NEC

User's Manual

78K0R-SPINIT

Single Board Low Voltage Motor Control Starter Kit

µPD78F1235

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Notes for CMOS Devices

1. **VOLTAGE APPLICATION WAVEFORM AT INPUT PIN**
   Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between VIL (MAX) and VIH (MIN) due to noise, etc., the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between VIL (MAX) and VIH (MIN).

2. **HANDLING OF UNUSED INPUT PINS**
   Unconnected CMOS device inputs can result in malfunction. If an input pin is unconnected, it is possible that an internal input level may be generated due to noise, etc., causing malfunction. CMOS devices behave differently than Bipolar or NMOS devices. Input levels of CMOS devices must be fixed high or low by using pull-up or pull-down circuitry. Each unused pin should be connected to VDD or GND via a resistor if there is a possibility that it will be an output pin. All handling related to unused pins must be judged separately for each device and according to related specifications governing the device.

3. **PRECAUTION AGAINST ESD**
   A strong electric field, when exposed to a MOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop generation of static electricity as much as possible, and to quickly dissipate it should it occur. Environmental control must be adequate. When it is dry, a humidifier should be used. It is recommended to avoid using insulators that easily build up static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors should be grounded. The operator should be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions need to be taken for PW boards with mounted semiconductor devices.

4. **STATUS BEFORE INITIALIZATION**
   Power-on does not necessarily define the initial status of a MOS device. Immediately after the power source is turned ON, devices with reset functions have not yet been initialized. Hence, power-on does not guarantee output pin levels, I/O settings or contents of registers. A device is not initialized until the reset signal is received. A reset operation must be executed immediately after power-on for devices with reset functions.

5. **POWER ON/OFF SEQUENCE**
   In the case of a device that uses different power supplies for the internal operation and external interface, as a rule, switch on the external power supply after switching on the internal power supply. When switching the power supply off, as a rule, switch off the external power supply and then the internal power supply. Use of the reverse power on/off sequences may result in the application of an overvoltage to the internal elements of the device, causing malfunction and degradation of internal elements due to the passage of an abnormal current. The correct power on/off sequence must be

judged separately for each device and according to related specifications governing the device.

6. **INPUT OF SIGNAL DURING POWER OFF STATE**
Do not input signals or an I/O pull-up power supply while the device is not powered. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements. Input of signals during the power off state must be judged separately for each device and according to related specifications governing the device.

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- Ordering information
- Product release schedule
- Availability of related technical literature
- Development environment specifications (for example, specifications for third-party tools and components, host computers, power plugs, AC supply voltages, and so forth)
- Network requirements

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Preface

Readers This manual is intended for users who want to understand the functions of the 78K0R-SPINIT for motor control.

Purpose This manual presents the hardware manual of the 78K0R-SPINIT for motor control.

Organization This system specification describes the following sections:

- Jumper Descriptions
- Hardware Setup
- Schematics

Legend Symbols and notation are used as follows:

- Weight in data notation: Left is high order column, right is low order column
- Active low notation: $\overline{xxx}$ (pin or signal name is over-scored) or /xxx (slash before signal name)
- Memory map address: High order at high stage and low order at low stage

Note Additional remark or tip

Caution Item deserving extra attention

Numeric Notation

- Binary: xxxx or xxxB
- Decimal: xxxx
- Hexadecimal: xxxxH or 0x xxxx

Prefixes representing powers of 2 (address space, memory capacity):

- K (kilo): 210 = 1024
- M (mega): 220 = 10242 = 1,048,576
- G (giga): 230 = 10243 = 1,073,741,824

Table of Contents

Chapter 1 Introduction

The 78K0R-SPINIT kit is a complete 3-phase motor control evaluation system based on NEC Electronics' µPD78F1235 microcontroller (MCU), a 16-bit application-specific product (ASSP) specifically designed for motor control applications.

The kit contains all of the hardware and software necessary to quickly set up and run a low-voltage brushless DC motor (BLDCM). On-board hardware facilitates easy programming with either the MINICUBE2 On-Chip debugger/programmer or directly through the onboard USB port using a standard USB cable, and source code debugging without the need for additional hardware tools.

The source code and project files are available free of charge and can be downloaded from the *NEC motor control website*

In order to modify the source code the IAR development environment is required and a time limited version can be acquired directly from the IAR website or a code limited trial version is included in the MINICUBE2 On-Chip debugger/programmer or the full IAR development tool can be purchased from NEC or through an NEC Electronics franchised distributor.

Please Note: If you require debugging the 78K0R-SPINIT kit while using the USB serial port for system communications a MINICUBE2 will be required.

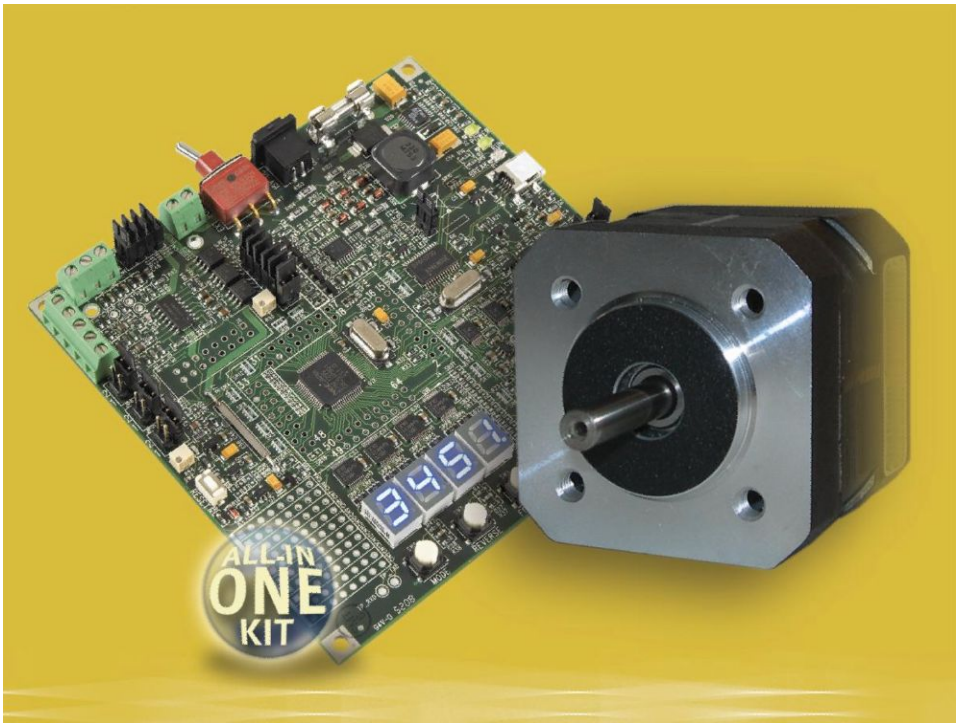


Figure 1-1 78K0R-SPINIT Kit Image

Chapter 2 78K0R-SPINIT Kit Contents

The 78K0R-SpinIt KIT should contain the following items:

- MC-78K0R-IE3 single board controller containing the µPD78F1235 ASSP microcontroller
- BLDC motor: Anaheim Automation BLY17S15V8000 (15V)
- FW75550/15 DC power supply
- USB Cable

For information about the electrical characteristics and hardware functions of the µPD78F1235 microcontroller, refer to 78K0R/IE3 (ïPD78F1235) User’s Manual (U19163EJ1V0UD00).

For the instruction descriptions, refer to the 78K0R 16-bit Single-Chip Microcontrollers Instruction Manual (U17792EJ4V0UM00).

Chapter 3 Hardware Setup

The kit is shipped with a default jumper configuration to run the motor with the following on-board user interface controls as soon as the motor is connected and power is supplied.

- START/STOP, FORWARD, REVERSE and MODE push-buttons
- SPEED potentiometer
- 7-segment LED

Table 3-1 DS1 Dip Switch Settings

Switch		USB Debug + Flash Programming	MINICUBE2 + (GUI Operation)
DS1	1-8	ON	ON
	2-7	OFF	OFF
	3-6	OFF	ON
	4-5	ON	OFF
JP22	Debug Mode	OFF = USB	ON = MINICUBE2

Table 3-2 Jumper Settings

Jumper	Description	Default Setting
JP5	MINICUBE2 RX - TX link	ON
JP6	1-2 Reset_USB (MINICUBE2) 3-4 Reset_KR (MINICUBE2)	3-4
JP7	1-2 FLMD0_USB (MINICUBE2) 3-4 FLMD0_KR (MINICUBE2)	3-4
JP9	1-2 Comparator1 (Phase U BEMF) 3-4 Hall1	3-4
JP10	1-2 Comparator2 (Phase V BEMF) 3-4 Hall2	3-4
JP11	1-2 Comparator3 (Phase W BEMF) 3-4 Hall3	3-4
JP12	U-Hi FET drive isolate	ON
JP13	V-Lo FET drive isolate	ON
JP14	U-Lo FET drive isolate	ON
JP15	W-Hi FET drive isolate	ON
JP16	V-Hi FET drive isolate	ON
JP17	W-Lo FET drive isolate	ON
JP18	U phase isolate (from onboard FET)	ON
JP19	V phase isolate (from onboard FET)	ON
JP20	W phase isolate (from onboard FET)	ON
JP21	Motor Over current Protection Hardware Circuit	ON
JP22	ON = MINICUBE2 Debug Mode OFF = USB Debug Mode	ON

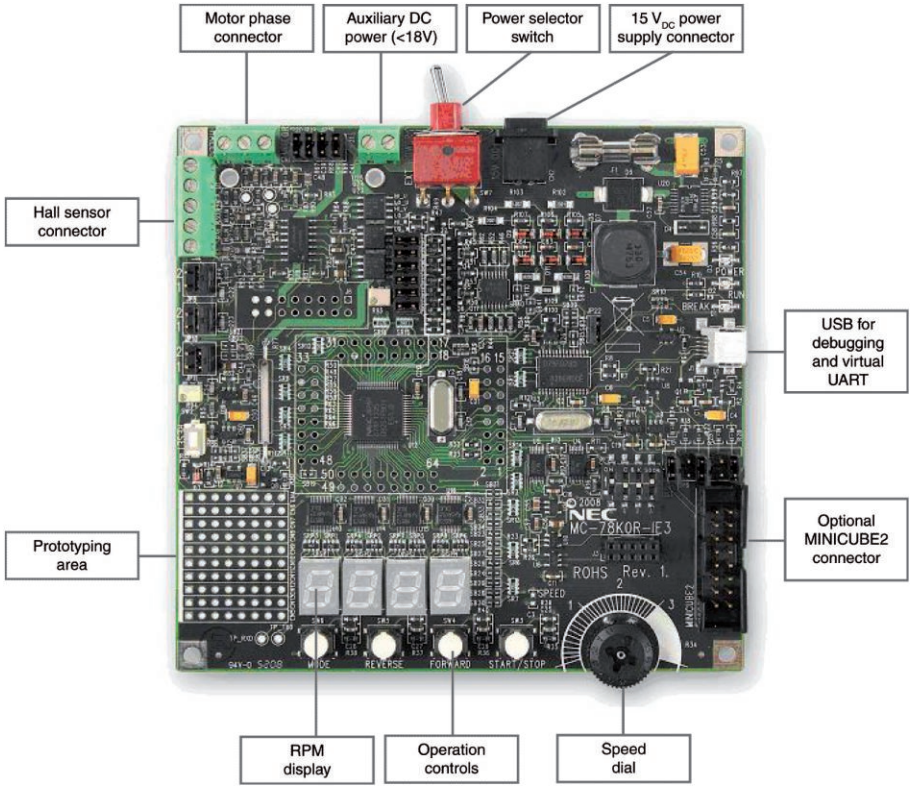


Figure 3-1 78K0R-SPINIT Controller Board Layout

To connect the motor, attach the phase terminals to connector CN1 and the Hall sensor terminals to connector J5, as shown in *Table 3-3* below.

Note Other low-voltage BLDC motors with similar characteristics may be used. Consult the motor specifications and make appropriate changes, including software if necessary based your own assessment.

Table 3-3 Motor Connections

Motor Terminals		**78K0R-SpinIt**
Function	**Anaheim Automation BLY171S-15V-8000**	
Phase U	Yellow	CN1-1
Phase V	Red	CN1-2
Phase W	Black	CN1-3
Hall sensor 1	White	J5-1
Hall sensor 2	Blue	J5-2
Hall sensor 3	Green	J5-3
Hall sensor 5 V_{DC}	Red	J5-4
Hall sensor GND	Black	J5-5

Motor terminal connections for Anaheim Automation BLY171S-15V-8000 motor are as shown below.

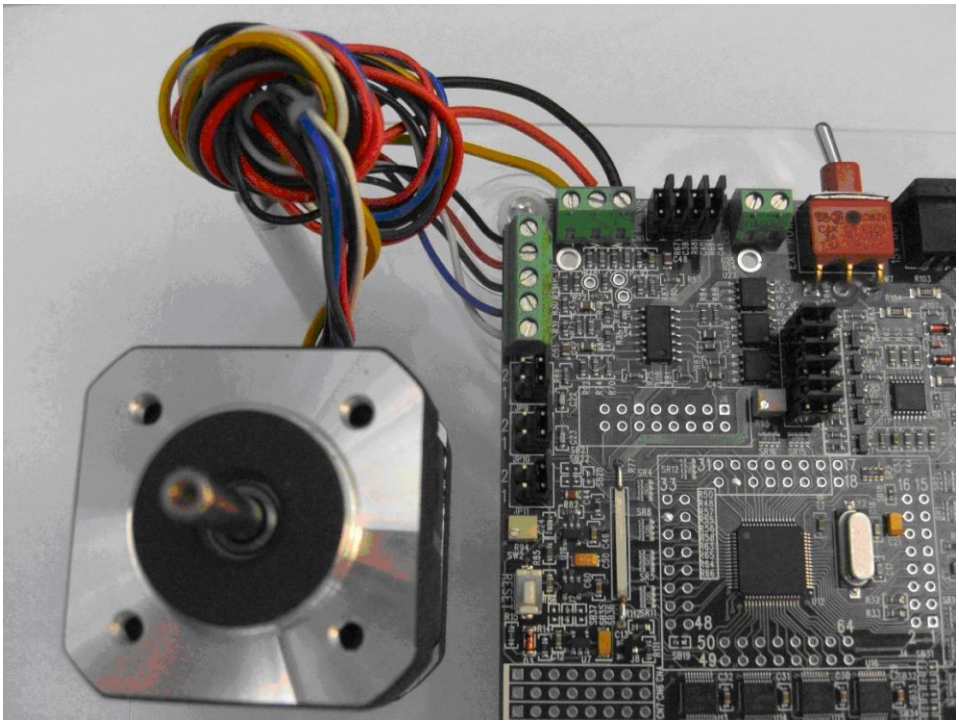


Figure 3-2 Motor Connections Image

The software to run the motor is pre-programmed into the microcontroller's flash memory and it is ready to run as soon as the power supply is connected and the power switch is turned on.
A quick start-up procedure is outlined in the chapter 4 below.

Chapter 4 Quick Start Procedure for Motor Operation and Control

The operation and control of the 78K0R-SPINIT starter kit and motor can be done in two ways:

- Standalone mode – with onboard pushbuttons, potentiometer and 7-Seg LED
- PC mode – with a PC based GUI and the onboard USB connector

4.1 Standalone Mode

The motor can be operated in standalone mode right out of the box after the motor terminals and hall sensor wires are connected and power is supplied. To operate in PC GUI mode a special NEC program “necgui.exe” program has to be installed. See the installation instructions and the operation in PC GUI mode in chapter 6 of this user manual.

To run the motor in standalone mode, connect the 15VDC power supply to CN2 connector and flip SW7 power selector switch towards CN2. At this point the green POWER LED should turn on and the 7-Segment LED should display “SELF”. This is an indication that the motor is ready to be operated from the on-board pushbuttons and potentiometer.

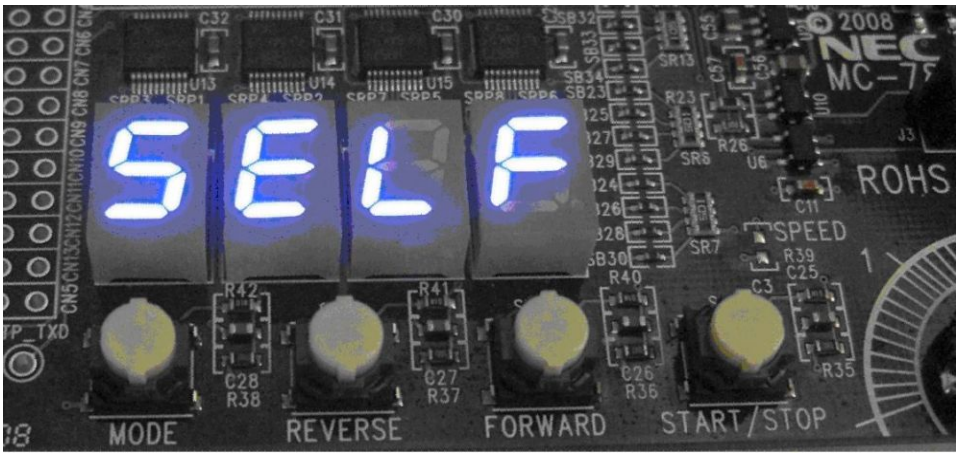


Figure 4-1 Power On Message

After three seconds the LED will display the reference RPM and can be set to the desired speed between 300 to 5000 RPM by the onboard potentiometer. The reference RPM is identified by the decimal point lit on the “units” digit. If the MODE button is pressed the display will toggle between reference RPM and measured or feedback RPM. The measured RPM is displayed without the decimal point.

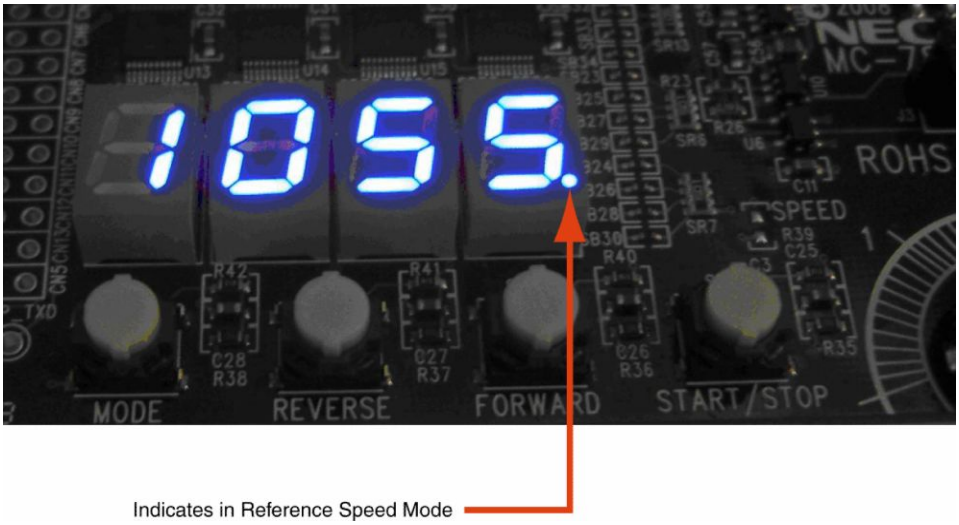


Figure 4-2 Reference RPM Display

To start the motor, press the START/STOP pushbutton.

To stop the motor, press START/STOP again.

During the motor operation, the RPM can be set to the desired speed using the SPEED potentiometer.

Pressing MODE during operation will toggle the display between the reference RPM and the actual measured RPM.

Changing the direction can be done while the motor is running with the REVERSE and FORWARD push buttons. The motor will ramp down and stop for a brief time and will ramp up in the opposite direction to the same set RPM.

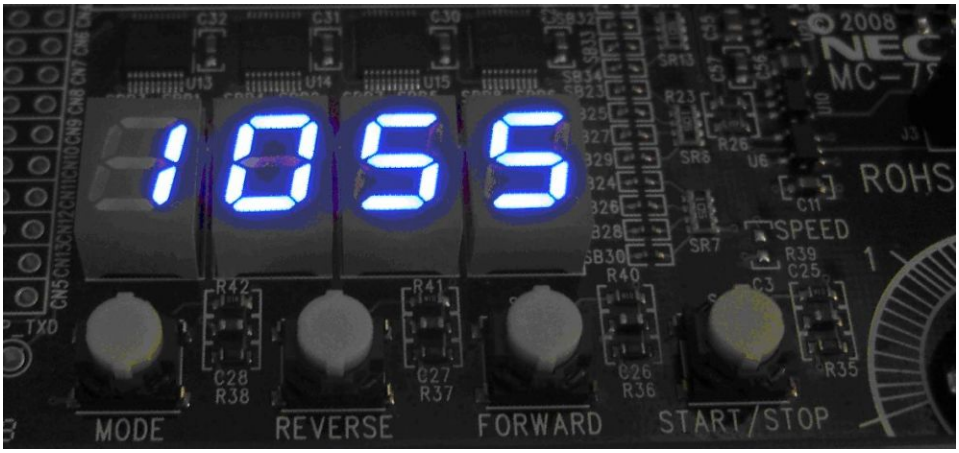


Figure 4-3 Measured RPM Display

4.2 PC Mode

In PC Mode the motor can be operated using a special GUI (Graphical User Interface) which can be downloaded from NEC Electronics website. See chapter 6 for the description of this mode of operation

Chapter 5 Drive and Motor Protection

The starter kit and the motor are protected against unexpected events such as overload, motor stall and malfunction of the Hall sensors. If such faults are detected, the motor stops rotating and the fault conditions are displayed on the seven-segment LED. For details on the protection functions implemented in hardware, consult the user's manual schematics. The sample code software also has built-in fault detection algorithms as an extra measure of protection.

In standalone (SELF) mode, the LED displays the following fault conditions:

- Motor over-current: 
- Motor stall fault: 
- Hall sensor fault: 
- Software over-current: 

In the Graphical Interface mode (PC), the LED displays "P.C." all the time and the GUI will display all fault conditions. Refer to section 6 for more information.

On power on the 78K0R-SPINIT kit will display „SELF":

Chapter 6 GUI Operation

The following information covers the installation and use of the remote control GUI application software.

The interface for the PC GUI is already built into the example software programmed into the board. so it Is not necessary to reprogram the device in order to use the GUI operation. If for any reason it is necessary to reprogram the device the complete IAR Embedded Workbench project can be downloaded from the Motor Control starter kit web site.

To reprogram the microcontroller please refer to section 7.

To operate the PC GUI you will need the USB cable included in the 78K0R-SpinIt starter kit and to install both the NEC Electronics Starter Kit Virtual UART driver and the NEC GUI application software.

6.1 Starter Kit Virtual UART for USB Installation

In order to use the remote control GUI you must install the NEC Electronics Starter Kit Virtual UART. First connect the USB cable to the 78K0R-SpinIt as shown in *Figure 6-1* below and then to the PC.

Prepare the 78K0R-SPINIT for GUI operation as shown below and ensure that DS1 is set to MINICUBE2 + GUI Operation settings (see *Table 3-1*).

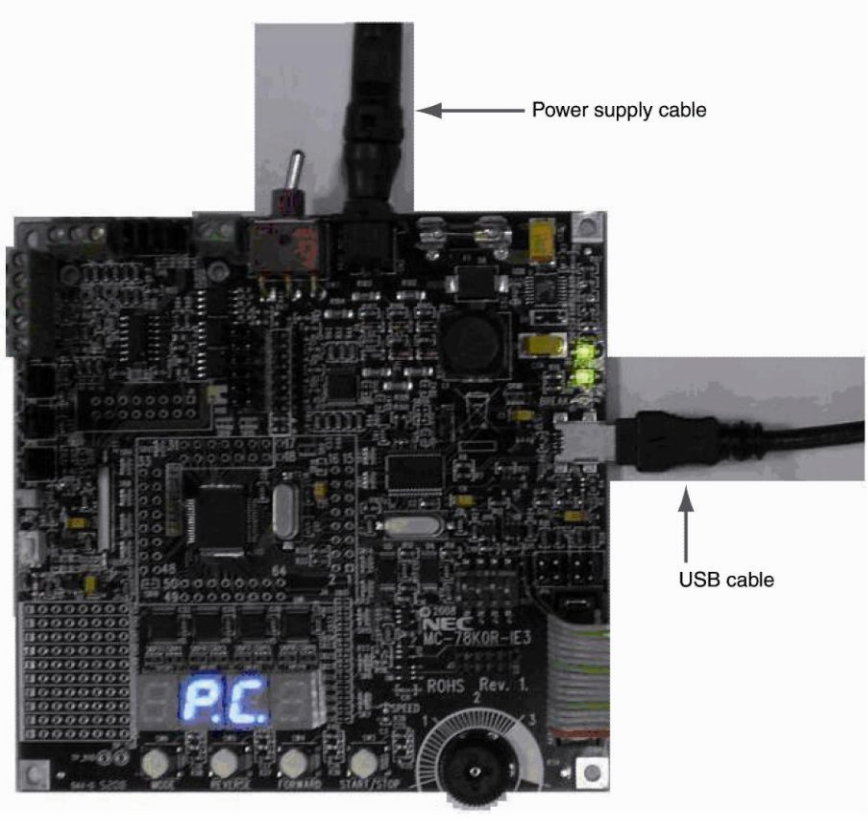


Figure 6-1 Connect USB cable to 78K0R-SPINIT

Windows will start the Found New Hardware Wizard. Select the “No, not this time” option.

Figure 6-2 Found New Hardware Screen

Once Windows has identified the hardware select the “Install from a list or specific location (Advanced) option”.

Figure 6-3 Install From List or Specific Location Screen

Select the “**Search for the best driver in these locations**” option and select the “**Include this location in the search**” box and in the browse box point to the location of the downloaded driver folder “**MQB2**” and click on the “**Next >**” button.

Figure 6-4 Choose Your Search and Installation Options Screen

Click on the “**Continue Anyway**” button which begins the driver installation.

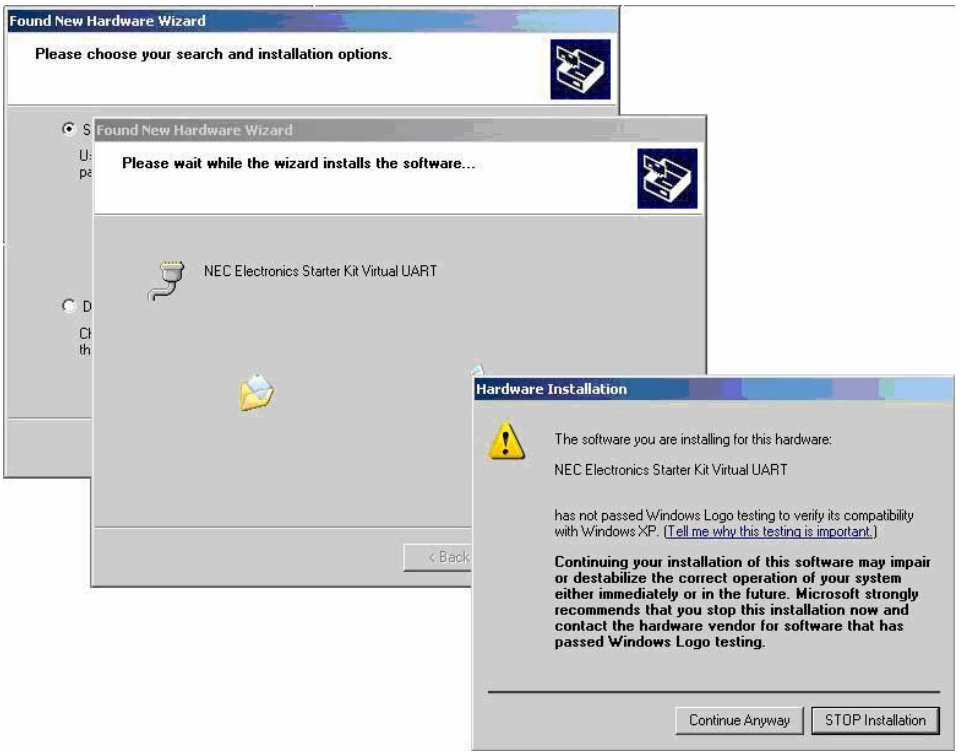


Figure 6-5 Continue to Install the Virtual UART

Click on the “**Finish**” button which will complete the driver installation.

Figure 6-6 Finish Installation and Close the Wizard Screen

Please make a note of the COM Port number that windows has assigned to the virtual driver as you will need to select this port from the GUI. Using your mouse Right click on **My Computer** and select **manage**. From the computer management screen select **Device Manager** and then **Ports (COM & LPT)**. You should now see the **NEC Electronics Starter Kit Virtual UART**.

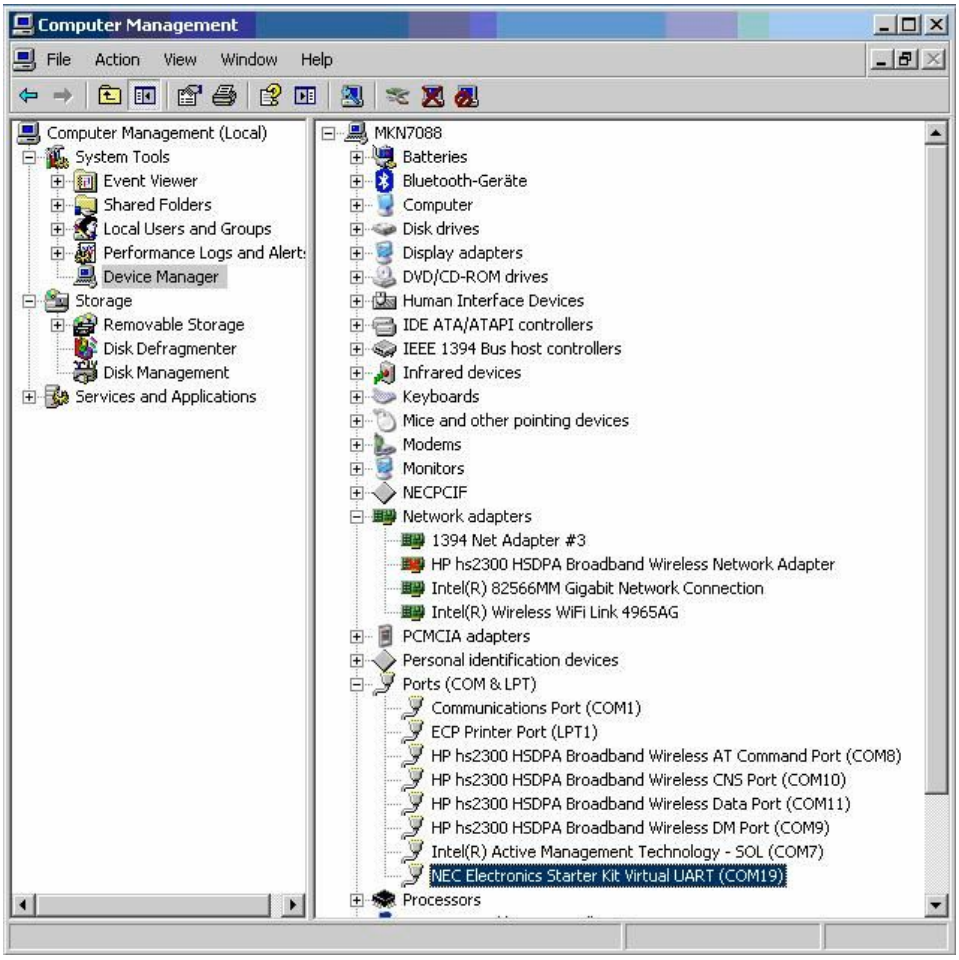


Figure 6-7 Display Virtual UART Port Number in Windows Device Manager Screen

The 78K0R-SpinIt starter kit uses the following UART settings:

Baud rate	57600
Data Bits	8
Stop Bits	1
Parity	None
Handshake	None

6.2 GUI Software Installation

The zip file "**NECGUI.zip**" contains all the files needed to install the NEC GUI application software. Simply extract the files to a folder named "**NECGUI**" and then click on the "**setup.exe**" application as shown below

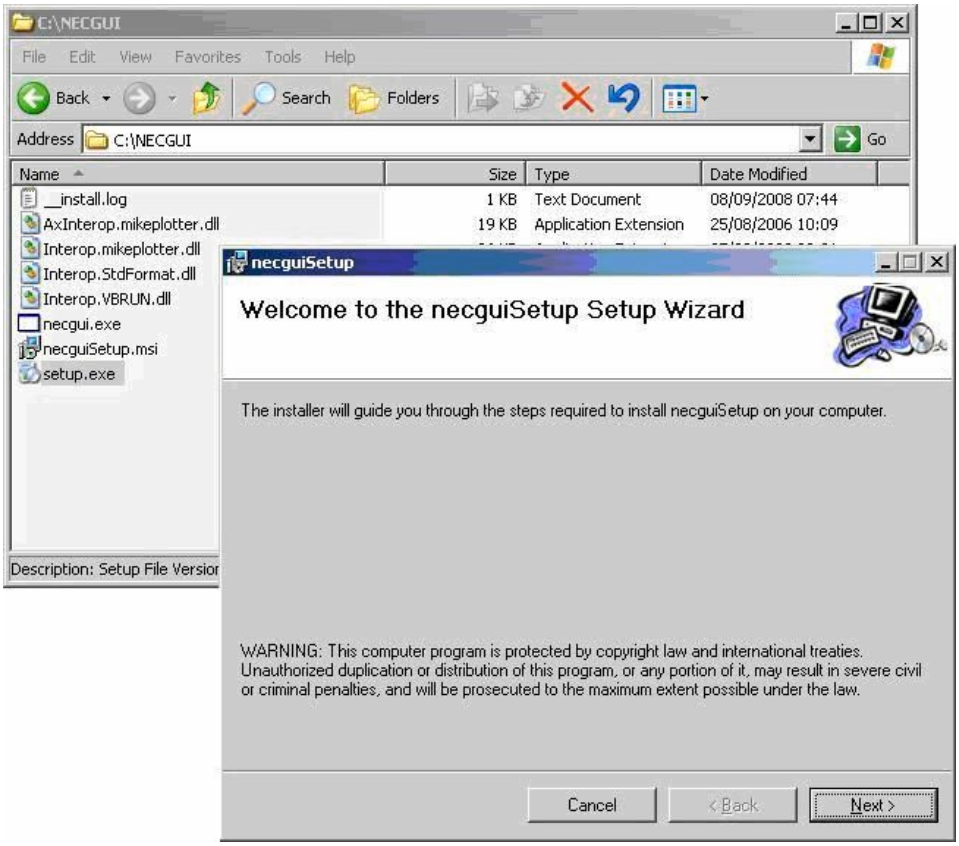


Figure 6-8 Launch the necguiSetup Wizard

Follow the instructions until the installation is complete.

6.3 To use GUI Software

Start the NEC GUI application software by selecting it from the programs list:

Figure 6-9 To Start NEC GUI

After selecting the program you may see a “**Comm error**” dialogue box appear

Figure 6-10 NEC GUI Comm error dialogue box

If this occurs then simply click on “**OK**” as many times as the box appears. You will be able to set the serial port number in the application software.

The application will launch and you should see the main user interface as shown below.

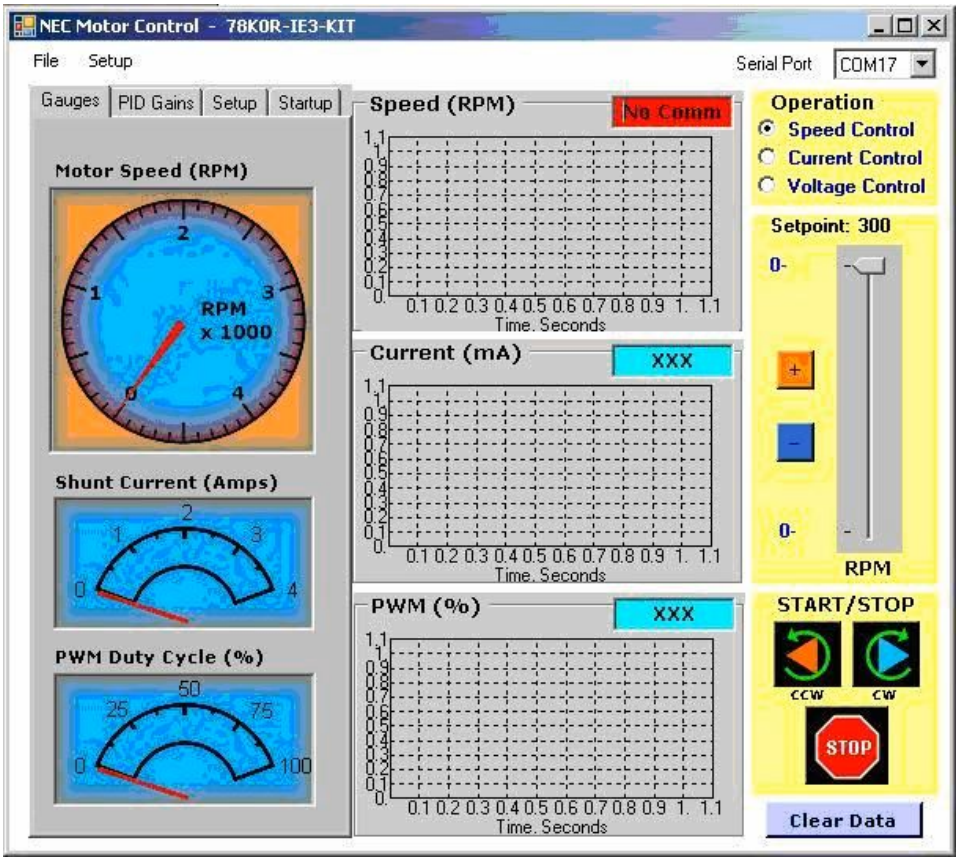


Figure 6-11 NEC GUI Main Display View

6.4 Set the Serial Port Number

The first step should be to set the serial port to the correct port number.

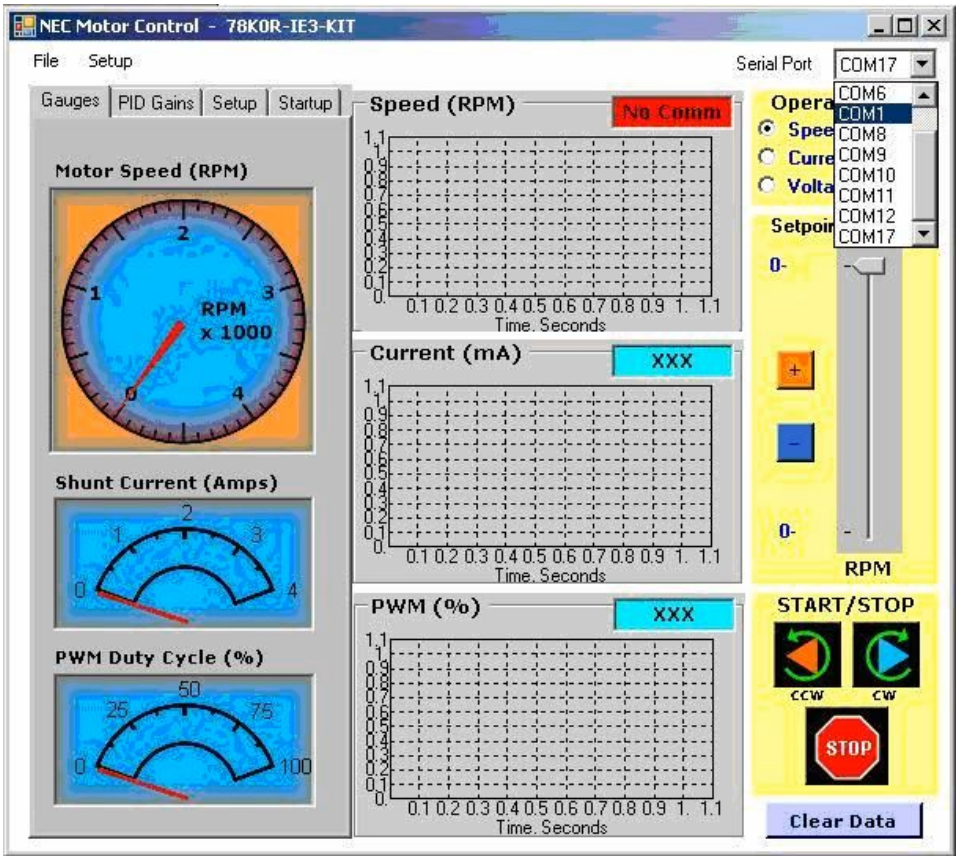


Figure 6-12 Setting the Comm Port Number

The Speed (RPM) text box will display "**No Comm**" when communications is interrupted

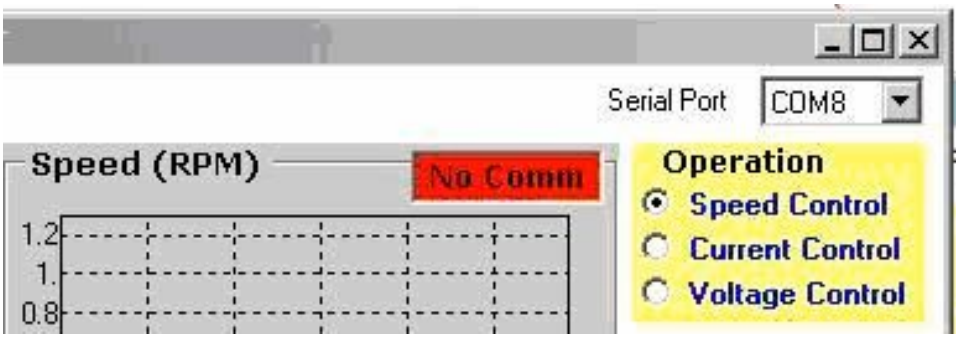
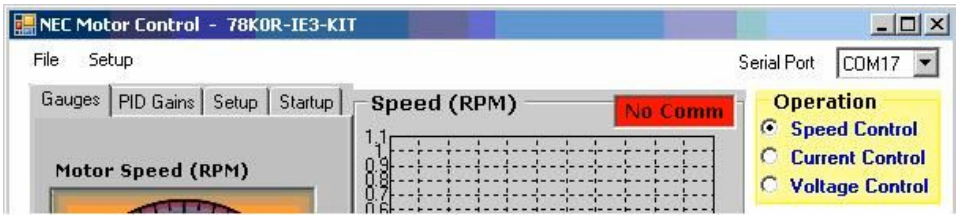


Figure 6-13 No Comm Displayed

Once communications is established then the Speed (RPM) text box will display the speed and the GUI can be used as normal.

6.5 Run the Motor Using Speed Control Mode

To operate the motor in Speed Control Mode, select Speed Control from the Operation menu (see below) and use the controls in the GUI window. The user has the same controls as described for the “Stand Alone” mode (Start / Stop, Clockwise / Anti-Clockwise, Speed increase / decrease)



6.6 Change the PID Settings

It is also possible to change the PID parameters from the GUI interface. (Please note that changes can only be made when the motor is stopped). To change the PID parameters click on the “**PID Gains**” tab. The PID Gains editor will be displayed as shown below. Please use the “**RPM to Current Gains**” as this is for speed control.

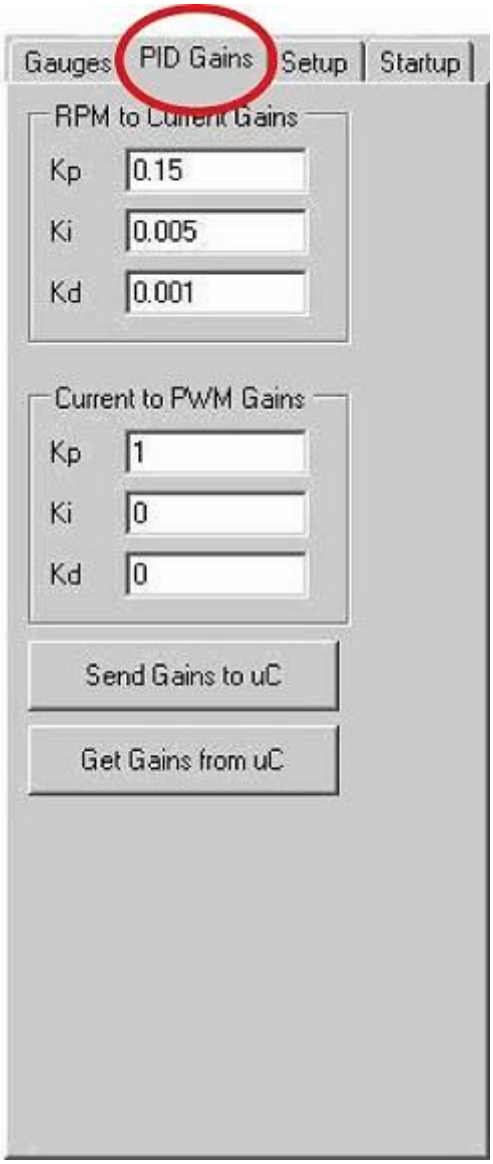


Figure 6-15 GUI PID Gains Settings

To read back the current PID settings from the 78K0R-SPINIT click on the "**Get Gains from uC**" button and the GUI will be updated.

Changes can be made in this view and sent down to the 78K0R-SPINIT. Simply make the appropriate changes and click on the "**Send Gains to uC**".

To make the changes permanent, the user will have to modify the initialised values in the original IAR project files (main_mcio.c) and then rebuild the project. This requires a licensed version of either IAR Embedded Workbench (Full Version) or IAR Embedded Workbench (Kick Start Version)

Find the function calls in the file "**main_mcio.c**" and change the values that are passed to the functions.

Set these parameters to the values shown in the Tuning Window of the GUI:

Motor_SetSpeedKp 0.150
Motor_SetSpeedKi 0.005
Motor_SetSpeedKd 0.001

Please note that only Speed Control Mode is described in this manual. The full version of the NEC GUI manual (**Motor Control Graphical User Interface Users**

Manual) will further discuss all other operational modes and settings. While the other control modes shown in the GUI will operate the motor this operation and subsequent performance cannot be guaranteed.

The term “Motor Tuning” is defined as the adjustment of motor start values, motor stop values, and the PID values in order to improve the motor speed tracking control during normal running.

6.7 Change the Setup Settings

It is also possible to change the Speed Limits, Current Limits, and Current A/D parameters by selecting the following tab as shown below:

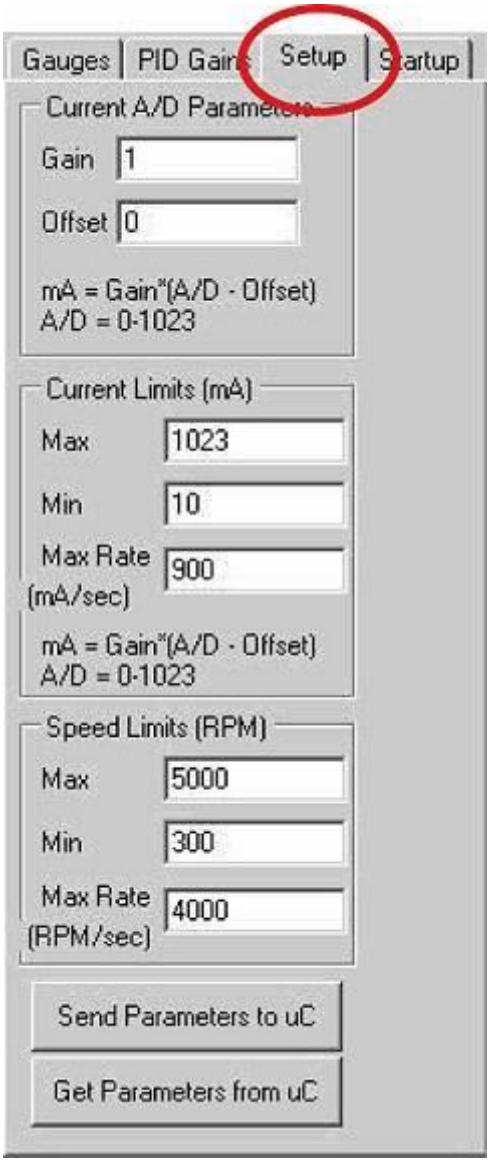


Figure 6-16 GUI Setup Settings

To read back the current Setup settings from the 78K0R-SPINIT click on the “**Get Parameters from uC**” button and the GUI will be updated.

Changes can be made in this view and sent down to the 78K0R-SPINIT. Simply make the appropriate changes and click on the “**Send Parameters to uC**”.

Current A/D Parameters

- Gain - for current shunt value amplification
- Offset - to correct any known constants

Current Limits (mA) – Used for current control mode not covered in this document

Speed Limits (RPM)

- Max – the maximum RPM speed setting for the motor
- Min – the minimum RPM speed setting for the motor
- Max Rate – the acceleration/deceleration rate in RPM/sec

6.8 Change the Startup Settings

It is also possible to change the Open Loop Time, RPM for Open Loop, and starting PWM settings by selecting the following tab as shown below:

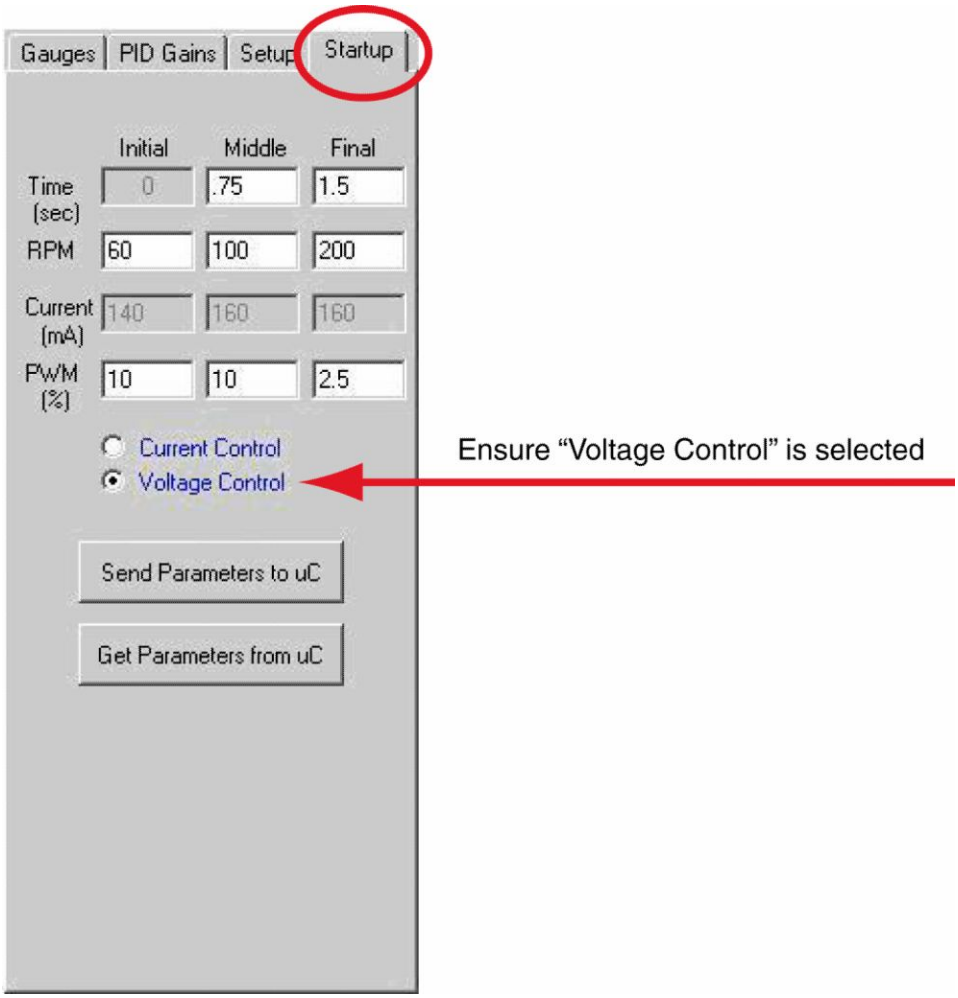


Figure 6-17 GUI Startup Settings

To read back the current Startup settings from the 78K0R-SPINIT click on the “**Get Parameters from uC**” button and the GUI will be updated.

Changes can be made in this view and sent down to the 78K0R-SPINIT. Simply make the appropriate changes and click on the “**Send Parameters to uC**”.

Time (sec) – start in open loop until final time is reached then switch to closed loop control

- Initial – the length of time in seconds to run open loop up to the set RPM and PWM%
- Middle - the length of time in seconds to run open loop up to the set RPM and PWM%
- Final - the length of time in seconds to run open loop up to the set RPM and PWM%

RPM

- The startup rpm speed for each phase initial, middle, and final

Current (mA) – Used for current control mode not covered in this document

PWM%

- The startup max PWM% for each phase initial, middle, and final

Chapter 7 Flash Programming the 78K0R-SPINIT Kit (USB)

If the user wishes to modify the program in the 78K0R-SPINIT then this can be done either with the onboard USB interface or using a separate Flash Programmer. This chapter will describe how to flash the microcontroller using the onboard USB interface.

Download the WriteEZ4 USB Flash Programming Graphical Interface (from the *NEC Electronics Tool download web site*) and install.

7.1 78K0R-SPINIT Switch Settings

To prepare the 78K0R-SPINIT for flash programming follow the steps below:

- Power **OFF** the 78K0R-SPINIT kit
- Set the DIP switch DS1 to the following:
  - 1-8 **ON**
  - 2-7 **OFF**
  - 3-6 **OFF**
  - 4-5 **ON**
- Remove **JP22** (OPEN = USB Flash/Debugging mode)
- Connect the **USB** cable from the PC to the 78K0R-SPINIT kit
- Power **ON** the 78K0R-SPINIT kit

7.2 Establish the Comm Port

The WriteEZ application requires a virtual comm Port so please note the appropriate comm Port number. Use “Device Manager” to view the ports.

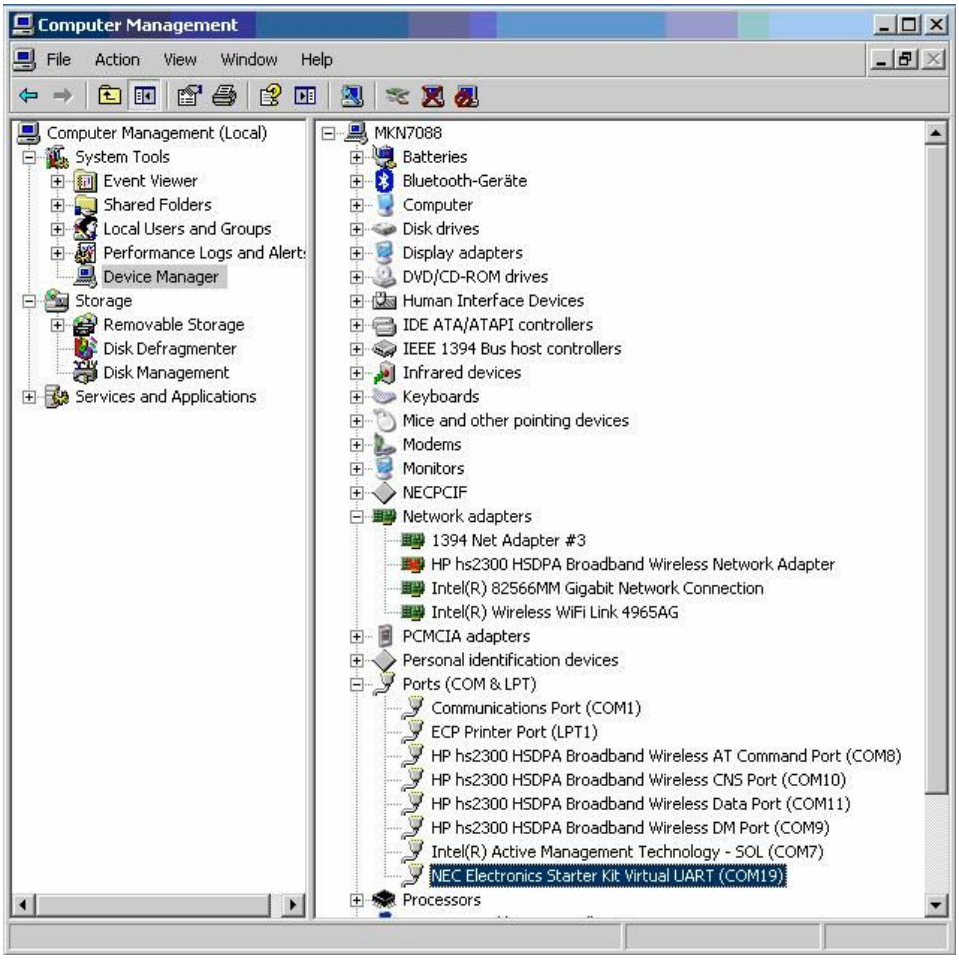


Figure 7-1 Display virtual UART port number in Windows Device Manager screen

7.3 Start the WriteEZ4 Application

Start -> All Programs -> NEC Electronics Tools -> WriteEZ4 -> v1.02 -> WriteEZ4

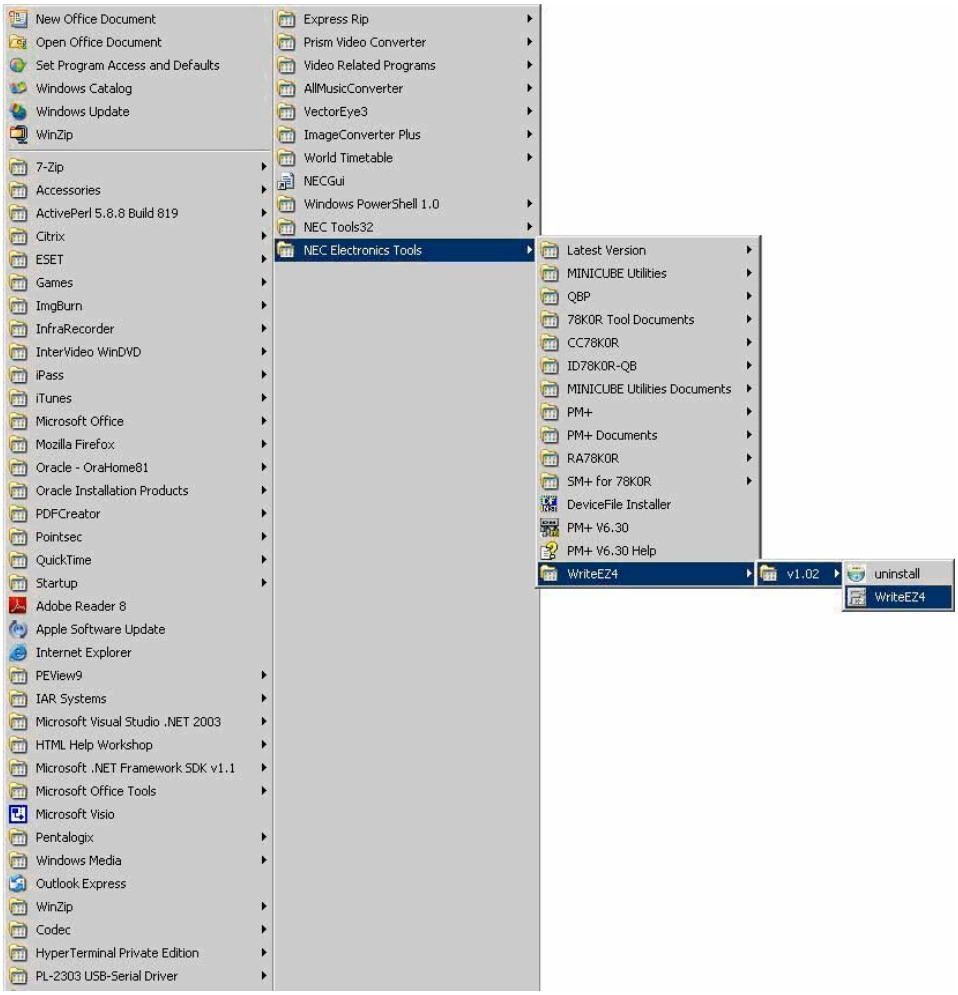


Figure 7-2 Starting WriteEZ4

The WriteEZ4 application will launch.

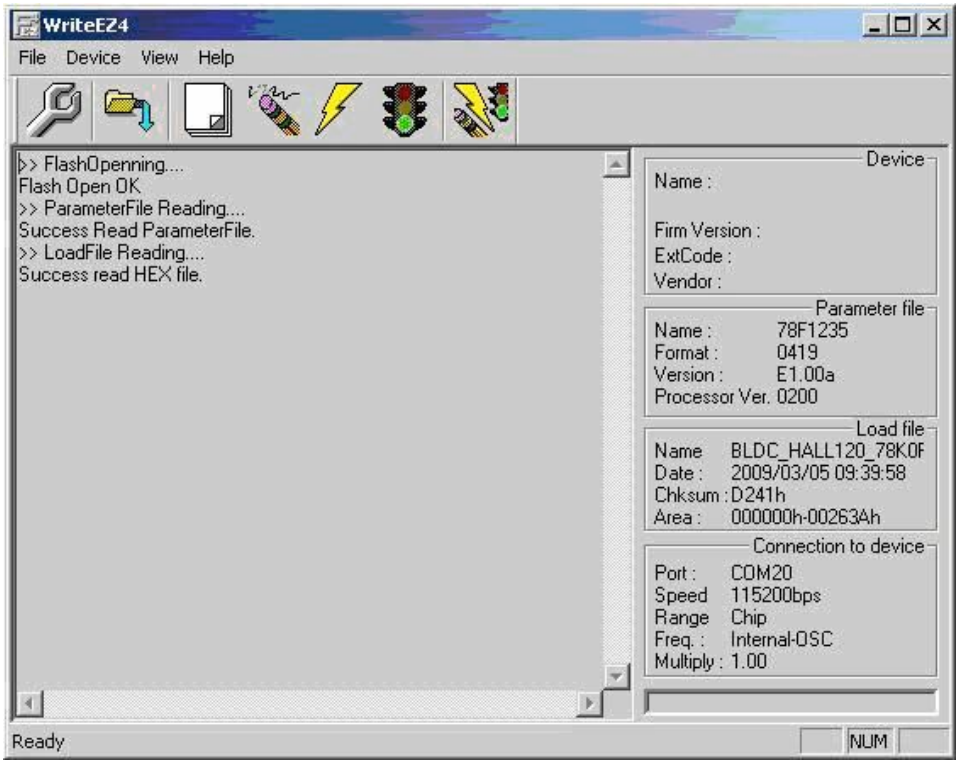


Figure 7-3 WriteEZ4 Screen

7.4 WriteEZ4 Device Setup

From the WriteEZ4 main menu select Device -> Setup … and the Device Setup screen will appear. From the Host Connection box set the Port to the correct number to use the virtual UART port (displayed under device manager … see above).

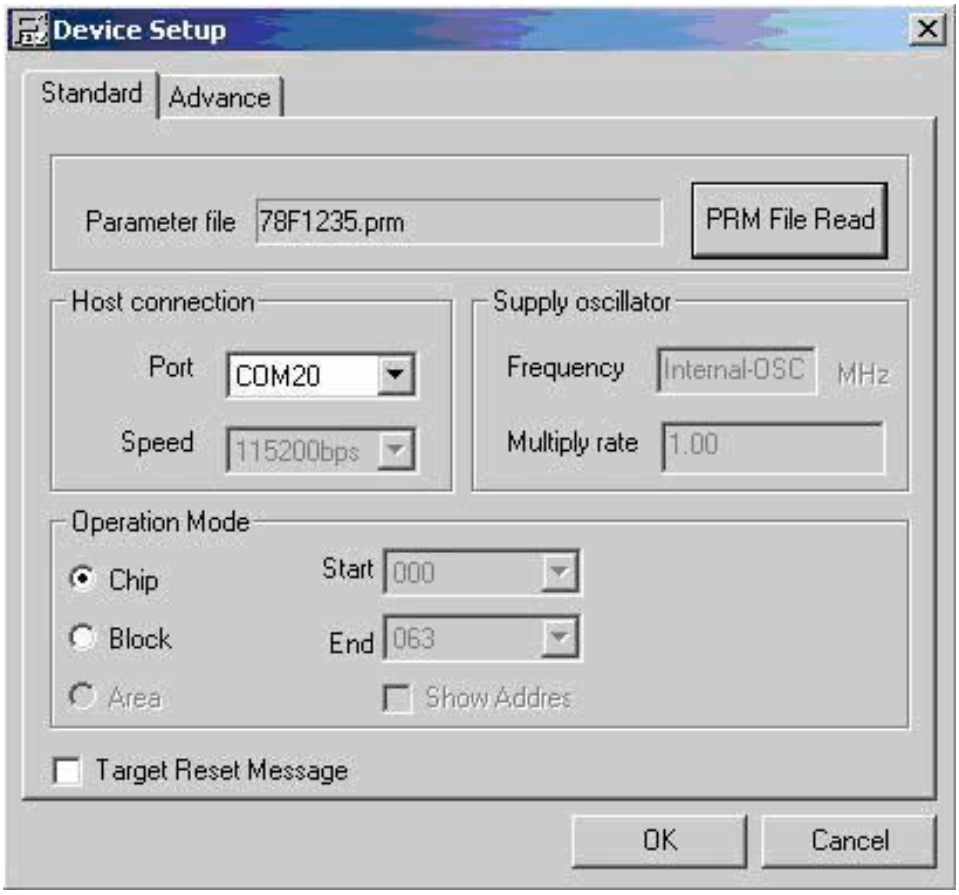


Figure 7-4 WriteEZ4 Device Setup Standard

Next ensure that the PRM file is correctly displayed. In this case it should be 78F1235.prm. If this is not the displayed PRM file then select the “PRM File Read” and select the 78F1235.prm file which is included in the project file.

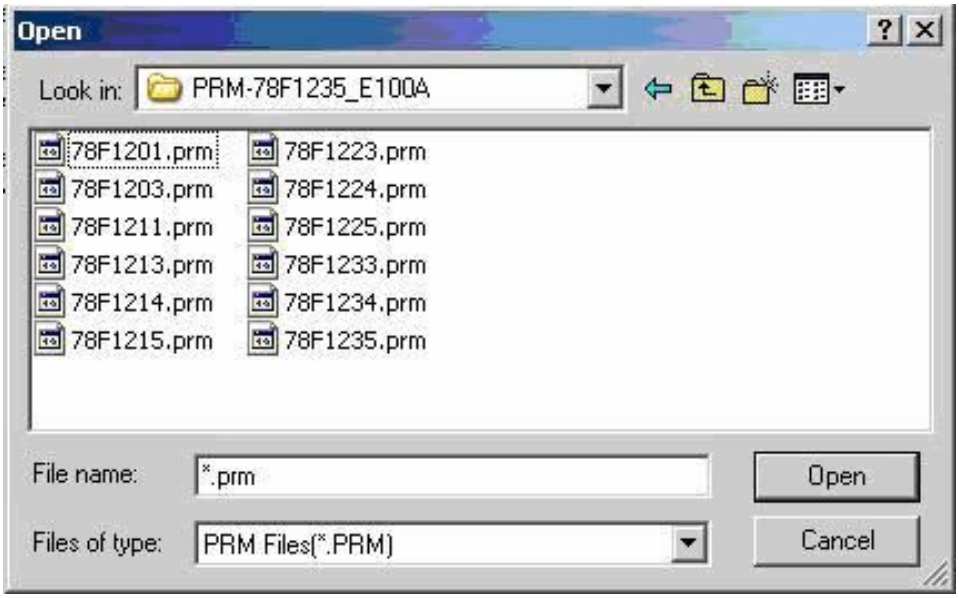


Figure 7-5 WriteEZ4 Select Parameter File

Keep the advance settings as detailed below.

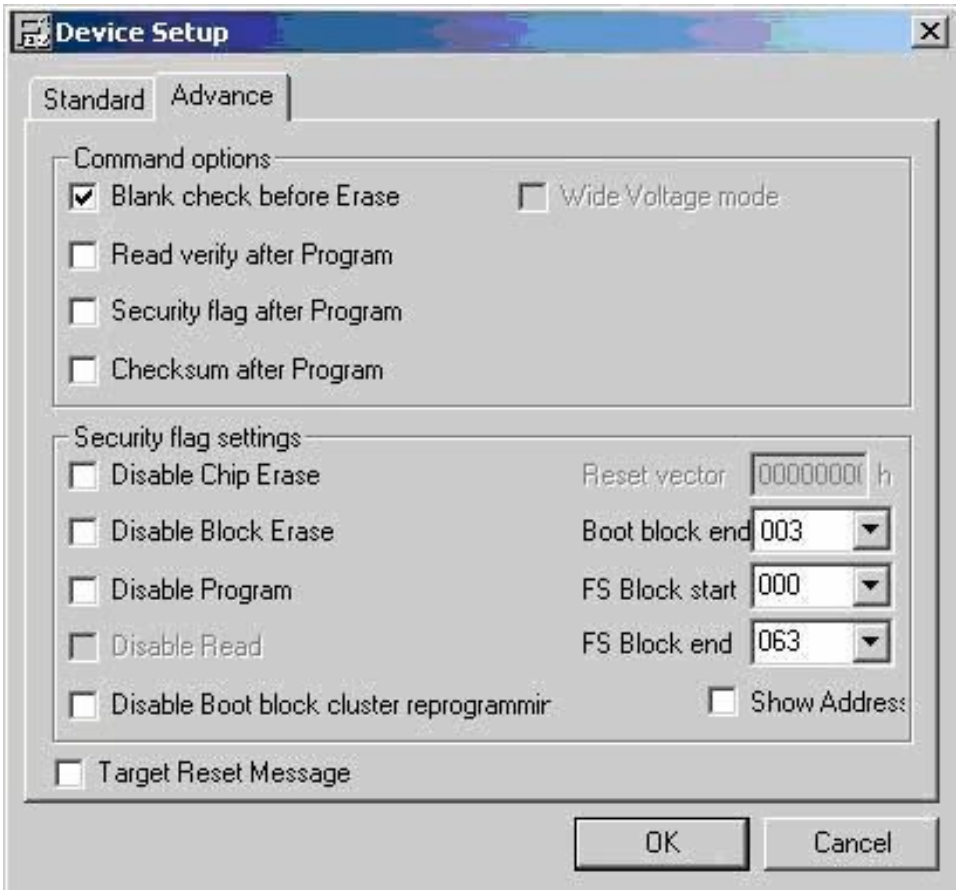


Figure 7-6 WriteEZ4 Device Setup Advance

7.5 WriteEZ4 Hex File Selection

Next press the select the “HEX” file to be programmed from the Menu File -> Load

Or press the “Load File” symbol in the ICON taskbar.

The following window should open:

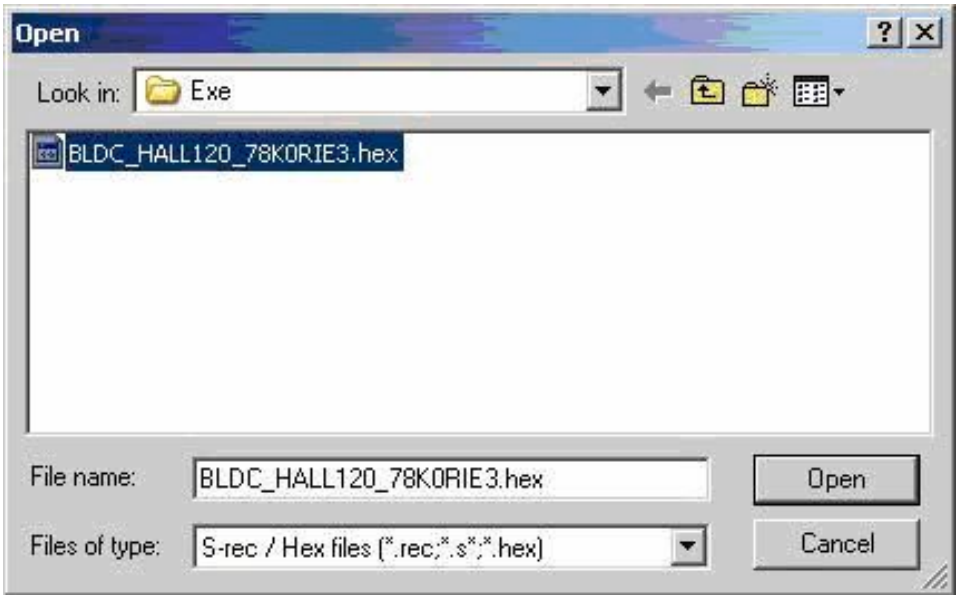


Figure 7-7 WriteEZ4 Hex File Selection

Locate the file as shown in the window from the downloaded IAR project.
The file will be located as follows:

$saved directory$\BLDC_HALL120_78K0RIE3\Debug\Exe\

Select the file (BLDC_HALL120_78K0RIE3.hex) and press the “OPEN” button

This will close the “LOAD” file window. The following should be displayed on the main screen

> Open Load File
Success read Load file.

The Flash programming setup is now complete

Now press the “AUTOPROCEDURE” button to start the programming sequence.
The following sequence should be seen:

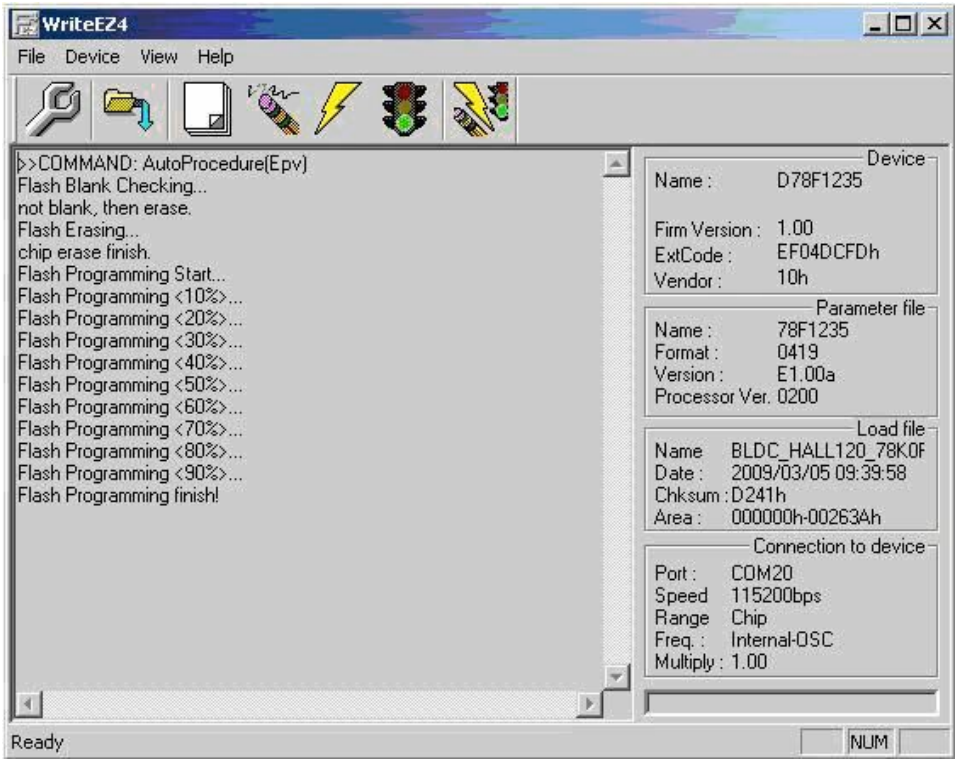


Figure 7-8 WriteEZ4 Autoprocedure

Note The “Verify Chip” operation is enabled by setting the “Read Verify after Program” option in the “Advanced” Tab of the “Device Setup” Window.

The 78K0RIE3 device has now been reprogrammed with the example program which is suitable for both standalone operation, and remote operation using the GUI.
Please make a backup copy of the original hex file before programming or running the compiler.

Chapter 8 Flash Programming with a Flash Programmer

This section describes the steps necessary to modify the program in the 78K0R-SPINIT microcontroller using a Flash Programmer (not included in the Starter Kit).

Two programmers are available:

- PG-FP5 Full Programmer
- MINICUBE2 On-Chip debugger/programmer

Figure 8-1 PG-FP5 Programmer

Figure 8-2 MINICUBE2 On-Chip debugger/programmer

The Graphical Interface for either of these programmers can be downloaded from the *NEC Electronics Development tools web site*.

In this guide we have shown only the MINICUBE2. The interface for the microcontroller board is the same for both programmers.

8.1 Download the Following Files

Download the appropriate *IAR project folder* which contains all the required source code for the application.

Download the *MINICUBE2 (QB programmer) Flash Programming Graphical Interface*.

Download the Appropriate IAR Work bench from the *IAR web site* or use the KickStart CD supplied with the MINICUBE2. The full IAR development tool can be purchased from NEC Electronics or through an NEC Electronics franchised distributor.

Uncompress and install the QB programmer GUI software (run the “SETUP” application).

8.2 Save and Uncompress the IAR Workbench Project

Uncompress the folder containing the 78K0R-SPINIT project to a local folder. This folder contains all the source code and IAR environment information required to build and compile both the debug files and the hex flash files.

8.3 Switch Settings and connecting the MINICUBE2

To prepare the 78K0R-SPINIT for flash programming follow the steps below:

- Power **OFF** the 78K0R-SPINIT kit
- Set the DIP switch **DS1** to the following:
  - 1-8 **ON**
  - 2-7 **OFF**
  - 3-6 **ON**
  - 4-5 **OFF**
- Install **JP22** (ON = MINICUBE2 flash programming mode)
- Check that the switches on the MINICUBE2 are set as shown below
  - Switch M1 / M2 is set to “M1”
  - Switch 3 - T - 5 is set to “T”
- Locate the MINICUBE2 16-pin connector (see Figure 2) and attach the MINICUBE2 programmer using the 16-pin cable
- Power **ON** the 78K0R-SPINIT kit

See the MINICUBE2 connected to the 78K0R-SPINIT kit as shown below:

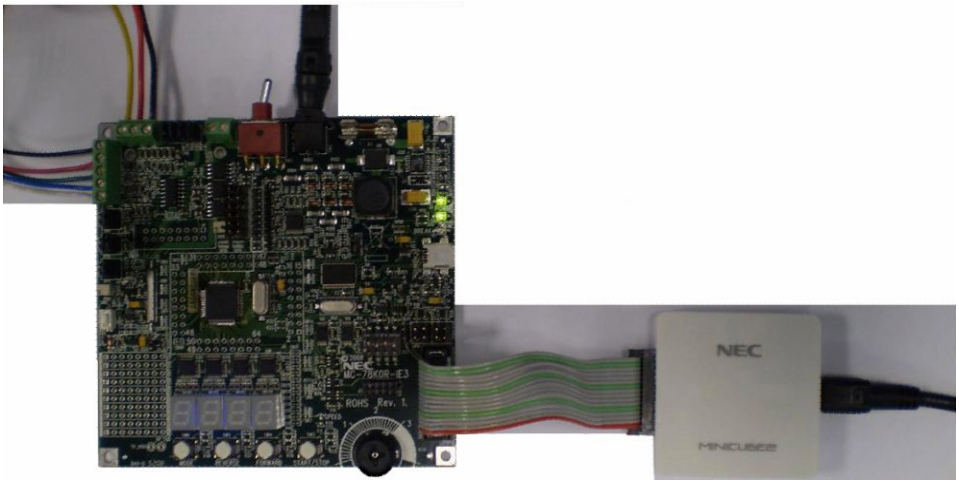


Figure 8-3 Connecting the MINICUBE2 to the 78K0R-SPINIT Kit

Copy the uPD78F1235 Flash programming parameter file (78F1235.prm) into the Installation directory for the QB programmer program or into a specific area which can be reached by the browse facility:

$installation path$\....\QBP\PRM
(This file is included with the IAR project download)

Once the Microcontroller board is configured and the programmer connected to the PC, open the Flash programming Graphical interface “QBP v2.22”.

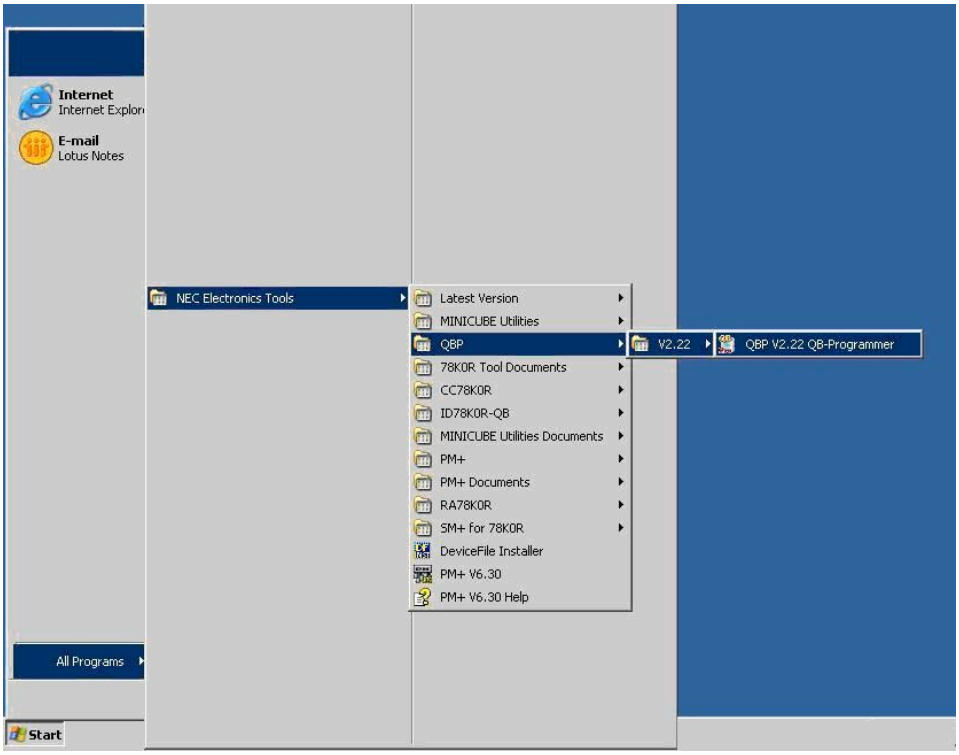


Figure 8-4 Starting the QBP V2.22 QB Programmer Graphical Interface

The following Screen should appear. (Note the text may differ after the 1st two lines.)

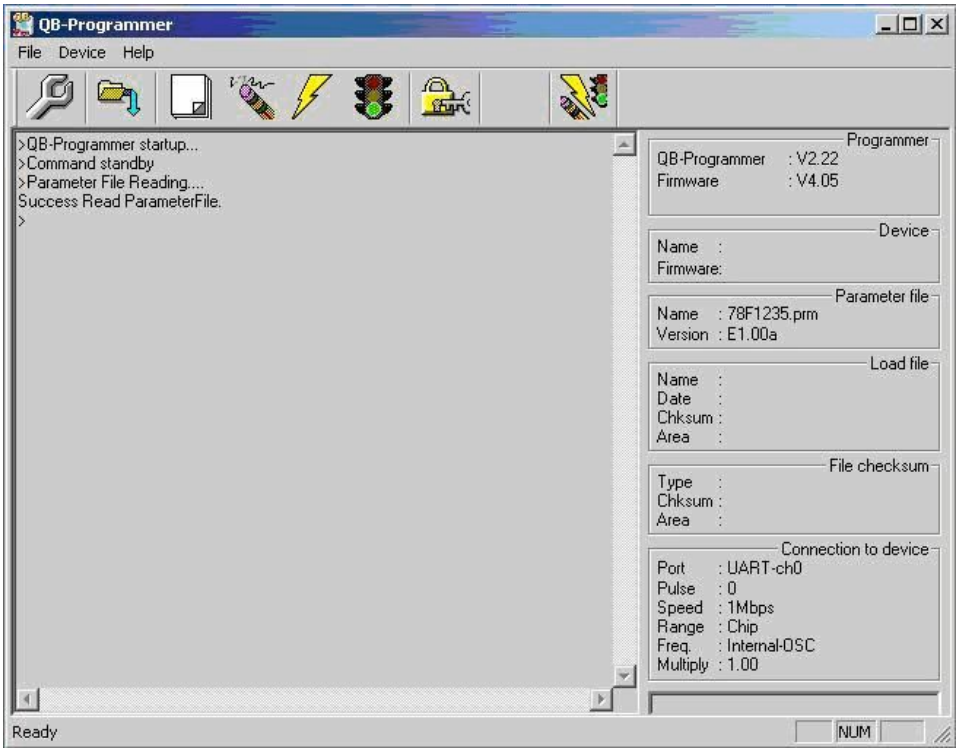


Figure 8-5 MINICUBE2 Programmer GUI (QB Programmer)

Next the device needs to be set up from the menu follow the following sequence:

Device -> Setup…

Or press the “Spanner” symbol in the ICON taskbar

The following screen should appear:

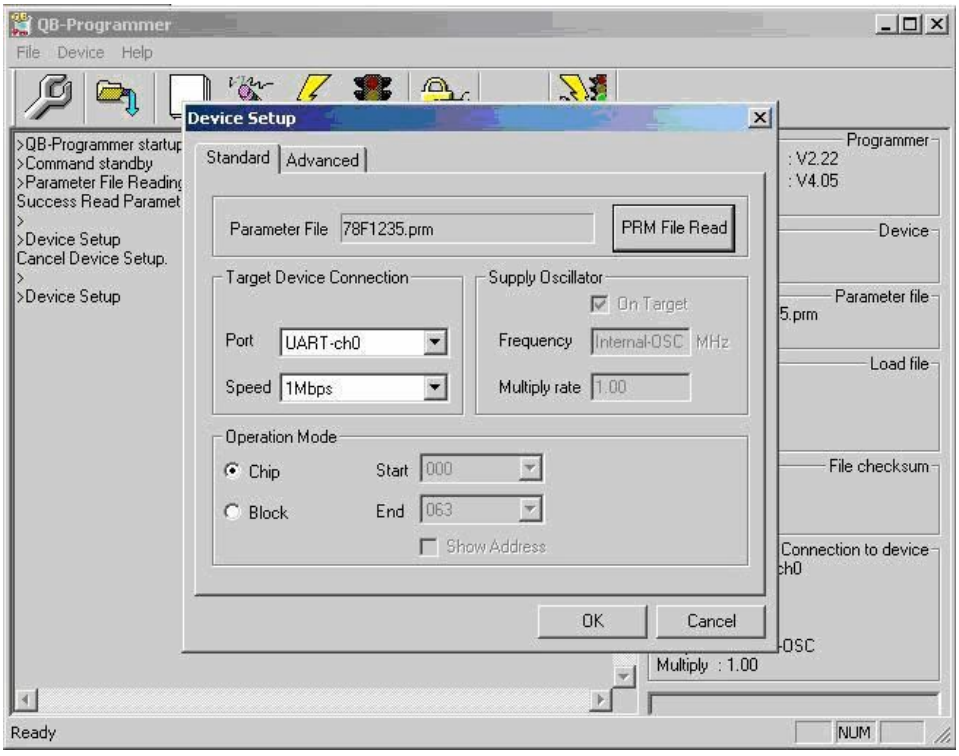


Figure 8-6 QB Programmer Device Setup

Set the details for the COM port, Speed etc as shown above.

Note Enter your COM port number as this will vary.

Next press the “PRM File Read” button and the following screen should appear. Select the 78F1235.prm file and press the “Open” button.

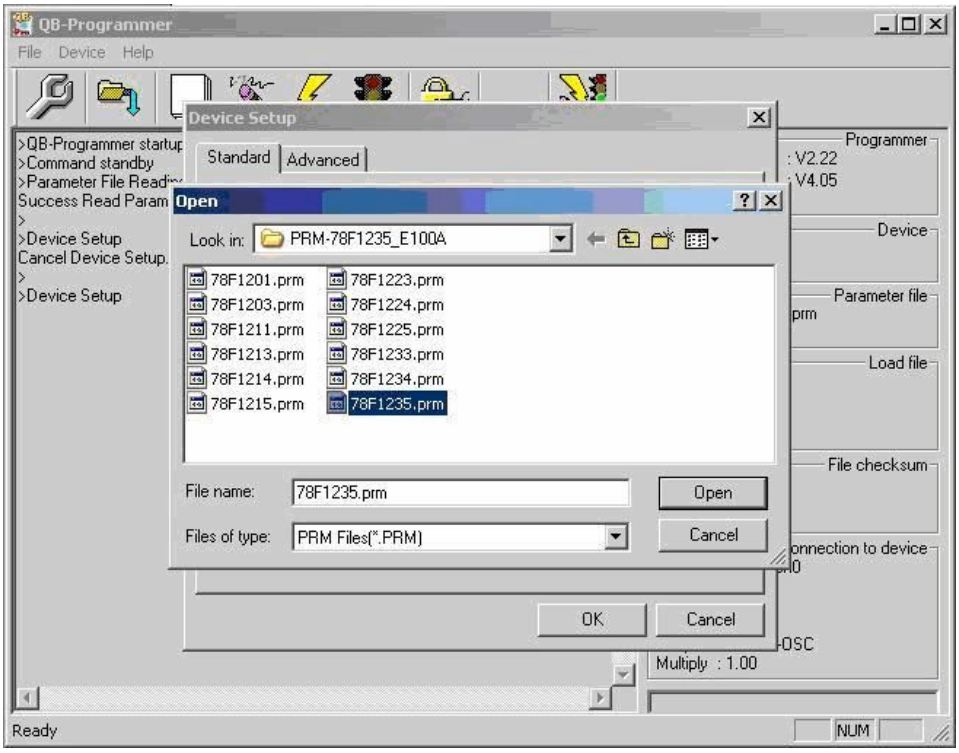


Figure 8-7 Parameter File Read

Then press the “OK” button to return to the main menu system.

The text in the main screen should read

> Device Setup
Parameter File Read Pass
>

Next press the select the “HEX” file to be programmed from the Menu.

File -> Load

Or press the “Load File” symbol in the ICON taskbar.

The following screen should open:

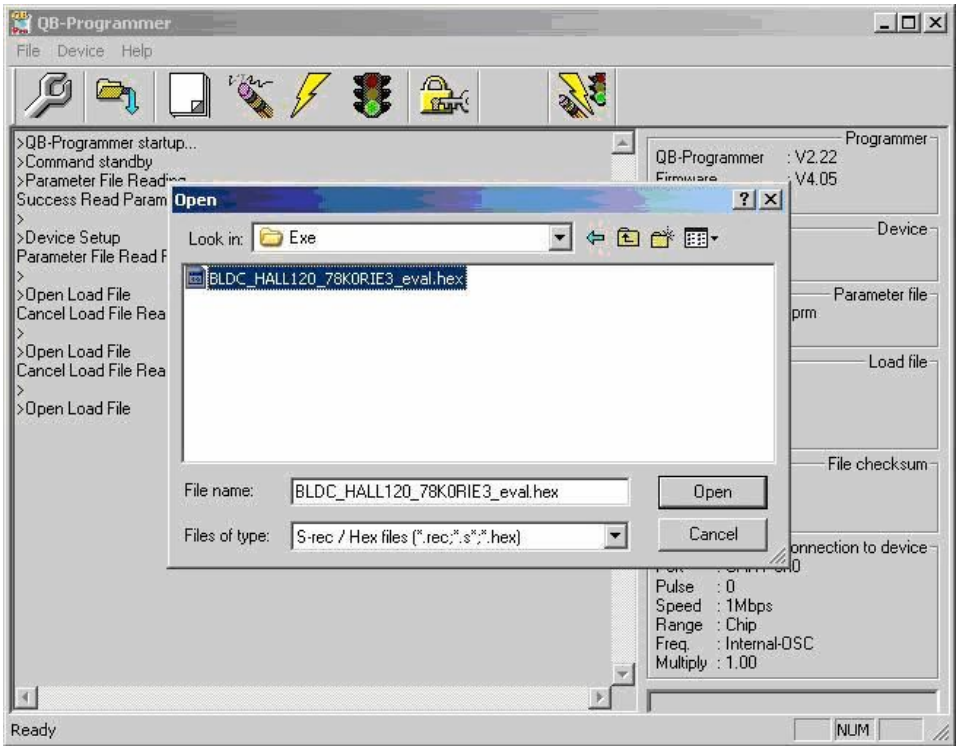


Figure 8-8 Hex File Selection

Locate the file as shown in the window from the downloaded IAR project. The file will be located as follows:

$saved directory$\BLDC_HALL120_78K0RIE3\Debug\Exe\

Select the file (BLDC_HALL120_78K0RIE3.hex) and press the “OPEN” button.

This will close the “LOAD” file window. The following should be displayed on the main screen:

> Open Load File
Success read Load file.

The Flash programming setup is now complete.

Now press the “AUTOPROCEDURE” button to start the programming sequence. The following sequence should be seen:

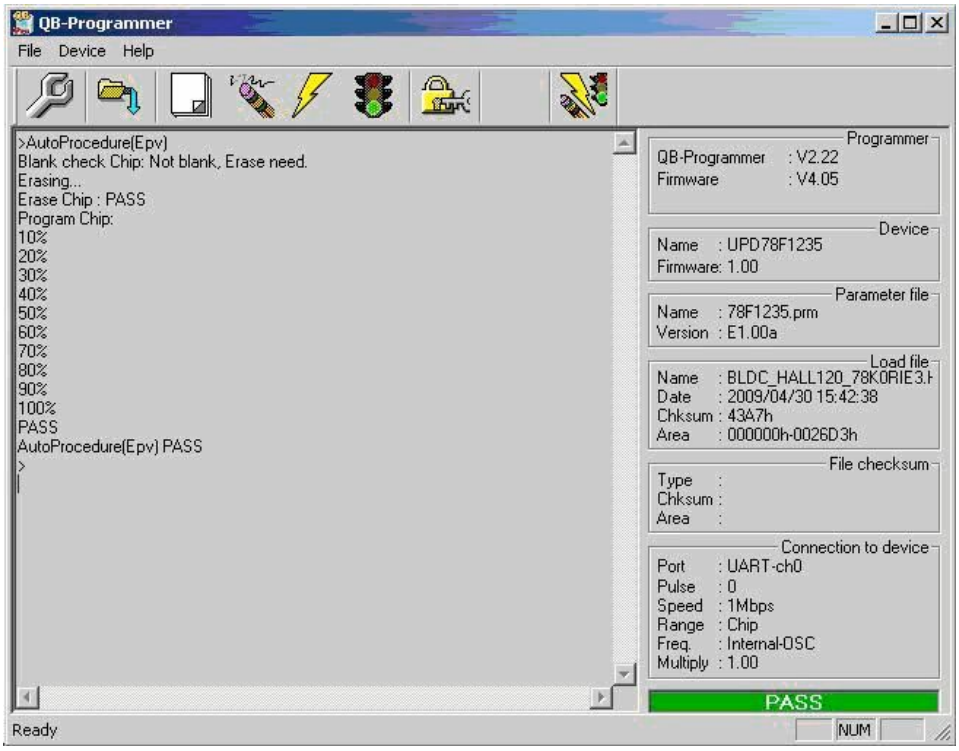


Figure 8-9 QB Programmer AutoProcedure

Note The “Verify Chip” operation is enabled by setting the “Read Verify after Program” option in the “Advanced” Tab of the “Device Setup” Window.

The 78K0RIE3 device has now been reprogrammed with the example program which is suitable for both standalone operation, and remote operation using the GUI.

Please make a backup copy of the original hex file before programming or running the compiler.

Chapter 9 Using the IAR Embedded Workbench

The example software for use with the 78K0R-SPINIT kit is for a HALL Sensored BLDC with 120 degree trapezoidal control for standalone/GUI operation. The kit is supplied with the 78K0R-SPINIT pre-programmed.

The complete example project program for the IAR 78K Embedded Workbench development tool environment can be downloaded from the *motor control web site* as detailed in starter kit package (i.e. where this manual was downloaded).

The software is supplied in source format and can be modified as required.

The following sections describe IAR 78K embedded Workbench development tool environment, how to install it on your computer, and how to rebuild and download executable code to the microcontroller's flash memory.

Before proceeding with the tools installation, however, refer to all of the documentation for the starter kit, On Chip Debugger tool and the IAR Embedded Workbench.

(Please note that a 16 Kbyte code limited version is included with the MINICUBE2 On-Chip Debugger/Programmer unit and can be used to run the example software.)

Please note that a Flash Programmer, On-Chip debugging/programming tool or IAR Embedded workbench are not included in this package. These items are available from your local NEC Electronics Distributor or contact your local NEC Electronics sales office.

9.1 Software Installation

1. If a version of the IAR tool is not already installed, then install the IAR embedded Workbench tool as per the instructions provided by IAR.
2. Ensure that if not already that the example software has been downloaded from the NEC starter kit web site and "unzipped" into an suitable location.

The example software can operate on any revision of either the IAR Kick Start or IAR Full versions. However it may be necessary to define your own project and workspace. This is described later in this chapter.

9.2 78K0R-SPINIT Setup for On-chip Debugging Using USB

To prepare the 78K0R-SPINIT kit for debugging using only the onboard USB interface, follow the steps below.

- Power **OFF** the 78K0R-SPINIT kit
- Set the DIP switch **DS1** to the following:
  - 1-8 **ON**
  - 2-7 **OFF**
  - 3-6 **OFF**
  - 4-5 **ON**
- Remove **JP22** (OPEN = USB Flash/Debugging mode)
- Connect the **USB** cable from the PC to the 78K0R-SPINIT kit
- Power **ON** the 78K0R-SPINIT kit

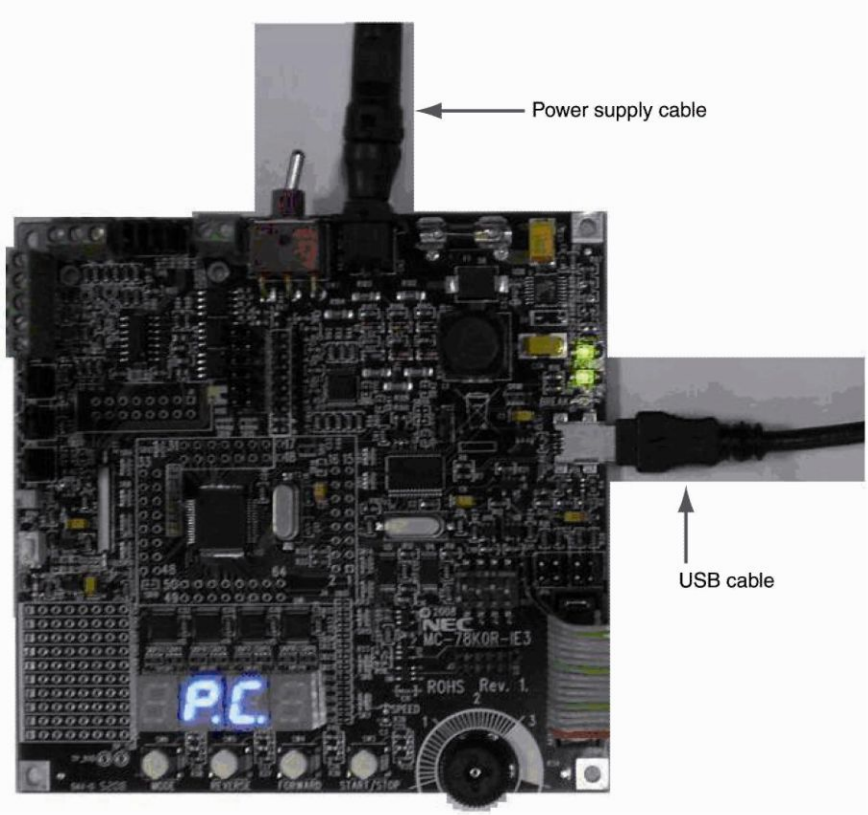


Figure 9-1 78K0R-SPINIT ready for USB debugging

9.3 78K0R-SPINIT Setup for On-chip Debugging Using MINICUBE2

To prepare the 78K0R-SPINIT kit for debugging using the MINICUBE2, follow the steps below.

- Power **OFF** the 78K0R-SPINIT kit
- Set the DIP switch **DS1** to the following:
  - 1-8 **ON**
  - 2-7 **OFF**
  - 3-6 **ON**
  - 4-5 **OFF**
- Install **JP22** (ON = MINICUBE2 flash programming mode)
- Check that the switches on the MINICUBE2 are set as shown below
  - Switch M1 / M2 is set to “M1”
  - Switch 3 - T - 5 is set to “T”
- Locate the MINICUBE2 16-pin connector (see *Figure 3-1*) and attach the MINICUBE2 programmer using the 16-pin cable
- Power **ON** the 78K0R-SPINIT kit

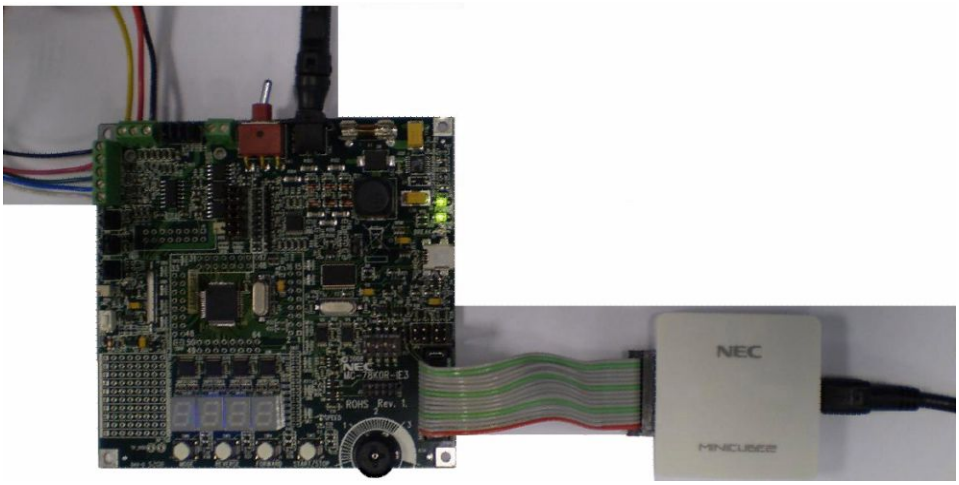


Figure 9-2 78K0R-SPINIT Kit ready for debug with MINICUBE2

9.4 IAR Embedded Workbench Start Up

Open the IAR workbench. The following Screen should be opened.

Note The exact display may vary depending on if this is a new installation.

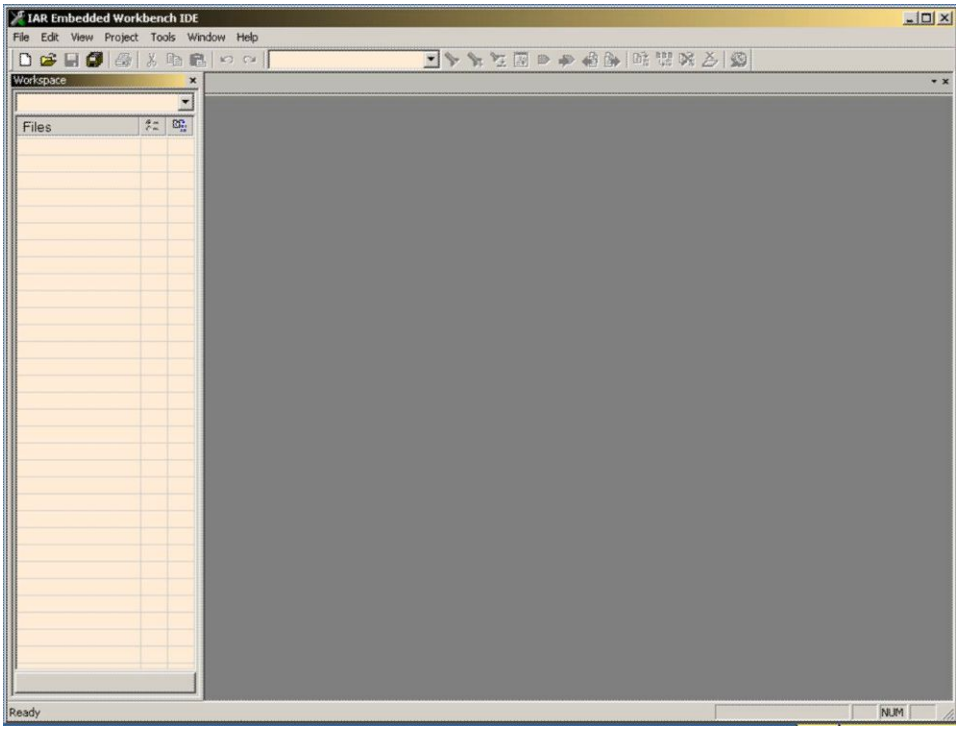


Figure 9-3 IAR Workbench Opening Screen

Next open the IAR Workspace by following the sequence and locating and then selecting the appropriate workspace file as shown below.

File -> Open -> Workspace -> BLDC_HALL120_78K0RIE3

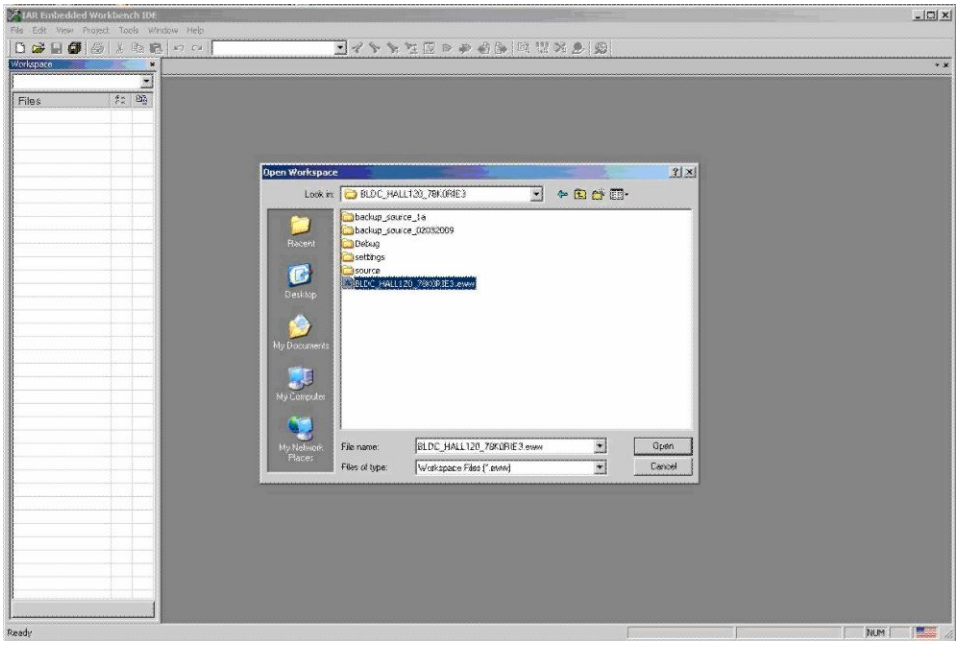


Figure 9-4 IAR Workbench Project Selection

Once the Workspace open the display should look something close to that as shown in the figure below.

This shows the workspace where the project is located and has opened the BLDC project. The display shows the following project files:

- Left Hand side window – Project File (Source. Header, Map etc)

- Bottom Build Debug messages when the project is re built or the debugger is active.
- The main centre display shows any open files in a tabbed form. The file can be viewed by selecting the relevant Tab in the wind.

Any of the files shown can be opened by double clicking on the file in the “Project” (left hand side) window. Debugging windows are described later.

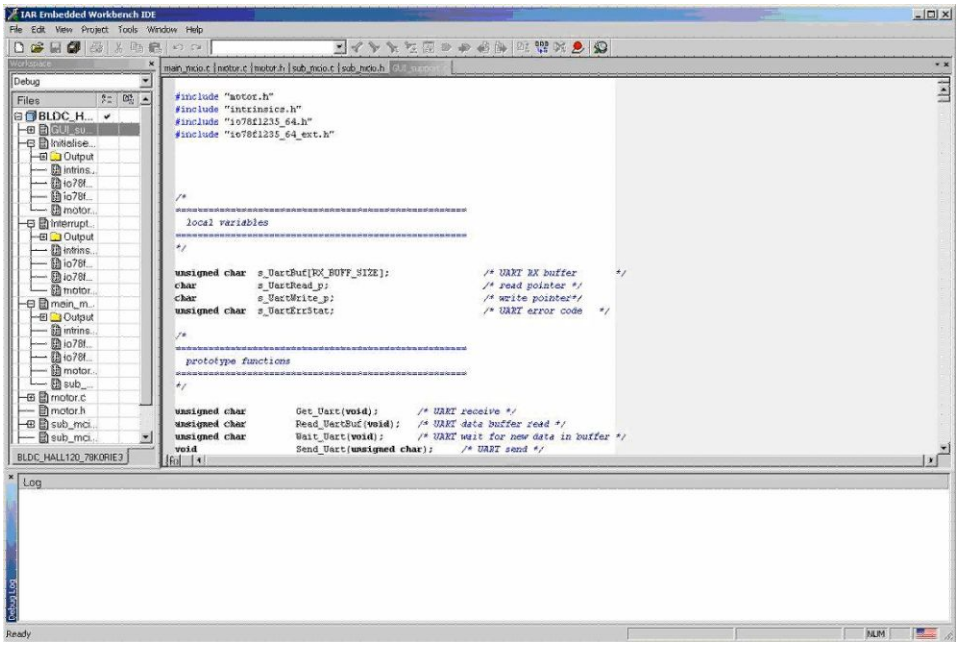


Figure 9-5 Workspace & Project open screen

The build options for the project can then be set or changed using the following menus. The build options are entered as shown in *Figure 9-6* below, and then ensure all the options are set according to the remaining figures below.

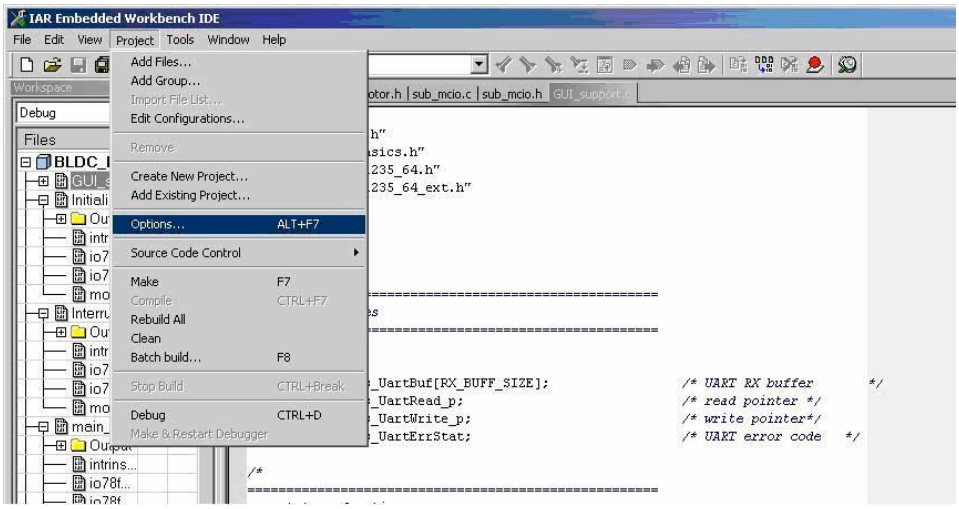


Figure 9-6 Project Build Options

9.5 General Options

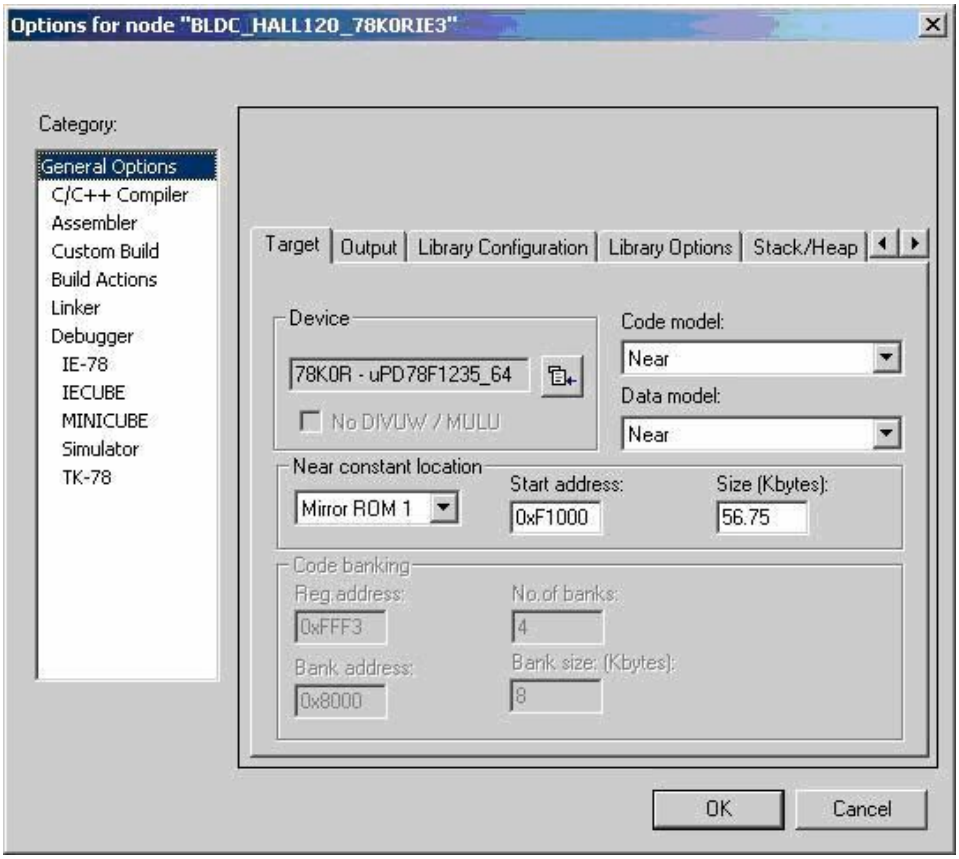


Figure 9-7 General Options – Setting the Target Device

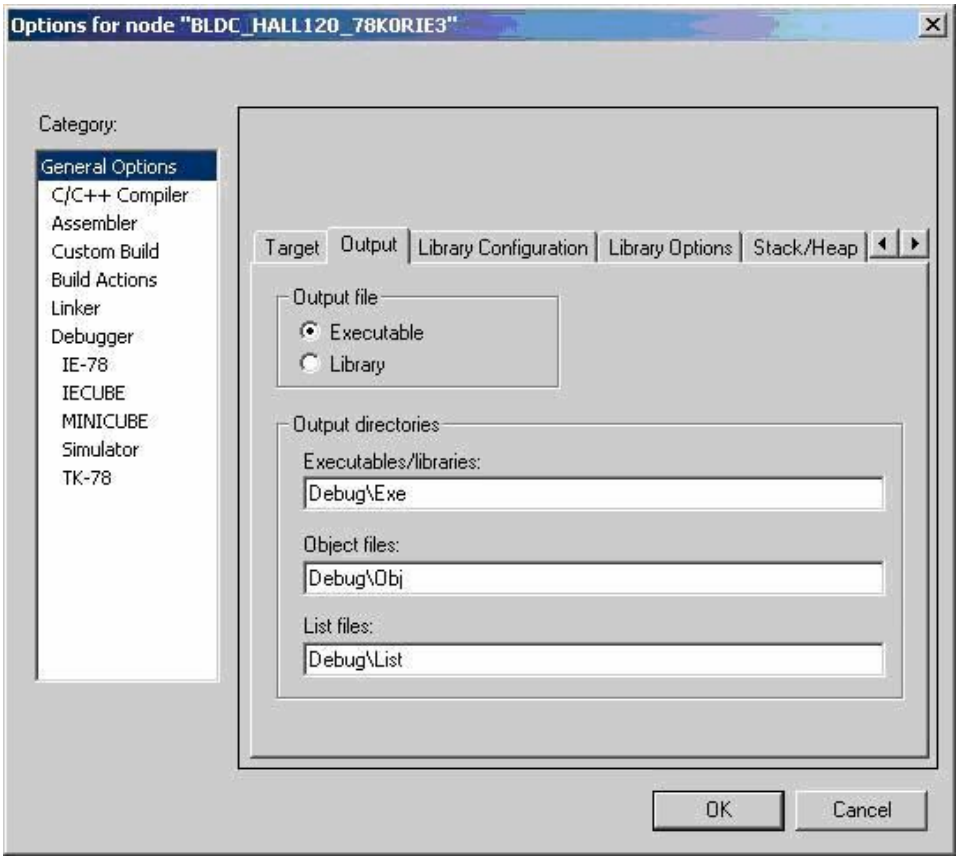


Figure 9-8 General Options – Setting the Output Locations

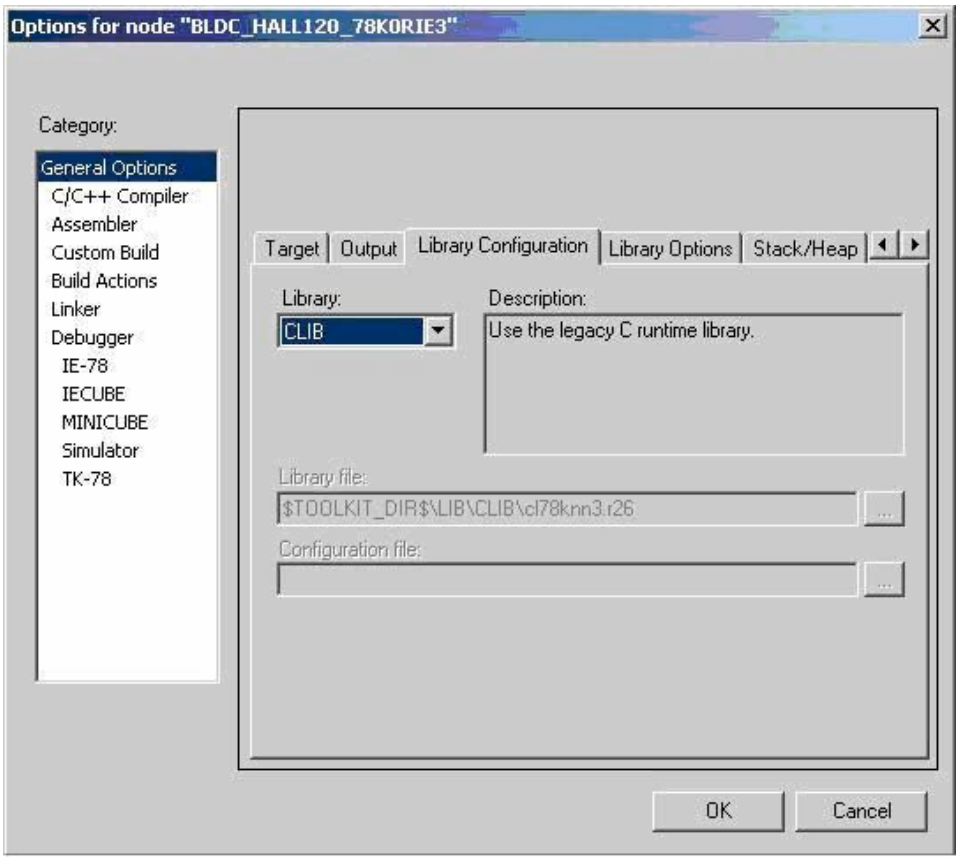


Figure 9-9 General Options – Selecting the C-Library

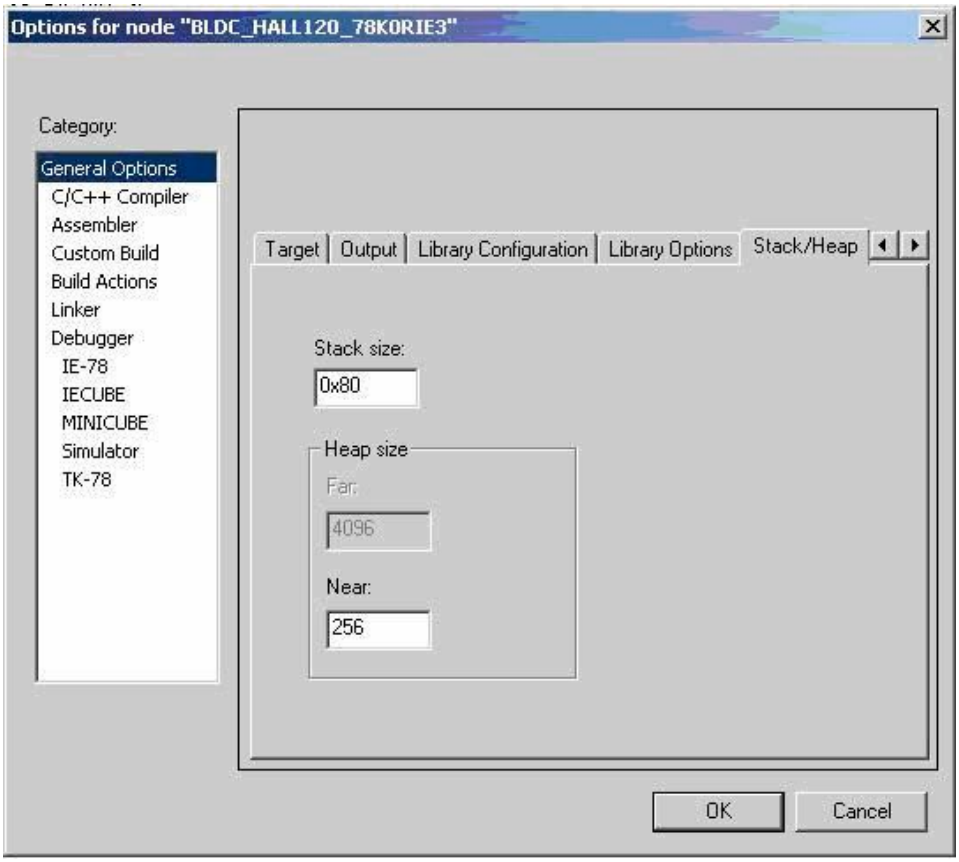


Figure 9-10 General Options – Setting the Stack and Heap

9.6 Compiler Options

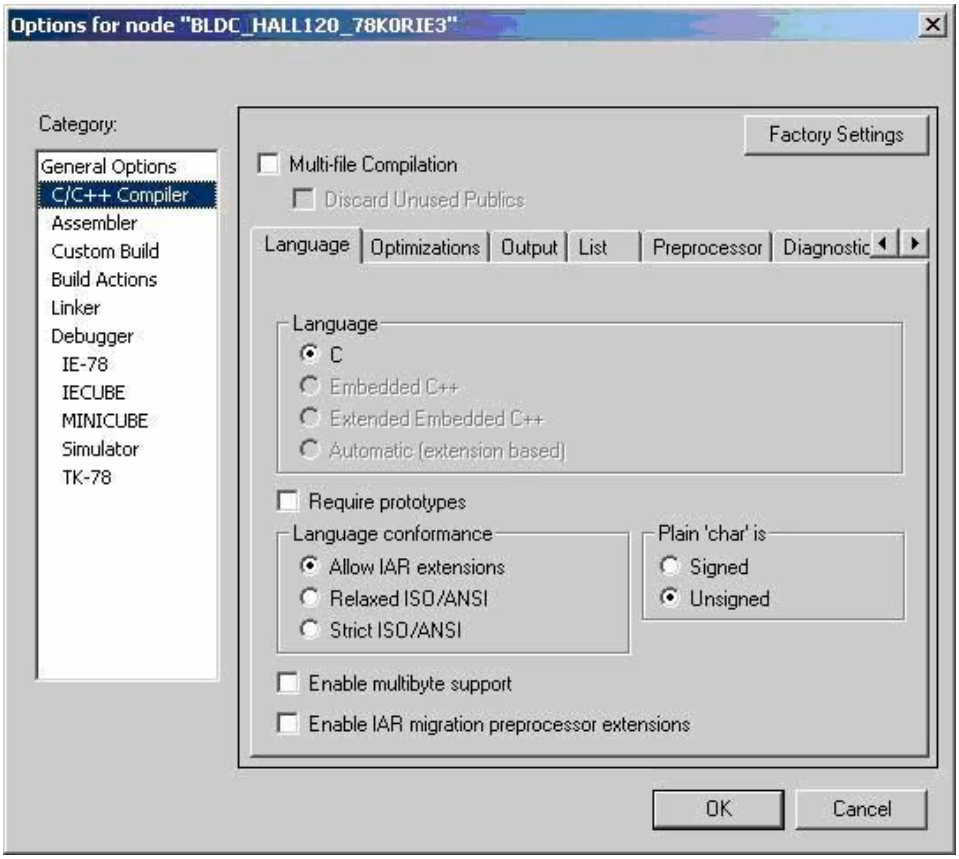


Figure 9-11 Compiler Options – Language Settings

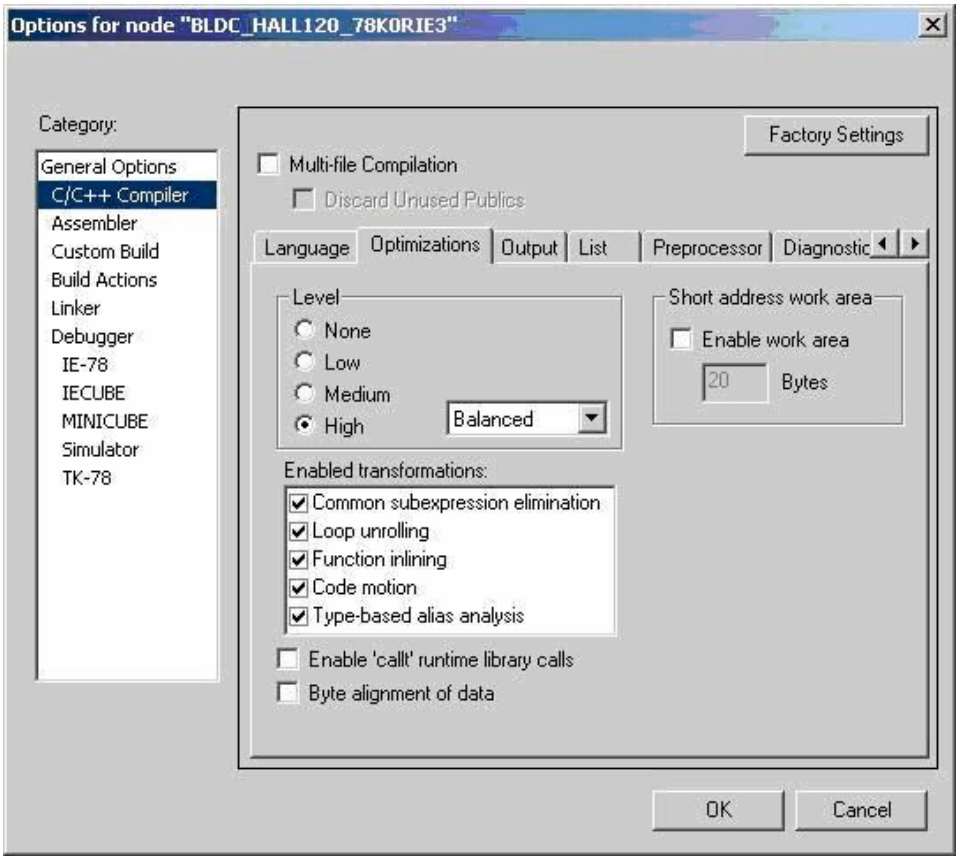


Figure 9-12 Compiler Options – Optimisation

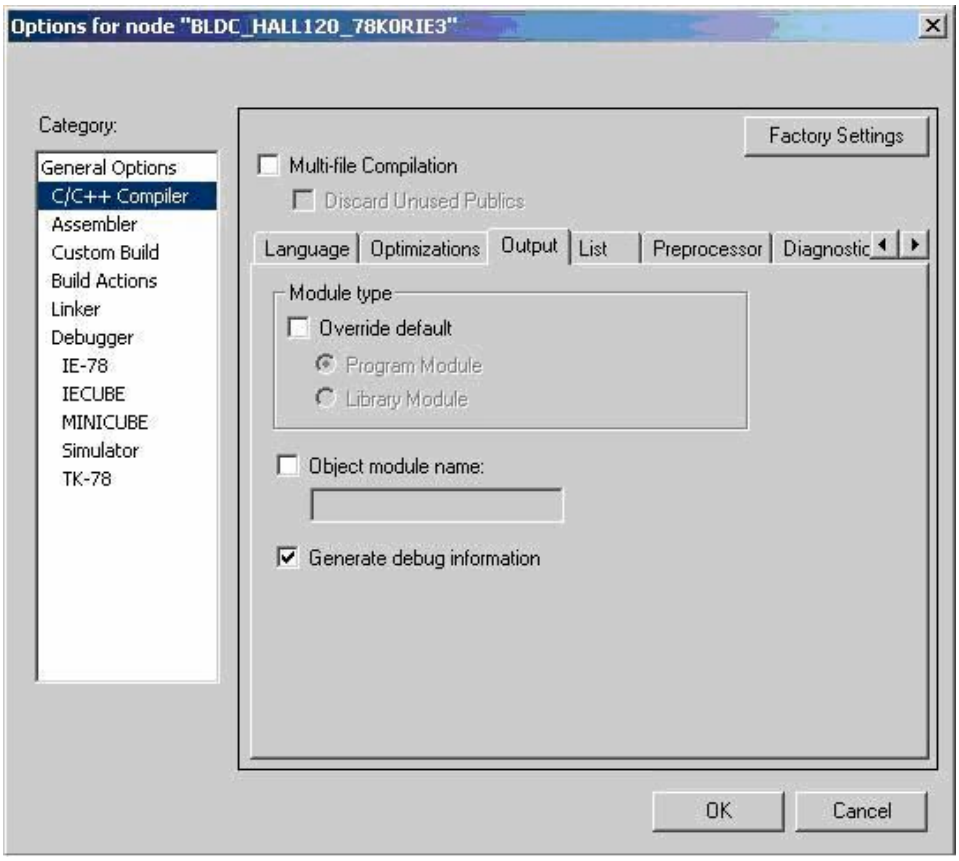


Figure 9-13 Compiler Options – Output Set for Debug

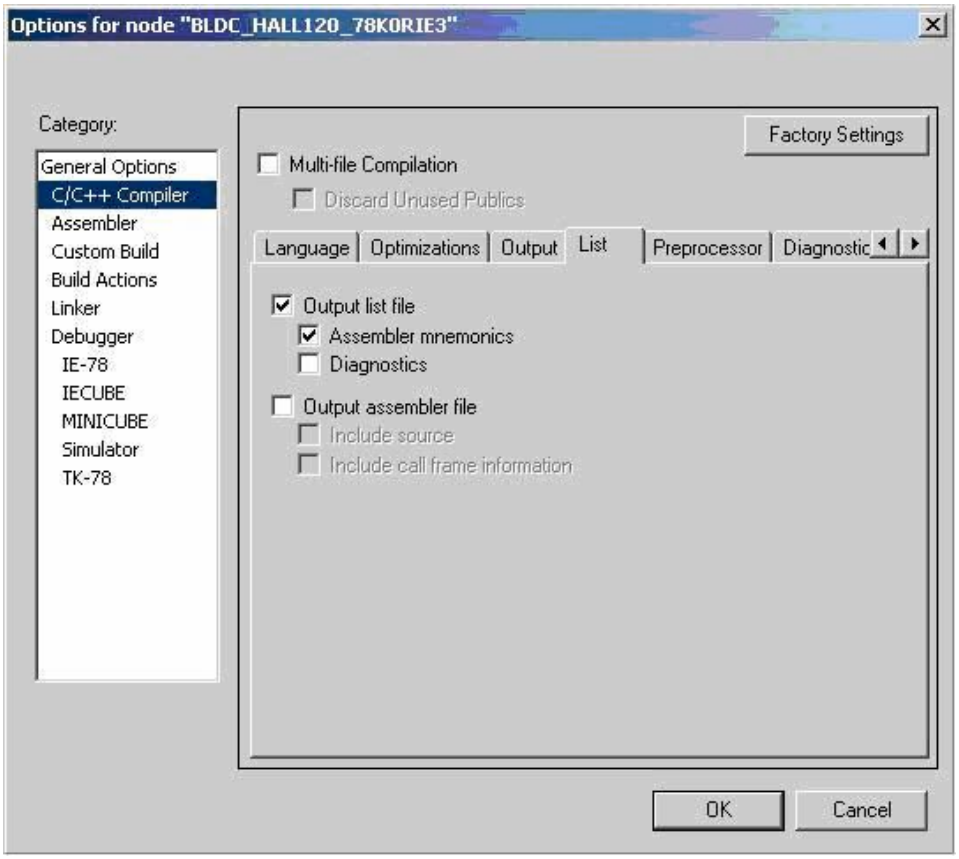


Figure 9-14 Compiler Options – Compiler Listings

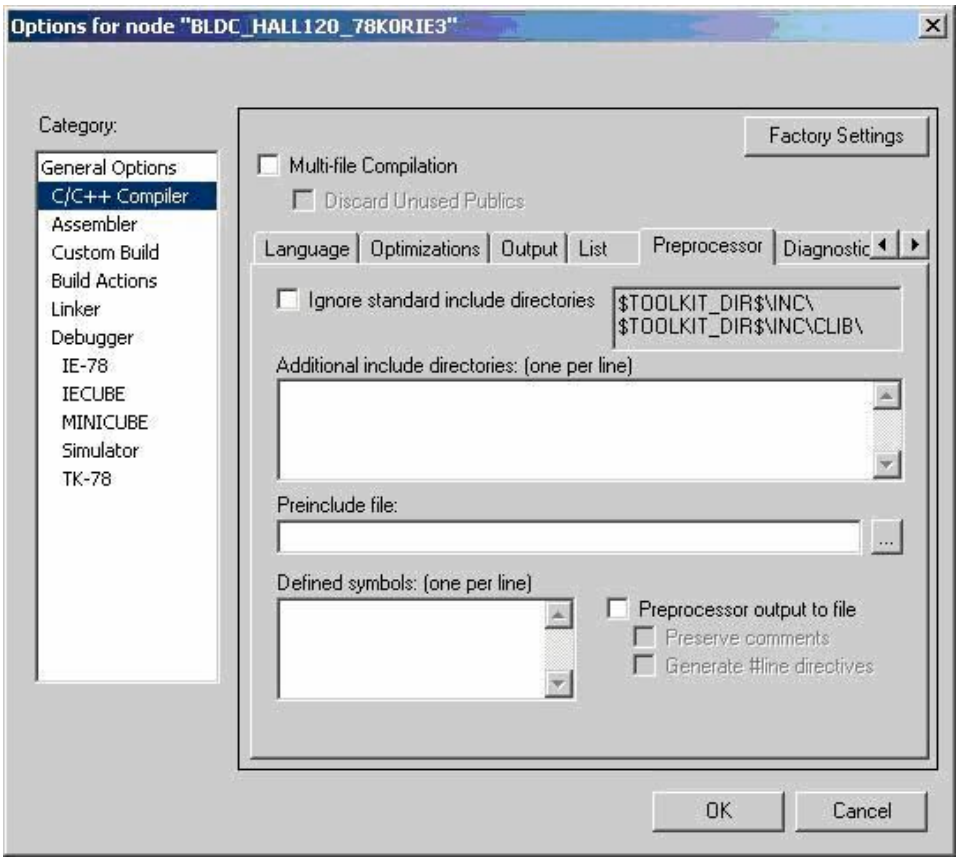


Figure 9-15 Compiler Options – Pre Processor Settings

Note All other Compiler Options settings can be remain as the default settings.

9.7 Assembler Options

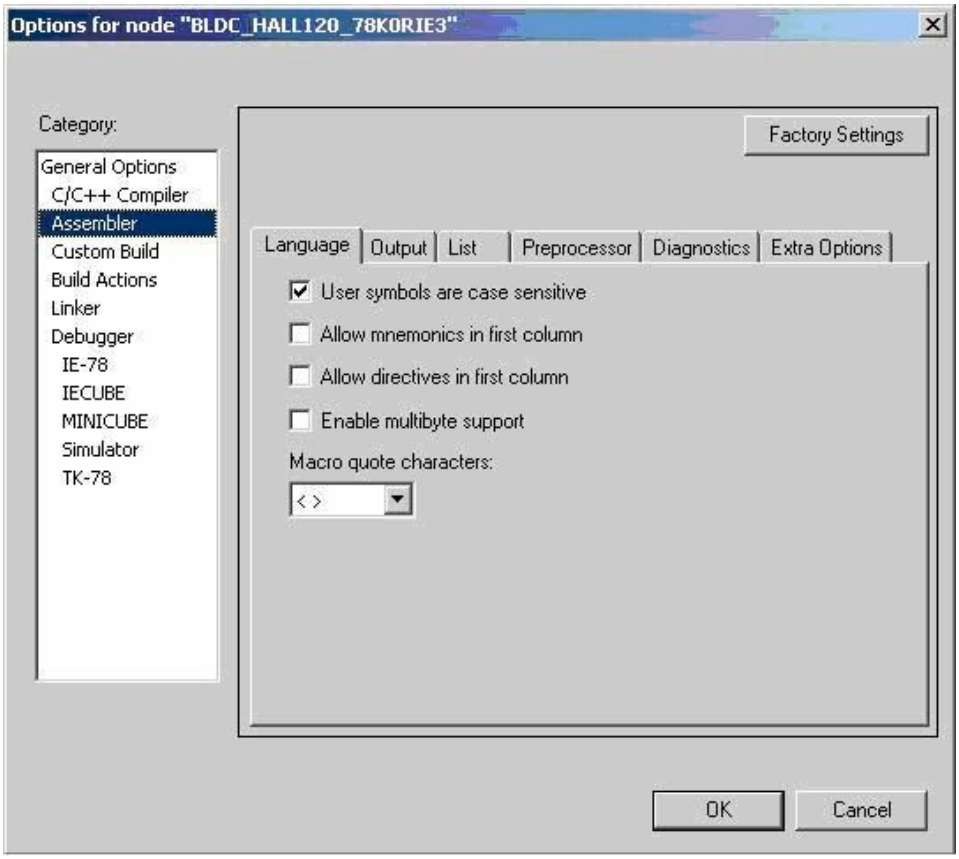


Figure 9-16 Assembler Options – Language Settings

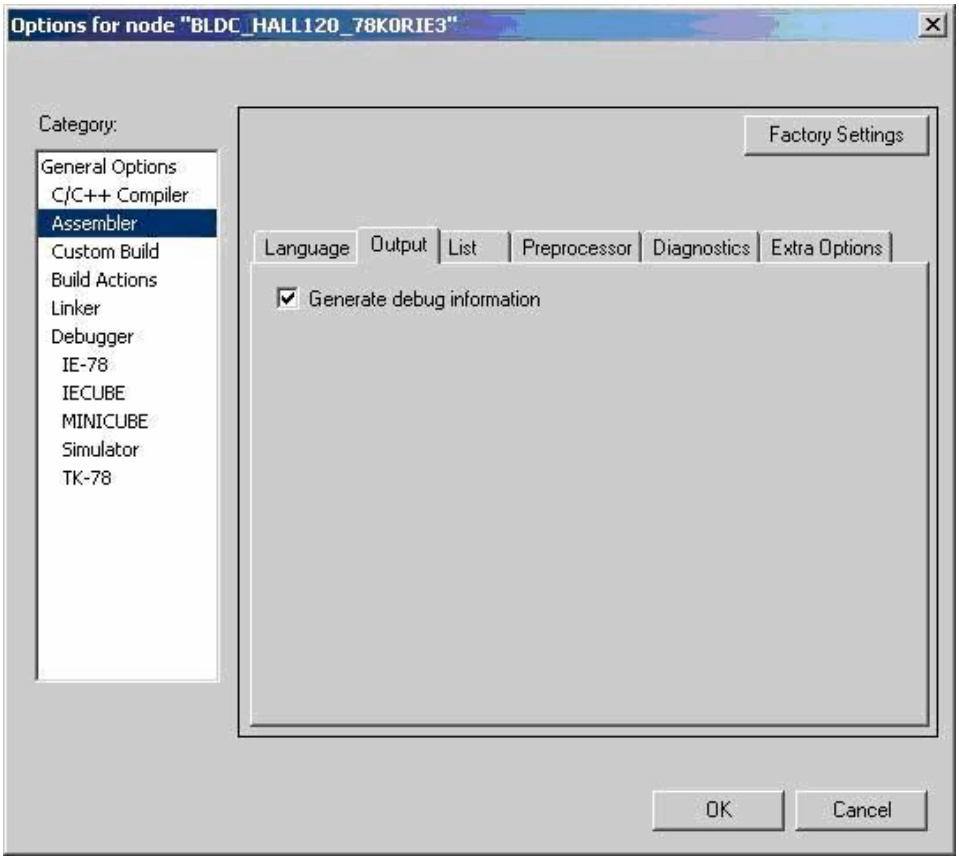


Figure 9-17 Assembler Options – Output set for Debug

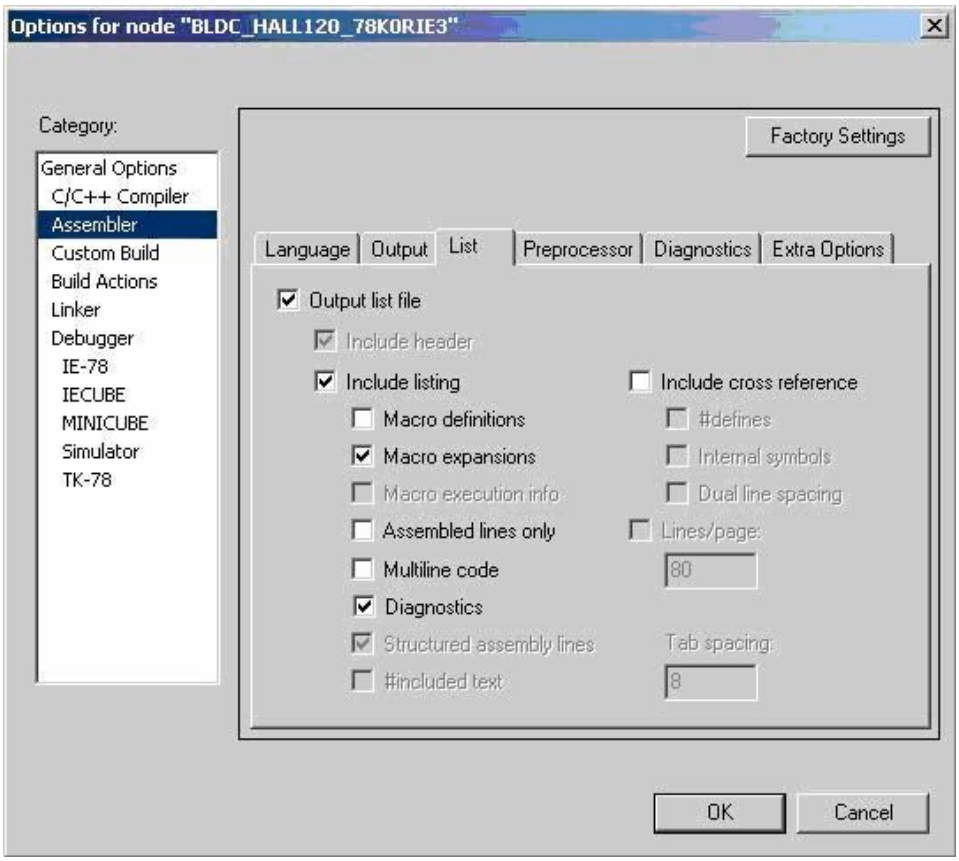


Figure 9-18 Assembler Options – Listings

9.8 Linker Options

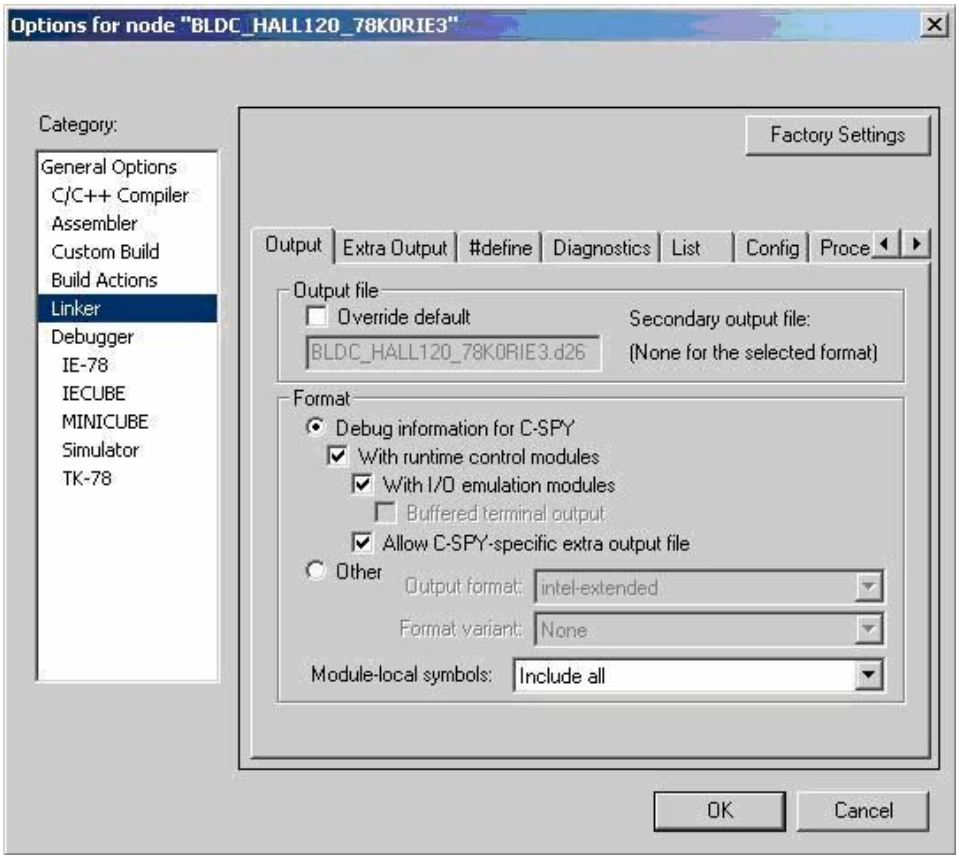


Figure 9-19 Linker Options – Primary File Output

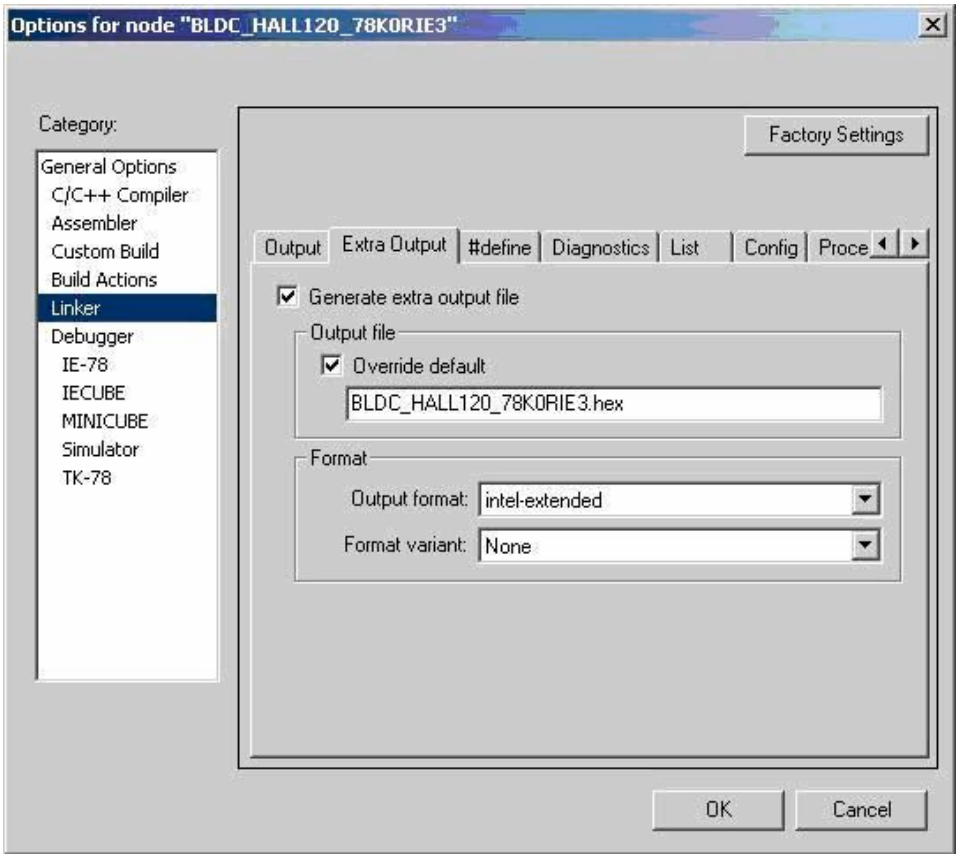


Figure 9-20 Linker Options – Secondary File Output

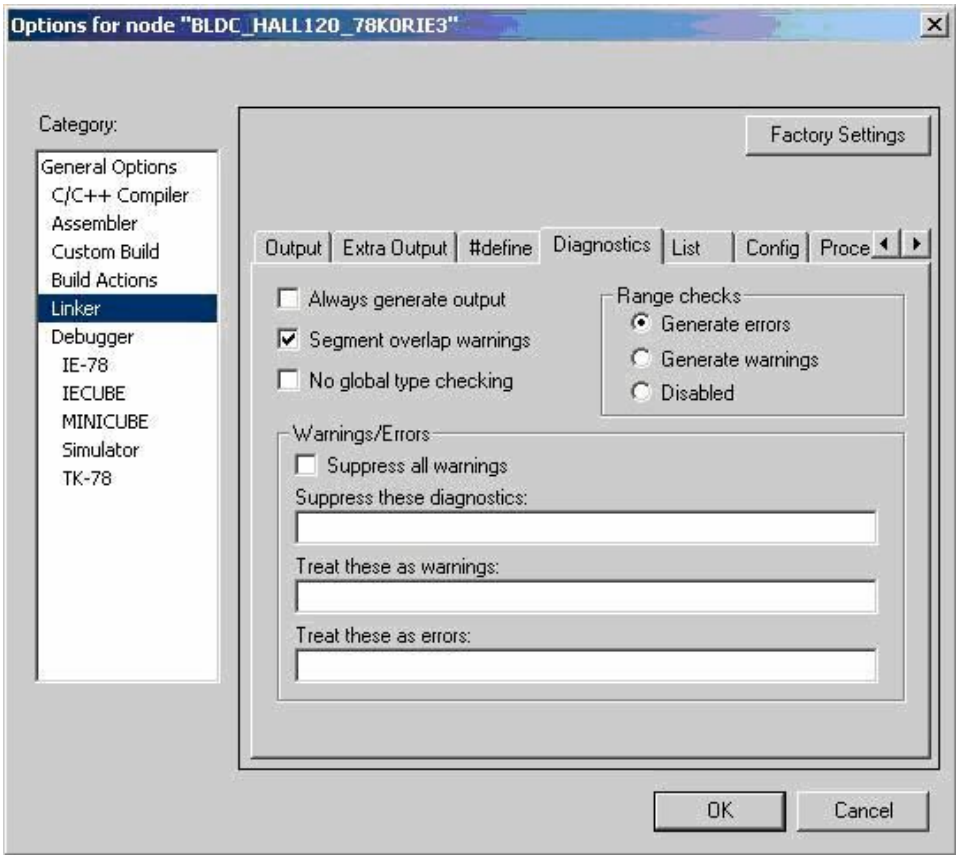


Figure 9-21 Linker Options – Diagnostic settings

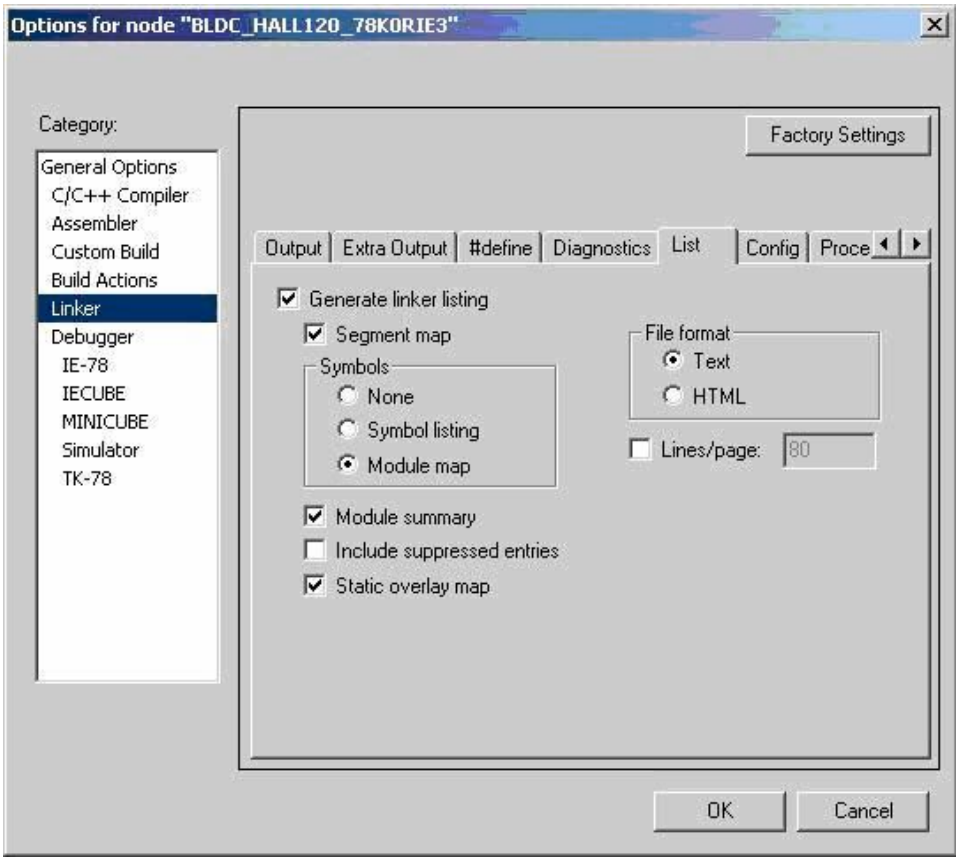


Figure 9-22 Linker Options – Generate MAP File Output

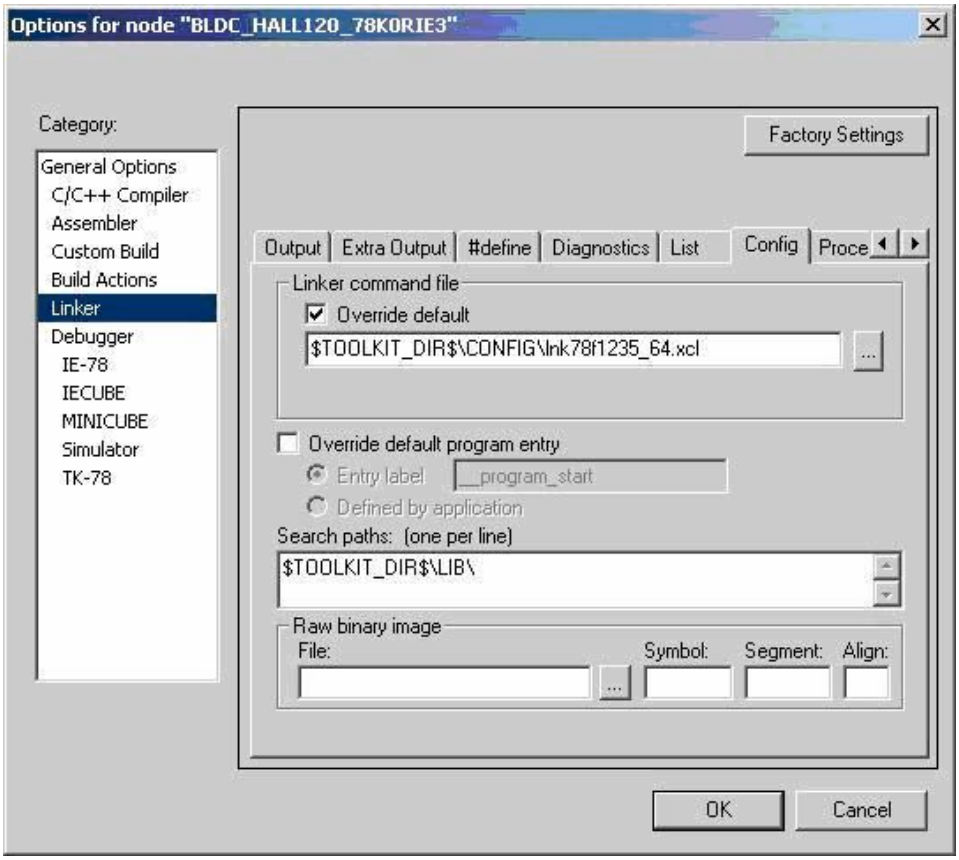


Figure 9-23 Linker Options – Linker Command File Selection

Note The Linker Control File must match the device selected. The remainder of the Linker setup can be left as the default setting.

9.9 Integrated Debugger Selection

Caution The MINICUBE debugger must be selected when using the MINICUBE2 and when using the onboard USB interface. **DO NOT SELECT THE TK-78 debugger option.**

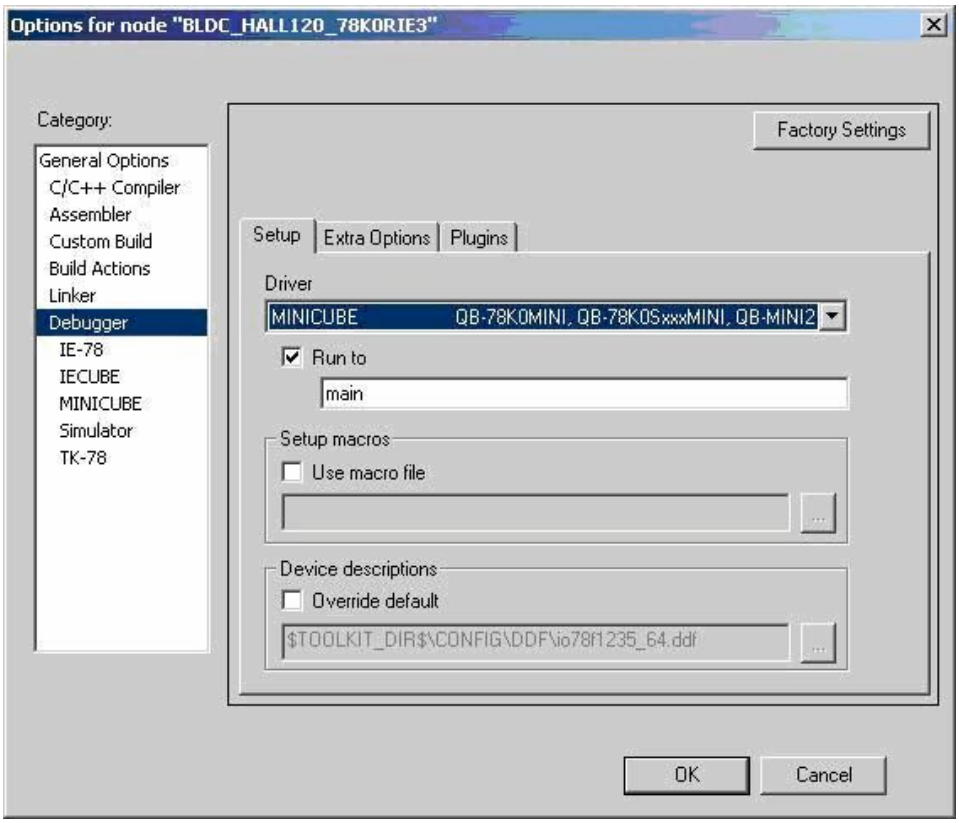


Figure 9-24 Integrated Debugger Selection

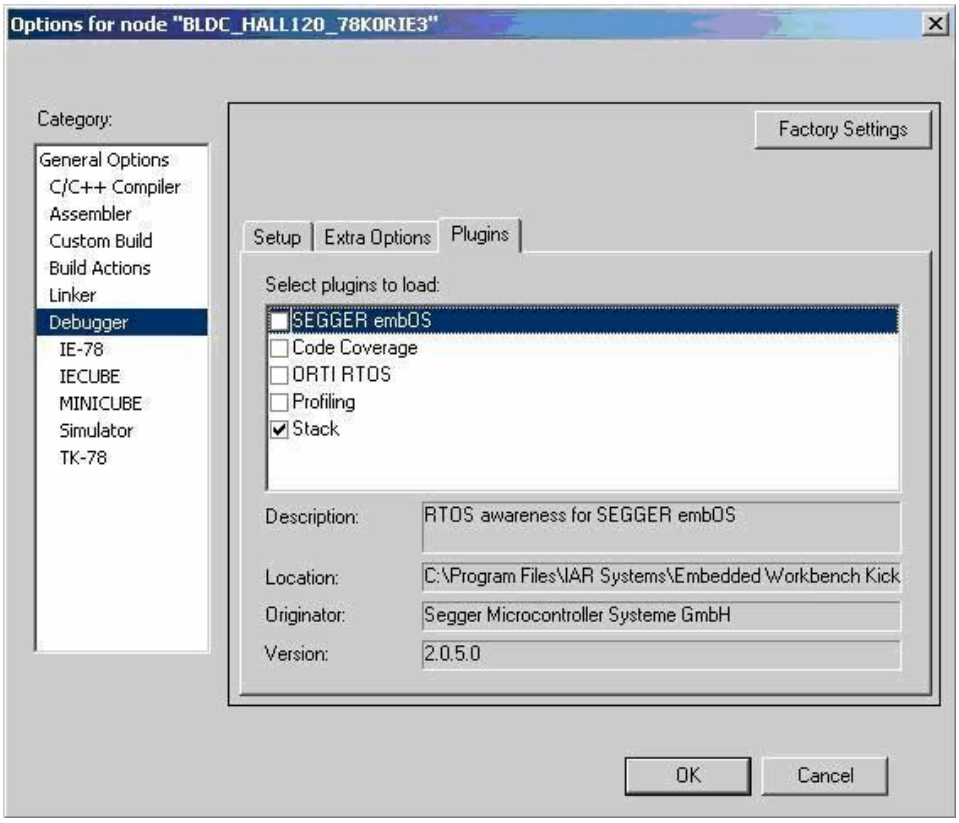


Figure 9-25 Integrated Debugger - Plug-in Selection

Note The Extra Option section can be ignored.

9.10 Workspace and Project Setup if Not Compatible with the Installed IAR Workbench

1. **Set a new workspace**
   File -> New -> Workspace

2. **Create a new Project**
   Project -> Create New Project -> Select “Empty Project” -> “OK”

   Enter a project name and set the location for the project
   (This can be the same location as the downloaded example software or a new location)

3. **Add the Source files to the project**

   C Source Files
   Project -> Add Files
   Locate and select all the C source files

   - Main_mcio.c
   - Sub_mcio.c
   - Initialise_hardware.c
   - Interrupt_handlers.c
   - Motor.c
   - GUI_support.c

Press "OPEN"

All these file should now appear in the Project Window (Left Hand Side of the IDE), as shown previously.

9.11 Build/Rebuild the Project

To build the project press the “make” icon in the task bar as shown below:

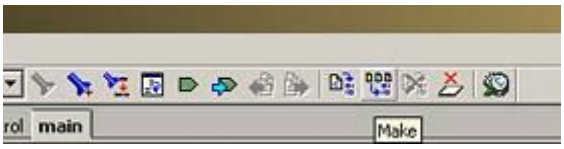


Figure 9-26 Make Button

The build results and any errors or warnings will be displayed in the Messages window at the bottom of the IAR Workbench window. These should be corrected before moving on to the Debugging section.

9.12 Debugging

Once the project has been built without errors the user can now start the debugging session.

This is done by pressing the "Debug" icon in the task bar.

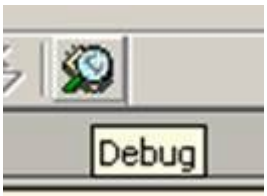


Figure 9-27 Start the Debug Session

The debugger will connect to the OCD unit and download the code to the Flash memory on the microcontroller board.

Once downloaded the debugging window will open as shown below in *Figure 9-29* .

Note The IAR embedded Workbench provides an integrated debugger, so the debugging window opens as part of the IDE.

If the debugger is run for the first time in a new project the following set up window will open. This is to set the basic function of the debugging hardware (i.e. Mini Cube or IECube etc.).

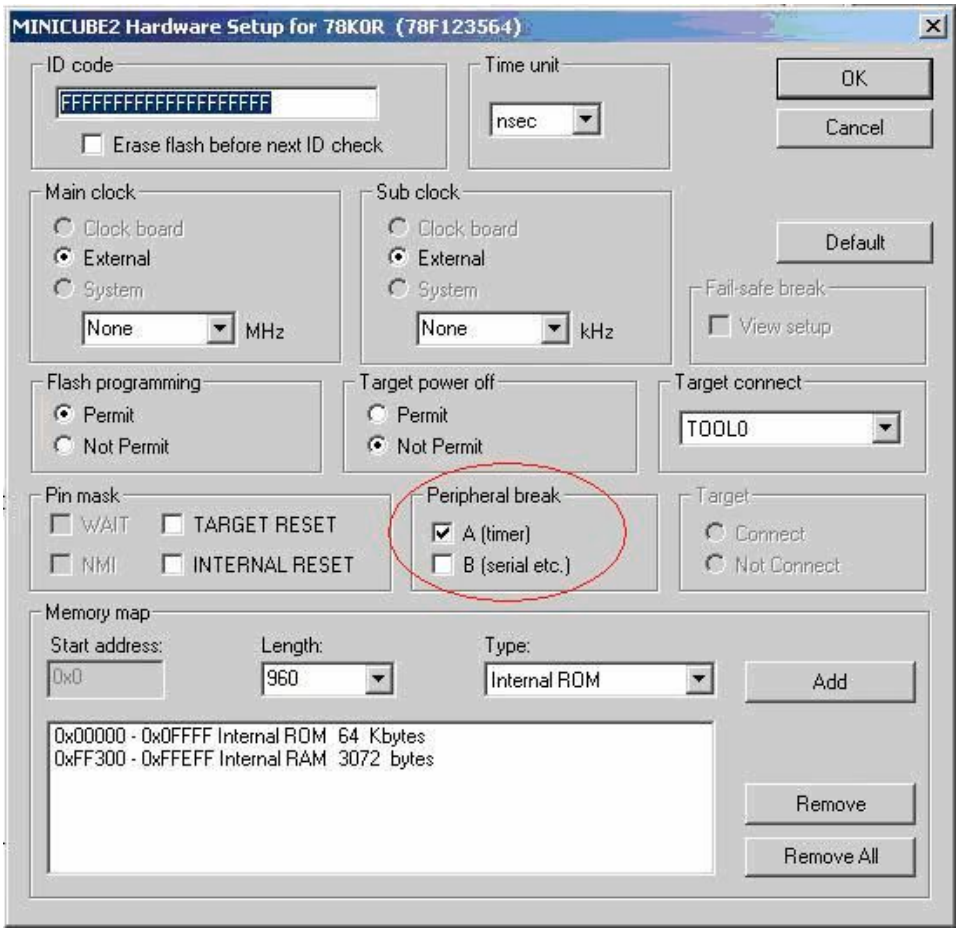


Figure 9-28 Debugging – Initial Hardware Setup

Ensure that the settings are as defined above.

Notes

1. If the Main Clock shows the “Clock board” detected, then ensure that this is selected.
2. If debugging with a motor connected, check the A (timer) box in the Peripheral break settings (as shown above) to avoid damaging the motor driver devices, fuse, or motor. Checking this box will force all timer output pins to a high impedance state during break conditions.

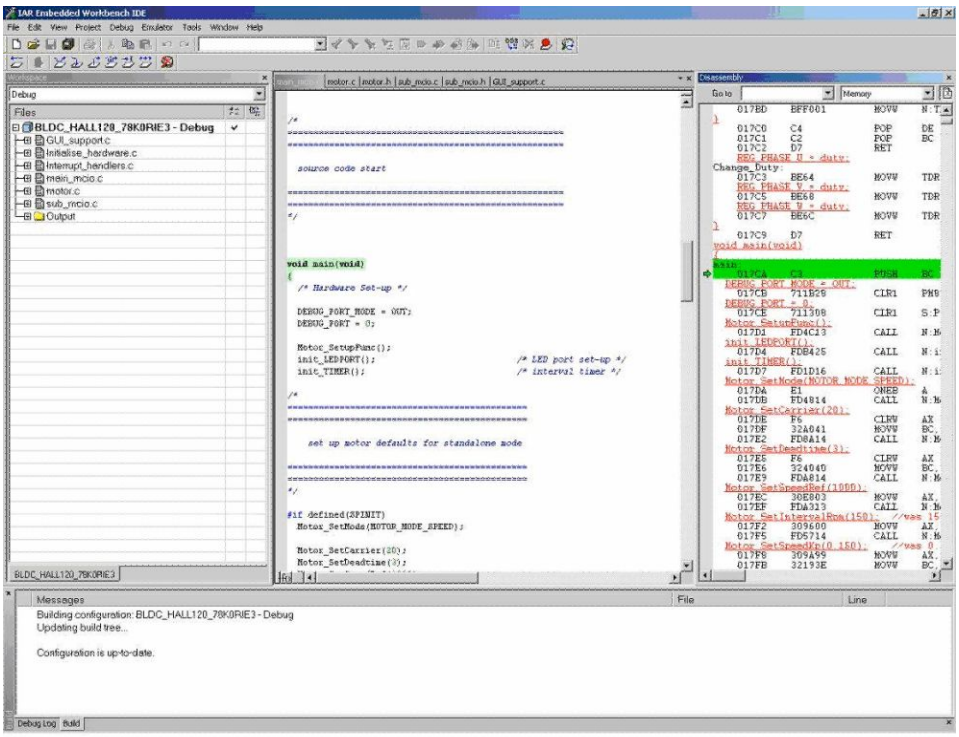


Figure 9-29 Integrated Debugger - Main Window

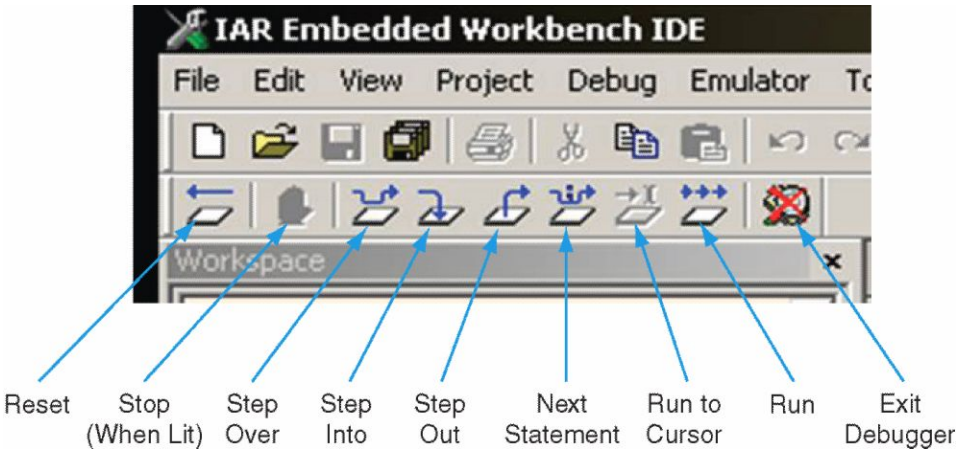


Figure 9-30 Debugger Task Bar Icons

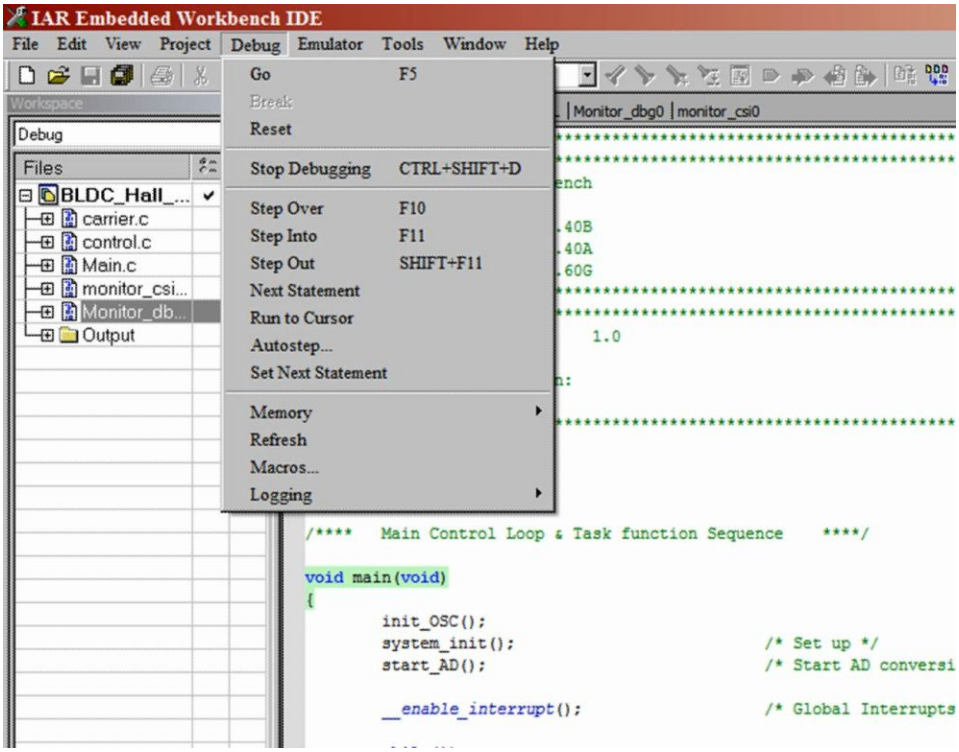


Figure 9-31 Debug Menus

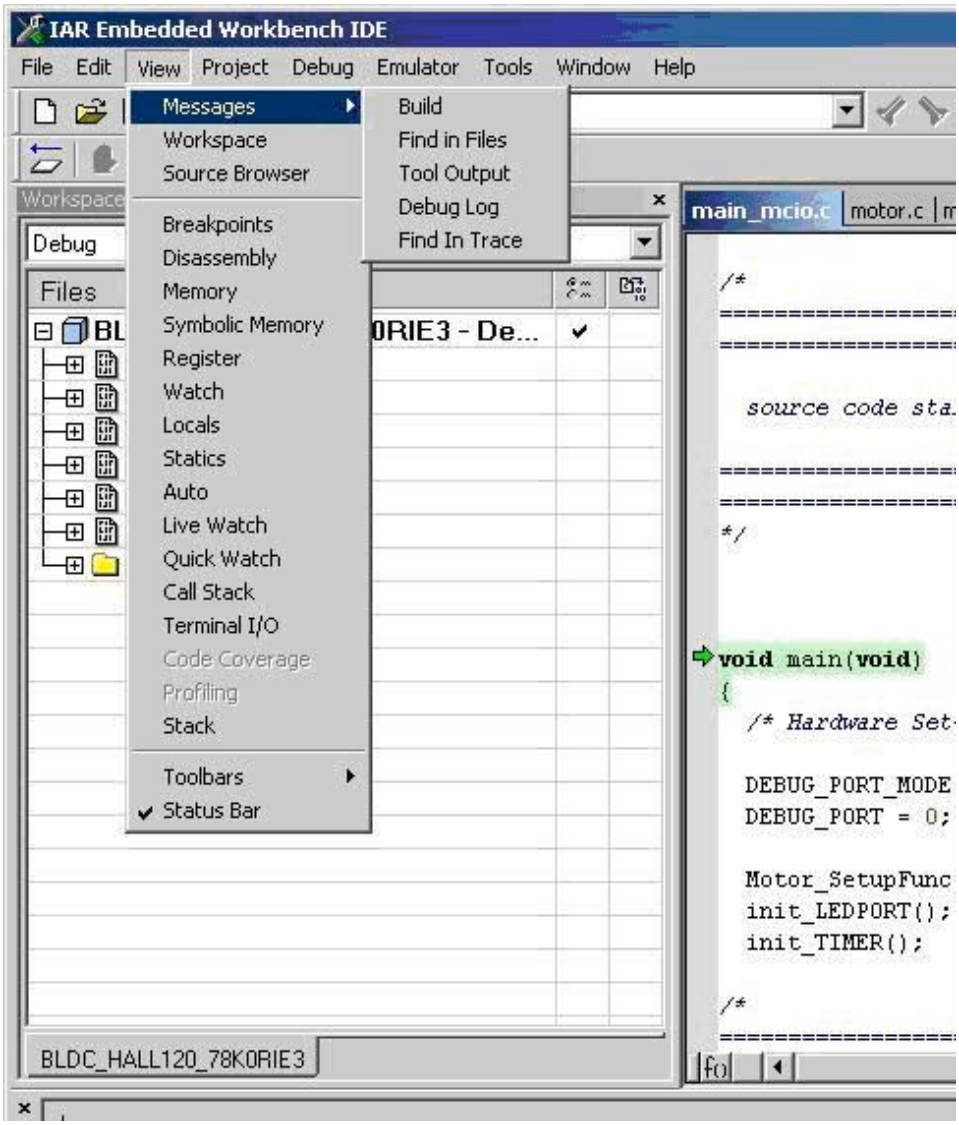


Figure 9-32 Debug Views Windows

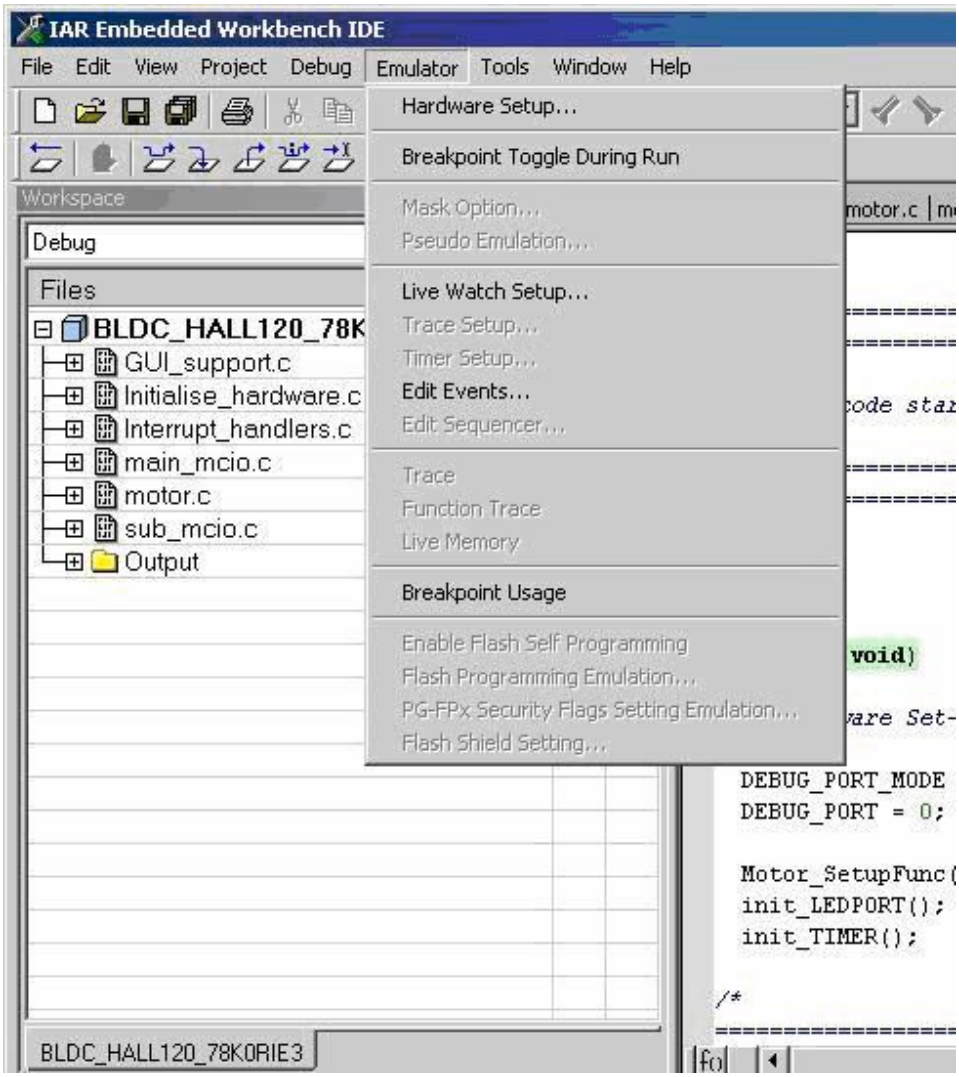


Figure 9-33 Emulator Debug Options

Note The "Live Watch" does not operate in real time on the on-chip debug unit.

Chapter 10 Appendix

Table 10-1 Port Pin Definitions

Pin	Port Pin	Definition of Use
22	P33	Mode PB
21	P32	Reverse PB
23	P77	Forward PB
24	P76	Start/Stop PB
50	P152/ANI10	Speed POT
17	P60 (78F0730)	RUN LED
28	P12 (78F0730)	BREAK LED
30	P70	HALL1
29	P71	HALL2
28	P72	HALL3
46	TMOFF0	Hardware Motor OC
49	P153/ANI11	AD_Shunt
27	TXD0	TXD0 (USB)
26	RXD0	RXD0 (USB)
19	TXD1	TXD1 (ZigBee)
20	RXD1	RXD1 (ZigBee)
42	TO02	HI-U
41	TO03	LO-U
40	TO04	HI-V
39	TO05	LO-V
38	TO06	HI-W
37	TO07	LO-W
34	P50	LED_segA
33	P51	LED_segB
32	P52	LED_segC
31	P53	LED_segD
60	P20	LED_segE
59	P21	LED_segF
58	P22	LED_segG
57	P23	LED_segDP
3	P42	LED_0
2	P43	LED_1
25	P141	LED_2
53	P75	LED_3

Schematics Schematics descriptions are attached to this document. Use the *Attachments* tab for access (lower left side of the screen).