

# TI-Android-GingerBread-2.3.4-DevKit-2.1 UserGuide



## TI Android GingerBread 2.3.4 DevKit 2.1 User Guide

User Guide - July 15, 2011

### About this manual

This document describes how to install and work with Texas Instruments' Android GingerBread DevKit release for AM37x, AM35x platforms running Android. This release package provides a stable Android distribution with integrated SGX (3D graphics) drivers, TI hardware abstraction for video overlay, and standard applications from Android. The package also includes Linux Android kernel, tools and documentation to ease development, deployment and execution of Android based systems. The product forms the basis for all Android application development on AM37x, AM35x platforms. In this context, the document contains instructions to:

- Install the release
- Setting up the hardware
- Steps to use pre-built binaries in the package
- Running Android on the supported platforms
- Setting up the Android debugger “adb” with the hardware platform
- Installing and executing Android (out of market) applications hardware platforms

### Installation

This section describes the list of Software and Hardware requirements to evaluate the DevKit release.

### Hardware Requirements

This release of TI Android GingerBread 2.3.4 DevKit 2.1 is evaluated on the below given list of platforms. This package should be easily portable on other platforms on similar TI devices.

TI Device	Platform Supported	Version	Other Accessories
OMAP35x			
	Beagleboard <sup>[1]</sup>	Rev Cx	DVI Monitor, USB HUB, USB Keyboard, USB Mouse, Ethernet, UART Cable, Audio Speakers, MMC/SD Card (2GB min)
AM35x			
	AM3517 Evaluation Module <sup>[2]</sup>	Rev C	DVI Monitor, USB HUB, USB Keyboard, USB Mouse, Ethernet, UART Cable, Audio Speakers, MMC/SD Card (2GB min)
AM37x			
	AM37x Evaluation Module <sup>[3]</sup>	Rev C	DVI Monitor, USB HUB, USB Keyboard, USB Mouse, Ethernet, UART Cable, Audio Speakers, MMC/SD Card (2GB min)

	BeagleBoard <sup>[1]</sup>	XM Rev A/B/C	DVI Monitor, USB HUB, USB Keyboard, USB Mouse, Ethernet, UART Cable, Audio Speakers, MMC/SD Card (2GB min)
--	----------------------------	-----------------	---

## Software Host Requirements

If you are a Android application developer or would like to use Android SDK Tools then refer to <http://developer.android.com/sdk/requirements.html> for Host PC requirements.

To evaluate this release we recommend you to have a Linux "Ubuntu 8.04 or above" Host machine, See Ubuntu Linux installation notes <sup>[4]</sup>

## Package Content

```

TI_Android_GingerBread_2_3_4_DevKit_2_1
|-- Android_Source_Manifest
|   `-- TI-Android-GingerBread-2.3.4-DevKit-2.1.xml
|-- Documents
|   |-- RowboPERF_User_Guide.pdf
|   |-- Software_Manifests
|   |   |-- TI-Android-DevKit-FS-Manifest.doc
|   |   |-- TI-Android-DevKit-Manifest-For-TSU-components.doc
|   |   `-- TI-Android-DevKit-Software-Manifest.doc
|   |-- TI-Android-GingerBread-2.3.4-DevKit-2.1_DeveloperGuide.pdf
|   |-- TI-Android-GingerBread-2.3.4-DevKit-2.1_ReleaseNotes.pdf
|   |-- TI-Android-GingerBread-2.3.4-DevKit-2.1_UserGuide.pdf
|   `-- Test_Performance_Results
|       |-- CTS_Report.tar.gz
|       `-- TestResults
|           |-- AM3517_Gingerbread_2.3.4_Devkit_2.1_Test_Report.pdf
|           `-- AM37x_Gingerbread_2.3.4_Devkit_2.1_Test_Report.pdf
|-- Prebuilt_Images
|   |-- AM35X
|   |-- AM37X
|   |-- AM37X_UBIFS
|   |-- beagleboard-rev-c4
|   `-- beagleboard-xm
`-- Tools
    |-- Flash_Tool_01_06_00_00.zip
    |-- android-sdk_r06-linux_86.tgz
    |-- mk-bootscr
    |-- mk-mmc
    |-- pinmux-utility.tar.gz
    `-- signGP

```

## Out of the Box Demo

This section gives the instructions to quickly prepare an SD Card image and get an experience of TI Android GingerBread 2.3.4 DevKit 2.1 on TI platforms/devices.

- Download the pre-built Image from [http://software-dl.ti.com/dsps/dsps\\_public\\_sw/sdo\\_tii/TI\\_Android\\_DevKit/TI\\_Android\\_GingerBread\\_2\\_3\\_4\\_DevKit\\_2\\_1/index\\_FDS.html](http://software-dl.ti.com/dsps/dsps_public_sw/sdo_tii/TI_Android_DevKit/TI_Android_GingerBread_2_3_4_DevKit_2_1/index_FDS.html) for the platform you own, can be AM35x EVM, AM37x EVM, Beagleboard Rev C4/XM.
- Get an SD Card of minimum size 2GBytes (Class4 minimum) and a USB Card reader
- Insert the USB SD Card reader (with SD Card) in your host Linux PC
- Prepare the MMC/SD card Image

```
tar -xzf <Board name>.tar.gz
cd <Board name>
sudo ./mkmmc-android /dev/sd<device>
```

- The above step prepares the SD Card.
- Setup the board/platform
  - Do the DIP switch settings to boot from SD Card, see the section on DIP switch setting below.
  - Insert the SD Card into the Board
  - Switch on the platform
  - Wait for 35sec to get Android up on the UI screen

NOTE: For the first time boot the System might take few minutes to boot.

NOTE: If your NAND flash is not empty the system might not boot with MMC,

in that case do the following with Serial Console / Terminal prompt in u-boot

```
#> mmc init
#> fatload mmc 0 0x82000000 boot.scr
#> source 0x82000000
```

- Click on the TI logo and run the apps you are interested in, look at the RowboPerf user guide for more details about this app [http://processors.wiki.ti.com/index.php/RowboPERF\\_User\\_Guide](http://processors.wiki.ti.com/index.php/RowboPERF_User_Guide).

## Android Booting Procedure

Booting Android on any TI platform requires following software components

- Kernel Image (uImage)
- Bootloader (u-boot.bin)
- Bootstrapping (x-load.bin.ift for NAND or MLO for MMC)
- Filesystem (rootfs)

The above listed software components or images can be populated by

- Building sources from this package
- Using the pre-built images in this package

## Software Integration

TI provides Android sources for all the supported devices in multiple locations, developers can download the sources from the rowboat repository (<http://gitorious.org/rowboat>) or use the pre-packaged repo in the DevKit.

Refer to [http://processors.wiki.ti.com/index.php/TI-Android-GingerBread-2.3.4-DevKit-2.1\\_DeveloperGuide](http://processors.wiki.ti.com/index.php/TI-Android-GingerBread-2.3.4-DevKit-2.1_DeveloperGuide)

[5] for the detailed procedure to compile and integrate all the required software components to boot Android on TI platforms.

## Setting up Hardware

This DevKit release supports six different platforms AM37x EVM, AM35x EVM, Beagleboard Rev Cx, Beagleboard XM. While they are different devices the hardware setup will almost remain the same.

- Connect the UART port of the platform to the Host PC and have a Terminal software like TeraTerm, Minicom or Hyperterminal.
- Connect the Ethernet (on Beagle Rev C4 we don't have an Ethernet port)
- Connect Audio Speakers
- For Beagle board you need to connect DVI Monitor through HDMI connector.
- Use self powered USB HUB and connect it to USB Host port of the platform, mainly for Beagle and AM35x EVM. For AM37x, the onboard keypad can be used
  - Connect USB keyboard and USB Mouse to the USB HUB for use with Beagle or EVM

### NOTE :

– Beagleboard have no keypad mappings, user is recommended to use USB Keyboard over a self powered USB HUB connected to the Host port of Beagleboard.

- Select Appropriate DIP Switch settings on EVM(s) to boot over MMC/SD

For MMC/SD boot - On AM37x EVM the DIP switch SW4 should be set as shown below

Switch	1	2	3	4	5	6	7	8
State	OFF	ON	ON	ON	OFF	OFF	OFF	OFF

For MMC/SD boot - On AM35x EVM the DIP switch S7 should be set as shown below

Switch	1	2	3	4	5	6	7	8
State	ON	OFF	OFF	ON	OFF	OFF	OFF	ON

## Bootting Android

TI platforms (Beagle or EVM) can be booted over MMC or NAND or UART. We follow and prefer MMC based booting of platforms.

### Procedure to populate MMC/SD Card

Use the mk-mmc utility provided in the tools folder of this package to populate the SD Card. This utility helps users create a MMC/SD Card with required Images to boot Android on any given TI platform.

This will partition the SD card to three partitions namely boot, rootfs and data. 1) The boot partition will get populated with the images required for booting. 2) The rootfs partition will be used as android root filesystem partition. 3) The Media inside the folder Media\_Clips will get copied to the data partition. The data partition will get mounted as EXTERNAL storage when Android boots up.

Execute the following command

Example:

```
#>./mkmmc-android.sh /dev/sdc MLO u-boot.bin uImage boot.scr  
rootfs.tar.bz2 Media_Clips
```

*This populates the SD/MMC card with all the images.*

NOTE:

To create the boot.scr boot script use the mkbootscr tool found in the Tools directory provided in the DevKit.

If you want to use the pre built images in the DevKit you have to adjust the above mentioned command to take them into account, as a more direct example the commands below will generate a SD card for an AM37x EVM. Ensure you have your SD card connected to the Linux machine you are using and that it is in /dev/sdb for this command otherwise adjust the command accordingly (**WARNING:** if you get this wrong it can wipe your HDD). Note that this assumes you installed the SDK in your home (~) directory and that the command is run with sudo (or your preferred way of getting super user privileges) to allow for the reformatting of the SD card.

```
HOST $ cd ~/TI_Android_GingerBread_2_3_4_DevKit_2_1/AM37X  
HOST $ sudo ../../Tools/mk-mmc/mkmmc-android.sh /dev/sdb
```

### Procedure to add Video, Audio and other media

To play media after booting Android on any platform, the content must be included in the MMC/SD card's FAT32 partition. If you use the mk-mmc script included in the release package then it creates 3 partitions. The media content should be placed into the 3rd (FAT32) partition.

Example:

```
HOST $ sudo mount /dev/sdd3 /mnt  
HOST $ sudo cp <all media files> /mnt  
HOST $ sudo umount /mnt
```

NOTE:

- This release supports all the standard Android media formats, listed here <http://developer.android.com/guide/appendix/media-formats.html>

### Bootting the platform

Bootting over MMC using boot.scr

NOTE:

- If the board has bootargs configured already, then the board will not boot for Android automatically,
- It is suggested to either delete the bootargs or use the following commands on u-boot prompt through UART console.

```
#> mmc init
#> fatload mmc 0 0x82000000 boot.scr
#> source 0x82000000
```

### Boot arguments

Boot arguments for various boards are as follows.

AM35X:

```
setenv bootargs 'console=ttyO2,115200n8 androidboot.console=ttyO2
mem=256M root=/dev/mmcblk0p2 rw rootfstype=ext3 rootdelay=1 init=/init
ip=off omap_vout.vidl_static_vrfb_alloc=y vram=8M omapfb.vram=0:8M'
```

AM37X:

```
setenv bootargs 'console=ttyO0,115200n8 androidboot.console=ttyO0
mem=256M root=/dev/mmcblk0p2 rw rootfstype=ext3 rootdelay=1 init=/init
ip=off omap_vout.vidl_static_vrfb_alloc=y vram=8M omapfb.vram=0:8M'
```

Beagleboard-rev-c4:

```
setenv bootargs 'console=ttyO2,115200n8 androidboot.console=ttyO2
mem=256M root=/dev/mmcblk0p2 rw rootfstype=ext3 rootdelay=1 init=/init
ip=off omap_vout.vidl_static_vrfb_alloc=y vram=8M omapfb.vram=0:8M'
```

Beagleboard-xm:

```
setenv bootargs 'console=ttyO2,115200n8 androidboot.console=ttyO2
mem=256M root=/dev/mmcblk0p2 rw rootfstype=ext3 rootdelay=1 init=/init
ip=off omap_vout.vidl_static_vrfb_alloc=y vram=8M omapfb.vram=0:8M'
```

### Keypad mappings

The below table lists the keypad and USB Keyboard mappings to Android UI functionality.

Functionality	USB Keyboard/Mouse	Keypad on AM37x EVM	Keypad on AM35x EVM
Home Screen	Home	R3C2	S3
Left	Left Arrow	R2C1	S6
Right	Right Arrow	R0C2	S5
Up	Up Arrow	R1C3	S7
Down	Down Arrow	R2C0	S9
Volume Up	Volume Up	R1C2	S4
Volume Down	Volume Down	R0C1	S1
Contacts	F3		
Power		R0C0	S2
Select	Enter	R3C1	
Back	Mouse right	R2C3	S8
Menu	F1	R3C3	S10

## Using Network Filesystem

Android filesystem can be mounted over network, the bootargs for doing the same should include below text instead of MMC

```
ip=dhcp rw root=/dev/nfs nfsroot=<your NFS server
ipaddr>:/home/USER/FILESYSTEM_DIR,nolock noinitrd
```

Example: Complete bootargs for AM37x board using NFS and LCD output

```
setenv bootargs init=/init console=ttyO0,115200n8 ip=dhcp rw
root=/dev/nfs nfsroot=192.168.133.01:/home/user/targetfs,nolock\
mem=256M noinitrd androidboot.console=ttyO0 vram=8M omapfb.vram=0:8M
```

## Important

NFS is not supported for Beagle Rev C4 since it doesn't have an Ethernet port.

## Using Flashing Utility

Android boot images x-loader and u-boot etc can be flashed to NAND from windows host, using flashing utility provided in tools. Flashing utility is tested on USB connection with AM37X Pre-built images. For instructions on flashing utility please refer the steps at [http://processors.wiki.ti.com/index.php/Flash\\_v1.6\\_User\\_Guide](http://processors.wiki.ti.com/index.php/Flash_v1.6_User_Guide).

In some cases the flashing utility's recommended settings of HWECC, 4-bit for flashing Uboot and the kernel image may not work and the board displays a bad CRC message. If this happens re-flash the components again using the SWECC setting of the utility for Uboot and kernel.

## Display Support

### Using DVI Monitor

On AM37x, DM37x and AM35x EVMs the on board LCD is used as output device by default. User is allowed to configure DVI port as output device, by changing the boot arguments as shown below.

Append the boot arguments with following text

```
omapfb.mode=dvi:1280x720MR-16 omapdss.def_disp="dvi"
```

Example:

To boot over MMC and use DVI at resolution 1024x768 on AM37x EVM, the complete bootargs would be,

```
setenv bootargs init=/init console=ttyO0,115200n8 ip=dhcp rw
root=/dev/mmcblk0p2 rw init=/init rootwait mem=256M
androidboot.console=ttyO0 omapfb.mode=dvi:1024x768MR-16
omapdss.def_disp="dvi" vram=8M omapfb.vram=0:8M
```

NOTE:

- On beagleboard the DVI port is configured as default output device.
- On AM3517, 8th switch on SW7 should be "ON" to enable DVI

## Using S-VIDEO Monitor

### By Setting Boot parameters

On AM37x and AM35x EVMs the on board LCD is used as output device by default. User is allowed to configure S-video port as output device, by changing the boot arguments as shown below.

Append the boot arguments with following text

```
omapdss.def_disp="tv"
```

Example:

To boot over MMC and use S-video port as output device on AM37x EVM, the complete bootargs would be,

```
setenv bootargs 'console=ttyO0,115200n8 androidboot.console=ttyO0
mem=256M root=/dev/mmcbk0p2 rw rootfstype=ext3 rootdelay=1 init=/init
ip=off omap_vout.vidl_static_vrfb_alloc=y vram=8M omapfb.vram=0:8M
omapdss.def_disp="tv" '
```

### By Sysfs configuration

Boot the device with LCD as default output device.

To boot over MMC and use lcd as output device on AM37x EVM, the complete bootargs would be,

```
setenv bootargs 'console=ttyO0,115200n8 androidboot.console=ttyO0
mem=256M root=/dev/mmcbk0p2 rw rootfstype=ext3 rootdelay=1 init=/init
ip=off omap_vout.vidl_static_vrfb_alloc=y vram=8M omapfb.vram=0:8M'
```

### Switch video on S-video device

Use the following procedure to display video on s-video device.

Disable overlay1. Before changing any overlay attributes, it should first be disabled.

```
#echo 0 > /sys/devices/platform/omapdss/overlay1/enabled;
```

Reset overlay1 manager which is set to lcd by default

```
#echo "" > /sys/devices/platform/omapdss/overlay1/manager;
```

Disable display1/tv

```
#echo 0 > /sys/devices/platform/omapdss/display1/enabled;
```

Set overlay manager to tv

```
#echo "tv" > /sys/devices/platform/omapdss/overlay1/manager;
```

Enable display1/tv

```
#echo 1 > /sys/devices/platform/omapdss/display1/enabled
```

Open gallery application and play video. Video will be played on s-video device and graphics will be displayed on the lcd.



### Switch video on lcd device

Use the following procedure to display video on lcd device.

Disable overlay1. Before changing any overlay attributes, it should first be disabled.

```
#echo 0 > /sys/devices/platform/omapdss/overlay1/enabled;
```

Disable display1/tv

```
#echo 0 > /sys/devices/platform/omapdss/display1/enabled;
```

Disable display0/lcd

```
#echo 0 > /sys/devices/platform/omapdss/display0/enabled;
```

Reset overlay1 manager which is previously set to tv

```
#echo "" > /sys/devices/platform/omapdss/overlay1/manager;
```

Set overlay manager to lcd

```
#echo "lcd" > /sys/devices/platform/omapdss/overlay1/manager;
```

Enable display0/lcd

```
#echo 1 > /sys/devices/platform/omapdss/display0/enabled
```

Open gallery application and play video. Video and graphics will be displayed on the lcd.

## Rotation Support

Graphics and Video rotation is managed by software. Use standard android API to rotate screen in portrait or landscape mode. Currently portrait and landscape graphics rotation mode is supported.

## Camera Support

Ti Android GingerBread 2.3.4 Devkit 2.1 supports camera sensor mt9v113 for beagleboard-xm and camera sensor mt9t111 for AM37x



### Feature supported:

- Image Capture
1. Go to application/activity view launcher > open camera
  2. Click on camera capture. By default images will get stored at - */sdcard/DCIM*

NOTE:

- Video recording is not supported

## Wireless

AM37x evm revG with the wireless module supports WLAN and Bluetooth on Android. For steps on installing the wireless module see this page.

### WLAN

- Menu->Settings->Wireless & networks->Wi-Fi settings
- click Wi-Fi and wait for few seconds.
- On the UI, Green check-mark appears and status shows scanning
- After scan completes, available APs are listed
- Connect to desired AP by clicking on its name and enter required details (username/key etc) and click connect
- The following appears on console

```
wl1271: loaded
wl1271: initialized
wl1271: firmware booted (Rev 6.1.5.50.69)
cfg80211: Calling CRDA to update world regulatory domain
wl1271: Association completed.
```

- when successfully connected, you will see status as connected to APNAME
- To turn off Wi-Fi, click Wi-Fi in Menu->Settings->Wireless & networks
- Following message appears on console and the green check mark is not visible on UI

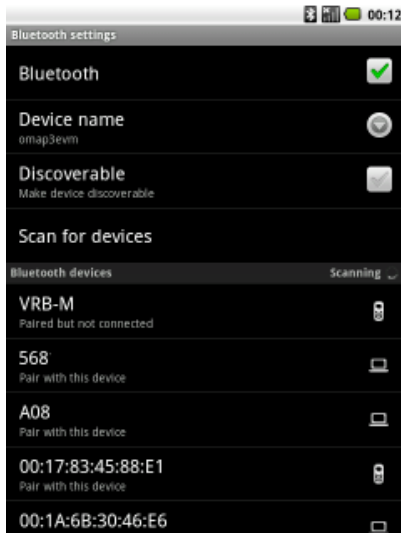
```
wl1271: down
wl1271: unloaded
```

### Bluetooth

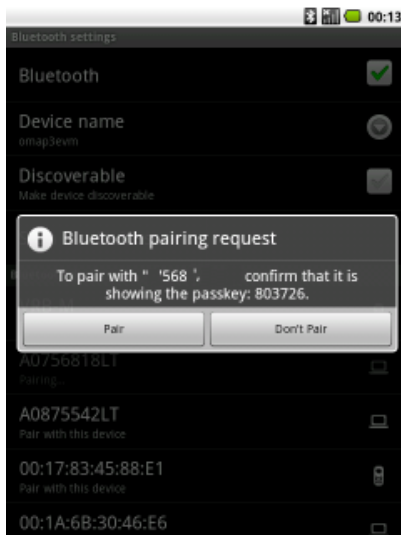
- Menu->Settings->Wireless & networks->Bluetooth settings
- Click Bluetooth and wait for few seconds
- LED LD3 turns ON on the wireless module and the Bluetooth icon appears on taskbar. The following appears on the debug console

```
Set BT_EN of WL1271
WL1271: Powering on
```

- If BT is enabled green check-mark appears and status shows scanning
- available bt devices are listed



- click on desired device to pair with
- popup with pin will appear



- click Pair button to confirm pairing
- verify that the desired device shows the same pin. click ok. devices paired

NOTE: When pairing with Bluetooth headset, pin may not be displayed. Android attempts to pair automatically with Bluetooth headsets. Pin dialog will be shown only if auto-pairing fails.

- To turn off Bluetooth, click Bluetooth in Menu->Settings->Wireless & networks
- LED LD3 turns OFF on the wireless module, Bluetooth icon is not displayed on taskbar and the following messages appear on console:

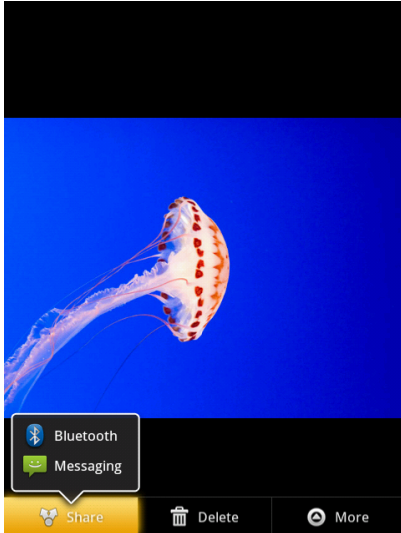
```
Set BT_EN of WL1271
WL1271: Powering off
```

## Bluetooth Object Push profile

Using Bluetooth, it is possible to send receive files (pictures, media files etc).

### Sending files

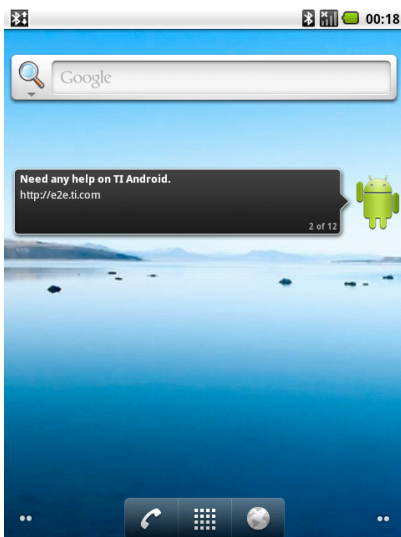
- go to Menu ->Gallery
- Select a picture to share
- click Menu (bottom right)
- click share, select bluetooth from the options



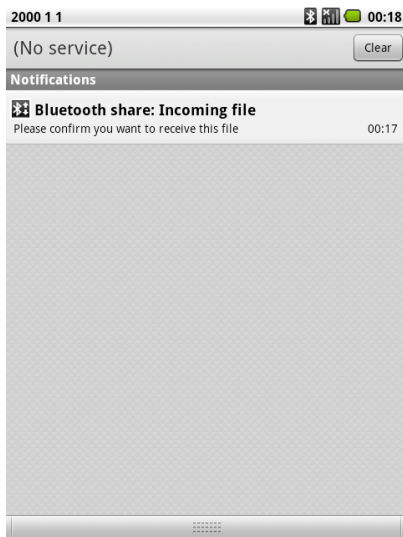
- select paired bt device to send to
- the bt device will prompt to accept. accept incoming file
- once download finished. check file

### Receiving files

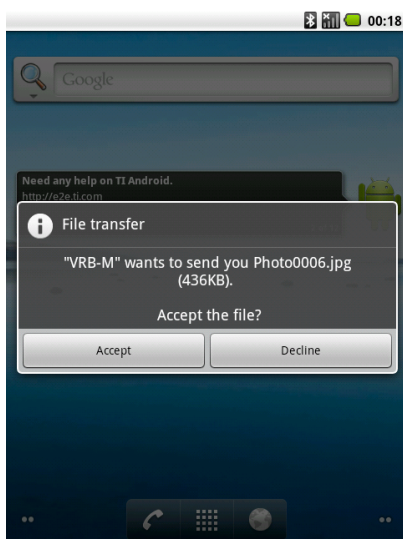
- on paired device (e.g. phone), select send to bt, click on omap3evm
- on evm, notification appears about incoming connection (top left)



- open task bar. click on note



- in popup click accept

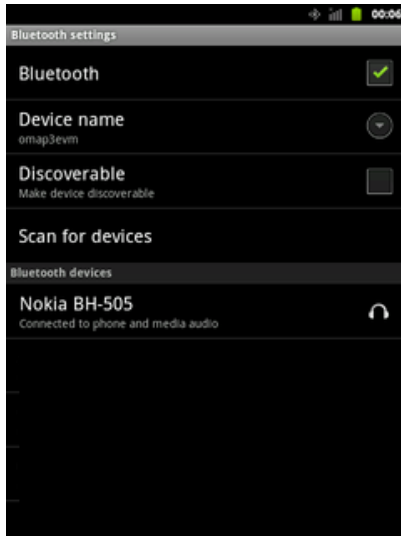


- once download complete. check file

## Bluetooth A2DP

You can listen to Media audio on Bluetooth A2DP headset.

- Pair A2DP capable bluetooth headset with device. Android uses the stereo headset icon to denote A2DP headset
- After pairing succeeds, the status is updated to 'Connected to phone and media audio'.



- Open Music player and play any audio clip
- Audio will be heard on the Bluetooth headset

## Bluetooth AVRCP

You can control Media playback with Media player keys on Bluetooth headset with AVRCP capabilities.

NOTE: The following steps assume Bluetooth A2DP headset with AVRCP.

- Pair the BT headset
- The following text appears on the debug serial when the pairing is successfully completed. This confirms that AVRCP feature is registered with android

```
input: AVRCP as /devices/virtual/input/input3
```

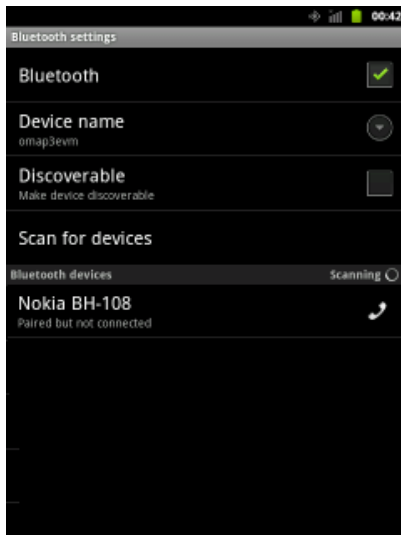
- Open Music Player and go to playlist view. Check that there are multiple clips in the playlist.
- Press the Play/Pause button on the BT headset - The currently queued clip begins playing on the headset
- Press the Play/Pause button again on the headset - The currently playing clip is paused
- Press the Next button on the headset; the next clip in the playlist begins to play on the headset
- Press the Prev button on the headset; the currently playing clip restarts from the beginning

## Bluetooth SCO Audio

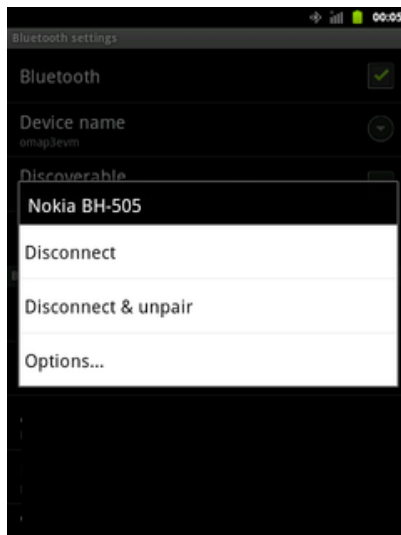
Android supports the Bluetooth Headset Profile/HandsFree Profile Audio Gateway (HSP/HFP AG). Bluetooth SCO connection is used to play/capture audio in these profiles.

It is possible to record audio from Bluetooth headset over SCO.

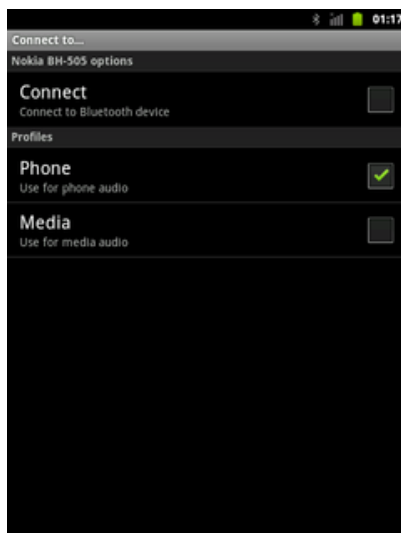
- Pair Bluetooth headset with device
- After pairing succeeds, the status is updated to 'Connected to phone audio'. If using A2DP headset, the status is 'Connected to media and phone audio'



- NOTE: If using A2DP headset, you need to disable the A2DP profile before BluetoothSCOApp can be used. To disable A2DP follow the steps below
  - Menu -> Settings -> Wireless & networks -> Bluetooth settings
  - Long tap on the entry for A2DP headset, a menu appears



- Tap Options
- Uncheck Media. This stops android from using A2DP profile of the headset



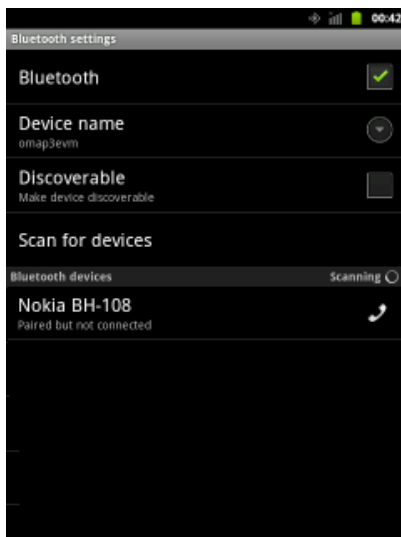
- To re-enable A2DP, repeat the above steps and check-mark Media
- Menu -> BluetoothSCOApp. BluetoothSCOApp is a sample app to establish SCO connectivity with a Bluetooth headset
- Menu -> Sound Recorder
- Tap record button
- Speak into the bluetooth headset mic, the VU meter display moves as per the sound. This confirms that audio is being recorded from bluetooth headset
- Stop recording and save the clip.
- Turn-off and Turn-on the Headset to come out of SCO mode. (This is a limitation of the current version of BluetoothSCOApp)

The audio is recorded in 3gpp format and can be played back by the Music player.

### Bluetooth Audio Recording and Playback using ALSA utils

An alternate method to capture and play audio using SCO using alsa-utils is given below. These steps do not use the Android MediaPlayer framework.

- Pair Bluetooth headset with device
- After pairing succeeds, the status is updated to 'Connected to phone audio'. If using A2DP headset, the status is 'Connected to media and phone audio'



- Tap once so that check mark appears against 'Enable Music via Media Player'

NOTE: If using A2DP headset, you need to disable the A2DP profile before BluetoothSCOApp can be used.

- Menu -> BluetoothSCOApp. BluetoothSCOApp is a sample app to establish SCO connectivity with a Bluetooth headset
- Tap once so that check mark appears against 'Enable Music via Media Player'
- On the serial console type in the following commands:

```
# ln -s /system/app/alsa_aylay /system/app/alsa_arecord
# alsa_arecord -D hw:0,1 -f S16 test.wav
```

- Speak into the Bluetooth Headset mic. This data will be captured and saved in test.wav. Press Ctrl-C to stop the capture session.
- To play the recorded sound, enter the following command on the console.

```
# alsa_aylay -D hw:0,1 test.wav
```

Turn off the HandsFree Headset to stop the SCO session.



NOTE: An active SCO session needs to be established to play/capture audio from Bluetooth Hands-Free.

### Known Issues

- After connection drop WiFi doesn't connect to Access Point automatically. User need to disconnect and connect again.

## Power Management

Below are the features supported in TI-Android-GingerBread-2.3.4-DevKit-2.1

### AM37X

- Change of LCD backlights based on Wake Locks and Screen Timeouts (DIM,OFF)
- LCD back light brightness control from Settings Application
- Suspending the device to Memory.The device can be suspended in two ways.
  1. Pressing the POWER key on the keypad
  2. Allowing the system go to suspend after a screen timeout
- Prevent Suspend based on Wake Locks
- System Resume on Key Press
- System Resume on Alarm
- CPU Dynamic Voltage and Frequency Scaling (ondemand, performance, powersave and userspace governors)
- CPU Idle States
- Enabling system for hitting retention during idle
- Enabling system for hitting OFF
- Smart Reflex

### AM35X

- Suspending the device to Memory.The device can be suspended in two ways.
  1. Pressing the POWER key on the keypad
  2. Allowing the system go to suspend after a screen timeout
- Prevent Suspend based on Wake Locks
- System Resume on Key Press
- Android Early Suspend Feature for frame buffer driver

### Basic Settings

#### Enable PM

By default we have disabled pm by setting "setprop hw.nopm true" in init.rc.

Replace the line with "setprop hw.nopm false" to enable suspend/resume features.

#### To go in suspend mode

- Press POWER key on the keypad

#### To resume from suspend mode

- Press any button on the key pad

#### To set the Screen Timeout to go suspend

- Select Settings->Display-> Screen Timeout
  - Select one of the options from the list
-

**To set the screen always on preventing suspend**

- Select Settings-> Applications-> Development-> Stay awake

**To set Screen Brightness**

- Select Settings->Display-> Brightness

**To set Alarm in Android**

- Select Clock->Alarm->Add Alarm->Select Time->Set

Device will be woken up from suspend at Alarm Time

**Advanced Settings****To Disable Power Management**

- Edit init.rc file on the root directory.
- Set the property hw.nopm to true
- This will prevent POWER key suspend and screen timeout based suspend

**CPU Idle and OFF mode Settings**

CPU Idle feature is enabled by default in the kernel. There are seven power states introduced by CPU Idle. Enable "sleep\_while\_idle" and "enable\_off\_mode" to achieve all the possible idle states. For maximum power reduction set the UART console timeouts as well

```
# echo 1 > /debug/pm_debug/sleep_while_idle
# echo 1 > /debug/pm_debug/enable_off_mode
# echo 5 > /sys/devices/platform/omap/omap_uart.0/sleep_timeout
# echo 5 > /sys/devices/platform/omap/omap_uart.1/sleep_timeout
# echo 5 > /sys/devices/platform/omap/omap_uart.2/sleep_timeout
```

The usage and time count for these different states can be checked via

```
#cat /sys/devices/system/cpu/cpu0/cpuidle/state*/time
#cat /sys/devices/system/cpu/cpu0/cpuidle/state*/usage
```

**CPU Dynamic Voltage Frequency Scaling settings****Enabling ondemand frequency governor**

The ondemand governor enables DVFS(frequency/OPP) transitions based on CPU load.

```
#echo ondemand >
/sys/devices/system/cpu/cpu0/cpufreq/scaling_governor
```

**Enabling performance frequency governor**

The performance governor keeps the CPU always at the highest frequency.

```
#echo performance >
/sys/devices/system/cpu/cpu0/cpufreq/scaling_governor
```

### Enabling powersave frequency governor

The powersave governor keeps the CPU always at the lowest frequency.

```
#echo powersave >
/sys/devices/system/cpu/cpu0/cpufreq/scaling_governor
```

### Enabling userspace frequency governor

Once this governor is enabled, DVFS( frequency) transitions will be manually triggered by a userspace application by using the CPUfreq sysfs interface

```
#echo userspace >
/sys/devices/system/cpu/cpu0/cpufreq/scaling_governor
```

See all the available operating points

```
#cat
/sys/devices/system/cpu/cpu0/cpufreq/scaling_available_frequencies
```

Application can select any of the available frequency from the above

```
#echo <Desired Frequency> >
/sys/devices/system/cpu/cpu0/cpufreq/ scaling_setspeed
```

### Smart Reflex

#### To enable smart reflex

```
# echo 1 > /debug/voltage/vdd_core/smartreflex/autocomp
# echo 1 > /debug/voltage/vdd_mpu/smartreflex/autocomp
```

#### To disable smart reflex

```
# echo 0 > /debug/voltage/vdd_core/smartreflex/autocomp
# echo 0 > /debug/voltage/vdd_mpu/smartreflex/autocomp
```

### To minimize the power consumption in runtime

The maximum power reduction in runtime is achieved when “enable\_off\_mode”, “sleep\_while\_idle”and “smart reflex” options are enabled and dvfs option is set to “power save”.

### To minimize the power consumption in suspend

The maximum power reduction in suspend is achieved when “enable\_off\_mode”, “sleep\_while\_idle”and “smart reflex” options are enabled and UART console timeouts are set.

Please check the power consumption analysis at [LINK](#)

### Limitations

- In beagle and am35x platforms there is no keypad connected to the wake up domain. So wake up is not possible by pressing keys. As a workaround, you can wake up am35x platform like below
  - Press ENTER on Serial Port console and then press any key on the keypad to wake up the device.
- If the usb device connected to the USB EHCI port when suspending the device, it might not work properly after resume. So Disconnect any usb device connected to USB EHCI port when suspending the device and connect it after resume.
- In Suspend, If USB OTG cable is connected, it makes Powerdomain (core\_pwrdom) not entering to sleep State

- Inserting and Removing USB OTG cable continuously after suspend-resume makes system hang sometimes

## NAND Booting

### NAND Image flashing from u-boot prompt

- The default ECC scheme is 1-bit hardware ECC with Kernel/FileSystem ECC layout. Before saving the environment to NAND flash, always select this scheme. This will ensure that U-boot can read the environment from NAND without any ECC mismatch.

The ECC algorithm supported in this release are:

```
# nandecc [ hw <hw_type> | sw | bch4_sw | bch8_sw ]
```

Usage:

```
sw                - Set software ECC for NAND
hw <hw_type>      - Set hardware ECC for NAND
                   <hw_type> - 1 for Kernel/FileSystem ECC layout
                               2 for X-loader/U-boot ECC layout
bch4_sw           - Set 4-bit BCH ECC for NAND
bch8_sw           - Set 8-bit BCH ECC for NAND

(hw 1 is set as the default nandecc)
```

### Saving Environment Variables

For example, to set bootargs and save them to the environment, the following commands could be used:

```
OMAP3_EVM # nandecc hw 1
OMAP3_EVM # setenv bootargs 'mem=128M console=ttyO0,115200n8 noinitrd
root=/dev/mtdblock4 rw rootfstype=jffs2'
OMAP3_EVM # saveenv
```

### Flashing x-loader

To flash MLO (x-load.bin.ift) to the NAND Flash, execute the commands listed below:

```
OMAP3_EVM # tftp 0x80000000 MLO
OMAP3_EVM # nand erase 0x0 0x50000
OMAP3_EVM # nandecc hw 2
OMAP3_EVM # nand write 0x80000000 0x0 0x50000
```

### Flashing U-boot

To flash u-boot.bin to the NAND Flash, execute the commands listed below:

```
OMAP3_EVM # tftp 0x80000000 u-boot.bin
OMAP3_EVM # nand erase 0x80000 0x1C0000
OMAP3_EVM # nandecc hw 2
OMAP3_EVM # nand write 0x80000000 0x80000 0x1C0000
```

### Flashing Linux kernel

To flash uImage to the NAND Flash execute the commands listed below:

```
OMAP3_EVM # tftp 0x80000000 uImage
OMAP3_EVM # nand erase 0x280000 <kernel image size>
OMAP3_EVM # nandeccl hw 1
OMAP3_EVM # nand write 0x80000000 0x280000 <kernel image size>
```

### Flashing UBI filesystem

To flash UBI image to the NAND Flash execute the commands listed below:

```
OMAP3_EVM # mw.b 0x80000000 0xFF <file system size>
OMAP3_EVM # tftp 0x80000000 <file system image>
OMAP3_EVM # nand erase 0x780000 <file system size>
OMAP3_EVM # nandeccl hw 1
OMAP3_EVM # nand write 0x80000000 0x780000 <file system size>
```

#### Note

The image size should be upward aligned to NAND page size which is 2KiB (i.e. 0x800). For example, if the image size is 0x19B8004 the size to be passed to the NAND write command should be 0x19B8800.

### Fastboot and UBI rootfs

Fastboot flashing utility is for updating the different software components of Android. Here is a guide to reflash the xloader, u-boot, kernel and root-file-system (UBIFS image). This guide assume that Rowboat has been compiled before trying out these instructions.

#### Establishing Fastboot connectivity

- Connect serial port to host PC via null modem cable.
- Serial port settings: 115200 8N1, No flow control.
- Apply power to the board.
- Press any key in serial port utility during boot and get U-boot command prompt.
- Run "fastboot" on u-boot command prompt (u-boot will echo "fastboot initialized").
- Connect USB cable between USB OTG port of the board and host PC.

#### Setup on linux host

- On command prompt, run

```
$ export ANDROID_ROOT=<rowboat top level directory>
```

```
$ cd $ANDROID_ROOT/out/host/linux-x86/bin
```

```
$ sudo ./fastboot devices
```

if a device number is echoed, fastboot is working.

### Setup on Windows host

- Refer ADB over USB on Windows Machine <sup>[6]</sup>
- Edit android\_winusb.inf - under section [Google.NTx86], add line as below:

```
%SingleBootLoaderInterface% = USB_Install, USB\VID_0451
```

- Proceed installing, with the difference that device to be selected is "Android Bootloader Interface" instead of "Android ADB Interface".

### Creating ubifs images

- Change the permission of target rootfs else it will give permission denied errors:

```
$ sudo chmod -R 777 android_rootfs_am37x
```

- Clone/download the latest mtd-utils sources and build them:

```
$ git clone git://git.infradead.org/mtd-utils.git
$ cd mtd-utils
$ make
```

- Creating ubifs image:

```
$ sudo mkfs.ubifs/mkfs.ubifs -r <path_to_rootfs>/ -m 2048 -e
126976 -c X -o ubifs.img
    where X = 3991 for 512MB NAND and X = 1948 for 256MB NAND flash
```

- Create/Edit ubinize.cfg:

```
[ubifs]
mode=ubi
image=ubifs.img
vol_id=0
vol_size=Y
    where Y=450MiB for 512MB NAND and X=200MiB for 256MB NAND
vol_type=dynamic
vol_name=rootfs
vol_flags=autoresize
```

- Creating ubi.img to be flashed:

```
$ sudo ubi-utils/ubinize -o ubi.img -O 2048 -m 2048 -p 128KiB -s 512
ubinize.cfg
```

**Important** Use either Fastboot to flash ubi.img over System partition of NAND or do it manually from u-boot prompt.

**Fastboot commands**

```
$ export ANDROID_ROOT=<rowboat_top_level_build_directory>
```

```
$ cd $ANDROID_ROOT/out/host/linux-x86/bin
```

- List connected devices

```
$ sudo ./fastboot devices
```

- Update xloader.

```
$ sudo ./fastboot flash xloader <xloader_binay_path>/MLO
```

- Updating u-boot.

```
$ sudo ./fastboot flash bootloader  
<uboot_binary_path>/u-boot.bin  
sending 'bootloader' (203 KB)... OKAY [ 0.541s]  
writing 'bootloader'... OKAY [ 0.552s]  
finished. total time: 1.093s
```

- Updating kernel.

```
$ sudo ./fastboot flash boot <kernel_image_path>/uImage  
sending 'boot' (2537 KB)... OKAY [ 6.466s]  
writing 'boot'... OKAY [ 3.330s]  
finished. total time: 9.796s
```

- Updating filesystem.

```
$ sudo ./fastboot flash system <rootfs_image_path>/ubi.img  
sending 'system' (72320 KB)... OKAY [183.758s]  
writing 'system'... OKAY [ 84.040s]  
finished. total time: 267.819s
```

- Erasing partition.

```
$ sudo ./fastboot erase <partition name> (eg. xloader)
```

- Display fastboot variable

```
$ sudo ./fastboot getvar <variable>
```

- Exit fastboot mode in uboot

```
$ sudo ./fastboot continue
```

### Booting with UBIFS rootfs

- Set the bootarguments from u-boot prompt.

```
# setenv nandboot 'echo Booting from nand ...; nand read ${loadaddr}
${boot_nand_offset} ${boot_nand_size}; bootm ${loadaddr}'

# setenv bootcmd 'run nandboot'

# setenv bootargs 'init=/init console=ttyO0,115200n8 noinitrd ip=off
androidboot.console=ttyO0 rootwait mem=256M \
omap_vout.vidl_static_vrfb_alloc=y rw ubi.mtd=4,2048
rootfstype=ubifs root=ubi0:rootfs rootdelay=2 vram=8M omapfb.vram=0:8M'
```

### Limitations

- AM3517evm u-boot doesn't support Full Speed USB mode(USB 1.1) and it expects HOST machine USB port to be High Speed USB (USB 2.0).

### YAFFS2 rootfs

Following the official(?) procedure how to incorporate yaffs linux <sup>[7]</sup> to write/flash the YAFFS2 image i.e flash\_erase <mtd\_partition>, mount the <mtd\_partition> and copy/untar the Android rootfs, from a running system (MMC/NFS), onto the mount\_point to boot from NAND partition.

### flashing the MTD partition

- Copy the rootfs.tar.bz2 file-system to the rootfs partition of MMC/SD card.
- Now boot the device from MMC/SD card and determine the MTD device for the file system partition of you Flash device

```
# cat /proc/mtd
dev:      size   erasesize  name
mtd0: 00080000 00020000 "X-Loader-NAND"
mtd1: 00140000 00020000 "U-Boot-NAND"
mtd2: 000c0000 00020000 "Boot Env-NAND"
mtd3: 00500000 00020000 "Kernel-NAND"
mtd4: 1f880000 00020000 "File System - NAND"
```

The file system partition of the flash device is /dev/mtd/mtd3

- Erase the file system partition

```
target# flash_eraseall /dev/mtd/mtd3
Erasing 16 Kibyte @ 3b9c000 -- 99 % complete.
```

- Mount the Flash file system partition using the block device node on a temporary directory /tempd.

```
target# mkdir /tempd
```



**Note:** Using the wrong version of YAFFS will result in error messages similar to:

```
target# mount -t yaffs2 /dev/block/mtdblock3 /tempd
yaffs: dev is 32505859 name is "mtdblock3"
yaffs: Attempting MTD mount on 31.3, "mtdblock3"
yaffs: MTD device does not support have the right page sizes
```



```
mount: wrong fs type, bad option, bad superblock on /dev/mtdblock3,
       or too many mounted file systems
```

- Untar the contents of the tarball file system image to the Flash device

```
target# cd /tempd
```

```
target# busybox tar xjf /rootfs.tar.gz
```

- Unmount the Flash file system partition

```
target# cd /
```

```
target# umount /tempd
```

- Now the target is ready to mount the rootfs from NAND.

```
target# reboot
```

### Bootting with YAFFS2 rootfs

- Set the YAFFS2 bootarguments from u-boot prompt.

```
# setenv bootargs 'init=/init console=ttyO0,115200n8 noinitrd ip=off
androidboot.console=ttyO0 rootwait mem=256M \
omap_vout.vidl_static_vrfb_alloc=y rw root=/dev/mtdblock3
rootfstype=yaffs2 bootdelay=2 vram=8M omapfb.vram=0:8M'
```

### To Do List

- Fastboot flashing support for YAFFS2

## Building Android Sources

Refer to TI Android DevKit Developer Guide at [http://processors.wiki.ti.com/index.php/TI-Android-GingerBread-2.3.4-DevKit-2.1\\_DeveloperGuide](http://processors.wiki.ti.com/index.php/TI-Android-GingerBread-2.3.4-DevKit-2.1_DeveloperGuide) for building Android sources and setting up the platform for booting.

### RowboPERF Integration

- Download the sources from rowboat

```
#> git clone -b rowboat-gingerbread
git://gitorious.org/rowboat/rowboperf.git
#> cd rowboperf
```

- Refer the instructions in the README file for building and installing rowboperf components

NOTE: Clone rowboperf sources outside the rowboat-android tree.

Refer to RowboPERF User Guide to know more.

## ADB Android Debugger & Downloader

Android Debug Bridge (adb) is a versatile tool lets you manage the state of the Android-powered device. For more information about what is possible with adb, see Android Debug Bridge page at <http://developer.android.com/guide/developing/tools/adb.html>. The ADB tool can be used to

- Download an application from a host machine, install & run it on the target board.
- Start a remote shell in the target instance.
- Debug applications running on the device using the debugging tool DDMS ( Dalvik Debug Monitor Server) which runs on top of adb connection.
- Copy files to and from the board to host machine

### Downloading "ADB" & Host setup

The adb tool is a part of Android SDK package located at <http://developer.android.com/sdk/index.html>. For an overview of how to install and set up the Android SDK, follow download & setup instructions from <http://developer.android.com/sdk/index.html>. Once you install Android SDK, the directory contents look like this.

```
add-ons/  
docs/  
platforms/  
  <platform>/  
    data/  
    images/  
    skins/  
    templates/  
    tools/  
    android.jar  
samples/  
tools/  
SDK Readme.txt
```

The adb tool is located in tools/ directory under the Android SDK installation. Export the tools directory path as shown below.

```
$> export PATH=${PATH}:<your_sdk_dir>/tools
```

### Connecting Host machine & board through adb

This release of DevKit has been tested for three different methods of connecting a given board with host machine

- adb over USB
- adb over USB Ethernet
- adb over Ethernet

The below sections describe each of these methods and provides necessary instructions for the same.

**adb over USB**

- Make sure that the mini-usb cable is connected between the host usb port and the target's USB OTG port
- Turn on "USB Debugging" on your board. On the board (UI screen)-
  - Go to home screen, press MENU,
  - Select Applications, select Development, then enable USB debugging.
  - Alternatively, you can navigate to Settings->Applications->Development and then enable the "USB debugging" option.
- Setup host machine to detect the board. On Ubuntu Linux host machines this is done by adding a rules file to configure device vendor ID of on-board OMAP device.
- For the EVMs and Boards covered here, the vendor ID is "18d1".
  - Log in as root and create this file: **/etc/udev/rules.d/51-android.rules**

```
For Gusty/Hardy, edit the file to read:
SUBSYSTEM=="usb", SYSFS{idVendor}=="18d1", MODE="0666"
```

```
For Dapper, edit the file to read:
SUBSYSTEM=="usb_device", SYSFS{idVendor}=="18d1", MODE="0666"
```

- Execute the following to change the user mode for the rules file.

```
$> chmod a+r /etc/udev/rules.d/51-android.rules
```

- Verify the adb connectivity between host and target board

```
$> adb devices
```

If device is connected, then output on screen should list the device, example:

```
List of devices attached
20100720    device
```

**adb over USB Ethernet (Ethernet over USB)**

- Make sure that the mini-usb cable is connected between the host usb port and the target's USB OTG port.
- Configure the Linux kernel to use Ethernet gadget. Enable USB support, configure the Inventra controller, and add USB gadget support.

**IMPORTANT NOTE:** Inventra configuration must occur in two places as shown in non-highlighted lines of the screen shots below.

```
#> make ARCH=arm CROSS_COMPILE=arm-eabi- menuconfig
```

Device Drivers --- USB Support

```

--- USB support
< >   ISP1362 HCD support
< >   OHCI HCD support
< >   SL811HS HCD support
< >   R8A66597 HCD support
< >   Host Wire Adapter (HWA) driver (EXPERIMENTAL)
<*>   Inventra Highspeed Dual Role Controller (TI, ADI, ...)
      *** OMAP 343x high speed USB support ***
[ ]   Driver Mode (Both host and peripheral: USB OTG (On The Go))
[ ]   Disable DMA (always use PIO)

```

Device Drivers --- USB Support --- USB Gadget Support

```

--- USB Gadget Support
[*]   Debugging messages (DEVELOPMENT)
[*]   Debugging information files (DEVELOPMENT)
[ ]   Debugging information files in debugfs (DEVELOPMENT)
(2)   Maximum VBUS Power usage (2-500 mA)
[ ]   USB Peripheral Controller (Inventra HDRC USB Peripheral (TI))
<*>   USB Gadget Drivers (Ethernet Gadget (with CDC Ethernet support)
      Ethernet Gadget (with CDC Ethernet support)
[*]   RNDIS support
[ ]   Ethernet Emulation Model (EEM) support

```

Device Drivers --- USB Support --- USB Gadget Support --- Enable Gadget Ethernet support

```

--- USB Gadget Support
[*]   Debugging messages (DEVELOPMENT)
[*]   Debugging information files (DEVELOPMENT)
[ ]   Debugging information files in debugfs (DEVELOPMENT)
(2)   Maximum VBUS Power usage (2-500 mA)
[ ]   USB Peripheral Controller (Inventra HDRC USB Peripheral (TI))
<*>   USB Gadget Drivers (Ethernet Gadget (with CDC Ethernet support)
      Ethernet Gadget (with CDC Ethernet support)
[*]   RNDIS support
[ ]   Ethernet Emulation Model (EEM) support

```

- Build the Kernel with the above configuration changes and use the uImage to boot the board. Refer to Kernel compiling instructions above.
- Establish network connection
  - Assign an IP address to the usb ethernet adapter.

The USB network gadget `g_ether` is named `usb0` (instead of `eth0` or other network interface names). The normal set of Ethernet configuration tools should work, such as `ifconfig`, `netstat`, and `route`.

For example, the following commands will assign the network address 192.168.194.2 to the target. Run this on the target:

```
$> ifconfig usb0 192.168.194.2 netmask 255.255.255.224 up
```

On Host machine, run the following commands to establish the connection to the target:

```
$> sudo ifconfig usb0 192.168.194.1 netmask 255.255.255.224 up
$> sudo route add 192.168.194.2 dev usb0
```

The target and the host machine should be connected, run ping command to test the same:

```
$ ping -c 3 192.168.194.2
PING 192.168.194.2 (192.168.194.2) 56(84) bytes of data.
64 bytes from 192.168.194.2: icmp_seq=1 ttl=64 time=6.08 ms
64 bytes from 192.168.194.2: icmp_seq=2 ttl=64 time=0.511 ms
64 bytes from 192.168.194.2: icmp_seq=3 ttl=64 time=0.485 ms
--- 192.168.194.2 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2000ms
rtt min/avg/max/mdev = 0.485/2.361/6.089/2.636 ms
```

- Establish ADB connection

On the host machine execute following commands to establish adb connection

```
$ export ADBHOST=<target's ip address>
$ adb kill-server
$ adb start-server
```

Verify the connection by executing

```
$ adb devices
```

If connected, device name should be listed as a "emulator"

```
$ adb devices
List of devices attached
emulator-5554    device
$ adb shell
```

### adb over Ethernet

- Make sure Ethernet port on board and host machine are connected to the network
- Check Ethernet configuration for the board

```
target #> netcfg

lo          UP      127.0.0.1      255.0.0.0      0x00000049

eth0        UP      172.24.190.59  255.255.252.0  0x00001043
```

- If Ethernet was not configured, configure Ethernet of the board using ifconfig/netcfg as shown below.

```
target #> netcfg eth0 dhcp
```

- Configure the ADB Daemon to use an ethernet connection using setprop as shown below.

```
target #> setprop service.adb.tcp.port 5555
```

- If network is configured successfully (above steps) then Restart service adbd on the target,

```
target #> stop adbd
target #> start adbd
```

- On the host machine use following commands to establish adb connection

```
$> export ADBHOST=<target's ip address>
$> adb kill-server
$> adb start-server
$> adb connect <target_ip_address>:5555
```

- Verify for device connectivity, by executing the following commands

```
$> adb devices If connected, you'll see the device name listed
as a "emulator"
```

```
$> adb devices
```

If connected, find the device name listed as a "emulator"

```
List of devices attached
emulator-5554      device
$ adb shell
```

For more information about adb commands, see Android Debug Bridge page at <http://developer.android.com/guide/developing/tools/adb.html>

### adb over USB on Windows Machine

Follow the below instructions to get ADB over USB work on a Windows PC

- Download latest Android SDK

(<http://developer.android.com/sdk/index.html>) and uncompress it in a local folder (i.e. c:\android\_sdk).

- Optionally, you may want to add the location of the SDK's primary tools directory to your system PATH. Right-click on My Computer, and select Properties. Under the Advanced tab, hit the Environment Variables button, and in the dialog that comes up, double-click on Path (under System Variables). Add the full path to the tools\ directory to the path.

- Download Android USB Driver

([https://dl-ssl.google.com/android/repository/usb\\_driver\\_r03-windows.zip](https://dl-ssl.google.com/android/repository/usb_driver_r03-windows.zip)) and uncompress it in a local folder (i.e. c:\android\_sdk\usb\_driver)

- Edit (or create and then edit if it doesn't already exist) file in

"%USERPROFILE%\android\adb\_usb.ini":

```
echo 0x18D1 > "%USERPROFILE%\android\adb_usb.ini"
```

- Edit android\_winusb.inf to match EVM/Beagle vendor and product ids:

Under [Google.NTx86] section add:

```
;TI EVM
%SingleAdbInterface%      = USB_Install, USB\VID_18D1&PID_9018
%CompositeAdbInterface%   = USB_Install,
USB\VID_18D1&PID_9018&MI_01
```

Note: Be careful to add it under Google.NTx86 and not under Google.NTamd64 unless your machine is AMD 64 bits. If you skip this step you won't be able to later install the driver as windows will reject it.

- Boot the board as normal and wait until shell prompt is available (micro-B USB cable must be disconnected).
- Connect micro-B USB cable between board and Windows PC.

- If it is proceeding as planned, Windows will tell you it found a new hardware asks you to install the driver. Install driver that was downloaded as described in step 3 above:

Answer "No, not this time" to the question about running Windows Update to search for software.

- Choose "Install the hardware that I manually select from a list (Advanced)" this is the 2nd option, then click "Next"
- Select "Show All Devices", then click "Next"
- You are going to see a grayed-out text box with "(Retrieving a list of all devices)", click the "Have Disk..." button
- Browse" to your driver folder (c:\android\_sdk\usb\_driver). It will be looking of a .inf file so select "android\_winusb.inf" and click "Open" then "OK". It's the only file there so you shouldn't go wrong.
- Select "Android ADB Interface" then click the "Next" button.
- A warning will appear, answer "Yes" but read the warning anyway.
- Click the "Close" when the wizard is completed.
- Disconnect and reconnect micro-B USB cable from Board(probably reboot it as well).
- Open command prompt and restart adb server just to make sure it is in a proper state:

```
adb kill-server
adb start-server
```

- List the attached devices with "adb devices". It should show your board/device with a random number.
- Type "adb shell". You should see the "#" indicating it works.

## Running Applications

The root File System provided in this DevKit releases contains only standard Android components and applications. User might be interested to download & run android applications (.apk) available in the market. The below procedure gives the steps to be followed to download any .apk file to the board and run it on the platform.

### Installing (.apk files) application on Target Platform

- From the host: You can use adb tool for package installation.

```
$> adb install <package>.apk.
```

NOTE: Use -s option with the adb tool, to install the package on external storage.

On successful installation adb tool will report SUCCESS on host terminal, and the application would be listed on the android main menu.

### Un-installing applications (.apk) using adb

- To un-install non-default components (that were installed later)
  - Method 1: On the host machine execute the following

```
$> adb uninstall <package>.apk
```

- Method 2: On target:

```
Main menu -> Menu -> Settings -> Applications -> Manage
applications -> Find the package
Tap on it -> Uninstall -> OK -> OK
```

- On successful removal, the application would have been removed from the android main menu. All the short-cuts to the application also removed.

- To un-install default components, use the following commands from adb on host machine

```
$ adb shell
#rm /system/app/app.apk
```

On successful removal, the application would have been removed from the android main menu.

## Setup ADB for application Debugging

ADB and Eclipse, with ADT( Android Development Tools plug-in) allow users to create and debug Android applications. Follow Developing In Eclipse, with ADT at [http:// developer. android. com/ guide/ developing/ eclipse-adt.html](http://developer.android.com/guide/developing/eclipse-adt.html)

Steps to connect Eclipse to the board.

- Setup the adb connection with the board by following the instructions given above in connecting board ...

```
Verify the connectivity by executing
$ adb devices
```

- Open Eclipse IDE. Eclipse, with ADT plugin enable users to
  - Create an android project.
  - Build and Run the project on a connected board.
  - Debug the project using the Debug perspective.
  - Use DDMS (Dalvik Debug Monitor Server) to monitor the connected board.

For more detailed and complete information on the above follow Developing In Eclipse, with ADT at [http:// developer. android. com/ guide/ developing/ eclipse-adt.html](http://developer.android.com/guide/developing/eclipse-adt.html)

- Open DDMS(Dalvik Debug Monitor Server) perspective. This DDMS perspective can be opened from the eclipse menu via:

```
Window -> Open Perspective -> Other -> DDMS;
Click on OK
```

- DDMS provides port-forwarding services, screen capture on the device, thread and heap information on the device, logcat, process, and radio state information, incoming call and SMS spoofing, location data spoofing, and more.
- For more information on DDMS and to use it, follow Using the Dalvik Debug Monitor page at [http://developer. android. com/ guide/ developing/ tools/ ddms. html](http://developer.android.com/guide/developing/tools/ddms.html)

## Copy any files to and from the board over ADB

- Using the adb commands "pull" and "push" user can copy files to and from the board.
- Unlike the install command, which only copies an .apk file to a specific location, the pull and push commands let you copy arbitrary directories and files to any location on the board.
- To copy a file or directory (recursively) from the board, use

```
adb pull <remote> <local>
```

- To copy a file or directory (recursively) to the board, use

```
adb push <local> <remote>
```

In the commands, <local> and <remote> refer to the paths to the file or directory on your development host (local) and on the target instance (remote).



```
Here's an example:
adb push foo.txt /sdcard/foo.txt
```

## Adobe Flash 10 Integration

The Android version of Flash10 that runs on GingerBread is now available for customer download (by registration) at, <http://focus.ti.com/docs/toolsw/folders/print/adobeflash-a8.html>

The below steps give the procedure to download the Adobe Flash 10 library for Android GingerBread and installing the same in File system.

The below steps give the procedure to download the Adobe Flash 10 library for Android GingerBread and installing the same in File system.

- Download the flashplayer installer “TI Flash10.3 Android Webkit Plugin-0.80-Linux-x86-Install.bin” from <http://focus.ti.com/docs/toolsw/folders/print/adobeflash-a8.html>

```
$ ./TI Flash10.3 Android Webkit Plugin-0.80-Linux-x86-Install.bin
```

Will result in following instruction, press "Y"

```
This will install Flash10.1 Android Webkit Plugin on your computer.
Continue? [n/Y] Y
Select the source install location
Where do you want to install Flash10.1 Android Webkit Plugin?
[/home/user/flash10_androidplugin] /home/user/flash10_androidplugin
```

```
Installing Flash10.1 Android Webkit Plugin...
Installing Program
Files...
```

```
Installation complete.
After Installation the following directory structure is resulted
```

- Change to Flash installed directory on Host PC

```
#> cd flash10_androidplugin
#> ls
install_flash_player.apk  uninstall
```

- Install flash player plug in on target via adb

```
#> adb install install_flash_player.apk
```

- Do the browser configuration
  - Explained in the below section
- Test the Adobe Flash installation
  - Browse the link <http://www.adobe.com/software/flash/about/>
  - Should display Adobe Flash Player Successfully Installed

## Compatibility Test Suite (CTS)

This section describe the procedure to run CTS on any platform.

- Pre-requisites
  - Download and extract (untar) the CTS package from [http://dl.google.com/dl/android/cts/android-cts-2.3\\_r3-x86.zip](http://dl.google.com/dl/android/cts/android-cts-2.3_r3-x86.zip)
  - Download and extract (untar) Google Android SDK from [http://dl.google.com/android/android-sdk\\_r12-linux\\_x86.tgz](http://dl.google.com/android/android-sdk_r12-linux_x86.tgz)
  - NOTE: Only the SDK mentioned on the above link will work with CTS.
- Setup an ADB connection between Host and platform as mentioned in ADB section above.
- Setup your platform to run the accessibility tests:
  - `adb install -r android-cts/repository/testcases/CtsDelegatingAccessibilityService.apk`
  - On the device enable Settings > Accessibility > Accessibility > Delegating Accessibility Service
- Launch the CTS.
  - Edit `android-cts/tools/startcts` to point `SDK_ROOT` to android sdk installation location.
  - Run `./tools/startcts`
  - On CTS prompt check the available plans

```
cts_host > ls -plan
```

- Start a specific Test Plan

```
cts_host > start --plan <plan name>
```

Once all the tests are executed, the results can be browsed in an browser by opening [android-cts/repository/results/session-name/testResult.xml] and use the results to adjust your design.

- NOTE: Sometimes when CTS is restarting the board, adb connection to CTS, may not happen automatically. In that case, execute the following command on the console, soon after the board has restarted.

```
#> stop adbd;sleep 1;start adbd;
```

## Configuring Android Applications

### Browser Configuration

To browse web pages user should configure the Internet connection as given below.

```
#> netcfg eth0 dhcp
#> getprop net.eth0.dns1
```

This prints the dns for the ethernet port, do the following to configure the DNS entries on board.

```
#> setprop net.dns1 <your_dns_server_ip>
```

If the platform is behind proxy, then following command should be executed to set the proxy settings

```
#> setprop net.gprs.http-proxy http://proxyurl:80
```

NOTE: If network is behind a proxy, in this DevKit release, we have NOT found a method to set the proxy server. We tried using "setprop net.eth0.http-proxy hostname:port" and "setprop net.gprs.http-proxy hostname:port", but neither could get us through the proxy. Also, the option of adding an entry of (99,'http\_proxy','hostname:port') to the 'system' and 'secure' tables in the /data/data/com.android.providers.settings/databases/settings.db database has also been tried, but failed.

## USB Mass Storage

The Android GingerBread 2.3.4 supports USB Mass storage functionality, however the external storage can be mounted either on SD Card or a USB mass storage device. The user is allowed to choose one of the two options.

By default the TI Android DevKit chooses SD card as the external storage device.

If a user is interested to use storage over USB (USB mass storage) then following changes have to be done in the default root filesystem

1) Create some directory on Android Filesystem via adb shell or console

```
# mkdir /partition
```

2) Insert the usb mass storage device, Assume the device node created at /dev/block/sda1 and the device has fat partition.

```
#mount -t vfat /dev/block/sda1 /partition
```

3) Now usb mass storage device is mounted at /partition. You can create browse the file

Limitations






- Auto mounting usb mass storage device not supported
- The gallery app/Android Settings doesn't recognize the mass storage mounted


## SD Card Recommendations

Some brands or models of SD cards are observed with poor performance on AM37x EVMs and other platforms. The symptom could be one or some of the followings.





- the boot-up time is much longer than normal (3x of normal or even longer);
- the reaction of UI operations is unacceptably delayed;
- the Gallery app cannot find the media files to create the albums;
- the video playback is sluggish.

The table below lists the SD cards tested which have no issue on performance.

	Brand/Model	Type	Class	Capacity
	SanDisk	SDHC	4	4GB
	SanDisk Ultra	SDHC	4	4GB
	SanDisk Ultra	SD	4	2GB
	Sony	SDHC	4	4GB
	Sony	SD	4	2GB

	Sony	micro SDHC	4	4GB
---	------	------------	---	-----

The table below lists the SD cards tested which have **poor** performance.

	Brand/Model	Type	Class	Capacity
	HP Invent	SDHC	4	4GB
	Kingston	SDHC	4	4GB
	Kingston	micro SDHC	4	4GB
	Lexar MULTI-USE	SDHC	4	4GB
	Lexar PLANTINUM II	SDHC	6	4GB
	PNY Optima	SDHC	4	4GB

## Versioning

This is Release DevKit-V2.3 The release is available from [http://software-dl.ti.com/dsps/dsps\\_public\\_sw/sdo\\_tii/TI\\_Android\\_DevKit/TI\\_Android\\_GingerBread\\_2\\_3\\_4\\_DevKit\\_2\\_1/index\\_FDS.html](http://software-dl.ti.com/dsps/dsps_public_sw/sdo_tii/TI_Android_DevKit/TI_Android_GingerBread_2_3_4_DevKit_2_1/index_FDS.html)

The release notes is available at [http://processors.wiki.ti.com/index.php/TI-Android-GingerBread-2.3.4-DevKit-2.1\\_ReleaseNotes](http://processors.wiki.ti.com/index.php/TI-Android-GingerBread-2.3.4-DevKit-2.1_ReleaseNotes)

## Technical Support and Product Updates

For further information or to report any problems, contact <http://e2e.ti.com/android> or <http://support.ti.com>.

For community support join <http://groups.google.com/group/rowboat>

For IRC #rowboat on [irc.freenode.net](http://irc.freenode.net)

## References

- [1] <http://beagleboard.org>
- [2] <http://focus.ti.com/docs/toolsw/folders/print/tmdsevm3517.html>
- [3] [http://focus.ti.com/docs/toolsw/folders/print/tmdxevm3715.html?DCMP=am37x\\_060710&HQS=Other+OT+am37xprtf](http://focus.ti.com/docs/toolsw/folders/print/tmdxevm3715.html?DCMP=am37x_060710&HQS=Other+OT+am37xprtf)
- [4] <http://developer.android.com/sdk/installing.html#troubleshooting>
- [5] [http://processors.wiki.ti.com/index.php/TI-Android-GingerBread-2.3-DevKit-1.0\\_DeveloperGuide](http://processors.wiki.ti.com/index.php/TI-Android-GingerBread-2.3-DevKit-1.0_DeveloperGuide)
- [6] [http://processors.wiki.ti.com/index.php/TI-Android-GingerBread-2.3-DevKit-1.0\\_UserGuide#adb\\_over\\_USB\\_on\\_Windows\\_Machine](http://processors.wiki.ti.com/index.php/TI-Android-GingerBread-2.3-DevKit-1.0_UserGuide#adb_over_USB_on_Windows_Machine)
- [7] <http://www.yaffs.net/howto-incorporate-yaffs-linux>

# Article Sources and Contributors

**TI-Android-GingerBread-2.3.4-DevKit-2.1 UserGuide** *Source:* <http://processors.wiki.ti.com/index.php?oldid=69108> *Contributors:* Alejandro, Arunjoseph05, Pankaj.bharadiya, Pundiramit, Sumahegde, Vishveshwarbhat

# Image Sources, Licenses and Contributors

**Image:TIBanner.png** *Source:* <http://processors.wiki.ti.com/index.php?title=File:TIBanner.png> *License:* unknown *Contributors:* Nsnehaprabha

**Image:Mt9v113.jpeg** *Source:* <http://processors.wiki.ti.com/index.php?title=File:Mt9v113.jpeg> *License:* unknown *Contributors:* Satish npatel

**Image:240px-Android bt on 1.png** *Source:* [http://processors.wiki.ti.com/index.php?title=File:240px-Android\\_bt\\_on\\_1.png](http://processors.wiki.ti.com/index.php?title=File:240px-Android_bt_on_1.png) *License:* unknown *Contributors:* Khasim

**Image:240px-Android bt pair 2.png** *Source:* [http://processors.wiki.ti.com/index.php?title=File:240px-Android\\_bt\\_pair\\_2.png](http://processors.wiki.ti.com/index.php?title=File:240px-Android_bt_pair_2.png) *License:* unknown *Contributors:* Khasim

**Image:Android bt share.png** *Source:* [http://processors.wiki.ti.com/index.php?title=File:Android\\_bt\\_share.png](http://processors.wiki.ti.com/index.php?title=File:Android_bt_share.png) *License:* unknown *Contributors:* Vishveshwarbhat

**Image:Android bt incoming taskbar.png** *Source:* [http://processors.wiki.ti.com/index.php?title=File:Android\\_bt\\_incoming\\_taskbar.png](http://processors.wiki.ti.com/index.php?title=File:Android_bt_incoming_taskbar.png) *License:* unknown *Contributors:* Vishveshwarbhat

**Image:Android bt incoming message.png** *Source:* [http://processors.wiki.ti.com/index.php?title=File:Android\\_bt\\_incoming\\_message.png](http://processors.wiki.ti.com/index.php?title=File:Android_bt_incoming_message.png) *License:* unknown *Contributors:* Vishveshwarbhat

**Image:Android bt incoming popup.png** *Source:* [http://processors.wiki.ti.com/index.php?title=File:Android\\_bt\\_incoming\\_popup.png](http://processors.wiki.ti.com/index.php?title=File:Android_bt_incoming_popup.png) *License:* unknown *Contributors:* Vishveshwarbhat

**Image:Android bt a2dp headset.png** *Source:* [http://processors.wiki.ti.com/index.php?title=File:Android\\_bt\\_a2dp\\_headset.png](http://processors.wiki.ti.com/index.php?title=File:Android_bt_a2dp_headset.png) *License:* unknown *Contributors:* Vishveshwarbhat

**File:Android bt headset.png** *Source:* [http://processors.wiki.ti.com/index.php?title=File:Android\\_bt\\_headset.png](http://processors.wiki.ti.com/index.php?title=File:Android_bt_headset.png) *License:* unknown *Contributors:* Vishveshwarbhat

**File:Android-bt-options.png** *Source:* <http://processors.wiki.ti.com/index.php?title=File:Android-bt-options.png> *License:* unknown *Contributors:* Vishveshwarbhat

**File:Android-disable-a2dp.png** *Source:* <http://processors.wiki.ti.com/index.php?title=File:Android-disable-a2dp.png> *License:* unknown *Contributors:* Vishveshwarbhat

**File:Light\_bulb\_icon.png** *Source:* [http://processors.wiki.ti.com/index.php?title=File:Light\\_bulb\\_icon.png](http://processors.wiki.ti.com/index.php?title=File:Light_bulb_icon.png) *License:* unknown *Contributors:* DanRinkes, PagePusher

**Image:Android USB ADB ENABLE.JPG** *Source:* [http://processors.wiki.ti.com/index.php?title=File:Android\\_USB\\_ADB\\_ENABLE.JPG](http://processors.wiki.ti.com/index.php?title=File:Android_USB_ADB_ENABLE.JPG) *License:* unknown *Contributors:* Khasim

**Image:Android USBGadget ADB.JPG** *Source:* [http://processors.wiki.ti.com/index.php?title=File:Android\\_USBGadget\\_ADB.JPG](http://processors.wiki.ti.com/index.php?title=File:Android_USBGadget_ADB.JPG) *License:* unknown *Contributors:* Khasim

**Image:Android USBEthernet ADB.JPG** *Source:* [http://processors.wiki.ti.com/index.php?title=File:Android\\_USBEthernet\\_ADB.JPG](http://processors.wiki.ti.com/index.php?title=File:Android_USBEthernet_ADB.JPG) *License:* unknown *Contributors:* Khasim

**Image:Sandisk-C4-4GB.jpg** *Source:* <http://processors.wiki.ti.com/index.php?title=File:Sandisk-C4-4GB.jpg> *License:* unknown *Contributors:* BinLiu

**Image:Sandisk-ultra-C4-16GB.jpg** *Source:* <http://processors.wiki.ti.com/index.php?title=File:Sandisk-ultra-C4-16GB.jpg> *License:* unknown *Contributors:* BinLiu

**Image:SONY-C4-4GB.jpg** *Source:* <http://processors.wiki.ti.com/index.php?title=File:SONY-C4-4GB.jpg> *License:* unknown *Contributors:* BinLiu

**Image:SONY-C4-2GB.jpg** *Source:* <http://processors.wiki.ti.com/index.php?title=File:SONY-C4-2GB.jpg> *License:* unknown *Contributors:* BinLiu

**Image:SONY-micro-C4-4GB.jpg** *Source:* <http://processors.wiki.ti.com/index.php?title=File:SONY-micro-C4-4GB.jpg> *License:* unknown *Contributors:* BinLiu

**Image:Kingston-C4-4GB.jpg** *Source:* <http://processors.wiki.ti.com/index.php?title=File:Kingston-C4-4GB.jpg> *License:* unknown *Contributors:* BinLiu

**Image:Lexar-Multi-Use-C4-4GB.jpeg** *Source:* <http://processors.wiki.ti.com/index.php?title=File:Lexar-Multi-Use-C4-4GB.jpeg> *License:* unknown *Contributors:* BinLiu

**Image:Lexar-PlatinumII-C6-4GB.jpeg** *Source:* <http://processors.wiki.ti.com/index.php?title=File:Lexar-PlatinumII-C6-4GB.jpeg> *License:* unknown *Contributors:* BinLiu

**Image:PNY-Optima-C4-4GB.jpg** *Source:* <http://processors.wiki.ti.com/index.php?title=File:PNY-Optima-C4-4GB.jpg> *License:* unknown *Contributors:* BinLiu

# License

THE WORK (AS DEFINED BELOW) IS PROVIDED UNDER THE TERMS OF THIS CREATIVE COMMONS PUBLIC LICENSE ("CCPL" OR "LICENSE"). THE WORK IS PROTECTED BY COPYRIGHT AND/OR OTHER APPLICABLE LAW. ANY USE OF THE WORK OTHER THAN AS AUTHORIZED UNDER THIS LICENSE OR COPYRIGHT LAW IS PROHIBITED. BY EXERCISING ANY RIGHTS TO THE WORK PROVIDED HERE, YOU ACCEPT AND AGREE TO BE BOUND BY THE TERMS OF THIS LICENSE. TO THE EXTENT THIS LICENSE MAY BE CONSIDERED TO BE A CONTRACT, THE LICENSOR GRANTS YOU THE RIGHTS CONTAINED HERE IN CONSIDERATION OF YOUR ACCEPTANCE OF SUCH TERMS AND CONDITIONS.

## License

### 1. Definitions

- "**Adaptation**" means a work based upon the Work, or upon the Work and other pre-existing works, such as a translation, adaptation, derivative work, arrangement of music or other alterations of a literary or artistic work, or phonogram or performance and includes cinematographic adaptations or any other form in which the Work may be recast, transformed, or adapted including in any form recognizably derived from the original, except that a work that constitutes a Collection will not be considered an Adaptation for the purpose of this License. For the avoidance of doubt, where the Work is a musical work, performance or phonogram, the synchronization of the Work in timed-relation with a moving image ("synching") will be considered an Adaptation for the purpose of this License.
- "**Collection**" means a collection of literary or artistic works, such as encyclopedias and anthologies, or performances, phonograms or broadcasts, or other works or subject matter other than works listed in Section 1(f) below, which, by reason of the selection and arrangement of their contents, constitute intellectual creations, in which the Work is included in its entirety in unmodified form along with one or more other contributions, each constituting separate and independent works in themselves, which together are assembled into a collective whole. A work that constitutes a Collection will not be considered an Adaptation (as defined below) for the purposes of this License.
- "**Creative Commons Compatible License**" means a license that is listed at <http://creativecommons.org/compatibility/licenses> that has been approved by Creative Commons as being essentially equivalent to this License, including, at a minimum, because that license: (i) contains terms that have the same purpose, meaning and effect as the License Elements of this License; and, (ii) explicitly permits the relicensing of adaptations of works made available under this license under this License or a Creative Commons jurisdiction license with the same License Elements as this License.
- "**Distribute**" means to make available to the public the original and copies of the Work or Adaptation, as appropriate, through sale or other transfer of ownership.
- "**License Elements**" means the following high-level license attributes as selected by Licensor and indicated in the title of this License: Attribution, ShareAlike.
- "**Licensor**" means the individual, individuals, entity or entities that offer(s) the Work under the terms of this License.
- "**Original Author**" means, in the case of a literary or artistic work, the individual, individuals, entity or entities who created the Work or if no individual or entity can be identified, the publisher; and in addition (i) in the case of a performance the actors, singers, musicians, dancers, and other persons who act, sing, deliver, declaim, play in, interpret or otherwise perform literary or artistic works or expressions of folklore; (ii) in the case of a phonogram the producer being the person or legal entity who first fixes the sounds of a performance or other sounds; and, (iii) in the case of broadcasts, the organization that transmits the broadcast.
- "**Work**" means the literary and/or artistic work offered under the terms of this License including without limitation any production in the literary, scientific and artistic domain, whatever may be the mode or form of its expression including digital form, such as a book, pamphlet and other writing; a lecture, address, sermon or other work of the same nature; a dramatic or dramatico-musical work; a choreographic work or entertainment in dumb show; a musical composition with or without words; a cinematographic work to which are assimilated works expressed by a process analogous to cinematography; a work of drawing, painting, architecture, sculpture, engraving or lithography; a photographic work to which are assimilated works expressed by a process analogous to photography; a work of applied art; an illustration, map, plan, sketch or three-dimensional work relative to geography, topography, architecture or science; a performance; a broadcast; a phonogram; a compilation of data to the extent it is protected as a copyrightable work; or a work performed by a variety or circus performer to the extent it is not otherwise considered a literary or artistic work.
- "**You**" means an individual or entity exercising rights under this License who has not previously violated the terms of this License with respect to the Work, or who has received express permission from the Licensor to exercise rights under this License despite a previous violation.
- "**Publicly Perform**" means to perform public recitations of the Work and to communicate to the public those public recitations, by any means or process, including by wire or wireless means or public digital performances; to make available to the public Works in such a way that members of the public may access these Works from a place and at a place individually chosen by them; to perform the Work to the public by any means or process and the communication to the public of the performances of the Work, including by public digital performance; to broadcast and rebroadcast the Work by any means including signs, sounds or images.
- "**Reproduce**" means to make copies of the Work by any means including without limitation by sound or visual recordings and the right of fixation and reproducing fixations of the Work, including storage of a protected performance or phonogram in digital form or other electronic medium.

### 2. Fair Dealing Rights

Nothing in this License is intended to reduce, limit, or restrict any uses free from copyright or rights arising from limitations or exceptions that are provided for in connection with the copyright protection under copyright law or other applicable laws.

### 3. License Grant

Subject to the terms and conditions of this License, Licensor hereby grants You a worldwide, royalty-free, non-exclusive, perpetual (for the duration of the applicable copyright) license to exercise the rights in the Work as stated below:

- to Reproduce the Work, to incorporate the Work into one or more Collections, and to Reproduce the Work as incorporated in the Collections;
- to create and Reproduce Adaptations provided that any such Adaptation, including any translation in any medium, takes reasonable steps to clearly label, demarcate or otherwise identify that changes were made to the original Work. For example, a translation could be marked "The original work was translated from English to Spanish," or a modification could indicate "The original work has been modified.";
- to Distribute and Publicly Perform the Work including as incorporated in Collections; and,
- to Distribute and Publicly Perform Adaptations.
- For the avoidance of doubt:

- Non-waivable Compulsory License Schemes.** In those jurisdictions in which the right to collect royalties through any statutory or compulsory licensing scheme cannot be waived, the Licensor reserves the exclusive right to collect such royalties for any exercise by You of the rights granted under this License;
- Waivable Compulsory License Schemes.** In those jurisdictions in which the right to collect royalties through any statutory or compulsory licensing scheme can be waived, the Licensor waives the exclusive right to collect such royalties for any exercise by You of the rights granted under this License; and,
- Voluntary License Schemes.** The Licensor waives the right to collect royalties, whether individually or, in the event that the Licensor is a member of a collecting society that administers voluntary licensing schemes, via that society by any exercise by You of the rights granted under this License.

The above rights may be exercised in all media and formats whether now known or hereafter devised. The above rights include the right to make such modifications as are technically necessary to exercise the rights in other media and formats. Subject to Section 8(f), all rights not expressly granted by Licensor are hereby reserved.

### 4. Restrictions

The license granted in Section 3 above is expressly made subject to and limited by the following restrictions:

1. You may Distribute or Publicly Perform the Work only under the terms of this License. You must include a copy of, or the Uniform Resource Identifier (URI) for, this License with every copy of the Work You Distribute or Publicly Perform. You may not offer or impose any terms on the Work that restrict the terms of this License or the ability of the recipient of the Work to exercise the rights granted to that recipient under the terms of the License. You may not sublicense the Work. You must keep intact all notices that refer to this License and to the disclaimer of warranties with every copy of the Work You Distribute or Publicly Perform. When You Distribute or Publicly Perform the Work, You may not impose any effective technological measures on the Work that restrict the ability of a recipient of the Work from You to exercise the rights granted to that recipient under the terms of the License. This Section 4(a) applies to the Work as incorporated in a Collection, but this does not require the Collection apart from the Work itself to be made subject to the terms of this License. If You create a Collection, upon notice from any Licensor You must, to the extent practicable, remove from the Collection any credit as required by Section 4(c), as requested. If You create an Adaptation, upon notice from any Licensor You must, to the extent practicable, remove from the Adaptation any credit as required by Section 4(c), as requested.
2. You may Distribute or Publicly Perform an Adaptation only under the terms of: (i) this License; (ii) a later version of this License with the same License Elements as this License; (iii) a Creative Commons jurisdiction license (either this or a later license version) that contains the same License Elements as this License (e.g., Attribution-ShareAlike 3.0 US); (iv) a Creative Commons Compatible License. If you license the Adaptation under one of the licenses mentioned in (iv), you must comply with the terms of that license. If you license the Adaptation under the terms of any of the licenses mentioned in (i), (ii) or (iii) (the "Applicable License"), you must comply with the terms of the Applicable License generally and the following provisions: (I) You must include a copy of, or the URI for, the Applicable License with every copy of each Adaptation You Distribute or Publicly Perform; (II) You may not offer or impose any terms on the Adaptation that restrict the terms of the Applicable License or the ability of the recipient of the Adaptation to exercise the rights granted to that recipient under the terms of the Applicable License; (III) You must keep intact all notices that refer to the Applicable License and to the disclaimer of warranties with every copy of the Work as included in the Adaptation You Distribute or Publicly Perform; (IV) when You Distribute or Publicly Perform the Adaptation, You may not impose any effective technological measures on the Adaptation that restrict the ability of a recipient of the Adaptation from You to exercise the rights granted to that recipient under the terms of the Applicable License. This Section 4(b) applies to the Adaptation as incorporated in a Collection, but this does not require the Collection apart from the Adaptation itself to be made subject to the terms of the Applicable License.
3. If You Distribute, or Publicly Perform the Work or any Adaptations or Collections, You must, unless a request has been made pursuant to Section 4(a), keep intact all copyright notices for the Work and provide, reasonable to the medium or means You are utilizing: (i) the name of the Original Author (or pseudonym, if applicable) if supplied, and/or if the Original Author and/or Licensor designate another party or parties (e.g., a sponsor institute, publishing entity, journal) for attribution ("Attribution Parties") in Licensor's copyright notice, terms of service or by other reasonable means, the name of such party or parties; (ii) the title of the Work if supplied; (iii) to the extent reasonably practicable, the URI, if any, that Licensor specifies to be associated with the Work, unless such URI does not refer to the copyright notice or licensing information for the Work; and (iv), consistent with Section 3(b), in the case of an Adaptation, a credit identifying the use of the Work in the Adaptation (e.g., "French translation of the Work by Original Author," or "Screenplay based on original Work by Original Author"). The credit required by this Section 4(c) may be implemented in any reasonable manner; provided, however, that in the case of a Adaptation or Collection, at a minimum such credit will appear, if a credit for all contributing authors of the Adaptation or Collection appears, then as part of these credits and in a manner at least as prominent as the credits for the other contributing authors. For the avoidance of doubt, You may only use the credit required by this Section for the purpose of attribution in the manner set out above and, by exercising Your rights under this License, You may not implicitly or explicitly assert or imply any connection with, sponsorship or endorsement by the Original Author, Licensor and/or Attribution Parties, as appropriate, of You or Your use of the Work, without the separate, express prior written permission of the Original Author, Licensor and/or Attribution Parties.
4. Except as otherwise agreed in writing by the Licensor or as may be otherwise permitted by applicable law, if You Reproduce, Distribute or Publicly Perform the Work either by itself or as part of any Adaptations or Collections, You must not distort, mutilate, modify or take other derogatory action in relation to the Work which would be prejudicial to the Original Author's honor or reputation. Licensor agrees that in those jurisdictions (e.g. Japan), in which any exercise of the right granted in Section 3(b) of this License (the right to make Adaptations) would be deemed to be a distortion, mutilation, modification or other derogatory action prejudicial to the Original Author's honor and reputation, the Licensor will waive or not assert, as appropriate, this Section, to the fullest extent permitted by the applicable national law, to enable You to reasonably exercise Your right under Section 3(b) of this License (right to make Adaptations) but not otherwise.

## 5. Representations, Warranties and Disclaimer

UNLESS OTHERWISE MUTUALLY AGREED TO BY THE PARTIES IN WRITING, LICENSOR OFFERS THE WORK AS-IS AND MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND CONCERNING THE WORK, EXPRESS, IMPLIED, STATUTORY OR OTHERWISE, INCLUDING, WITHOUT LIMITATION, WARRANTIES OF TITLE, MERCHANTIBILITY, FITNESS FOR A PARTICULAR PURPOSE, NONINFRINGEMENT, OR THE ABSENCE OF LATENT OR OTHER DEFECTS, ACCURACY, OR THE PRESENCE OF ABSENCE OF ERRORS, WHETHER OR NOT DISCOVERABLE. SOME JURISDICTIONS DO NOT ALLOW THE EXCLUSION OF IMPLIED WARRANTIES, SO SUCH EXCLUSION MAY NOT APPLY TO YOU.

## 6. Limitation on Liability

EXCEPT TO THE EXTENT REQUIRED BY APPLICABLE LAW, IN NO EVENT WILL LICENSOR BE LIABLE TO YOU ON ANY LEGAL THEORY FOR ANY SPECIAL, INCIDENTAL, CONSEQUENTIAL, PUNITIVE OR EXEMPLARY DAMAGES ARISING OUT OF THIS LICENSE OR THE USE OF THE WORK, EVEN IF LICENSOR HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

## 7. Termination

1. This License and the rights granted hereunder will terminate automatically upon any breach by You of the terms of this License. Individuals or entities who have received Adaptations or Collections from You under this License, however, will not have their licenses terminated provided such individuals or entities remain in full compliance with those licenses. Sections 1, 2, 5, 6, 7, and 8 will survive any termination of this License.
2. Subject to the above terms and conditions, the license granted here is perpetual (for the duration of the applicable copyright in the Work). Notwithstanding the above, Licensor reserves the right to release the Work under different license terms or to stop distributing the Work at any time; provided, however that any such election will not serve to withdraw this License (or any other license that has been, or is required to be, granted under the terms of this License), and this License will continue in full force and effect unless terminated as stated above.

## 8. Miscellaneous

1. Each time You Distribute or Publicly Perform the Work or a Collection, the Licensor offers to the recipient a license to the Work on the same terms and conditions as the license granted to You under this License.
2. Each time You Distribute or Publicly Perform an Adaptation, Licensor offers to the recipient a license to the original Work on the same terms and conditions as the license granted to You under this License.
3. If any provision of this License is invalid or unenforceable under applicable law, it shall not affect the validity or enforceability of the remainder of the terms of this License, and without further action by the parties to this agreement, such provision shall be reformed to the minimum extent necessary to make such provision valid and enforceable.
4. No term or provision of this License shall be deemed waived and no breach consented to unless such waiver or consent shall be in writing and signed by the party to be charged with such waiver or consent.
5. This License constitutes the entire agreement between the parties with respect to the Work licensed here. There are no understandings, agreements or representations with respect to the Work not specified here. Licensor shall not be bound by any additional provisions that may appear in any communication from You. This License may not be modified without the mutual written agreement of the Licensor and You.
6. The rights granted under, and the subject matter referenced, in this License were drafted utilizing the terminology of the Berne Convention for the Protection of Literary and Artistic Works (as amended on September 28, 1979), the Rome Convention of 1961, the WIPO Copyright Treaty of 1996, the WIPO Performances and Phonograms Treaty of 1996 and the Universal Copyright Convention (as revised on July 24, 1971). These rights and subject matter take effect in the relevant jurisdiction in which the License terms are sought to be enforced according to the corresponding provisions of the implementation of those treaty provisions in the applicable national law. If the standard suite of rights granted under applicable copyright law includes additional rights not granted under this License, such additional rights are deemed to be included in the License; this License is not intended to restrict the license of any rights under applicable law.