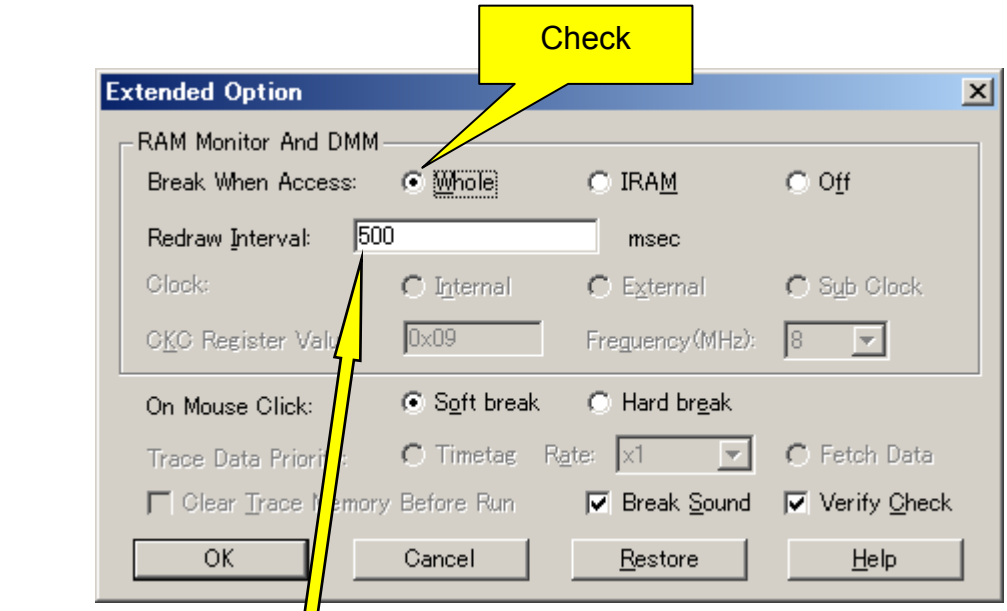


③Adding a variable to watch window is completed.



7.3.5 Display global variables while programs are running

RAM, general-purpose register, and SFR can be referred by the pseudo real-time monitor function even when the programs are running.
Select "Option" on menu bar, then "Extended Option...". Configure the settings for "RAM Monitor And DMM".



Specify the sampling interval time of the pseudo real-time monitor function.
The sampling time can be specified from 0 to 65500 with unit of 100ms.
It will not monitor if it is set to "0" or blank.

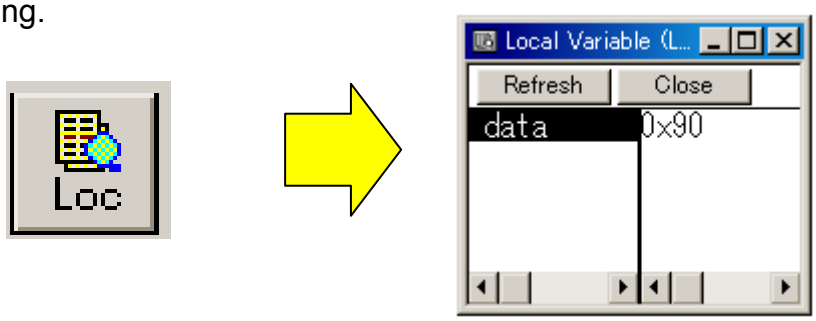
This completes the settings.

Note:

- The user program momentarily breaks upon a read.
- Do not use the pseudo real-time monitor function while using the memory window. It uses the system resources significantly as it monitors the displaying memory as well.
- It is recommended to close the memory window when you use the pseudo real-time monitor function.

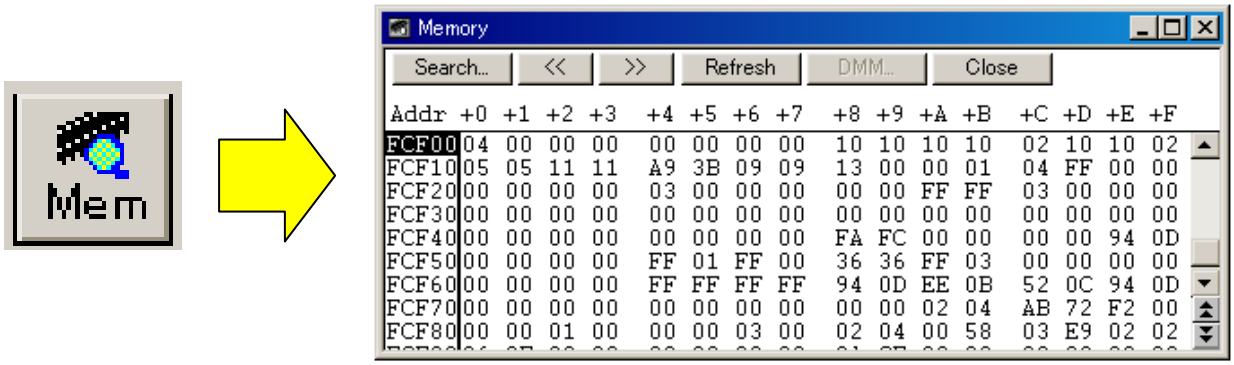
7.3.6 Display local variables

Local variable window is used to display local variables.
By clicking the button below, you can open the local variable window.
Unlike global variables, local variables cannot be displayed when programs are running.

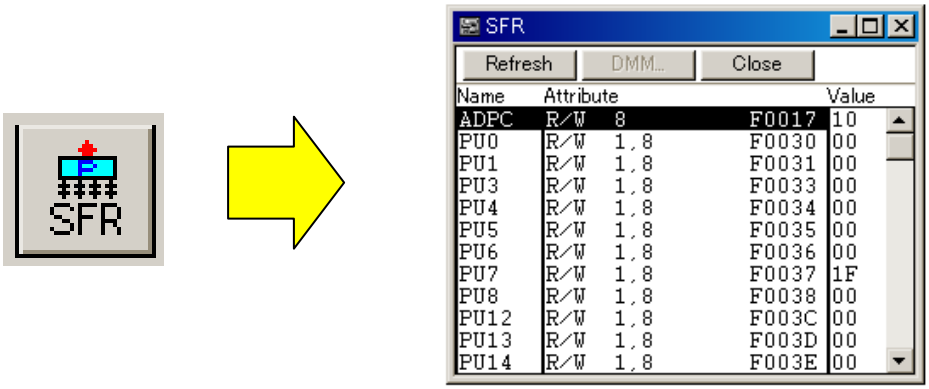


7.3.7 Display memory and SFR contents

By clicking the button below, you can open the memory window.



By clicking the button below, you can open the SFR window.

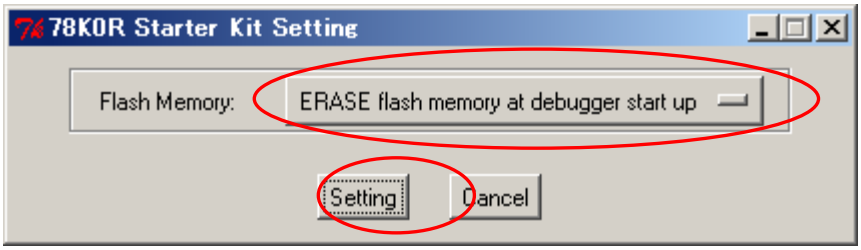


7.4 Erase of flash memory

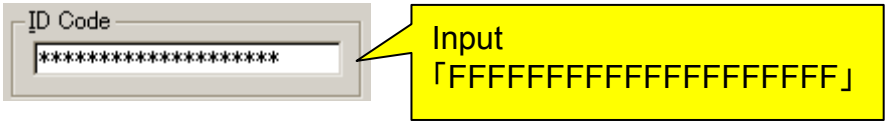
If the On-Chip Debug Option Byte is set to "Do not erase data of flash memory in case of failures in enabling on-chip debugging" and if you forget the security ID, you need to erase the flash memory completely.
To erase the flash memory, please follow the steps below.

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".

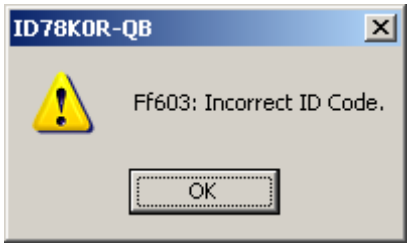


Restart the integrated debugger (ID78K0R-QB).
Now the ID code is the default value of 0xFFFFFFFFFFFFFFFFFFFF.



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 the flash memory too many times).

If you want to change the Security ID code to your favorite secret code, please input the secret code in the Linker option. Then, you will compile the program. After then, you have to input your secret security code everytime your starting up the debugger. If you input a wrong code, you will find the ollowing warning.



※ 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.

7.5 BOM List & Circuit diagram

Here is the BOM List & circuit diagram of the evaluation kit.

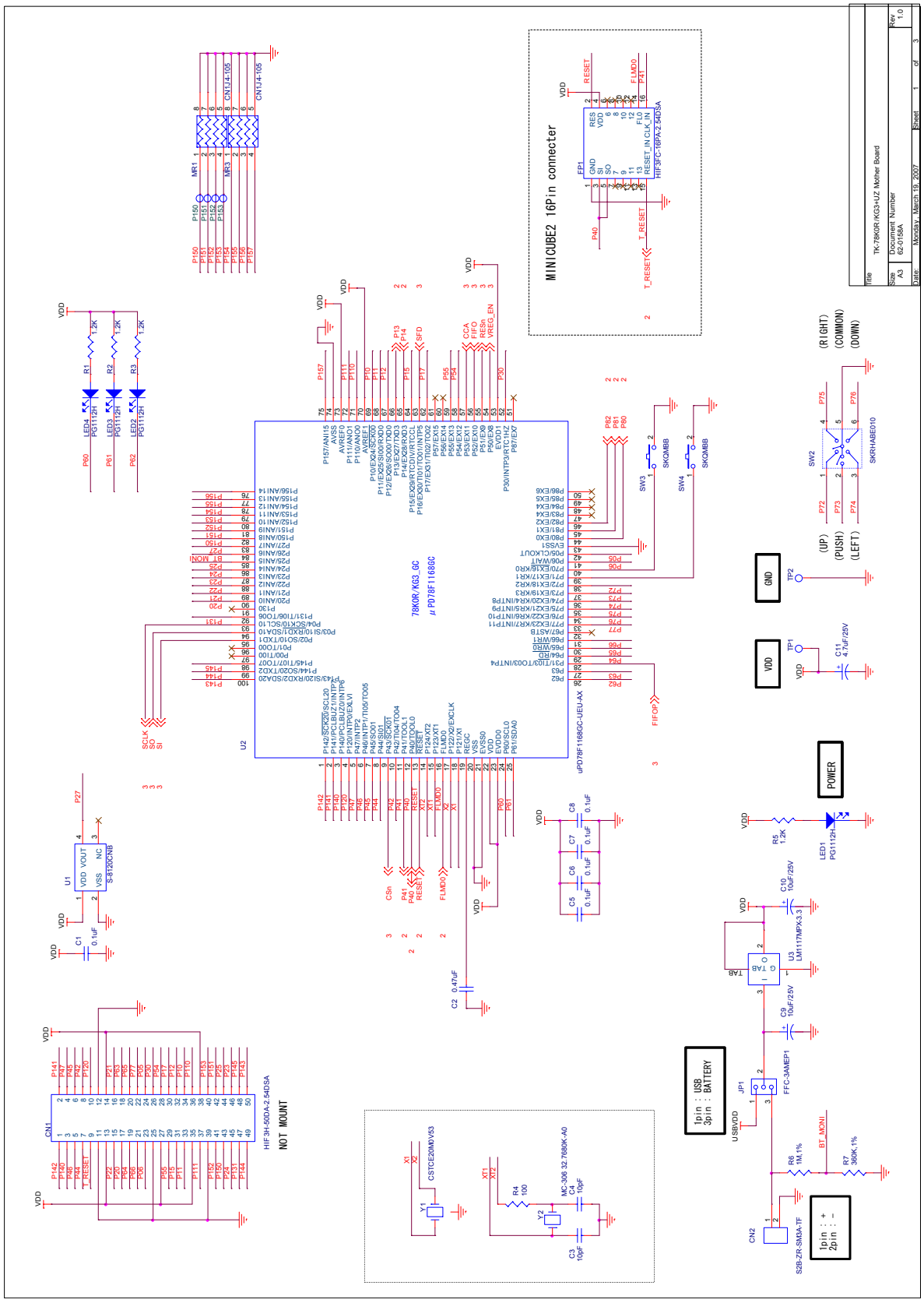
● CUP board BOM list

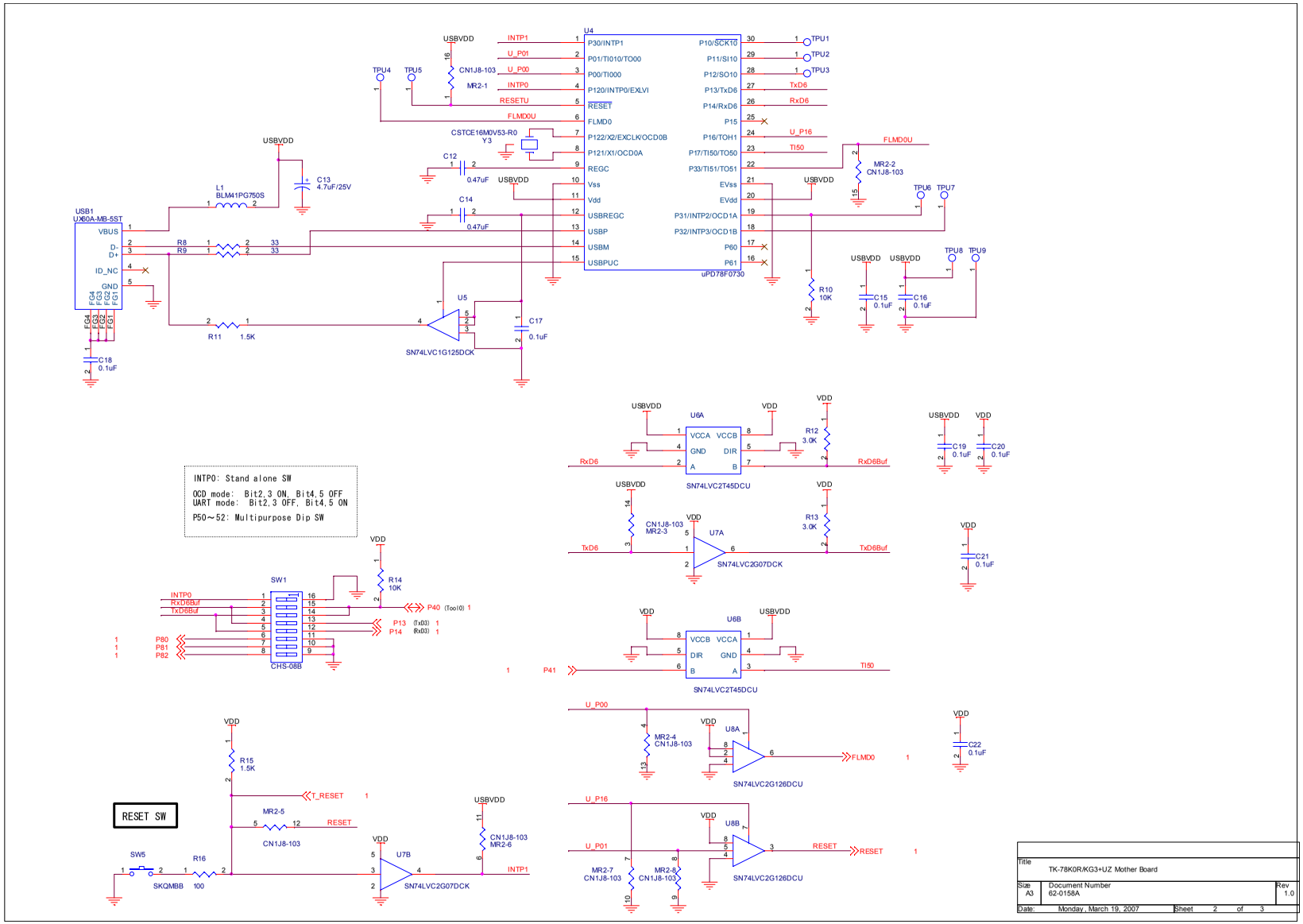
No.	Mount Quantity	Mount Parts Reference	Unmount Parts Reference	Type	Parts No	Maker	Note
1	0		CN1	Connecter	HIF3H-50DA-2.54DSA	HIROSE	Not Mounted
2	1	CN2		Connecter	S2B-ZR-SM3A-TF	JST	
3	2	CN4,CN3		Connecter	TFM-110-02-S-D-A-K-TR	SAMTEC	
4	14	C1,C5,C6,C7,C8,C15,C16, C17,C18,C19,C20,C21,C22, C23		Chip ceramic cap	0.1uF		
5	3	C2,C12,C14		Chip ceramic cap	0.47uF		
6	2	C3,C4		Chip ceramic cap	10pF		
7	2	C10,C9		Aluminum Electrolytic Cap	10uF/25V		
8	2	C13,C11		Aluminum Electrolytic Cap	4.7uF/25V		
9	1	FP1		Connecter	HIF3FC-16PA-2.54DSA	HIROSE	
10	1	JP1		Jumper	FFC-3AMEP1	HONDA	
11	0		JP2	Jumper	FFC-3AMEP1_xxx	HONDA	Not Mounted
12	4	LED1,LED2,LED3,LED4		LED	PG1112H	STANLY	
13	1	L1		Filter	BLM41PG750S	MURATA	
14	2	MR3,MR1		resister module	CN1J4-105	KOA	
15	1	MR2		resister module	CN1J8-103	KOA	
16	0		RFVDD1,P150,P151,P152, P153		SS		Solder pad
17	4	R1,R2,R3,R5		Chip resister	1.2K		
18	2	R16,R4		Chip resister	100		
19	1	R6		Chip resister	1M,1%		
20	1	R7		Chip resister	360K,1%		
21	2	R9,R8		Chip resister	33		
22	2	R14,R10		Chip resister	10K		
23	2	R11,R15		Chip resister	1.5K		
24	2	R13,R12		Chip resister	3.0K		
25	3	R18,R20,R21	R17,R19	Chip resister	4.7K		
26	2	R23,R22		Chip resister	0		
27	1	SW1		DIP SW	CHS-08B	COPAL	
28	1	SW2		SW	SKRHABE010	ALPS	
29	3	SW3,SW4,SW5		Push SW	SKQMBB	ALPS	
30	0		TPU1,TPU2,TPU3,TPU4,TPU5, TPU6,TPU7,TPU8,TPU9		TPU		Through hole
31	0		TP1,TP2,TP3,TP4,TP5		TP		Through hole
32	1	USB1		Connecter	UX60A-MB-5ST	HIROSE	
33	1	U1		TEMP sensor	S-8120CNB	SEIKO	
34	1	U2		IC	uPD78F1168GC-UEU-AX	NECEL	
35	1	U3		IC	LM1117MPX-3.3	NS	
36	1	U4		IC	uPD78F0730	NECEL	
37	1	U5		IC	SN74LVC1G125DCK	TI	
38	1	U6		IC	SN74LVC2T45DCU	TI	
39	1	U7		IC	SN74LVC2G07DCK	TI	
40	1	U8		IC	SN74LVC2G126DCU	TI	
41	1	Y1		Resonator	CSTCE20M0V53	MURATA	
42	1	Y2		Resonator	MC-306 32.7680K-A0	EPSON	
43	1	Y3		Resonator	CSTCE16M0V53-R0	MURATA	

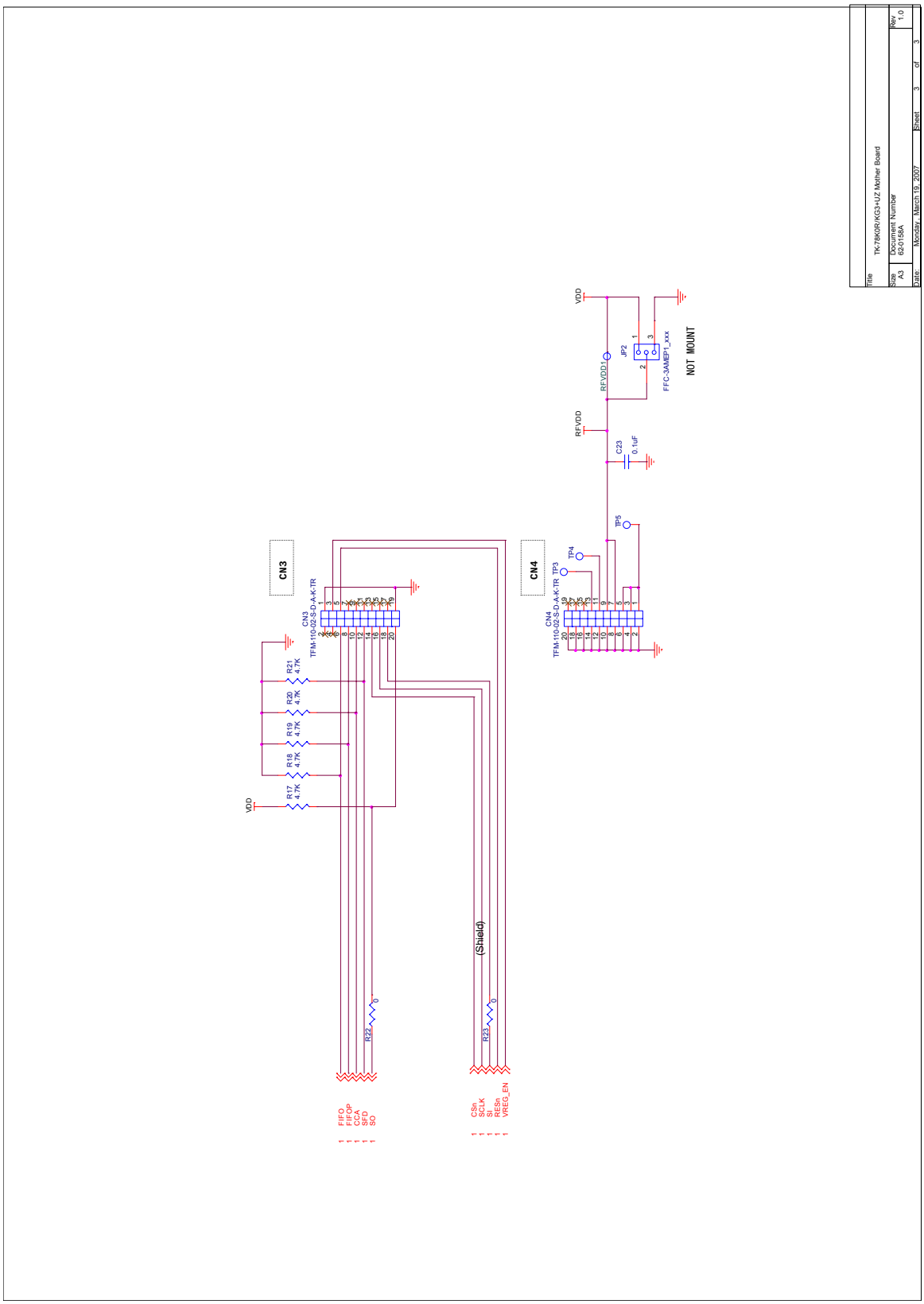
● RF board BOM list

No.	Mount Quantity	Mount Parts Reference	Unmount Parts Reference	Type	Parts No	Manufacturer
1	2	C37,C43		Chip ceramic cap	C0402CRNP09BNR50	Yageo
2	1	C38		Chip ceramic cap	CC0402CRNP09BN1R8	Yageo
3	2	C1,C53		Chip ceramic cap	C0402ZRY5V5BB105	Yageo
4	1	L3,L5		Chip ceramic inductor	LQG15HN5N1S02	Murata
4R					AL02BT5N1M	Viking
5	1	L4		Chip ceramic inductor	LQG15HN6N8J02	Murata
6	1	R5		Chip resister	RC0402JR-0710M	Yageo
7	4	C5,C39,C52,C63		Chip ceramic cap	C0402ZRY5V7BB103	Yageo
8	2	C2,C4		Chip ceramic cap	C0805ZKY5V6BB106	Yageo
9	1	C3		Chip ceramic cap	C0603ZRY5V6BB475	Yageo
10	2	C21,C54		Chip resister	C0402JRNP09BN150	Yageo
11	1	XTAL_2		Resonator	G5 Series 32.768kHz	Ecera
12	1	XTAL_1		Resonator	7M32000044	TXC
13	2	C60,C64		Chip resister	C0402JRNP09BN330	Yageo
14	1	C48		Chip ceramic cap	C0402JRNP09BN390	Yageo
15	5	C19,C40,C44,C55,C57		Chip ceramic cap	CC0402JRNP09BN470	Yageo
16	1	C45		Chip resister	C0402ZRY5V7BB104	Yageo
17	0		R1	Chip resister	RC0402JR-070R	Yageo
18	1	L2		inductor	LQH2MCN8R2M02	Murata
19	1	CON2		Connecter		HO YANG SYONE
20	2	CN3,CN4		Connecter	SFM-110-02-S-D-A	MetaTech
21	1	S1		Connecter	7865NS502BD000B	BO-JIANG
22	1	U1		UZ2400.D		UBEC

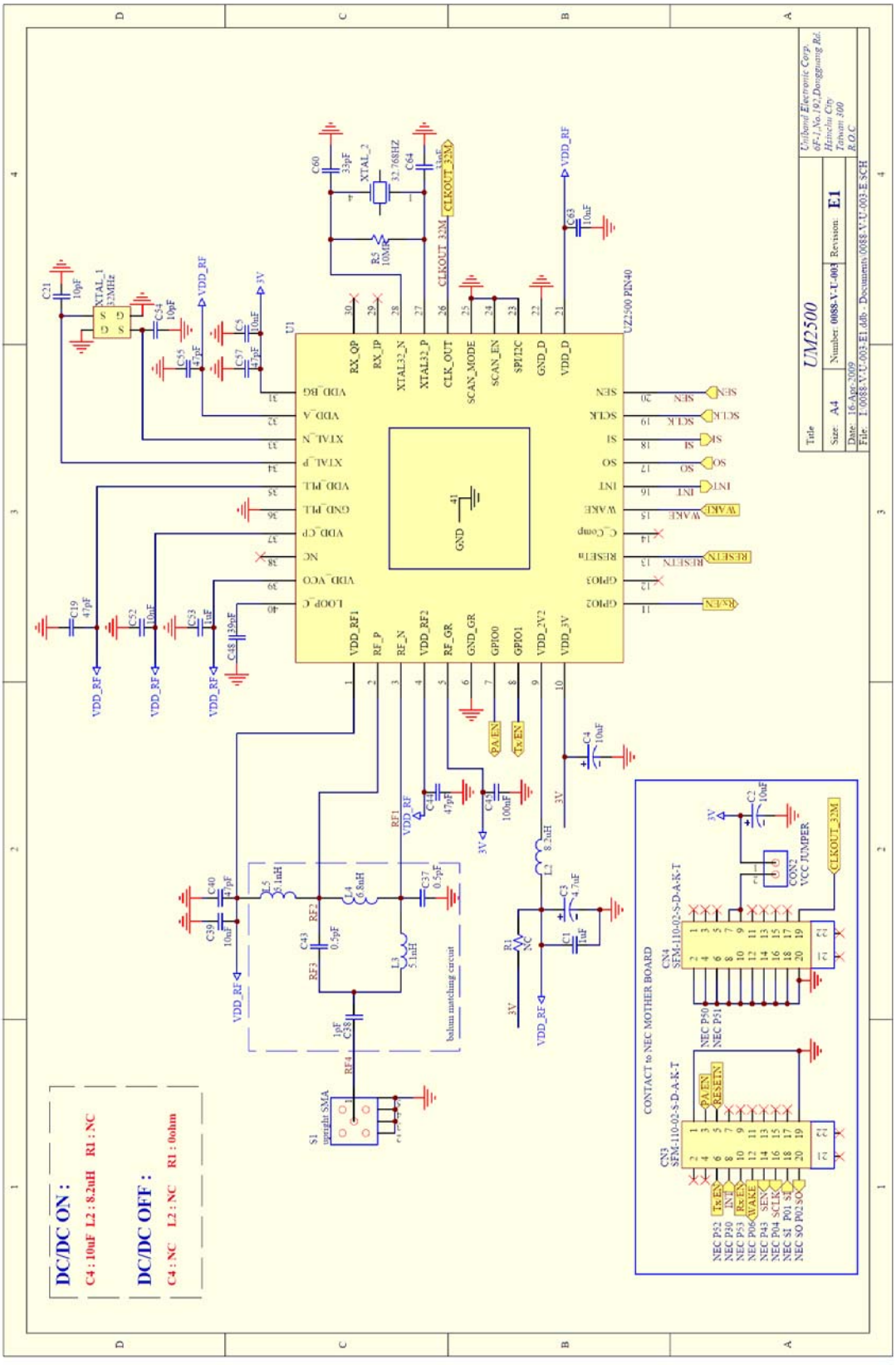
● CUP board schematic




INTP0: Stand alone SW
OCD mode: Bit2,3 ON, Bit4,5 OFF
UART mode: Bit2,3 OFF, Bit4,5 ON
P50～52: Multipurpose Dip SW
RESET SW
SN74LVC1G125DCK
SN74LVC2T45DCU
SN74LVC2G07DCK
SN74LVC2G126DCU
uPD78F0730
CHS-08B
SKQMBB
TK-78K0R/KG3+UZ Mother Board
Monday, March 19, 2007
62-0158A
1.0

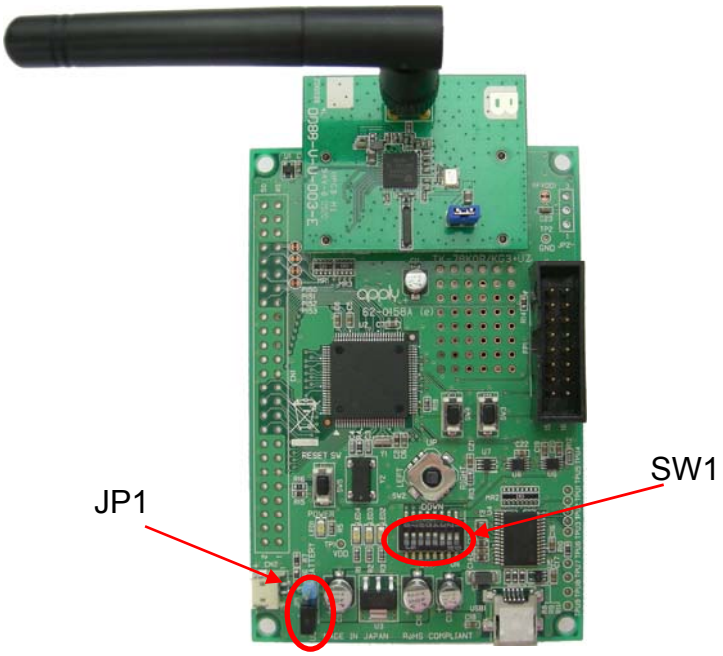

Title
TK-7360R/KG3+UZ Mother Board
Size
A3
Document Number
620158A
Rev
1.0
Date:
Monday, March 19, 2007
Sheet
3
of
3
CN3
CN4
NOT MOUNT
VDD
RFVDD
RFVDD1
JP2
FFC-3AMEP1_xxx
C23
0.1uF
TP5
TP4
TP3
CN3
TFM-110-02-S-D-A-K-TR
CN4
TFM-110-02-S-D-A-K-TR
R21
4.7K
R20
4.7K
R19
4.7K
R18
4.7K
R17
4.7K
R22
0
R23
0
(Shield)
FIFO
FIFOP
CCA
SFD
SO
CSn
SCLK
SI
RESn
VREG_EN

● RF board schematic



8 Mode setting of the board

The combination table of the switch of this board is shown.



SW \ Usage case		Normal	Debug	Debug (MINICUBE2)
SW1	Bit1	OFF	OFF/ON ※1	OFF
	Bit2	OFF	ON	OFF
	Bit3	OFF	ON	OFF
	Bit4	ON	OFF	ON
	Bit5	ON	OFF	ON

※1

ON: **The microcontroller stays being reset until ID78K0R-QB is started.**

OFF: **The microcontroller runs the programs stored in the flash memory as soon as it gets power supply.**

JP1 Power supply setting

1-2 short	supply power from USB connected to USB1
2-3 short	supply power from batteries connected to CN2