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CAN Development Kit

Using and Expanding the RSK CAN Demo Network

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Table of Contents

1.0 Introduction

This guide shows how to program, debug and run the standard demo on all CAN MCUs of the M16C family, the R32C being the latest addition**.**

The Renesas CAN Demonstration & Development Kit (CAN D Kit) comes with two **RSK-R8C23** Renesas Starter Kit boards, but the demo may be expanded to use any of the following starter kits; the **RSK-M16C29**, the dual-channel **RSK-M16C6NK**, **RSK-M32C87** and **RSK-R32C118**. Compatible demo code and cabling exists for all these evaluation boards. The demo is virtually the same for all boards. The RSK-M16C6NK, RSK-M32C87, RSK-R32C118 can run **two CAN networks** simultaneously.

The kits include firmware, a CAN Sniffer and cables and an E8 debugger. The E8 in-system debugger and programmer also supports all boards except the RSK-R32C118 which needs the E8A.

To get started quickly using a sample project with code for the RSK23 boards that come with the original kit, open the project file `CanDkit.hws` from `C:\Renesas\RCDK8C\Demo_code\CanDkit-RSK23-10bitAD`. Program one RSK23 board with the MOT file (see chapter 2.1 Programming the RSK23) and debug the other board with the same project (see chapter 2.2 Debugging the RSK23).

For LIN, consult the LIN documentation and sample code that comes with the CD install.

Demos

1.1. Summary

The demonstration projects show the M16C CAN API in use for the Renesas MCUs of the M16C family. The boards included in your CAN D Kit have already been programmed with software to demonstrate CAN bus communication, the LCD, the LEDs and pushbuttons, as well as transmit, receive, and timer interrupts.

The accompanying CAN Demo Kit project contains subprojects for all five aforementioned RSK boards. Each subproject contains two simultaneously running demos using four mailboxes (slots).

A minimum of two boards must be connected via the CAN bus connectors. Press SW1 to alternate between ‘PlayCatch’ and 'Streaming-AD' demo programs.

After installing the CAN D Kit CD, go to `C:\Renesas\RCDK8C\Demo_code` to access the demo source code.

1.2. CAN Bus Termination

The CAN bus must be terminated at its two outermost ends. Termination resistors are connected on all RSK boards by default at shipment.

If more than two boards are connected to the CAN bus, only the two boards on the outermost ends of the bus should be terminated; any boards connected in between should not have any termination. The demo will still run, but the more nodes are added with termination resistors, the more that value will deviate from the standard.

On some RSK boards, a jumper can be used to connect or disconnect the termination resistor to the CAN bus. The termination resistors are connected by default at shipment on all boards, without a termination selection jumper in place. A 0Ω resistor is installed by default to bypass the jumper. Therefore, if you want to enable or disable termination by adding this jumper you must first remove the 0Ω resistor that bypasses the jumper.

The RSK R8C/23
The termination jumper is JP11 and the 0Ω resistor to be removed is R62.

The RSK M16C/29
On the RSK29, the jumper is JP10 and the 0Ω resistor to be removed is R81.

The RSK M16C/6NK
The RSK6NK has no jumpers to enable or disable CAN bus termination. To eliminate CAN bus termination, remove resistors R132 + R133 for CAN0 and R134 + R135 for CAN1.

The RSK M32C/87
The RSK87 has no jumpers to enable or disable CAN bus termination. However make sure the bus is terminated at network ends. Also, make sure the board is fitted with the following resistors so it is CAN enabled:

- R129. Connects microcontroller pin 90 to CAN0 EN pin.
- R119. Connects microcontroller pin 89 to CAN0 STBn pin.
- R66. Connects microcontroller pin 88 to CAN1 EN pin.
- R46. Connects microcontroller pin 87 to CAN1 STBn pin.

The RSK R32C/118

The RSK R32C/118 has no jumpers to enable or disable CAN bus termination.

1.3. Connecting the Boards

Connect all the RSKs together onto the CAN bus by connecting the accompanying CAN D Kit red/white CAN bus cable (or your own CAN bus cable) between the boards — CAN Hi to the red wire and CAN Lo to the white wire. CAN Hi is marked with an arrow on the CAN connecting jumper.

RSK Board	MCU CAN Interface	CAN Connection Jumper
RSK23	CAN0	J12
RSK29	CAN0	J11
RSK6NK	CAN0	J15
	CAN1	J14
RSK87	CAN0	J14
	CAN1	J15
RSK R32C118	CAN0	Right above transceiver ‘U6’ on the RSK.
	CAN1	Right above transceiver ‘U5’ on the RSK.

Connect a DC 5V supply to each board’s power connector. You can use a power supply for this or use the E8 programmer/debugger to power up to six boards. See the CAN D Kit User Manual for more information on supplying power to the boards.

1.4. A-D demo

All RSKs can measure a variable analog voltage that is applied to one of its Analog-to-Digital Converter (A-D) input pins. When the A-D value is changed by turning the potentiometer on the demo board, it is transmitted on the CAN bus. If correctly connected to the CAN bus, the transmitting board’s red LED (LED2) lights up every time an ‘A-D data frame’ is transmitted onto the bus.

Use the workspace CanDkit_23_29_6NK_87_118 to run the demo. To select the RSK you have, in HEW, select from the menu, Project->Select current Project, then select your RSK.

After downloading the demo as described in the next section, press Switch one to start the A-D demo. The LCD should display **CAN:** ***xx*** on the first and **A-D Rx** on the second row. *xx* is a two-digit hex number that represents the Analog-to-Digital Converter value received via the CAN bus.

Turn the board’s potentiometer and the conversion value will be sent onto the CAN bus and displayed by another board configured to receive frames with this message ID. The receiving board must be in Streaming A-D demo mode to show the received value. (The transmitting board actually does not have to be in Streaming A-D demo mode — only the receiver.) The receiving board’s green LED0 lights up every time an ‘A-D data frame’ is received.

View the Receive ID (RXID) for a board by pressing SW3. View the Transmit ID (TXID) by pressing SW2.

Pressing and holding SW2, while at the same time pressing SW3, allows you to change the TXID to values from 01h to 0Fh. Each push of SW3 increments the TXID by one.

Pressing and holding SW3, while at the same time pressing SW2, allows you to change the RXID to values from 01h to 0Fh. Each push of SW2 increments the RXID by one.

To be able to receive the transmitted A-D data frame, the receiving board(s) RXID must be identical to the transmitting board’s TXID.

The voltage over the potentiometer R9 is A-D converted continuously. When the value changes, it is transmitted over the CAN bus. Turn the potentiometer on one board and see the value change on the other board(s). LED2 (red) blinks with every CAN interrupt as A-D data frames are transmitted over the bus. It indicates that you have a valid CAN bus connection.

On the receiving board(s), LED0 (green) blinks with every CAN interrupt as A-D data frames are received over the bus. If LED0 on the receiving board is not blinking when A-D values are sent by the transmitting board, check that the receiving board's RXID equals the transmitting board's TXID. Another thing to check is that you have connected your boards correctly to the CAN bus (red wire to CAN Hi and white wire to CAN Lo).

A red LED indicates that there has been a Receive Buffer error because the CAN peripheral has flagged Message Lost (or 'overrun'). This means that data frames were received but never processed, and were overwritten by the next frame. This may happen, for example, if a board is used in debug mode and code execution is stopped by the debugger. In that case, restart the board by selecting Reset->Go *in HEW.*

1.5. PlayCatch Network Test

This demo increments a received CAN data frame data field value by one and transmits it back onto the bus. It can be used as a never-ending test that creates an organized chain of communication, which confirms that all boards are continuously up and running. If each board is set up with unique RXID and TXID values, one board's failure will stop the whole demo.

The CAN IDs of 'PlayCatch' frames to be received and transmitted actually are exactly 10hex above the TXID and RXID values used for the A-D demo which are displayed on the LCD when pressing SW2 or SW3 respectively.

While holding down SW2, pressing SW3 allows you to change the TXID to values from 11h to 1Fh (01h to 0Fh displayed). Each push of SW3 increments the TXID by one.

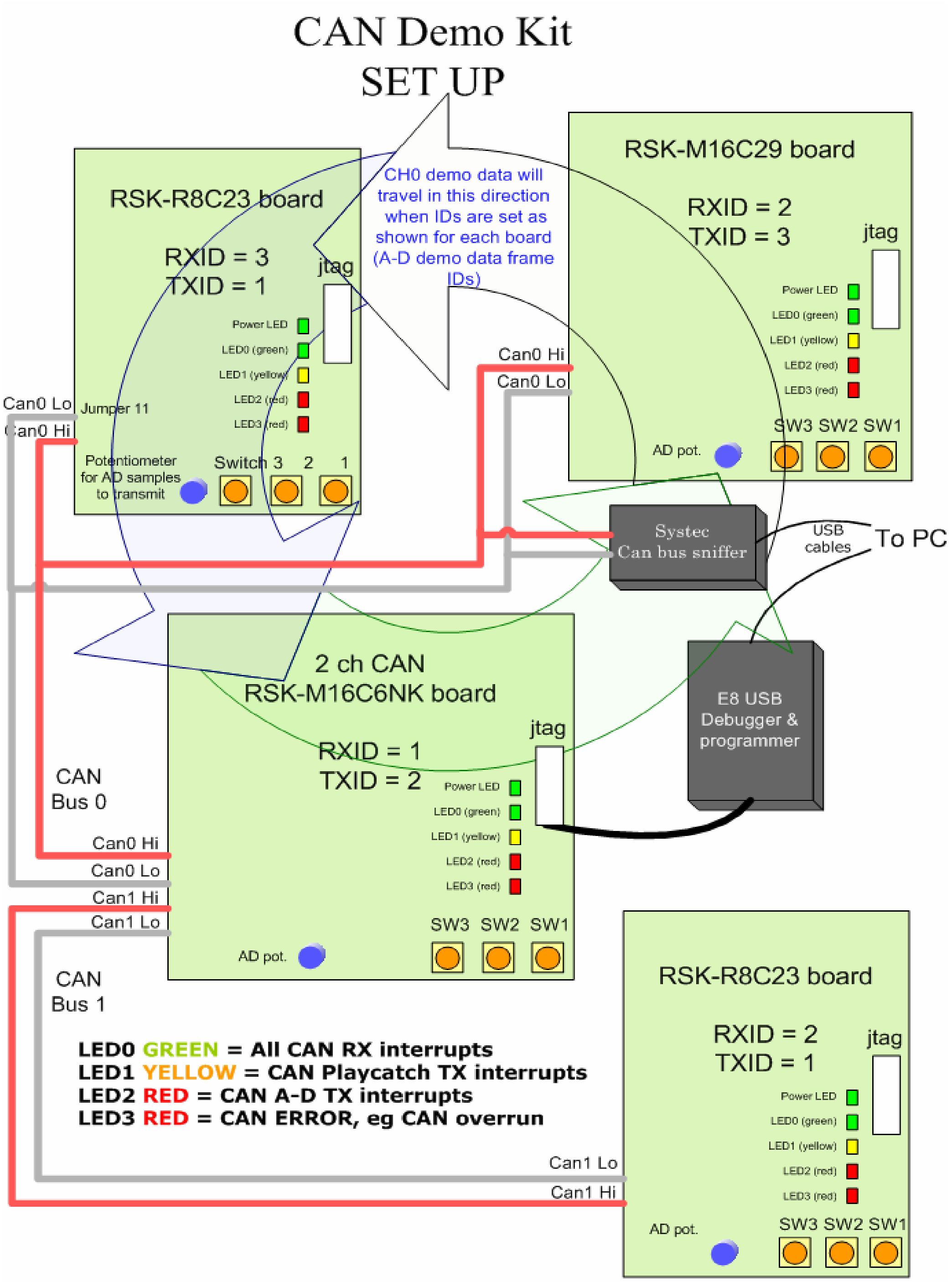
While holding down SW3, pressing SW2 allows you to change the RXID to values from 11h to 1Fh (01h to 0Fh displayed). Each push of SW2 increments the RXID by one

Connect two boards to the CAN bus and start the PlayCatch demo by pressing SW1 on each board until the LCD displays **PlayCatch** on the second line. The TXID of board 1 has to equal the RXID of board 2 and vice versa for the two boards to talk to each other.

If you connect more than two boards to the CAN bus to run the PlayCatch demo, the boards' RXID and TXID should be set up to form a communication ring as shown for three boards in Figure 2.1.

All boards must be in PlayCatch mode in order to establish the data frame sending chain, so press SW1 if they are not.

Once the boards have been set with receive and transmit IDs to create a loop, and they all have been put into PlayCatch mode, you should see their LEDs blinking — yellow when sending a PlayCatch frame, and green when receiving. Their LCDs will display the first two bytes of the data field of each data frame that they receive.



LED0 GREEN = All CAN RX interrupts
LED1 YELLOW = CAN Playcatch TX interrupts
LED2 RED = CAN A-D TX interrupts
LED3 RED = CAN ERROR, eg CAN overrun

SW1: Start/Stop, switch between 'Playcatch' and 'Streaming AD'
SW2: Show TXID
SW3: Show RXID
SW2+3: Change TXID, SW3+2: Change RXID

Figure 0.1: CAN Demo using four RSK boards of three different types.

The RSK-R8C23, RSK-M16C29, RSK-M16C6NK, and RSK-M32C87 all have demo code that interacts seamlessly. The TXID used determines the CAN ID of data frames when that board transmits, and the RXID determines which frames will be processed (received) by that board.

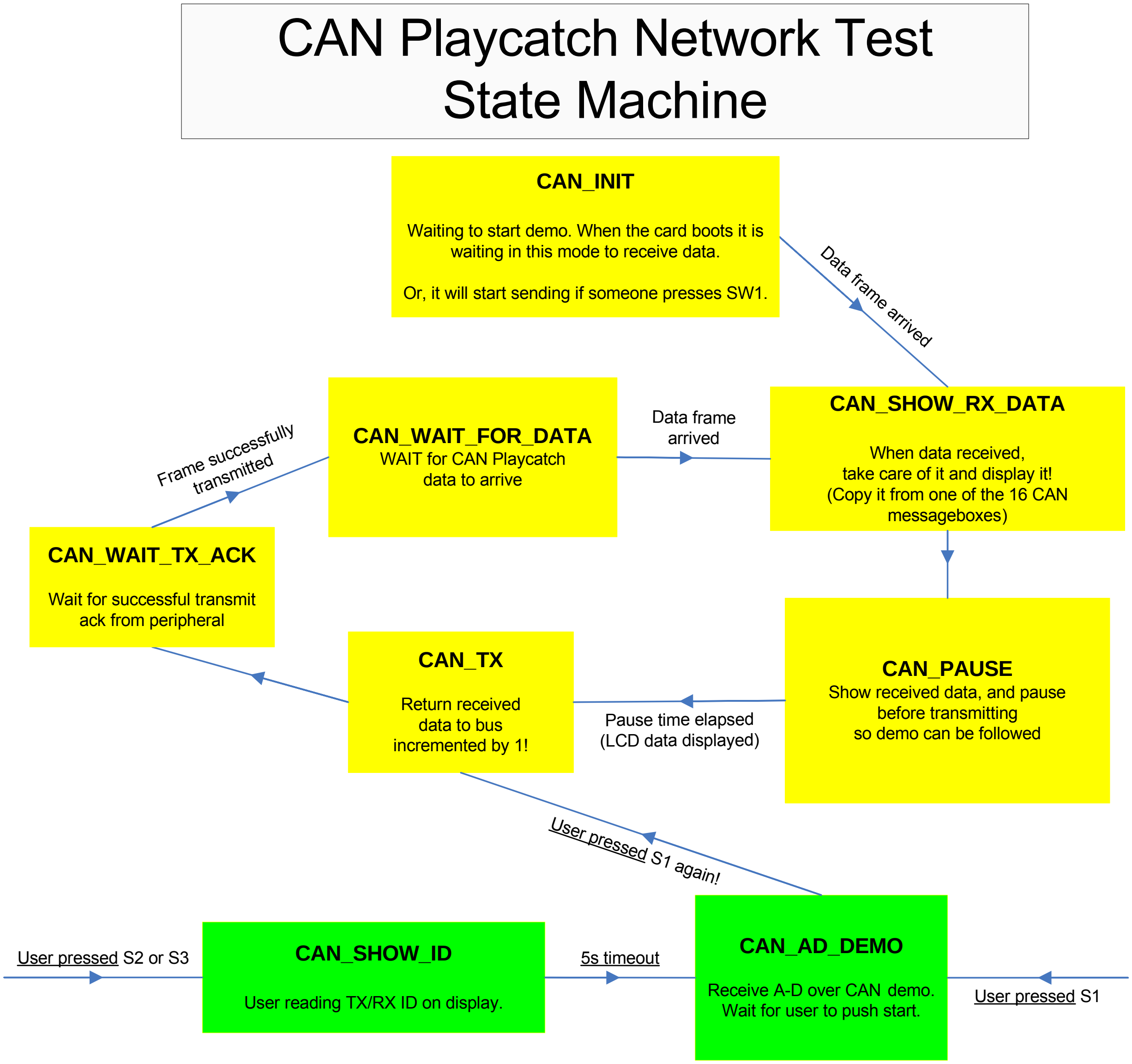

CAN Playcatch Network Test
State Machine
CAN_INIT
Waiting to start demo. When the card boots it is waiting in this mode to receive data.
Or, it will start sending if someone presses SW1.
Data frame arrived
CAN_SHOW_RX_DATA
When data received, take care of it and display it! (Copy it from one of the 16 CAN messageboxes)
Data frame arrived
CAN_WAIT_FOR_DATA
WAIT for CAN Playcatch data to arrive
Frame successfully transmitted
CAN_WAIT_TX_ACK
Wait for successful transmit ack from peripheral
CAN_TX
Return received data to bus incremented by 1!
Pause time elapsed (LCD data displayed)
CAN_PAUSE
Show received data, and pause before transmitting so demo can be followed
User pressed S1 again!
User pressed S2 or S3
CAN_SHOW_ID
User reading TX/RX ID on display.
5s timeout
CAN_AD_DEMO
Receive A-D over CAN demo. Wait for user to push start.
User pressed S1

Figure 0.2: PlayCatch Net Test Demo

Note: *All boards have the same receive and transmit CAN IDs at startup, so if you have reset the boards, you will have disorganized communication caused by all the boards' PlayCatch applications listening to and sending frames with the same CAN ID. Set the IDs to get an organized chain of communication for testing that all boards are up and running.*

See the CAN D Kit Quick Start Guide for details on how to run these demos. The demo code is practically identical in function for all RSKs.

2.0 The RSK-R8C23 Board

See the RSK-R8C23 User manual for details on the board's hardware and features. This section covers programming and debugging the RSK23 board.

The Kit's CD-ROM contains CAN demo code for the RSK-R8C23 that works seamlessly with the demo code for RSK-R8C23, RSK-M16C29, RSK-M16C6NK, and RSK-M32C87 boards on the bus.

2.1. Programming the RSK23

The E8 can be used as a programming device to flash the CAN demo code to an RSK board. Once achieved, the board can run independently; it will need only an external power supply.

If you get a communication error somewhere along the line, try one of these remedies:

1. *Cycle power to the RSK board.*
2. *Press <**Disconnect**> from the HEW menu and then physically disconnect and reconnect the USB cable to the E8.*

This section covers programming an S-record (.MOT) file into an RSK-R8C23 target. If you wish to run the target in debug mode, see the next section.

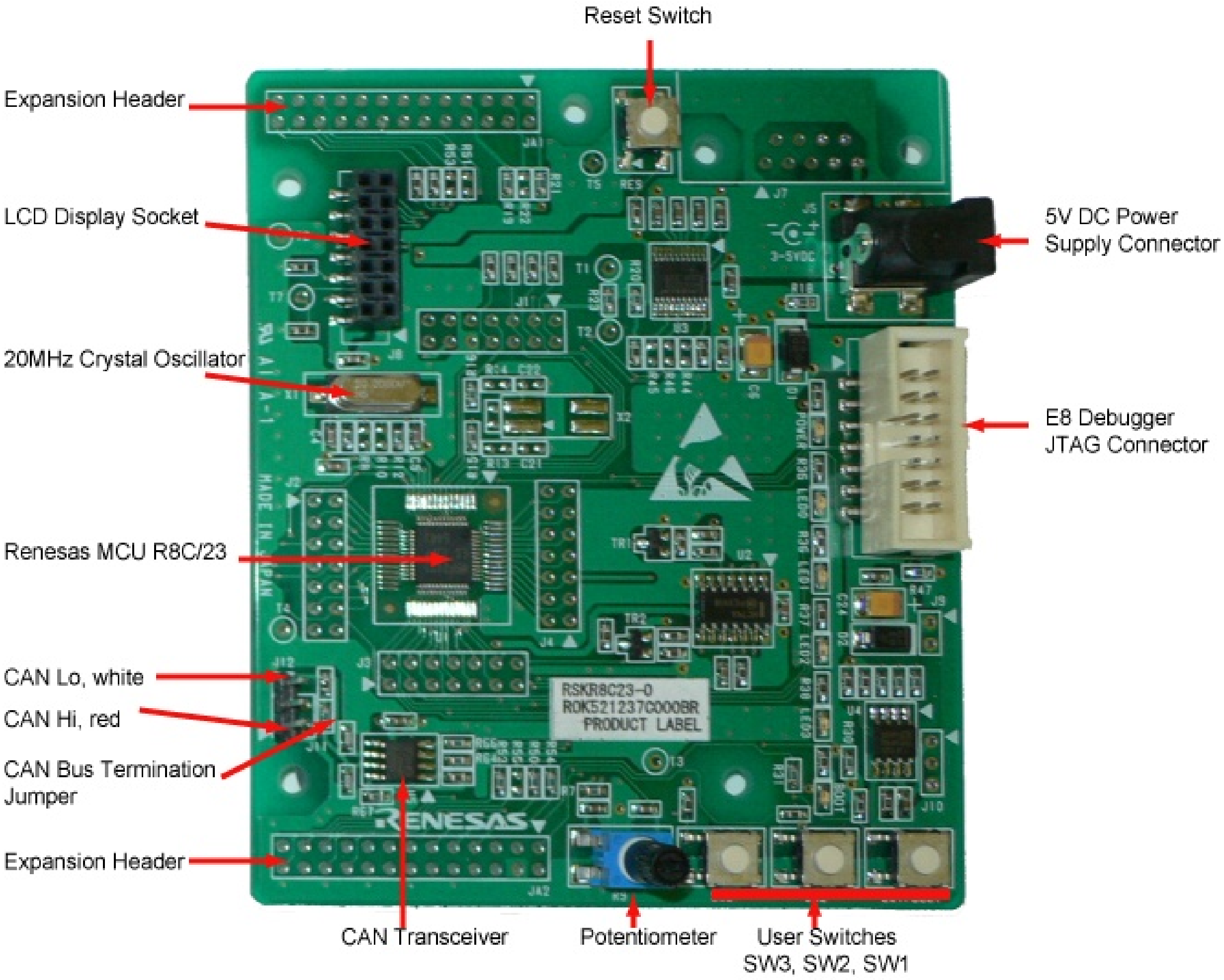
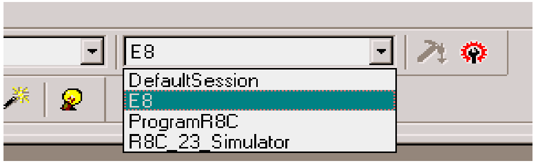
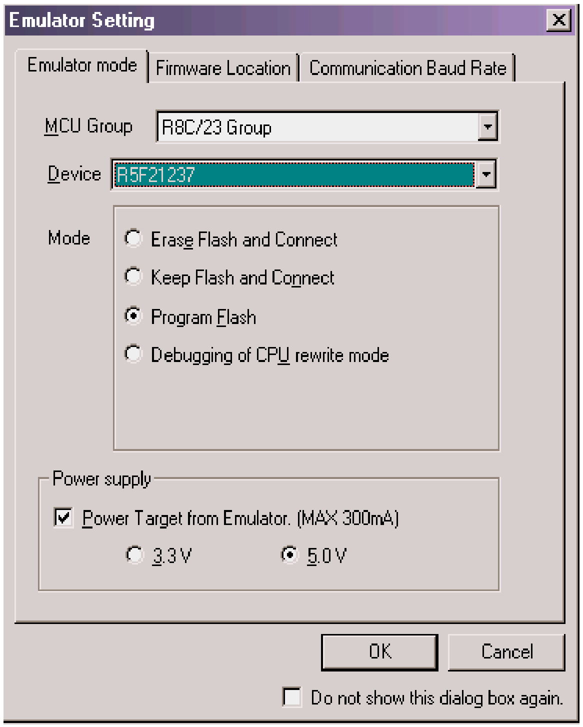


Figure 2.1: RSK-R8C23

1. Connect the E8 USB debugger to the RSK-R8C23 board and to the PC.
2. Launch HEW by double-clicking on the .HWS workspace file in folder `C:\Renesas\RCDK8C\demo_code\CANDKIT_23_29_6NK_87`. Close any initial connect windows that may come up.
3. Select the project for RSK23, if it is not already selected, via menu 'Project->Set Current Project'.
4. Select session "E8". We will load an S-record, or .MOT file to the MCU instead of the X30 used for debugging. (You can see the session settings in the *Debug->Debug settings* menu.)



5. The following window should appear. If not, click the <**Connect**> icon, or *Debug->Connect*.
   A message box will appear. Choose device "R5F21237" and *Writing Flash memory*.
   Check the "Power supply is carried out" box and select *5.0 V*, unless you connected a separate 5V supply to the board with the provided cables.



Emulator Setting

MCU Group: R8C/23 Group

Device: R5F21237

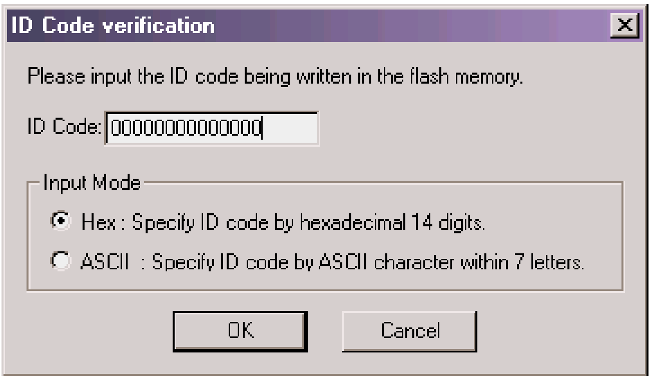
Mode:
○ Erase Flash and Connect
○ Keep Flash and Connect
● Program Flash
○ Debugging of CPU rewrite mode

Power supply
☑ Power Target from Emulator. (MAX 300mA)
○ 3.3 V ● 5.0 V

□ Do not show this dialog box again.

6. Click <**OK**> to continue.

7. If you get the next window, enter all ‘F’s in the next *ID Code verification* window. If that does not work use all ‘0’s, or the ID-code that you had for your previous project.



ID Code verification

Please input the ID code being written in the flash memory.

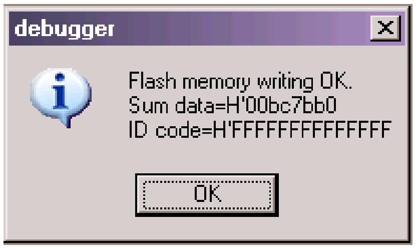
ID Code: 00000000000000

Input Mode
● Hex : Specify ID code by hexadecimal 14 digits.
○ ASCII : Specify ID code by ASCII character within 7 letters.

8. Click <**OK**>. The Flash memory write program will download.

9. Now you can download the application into Flash by double-clicking on the .MOT binary in the left hand pane under folder ‘Download modules’. If it is not there, make sure the correct project is selected and successfully compiled.

10. If successful, you will see the following window. The *Sum data* will vary. ***Before clicking OK, make a note of the ID code if it is not all 0’s or all F’s.***



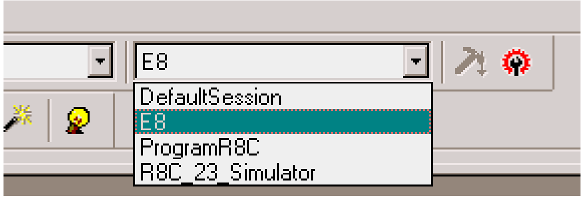
Flash memory writing OK.
Sum data=H'00bc7bb0
ID code=H'FFFFFFFFFFFFFF

11. Click <**Disconnect**> and disconnect the E8. The board is now ready to use.

2.2. Debugging the RSK23

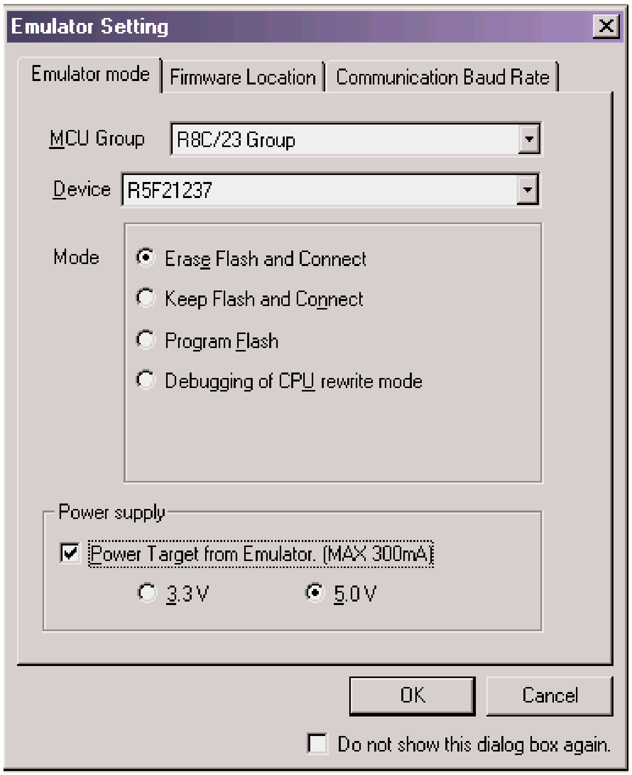
Note: *The Reset button on the RSK board can be used only when running a program in a non-debug session. Do not use the Reset button while in a debug session, or HEW and the target will lose communication with each other, causing errors.*

1. Connect the E8 USB debugger to the RSK-R8C23 board and to the PC.
2. Launch HEW by double-clicking on the .HWS workspace file in folder `C:\Renesas\RCDK8C\demo_code\CANDKIT_23_29_6NK_87`. Close any initial connect windows that may come up.
3. Select the project for RSK23, if it is not already selected, via menu ‘Project->Set Current Project’.
4. If it is not selected already, switch to debug session “E8”.



5. Select *Debug->Connect*. The “Emulator Settings” dialog box should come up. Choose device “R5F21237” and *Erase Flash and Connect* to download the debug monitor onto the RSK. If you want the E8 to power the board, select options as shown below. If you have connected an external 5V power supply, then leave the “Power supply is carried out” box

unchecked.



Emulator Setting

Emulator mode | Firmware Location | Communication Baud Rate

MCU Group: R8C/23 Group

Device: R5F21237

Mode:
- ● Erase Flash and Connect
- ○ Keep Flash and Connect
- ○ Program Flash
- ○ Debugging of CPU rewrite mode

Power supply

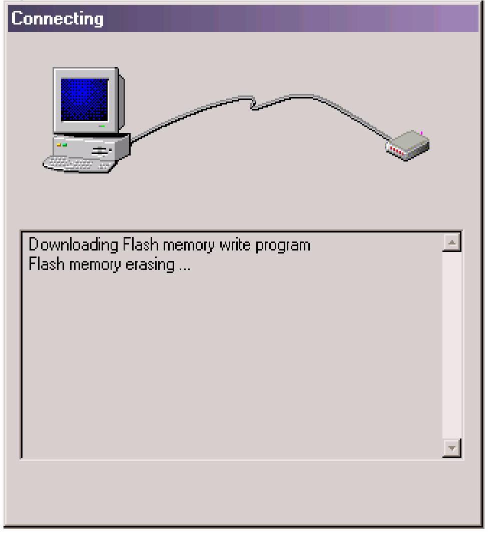
☑ Power Target from Emulator. (MAX 300mA)

○ 3.3 V ● 5.0 V

OK Cancel

□ Do not show this dialog box again.

6. Click <**OK**> and you will get the following connect confirmation, (if HEW asks if you want to update the E8 with new firmware, select Yes.), which disappears once you are connected:



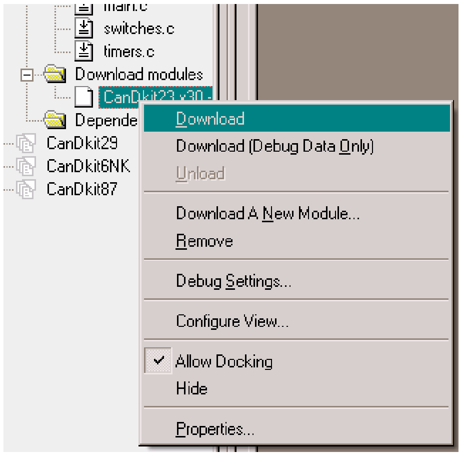
Connecting

```
Downloading Flash memory write program
Flash memory erasing ...
```

7. You should see “connected” in the HEW debug window . If you get an error, something is wrong with your generated project or session. Check the settings you chose in the project generator.
8. If the message “We should download new firmware” appears, click <**OK**>. The E8 will be updated.

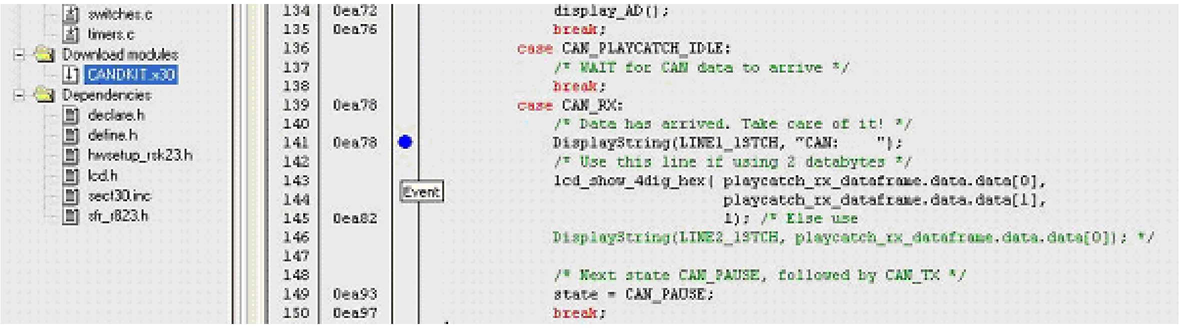
If you should get a communication error somewhere along these steps, cycle power to the board. Also disconnect and reconnect the USB cable to the E8.

9. Compile (press F7 key) and load the firmware by right-clicking on the `CANDKIT.x30` binary. X30 modules have debug data and code that runs on the target.



10. You can now run the code by selecting *Reset->Go*.

11. To set a breakpoint, click <**Stop**> then double-click in the column to the left of the line of code where you want the breakpoint to occur (e.g., where a frame is received). Select *Go* (F5) again and wait for the debugger to hit the breakpoint. The debugger stops when a CAN data frame is received at that point.



```
0ea72              display_AD();
0ea76              break;
               case CAN_PLAYCATCH_IDLE:
                   /* WAIT for CAN data to arrive */
                   break;
0ea78          case CAN_RX:
                   /* Data has arrived. Take care of it! */
0ea78              DisplayString(LINE1_1STCH, "CAN:    ");
                   /* Use this line if using 2 databytes */
                   lcd_show_4dig_hex( playcatch_rx_dataframe.data.data[0],
                                      playcatch_rx_dataframe.data.data[1],
0ea82                                 1); /* Else use
                   DisplayString(LINE2_1STCH, playcatch_rx_dataframe.data.data[0]); */

                   /* Next state CAN_PAUSE, followed by CAN_TX */
0ea93              state = CAN_PAUSE;
0ea97              break;
```

You can set the breakpoint in the receive interrupt or as shown here in the ‘PlayCatch’ state machine: file `main.c`, function `playcatch()`. Make sure you are running ‘PlayCatch’ to hit this breakpoint.

12. Press F10 (Step Over) to step and F11 to step into a function.

13. Right-click on a variable (e.g., `playcatch_rx_dataframe`), select *Instant Watch* and then *Add*.

14. Turn the other RSK board’s potentiometer to send some A-D frames to the RSK23. Now select *Go* (F5). A red LED indicates that there has been a Receive Buffer error because the peripheral has flagged Message Lost (or ‘overrun’). This means that data frames were received but never processed, and were overwritten by the next frame. These overflows happened because real-time code execution on your board was stopped. Restart the board by selecting *Reset->Go*.

2.2.1. Simple Demo to Begin Debugging CAN: ‘Just A-D’

For a simpler demo program (1.4 above), launch HEW and open the `.hws` workspace file in folder `C:\Renesas\RCDK8C\demo_code\CanDkit-RSK23-10bitAD`. Program one RSK23 board with the MOT file as explained in the chapter *Programming the RSK23*, and debug the other board with the same project.

3.0 The RSK-M16C29 Board

3.1. RSK29 Overview

The Kit's CD-ROM contains CAN demo code for the RSK-M16C29 that works seamlessly with the demo code for RSK-R8C23, RSK-M16C29, RSK-M16C6NK, and RSK-M32C87 boards on the bus.

The RSK29 boards are marked *RSKM16C29*. Details of the board can be seen in the layout document and schematics included on the CD.

3.1.1. The M16C/29 MCU

The RSK-M16C29 incorporates an M16C/29 M30290xxx MCU from the M16C/Tiny group of microcontrollers.

The M16C/29 MCU is based on the M16C/60 CPU core and has 1MB memory space. Maximum operating frequency is 20MHz. Internal Flash memory is programmable on a single power source.

Key features of the M16C/29:

- 16-bit Multifunction Timer (Timer A and B, incl. 3-phase inverter motor control function): 8 channels
- Input Capture/Output Compare Timer (Timer S)
    - Base Timer: 16-bit × 1 channel
    - I/O: 8 channels
- UART/Clock Synchronous Serial Interface: 3 channels
- Clock Synchronous Serial Interface: 2 channels
- Multi-Master I²C-bus™: 1 channel
- 10-bit A/D Converter: 27 channels
- DMAC: 2 channels
- CAN: 1 channel (2.0B)
- CRC Calculation Circuit
- Watchdog Timer
- Clock Generation Circuits: Main Clock Generation Circuit, Sub Clock Generation Circuit, On-chip Oscillator, PLL Synthesizer
- Oscillation Stop Detection Function
- Voltage Detection Circuit
- I/O Ports: 71
- Interrupts: 28 internal factors, 8 external factors, 4 software factors
- Data Flash: 2KB × 2 blocks

For more information, go to http://www.renesas.com and click on `Products / MPU and MCU / M16C Family / M16C/Tiny Series.`

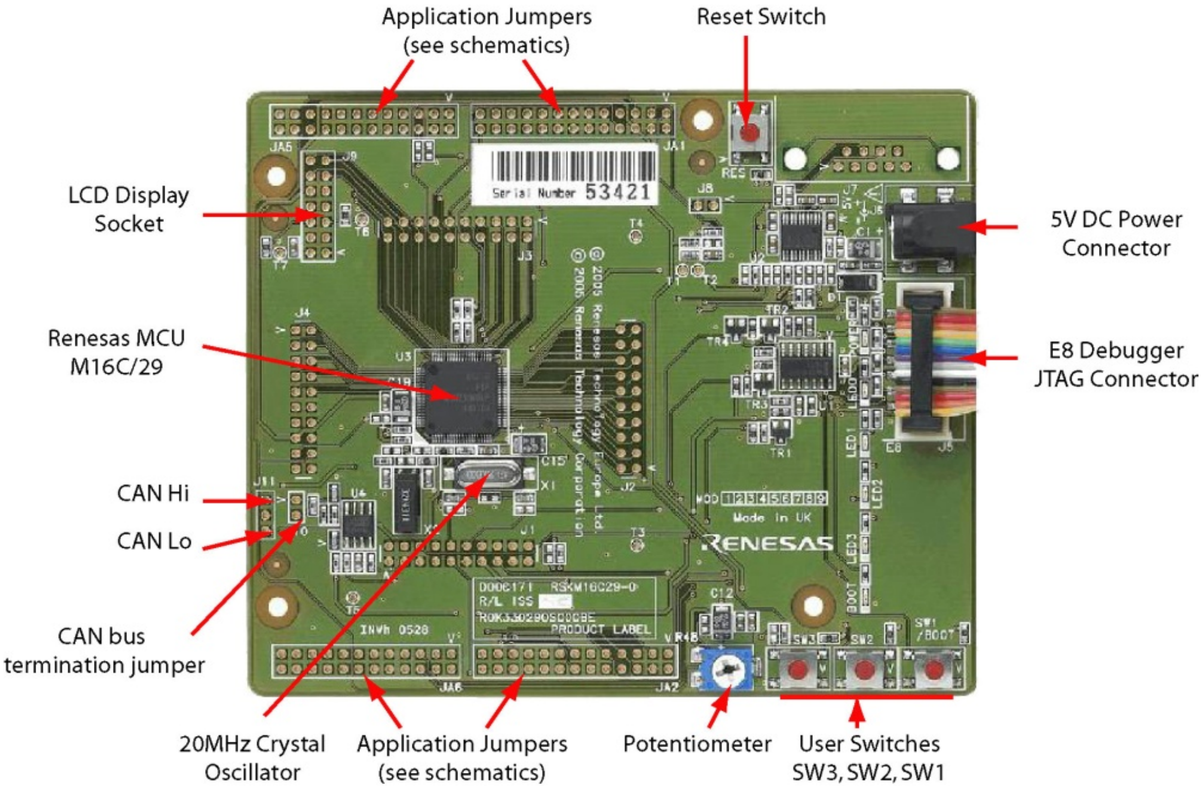


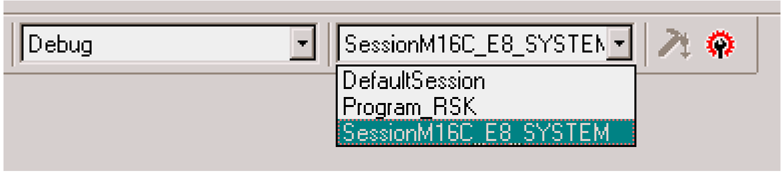
Figure 3.1: RSK-M16C29 Board

3.2. Programming the RSK29

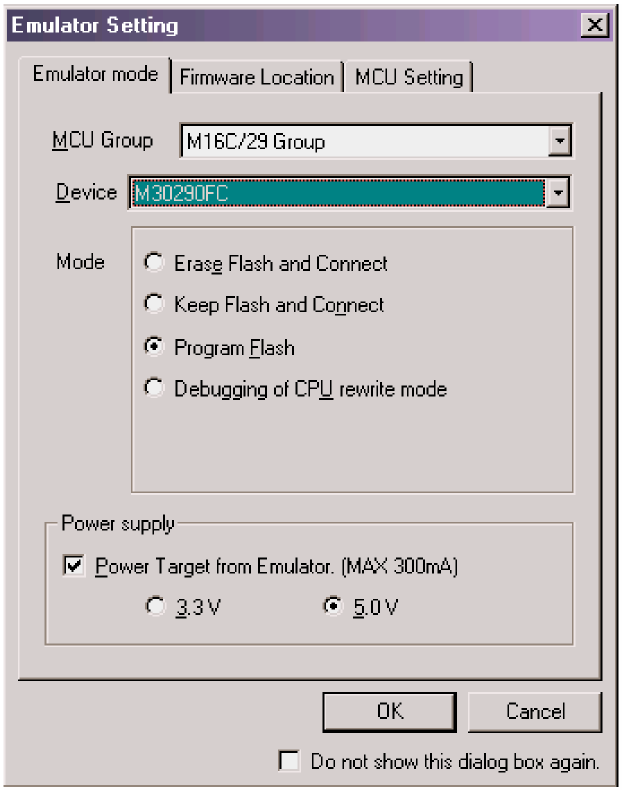
This section covers programming an S-record (.MOT) file into an RSK-M16C29 target. If you wish to run the target in debug mode, see the next section.

We will now load an S-record, or MOT file to the MCU instead of the X30 used for debugging.

1. Connect the E8 USB debugger to the RSK-M16C29 board and to the PC.
2. Launch HEW by double-clicking on the .HWS workspace file in folder `C:\Renesas\RCDK8C\demo_code\CANDKIT_23_29_6NK_87`. Close any initial connect windows that may come up.
3. Select the project for RSK29 via the menu ‘Project->Set Current Project’, if it is not already selected.
4. Select session “SessionM16C_E8”. You can see the session settings in the *Debug->Debug settings* menu.



5. Press the <**Connect**> icon, or *Debug->Connect*. A message box will appear. Choose Device “M30290FC” and *Writing Flash memory*. Check the “Power supply is carried out” box and select *5.0 V*, unless you connected a separate 5V supply to the board with the provided cables. Click <**OK**> to continue.



Emulator Setting

Emulator mode | Firmware Location | MCU Setting

MCU Group: M16C/29 Group

Device: M30290FC

Mode
○ Erase Flash and Connect
○ Keep Flash and Connect
● Program Flash
○ Debugging of CPU rewrite mode

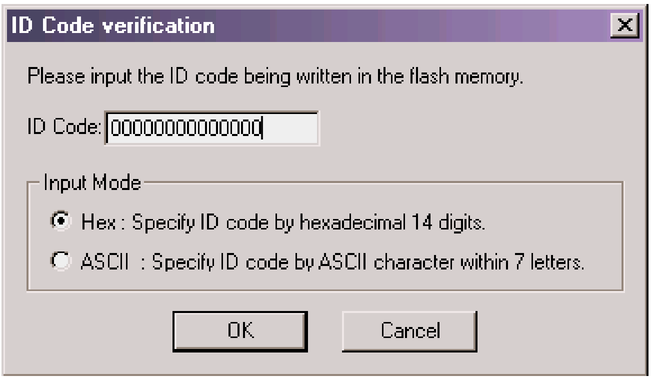
Power supply
☑ Power Target from Emulator. (MAX 300mA)
○ 3.3 V ● 5.0 V

OK | Cancel

□ Do not show this dialog box again.

6. If the message “We should download new firmware” appears, click <**OK**>. The E8 will be updated.

7. If you get the next window, enter all ‘F’s in the next *ID Code verification* window. If that does not work use all ‘0’s, or the ID-code that you had for your previous project.



ID Code verification

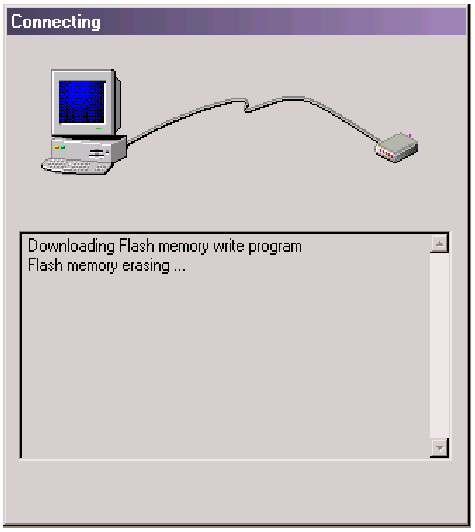
Please input the ID code being written in the flash memory.

ID Code: 00000000000000

Input Mode
● Hex : Specify ID code by hexadecimal 14 digits.
○ ASCII : Specify ID code by ASCII character within 7 letters.

OK | Cancel

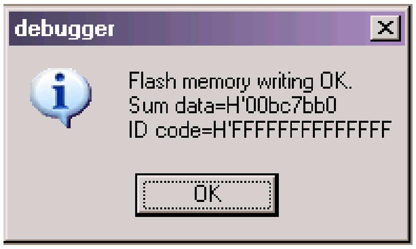
8. Click <**OK**>. The Flash memory write program will download.



Downloading Flash memory write program
Flash memory erasing ...

9. Now you can download the application into Flash by double-clicking on the .MOT binary in the left hand pane under folder 'Download modules'. If it is not there, make sure the correct project is selected and successfully compiled.

10. If successful, you will see the following window. The *Sum data* will vary. ***Before clicking OK, make a note of the ID code if it is not all 0's or all F's.***



Flash memory writing OK.
Sum data=H'00bc7bb0
ID code=H'FFFFFFFFFFFFFF

11. Click <**Disconnect**> and disconnect the E8. The board is now ready to use.

3.3. Debugging the RSK29

Note: *The Reset button on the RSK board can be used only when running a program in a non-debug session. Do not use the Reset button while in a debug session, or HEW and the target will lose communication with each other, causing errors.*

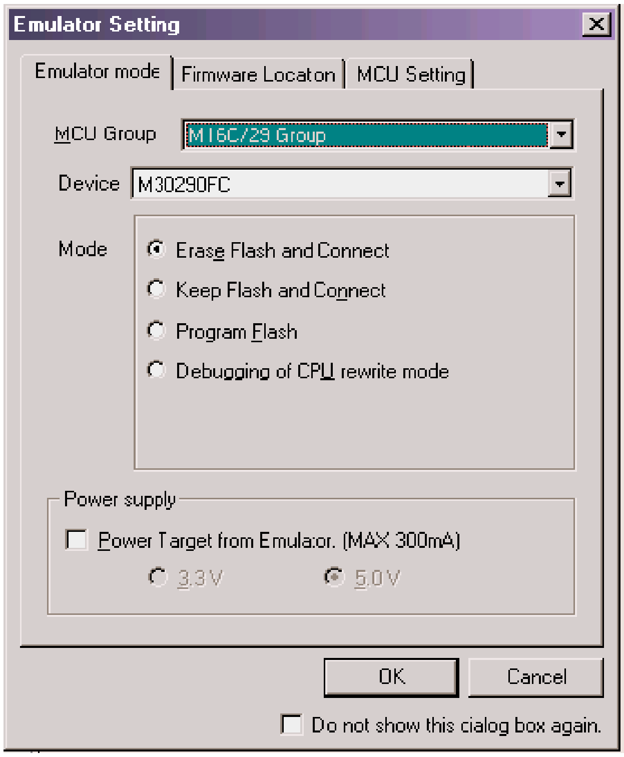
These steps for debugging the RSK29 are very similar to the steps for debugging the RSK23 above.

1. Connect the E8 USB debugger to the RSK-R8C29 board and to the PC.
2. Launch HEW by double-clicking on the .HWS workspace file in folder `C:\Renesas\RCDK8C\demo_code\CANDKIT_23_29_6NK_87`. Close any initial connect windows that may come up.
3. Select the project for RSK29 via the menu 'Project->Set Current Project', if it is not already selected.

4. Close any initial connect windows that may come up. To connect to the RSK29 target, change the debug session to “SessionM16C_E8_SYSTEM” (if it is not selected already) by choosing “DefaultSession” in the debug session selector toolbar. If requested to save the session, click <**Yes**>.

5. If you don’t see the “Select Emulator mode” dialog box, start the connection manually by selecting *Debug->Connect*.

6. In the “Emulator Setting” dialog box’s **Emulator Mode** tab, Select Device (MCU) “M30290FC” (if it is not selected already). Also select *Download emulator firmware*. Check the “Power supply is carried out” box and select *5.0 V*, unless you connected a separate 5V supply to the board with the provided cables. . Click <**OK**> to continue.



MCU Group: M16C/29 Group

Device: M30290FC

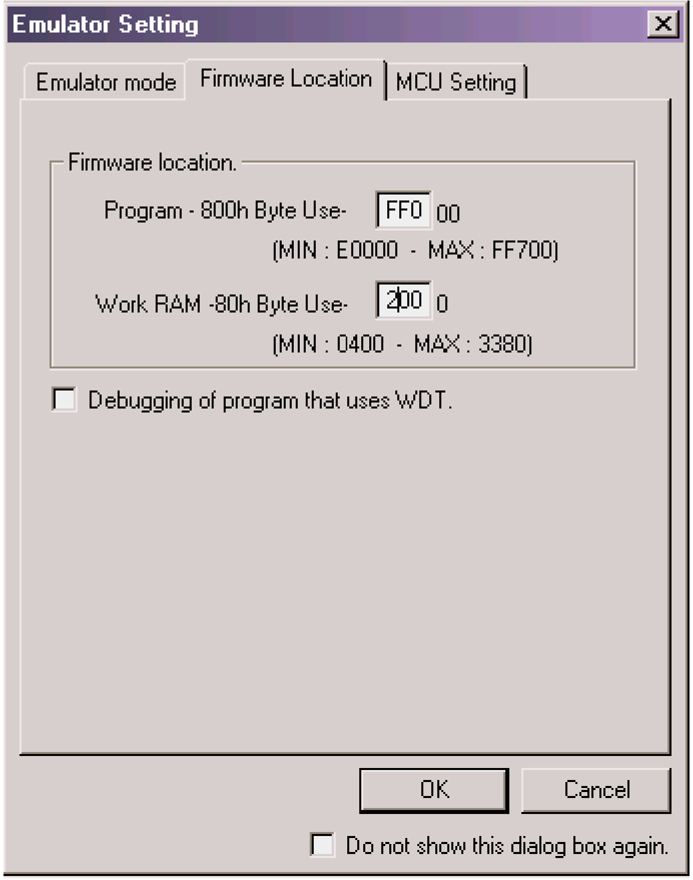
Mode:
- ● Erase Flash and Connect
- ○ Keep Flash and Connect
- ○ Program Flash
- ○ Debugging of CPU rewrite mode

Power supply
- □ Power Target from Emulator. (MAX 300mA)
- ○ 3.3V ● 5.0V

□ Do not show this dialog box again.

7. If the message “We should download new firmware” appears, click <**OK**>. The E8 will be updated.

8. In the “Emulator Setting” dialog box’s **Firmware location** tab, Download the target debug kernel firmware into program flash for example at **FF0**00 and Work RAM starting at **200**0.



Firmware location.

Program - 800h Byte Use- FF0 00
(MIN : E0000 - MAX : FF700)

Work RAM -80h Byte Use- 200 0
(MIN : 0400 - MAX : 3380)

□ Debugging of program that uses WDT.

□ Do not show this dialog box again.

9. You should see “connected” in the HEW debug window . If you get an error, something is wrong with your generated project or session. Check the settings you chose in the project generator.

10. From the “Debug” pull-down menu, select *Download Modules->All Download Modules*, or just double-click on the .X30 file icon in the left hand project pane.

11. Use *Reset->Go* (F5) to run the target, the <**Stop**> icon to stop the code, F10 to step, etc., as described in *Debugging the RSK23* above.

4.0 The RSK-M16C6NK Board

4.1. RSK Overview

The Kit's CD-ROM contains CAN demo code for the RSK-M16C6NK that works seamlessly with the demo code for RSK-R8C23, RSK-M16C29, RSK-M16C6NK, and RSK-M32C87 boards on the bus.

The RSK6NK boards are marked *RSKM16C6NK* or *ROK 33062PSxxx*. Details of the board can be seen in the layout document and schematics included on the CD.

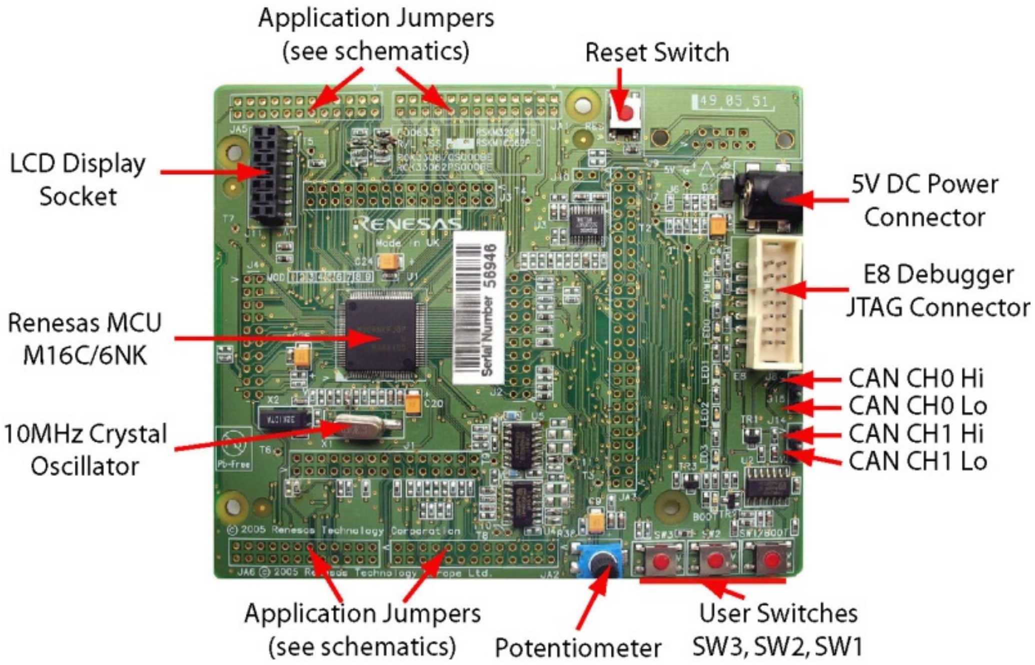


Figure 4.1: RSK-M16C6NK Board

4.1.1. The M16C/6NK MCU

The RSK6NK board incorporates an M16C/6NK M306NK*xxx* MCU from the M16C/60 group of microcontrollers. This single-chip microcontroller operates using sophisticated instructions featuring a high level of instruction efficiency. With 1MB of address space, it is capable of executing instructions at high speed. Equipped with two CAN modules for two CAN channels, the microcontroller is suited to car audio and industrial control systems. The CAN modules comply with the 2.0B specification. This microcontroller also has a multiplier and DMAC, which, combined with fast instruction processing capability, makes it suitable for control of various OA and communication equipment that require high-speed arithmetic/logic operations.

Key features of the M16C/6NK:

- CAN Module: 2 channels with 2.0B specification
- Multifunction Timer A: 16 bits, 5 channels
- Timer B: 16 bits, 6 channels
- Three-phase motor control circuit

- Serial I/O: 3 channels
- Clock synchronous, UART, I²C-bus™, IEBus (4 channels)
- 10-bit A/D converter: 1 circuit, 26 channels
- D/A Converter: 8 bits, 2 channels
- DMAC: 2 channels
- CRC Calculation Circuit
- Watchdog
- Interrupts
    - Internal: 34 sources,
    - External: 12 sources
    - Software: 4 sources, Priority level: 7 levels
- Clock Generating Circuits: Main Circuit, Sub-clock Circuit, On-chip Oscillator, PLL Frequency Synthesizer

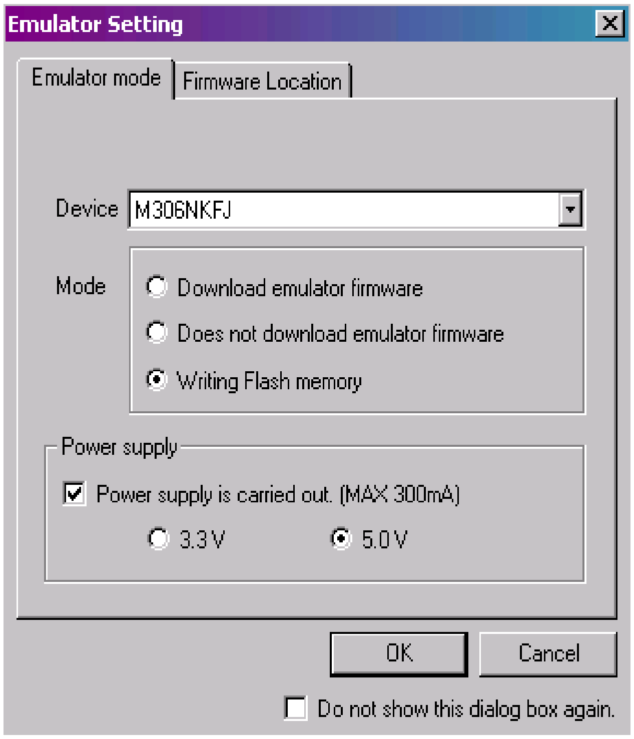
For more info go to http://www.renesas.com and click on `Products / MPU and MCU / M16C Family / M16C/60 Series.`

4.2. Programming the RSK6NK

This section covers programming an S-record (.MOT) file into an RSK-M16C6NK target. If you wish to run the target in debug mode, see the next section.

12. Connect the E8 USB debugger to the RSK-R8C6NK board and to the PC.
13. Launch HEW by double-clicking on the .HWS workspace file in folder `C:\Renesas\RCDK8C\demo_code\`CANDKIT_23_29_6NK_87. Close any initial connect windows that may come up.
14. Select the project for this RSK6NK via the menu ‘Project->Set Current Project’, if it is not already selected.
15. Select session “SessionM16C_E8_SYSTEM”. (Menu *Debug->Debug-=Sessions.*) This will enable you to load an S-record, or MOT file to the MCU instead of the X30 used for debugging. (You can see the session settings in the *Debug->Debug settings* menu.)

16. Press the <**Connect**> icon, or use *Debug->Connect*. A message box will appear. Choose MCU Device "M306NKFJ" and *Writing Flash Memory*. Check the "Power supply is carried out" box and select *5.0 V*, unless you connected a separate 5V supply to the board with the provided cables. Click <**OK**> to continue



Emulator Setting

Emulator mode | Firmware Location

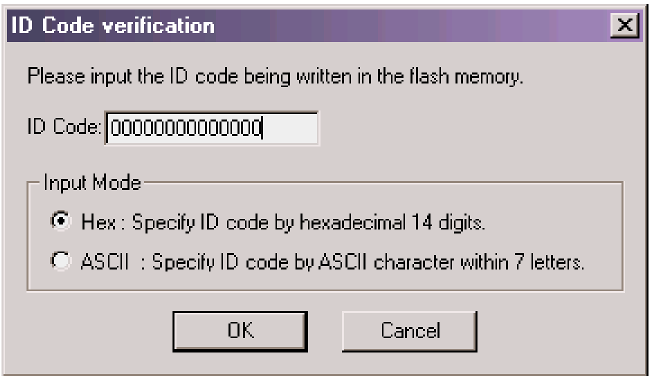
Device: M306NKFJ

Mode:
○ Download emulator firmware
○ Does not download emulator firmware
● Writing Flash memory

Power supply
☑ Power supply is carried out. (MAX 300mA)
○ 3.3 V ● 5.0 V

□ Do not show this dialog box again.

17. If you get the next window. Enter all 'F's in the next *ID Code verification* window. If that does not work use all '0's, or the ID-code that you had for your previous project.



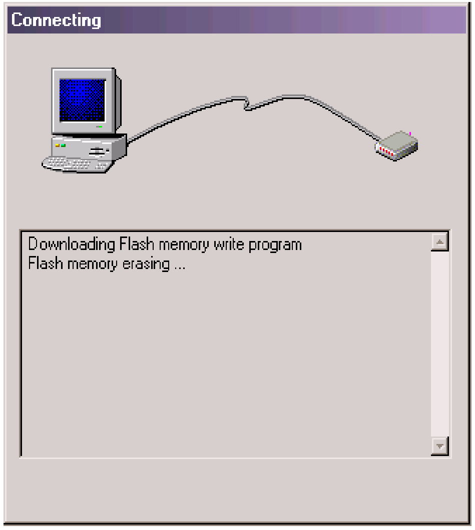
ID Code verification

Please input the ID code being written in the flash memory.

ID Code: 00000000000000

Input Mode
● Hex : Specify ID code by hexadecimal 14 digits.
○ ASCII : Specify ID code by ASCII character within 7 letters.

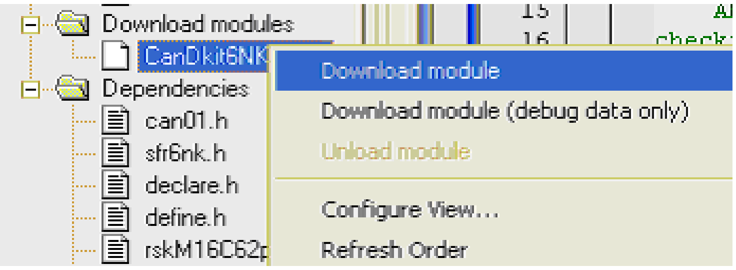
18. Click <**OK**>. The Flash memory write programmer will download.



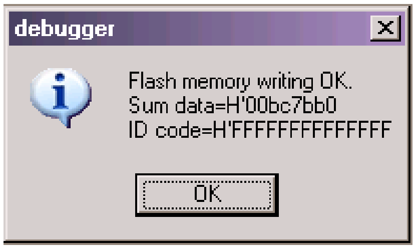
Connecting

Downloading Flash memory write program
Flash memory erasing ...

19. Now you can download the application into Flash by right-clicking on the .MOT binary.



20. If successful, you will see the following window. The *Sum data* will vary. ***Before clicking OK, make a note of the ID code if it is not all 0's or all F's.***



debugger

Flash memory writing OK.
Sum data=H'00bc7bb0
ID code=H'FFFFFFFFFFFFFF

21. Click <**Disconnect**> and disconnect the E8. The board is now ready to use.

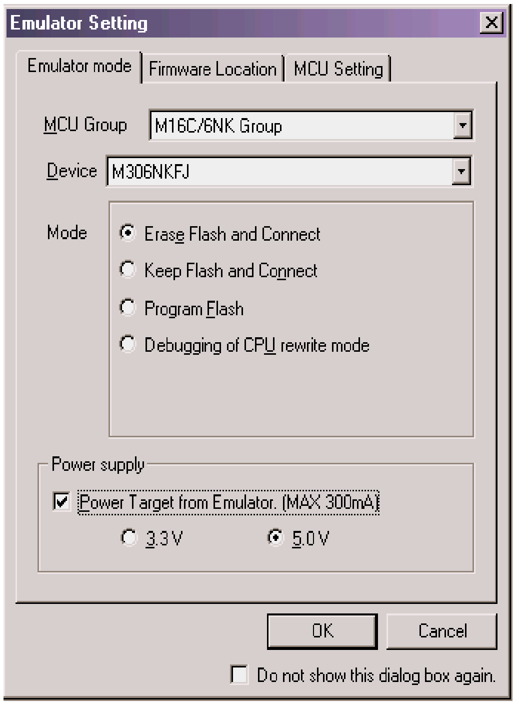
4.3. Debugging the RSK6NK

Note: *The Reset button on the RSK board can be used only when running a program in a non-debug session. Do not use the Reset button while in a debug session, or HEW and the target will lose communication with each other, causing errors.*

These steps for debugging the RSK6NK are very similar to the steps for debugging the RSK23 above.

1. Connect the E8 USB debugger to the RSK-6NK board and to the PC.

2. Launch HEW by double-clicking on the .HWS workspace file in folder `C:\Renesas\RCDK8C\demo_code\CANDKIT_23_29_6NK_87`. Close any initial connect windows that may come up.
3. Select the project for this RSK6NK via the menu 'Project->Set Current Project', if it is not already selected.
4. If not selected already, change the debug session to "SessionM16C_E8_SYSTEM" by clicking on "DefaultSession" in the debug session selector toolbar. If requested to save the session, click <**Yes**>.
5. If you don't see the "Select Emulator mode" dialog box, start the connection manually by selecting *Debug->Connect*.
6. In the "Emulator Setting" dialog box, select Device (MCU) "M306NKFJ" (if it is not selected already). Also select *Download emulator firmware*. Check the "Power supply is carried out" box and select *5.0 V*, unless you connected a separate 5V supply to the board with the provided cables. Click <**OK**> to continue



MCU Group: M16C/6NK Group

Device: M306NKFJ

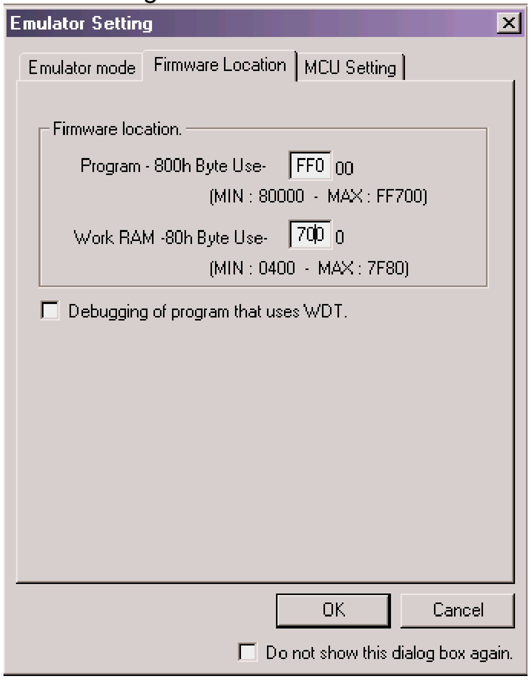
Mode
- ● Erase Flash and Connect
- ○ Keep Flash and Connect
- ○ Program Flash
- ○ Debugging of CPU rewrite mode

Power supply
- ☑ Power Target from Emulator. (MAX 300mA)
- ○ 3.3 V ● 5.0 V

☐ Do not show this dialog box again.

7. If the message "We should download new firmware" appears, click <**OK**>. The E8 will be updated.

8. Download the target debug kernel firmware into program flash for example at **FF0**00 and Work RAM starting at **700**0.



Emulator Setting

Firmware location.

Program - 800h Byte Use- FF0 00
(MIN : 80000 - MAX : FF700)

Work RAM -80h Byte Use- 700 0
(MIN : 0400 - MAX : 7F80)

□ Debugging of program that uses WDT.

□ Do not show this dialog box again.

9. You should see “connected” in the HEW debug window . If you get an error, something is wrong with your generated project or session. Check the settings you chose in the project generator.

10. From the “Debug” pull-down menu, select *Download Modules->All Download Modules*, or just double-click on the .X30 file icon in the left hand project pane.

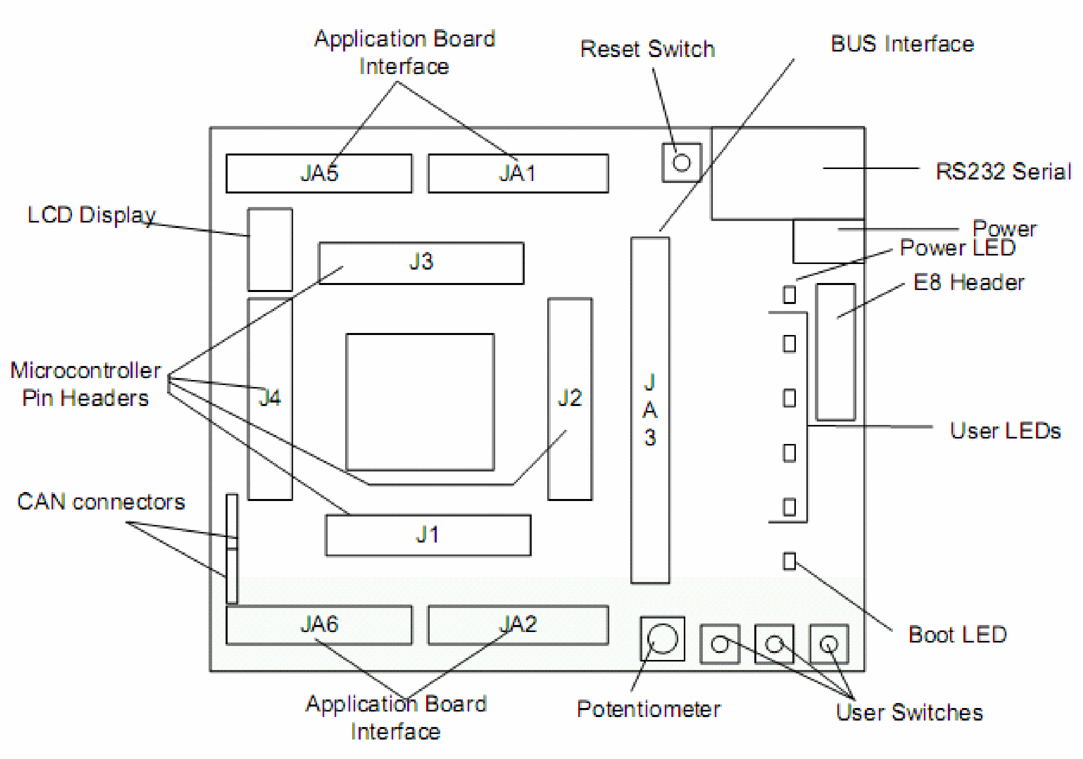
11. Use *Reset->Go* (F5) to run the target, the <**Stop**> icon to stop the code, F10 to step, etc., as described in *Debugging the RSK23* above.

5.0 The RSK-M32C87 Board

5.1. RSK Overview

The Kit’s CD-ROM contains CAN demo code for the RSK-M32C87 that works seamlessly with the demo code for RSK-R8C23, RSK-M16C29, RSK-M16C6NK, and RSK-M32C87 boards on the bus.

The RSK6NK boards are marked *RSKM32C87* or *ROK 33062PSxxx*. Details of the board can be seen in the layout document and schematics included on the CD.



5.1.1. The M32C/87 MCU

The RSK87 board incorporates an M32C/87 M306NK*xxx* MCU from the M16C/60 group of microcontrollers. This single-chip microcontroller operates using sophisticated instructions featuring a high level of instruction efficiency. With 1MB of address space, it is capable of executing instructions at high speed. Equipped with two CAN modules for two CAN channels, the microcontroller is suited to car audio and industrial control systems. The CAN modules comply with the 2.0B specification. This microcontroller also has a multiplier and DMAC, which, combined with fast instruction processing capability, makes it suitable for control of various OA and communication equipment that require high-speed arithmetic/logic operations.

Key features of the M32C/87:

- CAN Module: 2 channels with 2.0B specification
- Multifunction Timer A: 16 bits, 5 channels
- Timer B: 16 bits, 6 channels
- Three-phase motor control circuit
- Serial I/O: 3 channels
- Clock synchronous, UART, I²C-bus™, IEBus (4 channels)
- 10-bit A/D converter: 1 circuit, 26 channels
- D/A Converter: 8 bits, 2 channels
- DMAC: 2 channels
- CRC Calculation Circuit
- Watchdog
- Interrupts
  - Internal: 34 sources,
  - External: 12 sources
  - Software: 4 sources, Priority level: 7 levels

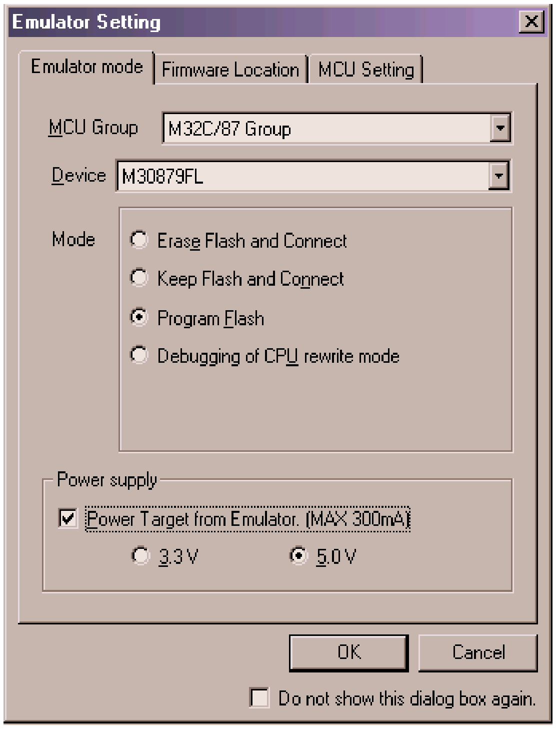
- Clock Generating Circuits: Main Circuit, Sub-clock Circuit, On-chip Oscillator, PLL Frequency Synthesizer

For more info go to http://www.renesas.com and click on `Products / MPU and MCU / M16C Family / M16C/60 Series.`

5.2. Programming the RSK87

This section covers programming an S-record (.MOT) file into an RSK-M32C87 target. If you wish to run the target in debug mode, see the next section.

12. Connect the E8 USB debugger to the RSK-R8C87 board and to the PC.
13. Launch HEW by double-clicking on the .HWS workspace file in folder `C:\Renesas\RCDK8C\demo_code\CANDKIT_23_29_6NK_87`. Close any initial connect windows that may come up.
14. Select the project for RSK87 via the menu 'Project->Set Current Project', if it is not already selected.
15. Select session "M32_E8". Or create a new session using the New Session Wizard. We will load an S-record, or MOT file to the MCU instead of the .X30 used for debugging. (You can see the session settings in the *Debug->Debug settings* menu.)
16. Press the <**Connect**> icon, or select menu *Debug->Connect*. A message box will appear. Choose MCU Device "M30879FL" and *Program Flash Memory*. Check the "Power target from Emulator" unless you use the separate DC supply that comes with the Kit, and select 3.3/*5.0 V*. Click <**OK**> to continue



MCU Group: M32C/87 Group

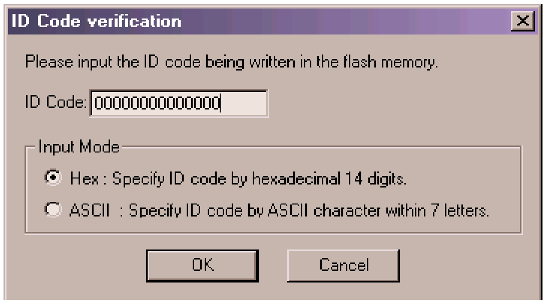
Device: M30879FL

Mode:
○ Erase Flash and Connect
○ Keep Flash and Connect
● Program Flash
○ Debugging of CPU rewrite mode

Power supply
☑ Power Target from Emulator. (MAX 300mA)
○ 3.3 V ● 5.0 V

□ Do not show this dialog box again.

17. Enter all 'F's in the next *ID Code verification* window. If that does not work use all '0's, or the ID-code that you had for your previous project



ID Code verification

Please input the ID code being written in the flash memory.

ID Code: 00000000000000

Input Mode

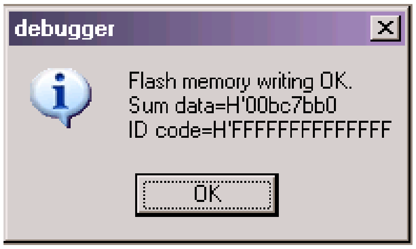
● Hex : Specify ID code by hexadecimal 14 digits.

○ ASCII : Specify ID code by ASCII character within 7 letters.

18. Click <**OK**>. The Flash memory write programmer will download.

19. Now you can download the application into Flash by double-clicking on the .MOT binary in the left hand pane under folder 'Download modules'. If it is not there, make sure the project CanDkit87 is selected and successfully compiled (F7).

20. If successful, you will see the following window. The *Sum data* will vary. ***Before clicking OK, make a note of the ID code if it is not all 0's or all F's.***



debugger

Flash memory writing OK.
Sum data=H'00bc7bb0
ID code=H'FFFFFFFFFFFFFF

21. Click <**Disconnect**> and disconnect the E8. The board is now ready to use.

5.3. Debugging the RSK87

Note: *The Reset button on the RSK board can be used only when running a program in a non-debug session. Do not use the Reset button while in a debug session, or HEW and the target will lose communication with each other, causing errors.*

These steps for debugging the RSK87 are very similar to the steps for debugging the boards above.

22. Connect the E8 USB debugger to the RSK-87 board and to the PC.

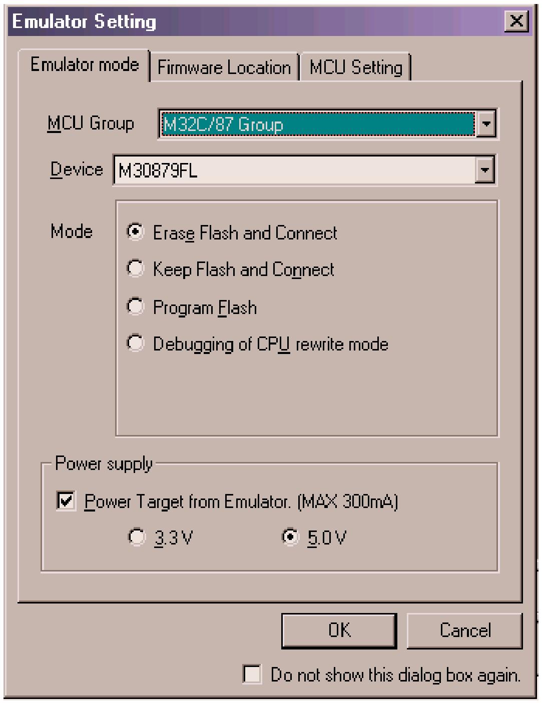
23. Launch HEW by double-clicking on the .HWS workspace file in folder `C:\Renesas\RCDK8C\demo_code\CANDKIT_23_29_6NK_87`.

24. Select the project for RSK87 via the menu 'Project->Set Current Project', if it is not already selected.

25. Close any initial connect windows that may come up. If not selected already, change the debug session to "SessionM16C_E8_SYSTEM" by clicking on "DefaultSession" in the debug session selector toolbar. If requested to save the session, click <**Yes**>.

26. If you don't see the "Select Emulator mode" dialog box, start the connection manually by selecting *Debug->Connect*.

27. In the "Emulator Setting" dialog box, select Device (MCU) "M30879FL" if not selected already. Also select *Erase flash and connect*. Check the "Power supply is carried out" box and select *5.0 V*, unless you connected a separate 5V supply to the board with the provided cables. Click <**OK**> to continue



Emulator Setting

Emulator mode | Firmware Location | MCU Setting

MCU Group: M32C/87 Group

Device: M30879FL

Mode
- ● Erase Flash and Connect
- ○ Keep Flash and Connect
- ○ Program Flash
- ○ Debugging of CPU rewrite mode

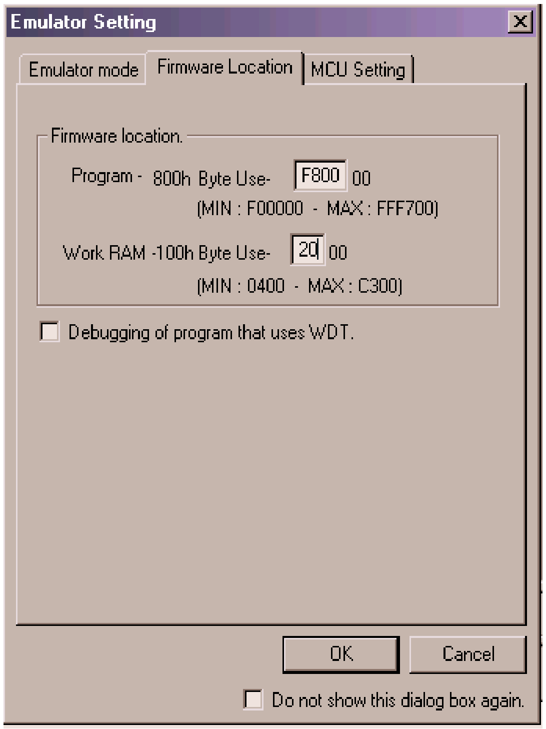
Power supply
- ☑ Power Target from Emulator. (MAX 300mA)
- ○ 3.3 V ● 5.0 V

OK Cancel

□ Do not show this dialog box again.

28. If the message “We should download new firmware” appears, click <**OK**>. The E8 will be updated.

29. In the firmware location tab, select Program Flash starting at for example **FF0**00 and Work RAM starting at **200**0. Press OK.



Emulator Setting

Emulator mode | Firmware Location | MCU Setting

Firmware location.

Program - 800h Byte Use- F800 00
(MIN : F00000 - MAX : FFF700)

Work RAM -100h Byte Use- 20 00
(MIN : 0400 - MAX : C300)

□ Debugging of program that uses WDT.

OK Cancel

□ Do not show this dialog box again.

30. You should see “connected” in the HEW debug window . If you get an error, something is wrong with your generated project or session. Check the settings you chose in the project generator.
31. From the “Debug” pull-down menu, select *Download Modules->All Download Modules*, or just double-click on the .X30 file icon in the left hand project pane.
32. Use *Reset->Go* (F5) to run the target, the <**Stop**> icon to stop the code, F10 to step, etc., as described in *Debugging the RSK23* above.

6.0 The RSK-R32C118 Board

6.1. Overview

The standard CAN demo workspace “CanDkit_23_29_6NK_87_118” contains a project for the RSK-R32C/118 that works seamlessly with the demos for any RSK-R8C23, RSK-M16C29, RSK-M16C6NK, and/or RSK-M32C87 boards on the bus.

The RSK118 boards are marked *RSK2R32C118* or *ROK564189Cxxx*. Details of the board can be seen in the schematics document for the board.

6.1.1. The R32C/118 MCU

The RSK87 board incorporates an R32C/100 CPU Core and has 64 MB of address space. Maximum operating frequency is 50 MHz when using PLL synthesizer. A Flash memory version is available. Internal Flash memory is programmable on a single power source.

This single-chip microcontroller operates using sophisticated instructions featuring a high level of instruction efficiency. Equipped with two CAN modules for two CAN channels, the microcontroller is suited to car audio and industrial control systems. The CAN modules comply with the 2.0B specification. This microcontroller also has a multiplier and DMAC, which, combined with fast instruction processing capability, makes it suitable for control of various high end applications e.g. communication equipment that require high-speed arithmetic/logic operations.

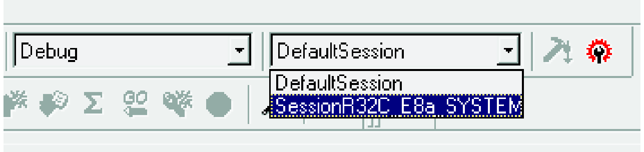
Key features of the R32C/118:

- 16-bit Multifunction Timer (Timers A and B, incl. three-phase motor control timer): 11
- Serial Interface: Asynchronous/synchronous serial interface, 9 channels
- Multi-master I^2C-bus Interface: 1 channel
- 10-bit A/D Converter: 34 channels*
- 8-bit D/A Converter: 2
- CRC Calculator
- X-Y Converter
- Intelligent I/O
  - Time Measurement (Input Capture): 16-bit x 16
  - Waveform Generation (Output Compare): 16-bit x 24
  - Serial Interface
- CAN Module compliant with ISO11898-1:
  1 channel (R32C/117) / 2 channels (R32C/118), 32 mailboxes
- DMAC: 4 channels
- DMAC II: Can be activated by any peripheral interrupt sources, for example processing the CAN FIFO interrupt

- Watchdog Timer
- External Interrupt Inputs: 14
- Clock Generation Circuits: Main clock, Sub clock, PLL, On-chip Oscillator
- Oscillation Stop Detector
- 5V Tolerant Input
- Voltage Detector (optional)
- I/O Ports: 120
- Data Flash: 4 KB × 2 blocks

6.2. Connecting to the RSK118

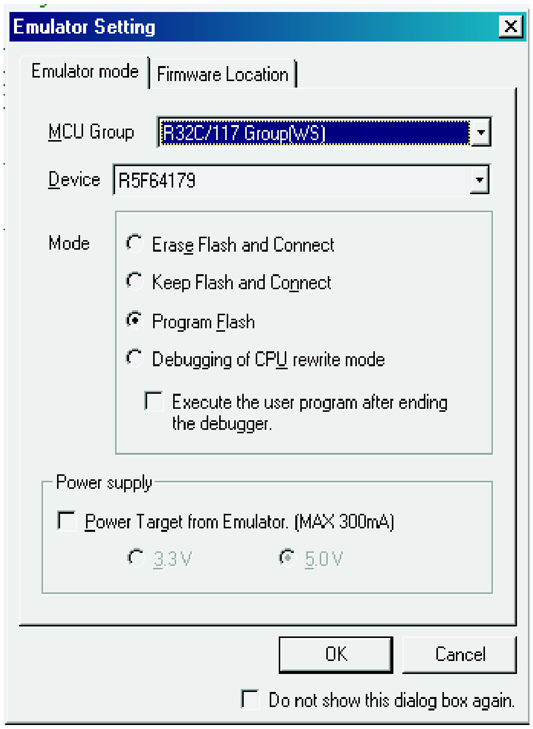
1. Connect the E8 USB debugger to the RSK-R32C118 board and to the PC.
2. Launch HEW by double-clicking on the .HWS workspace file in folder `C:\Renesas\RCDK8C\demo_code\CanDkit_23_29_6NK_87_118`.
3. Close the Emulator Setting window if it comes up.
4. Select the project ‘CanDkit_R32C118’ from the menu ‘Project->Set Current Project’, if it is not already selected.
5. Select session “SessionR32C_E8a_SYSTEM”. Or create a new E8a debug session using the New Session Wizard. (File->New Session.)



6. Press the <**Connect**> icon, or select menu *Debug->Connect*. The Emulator Setting window should come up.

6.3. Programming the RSK118

1. Follow first the steps under “Connecting to the RSK118”.
2. You should see the Emulator Setting window.



MCU Group: R32C/117 Group(WS)

Device: R5F64179

Mode:
○ Erase Flash and Connect
○ Keep Flash and Connect
● Program Flash
○ Debugging of CPU rewrite mode
□ Execute the user program after ending the debugger.

Power supply
□ Power Target from Emulator. (MAX 300mA)
○ 3.3 V ● 5.0 V

□ Do not show this dialog box again.

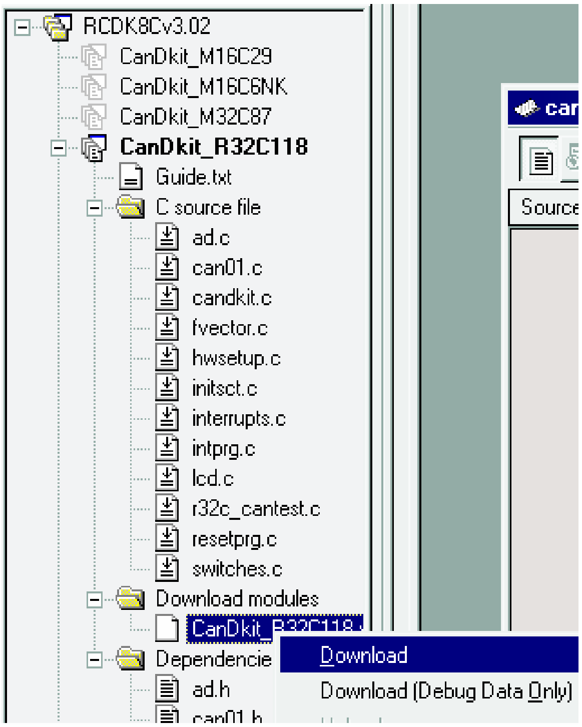
3. In the Emulator mode tab, choose MCU Device “R5F64179” or the device that is on your RSK, and *Program Flash*. Check the “Power target from Emulator” unless you use the separate DC supply that comes with the Kit, and select 3.3/*5.0 V*. (5.0 V is needed for the LCD.)
   Click <**OK**> to continue.

4. If a message appears asking whether to download new firmware for the debugger appears, click <**OK**>. The E8a will be updated.

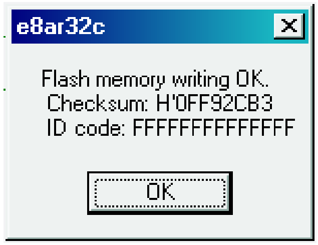
5. If the *ID Code verification* window comes up, enter all ‘F’s. If that does not work use all ‘0’s, or the ID-code that you had the last time you programmed the device.

6. You are connected if you see the icon. If not, select disconnect, reset the E8a debugger, and start over.

7. Now you can download the application into Flash by double-clicking on the .MOT binary in the file window pane to the left, under folder ‘Download modules’, or by left clicking on it. If it is not there, make sure the project is successfully compiled (F7).



8. Watch the output window showing writes to the flash memory blocks. If successful, you will see the following window. The Checksum will vary. ***Before clicking OK, make a note of the ID code if it is not all 0's or all F's****, as this will be needed at any future attempts to connect to the device.*


e8ar32c

Flash memory writing OK.
Checksum: H'0FF92CB3
ID code: FFFFFFFFFFFFFF

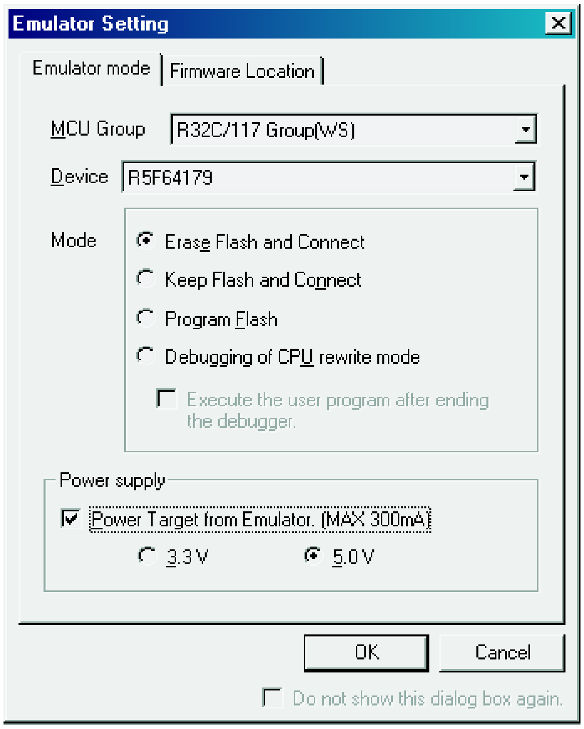
9. Click <**Disconnect**>.

10. Disconnect the E8a. The board is now ready to run standalone without the E8a debugger. Press the reset switch on the RSK to run.

6.4. Debugging the RSK-R32C118

11. Follow first the steps under “Connecting to the RSK118”.

12. You should see the Emulator Setting window.



Emulator Setting

Emulator mode | Firmware Location

MCU Group: R32C/117 Group(WS)

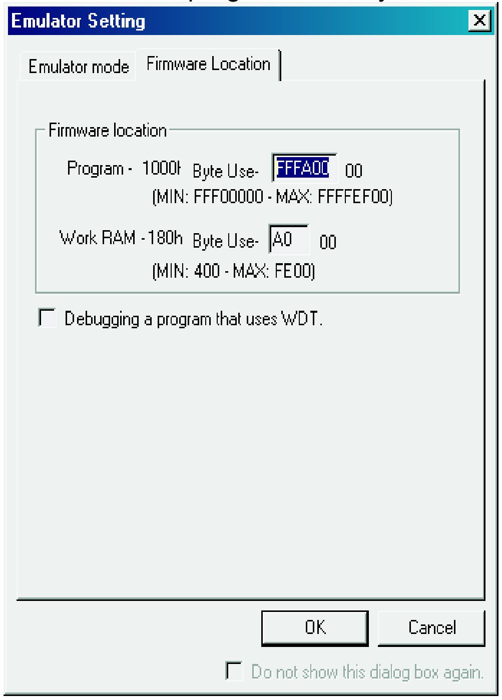
Device: R5F64179

Mode
- ● Erase Flash and Connect
- ○ Keep Flash and Connect
- ○ Program Flash
- ○ Debugging of CPU rewrite mode
- □ Execute the user program after ending the debugger.

Power supply
- ☑ Power Target from Emulator. (MAX 300mA)
- ○ 3.3 V ● 5.0 V

13. In the Emulator mode tab, choose MCU Device “R5F64179” or the device that is on your RSK, and *Program Flash*. Check the “Power target from Emulator” unless you use the separate DC supply that comes with the Kit, and select 3.3/*5.0 V*. (5.0 V is needed for the LCD.)

14. Click on the Firmware tab, enter the emulator firmware (debug kernel) location. For example **FFFA00**00 for its program memory and **A0**00 for its RAM location.



Emulator Setting

Emulator mode | Firmware Location

Firmware location

Program - 1000h Byte Use- FFFA00 00
(MIN: FFF00000 - MAX: FFFFEF00)

Work RAM - 180h Byte Use- A0 00
(MIN: 400 - MAX: FE00)

□ Debugging a program that uses WDT.

15. Click <**OK**>. The Flash memory write programmer will download the debug firmware.

16. If a message appears asking whether to download new firmware for the debugger appears, click <**OK**>. The E8a will be updated.
17. If the *ID Code verification* window comes up, enter all ‘F’s. If that does not work use all ‘0’s, or the ID-code that you had the last time you programmed the device.
18. You are connected if you see the icon . If not, select disconnect, reset the E8a debugger, and start over.

Note: The Reset button on the RSK board can be used only when running a program in a non-debug session. Do not use the Reset button while in a debug session, or HEW and the target will lose contact.

19. From the “Debug” pull-down menu, select *Download Modules->All Download Modules*, or just double-click on the .X30 file icon in the left hand project pane.
20. Use *Reset->Go* (F5) to run the target, the <**Stop**> icon to stop the code, F10 to step, etc., as described in *Debugging the RSK23* above.

7.0 The SysTec CAN Sniffer

See the Quick Start Guide for the CAN D Kit for instructions on how to use the Sniffer, and see the CAN D Kit User Manual for additional details.