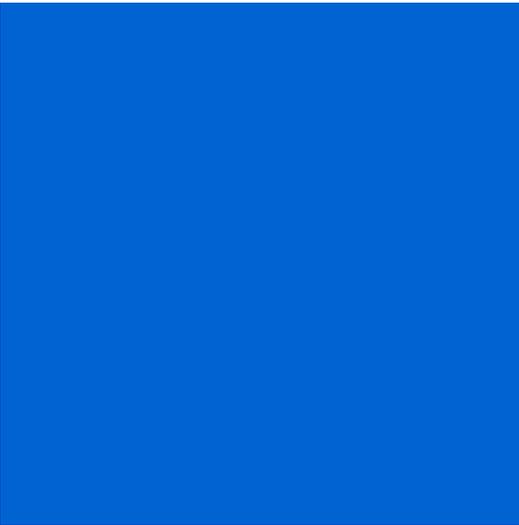


[Home](#)

# **OS-9<sup>®</sup> for ThinClient Board Guide**

## **Version 4.7**



**RadiSys.**  
THE POWER OF WE

[www.radisys.com](http://www.radisys.com)

Revision A • July 2006

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# Chapter 1: Installing and Configuring

## OS-9®

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This chapter describes installing and configuring OS-9® on the ADS SA-1100 Microprocessor Reference Platform (ThinClient). It includes the following sections:

- **Requirements and Compatibility**
- **Target Hardware Setup**
- **Connecting the Target to the Host**
- **Building the OS-9 ROM Image**
- **Creating a Startup File**
- **Optional Procedures**



# Requirements and Compatibility

---



## Note

Before you begin, install the *Microware OS-9 for StrongARM* CD-ROM on your host PC.

---

## Host Hardware Requirements (PC Compatible)

Your host PC should have the following:

- Windows 95, 98, ME, 2000, or NT
- A minimum of 32MB of free disk space (an additional 235MB of free disk space is required to run PersonalJava Solution for OS-9)
- An Ethernet network card
- A PCMCIA card reader/writer
- At least 16MB of RAM



## Note

If you are a PersonalJava Solution for OS-9 licensee and you plan to use the Java JCC to pre-load your Java classes, you may need as much as 64MB of RAM. Refer to the document *Using JavaCodeCompact for OS-9* for a complete discussion of using the JCC.

---

## Host Software Requirements (PC Compatible)

Your host PC should have a terminal emulation program (such as Hyperterminal, which comes with Microsoft Windows).

## Target Hardware Requirements



---

### Note

Please refer to the ***SA-1100 Microprocessor Evaluation Platform User's Guide*** for information on hardware preparation and installation, operating instructions, and functional descriptions prior to installing and configuring OS-9.

---

Your reference board requires the following hardware:

- Enclosure or chassis with power supply
- A RS-232 null modem serial cable
- LCD screen, keyboard, and mouse (for use with MAUI®)

### Java Hardware Requirements

Your reference board must have the following to run PersonalJava Solution for OS-9:

- 16MB of RAM
- 4MB of FLASH (Boot)
- LCD Display

# Target Hardware Setup

---

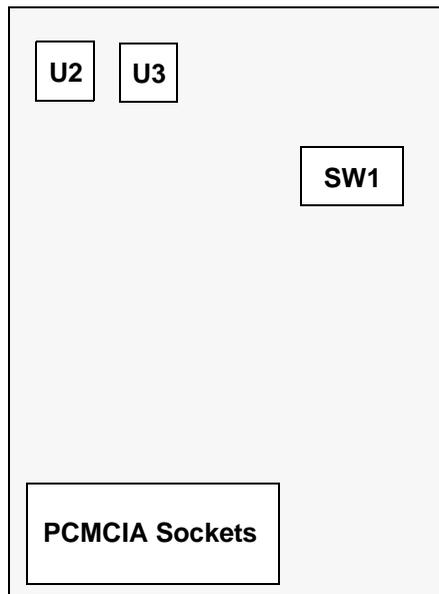
## Configure Board Switch Settings

The switch SW1, position 1, must be in the ON position for proper LCD operation. This defines the use of 8-bit color. The opposite setting defines the use of 16-bit color.

## Installing the Flash Devices

The first stage in configuring your reference board is to install the two pre-loaded FLASH devices included in your Microware OS-9 for StrongARM package. These devices include a coreboot system that has been pre-configured to get your board up and running quickly. Install the FLASH devices in sockets U3 (HIGH) and U2 (LOW).

**Figure 1-1 Installing the Flash Devices**





---

**Note**

If you need to reprogram the flash devices or create new flash devices, see the [Creating a new OS-9 Coreboot Image in Flash Memory](#) section.

---

## Configuring the ATA Card

You can use your ATA card to validate that your reference board is operational without requiring the connection to the host machine:

To configure the ATA card, complete the following steps:

- 
- Step 1. From a DOS prompt on the host machine, navigate to the following directory:

```
MWOS\OS9000\ARMV4\PORTS\THINCLIENT\BOOTS\SYSTEMS\PORTBOOT
```

and run `os9make`.

- Step 2. On the host machine, copy the files located in the following directory:

```
MWOS\OS9000\ARMV4\PORTS\THINCLIENT\BOOTS\SYSTEMS\PORTBOOT\os9kboot
```

into the root directory to the ATA card

- Step 3. Install the card in socket 0 (bottom) on the reference board.

- Step 4. Turn on the reference board.
- 



---

**Note**

Some ADS preproduction do not reset on power up. You must manually reset the board by pressing the reset button.

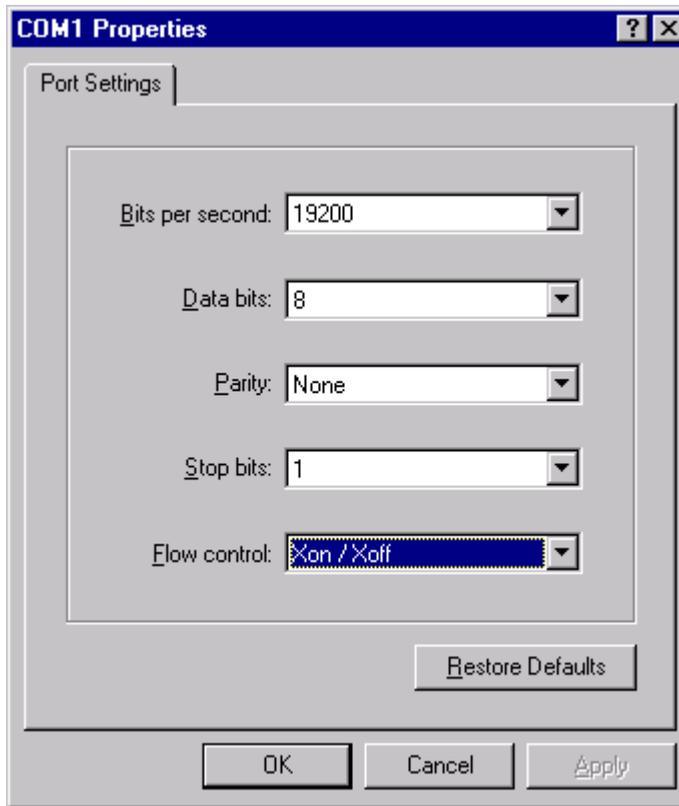
---

## Connecting the Target to the Host

---

Connect an RS-232 null modem cable from the reference board to the serial port of a Windows 95, Windows 98, or Windows NT system.

- 
- Step 1. Connect the serial cable to the P1 connector on the reference board. The P1 connector is the SA1100 serial port 3 (SP3).
  - Step 2. Connect the other end of the serial cable to the Host PC.
  - Step 3. On the Windows desktop, click on the **Start** button and select **Programs -> Accessories -> Hyperterminal**.
  - Step 4. Click the **Hypertrm** icon and enter a name for your Hyperterminal session.
  - Step 5. Select an icon for the new Hyperterminal session. A new icon is created with the name of your session associated with it. The next time you want to establish the same session, follow the directions in Step 3 and look for the icon you created in Step 4.
  - Step 6. Click **OK**
  - Step 7. In the Phone Number dialog, go to the Connect Using box, and select the communications port to be used to connect to the reference board.  
The port selected is the same port that you connected to the serial cable from the reference board.
  - Step 8. Click **OK**
  - Step 9. In the Port Settings tab, enter the following settings:  
Bits per second = **19200**  
Data Bits = **8**  
Parity = **None**  
Stop bits = **1**  
Flow control = **XOn/XOff**

**Figure 1-2 Port Settings**

- Step 10. Click **OK**.
  - Step 11. Go to the Hyperterminal menu and select **Call -> Connect** from the pull-down menu to establish your terminal session with the reference board. If you are connected, the bottom left of your Hyperterminal screen will display the word *connected*.
  - Step 12. Turn on the reference board. The OS-9 bootstrap message is displayed.
-

# Building the OS-9 ROM Image

---

## Overview

The OS-9 ROM Image is a set of files and modules that collectively make up the OS-9 operating system. The specific ROM Image contents can vary from system to system depending on hardware capabilities and user requirements.

To simplify the process of loading and testing OS-9, the ROM Image is generally divided into two parts—the low-level image, called `coreboot`; and the high-level image, called `bootfile`.

### Coreboot

The coreboot image is generally responsible for initializing hardware devices and locating the high-level (or bootfile) image as specified by its configuration. For example from a FLASH part, a harddisk, or Ethernet. It is also responsible for building basic structures based on the image it finds and passing control to the kernel to bring up the OS-9 system.

### Bootfile

The bootfile image contains the kernel and other high-level modules (initialization module, file managers, drivers, descriptors, applications). The image is loaded into memory based on the device you select from the boot menu. The bootfile image normally brings up an OS-9 shell prompt, but can be configured to automatically start an application.

Microware provides a Configuration Wizard to create a coreboot image, a bootfile image, or an entire OS-9 ROM Image. The wizard can also be used to modify an existing image. The Configuration Wizard is automatically installed on your host PC during the OS-9 installation process.

## Starting the Configuration Wizard

The OS-9 ROM Image enables booting from PCMCIA IDE type cards.



---

### Note

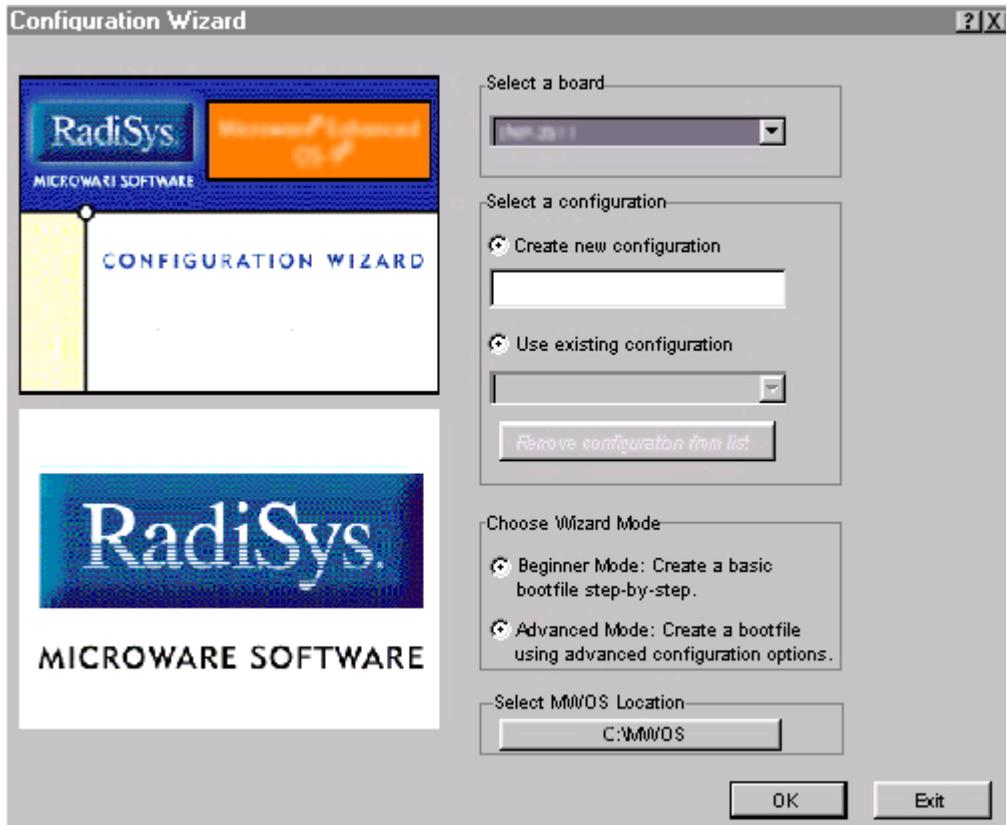
Microware OS-9 for StrongARM supports ATA Flash cards.

---

The Configuration Wizard is the application used to build the coreboot, bootfile, or ROM image. To start the Configuration Wizard, perform the following steps:

- Step 1. From the Windows desktop, select **Start -> RadiSys -> Microware OS-9 for <product> -> Configuration Wizard**. You should see the following opening screen:

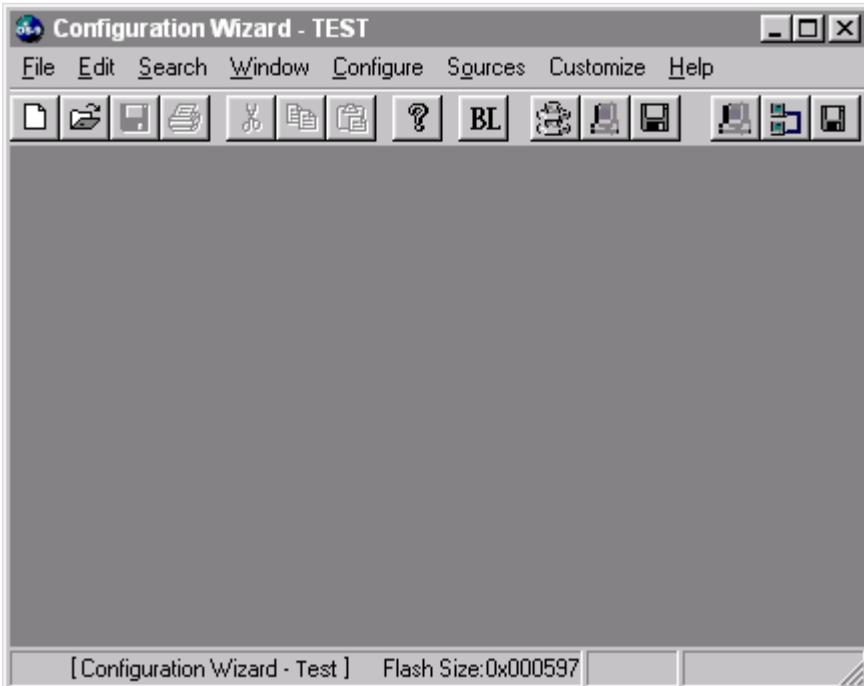
**Figure 1-3 Configuration Wizard Opening Screen**



- Step 2. Select your target board from the **Select a board** pull-down menu.
- Step 3. Select the **Create new configuration** radio button from the **Select a configuration** menu and type in the name you want to give your ROM image in the supplied text box. This names your new configuration, which can later be accessed by selecting the **Use existing configuration** pull down menu.

- Step 4. Select the **Advanced Mode** radio button from the **Choose Wizard Mode** field and click **OK**. The Wizard's main window is displayed. This is the dialog from which you will proceed to build your image. An example is shown in **Figure 1-4**.

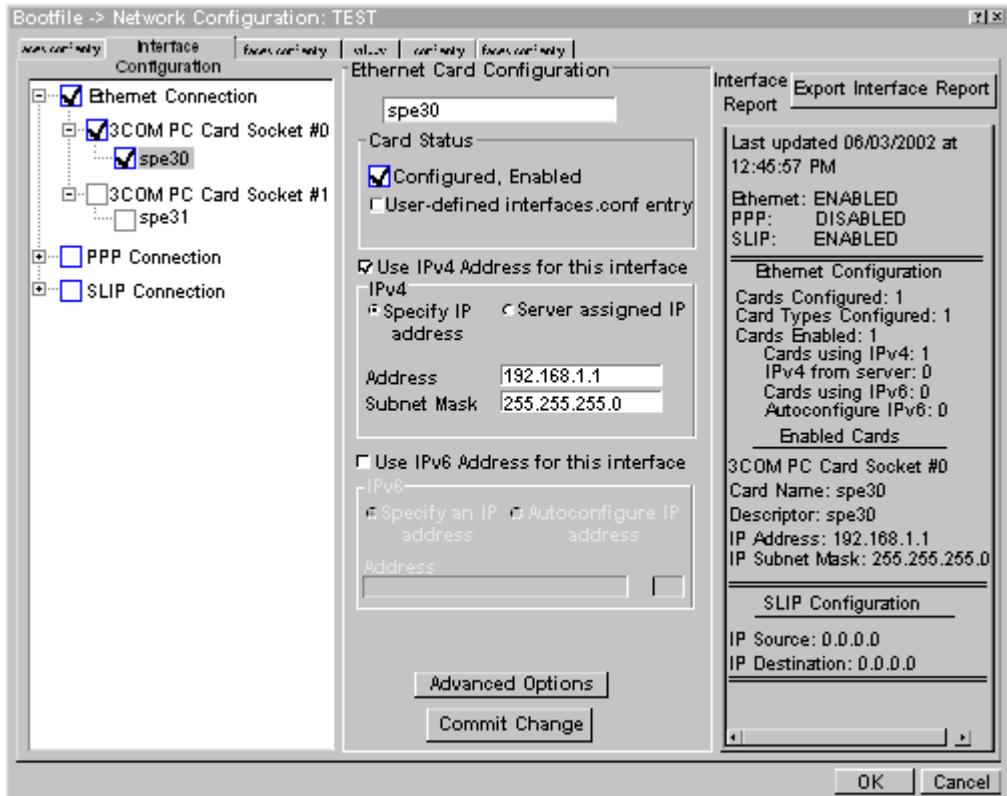
**Figure 1-4 Configuration Wizard Main Window**



- Step 5. If you want to use the target board across a network, you will need to configure the Ethernet settings within the Configuration Wizard. To do this, select **Configure** -> **Bootfile** -> **Network Configuration** from the Wizard's main menu.

Step 6. From the **Network Configuration** dialog, select the **Interface Configuration** tab. From here you can select and enable the interface. For example, you can select the appropriate Ethernet card from the list of options on the left and specify whether you would like to enable IPv4 or IPv6 addressing. **Figure 1-5** shows an example of the **Interface Configuration** tab.

**Figure 1-5 Bootfile -> Network Configuration -> Interface Configuration**



## For More Information

To learn more about IPv4 and IPv6 functionalities, refer to the **Using LAN** manual, included with this product CD.



---

## For More Information

Contact your system administrator if you do not know the network values for your board.

---

- Step 7. Once you have made your settings in the **Network Configuration** dialog, click **OK**.



---

## WARNING

On preproduction ThinClient boards, the MAC address may not be available. Run the `netstat -in` command to see if the MAC address is all 0x00s or 0xffs. If this is the case, change the `thinclient.ini` file, which is located in the following directory:

```
\Mwos\OS9000\ARMV4\PORTS\THINCLIENT\BOOTS\INSTALL\INI\
```

In `thinclient.ini`, set `SPF_MAC=TRUE` and change `[XMAKE_SPF_DESC]` to `[MAKE_SPF_DESC]`. You will now see a MAC address option below the IP address fields when running the Configuration Wizard. The Configuration Wizard will now also rebuild the descriptor since the `MAKE_SPF_DESC` section is defined."

---

- Step 8. Select **Configure -> Build Image** to display the Master Builder window. If networking is desired, make sure the SoftStax® (SPF) Support box is checked.
- Step 9. Click **Build**. This will build a boot image that can be placed on the PCMCIA card.
- Step 10. Insert the PCMCIA IDE card into the PCMCIA slot of your computer.
- Step 11. Click **Save As** to save the file `os9kboot` to the root directory of the PCMCIA IDE card.

Step 12. Turn off the power to the reference board.



---

### **WARNING**

Inserting and removing a PCMCIA card with the power on is not supported in this release. Damage may occur to the PCMCIA card if it is inserted or removed while power is applied to the board.

---

Step 13. Remove the PCMCIA IDE card from the computer.

Step 14. Position the PCMCIA card so that the end with the connector holes is facing the PCMCIA socket and the label is facing up.

Step 15. Slide the card into the lower socket (socket 0) of the reference board until the card snaps onto the connector pins and the eject button pops out.



---

### **Note**

The ThinClient design does not provide enough current for the TypeIII PCMCIA (double height).

---

Step 16. Apply power to the board. The reference board will boot from the IDE PCMCIA card and you should see the “\$” prompt.

---

## Creating a Startup File

---

When the Configuration Wizard is set to use a hard drive, or another fixed drive such as a PC Flash Card, as the default device, it automatically sets up the `init` module to call the `startup` file in the `SYS` directory in the target (For example: `/h0/SYS/startup`, `/mhc1/SYS/startup`). However, this directory and file will not exist until you create it. To create the startup file, complete the following steps:

- 
- Step 1. Create a `SYS` directory on the target machine where the `startup` file will reside (for example: `mkdir /h0/SYS`, `mkdir /dd/SYS`).
- Step 2. On the host machine, navigate to the following directory:  
`MWOS/OS9000/SRC/SYS`
- In this directory, you will see several files. The files related to this section are listed below:
- `motd`: Message of the day file
  - `password`: User/password file
  - `termcap`: Terminal description file
  - `startup`: Startup file
- Step 3. Transfer all files to the newly created `SYS` directory on the target machine. (You can use Kermit, or FTP in ASCII mode to transfer these files.)
- Step 4. Since the files are still in DOS format, you will be required to convert them into the OS-9 format with the `cudo` utility. The following command is an example:  
`cudo -cdo password`
- This will convert the `password` file from DOS to OS-9 format.



## For More Information

For a complete description of all the `cuDo` command options, refer to the *Utilities Reference Manual* located on the Microware OS-9 CD.

- Step 5. Since the command lines in the startup file are system-dependent, it may be necessary to modify this file to fit your system configuration. It is recommended that you modify the file before transferring it to the target machine.

## Example Startup File

Below is the example startup file as it appears in the `MWOS/OS9000/SRC/SYS` directory:

```
-tnxnp
tmode -w=1 nopause
*
*OS-9 - Version 3.0
*Copyright 2001 by Microware Systems Corporation
*The commands in this file are highly system dependent and
*should be modified by the user.
*
*setime </term                ;* start system clock
setime -s                    ;* start system clock
link mshell csl              ;* make "mshell" and "csl" stay in memory
* iniz r0 h0 d0 t1 p1 term   ;* initialize devices
* load utils                  ;* make some utilities stay in memory
* tsmon /term /t1 &          ;* start other terminals
list sys/motd
setenv TERM vt100
tmode -w=1 pause
mshell<>>>/term -l&
```



---

## For More Information

Refer to the **Making a Startup File** section in Chapter 9 of the *Using OS-9* manual for more information on startup files.

---

## Optional Procedures

---

### Connecting the Target to an Ethernet Network

Microware OS-9 for StrongARM supports using the onboard SMC91C94 or a 3COM Etherlink III - LAN PC Card for SoftStax® TCP/IP connections. Also, Microware OS-9 for StrongARM provides system level support for telnet, FTP, and NFS.

To use Ethernet networking, you must create a bootfile that has the Ethernet options enabled and insert an Ethernet PCMCIA card into the reference board if you choose to use a PCMCIA Ethernet card.

- 
- Step 1. Click the **Start** button on the Windows desktop.
  - Step 2. Select **Programs -> RadiSys -> Microware OS-9 for <product> -> Configuration Wizard**. You should see the opening screen.
  - Step 3. Click **OK**. The configuration screen is displayed.
  - Step 4. Select **Configure -> Bootfile -> Network Configuration**. The **Network Configuration** dialog box appears.
  - Step 5. Change the network settings as needed. Refer to the Configuration Wizard help for more information on the network settings.
  - Step 6. Create a new Bootfile by following the directions in the **Building the OS-9 ROM Image** section.
  - Step 7. Turn off the power to the reference board.



---

#### **WARNING**

Inserting and removing a PCMCIA card with the power on is not supported in this release. Damage may occur to the PCMCIA card if it is inserted or removed while power is applied to the board.

---



---

**Note**

The default configuration assumes that PCMCIA IDE card is in the lower PCMCIA slot. If 3COM PCMCIA Ethernet is used, the IDE card should be in the upper slot. This can be changed by the user.

---

**Step 8.** Position the PCMCIA IDE card so that the end with the PCMCIA female connector is facing PCMCIA socket 0 (the lower socket) and the label is facing up.

Slide the PCMCIA IDE card into socket 0 (the lower socket) until the card snaps onto the pins and the eject button pops out.

**Step 9.** Connect the 10 Base T connector into J7 if using the onboard Ethernet.  
or

Position the Ethernet PCMCIA card so that the end with the PCMCIA female connector is facing PCMCIA socket 0 (the lower socket) and the label is facing up.

Slide the PCMCIA Ethernet card into socket 0 (the lower socket) until the card snaps onto the pins and the eject button pops out.

**Step 10.** Restart your reference board.

**Step 11.** Test the Ethernet connection by pinging the reference board.

If the ping operation fails, you will have to check the following items:

- is the board connected to a live Ethernet port?
  - is the Ethernet cable defective?
  - are the network settings for the reference board correct?
-

## Pinging the Reference Board

Windows 95, Windows 98, and Windows NT include a Ping command that can be used to test the Ethernet connection for the reference board.

---

Step 1. Go to the DOS prompt.

Step 2. Type `ping <IP Address>`.

The IP Address is the address you assigned to the evaluation board in either the Coreboot module or the Bootfile module. The address is typed without the <> brackets.

If the ping was successful, you will see the following response:

```
Reply from <IP Address>: bytes=xx time =xms TTL= xx
```

If the ping was unsuccessful, you will see the following response:

```
Request timed out.
```



### Note

Windows 95, 98, and NT do not support IPv6.

---

## Creating a new OS-9 Coreboot Image in Flash Memory

If you want to use ROM Ethernet services such as System State Debugging, you must create a new coreboot image. The coreboot image that was shipped with the reference board does not allow you to perform System State Debugging because the IP address in Flash ROM is set to “0.0.0.0”. You can create the coreboot image with either an EPROM programmer or by programming the flash onboard.



---

**Note**

Re-creating the Coreboot image is required only when system state debugging is desired.

---

## Making a Coreboot Image with an EPROM programmer

This section describes creating the Coreboot Image. When you are done creating the coreboot image, please refer to your EPROM programmer's instructions to learn how to load the Coreboot image into the EPROMS.

---

- Step 1. Click the **Start** button on the Windows desktop.
- Step 2. Select **Programs -> RadiSys -> Microware OS-9 for <product> -> Configuration Wizard**. The opening screen is displayed (see **Figure 1-3**).
- Step 3. Select the path where the MWOS directory structure is located from the MWOS location button.
- Step 4. Select the target board from the Port Selection pull-down menu.
- Step 5. Name the ROM Image, select **Advanced Mode**, and click **OK**. The main window is displayed.
- Step 6. To change the low level IP address, select **Configure -> Coreboot -> Master Configuration** then select either the **Ethernet** or **Slip** tabs and set the IP address as appropriate. Click the OK button to dismiss the dialog.
- Step 7. To enable remote system state debugging, select **Configure -> Coreboot -> Master Configuration** then select the **Debugger** tab and click the **Remote** button under **Select Debugger**. Make sure that the **Enter Debugger On Power Up** button is not selected. Click the OK button to dismiss the dialog.

- Step 8. Select **Configure** -> **Build Image** to display the Master Builder screen.
  - Step 9. Select the **Coreboot Only Image** setting and click **Build**.
  - Step 10. Click **Save As** to save the coreboot image to a directory of your choosing. If you do not have a directory on the drive, you can create one.
  - Step 11. Transfer the coreboot image to the EPROMS with the EPROM programmer. You will need to follow the documentation for the EPROM programmer to complete this step.
- 

## Compressing the Bootfile Image

OS-9 bootfiles can be compressed to allow more modules to be loaded into a bootfile; this can be useful if you plan on storing your image on a small FLASH part or a floppy disk.



### Note

The bootfile compression utility performs the compression at approximately a 2.5:1 ratio.

---

Complete the following steps to compress your image:

---

- Step 1. Verify that your coreboot contains the `uncompress` module. This module can be found in the pre-built ROM and coreboot images that were shipped with your Microware OS-9 product.



---

**Note**

The `uncompress` module must be included in order for the compression to execute properly.

---

- Step 2. Open the Configuration Wizard and select **Configure** -> **Coreboot** -> **Main Configuration** from the main menu.
- Step 3. Select the **Bootfile Compression** tab. Verify that the **Include bootfile uncompress module** box is checked and select OK.
- Step 4. When you are ready to build the image, open the **Master Builder** dialog. Verify that the **Compress Bootfile** box is checked and then press **Build** to begin the installing the image.
-



---

# Chapter 2: Board Specific Considerations

---

This chapter contains information that is specific to the INTEL SA-1100 Microprocessor Reference Platform (ThinClient) reference board. It includes the following sections:

- **Boot Options**
- **The Fastboot Enhancement**
- **OS-9 Vector Mappings**
- **ThinClient GPIO Usage**
- **Port Specific Utilities**



---

## For More Information

For general information on porting OS-9, see the ***OS-9 Porting Guide***.

---



## Boot Options

---

Following are the default boot options for the reference board. You can select these by hitting the space bar when the Now Trying to Override Autobooters message appears on the console port when booting.

You can configure these booters by altering the `default.des` file at the following location:

```
MWOS/OS9000/ARMV4/PORTS/THINCLIENT/ROM
```

Booters can be configured to be either menu or auto booters. The auto booters automatically try and boot in order from each entry in the auto booter array. Menu booters from the defined menu booter array are chosen interactively from the console command line after getting the boot menu.

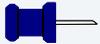
## Booting from FLASH

When the `romcnfg.h` has a ROM search list defined the options `ro` and `lr` appear in the boot menu. If no search list is defined N/A appears in the boot menu. If an OS9 bootfile is programmed into flash in the address range defined in ports `default.des` file the system can boot and run from flash.

<code>ro</code>	rom boot—the system runs from the FLASH bank.
<code>lr</code>	load to ram—the system copies the flash image into ram and runs from there.

## Booting from PCMCIA ATA Card

The system can boot from a PC formatted PCMCIA hard card which resides in slot 0 or slot 1.



### Note

The system will hang during boot if there is not PCMCIA card, and it is configured to boot from one.

---

ide1	The file os9kboot is searched for in slot 1. If found it is copied to system RAM and runs from there.
ide0	The file os9kboot is searched for in slot 0. If found it is copied to system RAM and runs from there.

## Booting from PCMCIA Ethernet Card

The system can boot using the BootP protocol using an Ethernet card and eb option.

eb	Ethernet boot—a PCMCIA card which supports ethernet will use the bootp protocol to transfer in a bootfile into RAM and the systems runs from there.
----	---





# The Fastboot Enhancement

---

The Fastboot enhancements to OS-9 provide faster system bootstrap performance to embedded systems. The normal bootstrap performance of OS-9 is attributable to its flexibility. OS-9 handles many different runtime configurations to which it dynamically adjusts during the bootstrap process.

The Fastboot concept consists of informing OS-9 that the defined configuration is static and valid. These assumptions eliminate the dynamic searching OS-9 normally performs during the bootstrap process and enables the system to perform a minimal amount of runtime configuration. As a result, a significant increase in bootstrap speed is achieved.

## Overview

The Fastboot enhancement consists of a set of flags that control the bootstrap process. Each flag informs some portion of the bootstrap code that a particular assumption can be made and that the associated bootstrap functionality should be omitted.

The Fastboot enhancement enables control flags to be statically defined when the embedded system is initially configured as well as dynamically altered during the bootstrap process itself. For example, the bootstrap code could be configured to query dip switch settings, respond to device interrupts, or respond to the presence of specific resources which would indicate different bootstrap requirements.

In addition, the Fastboot enhancement's versatility allows for special considerations under certain circumstances. This versatility is useful in a system where all resources are known, static, and functional, but additional validation is required during bootstrap for a particular instance, such as a resource failure. The low-level bootstrap code may respond to some form of user input that would inform it that additional checking and system verification is desired.

## Implementation Overview

The Fastboot configuration flags have been implemented as a set of bit fields. An entire 32-bit field has been dedicated for bootstrap configuration. This four-byte field is contained within the set of data structures shared by the ModRom sub-components and the kernel. Hence, the field is available for modification and inspection by the entire set of system modules (high-level and low-level). Currently, there are six bit flags defined with eight bits reserved for user-definable bootstrap functionality. The reserved user-definable bits are the high-order eight bits (31-24). This leaves bits available for future enhancements. The currently defined bits and their associated bootstrap functionality are listed below:

### **B\_QUICKVAL**

The `B_QUICKVAL` bit indicates that only the module headers of modules in ROM are to be validated during the memory module search phase. This causes the CRC check on modules to be omitted. This option is a potential time saver, due to the complexity and expense of CRC generation. If a system has many modules in ROM, where access time is typically longer than RAM, omitting the CRC check on the modules will drastically decrease the bootstrap time. It is rare that corruption of data will ever occur in ROM. Therefore, omitting CRC checking is usually a safe option.

### **B\_OKRAM**

The `B_OKRAM` bit informs both the low-level and high-level systems that they should accept their respective RAM definitions without verification. Normally, the system probes memory during bootstrap based on the defined RAM parameters. This allows system designers to specify a possible RAM range, which the system validates upon startup. Thus, the system can accommodate varying amounts of RAM. In an embedded system where the RAM limits are usually statically defined and presumed to be functional, however, there is no need to validate the defined RAM list. Bootstrap time is saved by assuming that the RAM definition is accurate.

## B\_OKROM

The `B_OKROM` bit causes acceptance of the ROM definition without probing for ROM. This configuration option behaves like the `B_OKRAM` option, except that it applies to the acceptance of the ROM definition.

## B\_1STINIT

The `B_1STINIT` bit causes acceptance of the first `init` module found during cold-start. By default, the kernel searches the entire ROM list passed up by the `ModRom` for `init` modules before it accepts and uses the `init` module with the highest revision number. In a statically defined system, time is saved by using this option to omit the extended `init` module search.

## B\_NOIRQMASK

The `B_NOIRQMASK` bit informs the entire bootstrap system that it should not mask interrupts for the duration of the bootstrap process. Normally, the `ModRom` code and the kernel cold-start mask interrupts for the duration of the system startup. However, some systems that have a well defined interrupt system (i.e. completely calmed by the `sysinit` hardware initialization code) and also have a requirement to respond to an installed interrupt handler during system startup can enable this option to prevent the `ModRom` and the kernel cold-start from disabling interrupts. This is particularly useful in power-sensitive systems that need to respond to “power-failure” oriented interrupts.



---

### Note

Some portions of the system may still mask interrupts for short periods during the execution of critical sections.

---

## B\_NOPARITY

If the RAM probing operation has not been omitted, the `B_NOPARITY` bit causes the system to not perform parity initialization of the RAM. Parity initialization occurs during the RAM probe phase. The `B_NOPARITY` option is useful for systems that either require no parity initialization at all or systems that only require it for “power-on” reset conditions. Systems that only require parity initialization for initial “power-on” reset conditions can dynamically use this option to prevent parity initialization for subsequent “non-power-on” reset conditions.

## Implementation Details

This section describes the compile-time and runtime methods by which the bootstrap speed of the system can be controlled.

### Compile-time Configuration

The compile-time configuration of the bootstrap is provided by a pre-defined macro (`BOOT_CONFIG`), which is used to set the initial bit-field values of the bootstrap flags. You can redefine the macro for recompilation to create a new bootstrap configuration. The new over-riding value of the macro should be established by redefining the macro in the `rom_config.h` header file or as a macro definition parameter in the compilation command.

The `rom_config.h` header file is one of the main files used to configure the ModRom system. It contains many of the specific configuration details of the low-level system. Below is an example of how you can redefine the bootstrap configuration of the system using the `BOOT_CONFIG` macro in the `rom_config.h` header file:

```
#define BOOT_CONFIG (B_OKRAM + B_OKROM + B_QUICKVAL)
```

Below is an alternate example showing the default definition as a compile switch in the compilation command in the makefile:

```
SPEC_COPTS = -dNEWINFO -dNOPARITYINIT -dBOOT_CONFIG=0x7
```

This redefinition of the `BOOT_CONFIG` macro results in a bootstrap method that accepts the `RAM` and `ROM` definitions without verification, and also validates modules solely on the correctness of their module headers.

## Runtime Configuration

The default bootstrap configuration can be overridden at runtime by changing the `rinf->os->boot_config` variable from either a low-level P2 module or from the `sysinit2()` function of the `sysinit.c` file. The runtime code can query jumper or other hardware settings to determine what user-defined bootstrap procedure should be used. An example P2 module is shown below.



### Note

If the override is performed in the `sysinit2()` function, the effect is not realized until after the low-level system memory searches have been performed. This means that any runtime override of the default settings pertaining to the memory search must be done from the code in the P2 module code.

```
#define NEWINFO
#include <rom.h>
#include <types.h>
#include <const.h>
#include <errno.h>
#include <romerrno.h>
#include <p2lib.h>

error_code p2start(Rominfo rinf, u_char *gbls)
{
    /* if switch or jumper setting is set... */
    if (switch_or_jumper == SET) {
        /* force checking of ROM and RAM lists */
        rinf->os->boot_config &= ~(B_OKROM+B_OKRAM);
    }
    return SUCCESS;
}
```

## OS-9 Vector Mappings

This section contains the vector mappings for the OS9 ThinClient implementation of the SA1100.

The ARM standard defines exceptions 0x0-0x8. The OS-9 system maps these 1-1. External interrupts from vector 0x6 are expanded to the virtual vector range shown below by the irq1100 module.



### Note

Vectors can be virtually remapped from a ROM at physical address 0, into DRAM at virtual address 0. This speeds up interrupt response time and is enabled by defining the first cache list entry as a sub 1 Meg size.



### For More Information

See the 1100 hardware documentation for more information on individual sources.

**Table 2-1** and **Table 2-2** show the OS9 IRQ assignment for the ThinClient SA1100 board.

**Table 2-1 IRQ Assignments and ARM Functions**

OS9 IRQ #	ARM Function
0x0	Processor Reset
0x1	Undefined Instruction
0x2	Software Interrupt

**Table 2-1 IRQ Assignments and ARM Functions (continued)**

<b>OS9 IRQ #</b>	<b>ARM Function</b>
0x3	Abort on Instruction Prefetch
0x4	Abort on Data Access
0x5	Unassigned/Reserved
0x6	External Interrupt
0x7	Fast Interrupt
0x8	Alignment error

**Table 2-2 IRQ Assignments and SA1100 Specific Functions**

<b>OS9 IRQ #</b>	<b>SA1100 Specific Function (pic)</b>
0x40	GPIO[0] Edge Detect (IRQ Input from ThinClient PIC.)
0x41	GPIO[1] Edge Detect
0x42	GPIO[2] Edge Detect
0x43	GPIO[3] Edge Detect
0x44	GPIO[4] Edge Detect
0x45	GPIO[5] Edge Detect
0x46	GPIO[6] Edge Detect
0x47	GPIO[7] Edge Detect

**Table 2-2 IRQ Assignments and SA1100 Specific Functions (continued)**

<b>OS9 IRQ #</b>	<b>SA1100 Specific Function (pic)</b>
0x48	GPIO[8] Edge Detect
0x49	GPIO[9] Edge Detect
0x4a	GPIO[10] Edge Detect
0x4b	OR of GPIO edge detects 27 - 11
0x4c	LCD controller service request
0x4d	UDC service request (0)
0x4e	SDLC service request (1a)
0x4f	UART service request (1b)
0x50	UART/HSSP service request (2)
0x51	UART service request (3)
0x52	MCP service request (4a)
0x53	SSP service request (4b)
0x54	DMA controller channel 0
0x55	DMA controller channel 1
0x56	DMA controller channel 2
0x57	DMA controller channel 3
0x58	DMA controller channel 4

**Table 2-2 IRQ Assignments and SA1100 Specific Functions (continued)**

<b>OS9 IRQ #</b>	<b>SA1100 Specific Function (pic)</b>
0x59	DMA controller channel 5
0x5a	OS timer 0
0x5b	OS timer 1
0x5c	OS timer 2
0x5d	OS timer 3
0x5e	One Hz clock tick
0x5f	RTC als alarm register
0x60	GPIO[11] Edge Detect (the vector 0x4b OR is broken out here to make each one distinct)
0x61	GPIO[12] Edge Detect
0x62	GPIO[13] Edge Detect
0x63	GPIO[14] Edge Detect
0x64	GPIO[15] Edge Detect
0x65	GPIO[16] Edge Detect
0x66	GPIO[17] Edge Detect
0x67	GPIO[18] Edge Detect
0x68	GPIO[19] Edge Detect
0x69	GPIO[20] Edge Detect

**Table 2-2 IRQ Assignments and SA1100 Specific Functions (continued)**

<b>OS9 IRQ #</b>	<b>SA1100 Specific Function (pic)</b>
0x6a	GPIO[21] Edge Detect
0x6b	GPIO[22] Edge Detect
0x6c	GPIO[23] Edge Detect
0x6d	GPIO[24] Edge Detect
0x6e	GPIO[25] Edge Detect
0x6f	GPIO[26] Edge Detect
0x70	GPIO[27] Edge Detect

**Table 2-3** shows the ThinClient Pic functions.

**Table 2-3 ThinClient Pic Functions**

<b>OS9 IRQ #</b>	<b>ThinClient Function (ThinClient Pic)</b>
0xb1	16554 UART1
0xb2	16554 UART2
0xb3	16554 UART3
0xb4	16554 UART4
0xb5	CAN1
0xb6	CAN2
0xb7	PCMCIA slot 0 Ready/IRQ

**Table 2-3 ThinClient Pic Functions (continued)**

<b>OS9 IRQ #</b>	<b>ThinClient Function (ThinClient Pic)</b>
0xb8	PCMCIA slot 1 Ready/IRQ
0xb9	UCB 1200
0xba	SMC 91C94 Ethernet
0xbb	Parallel Port
0xbc	PCMCIA Card A detect
0xbd	PCMCIA Card B detect
0xbe	Board Switch
0xbf	reserved
0xc0	reserved



---

**Note*****Fast Interrupt Vector (0x7)***

The ARM4 defined fast interrupt (FIQ) mapped to vector 0x7 is handled differently by the OS-9 interrupt code and can not be used as freely as the external interrupt mapped to vector 0x6. To make fast interrupts as quick as possible for extremely time critical code, no context information is saved on exception and FIQs are never masked. This requires any exception handler to save and restore its necessary context if the FIQ mechanism is to be used. This requirement means that a FIQ handler's entry and exit points must be in assembly, as the C compiler will make assumptions about context. In addition, no system calls are possible unless a full C ABI context save has been done first. The OS-9 IRQ code for the SA1100 has assigned all interrupts as normal external interrupts and the user must re-define a source as an FIQ to make use of this feature.

---

## ThinClient GPIO Usage

**Table 2-4** shows GPIO usage of the ThinClient board in an OS9 system.



### For More Information

See the Intel ThinClient board guide for available alternate pin functions.

**Table 2-4 GPIO Usage of ThinClient Board**

GPIO	Signal Name	Direct	Description
GPIO0	SW2	Input	ThinClient switch SW22
GPIO1	SW1	Input	ThinClient switch SW21
GPIO2	P0_STSCHG	Input	PCMCIA Slot 0 status change
GPIO3	P0_IRQ	Input	PCMCIA Slot 0 IRQ
GPIO4	P0_F1	Input	PCMCIA Slot 0 valid
GPIO5	P1_STSCHG	Input	PCMCIA Slot 1 status change
GPIO6	P1_IRQ	Input	PCMCIA Slot 1 IRQ
GPIO7	P1_F	Input	PCMCIA Slot 1 valid
GPIO8	LED_GRN2	Output	

**Table 2-4 GPIO Usage of ThinClient Board (continued)**

<b>GPIO</b>	<b>Signal Name</b>	<b>Direct</b>	<b>Description</b>
GPIO9	LED_GRN1	Output	
GPIO10	SSP_TXD	Output	SSP Port transmit
GPIO11	SSP_RXD	Input	SSP Port Receive
GPIO12	SSP_SCLK	Output	SSP Port Clock
GPIO13	SSP_SFRM	Output	SSP Port Frame
GPIO14	UART_TXD	Output	SP1 uart transmit
GPIO15	UART_RXD	Input	SP1 uart receive
GPIO16	SDLC_HSKO	Output	
GPIO17	SDLC_AAF	Output	
GPIO18	SDLC_HSKI	Input	
GPIO19	SDLC_GPI	Input	
GPIO20	LED_RED	Output	led output
GPIO21	IRDA_SD	Output	IRDA data line
GPIO22	IRQ_C	Input	
GPIO23	KBC_WKUP	Output	Keyboard wake up
GPIO24	KBC_WUKO	In/Out	Keyboard wake up
GPIO25	KBC_ATN	Input	Keyboard atn

**Table 2-4 GPIO Usage of ThinClient Board (continued)**

GPIO	Signal Name	Direct	Description
GPIO26	RCLK_OUT	Output	Ref clock output
GPIO27	32Khz Out	Output	32Khz Out clock

## GPIO Interrupt Polarity

When GPIOs are used as interrupt sources, the `_PIC_ENABLE()` function will set default polarity to rising edge (GRER) along with enabling the interrupt at the SA-1100 PIC. If falling edge is required, software must assert the appropriate bit in the GFER and negate the corresponding bit in the GRER.

## Port Specific Utilities

---

The following port specific utilities are included:

- `pcmcia`
- `pflash`
- `touch_cal`
- `ucbtouch`

## pcmcia

---

### Syntax

```
pcmcia [<opts>]
```

---

### options

-s=	socket: socket [default all sockets]
-d	de-iniz socket(s)
-i	iniz socket(s)
-v	verbose mode
-x	dump CIS/Config information
-?	Print this help message

---

### Description

`pcmcia` provides the ability to initialize or deinitialize a PCMCIA card after the system has booted. It also displays a PCMCIA cards CIS structure.

**Example**

```

$ pcmcia -x -s=0
ATA IDE disk found in socket0
Dump CIS Window for Socket #0
  Addr      0  1  2  3  4  5  6  7  8  9  A  B  C  D  E  F  0  2  4  6  8  A  C  E
-----
28000000  01 03 d9 01 ff 1c 04 03 d9 01 ff 18 02 df 01 20 .....
28000020  04 01 4e 00 01 15 2b 04 01 56 49 4b 49 4e 47 20 ..N...+.VIKING
28000040  43 4f 4d 50 4f 4e 45 4e 54 53 20 20 20 20 20 20 COMPONENTS
28000060  20 20 00 43 46 20 41 54 41 20 00 56 2e 31 30 32 .CF ATA .V.102
28000080  00 ff 21 02 04 01 22 02 01 01 22 03 02 04 5f 1a ..!..."..."..._
280000a0  05 01 03 00 02 0f 1b 09 c0 40 a1 21 55 55 08 00 .....@.!UU..
280000c0  22 1b 06 00 01 21 b5 1e 35 1b 0b c1 41 99 21 55 ".!!!!.5...A.!U
280000e0  55 64 f0 ff ff 22 1b 06 01 01 21 b5 1e 35 1b 0d Ud..."!!!!.5..
28000100  82 41 98 ea 61 f0 01 07 f6 03 01 ee 22 1b 06 02 .A..a....."....
28000120  01 21 b5 1e 35 1b 0d 83 41 98 ea 61 70 01 07 76 .!..5...A..ap..v
28000140  03 01 ee 22 1b 06 03 01 21 b5 1e 35 14 00 ff ff ..."....!.5....
28000160  ff .....
28000180  ff .....
280001a0  ff .....
280001c0  ff .....
280001e0  ff .....
Dump Config Window for Socket #0
  Addr      0  1  2  3  4  5  6  7  8  9  A  B  C  D  E  F  0  2  4  6  8  A  C  E
-----
28000200  43 00 02 00 00 00 00 00 00 00 00 00 00 00 00 00 C.....
28000220  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
28000240  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
28000260  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
28000280  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
280002a0  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
280002c0  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
280002e0  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
28000300  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
28000320  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
28000340  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
28000360  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
28000380  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
280003a0  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
280003c0  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
280003e0  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....

```

## pflash

---

### Syntax

```
pflash [options]
```

---

### Options

-f [=] filename	input filename
-eu	erase used space only (default)
-ew	erase whole flash
-ne	don't erase flash
-r	program resident flash (default)
-p0	program PCMCIA slot 0
-p1	program PCMCIA slot 1
-ncis	don't emit cis for PCMCIA flash cards
-b [=] addr	specify base address of flash (hex) for part identification (replaces -r,-p0,-p1)
-s [=] addr	specify write/erase address of flash(hex) defaults to base address)
-u	leave flash unlocked
-i	print out information on flash
-nv	don't verify erase or write
-q	no progress indicator

---

### Description

The pflash utility allows the programming of Intel Strata Flash parts. The primary use will be in the burning of the OS-9 ROM image into the on-board flash parts at U25/U26. This allows for booting using the lr/bo booters and allows for booting with out a PCMCIA card. The pflash utility also can be used to burn OS-9 ROM images into Intel Value Series PCMCIA cards, which internally use StrataFlash parts. This allows for booting using a PCMCIA slot and the f0 booter.

## Example

In this example an OS-9 ROM image was built and placed on an ATA PCMCIA card. After booting using the PCMCIA card, the image can be burned into the on-board Flash.

```
- Erase FLASH ////

$ pflash -ew
Unlocking Device
Erasing
Locking Device

- FLASH bootfile image ////

$ pflash -f=/mhc1/os9kboot
Unlocking Device
Erasing
Programming
Locking Device

- Test FLASHED bootfile image ////

OS-9000 Bootstrap for the ARM (Edition 62)

ATA IDE disk found in socket 00
Now trying to Override autobooters.

Press the spacebar for a booter menu

BOOTING PROCEDURES AVAILABLE ----- <INPUT>

Boot embedded OS-9000 in-place ----- <bo>
Copy embedded OS-9000 to RAM and boot - <lr>
Boot from PCMCIA-1 IDE ----- <ide1>
Boot from PCMCIA-0 IDE ----- <ide0>
Boot over Ethernet (11e509) ----- <eb>
Enter system debugger ----- <break>
Restart the System ----- <q>

Select a boot method from the above menu: bo

Now searching memory ($08000000 - $081fffff) for an OS-9000 Kernel...

An OS-9000 kernel was found at $08000000
A valid OS-9000 bootfile was found.
+3
$
```



---

**Note**

The ROMLIST search is from 0x08000000 - 0x08200000. This yeilds 0x200000 maximun size for the bootfile image—about 2MBs.

---

**touch\_cal****Touchscreen Calibration Program**

---

**Syntax**

```
touch_cal <options>
```

---

**Options**

-f [=] <name>	Output filename
-c	Only run calibration if output filename does not exist
-m [=] <font_module>	Use given UCM font module to display text

---

**Description**

The `touch_cal` utility will present a text message on the LCD screen as well as points for the user to press. After the points are pressed, the protocol module `mp_ucb1200` will be updated with the new calibration information.

---

**Example**

```
$ touch_cal
Found touch screen device '/ucb_touch/mp_ucb1200'
```

## ucbtouch

---

### Syntax

```
ucbtouch <>
```

---

### Description

The `ucbtouch` utility prints the raw x,y and pressure values at a set sample rate.

Press the touch screen and observe the output on your console. The utility is helpful in determining whether your touch screen is connected properly.

---

### Example

```
$ ucbtouch
Touch[00000]: Touch=0x30c3 X1=00328 Y1=00321 P= 28 X=329 Y=322
Touch[00001]: Touch=0x30c3 X1=00329 Y1=00325 P= 28 X=330 Y=326
Touch[00002]: Touch=0x30c3 X1=00329 Y1=00321 P= 28 X=330 Y=322
Touch[00003]: Touch=0x30c3 X1=00329 Y1=00321 P= 29 X=330 Y=322
Touch[00004]: Touch=0x30c3 X1=00329 Y1=00319 P= 29 X=330 Y=320
Touch[00005]: Touch=0x30c3 X1=00329 Y1=00321 P= 28 X=330 Y=322
Touch[00006]: Touch=0x30c3 X1=00329 Y1=00327 P= 28 X=330 Y=328
Touch[00007]: Touch=0x30c3 X1=00329 Y1=00321 P= 28 X=330 Y=322
Touch[00008]: Touch=0x30c3 X1=00329 Y1=00321 P= 29 X=330 Y=322
Touch[00009]: Touch=0x30c3 X1=00329 Y1=00322 P= 28 X=330 Y=323
Touch[00010]: Touch=0x30c3 X1=00329 Y1=00319 P= 28 X=0 Y=0
Touch[00011]: Touch=0x30c3 X1=00328 Y1=00321 P= 28 X=-1 Y=2
Touch[00012]: Touch=0x30c3 X1=00329 Y1=00315 P= 28 X=0 Y=-4
Touch[00013]: Touch=0x30c3 X1=00329 Y1=00322 P= 29 X=0 Y=3
```

---

# Appendix A: Board-Specific Modules

---

This chapter describes the modules specifically written for the target board. It includes the following sections:

- **Low-Level System Modules**
- **High-Level System Modules**



# Low-Level System Modules



## For More Information

For a complete list of OS-9 modules common to all boards, see the ***OS-9 Device Descriptor and Configuration Module Reference manual***.

The following low-level system modules are tailored specifically for the ADS SA1100 ThinClient platform. The functionality of these modules can be altered through changes to the configuration data module (cnfgdata). **Table A-1** provides a list and brief description of the modules.

These modules can be found in the following directory:

MWOS/OS9000/ARMV4/PORTS/THINCLIENT/CMDS/BOOTOBS/ROM

**Table A-1 ThinClient-Specific Low-Level System Modules**

Module Name	Description
cnfgdata	Contains the low-level configuration data.
cnfgfunc	Provides access services to cnfgdata data.
commcnfg	Inits communication port defined in cnfgdata.
conscnfg	Inits console port defined in cnfgdata.
ide	IDE boot support module. PCMCIA compatible.
io1100	Provides polled serial driver support for the low-level system.

**Table A-1 ThinClient-Specific Low-Level System Modules (continued)**

<b>Module Name</b>	<b>Description</b>
io16550	Provides polled serial support for the low-level system via external UART.
llcis	Initiates the PCMCIA interface including cards.
lle509	Provides low-level ethernet services via 3COM PCMCIA card.
portmenu	Initiates booters defined in the cnfgdata.
romcore	Board specific initialization code.
splash	Provides way to init LCD screen with a compressed image.
tmr1_1100	Provides low-level timer services via time base register.
usedebug	Initiates low-level debug interface to RomBug, SNDP, or none.

The following low-level system modules provide generic services for OS9000 Modular ROM. [Table A-2](#) provides a list and brief description of the modules.

These modules can be found in the following directory:

MWOS/OS9000/ARMV3/CMDS/BOOTOBS/ROM

**Table A-2 Generic Services Low-Level System Modules**

<b>Module Name</b>	<b>Description</b>
bootsys	Booter registration service module.
console	Provides console services.
dbgentry	Initiates debugger entry point for system use.
dbgserve	Provides debugger services.
exception	Provides low-level exception services.
flshcach	Provides low-level cache management services.
hlproto	Provides user level code access to protoman.
llbootp	Booter which provides bootp services.
llip	Provides low-level IP services.
llslip	Provides low-level SLIP services.
lltcp	Provides low-level TCP services.
lludp	Provides low-level UDP services.
llkermit	Booter which uses kermit protocol.
notify	Provides state change information for use with LL and HL drivers.
override	Booter which allows choice between menu and auto booters.

**Table A-2 Generic Services Low-Level System Modules (continued)**

<b>Module Name</b>	<b>Description</b>
parser	Provides argument parsing services.
pcman	Booter which reads MS-DOS file system.
protoman	Protocol management module.
restart	Booter which cause a soft reboot of system.
romboot	Booter which allows booting from ROM.
rombreak	Booter which calls the installed debugger.
rombug	Low-level system debugger.
sndp	Provides low-level system debug protocol.
srecord	Booter which accepts S-Records.
swtimer	Provides timer services via software loops.

## High-Level System Modules

---

The following OS-9 system modules are tailored specifically for your Intel SA1100 ThinClient board and peripherals. Unless otherwise specified, each module is located in a file of the same name in the following directory:

MWOS/OS9000/ARMV4/PORTS/THINCLIENT/CMDS/BOOTOBS

### CPU Support Modules

These files are located in the following directory:

MWOS/OS9000/ARMV4/CMDS/BOOTOBS

kernel	The kernel provides all basic services for the OS-9 system.
cache	Provides cache control for the CPU cache hardware. The cache module is in the file <code>cach1100</code> .
fpu	Provides software emulation for floating point instructions.
ssm	The System Security Module provides support for the Memory Management Unit (MMU) on the CPU.
vectors	Provides interrupt service entry and exit code. The vectors module is found in the file <code>vect110</code> .

## System Configuration Module

These files are located in the following directory:

MWOS/OS9000/ARMV4/PORTS/THINCLIENT/CMD5/BOOTOBJS/INITS

<code>init</code>	Descriptor module with high level system initialization information.
<code>nodisk</code>	Same as <code>init</code> , but used in a disk-less system.

## Interrupt Controller Support

This module provides extensions to the vectors module by mapping the single interrupt generated by an interrupt controller into a range of pseudo vectors which are recognized by OS-9 as extensions to the base CPU exception vectors.




---

### For More Information

The mappings are described in [Chapter 2](#).

---

<code>irq1100</code>	P2module that provides interrupt acknowledge and dispatching support for the SA1100 pic.
<code>irqtc</code>	P2module that provides interrupt acknowledge and dispatching support for the ThinClient pic (vector range 0xB1-0xC0).

## Real Time Clock

<code>rtc1100</code>	Driver that provides OS-9 access to the SA1100 on-board real time clock.
----------------------	--

## Ticker

tk1100

Driver that provides the system ticker based on the SA1100 Operating System Timer.

## Abort Handler

abort

P2module which provides a way to enter the system-state debugger via the GPIO[0] interrupt triggered by ThinClient switch SW2.

## Generic IO Support modules (File Managers)

These files are located in the following directory:

MWOS/OS9000/ARMV3/CMD5/BOOTOBJS

ioman

Provides generic io support for all IO device types.

scf

Provides generic character device management functions.

rbf

Provides generic block device management functions for OS-9 specific format.

pcf

Provides generic block device management functions for MS-DOS FAT format.

spf

Provides generic protocol device management function support.

mfm

Provides generic graphics device support for MAUI.

pipeman

Provides a memory FIFO buffer for communication.

## Pipe Descriptor

This file is located in the following directory:

MWOS/OS9000/ARMV4/PORTS/THINCLIENT/CMD5/BOOTOBS/DESC

pipe	Pipeman descriptor that provides a RAM based FIFO which can be used for process communication.
------	--

## RAM Disk Support

ram	RBF driver which provides a RAM based virtual block device.
-----	---

### Descriptors for Use with RAM

These files are located in the following directory:

MWOS/OS9000/ARMV4/PORTS/THINCLIENT/CMD5/BOOTOBS/DESC/RAM

r0	RBF descriptor which provides access to a ram disk.
r0.dd	Same as r0 except with module name dd (for use as the default device).

## Serial and Console Devices

sc1100	SCF driver which provides serial support the SA1100's SP1 and SP3 ports when configured as UARTS.
--------	---

### Descriptors for Use with sc1100

term1/t1	Descriptor modules for use with sc1100 and SP1.
----------	---

ThinClient Board header: J22

	Default Baud Rate:	19200
	Default Parity:	None
	Default Data Bits:	8
	Default Handshake:	Software
term3/t3	Descriptor modules for use with sc1100 and SP3.	
	ThinClient Board header:	J23
	Default Baud Rate:	115200
	Default Parity:	None
	Default Data Bits:	8
	Default Handshake:	Software
sc16550	SCF driver which provides serial support the ThinClient 16C554.	

### Descriptors for use with sc16550

term1e/t1e	Descriptor modules for use with the external sc16550.	
	ThinClient Board header:	P2
	Default Baud Rate:	19200
	Default Parity:	None
	Default Data Bits:	8
	Default Handshake:	Software

term2e/t2e	Descriptor modules for use with the sc16550, ThinClient Board header: P4 Default Baud Rate: 19200 Default Parity: None Default Data Bits: 8 Default Handshake: Software
term3e/t3e	Descriptor modules for use with the external sc16550. ThinClient Board header: JP5 Default Baud Rate: 19200 Default Parity: None Default Data Bits: 8 Default Handshake: Software ** TTL device logic levels
term4e/t4e	Descriptor modules for use with the sc16550, ThinClient Board header: JP8 Default Baud Rate: 19200 Default Parity: None Default Data Bits: 8 Default Handshake: Software
m0_t1/m0_t2 m0_t2/m0_t3	Serial mouse descriptor modules for use with the external sc16550. ThinClient Board headers: P2/P4/JP5/JP8 Default Baud Rate: 1200 Default Parity: None Default Data Bits: 8 Default Handshake: None

## Descriptors for Use with scllio

`vcons/term` Descriptor modules for use with `scllio` in conjunction with a low-level serial driver. Port configuration and set up follows what is configured in `cnfgdata` for the console port. It is possible for `scllio` to communicate with a true low-level serial device driver like `io1100`, or with an emulated serial interface provided by `iovcons`. See the OEM manual for more information.

## PCMCIA Support for IDE Type Devices

`rb1003` RBF/PCF driver that provides driver support for IDE/EIDE devices. This driver is used to provide disk support for PCMCIA ATA FLASH.

### Descriptors for Use with rb1003

`hc1/hc1fmt` and `hc1.dd`  
 RBF Descriptor modules for use with PCMCIA slot #0 (bottom)  
 ThinClient Board header: J15  
`hc1fmt:` format enabled  
`hc1.dd:` module name of `dd`

`mhc1/mhc1.dd`  
 PCF Descriptor modules for use with PCMCIA slot #0 (bottom)  
 ThinClient Board header: J15  
`mhc1.dd:` module name of `dd`

`he1/he1fmt` and `he1.dd`  
 RBF Descriptor modules for use with PCMCIA slot #1 (top)

ThinClient Board header: J15

he1fmt: format enabled

he1.dd: module name of dd

mhe1/mhe1.dd

PCF Descriptor modules for use with PCMCIA slot #1 (top)

ThinClient Board header: J15

mhc1.dd: module name of dd

## PCMCIA Support for 3COM Ethernet card

These files are located in the following directory:

MWOS/OS9000/ARMV4/PORTS/THINCLIENT/CMD5/BOOTOBS/SPF

spe509\_pcm            SPF driver to support ethernet for a 3COM EtherLink III PCMCIA card.

### Descriptors for Use with spe509\_pcm

spe30            SPF descriptor module for use with PCMCIA slot #0 (bottom, J15)

spe31            SPF descriptor module for use with PCMCIA slot #1 (top, J15)

### Network Configuration Modules

inetdb/inetdb2/rpcdb

## SMC91C94 Ethernet Support

These files are located in the following directory:

MWOS/OS9000/ARMV4/PORTS/THINCLIENT/CMD5/BOOTOBS/SPF

sp91c94                      SPF driver to support ethernet for the SMC91C94 chip.

### Descriptor for Use with sp91c94

spsm0                      SPF descriptor module for use with SMC91C94 at J7.

### Network Configuration Modules

inetdb/inetdb2/rpcdb

## UCB1200 Support modules.

These files are located in the following directory:

MWOS/OS9000/ARMV4/PORTS/THINCLIENT/CMD5/BOOTOBS/SPF

spucb1200                      SPF driver that supports the on-board Phillips UCB1200 chip. This device communicates to the SA1100 over SP4 using MCP.

### Descriptors for Use with spucb1200

ucb                      SPF descriptor module that provides access to UCB1200.

ucb\_touch                      SPF descriptor module used with the touch screen.

## Maui Graphical Support modules

These files are located in the following directory:

MWOS/OS9000/ARMV4/PORTS/THINCLIENT/CMDS/BOOTOBS/MAUI

`gx_sa1100` MFM MAUI driver module with support for the ThinClient LCD panel.

### Descriptors for Use with `gx_sa1100`

`gfx` MFM MAUI descriptor module for ThinClient LCD.

`sd_ucb 1200` MFM MAUI driver module that provides PCM/mu-law sound support via the `ucb1200`.

### Descriptors for Use with `sd_ucb1200`

`snd` MFM MAUI descriptor module for UCB1200 sound functions.

### MAUI configuration modules

`cdb` MAUI configuration data base module.

`cdb_ptr` Serial mouse configuration data base module.

`cdb_touch` Touch screen configuration data base module.

### MAUI protocol modules

`mp_kybrd` Keyboard protocol module

`mp_msptr` Serial mouse protocol module.

`mp_ucb1200` `ucb1200` protocol module.



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## For More Information

The MAUI drivers are described in more detail in [Appendix B: MAUI Driver Descriptions](#).

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# Appendix B: MAUI Driver Descriptions

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This chapter provides MAUI driver descriptions. It includes the following sections:

- **ThinClient Objects**
- **GX\_SA1100 LCD Graphic Driver Specification**
- **SD\_UCB1200 Sound Driver Specification**
- **SPUCB1200 driver for the UCB1200 Codec**
- **MP\_UCB1200 MAUI Touch screen Protocol Module**



## ThinClient Objects

---

This package provides object-level support for the Intel ThinClient reference board. The port directory is at the following location:

MWOS/OS9000/ARMV4/PORTS/THINCLIENT

### MAUI objects

<code>cdb</code>	Lists the devices on the system.
<code>mp_mspttr</code>	Serial mouse protocol module.
<code>mp_ucb1200</code>	Touch screen protocol module for the UCB1200.
<code>gfx</code> and <code>gx_sa1100</code>	LCD graphics descriptor and driver.

# GX\_SA1100 LCD Graphic Driver Specification

---

This section describes the hardware specification of the StrongARM SA1100 LCD driver (named `gx_sa1100`) and descriptor (named `gfx`). The hardware sub-type defines the board configuration. This specification should be used with the MAUI Graphics Device API.

## Board Ports

This driver is used in the following example board StrongArm ports.

The ThinClient board uses a Sharp LQ64D341 18 bpp color (16 used), TFT, with a resolution of 640x480 single panel. This panel is connected to the ThinClient with one of several possible cables:

- 8 bpp - most common to date
- RGB 565 - next most common
- RGB 655
- RGB 556

The SideArm board can support an LCD panel, but does not typically ship with one. For this reason the SideArm port does not build this driver. If the user did connect a LCD panel to this board, simply copy the makefiles from one of the other ports into the SideArm port.

## Device Capabilities

Information about the hardware capabilities is determined by calling `gfx_get_dev_cap()`. The hardware sub-type defines the board configuration. This function returns a data structure formatted as shown in **Table B-1**. See `GFX_DEV_CAP` for more information about this data structure.

**Table B-1 `gfx_get_dev_cap()` Data Structure**

Member Name	Description	Value
<code>hw_type</code>	Hardware type (embedded in driver)	SA1100 LCD Controller
<code>hw_subtype</code>	Hardware subtype (embedded in descriptor)	Thinclient 8 bit color LCD, or Thinclient 16 bit color LCD
<code>sup_vpmix</code>	Supports viewport mixing	FALSE
<code>sup_extvid</code>	Supports external video as a backup	FALSE
<code>sup_bkcol</code>	Supports background color	FALSE
<code>sup_vptrans</code>	Supports viewport transparency	FALSE
<code>sup_vpinten</code>	Supports viewport intensity	FALSE
<code>sup_sync</code>	Supports retrace synchronization	FALSE

**Table B-1 gfx\_get\_dev\_cap() Data Structure (continued)**

<b>Member Name</b>	<b>Description</b>	<b>Value</b>
num_res	Number of display resolutions	1
res_info	Array of display resolution information	See Display Resolution table
dac_depth	Depth of the DAC in bits	12
num_cm	Number of coding methods	1
cm_info	Array of coding method information	See Coding Methods table
sup_viddecode	Supports video decoding into a drawmap	FALSE

## Display Resolution

The display resolution is configured by the descriptor and can be changed to support LCD panels of different sizes. The driver is only designed to support one resolution at a time. That resolution is

specified by the descriptor. Modify the `DEFAULT_RES` macro in `mfm_desc.h` to change the resolution. If you change the resolution, you must also change all of the LCD timing fields as well.

**Table B-2 Display Specifications**

<b>Board</b>	<b>Width</b>	<b>Height</b>	<b>Refresh Rate</b>	<b>Interlace Mode</b>	<b>Aspect Ratio X:Y</b>
No current hardware implementation available	320	240	0*	GFX_INTL_OFF	1:1
ThinClient	640	480	0*	GFX_INTL_OFF	1:1

\*Refresh rate is determined by timing specified in descriptor. The devcap is not automatically update to reflect this.

## Coding Methods

The coding method is also configured by the descriptor and can be changed to support b/w and color LCD panels. The coding method can be selected in the descriptor by simply specifying the coding method in the `DEFAULT_CM` macro in `mfm_desc.h`.

This driver was verified on the ThinClient with both a 8-bit and 565 cables. The maximal coding method supported by SA1100 LCD Controller is 16 bpp.

**Table B-3 Coding Method Description**

<b>Board</b>	<b>Coding Method</b>	<b>CLUT Based</b>	<b>X,Y Multipliers</b>	<b>Palette Color Types</b>
ThinClient w/8 bit cable	GFX_CM_8BIT	TRUE	1,1	GFX_COLOR_RGB
ThinClient w/16 bit cable	GFX_CM_565, GFX_CM_655, or GFX_CM_556	FALSE	1,1	NA
No current hardware implementation available	GFX_CM_4BIT	TRUE	1,1	GFX_COLOR_RGB

## Viewport Complexity

The driver supports one active viewport at a time. The application can create multiple viewports and stack them. The viewport must be aligned with, and the same size as the display. Display drawmaps must be the same size as the viewport.

## Memory

Applications are expected to request graphics memory from the driver. The driver allocates memory from the system as needed. It requests this memory from color 0x80. This memory (specified in the init module) is located at the bottom of 16 MB DRAM address space and is marked as non cached.

## Location

This driver's source is located in:

`SRC/DPIO/MFM/DRVR/GX_SA1100`

This driver's makefiles are located in:

`OS9000/ARMV4/PORTS/THINCLIENT/MAUI/GX_SA1100`

This directory contains the makefiles and descriptor header file to build the descriptor(s) and driver(s) (not all packages include driver source) for the StrongARM reference platform. This directory contains:

<code>makefile</code>	Calls each of the other makefiles in this directory
<code>drvr.mak</code>	Builds the driver
<code>desc.mak</code>	Builds the descriptor(s)
<code>mfm_desc.h</code>	Defines values for all modifiable fields of the descriptor(s)

### Build the Driver

The driver source is located in `SRC/DPIO/MFM/DRVR/GX_SA1100`. To build the driver, use the following commands:

```
cd OS9000/ARMV4/PORTS/THINCLIENT/MAUI/GX_SA1100
os9make -f drvr.mak
```

### Build the Descriptor

To build a new descriptor, modify `mfm_desc.h`, and use the following commands to compile:

```
cd OS9000/ARMV4/PORTS/THINCLIENT/MAUI/GX_SA1100
os9make -f desc.mak
```

To build both the driver and the descriptor you can specify `os9make` with no parameters.

## SD\_UCB1200 Sound Driver Specification

---

This section describes the hardware specifications for the Philips UCB1200 driver `sd_ucb1200`. The hardware sub-type defines the board configuration. This specification should be used in conjunction with the MAUI Sound Driver Interface.

This driver works in conjunction with the `spucb1200` driver.

### Device Capabilities

Information about the hardware capabilities is determined by calling `_os_gs_snd_devcap()`. This function returns a data structure formatted as in the following table. See `SND_DEV_CAP` for more information about this data structure.

**Table B-4 Data Returned in `SND_DEV_CAP`**

Member Name	Value	Description
<code>hw_type</code>	"CS4231	"Hardware type
<code>hw_subtype</code>	"CS4231A	"Hardware sub-type
<code>sup_triggers</code>	<code>SND_TRIG_ANY</code>	Supported triggers
<code>play_lines</code>	<code>SND_LINE_SPEAKER</code>	Play gain/mix lines
<code>record_lines</code>	<code>SND_LINE_MIC</code>	Record gain/mix lines
<code>sup_gain_cmds</code>	<code>SND_GAIN_CMD_MONO</code>	Mask of supported gain commands
<code>num_gain_caps</code>	2	Number of <code>SND_GAIN_CAPS</code>

**Table B-4 Data Returned in SND\_DEV\_CAP (continued)**

<b>Member Name</b>	<b>Value</b>	<b>Description</b>
gain_caps	See Gain Capabilities Array	Pointer to SND_GAIN_CAP array
num_rates	30	Number of sample rates
sample_rates	See Sample Rates	Pointer to sample rate array
num_chan_info	1	Number of channel info entries
channel_info	See Number of Channels	Pointer to channel info array
num_cm	3	Number of coding methods
cm_info	See Encoding and Decoding Formats	Pointer to coding method array

## Gain Capabilities Array

The following tables show the various gain capabilities for the Philips UCB1200. This information is pointed to by the gain\_cap member of the SND\_DEV\_CAP data structure. See SND\_GAIN\_CAP for more information about this data structure. This driver allows control of following individual physical gain controls:

**Table B-5 Individual Gain Controls**

SND_LINE_SPEAKER	Output Attenuation
SND_LINE_MIC	Microphone Gain

The following tables detail the various individual gain capabilities:

**Table B-6 Speaker Gain Enable**

Member Name	Value	Step	HW	Level	Comments
lines	SND_LINE_SPEAKER	0-3	31	-69 dB	default_level
sup_mute	TRUE	4-7	30	-66.8 dB	
default_type	SND_GAIN_CMD_MONO	8-11	29	-64.7 dB	
default_level	SND_LEVEL_MAX	12-15	28	-62.5 dB	
zero_level	SND_LEVEL_MIN	...	...	...	
num_steps	32	112-115	3	-6.5 dB	
step_size	216	116-119	2	-4.3 dB	
mindb	-6900	120-123	1	-2.2 dB	
maxdb	0	124-127	0	0.0 dB	zero_level

**Table B-7 Mic Gain Enable**

Member Name	Value	Step	HW	Level	Comments
lines	SND_LINE_MIC	0-3	0	0 dB	zero_level
sup_mute	FALSE	4-7	1	0.7 dB	
default_type	SND_GAIN_CMD_MONO	...	...	...	...
default_level	SND_LEVEL_MAX	64-67	16	11.3 dB	default_level
zero_level	SND_LEVEL_MIN	...	...	...	...
num_steps	32	112-115		20.4 dB	
step_size	70	116-119	29	21.1 dB	
mindb	0	120-123	30	21.8 dB	
maxdb	2250	124-127	31	22.5 dB	

## Sample Rates

Following is an abbreviated list of the supported sample rates for the UCB1200. Below is a formula to derive valid sample rates:

$$\text{sample\_rate} = 11981000 / (32 * i), \text{ where } 8 < i < 128$$

This information is pointed to by the `sample_rates` member of the `SND_DEV_CAP` data structure.

**Table B-8 Sample Rate (Hz)**

2948	3941	4926	5942	6933
7966	8914	9852	10697	11700
12910	13866	14976	15600	17828
18720	19705	20800	22023	23400
24960	26743	28800	31200	34036
37440	41600	46801	53486	62401

## Number of Channels

The following table shows the different supported number of channels for the Philips UCB1200. The first entry in the table is the default number of channels. This information is pointed to by the `channel_info` member of the `SND_DEV_CAP` data structure.

**Table B-9 Number of Channels**

Channels	Description
1	Mono

## Encoding and Decoding Formats

The following table shows the supported encoding and decoding formats for the Philips UCB1200. The first entry in the table is the default format. This information is pointed to by the `cm_info` member of the `SND_DEV_CAP` data structure.

**Table B-10 Encoding and Decoding Formats**

<b>Coding Method</b>	<b>Sample Size</b>	<b>Boundary Size</b>	<b>Description</b>
<code>SND_CM_PCM_ULAW</code>	8	2	8 bit u-Law commanded
<code>SND_CM_PCM_SLINEAR</code> <code>SND_CM_LSBYTE1ST</code>	16	4	16 bit Linear (two's complement) little-endian
<code>SND_CM_PCM_SLINEAR</code>	16	4	16 bit Linear signed (two's complement) big-endian

## SPUCB1200 driver for the UCB1200 Codec

---

This document describes the hardware specifications for the Philips UCB1200 driver. This is an SPF driver.

### Capabilities

The UCB1200 is capable of controlling a microphone/speaker, input/output telecommunications lines, resistive style touch screen, and 16 General Purpose Input/Output lines. This driver currently can only control the touch screen, and general purpose input/output lines. The microphone/speaker can be controlled with a MAUI Sound driver called `sd_ucb1200`. No driver has been written for the telecommunications part of the UCB1200.

### Descriptors

**Table B-11** lists the UCB1200 descriptors.

**Table B-11**

<b>Name</b>	<b>Function</b>
<code>ucb</code>	UCB1200 Chip Initialization
<code>ucb_audio</code>	Not Implemented
<code>ucb_touch</code>	Touch Screen
<code>ucb_gpio</code>	Control GPIO Lines
<code>ucb_telecom</code>	Not Implemented

## UCB

Opening the /ucb device will perform basic chip initialization. Normally this is not necessary, unless another driver is written to control part of the UCB1200 functions. This is the case for audio. The MAUI Sound driver `sd_ucb1200` will open /ucb to perform chip initialization. In this way, the MAUI Sound driver play audio and this driver can control the touch screen at the same time.

## Audio

This portion of the driver is not implemented since the MAUI Sound driver `sd_ucb1200` already exists. `sd_ucb1200` and this driver can co-exist.

## Touch Screen

This portion of the driver controls the touch screen operation. When pressure is applied to the touch screen, a hardware interrupt is raised, and this driver's interrupt service routine will execute. A system state alarm, then, will fire at regular intervals to sample data from the touch screen. When pressure is removed, the alarm stops. This mechanism leaves the UCB1200 in a low power state until the user presses the touch screen. The alarm rate can be controlled in the `ucb_touch` descriptor.

Each sample contains an x, y coordinate as well as pressure information. The data is formatted into a six byte packet as defined in the table below. Each packet contains 10 bits of x, 10 bits of y, and 8 bits of pressure information.

**Table B-12 Touch Screen Descriptor Data**

Byte number	Description
0	sync code - 0x80
1	header: bit 1: pendown bit 2: penup bit 3: penmove (may occur with pendown or penup)
2	bits 0..2: high 3 bits of x bits 3..6: high 4 bits of pressure bit 7: 0
3	bits 0..6: low 7 bits of x bit 7: 0
4	bits 0..2: high 3 bits of y bits 3..6: low 4 bits of pressure
5	bits 0..6: low bits of y bit 7: 0

## GPIO

This section of the driver has basic GPIO line control, where lines 0..9 are connected to a 7 segment display or LED. Each line can be controlled with an `_os_write()` call. (Refer to the UCBHEX program in the TEST directory.)

## Telecom

This portion of the driver is not implemented.

## Supporting Modules

Before this driver can be used, the following modules must be in memory: `spf`, `sysmbuf`, `mbinstall`. `mbinstall` must also be run before use.

# MP\_UCB1200 MAUI Touch screen Protocol Module

---

This document describes the function of the `mp_ucb1200` protocol module, as well as a high level discussion of the touch screen driver and calibration application.

## Overview

The protocol module converts the driver raw data into a `MAUI_MSG` structure. In this way, applications can remain somewhat ignorant of the details of the hardware since it deals with the MAUI Input layer. In this protocol module, the raw hardware data is converted into screen coordinates. In addition, some data filtering occurs to reduce the amount of erroneous data that the touch screen hardware can produce.

## Data Format

The touch screen driver sends a 6 byte packet that contains x, y, and pressure information. The exact format of this packet is described in the `spucb1200` driver.

## Data Filter

This protocol module filters the data coming from the hardware in an attempt to reduce erroneous data. Two methods are implemented: data point averaging and low pressure point removal. The first method will average the last two points received from the driver. The data point will lag slightly behind the current position, then, but the average will reduce erroneous data points produced by the hardware. The second method throw out data points where the pressure below a certain threshold. It seems that extremely light touches will cause the data to become erratic, although the exact pressure threshold is hardware dependent.

## Raw Mode

An application can put this protocol module in a "raw" mode where data points are not filtered, averaged, or converted to screen coordinates. That is, the data from the hardware is passed directly up to the application.

The application can put this protocol module in a "raw" mode by calling: `inp_set_sim_meth(inpdev, RAW_MODE)`. After calibration, the program will need to put the protocol module back in NATIVE mode by calling: `inp_set_sim_meth(inpdev, DEFAULT_SIM_METH)`. There is a sample touch screen Calibration Application in the `TOUCH_CAL` directory.

When the protocol module is taken out of "raw" mode, it will try to read new calibration data points from the `ucb1200.dat` data module. After the data is read from the module, it is no longer needed.

## `cdb.touch`

The touch screen can be registered with MAUI by loading the `cdb.touch` module in memory before any programs using input are started. This will specify the `spucb1200` as the driver, `cdb.touch` as the descriptor, and `mp_ucb1200` as the protocol module.

## Compile Time Options

**Table B-13** shows compile time options used to control the default calibration settings and also the screen size. These options can be specified with a value in the `mp_ucb1200` makefile to modify the defaults.

**Table B-13 Compile Time Options**

Name	Purpose
SCREEN_WIDTH	Screen Width in Pixels
SCREEN_HEIGHT	Screen Weight in Pixels
DEFAULT_CALIBRATION_X	Left Calibration Hardware Point
DEFAULT_CALIBRATION_Y	Top Calibration Hardware Point
DEFAULT_CALIBRATION_WIDTH	Width of Screen In Hardware Points
DEFAULT_CALIBRATION_HEIGHT	Height of Screen In Hardware Points
JITTER_THRESHOLD	Minimum Pixel Change Required Before Points are Reported to the Application.
NUM_PTS	This allows you to choose how many successive data points to average in order to produce less erroneous screen coordinate data to the application. The default is 2, and valid choices are 1, 2, 4, 8, 16.
MIN_PRESSURE	Any pressure point less than this value will be ignored. This is another way to reduce erroneous data. This represents the 8 bit pressure value we get from the driver. The default is 40.

## Calibration Application

There is a sample calibration application located in the `$(MWOS)/SRC/MAUI/MP/MP_UCB1200/TOUCH_CAL` directory. This application, called `touch_cal`, will present a text message on the screen as well as points for the user to press. After the points are pressed, the protocol module `mp_ucb1200` will be updated with the new calibration information.

### Assumptions/Dependencies

1. A Window Manager must be running before this application will operate.
2. A font module must be present to run the demo. `default.fnt` is the default module, or you can specify one on the command line.
3. `touch_cal` will open the first `CDB_TYPE_REMOTE` device in the `cdb`.

### Command Line Options

- `-f [=] <outfile>` Specifies the filename of the calibration information module. This program will write the calibration information to this filename if it is specified. The file contains the calibration information as a data module, thus allowing the information to be stored on disk, nv RAM, flash, etc. for use the next time the hardware is rebooted.
- `-c` This option only works if `-f` is specified. This will cause the calibration program to run only if the filename specified with `-f` is not present.
- `-m=<font module>` Specifies the font module to use for displaying the text message on the screen.

## Coordination with Protocol Module

The protocol module `mp_ucb1200` and the touch screen application `touch_cal` work together to provide the calibration functionality. `touch_cal` must first open the touch screen device, and then must set it into Raw Mode. After the user selects each calibration point, `touch_cal` computes the average of them. These averaged hardware points (as well as the screen resolution) are then stored in a data module called `ucb1200.dat`. When the input device is taken out of Raw Mode, the protocol module will link to `ucb1200.dat` and update itself with the new calibration information.

## Compiling

The makefile for `touch_cal` exists in the `$(PORTS)/MAUI/MP_UCB1200/TOUCH_CAL` directory.

