Sim64KS Hardware Reference Manual Revision 1.01

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CONTENTS

1.0 Hardware Overview

The Sim64KS Simulator consists of hardware and software parts. The Simulator Software requires hardware function boards connected to a personal computer by an interface board for microcontroller simulation. The function boards perform the microcontroller simulation, and the result is transmitted to the personal computer via a computer interface adapter card.

The Simulator Hardware consists of the following components:

Hardware Components:
1. ISA or PCI Computer Adapter Card
2. Simulator Function Boards
3. CROSC Boards
4. ADPOD Boards

Accessories
1. 50-Pin Adapter Cable
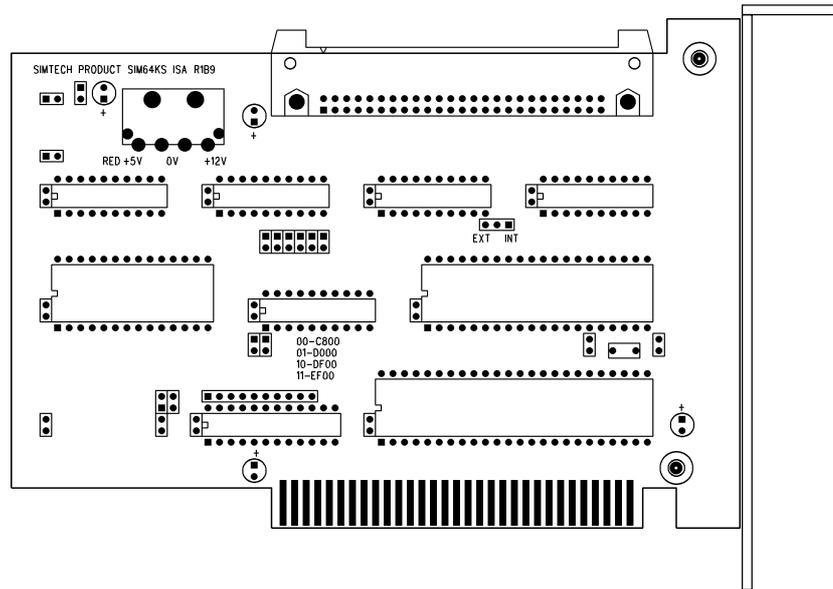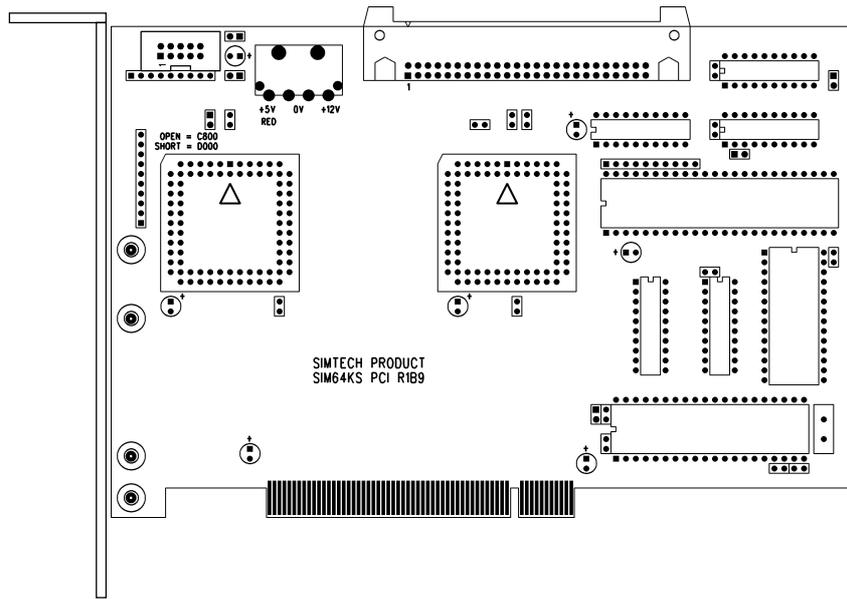2. 40-Pin I/O User Cable
3. 40-Pin LCD User Cable

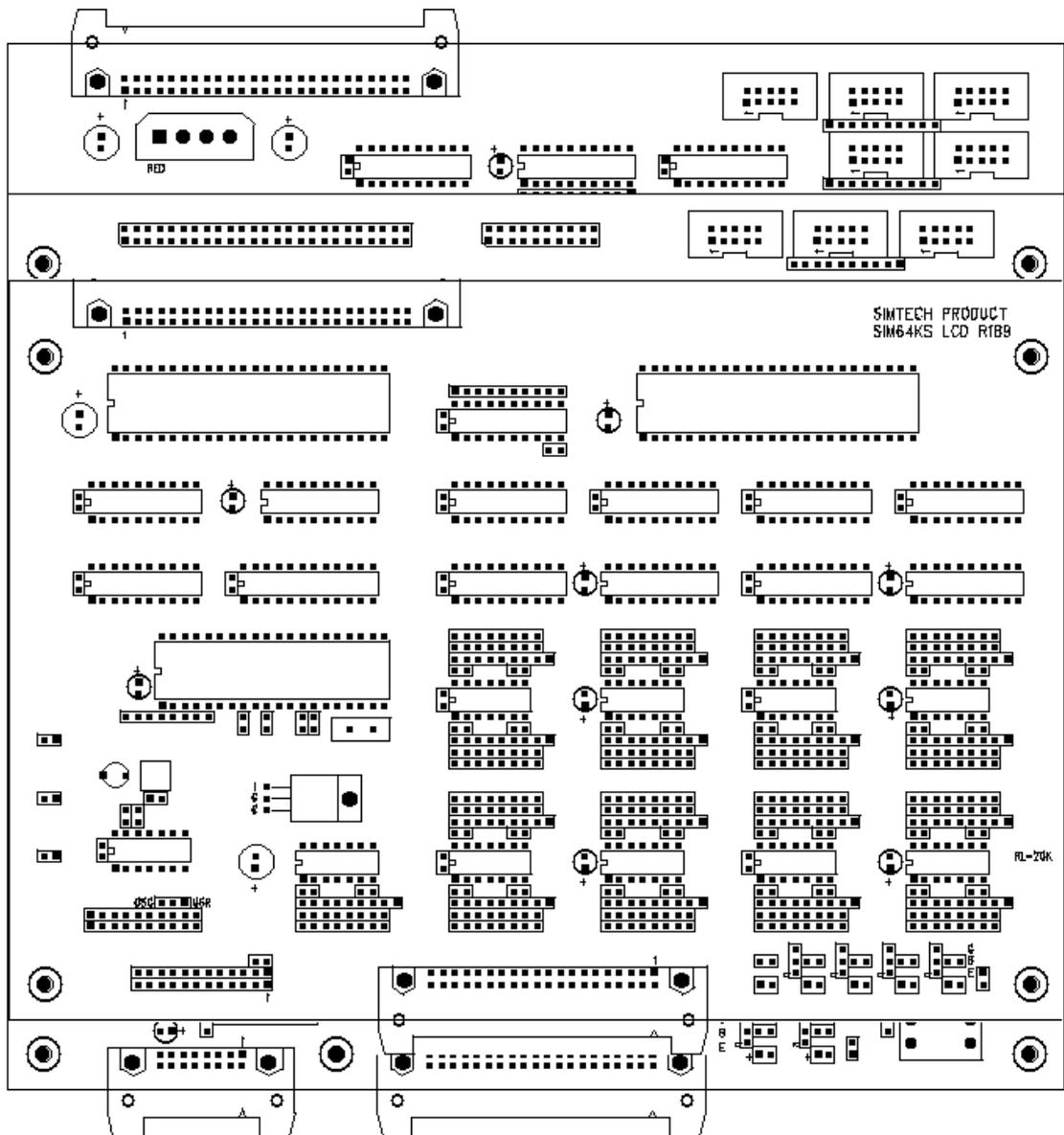**Figure 1-1 PCI (upper) and ISA (lower) Computer Interface Board**
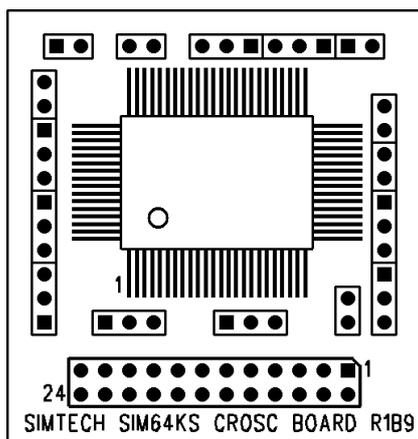
Figure 1-2 Sim64KS Function Boards
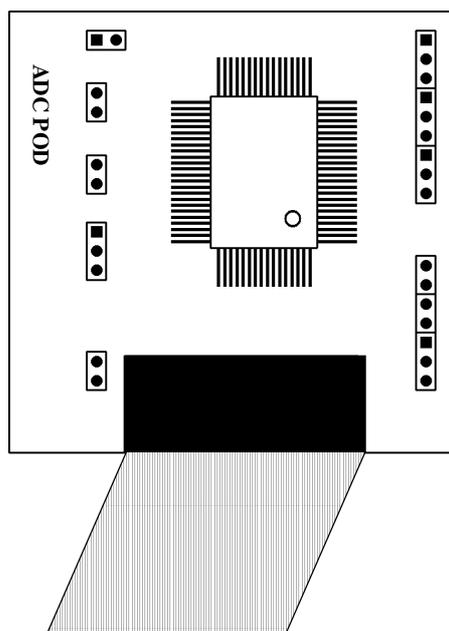
Figure 1-3 Sim64KS CROSC Board

Figure 1-4 ADPOD Board

2.0 ISA or PCI Computer Adapter Card

The computer adapter card is installed into a Personal Computer with expansion slots for ISA or PCI bus interface.

Since each set of Simulator hardware commonly supplied with one type of interface card, and the computer may be constructed with only one bus interface, please consult the computer hardware manual and acquire the right interface card for your computer.

The Simulator function boards are external devices to the computer system, and require power supply from the computer by connecting a power cable to the adapter card.

2.1 Hardware Installation

Installation Prepare

The adapter card must be set to proper card address in order to run the Simulator Software. Any other computer devices or the computer motherboard must not use the same address. There will be resource conflict if other devices occupy the same address and the adapter card cannot work.

The default address is "C800" and is commonly not used by other devices. Please check the jumpers labeled with "JA1" and "JA2" (only JA1 for PCI), the jumpers should be left open for using with the default address.

Installation Instructions

1. Set proper card address for use in the adapter card.
2. Turn off computer power and open the computer's case.
   NOTE: Some computer motherboards (especially for ATX Form Factor motherboards) supply power to computer slots even when the computer is turned off. To prevent damage to your computer or adapter card, always remove the power cord from the computer power supply when installing or removing the adapter card.
3. Locate a free expansion slot and insert the card firmly into the slot.
4. Find a free power cable and connect it to the power connector (white in color) of the adapter card, make sure the red cable situated on the right side of the power connector labeled with "RED".
5. Connect the 50-pin flat cable from the adapter card to the Simulator Function Boards.
6. Replace the computer's cover and restart the system.

After you have installed the adapter card, and run the Simulator Software. The Simulator Software will auto-detect the address setting in the adapter card.

If the Simulator Software cannot find the adapter card, there may be conflict on the card address. You may need to change to other address options.

For a successful installation, the address is shown in the "I/O Card Address" item of the Project Window.

2.1.1 Sim64KS ISA Interface Board
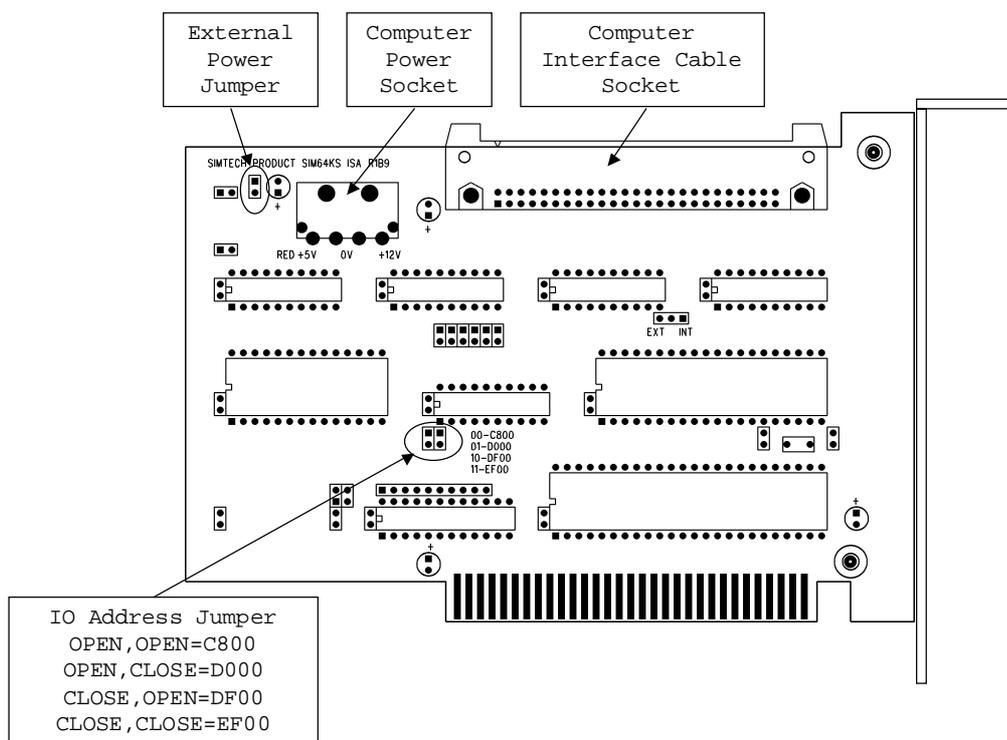
Figure 2-1 Sim64KS ISA Interface Board

Specifications for ISA Adapter Card

- 8-bit ISA bus interface
- Maximum 8Mhz bus clock
- Four Card address options by hardware jumpers
- 4-Pins computer standard power connector
- 50-Pins function board connection cable

2.1.2 Sim64KS PCI Interface Board
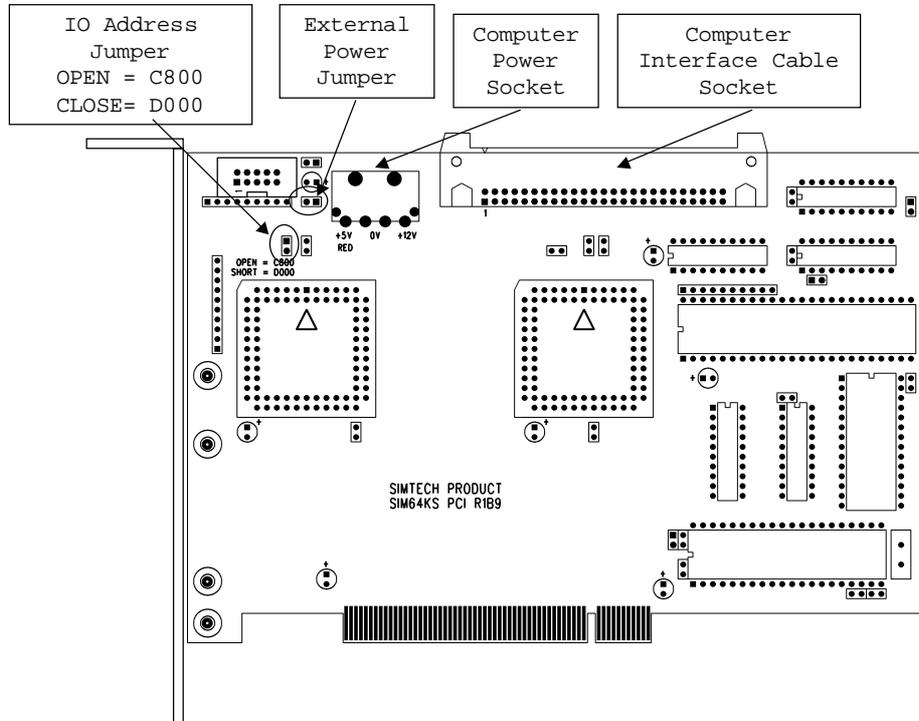
Figure 2-2 Sim64KS PCI Interface Board

Specifications for PCI Adapter Card

- 32-Bit interface bus
- Maximum 33MHz bus clock
- Support PCI Revision 2.0
- Two Card address options by hardware jumpers
- 4-Pins computer standard power connector
- 50-Pins function board connection cable

2.2 Card Address Options

<u>**Card Address Option for ISA Interface Card**</u>

The option jumpers are located near the top left corner of the interface card, and are labeled with "JA1" and "JA2". Each jumper can be set to 0 or 1 for user defined card address. There are four address options:

Option 1: 00 for Address C800…C8FF (default)

Option 2: 01 for Address D000…D0FF

Option 3: 10 for Address DF00…DFFF

Option 4: 11 for Address EF00…EFFF

<u>**Card Address Options for PCI Interface Card**</u>

The option jumper is located near the top center of the interface card, and is labeled with "JA1". The jumper can be set to 0 or 1 for user defined card address.
There are two address options:

Option 1 : Address C800 … C8FF (default)

Option 2 : Address D000 … D0FF

Symbol Notations:

	Indicate OPEN setting,	Indicate SHORT setting,
	No jumper inserted and	Inserted with jumper and
	Denoted as "0"	Denoted as "1"

The interface card must be set to proper card address before the computer is turned on. Other devices must not use the same address in the computer system.

The memory address range must also be excluded from using by the operating system (OS) or other software.

Modify the CONFIG.SYS System File Settings in the Operating System.

Example for DOS operation system and card address option 1

```
SHELL = C:\COMMAND.COM C:\ /p
FILES = 50
DOS = HIGH,UMB
DEVICE = C:\DOS\HIMEM.SYS
DEVICE = C:\DOS\EMM386.EXE NOEMS X=C800-C8FF
```

Example for Windows operation system and card address option 1

```
SHELL = C:\COMMAND.COM C:\ /p
FILES = 50
DOS = HIGH,UMB
DEVICE = C:\WINDOWS\HIMEM.SYS
DEVICE = C:\WINDOWS\EMM386.EXE NOEMS X=C800-C8FF
```

Replace X=address with the address according to the jumper settings in the interface card.

2.3 Computer Power Connector

Pin Layout of Power Connector

Symbol	Pin No.	Supply Voltage	Common Cable Color
	1	+5 V	RED
	2	0 V	BLACK
	3	0 V	BLACK
	4	+12 V	YELLOW

2.4 External Power Jumper

Some computers may not provide enough power due to connecting too much devices or low output from power supply (recommend 250W power supply).

In this case, user can use an external computer power supply to connect to Simulator Function Boards.

External Power Jumper must be shorted when using external power supply. Refer to Figure 2-2 for location of External Power Jumper.

Factory default of External Power Jumper is shorted.

*** ATTENTION ***
- When using external power supply socket by external power supply, the power socket at Interface Board is no need to be connected.
- When using external power, the external power supply should be switched on before the computer is switched on.

2.5 Measuring Computer Power Supply

Insufficient power supplied by computer power supply may result in abnormal hardware functionalities.

User can measure the power supplied from computer by connecting voltmeter with the positive probe to JVCC and negative probe to JGND jumpers. Refer to Figure 3-1 for locations of JVCC and JGND jumpers.

The measured voltage should be minimum 4.9V.

If measured voltage is found to be lower than 4.9V, external power should be used or should change the computer power supply with higher output.

3.0 Simulator Function Boards

The Simulator Function Boards provide simulation of microcontroller software and hardware features. Simulator provides simulation of nX-4 Microcontroller instruction execution.

3.1 Sim64KS Simulator Function Boards Layout

ITEM	DESCRIPTION
Interface Board Connector	For connecting the 50 pin flat cable from the Sim64KS Computer Interface Board This connector should be connected to the cable all the time when the Sim64KS Computer Interface board is installed in the computer
External Power Connector	The External Power Connector is used when the host computer does not supply enough power to the Simulator Hardware To ensure sufficient the power supplied from the computer, check the voltage between the jumpers JVCC and JGND on the top of the Simulator Function Boards. Voltage between JVCC and JGND as follows : Minimum : 4.8V Nominal : 5.0V Maximum : 5.5V
JVCC Jumper	Pin for measuring the power supplied from the computer
JGND Jumper	Pin for measuring the power supplied from the computer
CROSC Board Socket	Plug the CROSC Board on this socket to enable fast clock function
ADPOD Connector	Connect ADPOD Board cable to this connector to enable ADC function
LCD Cable Connector	Connecting LCD cable can output display to LCD Panel
User IO Cable Connector	Connect User IO Cable can have input and output ports interaction with user's prototype board
CPU Reset Button	Press and release this button can perform CPU reset function
LED Indicators	Indicates Simulator status

Sim64KS Simulator Function Boards

External Power Connector

Interface Board Connector

SIMTECH PRODUCT
SIM64KS LCD R1B9

RL-20K

VCC Jumper

GND Jumper

Pin 1

CROSC Board Socket

ADPOD Connector

LCD Cable Connector

User IO Cable Connector

CPU RESET

Fast Clock Jumper

ROS Resistor

GND Jumper

Pin 1

CROSC Board

POWER   RUN   1.5 V   3.0 V   5.0 V

FAST CLOCK   HALT
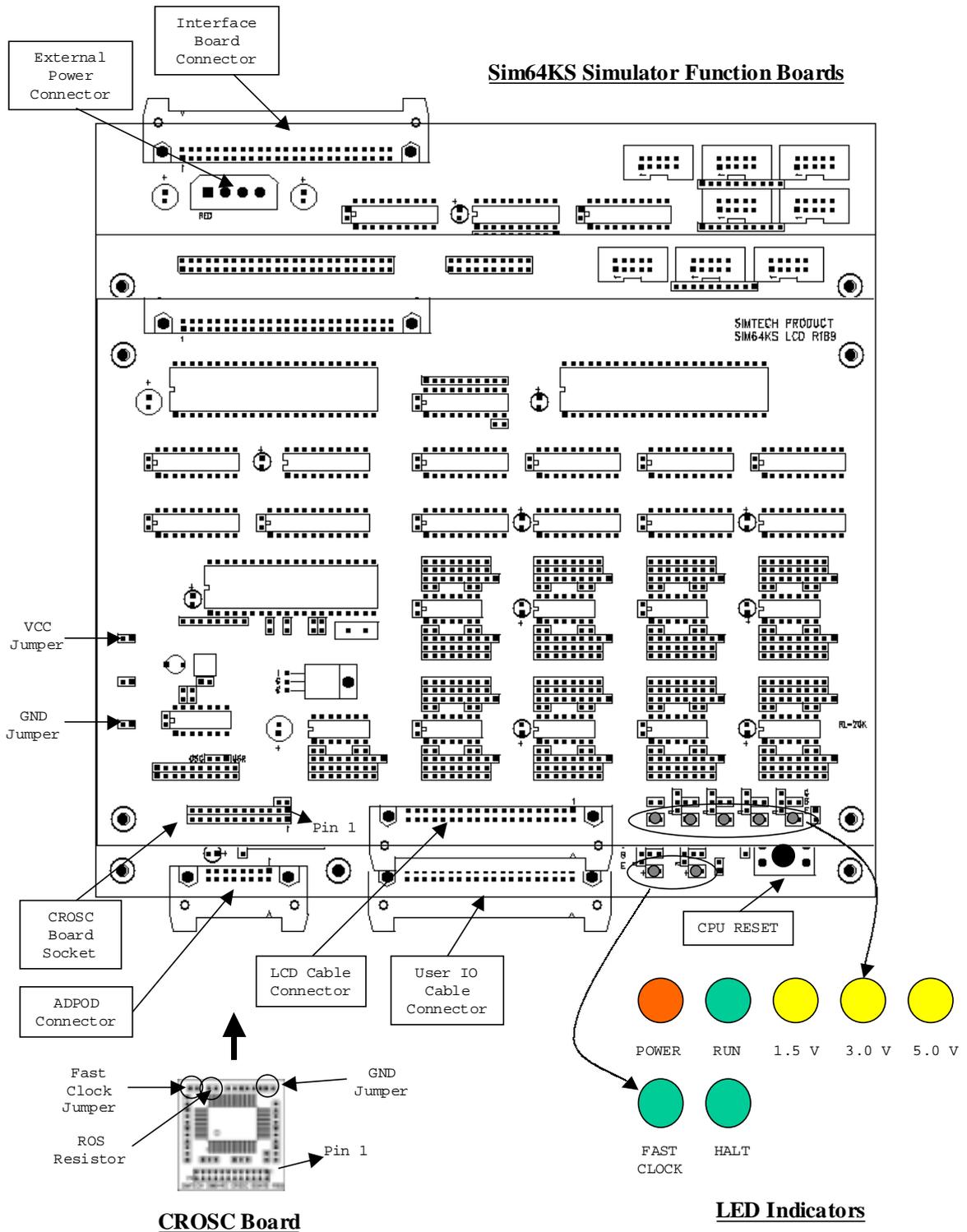
LED Indicators

Figure 3-1 Sim64KS Function Boards

3.1.1 LED Indicator
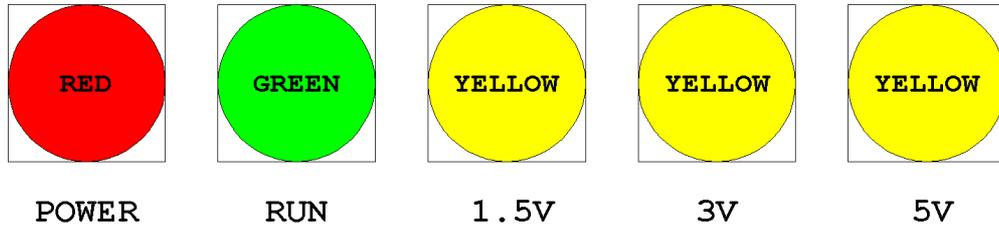
Figure 3-2 Sim64KS Function Boards LED Indicators

There are five LED indicators labeled with "POWER", "RUN", "1.5V", "3V" and "5V". The LED indicators are located on the top front side of the Simulator device.

LED	Descriptions
POWER	• The Power LED is light whenever the computer system is turned on.
RUN	• When Simulator device is standby, The Run LED is turned off. • When microcontroller simulation is running, The Run LED is flashing.

1.5V, 3V, 5V	• The Voltage LED is light after simulation project is loaded into the Simulator Software. Only one of the voltage indicators will be turned light according to the "I/O Voltage" and "Supply Voltage" of the simulation project settings.
	
	  1.5V LED for I/O voltage = "VSS1/VSS2" and supply voltage = "1.5V".
	
	  3V LED for I/O voltage = "VSS1/VSS2" and supply voltage = "3.0V".
	
	  5V LED for I/O voltage = "5V".

CPUCLK   HALT
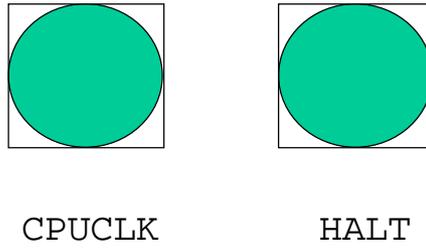
Figure 3-3 Special Function LED Indicator

LED	Descriptions
CPUCLK	The CPUCLK LED is located on the second deck of the Function Boards. This LED will turn on when the application target program is running with fast clock. When the microcontroller target program starts fast clock, The CPUCLK LED turns on When the microcontroller target program stops fast clock, The CPUCLK LED turns off
HALT	The HALT LED is located on the second deck of the Function Boards This LED will turn on when the application target program enters Halt mode. When the microcontroller target program enters Halt mode, The HALT LED will turn on. When the microcontroller target program exits Halt mode, The HALT LED will turn off .

3.2 Hardware Features

Hardware features includes :
- Target Microcontroller
- Supply Voltage and I/O Voltage
- Low-Speed Clock and High-Speed Clock
- Input Ports, Output Ports, I/O Ports and Buzzer Output
- Time Base Counter (TBC) and Watchdog Timer (WDT)
- Battery Check Circuit
- Constant Voltage for Logic Power Supply (BUPF)
- A/D Converter
- LCD Drivers
- User Reset

Note, the Test Circuit is not implemented in Simulator device.

3.2.1 Target Microcontroller

Supported microcontrollers are MSM64160D, MSM64162A, MSM64164 and ML64168.

The Simulator is auto-configure to proper existence of hardware feature for individual microcontroller.

3.2.2 Supply Voltage and I/O Voltage

The supply voltage and I/O voltage determines the input and output voltage level used in the external I/O interface of the Simulator device.

The I/O interface consists of input ports (P0), output ports (P1), I/O ports (P2, P3, P4), buzzer output (BD), LCD output ports (P5, P6) and User reset input (RESET).

The supply voltage can be set to +1.5V (VSS1) or +3.0V (VSS2).
The I/O voltage can be set to "VSS1/VSS2" or +5V.

When "VSS1/VSS2" is used, the interface voltage is set to the supply voltage.
When +5V is used, the interface voltage is set to +5V.

3.2.3 Low-Speed Clock and High-Speed Clock

The low-speed clock is generated internally in Simulator device by a 32.768 kHz crystal oscillation circuit.

The high-speed clock is derived from a CR oscillation circuit on an external plug-in CROSC board; user can change the high-speed clock frequency by replacing the resistor on the CROSC board.

3.2.4 Input Ports, Output Ports, I/O Ports and Buzzer Output

The Simulator I/O Connector acts as the I/O terminals of the microcontroller. The I/O connector contains input ports (P0), output ports (P1), I/O ports (P2, P3, P4) and buzzer output (BD).

The Simulator is supplied with a 40-Pin I/O user cable, which is used to connect from the I/O connector to a user application board.

The user application board is commonly constructed with push buttons, switches or buzzer device for external interface with the application program.

3.2.5 Time Base Counter (TBC) and Watchdog Timer (WDT)

The time base counter and watchdog timer start counting after the simulation is reset and starts. The counter and timer are stopped when the simulation is break.

The counter and timer values are preserved during the break, and start counting from the preserved values when the simulation is started again.

Therefore, if user does not modify the preserved counter values during break, operation synchronized to internal counters and timers is assured for real-time simulation and step mode simulation.

However, when operation synchronized to external clocks is not guaranteed, since the external clock does not stop and preserve counter values during break.

3.2.6 Battery Check Circuit

The operation of battery check circuit is done by comparing the input voltage from the input port P0.3 with an internal reference voltage (Vrb).
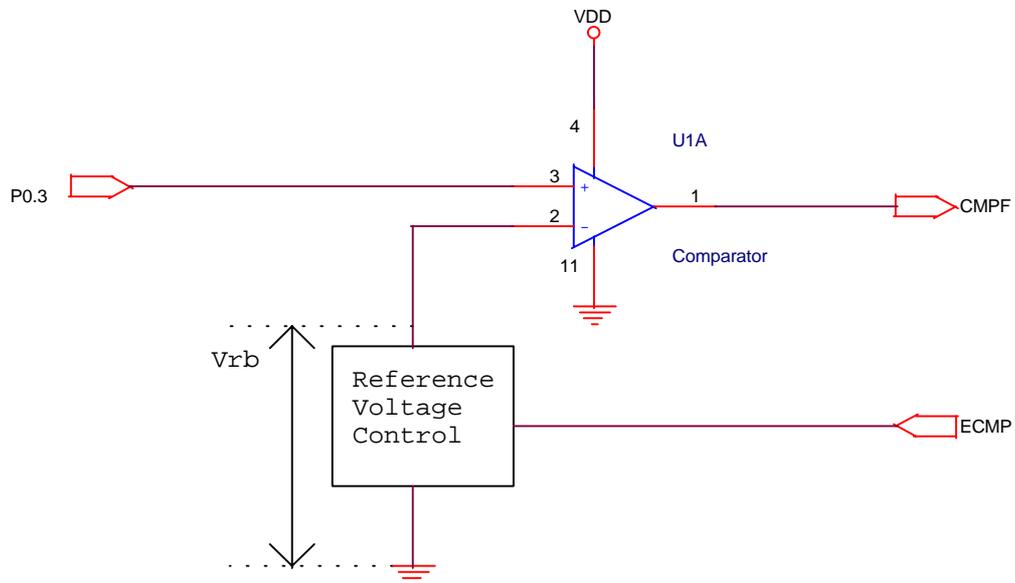
Figure 3-4 Battery Check Circuit

The reference voltage is according to the I/O voltage used.

I/O Voltage	Battery Check Reference Voltage
1.5V	About 0.8V
3.0V	About 2.3V
5.0V	About 4.3V

These reference voltages do not have the same value with that of the microcontroller Please refer to Chapter 8 of MSM64164C User's Manual for details.

Simulator is designed with positive voltage level logic (i.e. VDD=+1.5V or +3.0V or +5V and all voltage level is referenced to GND=0V)

With the battery check flag (ECMP) of the backup control register (BUPCON) of SFR is set to 1, the following output will occur :

When voltage level of P0.3 is lower than Vrb, then CMPF outputs logical 1.
When voltage level of P0.3 is higher than or equal to Vrb, then CMPF outputs logical 0.

3.2.7 Constant Voltage for Logic Power Supply (BUPF)

The Constant Voltage for Logic Power Supply function is controlled by bit 0 (BUPF) of the backup control register (BUPCON).

The reset, read and write operation on the BUPF are simulated as a memory bit, but no voltage level is changed since VSSL does not exist in Simulator.

3.2.8 A/D Converter

To constructs an A/D application such as a thermometer or a hygrometer, connect the A/D components (resistors, capacitor and/or sensors) to the jumpers on the ADPOD board.

Each jumper on the ADPOD board corresponds to the A/D terminals (RS0, RT0, CS0, etc) of the microcontroller.

Please see section "ADPOD Board" for more details.

3.2.9 LCD Drivers

For performing LCD simulation, the Simulator requires the following files:

LCD Simulation File (created by LCD Workshop Program)
Mask Option File (created by Mask Option Program)

The LCD simulation is usually performed on the computer monitor.

However when an external LCD is used, connect the 40-Pins LCD user cable from the LCD connector of the Simulator device to the external LCD display.

The LCD duty cycle, bias voltage method and LCD drivers usage table are defined in the mask option file.

The LCD connector represents the LCD driver terminals of the microcontroller.

Connect the external LCD display according to the following pin-table and LCD driver settings for COMMON and SEGMENT signals in the mask option file.

When using LCD drivers as CMOS output ports is implemented in the I/O connector, the LCD output ports (P5 and P6) in the I/O connector always perform CMOS output according to the DSPR values regardless of the LCD drivers are defined to LCD signal output or CMOS output.

P5 corresponds to DSPR00 (address 040H)
P6 corresponds to DSPR01 (address 041H)

3.2.10 User RESET

User can reset the microcontroller simulation by the input of a low voltage level on the User Connector RESET pin during real-time simulation.

Refer to section 4.2 for pin assignment of User Connector

The following operations will be performed :
- The CPU is initialized.
- The LCD is turned off.
- All the special function registers (SFR) are initialized with default values.
- Then the execution of an instruction is started from address 000H.

Please note that the inactive state of reset input requires input of a high voltage level according to the I/O voltage settings in the simulation project.

When the user reset is not used, the reset input pin can be left open for a built-in pull-up resistor.

User can also use the CPU RESET button mounted on the Simulator Function Boards without connecting the RESET pin from User IO Cable.

Refer to Figure 3-1 for location of RESET button.

3.3 CROSC Board
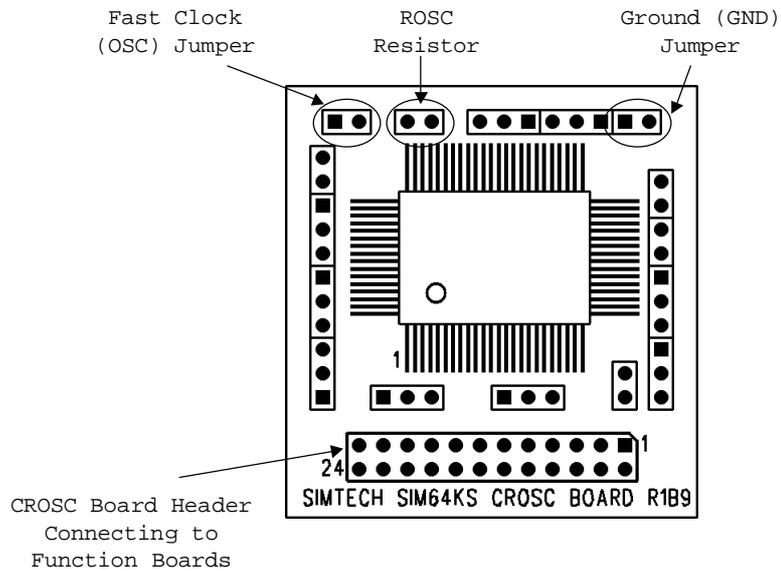
Figure 3-5 CROSC Board

When the Simulator operates in high-speed clock mode, the frequency of the high-speed clock is derived from a CR oscillation circuit of the CROSC board.

The Resistance component is installed externally to the CR circuit, and can be replaced with a user-defined resistor for generating proper high-speed clock frequency for user application.

The CROSC Board is situated on the topside of the Simulator function boards, and can be removed out for replacing user-defined resistors.

Users must use the proper CROSC board for different microcontrollers and supply voltages. Please see the table below for the model of CROSC boards.

CROSC Models	For Microcontrollers	With Supply Voltage
415V	MSM64160D MSM64162A MSM64164	1.5 V
430V	MSM64160D MSM64162A MSM64164	3.0 V
815V	ML64168	1.5 V
830V	ML64168	3.0 V

3.3.1 Changing Resistor on CROSC Board

Procedure to change resistor on CROSC Board:

1. Remove the CROSC board from the Simulator.
2. Remove the previous resistor located (labeled with "ROSC") on the topside of the CROSC board.
3. Insert a new user-defined resistor on the same female header.
4. Insert the board back to the Simulator.
5. Reset the Simulator.

3.3.2 Check Frequency Generation on CROSC Board

There are two jumpers labeled with "GND" and "OSC" on the CROSC board.

The frequency of the high-speed clock is output on the OSC jumper.

Connect the two jumpers to a frequency counter or CRO measurement equipment for checking the frequency generation.

The checking must be performed during the "High Speed Clock Frequency" function; otherwise it may affect proper microcontroller simulation.

The "High Speed Clock Frequency" function can be performed from the "Simulate" menu of the Simulator Software.

3.4 ADPOD Board

When a user application performs A/D Converter (ADC) function of microcontroller, the function is simulated on the ADPOD board.

The discrete components (resistors, capacitors and/or sensors) used for A/D conversion is installed on a user application board with the ADPOD board connected to it.

The ADPOD board provides with two channels of A/D terminals/jumpers labeled with "RS0", "RT0", "CRT0", "CS0", "IN0" for channel 0, and "RS1", "RT1", "CS1", "IN1" for channel 1.

Each of the jumpers is identical to the corresponding microcontroller A/D terminals.

Connect discrete components on those terminals that match the oscillation mode used in the target application, and left open for other not used terminals.
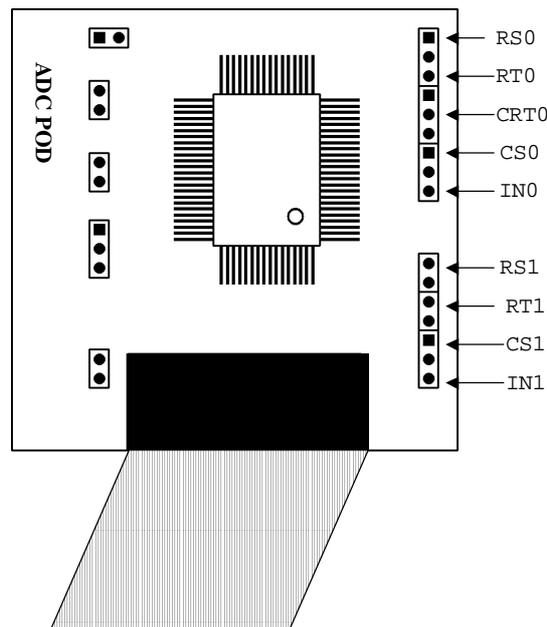

Figure 3-6 ADPOD Board with pin layout

The pin name is marked on the PCB of ADPOD board. Please refer to

Table of ADPOD Jumper Pins

Jumper Name	Input/Output	Note
RT0	Output	Resistance sensor connection pin to measure Channel 0
CRT0	Output	Resistance/capacitance sensor connection pin to measure Channel 0
RS0	Output	Reference resistance connection pin for Channel 0
CS0	Output	Reference capacitance connection pin for Channel 0
IN0	Input	Input pin of RC oscillation circuit of Channel 0
RT1	Output	Resistance sensor connection pin to measure Channel 1
RS1	Output	Reference resistance connection pin for Channel 1
CS1	Output	Reference capacitance connection pin for Channel 1
IN1	Input	Input pin of RC oscillation circuit of Channel 1

User must use correct models of ADPOD board for different target microcontrollers and supply voltage.

3.4.1 Procedure for changing ADPOD board

1. Stop the execution if the Simulator is running in real mode.
2. Remove the ADPOD board from the ADPOD Connector Simulator Function Boards and user application board.
3. Connect the 16-Pins header, leaded by a cable extended from the ADPOD board, to a 16-Pins connector of the Simulator Function Boards. The 16-Pins connector is named with "POD" and is located on the second deck of the Simulator function boards.
4. Then connect the ADPOD board to the discrete components of the user application board.
5. Reset the Simulator.

3.4.2 Voltage Consideration of ADPOD Boards

ADPOD Boards uses real masked MCU to operate A To D functions. However there are difference in voltage logic between masked 64164 and 64168. The following table shows the differences of the voltage logic between Simulator, ADPOD 64164 and ADPOD 64168:

Sim64KS Simulator	ADPOD 64164	ADPOD 64168
VDD +5.0V	VDD 0V	VDD +5.0V
VSS2 +3.0V	VSS2 -1.5V	VSS2 +3.0V
VSS1 +1.5V	VSS1 -3.0V	VSS1 +1.5V
GND 0V	VSS -5.0V	VSS 0V

It should be careful when connecting the user target board to the ADPOD and Simulator. For example,

An application is implemented by using the A/D function with external clock input mode by feeding clock pulse to IN0 pin to the ADPOD board. The external clock circuit cannot connect the ground signal (GND) of Simulator and connect the clock output to IN0 of the ADPOD 64164 board. However the same connections can be applied to ADPOD 64168 board. Please see the following diagrams below :
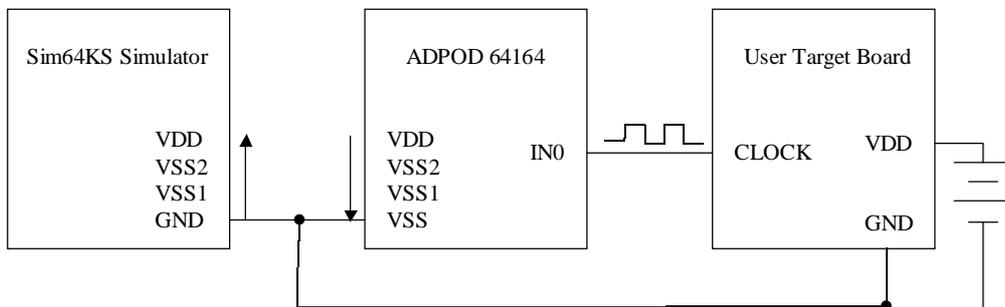
Figure 2-1   Incorrect Circuit Connection
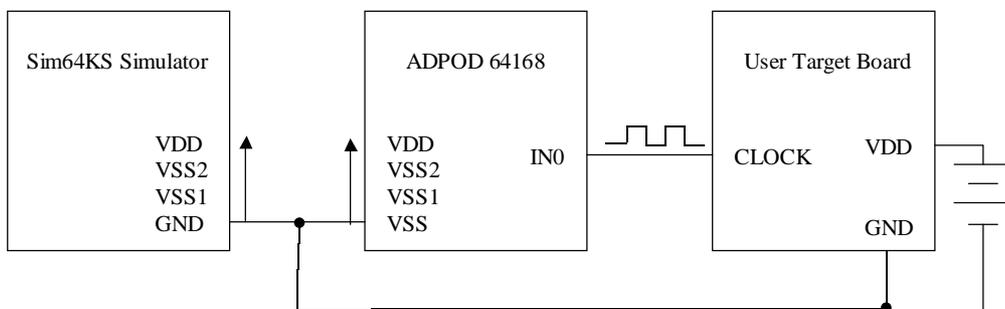
Figure 2-2   Correct Circuit Connection

4.0 Connectors and User Cables

The Simulator function boards consist of three electronic boards and are assembled in a deck form.

Connectors

Position	Connector	Notes
Top deck:	40-Pin LCD connector	Connect to an external LCD display
	24-Pin CROSC header	Connect to CROSC board
Middle deck:	40-Pin I/O connector	Connect to User application board
	16-Pin ADPOD connector	Connect to ADPOD board
Bottom deck:	50-Pin Adapter connector	Connect to Computer Adapter Card

User Cables

Cable	Notes
40-Pin LCD user cable	Connect from the LCD connector to the external LCD display
40-Pin I/O user cable	Connect from the I/O connector to the User application board
50-Pin Adapter cable	Connect from the Computer Adapter Card to the Adapter connector

4.1 Pin Layout of LCD Connector

Pin Number	Signal Name	Pin Number	Signal Name
1	L0	2	L1
3	L2	4	L3
5	L4	6	L5
7	L6	8	L7
9	L8	10	L9
11	L10	12	L11
13	L12	14	L13
15	L14	16	L15
17	L16	18	L17
19	L18	20	L19
21	L20	22	L21
23	L22	24	L23
25	L24	26	L25
27	L26	28	L27
29	L28	30	L29
31	L30	32	L31
33	L32	34	L33
35	---	36	---
37	---	38	---
39	---	40	---

Signal Name Notations:

L0 to L33	LCD Drivers
---	Not used and Cannot be connected

*** WARNING ***

All equipment used to measure the signals at all input and output pins must *be properly grounded* with a three-leg power cord; otherwise, hardware damage may result.

4.2 Pin Layout of I/O Connector

Pin Number	Signal Name	Pin Number	Signal Name
1	P2.0	2	P2.1
3	P2.2	4	P2.3
5	P3.0	6	P3.1
7	P3.2	8	P3.3
9	P4.0	10	P4.1
11	P4.2	12	P4.3
13	P0.0	14	P0.1
15	P0.2	16	P0.3
17	P1.0	18	P1.1
19	P1.2	20	P1.3
21	BD	22	P5.0 (DSPR00.a)
23	P.51 (DSPR00.b)	24	P5.2 (DSPR00.c)
25	P5.3 (DSPR00.d)	26	P6.0 (DSPR01.a)
27	P6.1 (DSPR01.b)	28	P6.2 (DSPR01.c)
29	P6.3 (DSPR01.d)	30	---
31	RESET	32	---
33	---	34	---
35	---	36	---
37	---	38	---
39	GND	40	GND

Signal Name Notations:

P0.0 to P0.3	Input port P0.
P1.0 to P1.3	Output port P1.
P2.0 to P2.3	I/O port P2.
P3.0 to P3.3	I/O port P3.
P4.0 to P4.3	I/O port P4.
P5.0 to P5.3	LCD output port P5.
P6.0 to P6.3	LCD output port P6.
BD	Buzzer output port.
RESET	User reset input port.
GND	Power Ground (0V)
---	Not used and Cannot be connected

*** WARNING ***
All equipment used to measure the signals at all input and output pins must *be properly grounded* with a three-leg power cord; otherwise, hardware damage may result.

5.0 Signal Descriptions and DC Characteristics

Signal Descriptions

Input Port	LOW Level	HIGH Level	Open Circuit
High Impedance Input	Input 0	Input 1	Undefined
Pull-down Input	Input 0	Input 1	Input 0
Pull-up Input	Input 0	Input 1	Input 1

Output Port	Output 0	Output 1
CMOS Output	LOW Level	HIGH Level
NMOS Open Drain Output	LOW Level	Open Circuit

DC Characteristics

All input voltages apply to P0, P2, P3, P4 and RESET.
All output voltages and output current apply to P1 and BD.

For 1.5V I/O Voltage

Signal	Symbol	Min.	Typ.	Max.	Unit
High Level Input Voltage	VIH	1.2		1.6	V
Low Level Input Voltage	VIL	0.0		0.6	V
High Level Output Voltage	VOH	1.5	1.52	1.58	V
Low Level Output Voltage	VOL	0.0	0.0	0.3	V
Output Current				4.5	mA

For 3.0V I/O Voltage

Signal	Symbol	Min.	Typ.	Max.	Unit
High Level Input Voltage	VIH	2.7		3.1	V
Low Level Input Voltage	VIL	0.0		0.6	V
High Level Output Voltage	VOH	3.0	3.02	3.08	V
Low Level Output Voltage	VOL	0.0	0.0	0.3	V
Output Current				9	mA

For 5.0V I/O Voltage

Signal	Symbol	Min.	Typ.	Max.	Unit
High Level Input Voltage	VIH	4.7		5.1	V
Low Level Input Voltage	VIL	0.0		0.6	V
High Level Output Voltage	VOH	5.0	5.02	5.08	V
Low Level Output Voltage	VOL	0.0	0.0	0.3	V
Output Current				15	mA

6.0 Electrical Characteristics

Recommended Operating Conditions

Parameter	Min.	Nominal	Max.	Unit
Supply Voltage 1*	+4.8	+5.0	+5.0	V
Supply Voltage 2*	+11.5	+12.0	+12.0	V
Supply Current	---	1.0	2.0	A
Ground Voltage	---	0	---	V
Operating Temperature	---	+25	---	^{o}C

* Please refer to section 2.3 for applying supply voltage 1 and supply voltage 2.