Freescale Semiconductor
Application Note

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Changing the i.MX31 USB PHY

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

Freescale recommends to use the USB PHYs that are included in the i.MX31 PDK. However, some customers have their own preferred transceivers to use in their custom designs. This application note helps to interface the most common USB PHYs with the i.MX31 microprocessor.

The Universal Serial Bus On-The-Go (USBOTG) high speed module contains all the functionality required to support the three independent USB ports, that are compatible with the USB 2.0 specification. In addition to the normal USB functionality, the module also provides support for direct connections to the on-board USB peripherals and supports multiple types of interfaces for serial transceivers. The USBOTG module provides high performance USB On-The-Go functionality which is compliant with the USB 2.0 specification, the OTG supplement, and the ULPI 1.0 Low Pin Count specification.

The USBOTG module consists of three independent USB cores, each controlling one USB port:

- HOST1—Full/Slow speed (serial)
- HOST2—All speeds (ULPI) and Full/Low speed (serial)
- OTG—All speeds (ULPI) and Full/Low speed (serial)

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1 Booting

The i.MX31 device can be interfaced with any ULPI/Serial PHY. However, the internal ROM in the microprocessor supports only three USB transceivers (shown in Table 1) for downloading software to the non-volatile memories in bootstrap mode.

Table 1. Supported USB Transceivers for Booting

External Transceiver	Speed	Interface	Transceiver Mode	USB Controller Mode
Philips ISP 1301 USB Transceiver	Full Speed	Serial Interface	DAT_SE0 and Unidirectional	TX => SE RX => Diff
Freescale Atlas ASIC	Full Speed	Serial Interface	VP_VM Mode	TX => Diff RX => Diff
Philips ISP 1504 USB Transceiver	Full Speed	ULPI	ULPI	ULPI

The selection of the boot device is made by polling the UART1 and USB controllers in turn and the device that shows activity first is selected. For the USB, activity is detected through the setup endpoint status register, indicating that the setup transaction is received.

The customers must only connect the transceivers according to the Freescale's PDK or ADS as shown in Figure 1, Figure 2, and Figure 3. These schematics are changed depending on the customer's needs. For example, the customers may want to add ESD protection to the transceiver.

Figure 1 shows the ISP1504 serial interface.

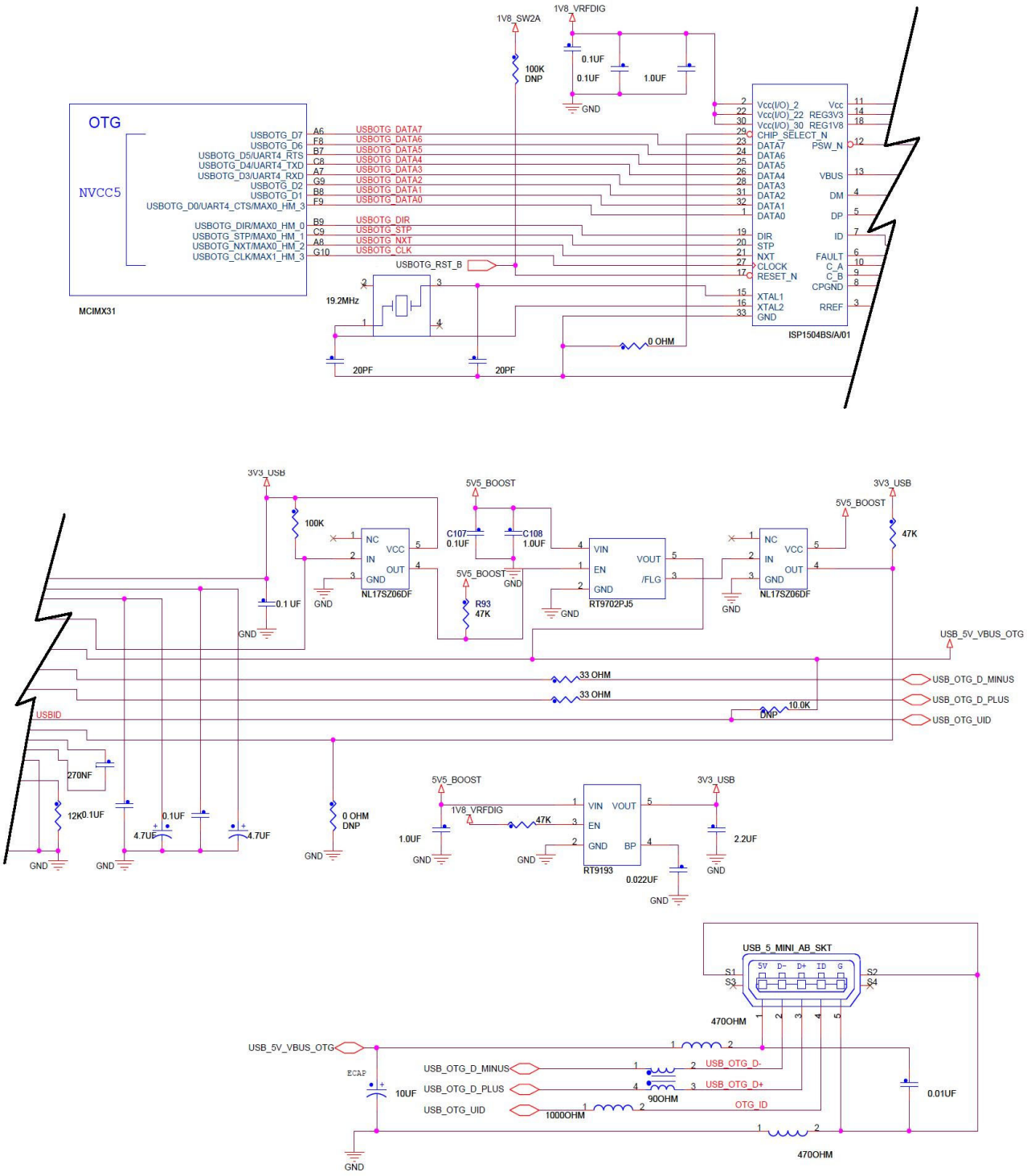

Figure 1. ISP1504 Serial Interface

Figure 2 shows the ISP1301 OTG interface.

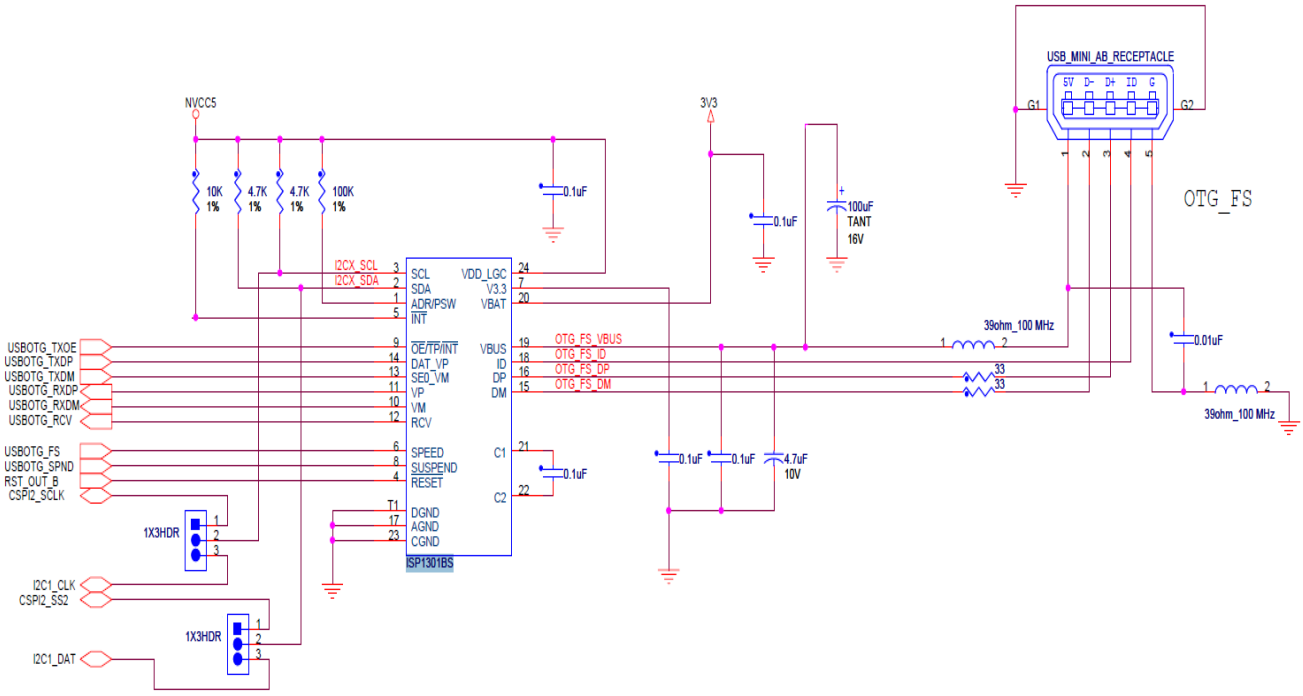

Figure 2. ISP1301 OTG Interface

Figure 3 shows the Atlas interface.

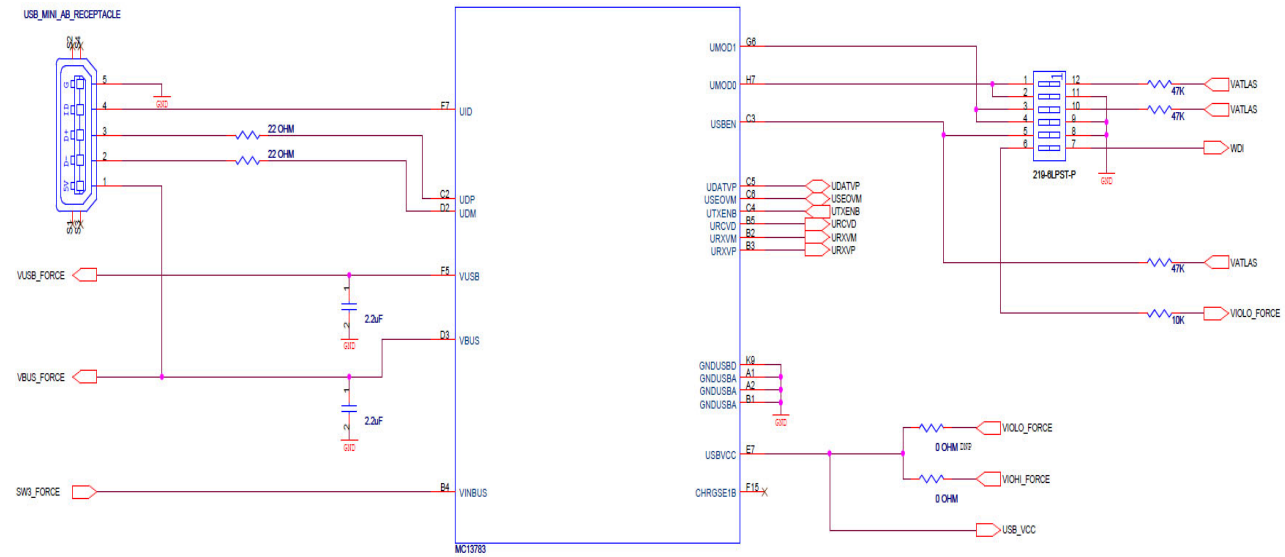

Figure 3. Atlas Interface

Figure 4 and Figure 5 show two configurations that are not available on the PDK or the ADS. These schematics show the interconnection between the USB3317 (as Host HS) and USB3311 (as OTG). These schematics are also changed depending on the customer's needs. For example, the customers may want to add ESD protection to the transceiver.

Figure 4 shows the USB3317 host interface.

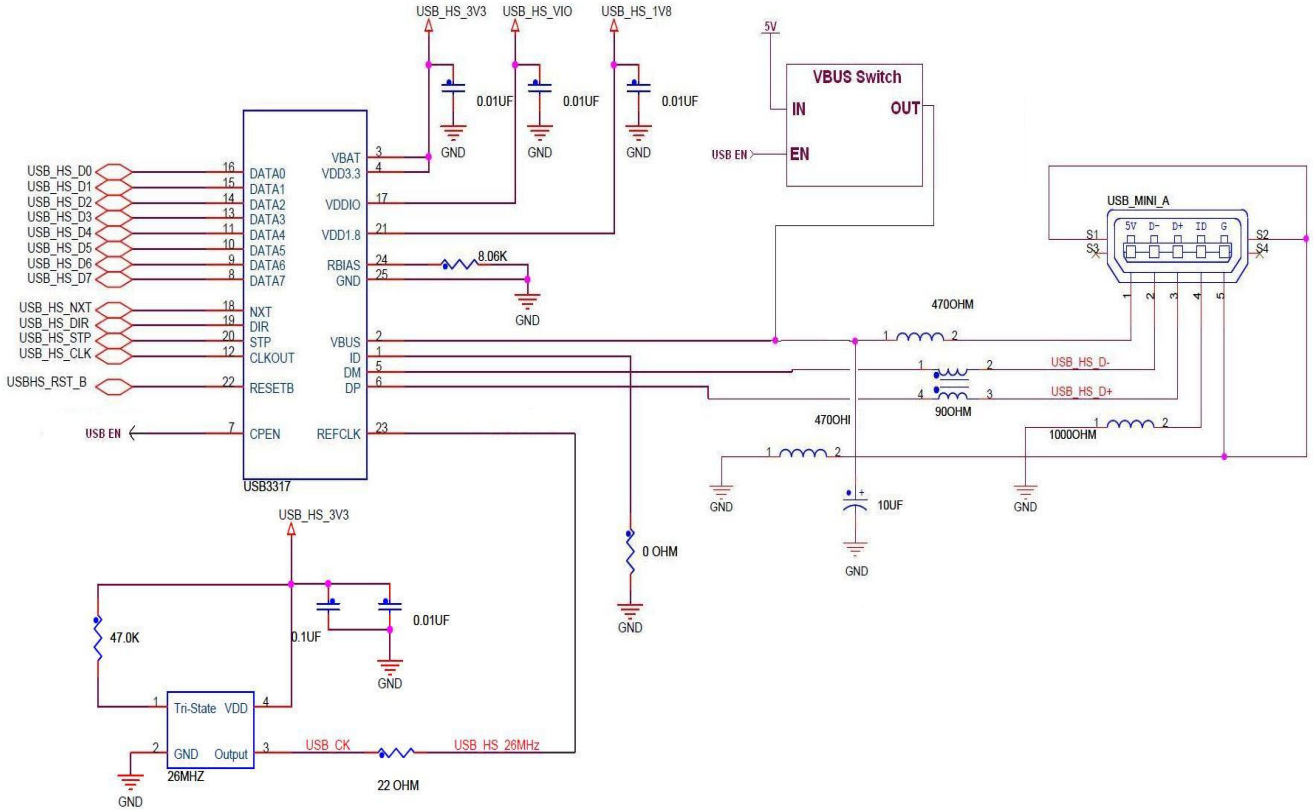

Figure 4. USB3317 Host Interface

Figure 5 shows the USB3311 OTG interface.

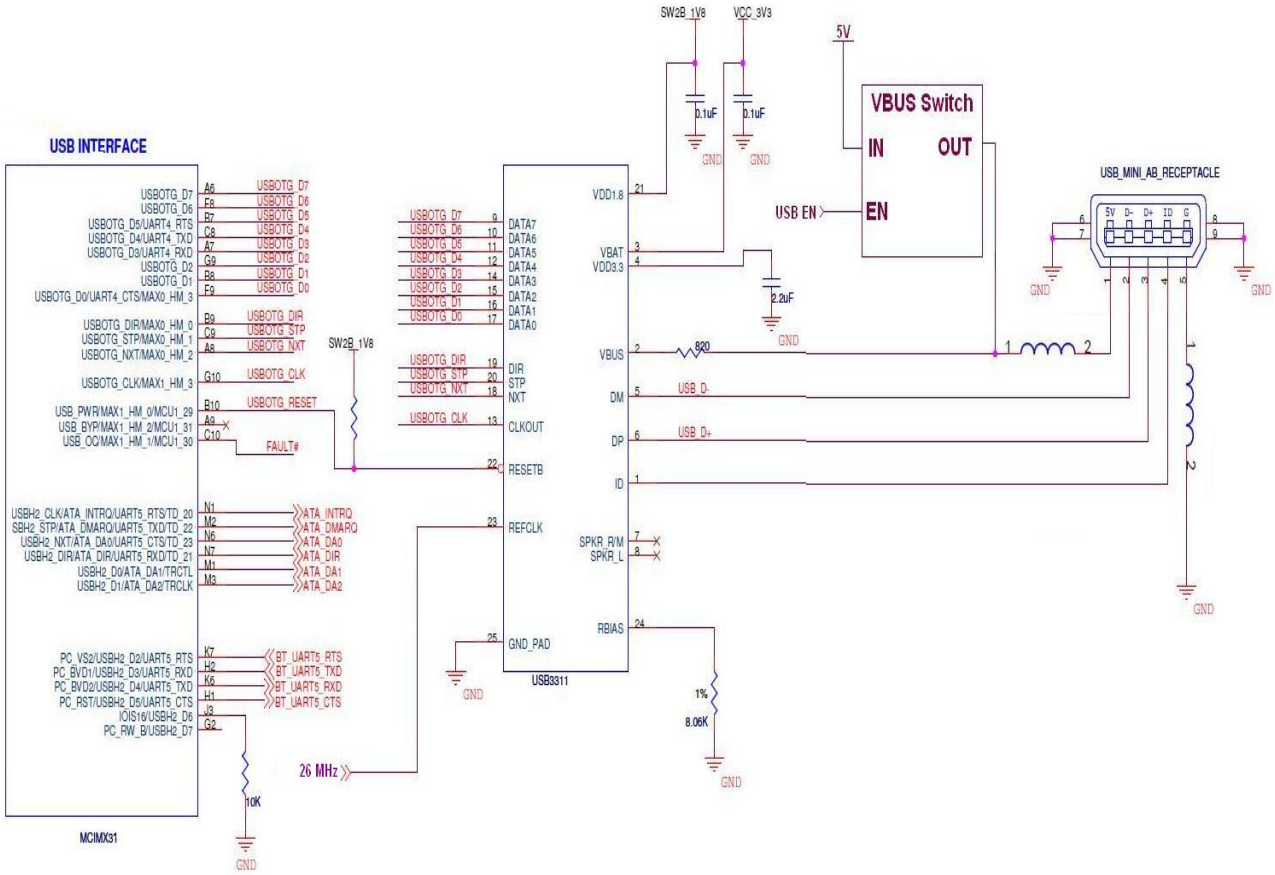

Figure 5. USB3311 OTG Interface

2 Changing the PHY

The i.MX31 device can be interfaced with other USB PHYs, either serial or ULPI, using proper interconnections and the software driver to manage the PHY. The Board Support Packages (BSP) for both Linux and Windows contain USB drivers, that can be used to customize designs for a specific transceiver.

The interface between the host controller and the PHY is time sensitive. Special care is to be taken for the design and timing of the communication interface, while working with a ULPI PHY.

The following recommendations help to avoid problems:

- Reduce the distance between the controller and the PHY (by means of small traces)
- Reduce loads on the lines
- Identify the correct configuration between the pad strength and the load

These recommendations depends on the timing of the specific PHY being used.

2.1 Supported USB Profiles

The USB class driver determines the type of interface exposed to the connecting device:

- Common i.MX31-as-client profiles
  - Serial: ActiveSync (default profile for WinCE BSP)
  - Mass storage: Requires storage media (hard disk, SD, and so on)
  - Media Transfer Protocol (MTP): PMC-like devices (requires hard disk)
- Common i.MX31-as-host profiles
  - Mass storage: USB memory sticks, SD card readers, CD ROMs and Hard drives
  - Human Interface Devices (HID): Mouse, Keypad
  - Serial: Bluetooth devices or other i.MX31-like devices
  - RNDIS: WLAN or Bluetooth radios
- i.MX31 OTG profiles
  - Dynamic switching requires Host Negotiation Protocol (HNP) and this is not supported in WinCE or Linux. The host or client role is determined only once during the plug-in
  - Transceiver detects the type of cable plugged into the OTG port and only then the proper driver stack (host or client) is loaded
  - A device plug: MX31 is the host
  - B device plug: MX31 is the client/device/function
  - Mini-AB plug for dynamic role switching (not supported on i.MX31)

The files to be configured vary depending on the specific PHY and interface used. In general, the `hwinit.c` file in the BSP has to be modified and this file is usually located at the following location:

```
\PLATFORM\iMX313DS\SRC\DRIVERS\USBH\COMMON\hwinit.c
```

Most of the PHY configurations are set in this file. For example, this file contains dedicated sections where the interface, Host1, Host2 or OTG, is set. The `IOMUX` and `CONTROL REGISTER` is configured in this file to set up the specific hardware requirements. This file also modifies the interface to be either High Speed or Full Speed.

There are several `IOMUX` options for the USB pads:

- Host 1: CSPI_BB (Alt1) + GPIO1 (Alt1, 1pin)
- Host 2: Part is dedicated, the other part can be:
  - Option 1: NandFlash (Alt2)
  - Option 2: PCMCIA (Alt1)
  - Option 3: Audiomux 3,6: (HW1)
- OTG: Dedicated, Full UART (Alt1) + UART1 (HW2)

All these options are software programmable. For example, there are some differences between the i.MX31 ADS and PDK, HS2 pin configuration.

Table 2 shows the comparison between various pins in the i.MX31 processor.

Table 2. HS2 Pin Comparison

	ADS	PDK
D7	SRXD6	PC_RW_B
D6	STXD6	IOIS16
D5	SFS3	PC_RST
D4	SCK3	PC_BVD2
D3	SRXD3	PC_BVD1
D2	STXD3	PC_VS2
D1	USBH2_DATA0	USBH2_DATA0
D0	USBH2_DATA1	USBH2_DATA1
DIR	USBH2_DIR	USBH2_DIR
STP	USBH2_STP	USBH2_STP
NXT	USBH2_NXT	USBH2_NXT
CLK	USBH2_CLK	USBH2_CLK

Set the appropriate `IOMUX` configuration in the hardware configuration code to port the driver to a different platform. The transceiver initialization is performed in the `BOOL InitializeTransceiver` function within the `hwinit.c` file. If the USB controller enters any of the sleep modes, then the wake up event must be configured in the `BSPUsbSetWakeUp` function.

Depending on the interface being used, (Serial or ULPI) the control registers such as PORTSC, USB mode, and USB cmd must be configured through the control register.

For a serial interface, configure the transceiver in the OTG Serial Interface Configuration (OSIC) register to distinguish between the serial and ULPI interface. Then, accommodate the file located at the following location:

```
\PLATFORM\iMX313DS\SRC\DRIVERS\USBXVR\hwinit.c
```

If the USB port is to be used as ‘Device’ only, then another `hwinit.c` file must be modified and this is located at the following location:

```
\PLATFORM\iMX313DS\src\DRIVERS\USBD\hwinit.c
```

2.2 Building an Image with Different Client Driver Support

This section describes the process of building an image using different client driver support.

- Host Driver supports dynamic switch between MSC/HID/Printer and so on
- Device Driver does not support dynamic switch

Three Function Clients catalog are provided in the following location:

```
Device Drivers\USB Function\USB Function Clients
```

- Mass Storage

- RNDIS
- Serial
- Priority : Serial > RNDIS > Mass Storage

NOTE

Remove the high priority catalog to use the low level client driver.

For information on USB module errata, see MCIMX31 and MCIMX31L Chip Errata (Doc. #MCIMX31CE), available at http://www.freescale.com/imx31.

3 Revision History

Table 3 provides a revision history for this application note.

Table 3. Document Revision History

Rev. Number	Date	Substantive Change(s)
1	05/2012	• In lead sentence and title of Figure 1, replaced ISP 1301 with ISP1504. • In lead sentence and title of Figure 2, replaced ISP 1504 with ISP1301. • In Table 1, replaced the transreceiver value 1540 with 1504.
0	05/2010	Initial release.

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Freescale Semiconductor, Inc.
Technical Information Center, EL516
2100 East Elliot Road
Tempe, Arizona 85284
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Europe, Middle East, and Africa:
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+44 1296 380 456 (English)
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Japan:
Freescale Semiconductor Japan Ltd.
Headquarters
ARCO Tower 15F
1-8-1, Shimo-Meguro, Meguro-ku
Tokyo 153-0064
Japan
0120 191014 or
+81 3 5437 9125
support.japan@freescale.com

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

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

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