Freescale Semiconductor
Application Note

Document Number: AN4061
Rev. 0, 02/2010

i.MX31 PDK Power Measurement with GUI

by *Multimedia Application Division*
Freescale Semiconductor, Inc.
Austin, TX

This application note describes the power measurement capabilities of the i.MX31 PDK. The details on obtaining these measurements from the PDK31 debug board, using an 8-bit MCU board for data acquisition, and running the graphical user interface (GUI) into the PDK31 which shows all the current and power measurements, are also described in this application note.

Contents

1 Overview

Figure 1 shows the PDK31 connected to the MCU board.

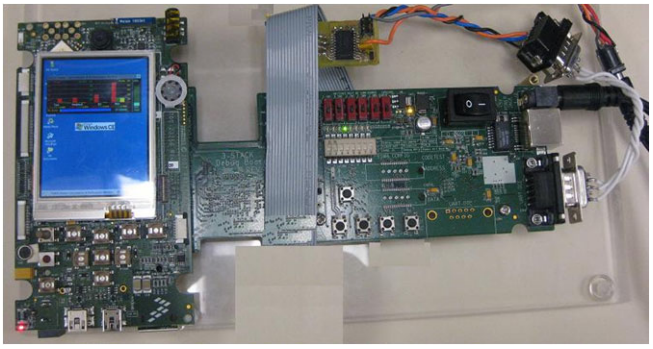


Figure 1. PDK31 Connected to MCU Board

1.1 Block Diagram of the System

Figure 2 shows a block diagram of the system.

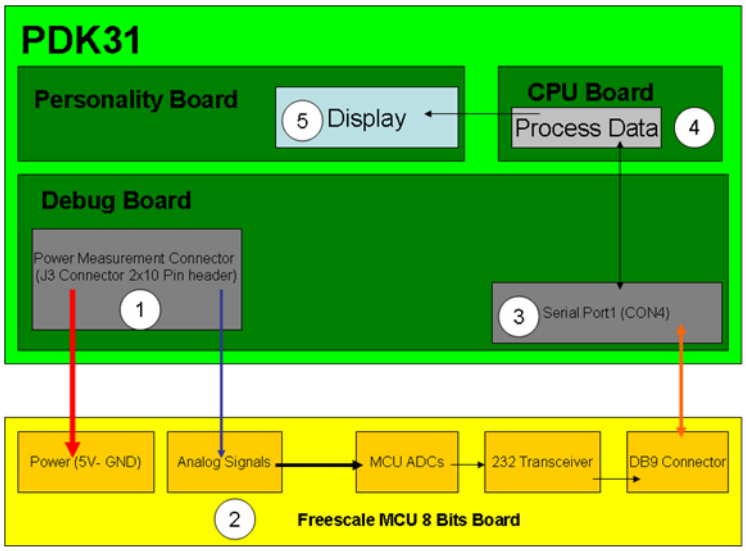


Figure 2. Block Diagram of the System

The following items are shown on Figure 2.

1. J3 on the PDK31 debug board provides power and provides all current measurement signals to the 8-bits MCU Board.
2. The 8-bit MCU takes the current measurement signal through the ADC port (analog to digital converter port), processes it, and sends it to the RS232 transceiver to convert the signals from TTL level to RS232 level. The transceiver is tied to the DB9 connector for connecting it to the PDK31 CON4 (serial port1 on debug board).
3. The PDK31 CON4 (serial port1 on debug board) is controlled by a Windows CE 5.0 or 6.0 GUI.
4. The PDK31 CPU board runs the GUI (executable file) to send and receive data from CON4. The information is processed and the data is displayed in a graphical form on the LCD display.
5. The LCD display of the PDK31 personality board shows the GUI, current, and power measurements.

2 Current Measurements from the PDK31

Figure 3 shows the PDK31 and the J3 (Current Measurement Connector).

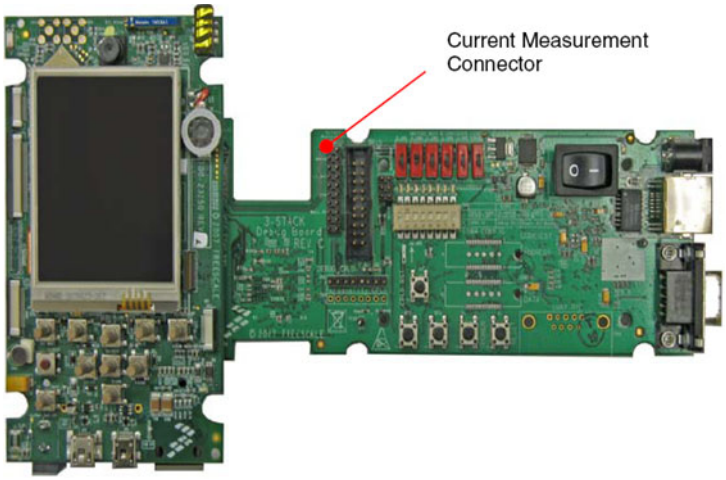


Figure 3. PDK31 Current Measurement Connector

All the current measurement pins are the output pins of each current sensor (Maxim MAX4071) that the PDK31 CPU board has for this purpose. Table 1 shows the pin-out of the PDK31 J3 connector.

Table 1. Current Measurement Connector Pin-Out

Pin Number	Description
1	Ground (Take this Ground pin for 8-bit MCU Board Power)
2	SW1 Core and L2 current (1V2_1V6_SW1) (Take this pin for Current Measurement to 8-bit MCU board ADC)
3	VMAIN voltage (Take this Ground pin for 8-bit MCU Board Power)
4	1.8 V Memories (1V8_SW2A)
5	Ground
6	VMAIN current (Take this pin for Current Measurement to 8-bit MCU board ADC)
7	LI_BATTERY voltage
8	Reserved
9	Ground
10	Reserved
11	1.8 V voltage
12	1.8 V peripherals (EXT_1V8) (Take this pin for Current Measurement to 8-bit MCU board ADC)
13	Ground
14	3.3 V to HDD (HDD_3V3) (Take this pin for Current Measurement to 8-bit MCU board ADC) for the author verify ths pin
15	WALL_5V_IN

Table 1. Current Measurement Connector Pin-Out (continued)

Pin Number	Description
16	Wall Supply 5V (WALL_5V_IN)
17	Ground
18	Lithium Battery (LI_BATTERY)
19	Ground
20	Reserved

Equation 1 shows the current measurement formula:

$$I(mA) = (\text{Pin Voltage read}(V) - 1.5V) \times 500 \qquad \text{Eqn. 1}$$

Table 2 provides an example of the current consumption values for a given voltage on the pin.

Table 2. Example of Current Consumption Values

Voltage at J3 Connector Pin No. 2 (Core Current)	Current (mA)
3.5 V of Voltage Read: 3.5 V - 1.5 V = 2, 2×500 = 1000	1000
2.5 V	500
1.5 V	0
0.5 V	- 500

2.1 8-bit MCU MC9S08SH4 Board Schematics

Figure 4 shows the board schematics.

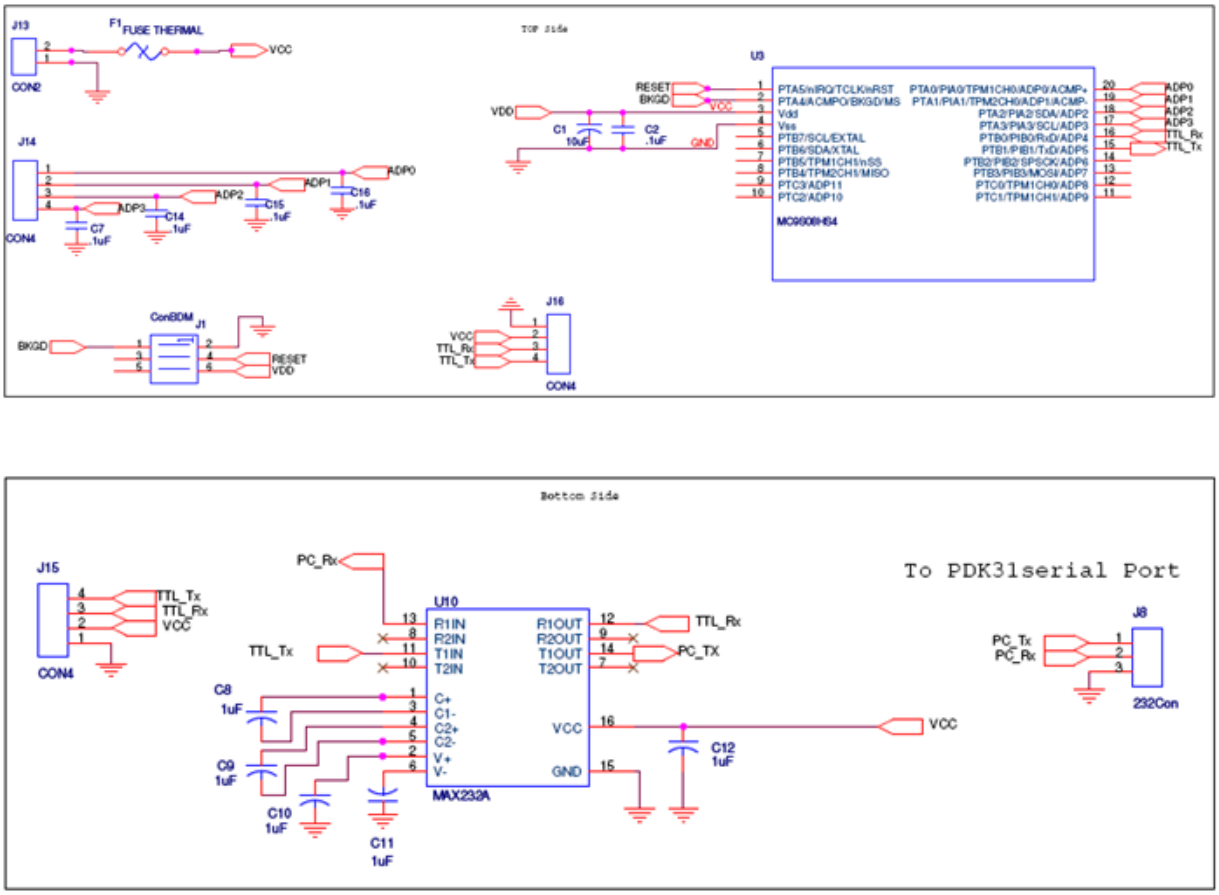


Figure 4. Board Schematics

2.2 Freescale MCU MC9S08SH4 Board BOM

Table 3 describes the board BOM.

Table 3. Board BOM

Item	Quantity	Reference	Part	DigiKey Part No.	
1	1	ConBDM	J1	—	—
2	1	C1	10uF	—	—
3	10	C2,C7,C8,C9,C10,C11,C12,C14,C15,C16	.1uF	—	—
4	1	F1	FUSE THERMAL	—	—
5	1	J8	232Con	—	—
6	1	J13	CON2	—	—

Table 3. Board BOM (continued)

Item	Quantity	Reference	Part	DigiKey Part No.	
7	3	J14,J15,J16	CON4	—	—
8	1	U3	MC9S08HS4	—	—
9	1	U10	ST3232CDR	—	—

2.3 Freescale MCU MC9S08SH4 Board Firmware

The CodeWarrior project for the MC9S08SH4 is available at www.freescale.com. Download it and program the MCU to test this application note.

3 PDK31 Power Monitor GUI

The PDK31 power measurement GUI is developed with Microsoft Visual Studio 2005 using Visual Basic 2005 for Windows CE 5.0 (.NET Compact Framework). The GUI displays the current and power measurements in a user-friendly bar chart.

For this purpose, the GUI interacts with the 8-bit MCU as shown in Figure 5.

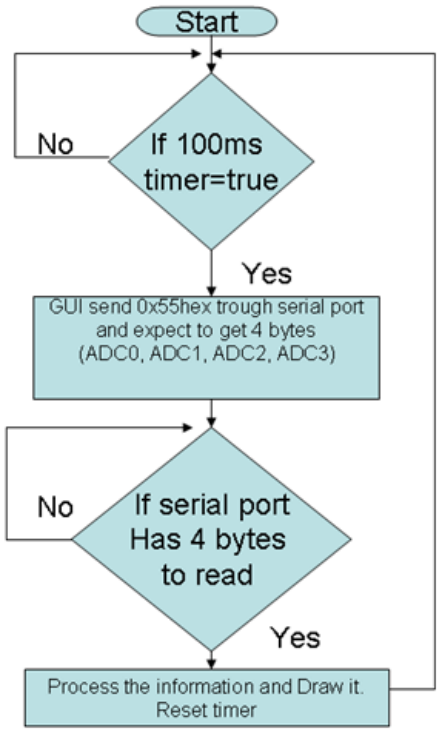
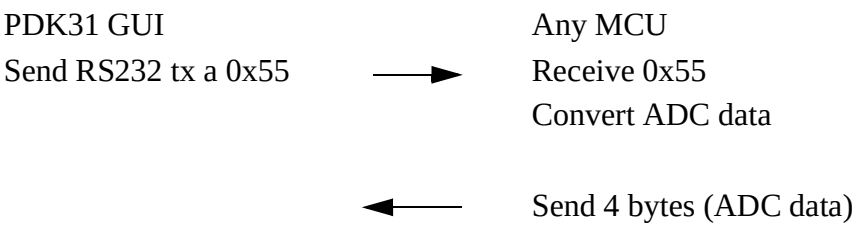


Figure 5. Flow Diagram

Any MCU can be used to convert the analog signals of the current measurements and perform the steps listed in Figure 5. These steps are as follows:

1. For every 100 ms the GUI and MCU does the following



2. Process the information, display it, and reset the timer to start the count of 100 ms.

NOTE

The protocol is very simple. The loss of MCU time can be avoided by not implementing a long bytes protocol with ID preamble message and checksum. The system is interconnected by a cable (not an RF or wireless system) and the cable is not too long, this helps to receive the information at 97% integrity.

4 Setting and Starting the PDK31 GUI Application

The following steps are used to set and start the PDK GUI application:

1. Download the Microsoft Windows CE image file—PDK31 Power Monitor GUI Windows CE 6.0 Image.zip from www.freescale.com.

   This image contains:

   – .NET Compact Framework that the GUI needs
   – A driver for CPU load (see Section 4.1, “CPU Load Driver”)
   – Platform.reg modifications (see Section 4.2, “Modifying Platform.reg”)
   – The PDK31_PowerMonitorGUI.exe application file
2. Burn the PDK31 with the image described in step 1.
3. Connect the MCU board to PDK31 J3 connector (power measurements) and to serial port (CON4).
4. Turn on the PDK31 and go to My Device > Windows and double-click the PDK31_PowerMonitorGUI.exe file.

The GUI displays the data as shown in Figure 6.

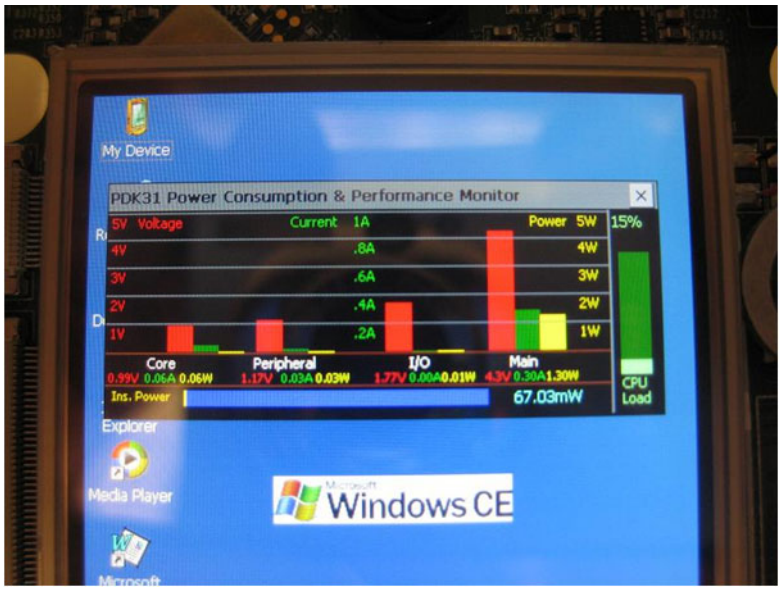


Figure 6. GUI Display

The GUI has the following scales:

1. The red scale is for the voltage from 0 V to 5 V
2. The green scale is for current from 0 A to 1 A
3. The yellow scale is for power from 0 W to 5 W

All the data measurements are in groups of three bar graphs. Under each group the domain label of that particular bar graph group (core, peripheral, I/O, main) is displayed. Each bar has a color and these colors represent voltage (red), current (green), or power (yellow).

Similarily, under the name of each group (core, peripheral, I/O, main) the values and units are displayed with the same colors. These values are the voltage, current, and power measurements of each group. At the bottom of the display is, the Instant Core Power horizontal bar graph is displayed. At the right side the CPU load vertical bar graph is displayed. This graph shows the CPU percentage of a video, audio, or application. With this feature, the performance of specific applications can be monitored and the amount of power consumed by the application is known.

The following are the steps to monitor power:

1. Turn on the PDK31 and go to My Device > Windows and double-click the PDK31_PowerMonitorGUI.exe file.
2. The power monitor GUI window is displayed at the top of the screen.
3. By default, the GUI shows about 70 mW of core power.
4. If a video is played, then about 300 mW of core power is displayed.
5. Run a specific application to see the power consumptions and the performance (CPU load) in real time.

4.1 CPU Load Driver

This CPU load driver is embedded on the WinCE 6.0 image. (Download the Microsoft Windows CE image file— PDK31 Power Monitor GUI Windows CE 6.0 Image.zip from www.freescale.com). To obtain the driver code for other purposes, download it from www.freescale.com.

4.2 Modifying Platform.reg

To modify a Microsoft Windows CE Image to run the PDK31 power monitor application, perform the following changes on the Platform Builder:

1. Edit Platform.reg

```
[HKEY_LOCAL_MACHINE\Drivers\BuiltIn\COM1]
"DeviceArrayIndex"=dword:0
"IoBase"=dword:43F90000
"IoLen"=dword:D4
"Prefix"="COM"
"Dll"="csp_serial.dll"
"Index"=dword:1
"Order"=dword:9
[HKEY_LOCAL_MACHINE\Drivers\BuiltIn\COM1\Unimodem]
"Tsp"="Unimodem.dll"
"DeviceType"=dword:0
"FriendlyName"="MGN COM1 UNIMODEM"
"DevConfig"=hex: 10,00, 00,00, 05,00,00,00, 10,01,00,00, 00,4B,00,00, 00,00, 08, 00, 00,
00,00,00,00
```

   The last paragraph enables the PDK31 serial port (CON4).

   Cut and paste last paragraph before the following line:

```
@CESYSGEN IF CE_MODULES_SERIAL
```

2. Open the `bsp_cfg.h` file and apply next changes:

   To completely disable debug port messages, define `DEBUG_PORT` to `0`

```
//#define DEBUG_PORT DBG_UART1
#define DEBUG_PORT 0
```

3. Finally, run Build current BSP and Subprojects.

5 Revision History

Table 4 provides a revision history for this application note.

Table 4. Document Revision History

Rev. Number	Date	Substantive Change(s)
0	2/2010	Initial Release

THIS PAGE INTENTIONALLY LEFT BLANK

THIS PAGE INTENTIONALLY LEFT BLANK

How to Reach Us:

Home Page:
www.freescale.com

Web Support:
http://www.freescale.com/support

USA/Europe or Locations Not Listed:
Freescale Semiconductor, Inc.
Technical Information Center, EL516
2100 East Elliot Road
Tempe, Arizona 85284
1-800-521-6274 or
+1-480-768-2130
www.freescale.com/support

Europe, Middle East, and Africa:
Freescale Halbleiter Deutschland GmbH
Technical Information Center
Schatzbogen 7
81829 Muenchen, Germany
+44 1296 380 456 (English)
+46 8 52200080 (English)
+49 89 92103 559 (German)
+33 1 69 35 48 48 (French)
www.freescale.com/support

Japan:
Freescale Semiconductor Japan Ltd.
Headquarters
ARCO Tower 15F
1-8-1, Shimo-Meguro, Meguro-ku
Tokyo 153-0064
Japan
0120 191014 or
+81 3 5437 9125
support.japan@freescale.com

Asia/Pacific:
Freescale Semiconductor China Ltd.
Exchange Building 23F
No. 118 Jianguo Road
Chaoyang District
Beijing 100022
China
+86 10 5879 8000
support.asia@freescale.com

For Literature Requests Only:
Freescale Semiconductor
Literature Distribution Center
1-800 441-2447 or
+1-303-675-2140
Fax: +1-303-675-2150
LDCForFreescaleSemiconductor
@hibbertgroup.com

Document Number: AN4061
Rev. 0
02/2010