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User's Manual

78K0R - Cool it!

Demonstration Kit for the 78K0R 16-bit microcontroller family

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NEC Electronics Inc. (U.S.)
Santa Clara, California
Tel: 408-588-6000
800-366-9782
Fax: 408-588-6130
800-729-9288

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Duesseldorf, Germany
Tel: 0211-65 03 0
Fax: 0211-65 03 1327

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Tel: 02-66 75 41
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NEC Electronics Hong Kong Ltd.
Hong Kong
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Electron Devices Division
Guarulhos, Brasil
Tel: 55-11-6465-6810
Fax: 55-11-6465-6829

Revision History

Date	Revision	Chapter	Description
25-10-2006	V1.00	---	First release

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1. Introduction

78K0R - Cool it! is a demonstration kit for the NEC 78K0R 16-bit microcontroller family. It supports onboard debugging and real time execution of application programs. The board is prepared to be connected to user hardware parts such as digital I/O or analog signals.

1.1 Main features of *78K0R – Cool it!*

- Easy to use device demonstration capabilities
  78K0R - Cool it! contains elements to easily demonstrate simple I/O-functions, i.e. navigator switch, 16*2 LC display, I/O lines, analog inputs, UART serial interface etc.

- On-Board debug function (TK-78K0R debugging)
  The *78K0R – Cool it!* supports an On-Board debug function by using the IAR C-SPY debugger without a need of additional debug hardware. It allows FLASH downloading and standard debug functions like code execution, single stepping, breakpoints, memory manipulation etc.

- 16*2 character LC display
  78K0R - Cool it! provides a 16*2 character LC display, allowing the implementation of human / machine interfaces, comfortable input / output functions, output of measurement values, output of status information etc.

- Power supply by USB interface

- Analog to digital signal conversion

- Digital to analog signal conversion

- Various input / output signals available, such as

  - I/O ports prepared to be connected to user hardware
  - 16*2 LCD display
  - Timer input / output signals
  - Two or three wire serial I/O
  - Virtual UART interface, via the µPD78F0731 78K0 8-bit microcontroller with on-board USB interface
  - 16 analog input lines
  - 2 analog output lines
  - Navigation switch prepared for key interrupt generation

- The IAR Embedded Workbench for 78K0/78K0S/78K0R and the IAR C-SPY debugger / simulator are included. These packages are restricted in such that maximum program code size is limited to 4 kByte.

- Full documentation is included for the NEC 78K0R/KG3 microcontroller, IAR Systems Embedded Workbench and IAR Systems C-SPY debugger / simulator.

***78K0R - Cool it!* is not intended for code development. NEC does not allow and does not support in any way any attempt to use *78K0R - Cool it!* in a commercial or technical product.**

1.2 System requirements

HOST PC A PC supporting Windows 2000 or Windows XP is required for the IAR Systems Embedded Workbench demo-version and the *78K0R – Cool it!* board. Pentium 200 MHz (at least), 128 MB of RAM, 256-color display (1024 * 768), mouse, CD-ROM drive and 200 Mbytes of free hard disk space are required to install the tool packages.

Host interface USB interface that enables communication based on USB (Ver1.1 or later)

1.3 Package contents

Please verify that you have received all parts listed in the package contents list attached to the *78K0R - Cool it!* package. If any part is missing or seems to be damaged, please contact the dealer from whom you received your *78K0R - Cool it!*.

Note: Updates of the IAR Embedded Workbench for 78K, documentation and/or utilities for *78K0R - Cool it!*, if available, may be downloaded from the NEC WEB page(s) at **http://www.eu.necel.com/updates**

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2. *78K0R - Cool it!* system configuration

The *78K0R - Cool it!* system configuration is given in the diagram below:

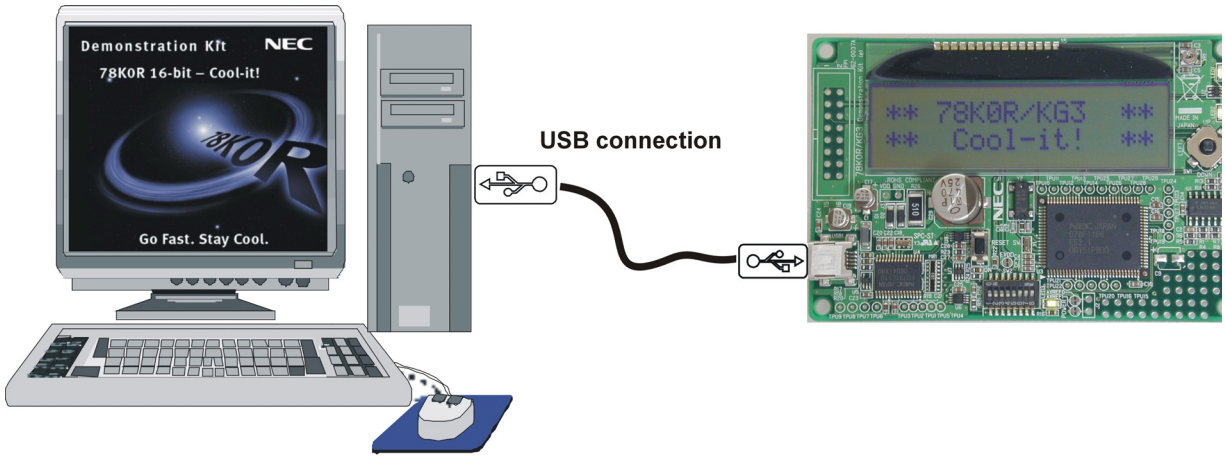


Figure 1: *78K0R - Cool it!* system configuration

2.1 78K0R - Cool it!

78K0R – Cool it! is a demonstration kit for the 78K0R/KG3 16-bit microcontroller of the 78K0R family. The demonstration board is connected to the host system via USB interface cable. The host system may be used for On-Chip debugging by using the IAR C-SPY debugger and to allow execution of application programs on *78K0R – Cool it!* starterkit.

78K0R - Cool it! runs the microcontroller at 20 MHz operating speed. The sub-clock is provided with 32.768 kHz.

2.2 Host computer

The USB host interface enables communication to the *78K0R - Cool it!* board. The µPD78F0731 78K0 8-Bit microcontroller with on-chip USB interface and the NEC virtual UART driver allows application software to access the USB device in the same way as it would access a standard RS232 interface. The NEC virtual UART driver appears to the windows system as an extra Com Port, in addition to any existing hardware Com Ports.

2.3 Power supply via USB interface

The *78K0R - Cool it!* is powered by the USB interface. Optional the power supply can be applied via connector J3.

3. *78K0R - Cool it!* components

The *78K0R - Cool it!* board is equipped with a navigation switch, a 16*2 character LC display, LED's and with several connectors in order to be connected to host computers, FLASH programmer or any external target hardware.

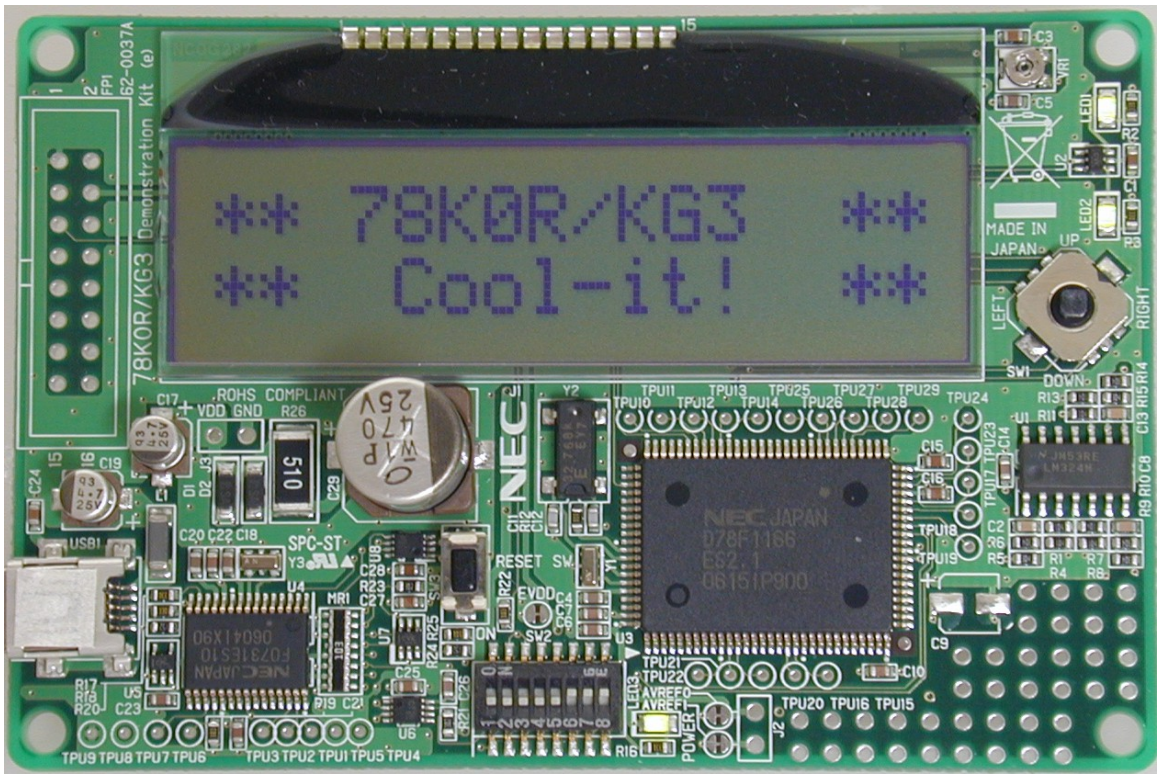


Figure 2: *78K0R - Cool it!* board connectors and switches

Some of the *78K0R – Cool it!* components are free for user application hardware and software. Please read the user's manual of the 78K0R/KG3 device carefully to get information about the electrical specification of the available I/O ports before you connect any external signals to the *78K0R – Cool it!* board.

3.1 Configuration switch SW2

The different operation modes of the *78K0R - Cool it!* board can be set by switch SW2/bit1-8.

SW2/bit	Factory settings	Mode
1	OFF	Stand alone and debug Mode
2	ON	enable On-Board debug function (TK-78K0R debugging)
3	ON	enable On-Board debug function (TK-78K0R debugging)
4	OFF	TxD3 disconnected
5	OFF	RxD3 disconnected
6	ON	L_EVDD applied
7	ON	L_VDD applied
8	ON	L_AVREF0 applied

Table 1: Configuration switch SW2, factory settings

3.1.1 Stand alone / debug mode selection, SW2/bit1

Switch SW2/bit1 controls the operation mode of the *78K0R - Cool it!* board. By setting SW2/bit1 to OFF the *78K0R – Cool it!* board is set to the “stand-alone mode”. Within this mode the RESET can be controlled by the user via switch SW3 and by the IAR C-SPY debugger. Within the stand-alone mode the user program stored in the internal FLASH memory of the 78K0R/KG3 microcontroller is executed. The usage of the On-Board debug function (TK-78K0R debugging) is also support within the “stand-alone mode”.

By switching SW2/bit1 to ON the *78K0R – Cool it!* board is set to the “debug mode” exclusively. Within this mode the 78K0R/KG3 device is permanently hold within RESET state. Only the IAR C-SPY debugger can control the RESET signal within this mode. The RESET switch SW3 is inactive.

SW2/bit1	Mode
OFF	Stand alone and debug mode
ON	Debug mode only

Table 2: Operation mode selection SW1/bit1

Note: After changing the configuration of SW2/bit1 it is necessary to power-up the *78K0R - Cool it!* board to make changing active. This can be done by <plug and play> the USB interface cable.

3.1.2 On-Board debug function (TK-78K0R debugging) selection, SW2/bit2-bit3

SW2/bit2 and bit3 are controlling the On-Board debug function of the *78K0R – Cool it!* board. By switching bits2 and 3 to ON the TK-78K0R debugging is enabled. In this mode a dedicated single-line UART (pin Tool0) of the 78K0R/KG3 is connected to the µPD78F0731 USB microcontroller. The Tool0 pin of the 78K0R/KG3 microcontroller is reserved for on-board FLASH programming and debugging purpose.

Switching bit2 and bit3 to OFF disconnects the single-line UART from the µPD78F0731 USB microcontroller. Within this mode no TK-78K0R debugging is supported. Use this mode in case you want to establish standard serial communication via UART3 to a terminal program running on the HOST PC.

SW2/bit2	SW2/bit3	Mode
OFF	OFF	Disable On-Board debug function
ON	ON	Enable On-Board debug function

Table 3: On-Board debug function (TK-78K0R debugging) selection, SW2/bit2-bit3

3.1.3 UART mode selection, SW2/bit4-bit5

By switching bit4 and bit5 of SW2 to ON the UART3 signals RxD3 and TxD3 are connected to the µPD78F0731 USB microcontroller. Within this mode standard serial communication to a terminal program running on the HOST PC can be established.

Switching bit4 and bit5 to OFF disconnects the UART3 serial lines from the µPD78F0731 USB microcontroller.

SW2/bit4	SW2/bit5	Mode
OFF	OFF	disconnect UART3 signals
ON	ON	connect UART3 signals

Table 4: UART mode selection, SW2/bit4-bit5

3.1.4 L_EVDD control, SW2/bit6

Switch SW2/bit6 controls the power supply (L_EVDD) for the LC display, LED1 and LED2. By switching bit6 to ON VDD is applied to L_EVDD. Switching bit6 to OFF disconnects the power supply for the output devices.

SW2/bit6	Mode
OFF	L_EVDD disconnected
ON	L_EVDD = VDD

Table 5: L_EVDD control, SW2/bit6

3.1.5 L_VDD control, SW2/bit7

Switch SW2/bit7 controls the power supply (L_VDD) for the digital logic of the *78K0R – Cool it!* board. By switching bit7 to ON VDD is applied to L_VDD. Switching bit7 to OFF disconnects VDD.

SW2/bit7	Mode
OFF	L_VDD disconnected
ON	L_VDD = VDD

Table 6: L_VDD control, SW2/bit7

3.1.6 L_AVREF0 control, SW2/bit8

Switch SW2/bit8 controls the power supply (L_AVREF0) for the analog components – the operational amplifier LM324M – of the *78K0R – Cool it!* board. By switching bit8 to ON VDD is applied to L_AVREF0. Switching bit8 to OFF disconnects VDD.

SW2/bit8	Mode
OFF	L_AVREF0 disconnected
ON	L_AVREF0 = VDD

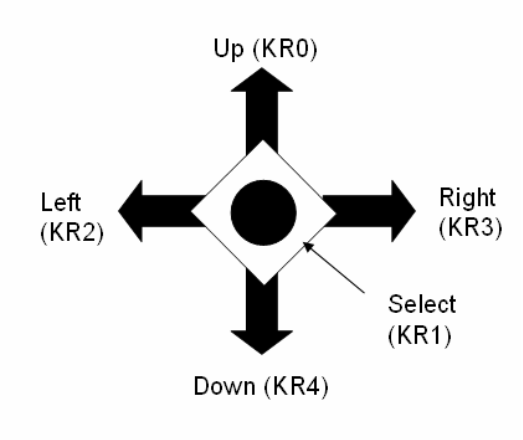
Table 7: L_AVREF0 control, SW2/bit8

3.2 RESET button, SW3

SW3 is the reset button. It activates the power on reset. Switch SW3 controls the reset input signal of the 78K0R/KG3 microcontroller.

3.3 Navigation switch, SW1

Button SW1 is a navigation switch connected to the key interrupt input of the 78K0R/KG3 device. It operates in five directions including a center push function. The connection of SW1 is shown in the table below:



SW1	Connection to the 78K0R/KG3 device
Left	P72/KR2
Down	P74/KR4
Select	P71/KR1
Right	P73/KR3
Up	P70/KR0

Table 8: Navigation switch SW1

3.4 LED1

LED1 is connected to I/O pin P145 / TI07 / TO07 of the 78K0R/KG3 microcontroller. A low signal output at this I/O pin switches the LED on.

3.5 LED2

LED2 is connected to I/O pin P46 / INTP1 / TI05 / TO05 of the 78K0R/KG3 microcontroller. A low signal output at this I/O pin switches the LED on.

3.6 Power LED, LED3

LED3 is the power LED of the *78K0R – Cool it!* board. It indicates if power is applied to the *78K0R – Cool it!* board.

3.7 Soldering bridges EVDD, AVREF0 and AVREF1

Additional configuration of the *78K0R - Cool it!* board can be done by the soldering bridges EVDD, AVREF0 and AVREF1. The different configuration modes are shown in the table below:

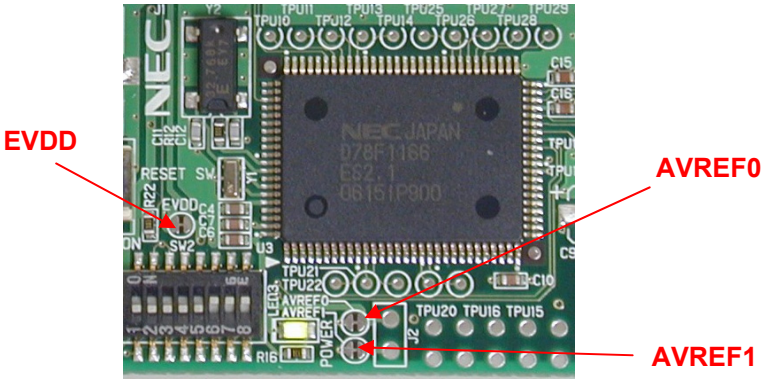


Figure 3: Soldering bridges EVDD, AVREF0 and AVREF1

Soldering bridge	Configuration	Mode
EVDD	Closed (default)	VDD connected to EVDD
	Open	VDD disconnected from EVDD
AVREF0	Closed (default	VDD connected to AVREF0 pin
	Open	VDD disconnected from AVREF0 pin
AVREF1	Closed (default)	VDD connected to AVREF1 pin
	Open	VDD disconnected from AVREF1 pin

Table 9: Soldering bridges EVDD, AVREF0 and AVREF1

3.8 Analog reference voltage input, J2

By using connector J2 (not assembled) different reference voltages can be applied to the A/D converter reference input pin AVREF0 and to the D/A converter reference input pin AVREF1 of the 78K0R/KG3 microcontroller.

J2	Input
1	AVREF0 (A/D converter reference)
2	AVREF1 (D/A converter reference)

Table 10: Analog reference voltage input, J2

Note: Before applying different reference voltages to the *78K0R – Cool it!* board be sure to cut off the corresponding soldering bridges AVREF0 respectively AVREF1.

3.9 External power supply input, J3

By using connector J3 (not assembled) external power supply can be applied to the *78K0R – Cool it!* board without a need of an active USB connection.

J3	Input
1	VDD (+5V)
2	GND

Table 11: External power supply input, J3

Note: Be sure to unplug the USB connection before applying external power supply to input J3.

3.10 USB1 interface connector

This interface allows connecting the IAR C-SPY debugger to the *78K0R - Cool it!* board in order to use the On-Board debug function (TK-78K0R debugging). The TK-78K0R interface supports On-board FLASH erasing / programming and standard debug features like code execution, single stepping, breakpoints, memory manipulation etc.

For standard communication to a host computer - i.e. by using a terminal program - the input/output signals of UART3 of the 78K0R/KG3 device can be redirected to the USB1 connector via the µPD78F0731 USB microcontroller.

The power supply of the *78K0R - Cool it!* board is also provided by the USB1 connector.

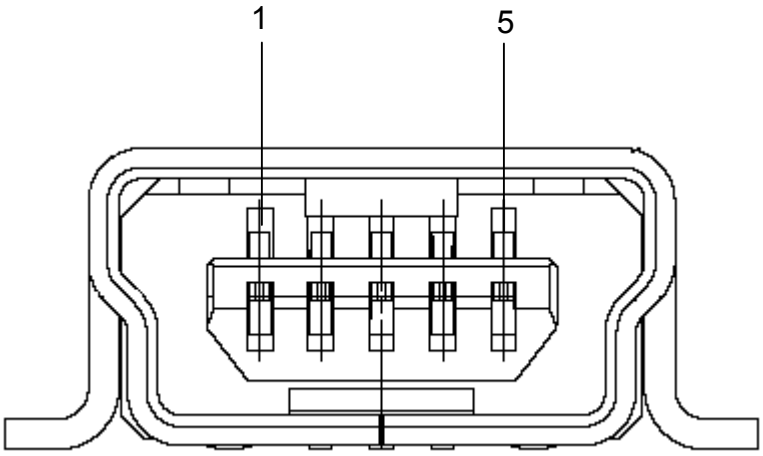


Figure 4: Connector USB1, USB Mini-B Type Host Connector Pin Configuration

Connector USB1	Signal Name
1	VBUS
2	D-
3	D+
4	N.C.
5	GND

Table 12: Pin Configuration of Connector USB1

For connection with the host machine, use a USB cable (Mini-B type). For confirmation, NEC Electronics used only the USB cable delivered with the *78K0R - Cool it!* board.

3.11 PG-FP4 / QB-MINI2 connector FP1

Connector FP1 (not assembled) allows connecting the PG-FP4 FLASH programmer to *78K0R - Cool it!* board in order to program application software into the 78K0R/KG3 internal flash memory. Please note, the PG-FP4 FLASH programmer is a separate product from NEC and it is not included in this package.

Additional FP1 allows connecting the QB-MINI2 On-Chip debug emulator to the *78K0R - Cool it!* board in order to use On-Chip debug function of the 78K0R/KG3 device. Please note, QB-MINI2 is a separate product from NEC and it is not included in this starterkit package.

FP1	Signal
1	GND
2	RESET
3	SI
4	VDD
5	SO
6	N.C.
7	N.C.
8	N.C.
9	N.C.
10	N.C.
11	N.C.
12	N.C.
13	N.C.
14	FLMD0
15	RESET_IN
16	CLK_IN

Table 13: PG-FP4 / QB-MINI2 connector FP1

When using PG-FP4 for FLASH programming or QB-MINI2 for debugging purpose, please configure switch SW2 of the *78K0R - Cool it!* board as following:

SW2	Setting	Mode
1	OFF	Stand alone and debug mode
2	OFF	Disable On-Board debug function
3	OFF	Disable On-Board debug function
4	ON/OFF (*)	TxD3 connected / disconnected
5	ON/OFF (*)	RxD3 connected / disconnected
6	ON	L_EVDD applied
7	ON	L_VDD applied
8	ON	L_AVREF0 applied

Table 14: Configuration of SW2 when using PG-FP4 or QB-MINI2

(*) = individual selectable by user.

3.12 Display D1, 16*2 character LC display

The *78K0R – Cool it!* board is equipped with a character LC display. The alignment of the display is equal to 16 character words at 2 lines. The LCD module contains about a character generator ROM - including predefined standard characters - and a character RAM where the user can define its own characters. The display is connected to the 78K0R/KG3 device via three control lines and eight data lines.

Display Pin	Display Signal	78K0R/KG3 I/O pin	*78K0R - Cool it!* board
1	RS0	P50	-
2	RW	P66	-
3	E	P65	-
4	DB0	P80	-
5	DB1	P81	-
6	DB2	P82	-
7	DB3	P83	-
8	DB4	P84	-
9	DB5	P85	-
10	DB6	P86	-
11	DB7	P87	-
12	GND		GND
13	VDD		L_EVDD
14	V0		VR1 potentiometer arm
15	F-GND		GND via capacitor C3

Table 15: Display connections

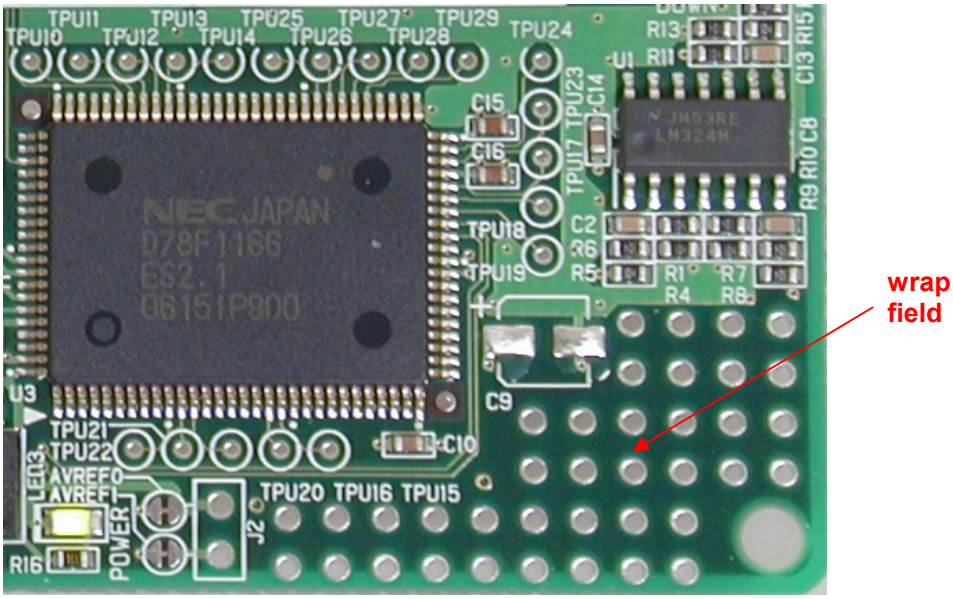
For more details about the LC display specification, commands and character table, please refer to the corresponding User's Manual "ML9042.pdf" located in the `/doc` folder of the *78K0R – Cool it!* CDROM.

3.13 Potentiometer VR1

The 10K potentiometer VR1 is connected between L_EVDD and ground. The potentiometer arm is connected to the V0 signal of the LCD module. It controls the operating voltage - contrast adjustment - of the LC display D1.

3.14 Connectors TPU10 – TPU29 and wrap field

Several pins of the 78K0R/KG3 microcontroller are combined to the connectors TPU10 – TPU29. The corresponding assignment can be found in table below. Additional the *78K0R - Cool it!* board provides a wire wrap field area allowing the integration of additional application hardware.



Connector	78K0R/KG3 I/O pin
TPU10	P00 / TI00
TPU11	P01 / TO00
TPU12	P02 / SO10 / TXD1
TPU13	P03 / SI10 / RXD1 / SDA1
TPU14	P04 / SCK10 / SCL1
TPU15	P05 / CLKOUT
TPU16	P06 / WAIT
TPU17	P10 / EX24 / SCK00
TPU18	P11 / EX25 / SI00 / RXD0
TPU19	P12 / EX26 / SO00 / TXD0
TPU20	P75 / EX21 / KR5 / INTP9
TPU21	P76 / EX22 / KR6 / INTP10
TPU22	P77 / EX23 / KR7 / INTP11
TPU23	P110 / ANO0
TPU24	P111 / ANO1
TPU25	P150 / ANI8
TPU26	P151 / ANI9
TPU27	P152 / ANI10
TPU28	P153 / ANI11
TPU29	P154 / ANI12

Table 16: Connectors TPU10 – TPU29

3.15 Low-pass filter's U1A, U1B and U1C

The *78K0R – Cool it!* board is equipped with three low-pass filter's U1A, U1B and U1C, realized by the operational amplifier LM324M. Each input of a low-pass filter is connected to a dedicated timer output signal of the 78K0R/KG3 microcontroller. The corresponding output signal of a low-pass filter feeds a dedicated input of the A/D converter of the 78K0R/KG3 device. The corresponding assignment can be found in table below.

Low Pass filter		78K0R/KG3 I/O pin	
U1A	Input	P16 / EX30 / TI01 / TO01 / INTP5	16-bit Timer01 output
	Output	P157 / ANI15	A/D converter input channel 15
U1B	Input	P17 / EX31 / TI02 / TO02	16-bit Timer02 output
	Output	P156 / ANI14	A/D converter input channel 14
U1C	Input	P31 / TI03 / TO03 / INTP4	16-bit Timer03 output
	Output	P155 / ANI13	A/D converter input channel 13

Table 17: Low-pass filter's U1A, U1B and U1C

4. On-Chip debugging

The *78K0R - Cool it!* board offers two possibilities to use On-Chip debugging (OCD). The TK-78K0R On-Board debug function of *78K0R – Cool it!* allows On-Chip debugging without a need of external debug hardware. Within this mode the default USB connection to the Host computer based on the virtual UART driver is used as debug interface. All standard debug functions are available in the On-Board debugging mode like FLASH programming / downloading, code execution, single stepping, breakpoints, memory manipulation etc.

Additionally *78K0R – Cool it!* supports the QB-MINI2 On-Chip debug emulator in order to use On-Chip debug function of the 78K0R/KG3 device. The system configuration for On-Chip debugging is shown in figure below.

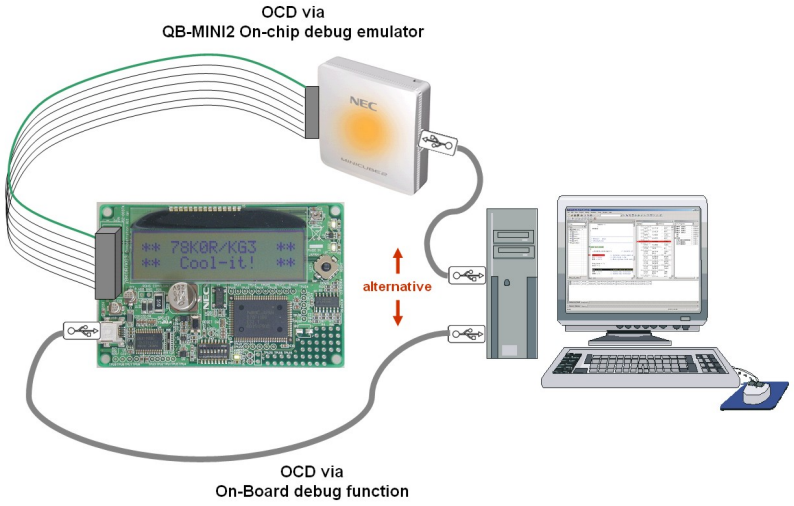


Figure 5: On-Chip debugging

4.1 OCD via TK-78K0R On-Board debug function

To operate the *78K0R - Cool it!* board within the On-Board debug mode, configure switch SW2 as following:

SW2	Setting	Mode
1	ON/OFF (*)	Stand alone and debug mode / debug mode only
2	ON	Enable On-Board debug function
3	ON	Enable On-Board debug function
4	OFF	TxD3 disconnected
5	OFF	RxD3 disconnected
6	ON	L_EVDD applied
7	ON	L_VDD applied
8	ON	L_AVREF0 applied

Table 18: OCD via TK-78K0R On-Board debug function

(*) = individual selectable by user.

4.2 OCD via QB-MINI2 emulator

To operate the *78K0R - Cool it!* board together with the QB-MINI2 On-Chip debug emulator, configure switch SW2 as following:

SW2	Setting	Mode
1	OFF	Stand alone and debug mode
2	OFF	Disable On-Board debug function
3	OFF	Disable On-Board debug function
4	ON/OFF (*)	TxD3 connected / disconnected
5	ON/OFF (*)	RxD3 connected / disconnected
6	ON	L_EVDD applied
7	ON	L_VDD applied
8	ON	L_AVREF0 applied

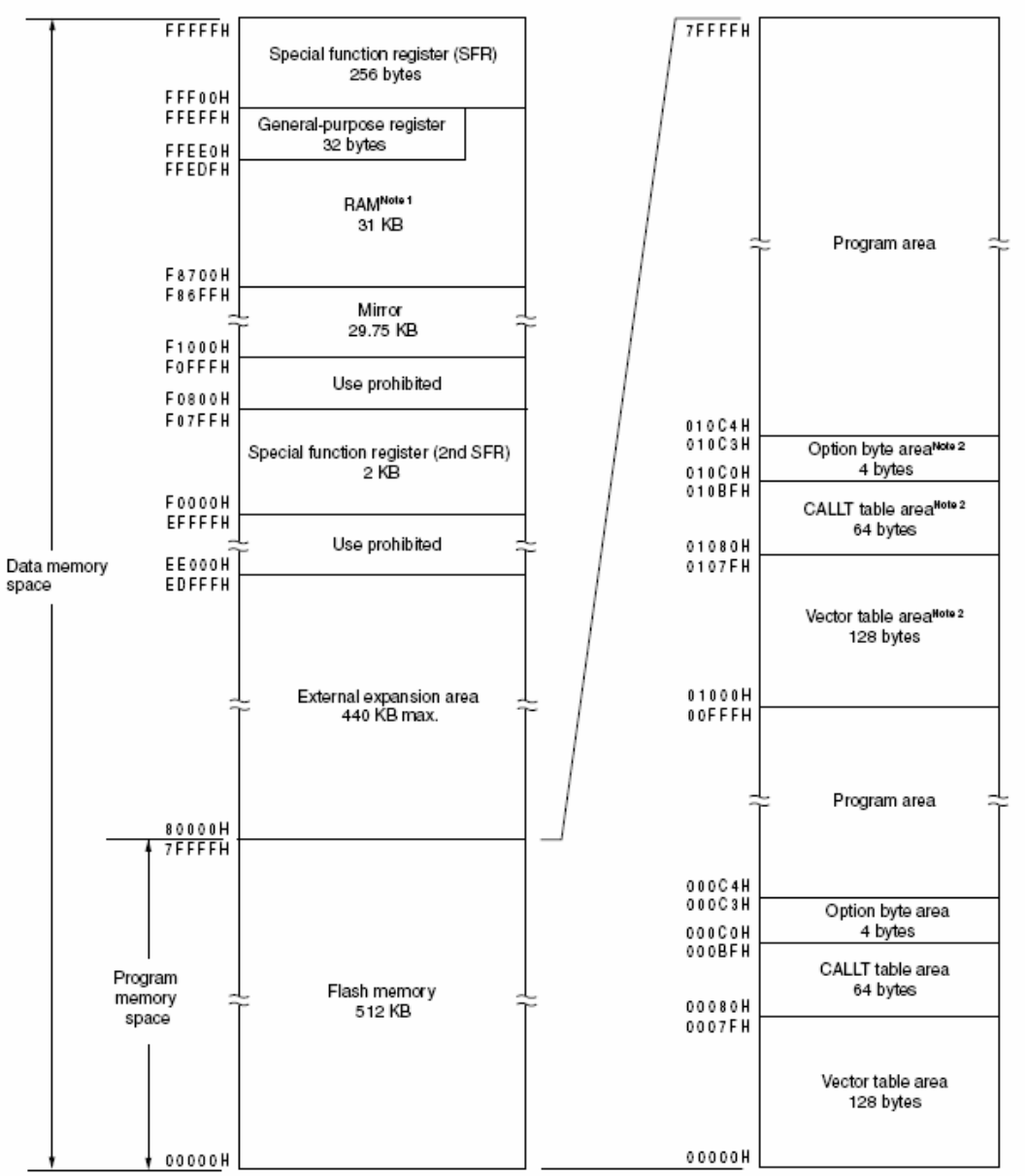
Table 19: OCD via QB-MINI2 emulator

(*) = individual selectable by user.

Note: By supplying power from the QB-MINI2 do not connect external hardware to the *78K0R - Cool it!* board. Within this mode the *78K0R - Cool it!* board can operate without external power supply from USB.

5. 78K0R/KG3 memory map

The memory layout of 78K0R/KG3 device is shown in the figure below.



Notes 1. Use of the area F8700H to F8EFFH is prohibited when using the self-programming function.

2. When using boot swap, write the contents of 00000H through 00FFFH to 01000H through 01FFFH.

Figure 6: 78K0R/KG3 memory map

The *78K0R – Cool it!* does not reserve any resources of the 78K0R/KG3 microcontroller, consequently all available memory of the device is free for application software.

6. *78K0R - Cool it!* installation and operation

6.1 Getting started

The IAR Embedded Workbench including the C-SPY debugger allows to build and download application programs to the *78K0R - Cool it!* starterkit. As communication interface between the PC host system and the *78K0R - Cool it!* board a USB interface line is needed. Before you can download and run a program, software and hardware must be installed properly.

6.1.1 CD-ROM contents

The CD-ROM shows following directory structure:

78K0R – Cool it! (F:)	CD-ROM ROOT
Acrobat	- Acrobat Reader for 32Bit Windows OS
Doc	- Documentation
IAR Embedded Workbench 78K0	- IAR Embedded Workbench for 78K0/78K0S/78K0R
SamplePrograms	- Sample program for *78K0R – Cool it!*
ADC_Demonstration	… AD Converter demonstration program
DMA_Demonstration	… DMA demonstration program
PWM_Demonstration	… PWM demonstration program
RTC_Demonstration	… Real-Time-Clock demonstration program
UART_Demonstration	… UART demonstration program

Table 20: *78K0R - Cool it!* CD-ROM directory structure

7. Hardware installation

After unpacking *78K0R - Cool it!,* connect the board to your host computer using the provided USB interface cable. When *78K0R - Cool it!* is connected, the USB driver needs to be installed on the host machine. Please refer to the following **CHAPTER 8 SOFTWARE INSTALLATION**.

8. Software installation

The *78K0R - Cool it!* package comes with the following software demo packages:

- IAR Systems Embedded Workbench for 78K0/78K0S/78K0R, including C compiler, assembler, linker, librarian and IAR C-SPY debugger / simulator
- Sample programs

The IAR Systems Embedded Workbench must be installed on your PC. For detailed installation hints, refer to the following chapters and to the corresponding documentation of the IAR Embedded Workbench.

8.1 IAR Systems Embedded Workbench for 78K0/78K0S/78K0R installation

To install the IAR Systems Embedded Workbench for 78K0/K0S/K0R including C-SPY debugger / simulator, select the `SETUP` program in the directory `\IAR Embedded Workbench 78K\ew78k\` of the CDROM. The setup dialogues will guide you through the installation process.

8.2 Sample program installation

To install the sample/demonstration program for the *78K0R – Cool it!* board select the `SETUP` program in the directory `\SamplePrograms\` of the CDROM. The setup dialogues will guide you through the installation process.

8.3 USB Driver Installation

In order to use the *78K0R - Cool it!* board for On-Chip debugging the USB driver needs to be installed on the host machine. Install the driver according to the following procedure:

Note: The USB driver is part of the IAR Embedded Workbench software package. Therefore please install the IAR Embedded Workbench first.

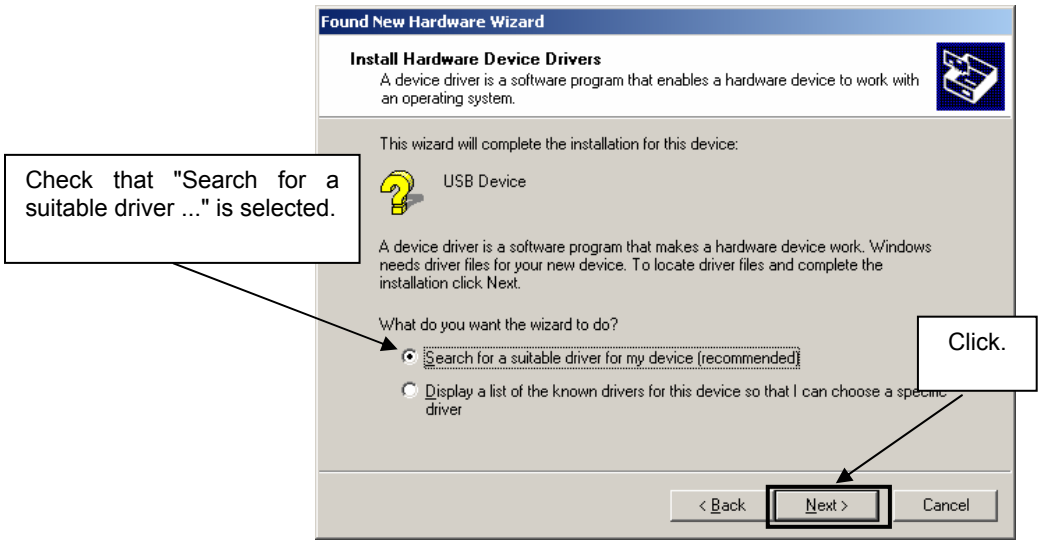
8.3.1 Installation on Windows 2000

1. When the *78K0R - Cool it!* board is connected with the host machine, the board is recognized by <Plug and Play>, and the wizard for finding new hardware is started. Click Next>.

Figure 7: Found New Hardware Wizard (Windows 2000)

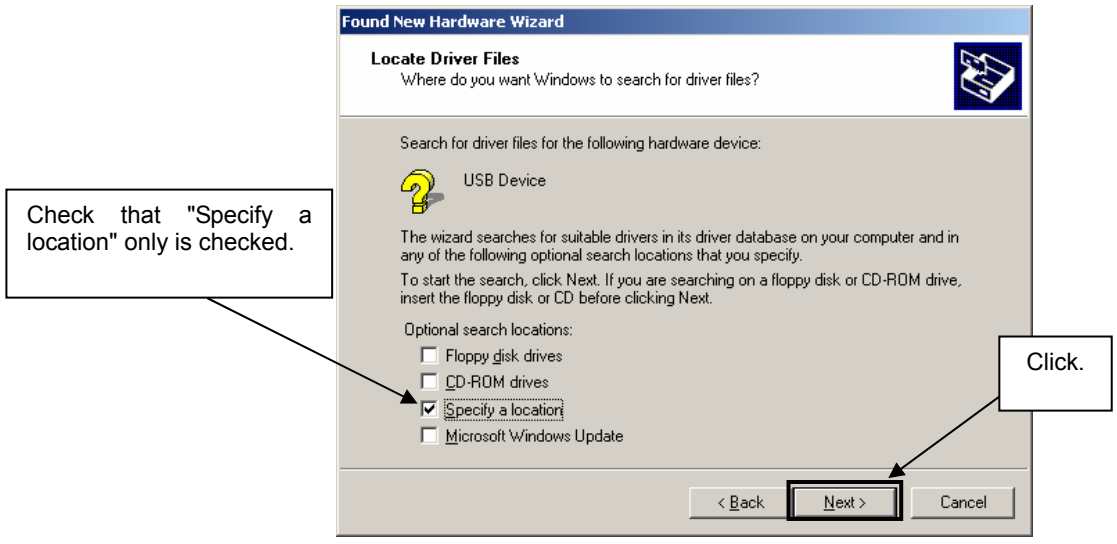
2. Following the window below is displayed. So, check that "Search for a suitable driver ..." is selected, then click Next>.

Figure 8: Search Method (Windows 2000)



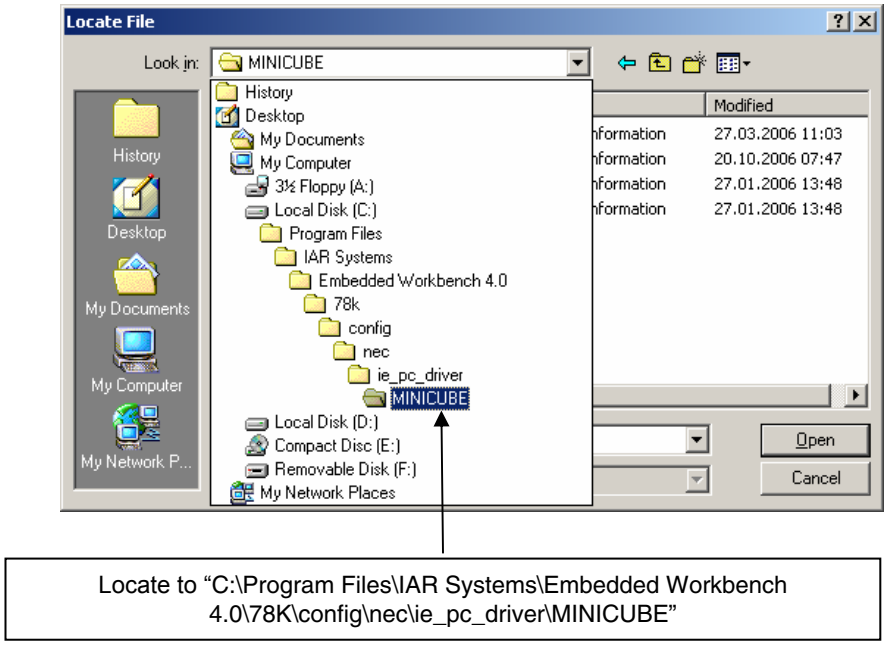
3. Check the "Specify a location" check box only, then click Next>.

Figure 9: Driver File Location (Windows 2000)



4. Locate to the folder "C:\Program Files\IAR Systems\Embedded Workbench 4.0\78K\config\nec\ie_pc_driver\MINICUBE".

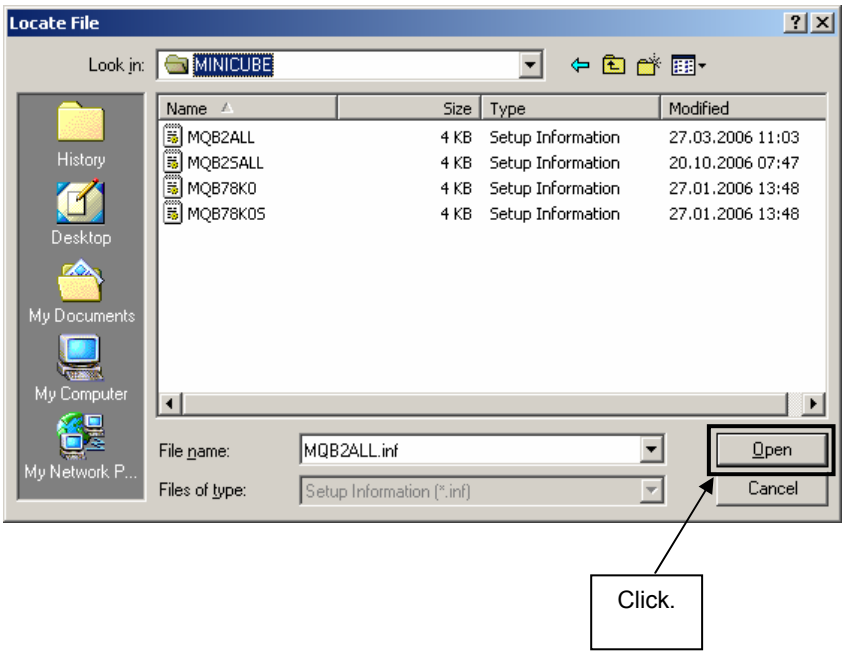
Figure 10: Address Specification 1 (Windows 2000)



Remark If the installation destination folder is changed at the time of IAR Embedded Workbench installation, enter "new-folder\78K\config\nec\ie_pc_driver\MINICUBE".

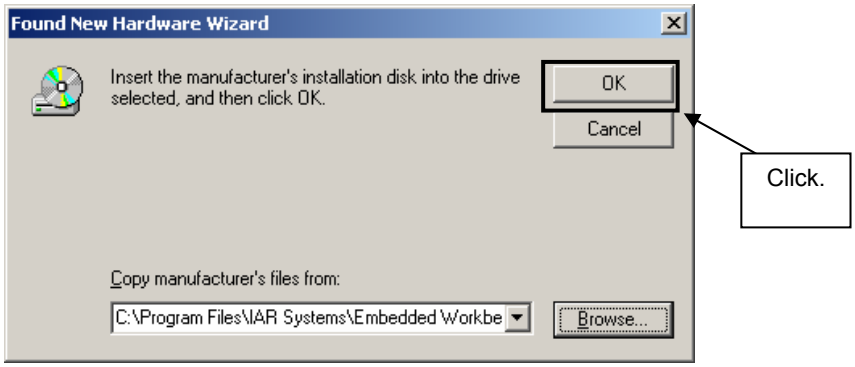
5. The setup information file “MQB2ALL.inf” is automatic selected, then click Open to proceed within driver installation.

Figure 11: Address Specification 2 (Windows 2000)



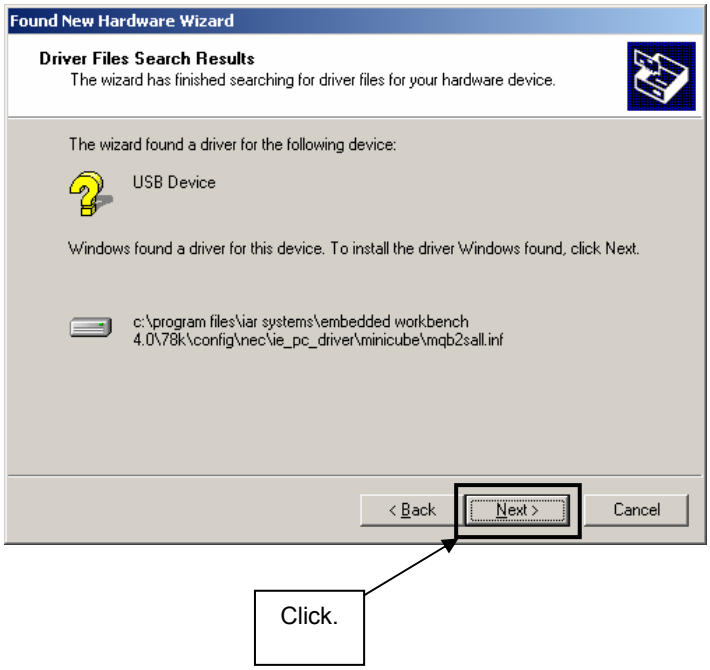
6. After the location of the USB driver has been specified click OK to proceed.

Figure 12: Address Specification 3 (Windows 2000)



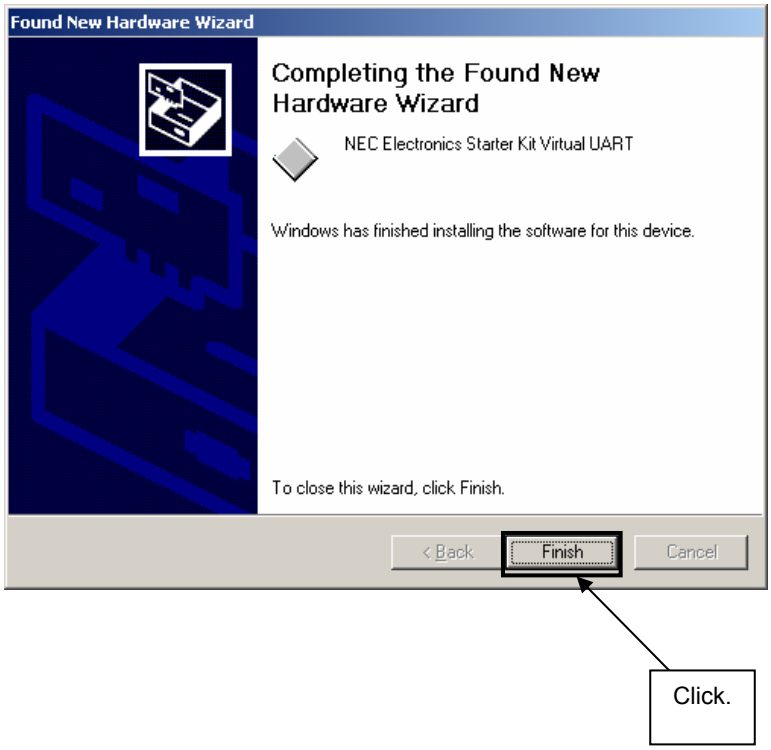
5. Click Next>.

Figure 13: Driver File Search (Windows 2000)



6. Click Finish to complete the installation of the USB driver.

Figure 14: USB Driver Installation Completion (Windows 2000)



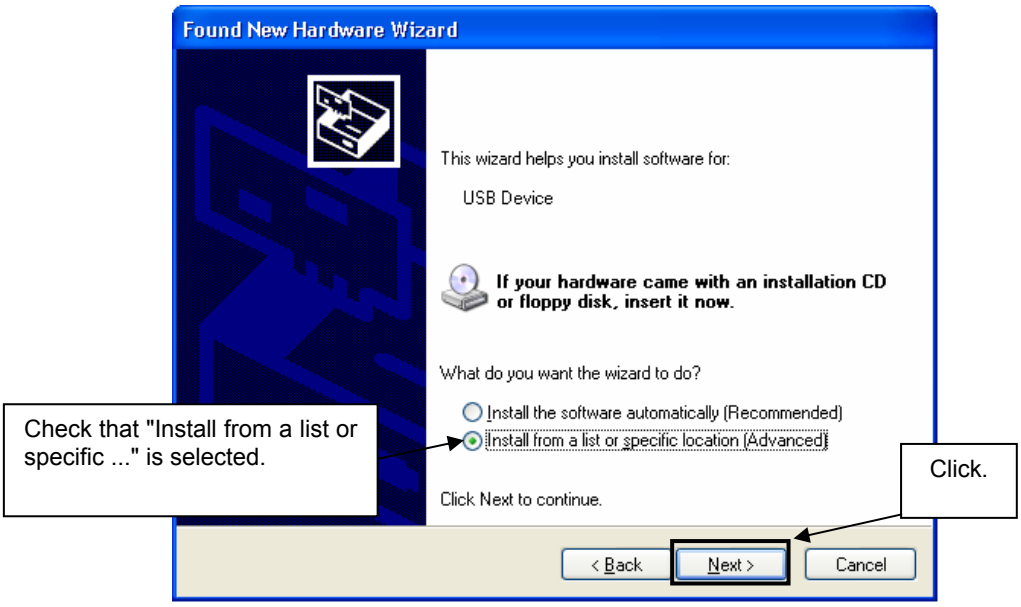
8.3.2 Installation on Windows XP

1. When the *78K0R - Cool it!* board is connected with the host machine, the board is recognized by Plug and Play, and the wizard for finding new hardware is started. At first the hardware wizard will ask if windows should search on the windows update web, check "No, not this time" and then click Next>.

Figure 15: Found New Hardware Wizard 1 (Windows XP)

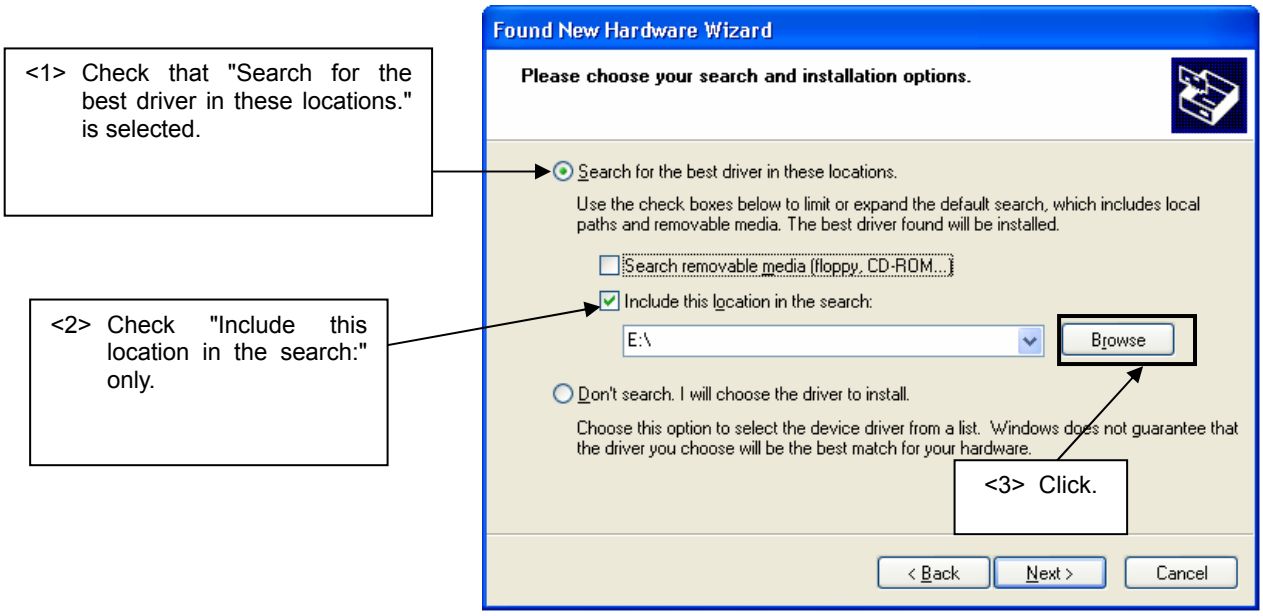
2. Check that "Install from a list or specific location (Advanced)" is selected, then click Next>.

Figure 16: Found New Hardware Wizard 2 (Windows XP)



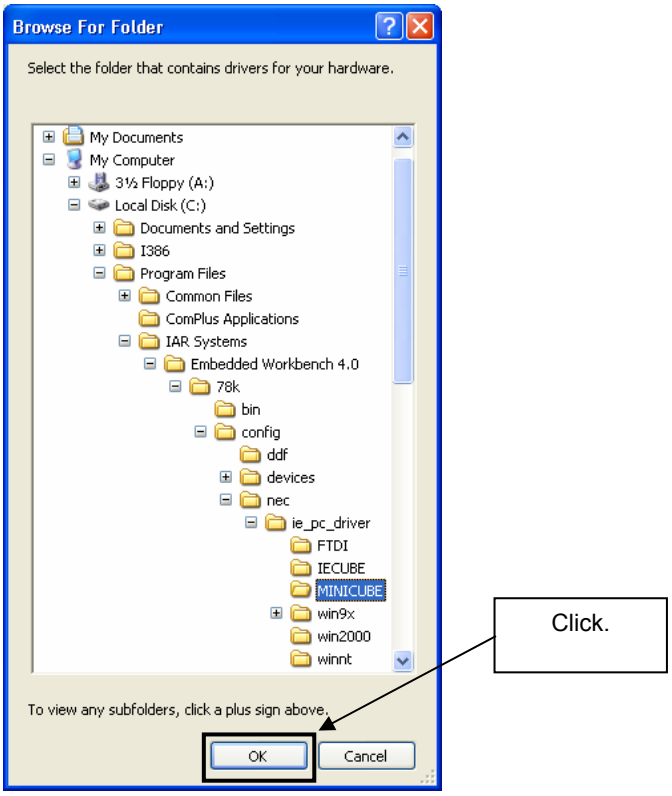
3. Check that "Search for the best driver in these locations." is selected. Select the "Include this location in the search:" check box and then click Browse.

Figure 17: Search Location Specification 1 (Windows XP)



4. Locate the folder "C:\Program Files\IAR Systems\Embedded Workbench 4.0\78K\config\nec\ie_pc_driver\MINICUBE" and click OK.

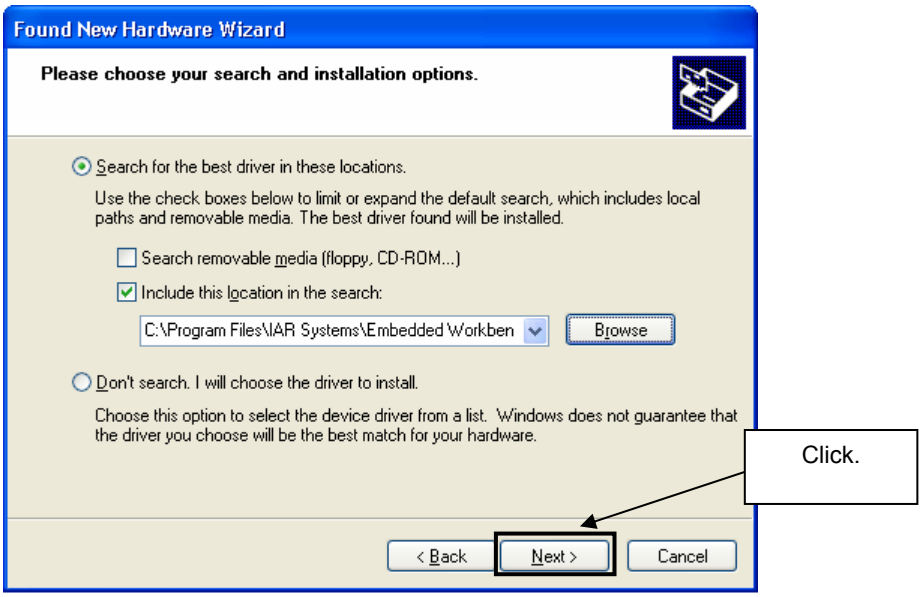
Figure 18: Search Location Specification 2 (Windows XP)



Remark If the installation destination folder is changed at the time of IAR Embedded Workbench installation, enter "new-folder\78K\config\nec\ie_pc_driver\MINICUBE".

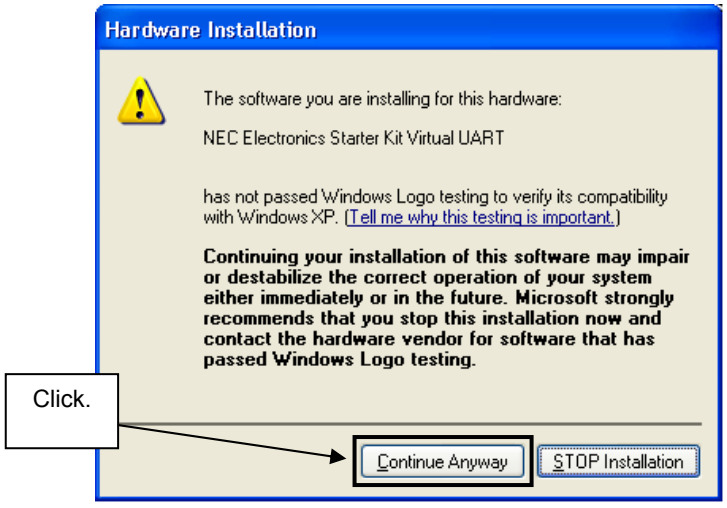
5. After the location of the USB driver has been specified click Next> to continue driver installation.

Figure 19: Search Location Specification 3 (Windows XP)



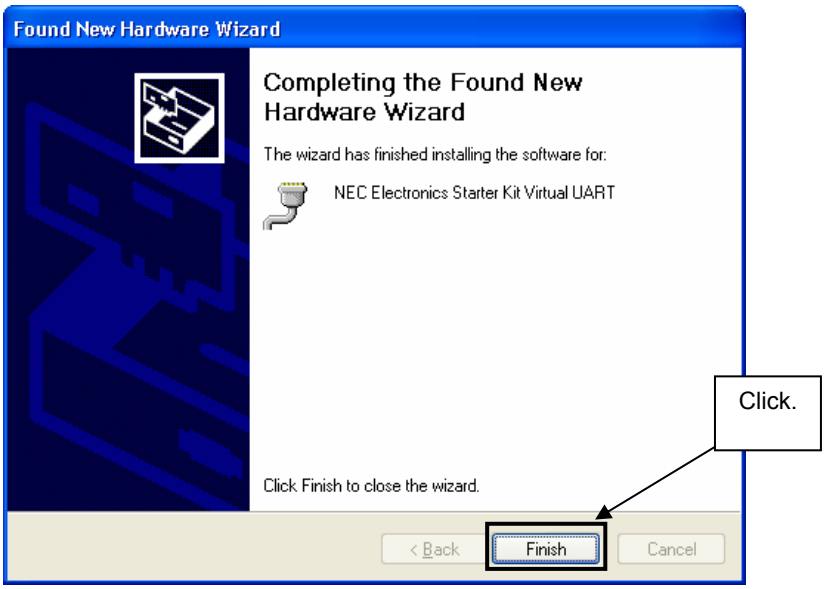
6. As shown below, "NEC Electronics Starter Kit Virtual UART has not passed Windows Logo testing to verify its compatibility with Windows XP." is displayed. Click Continue Anyway.

Figure 20: Windows XP Logo Testing (Windows XP)



7. After the installation of the USB driver is completed the window below is displayed. Click Finish to close the hardware wizard.

Figure 21: USB Driver Installation Completion (Windows XP)

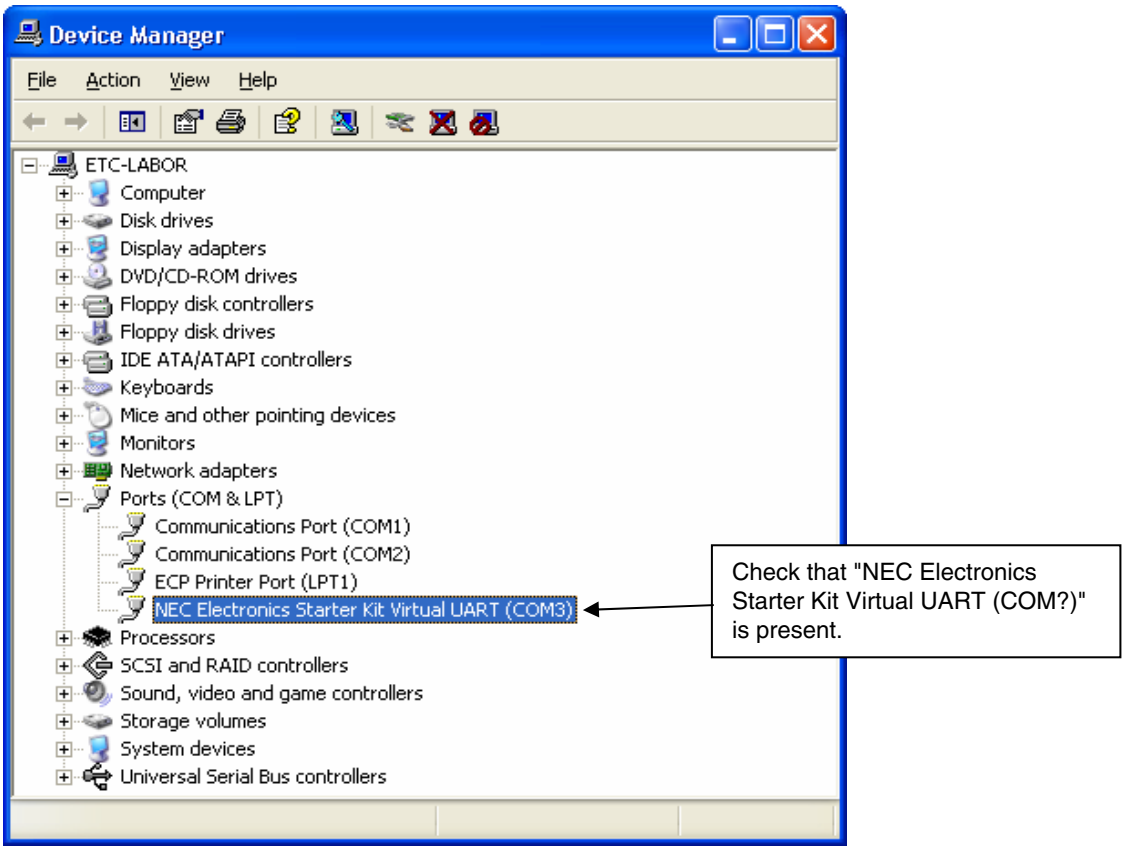


8.4 Confirmation of USB Driver Installation

After installing the USB driver, check that the driver has been installed normally, according to the procedure below. When using the *78K0R - Cool it!* board in combination with IAR C-SPY debugger the “NEC Electronics Starter Kit Virtual UART” should be present like in the figure below.

By choosing the "Device Manager" within the Windows Properties (“Hardware” tab), check that the driver is installed normally.

Figure 22: Device Manager



9. IAR sample session

When everything is set up correctly the IAR Embedded Workbench can be started. To do so, start the Embedded Workbench from Windows “Start” menu > “Programs” > folder “IAR Systems” > “IAR Embedded Workbench Kickstart for 78K”. The following screen appears:

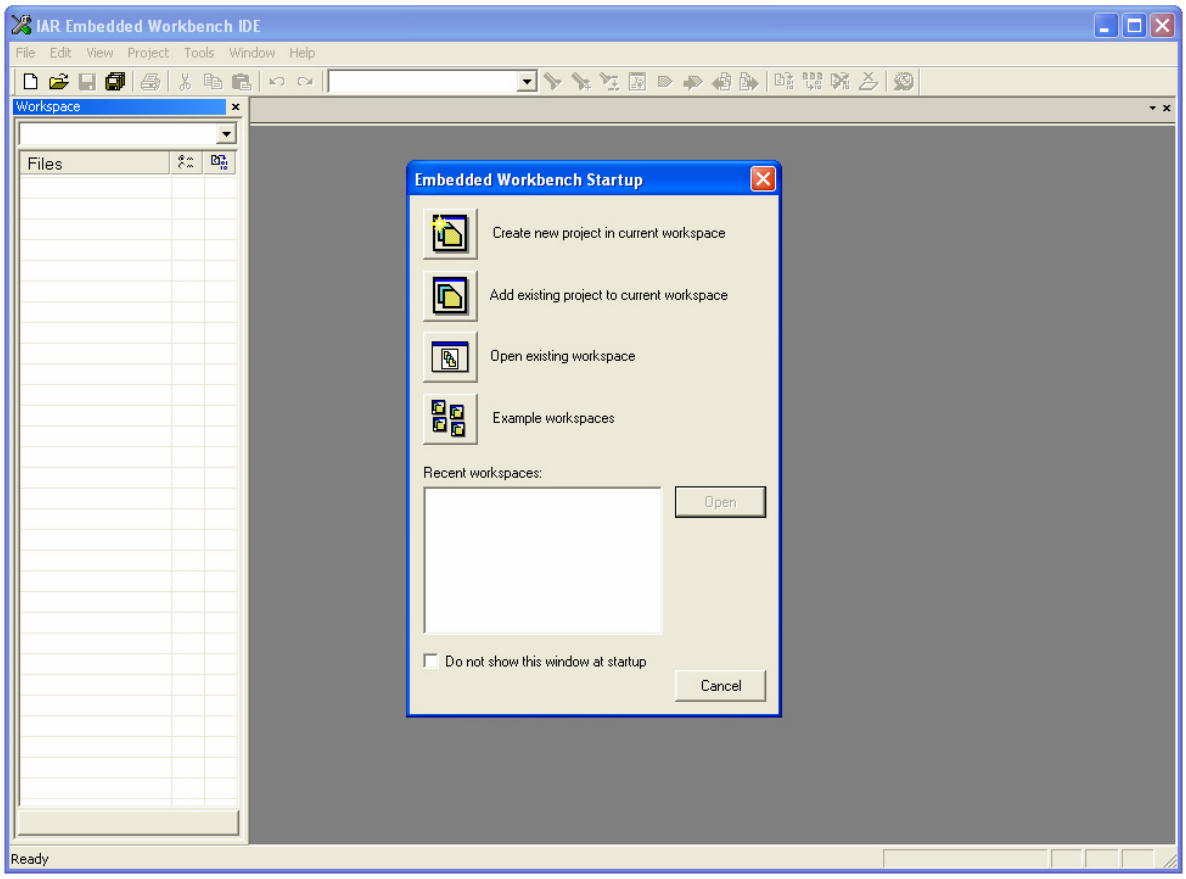


Figure 23: IAR Embedded Workbench

Now select the option “Open exiting workspace” from the “File” menu and locate the sample project. Open the file “78K0R_Coolit.eww”. This is the workspace file that contains general information about the demo projects and corresponding settings.

After the demo workspace has been opened the files contained in the workspace are displayed. Now click on the little “+” sign next to the project filename “ADC_demo - Debug” to show all files that were part of the selected demonstration project. The screen should now look similar to this:

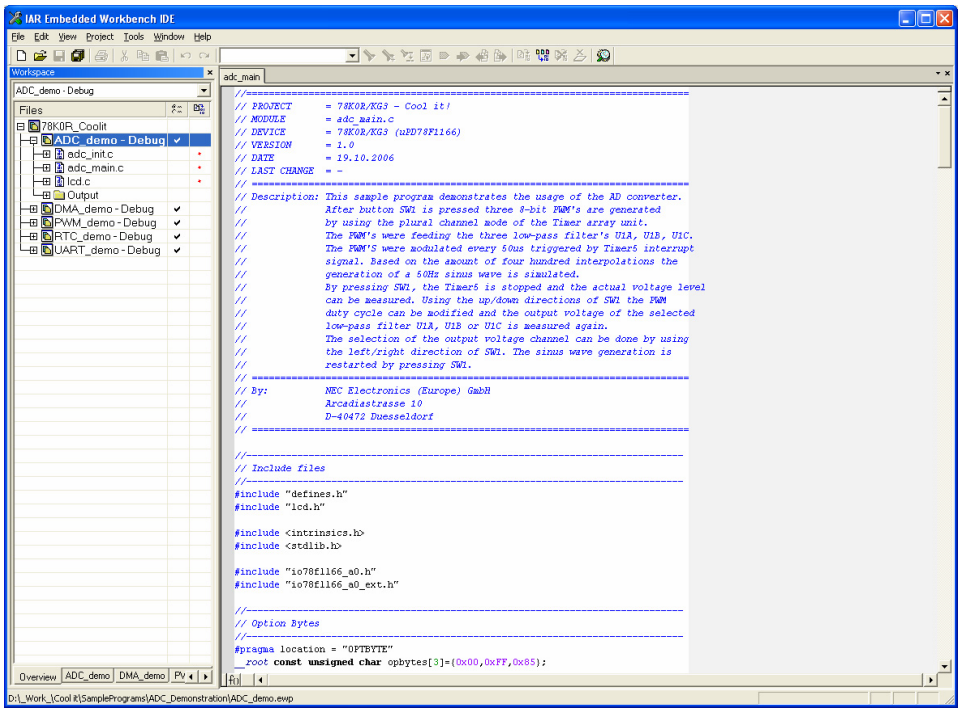


Figure 24: IAR project workspace

As a next step check some settings of the IAR Embedded Workbench that have to be made for correct operation and usage of the On-Board debug function of the *78K0R – Cool it!* board. First highlight the upper project folder called “ADC_demo – Debug” in the workspace window. Then select “Project” > “Options” from the pull-down menus. Next select the category “Debugger”. Make sure that the driver is set to “TK-78” in order to use the On-Board debug function of the *78K0R – Cool it!* board. The device description file must be set to “io78f1166_a0.ddf”. The corresponding COM port where the *78K0R – Cool it!* board is connected to the host PC will be detected automatically by the IAR C-SPY debugger.

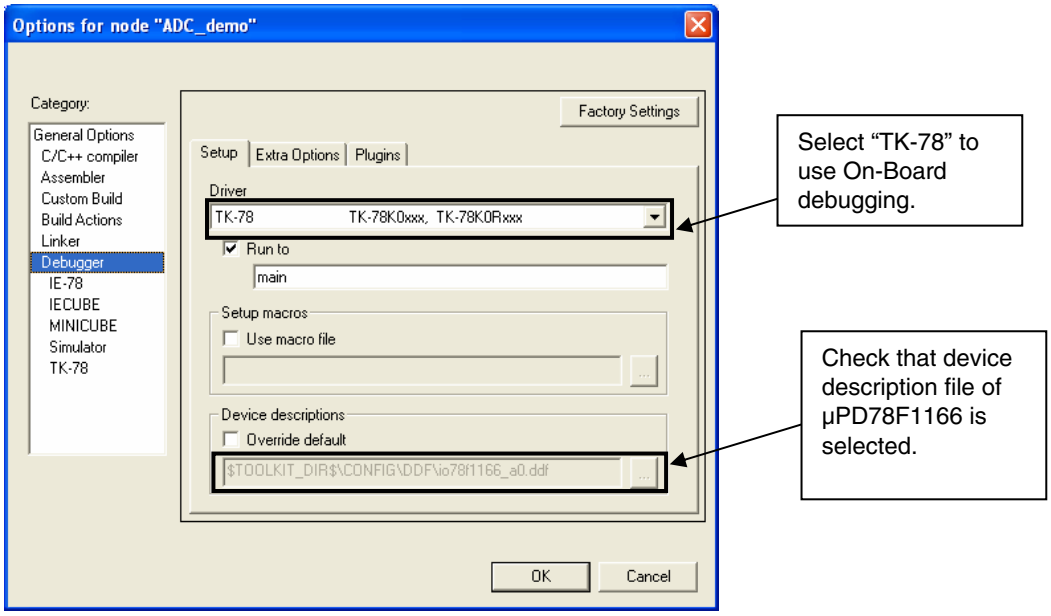


Figure 25: IAR debugger options

Next the correct linker settings of the demo project will be checked. This can be done in the “Linker” category as shown below. Select the “Config” tab and check that the linker command file “lnk78f1166_a0.xcl” is selected. This file is used by the linker and contains information on where to place the different sections of code, data and constants that may be used within the demo project:

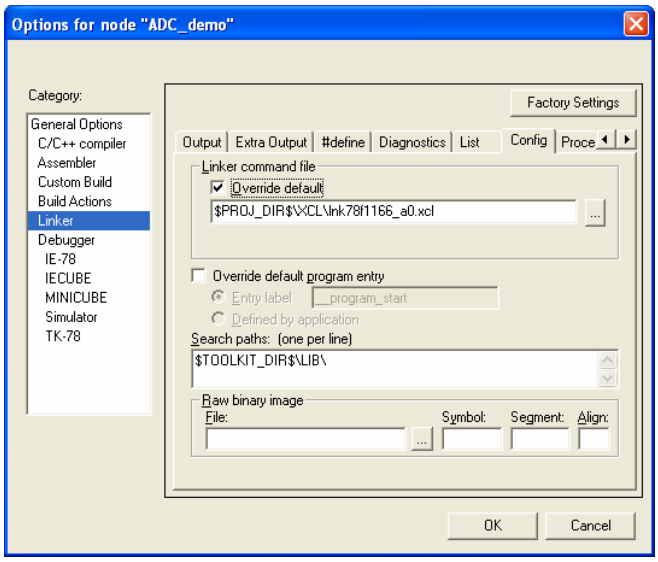


Figure 26: IAR Linker options

Now after everything has been setup correctly it’s time to compile and link the demonstration project. Close the Options menu and select “Rebuild All” from the “Project” menu. If the project is compiled and linked without errors or warnings it can now be downloaded to the *78K0R – Cool it!* board and debugged. To start the IAR C-SPY debugger select the option “Debug” from the “Project” menu or press the ( ) “Debugger” button. In the next step the TK-78 Emulator has to be configured before downloading a new application. Press the OK button to enter the emulator hardware setup. Set the configuration as show in the figure below and start the download by pressing the OK button.

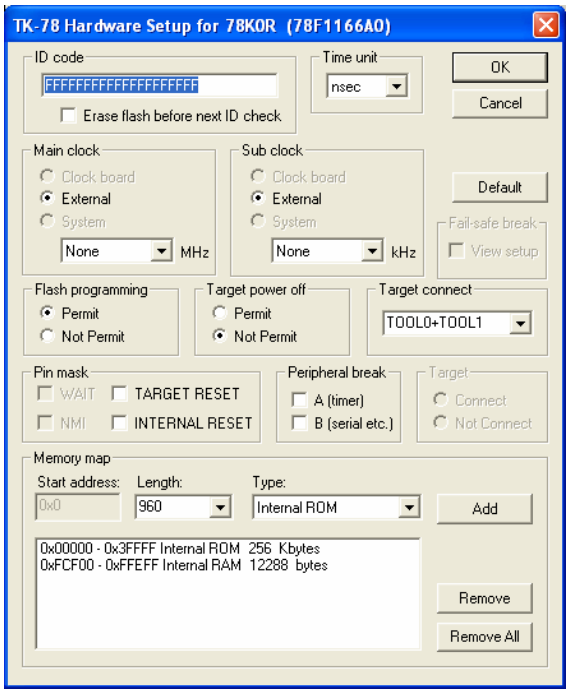


Figure 27: TK-78 hardware setup menu

Now the debugger is started and the demo project is downloaded to the *78K0R – Cool it!* board. The progress of downloading is indicated by blue dots in the TK-78 Emulator window. Please note, downloading of larger executables can take some time.

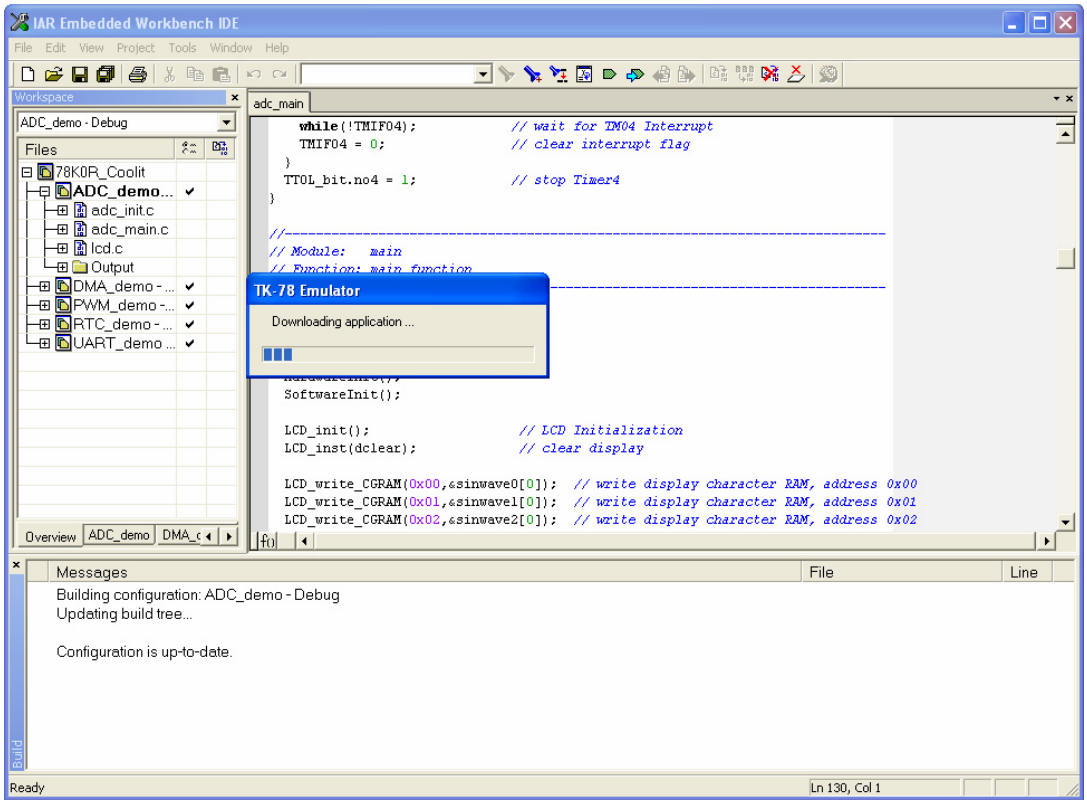


Figure 28: IAR project download

After the download was completed all debug features of IAR C-SPY debugger are available, i.e. Single Stepping, Step Over/-In/-Out, Go-Execution, Breakpoints, Register / Memory view etc.

To get more details on the debugger configuration and capabilities please refer to the “78K IAR Embedded Workbench IDE User Guide” of the IAR installation.

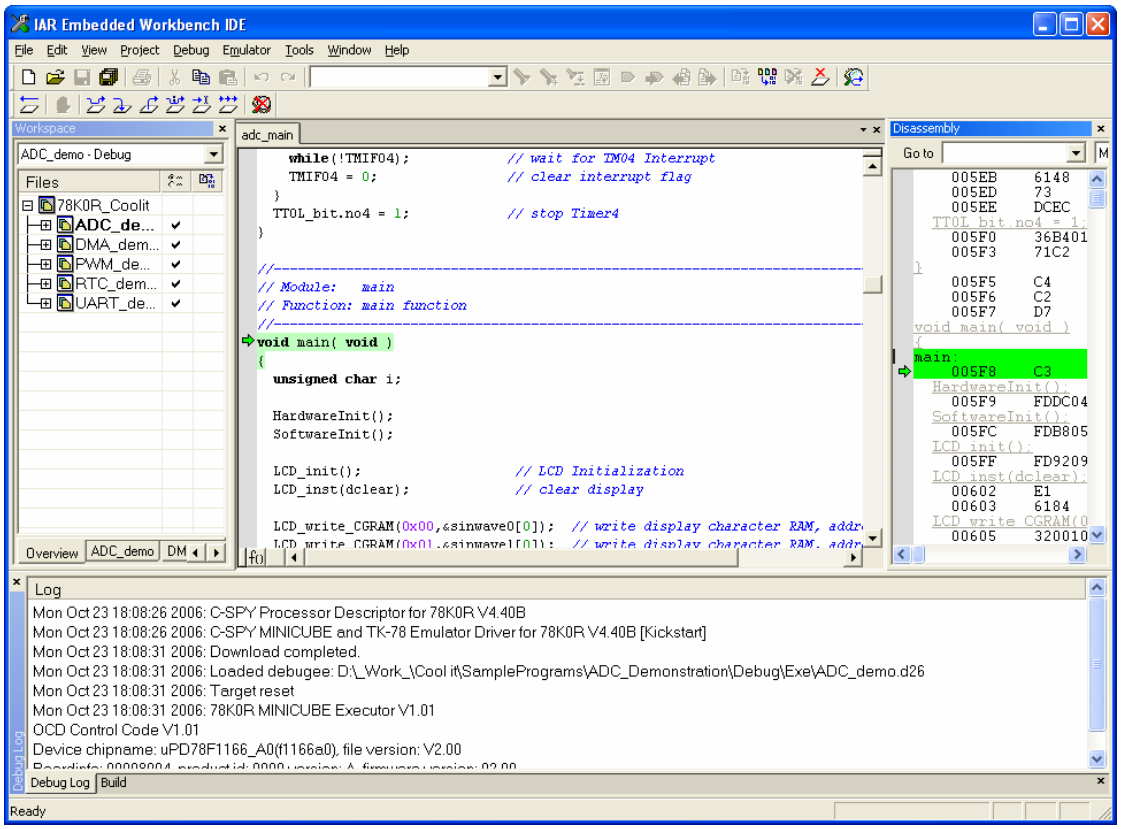


Figure 29: IAR C-SPY debugger

10. Troubleshooting

In some cases it might happen that the connection to the 78K0R – Cool it! can not be established. This can be caused by the following two situations:

- ***Wrong security ID***: The security ID is required to prevent the FLASH memory of the 78K0R/KG3 microcontroller from being read by an unauthorized person. The security ID is located in the internal flash memory at addresses 0xC4-0xCD of the 78K0R/KG3 microcontroller. The IAR C-SPY debugger starts only when the security ID that is set during debugger start-up and the security ID set at addresses 0xC4 to 0xCD do match.

- ***Disabled On-Chip debug***: The On-Chip debug function of the 78K0R/KG3 microcontroller can be controlled by a dedicated Option Byte located at address 0xC3 in the internal flash memory. By disabling the On-Chip debug operation no connection to device can be established neither using the TK-78 interface nor using the QB-MINI2 On-Chip debug emulator.

In the above mentioned cases it is necessary to erase the internal flash memory of the 78K0R/KG3 microcontroller to restore the security ID and to enabled the On-Chip debug function.

In case of a security ID mismatch the following message box is displayed by the IAR C-SPY debugger. Click the YES button to enter the Hardware Setup menu.

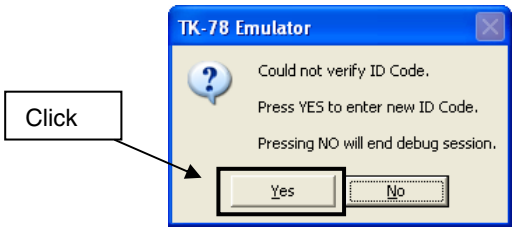


Figure 30: TK-78 enter Hardware Setup

Specify the default security ID <1> - the default security ID of an erased flash is equal to 10bytes 0xFF each -and enable the “erase flash before next ID check” option <2>. Then press the OK button <3> to start flash erasing and to establish the debugging session.

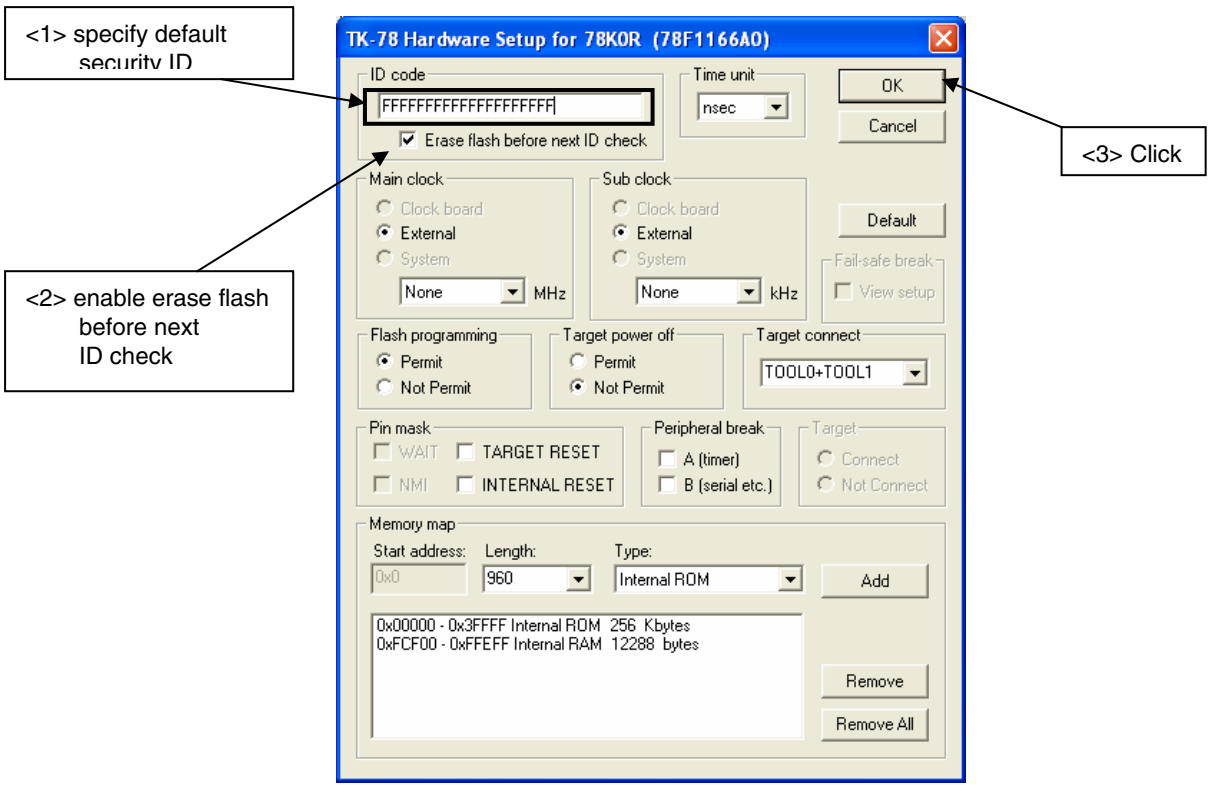


Figure 31: TK-78 Hardware Setup menu

The progress of flash erasing is indicated by blue dots in the TK-78 Emulator window. Following the debugger starts downloading the executable to the *78K0R – Cool it!* board like shown in figure 28.

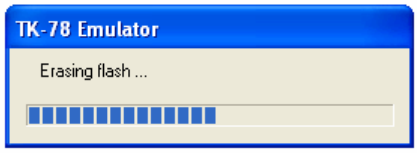


Figure 32: TK-78 flash erasing

11. Sample programs

11.1 General Introduction

Each of the sample programs is located in a single directory, which will be called main-directory of the sample. This main directory of each sample contains the complete project inclusive all output files of the development tool. The workspace file "**78K0R_Coolit.eww**" is located on top of the sample program directories. All sample programs use the same directory structure:

ADC_Demonstration	78K0R/KG3 project and output files
Debug	debug output files for IAR C-SPY debugger
inc	C header files
Release	release output files, i.e. Intel HEX file
settings	configuration files, IAR Embedded Workbench
source	C source files
xcl	Linker control file
ADC_demo.dep	dependency information file, IAR Embedded Workbench
ADC_demo.ewd	project setting file, IAR C-SPY debugger
ADC_demo.ewp	project file, IAR Embedded Workbench
DMA_Demonstration	78K0R/KG3 project and output files
PWM_Demonstration	78K0R/KG3 project and output files
RTC_Demonstration	78K0R/KG3 project and output files
UART_Demonstration	78K0R/KG3 project and output files
78K0R_Coolit.eww	workspace file, IAR Embedded Workbench 78K0/78K0S/78K0R

Table 21: Example directory structure

The main directory contains only the project files for the IAR Systems Embedded Workbench 78K0/78K0S/78K0R. All source files are located in the directory `/source` and the `/inc` directory contains the header files. The `/xcl` directory contains the linker control file of the 78K0R/KG3 device. Each sample project uses two targets. One target is the "Debug" (directory `/Debug`) that holds all information for debugging purpose and the other one the "Release" target (directory `/Release`) contains the programmable file, i.e. the Intel HEX file, for programming the 78K0R/KG3 internal FLASH memory via PG-FP4.

All output files of the development tools for the corresponding target are generated in the directories `/Debug` and `/Release`.

For details of using the IAR Embedded Workbench and the IAR C-SPY debugger please refer to the "78K IAR Embedded Workbench IDE User Guide".

11.2 ADC demo

This sample program demonstrates the usage of the A/D converter. After button SW1 is pressed three 8-bit PWM's are generated by using the plural channel mode of the Timer array unit. The PWM's were feeding the three low-pass filter's U1A, U1B, U1C. The PWM's were modulated every 50us triggered by Timer channel 5 interrupt signal. Based on the amount of four hundred interpolations the generation of a 50Hz sinus wave is simulated. By pressing SW1, the Timer channel 5 is stopped and the actual voltage level can be measured. Using the up/down directions of SW1 the PWM duty cycle can be modified and the output voltage of the selected low-pass filter U1A, U1B or U1C is measured again. The selection of the output voltage channel can be done by using the left/right direction of SW1. The sinus wave generation is restarted by pressing SW1.

11.3 DMA demo

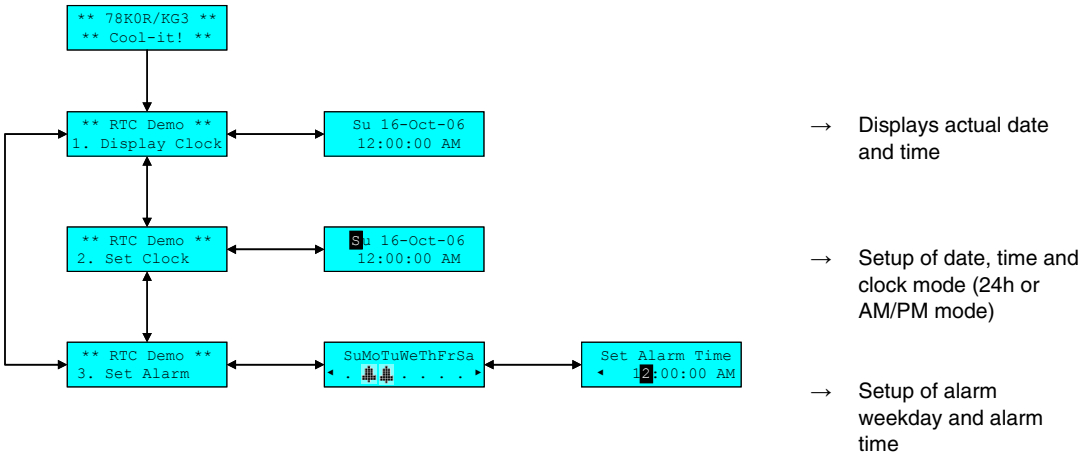
This sample program demonstrates the usage of the DMA controller. After the program is started press button SW1 to start DMA transfer. The DMA is trigger by Timer channel 1 every 100 ns. After 52 bytes are transferred to the D/A converter channel 0 and 1, the DMA is re-initialized within the DMA interrupt service routine. The analog output values can be measured using the connectors TPU23 and TPU24.

11.4 PWM demo

This sample program demonstrates the generation of a 8-bit and 16-bit PWM by using the Timer array unit. After the program is started press button SW1 to start the PWM demonstration. The Timer channels 4 and 5 are used for the generation of the 16-bit PWM and the Timer channels 6 and 7 for the generation of the 8-bit PWM. The duty cycles of the PWM's can be changed by using the up/down direction of the navigation switch SW1. By pressing SW1 the increment respectively decrement of the duty cycle is stopped. The 8-bit PWM controls the lighting intensity of LED1 and the 16-bit PWM controls LED2. By using the left/right direction of the navigation switch SW1 the minimum / maximum duty cycle can be set.

11.5 RTC demo

This sample program demonstrates the usage of the real time counter. After the program is started press button SW1 to start RTC demonstration. By using the navigation switch SW1 the following Menus can be selected:



A menu can be selected by using the up/down direction of SW1. The corresponding menu point can be entered and left by pressing SW1. Changing of date, time, clock mode, alarm weekday and alarm time is done by using the up/down direction of navigation switch SW1.

11.6 UART demo

This sample program demonstrates the initialization and usage of the UART3 by using the Serial array unit 1, channel 2 and 3. After the program is started press a key on the terminal program that is running on your host system.

Because the TK-78K0R debugging interface and the UART3 are sharing the same virtual COM port, please close the IAR C-SPY debugger after the sample program has been downloaded to the 78K0R - Cool it! board. Unplug the USB interface and switch SW2 bits 1,2,3 to OFF and bits 4,5,6,7,8 to ON to allow communication via UART3.

Plug the USB interface and open a terminal program. Configure the serial com port of your terminal program as following and press the reset button SW3 to restart the sample program.

Serial COM Port configuration	
Baud rate:	9600
Data:	8-bit
Parity:	None
Stop:	1-bit
Flow control:	None

12. Cables

12.1 USB interface cable (Mini-B type)

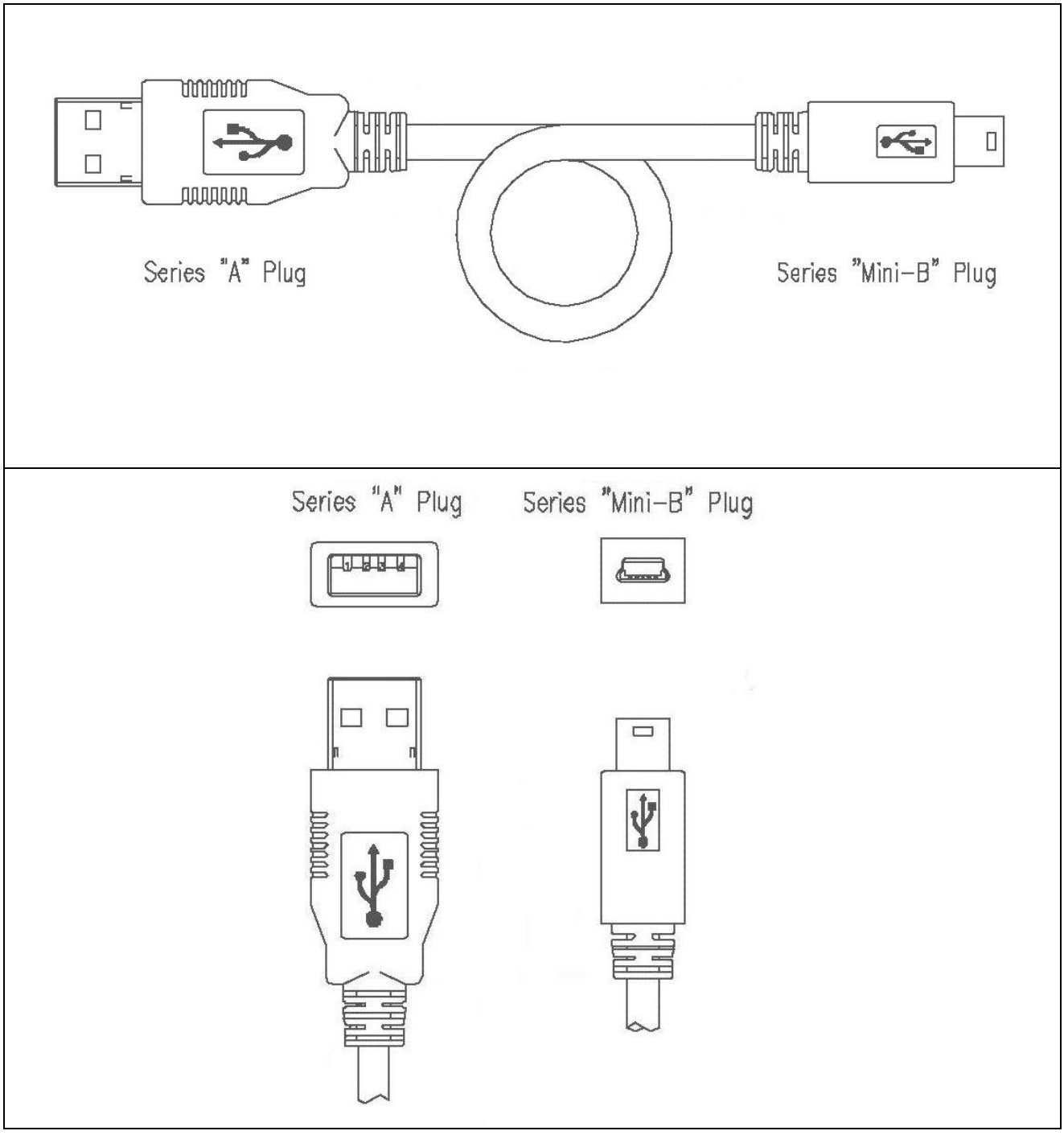


Figure 33: USB interface cable (Mini-B type)

13. Schematics

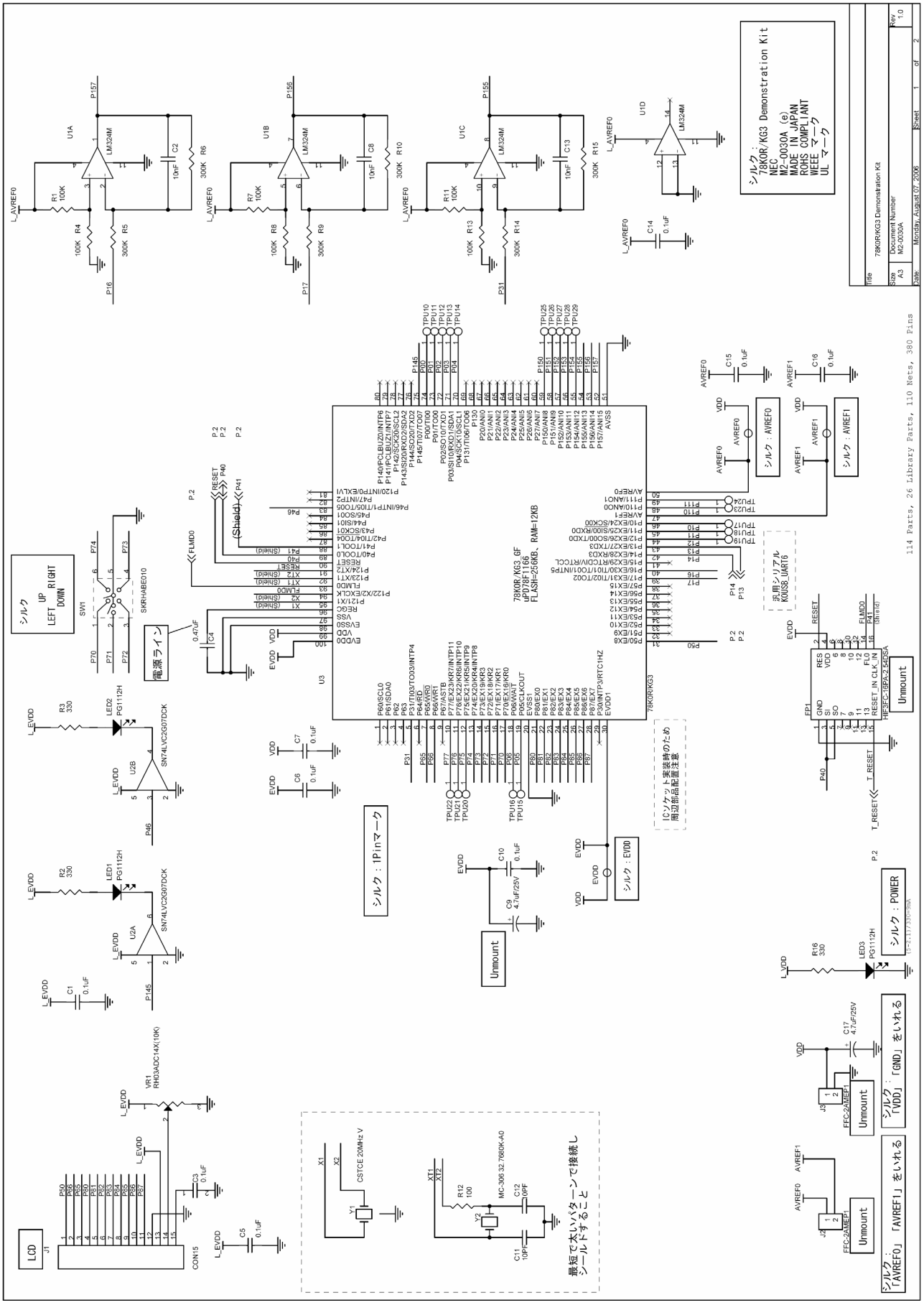


Figure 34: *78K0R - Cool it!* schematics 1/2

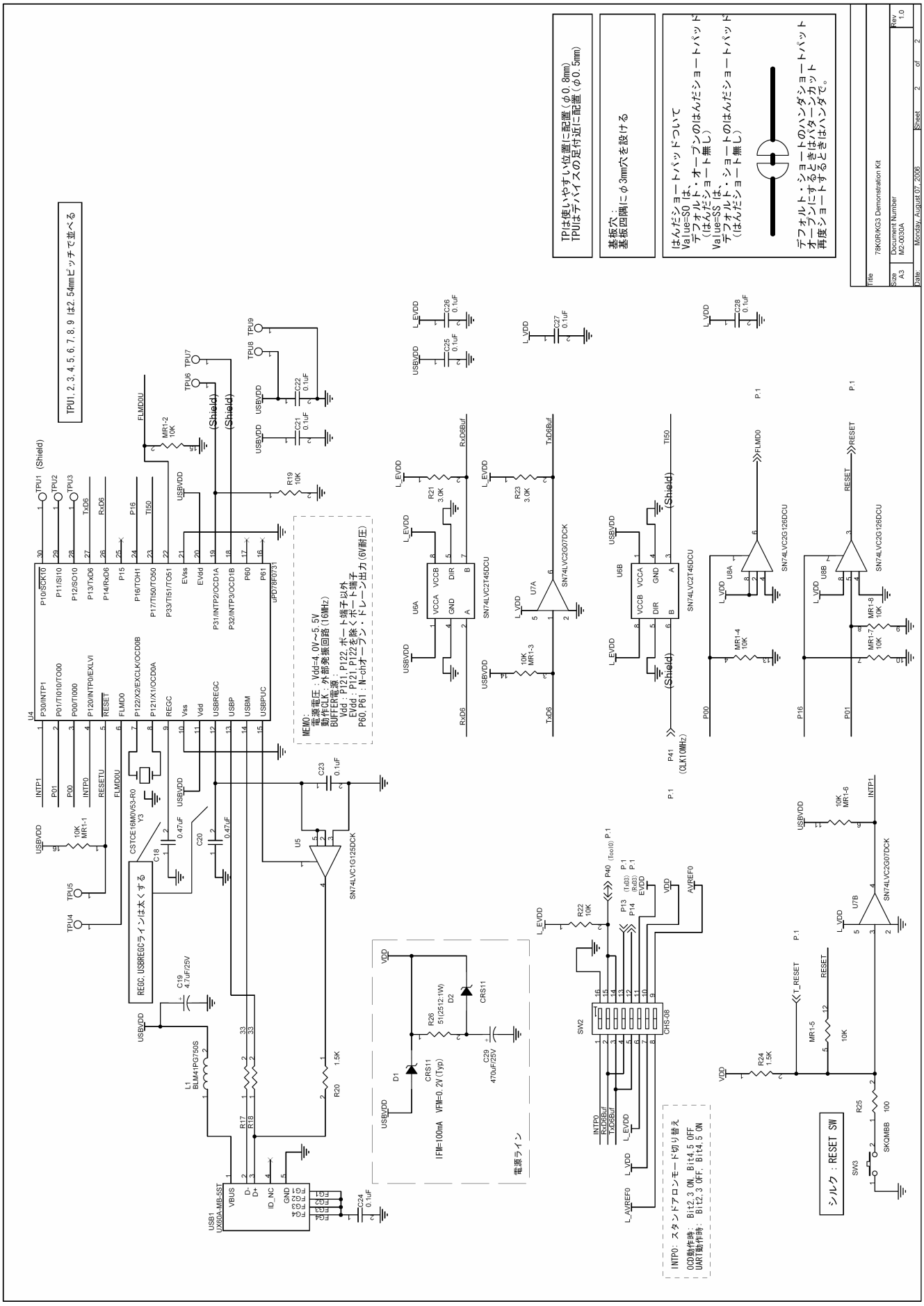


Figure 35: *78K0R - Cool it!* schematics 2/2

[MEMO]

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78K0R-COOLIT

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