

TN00071

USB Detection with Full-Speed Hubs

Rev 1.0 — December 12, 2020

Technical Note

Document information

Info	Content
Keywords	LPC55xx, iMXRT6xx, iMXRT5xx, USB High-Speed device, Full-Speed hub, USB PHY.
Abstract	This tech. note describes how to address certain USB full-speed hub failure when used in between USB High-Speed host and LPC55xx, iMXRT6xx, iMXRT5xx High-speed USB port configured as device.



Revision history

Rev	Date	Description
1.0	12/01/2020	Initial version

Contact information

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1. Introduction

On the LPC55xx, i.MXRT600, and i.MXRT500 devices, there is an errata when using USB High Speed Device controller with Full-Speed Hub. The USB device does not detect the HOST KJ sequence correctly and as a result, it does not recognize the speed of the host connected to. Therefore, USB device will behave erratically due to the wrong speed detection.

Please note, there is no known issue when HS USB hubs are used in between the USB host and our HS USB port configured as the device in these MCUs mentioned in above. Not all FS hubs fail the same way described here, so, this is an extremely rare case.

This technical note describes the software workaround # 2 mentioned in the errata and describes how to use the USB PHY Receiver Control (RX) register to ensure we can detect the host speed correctly during the USB connection stage. Modified source file has been provided with the tech note.

2. USB High-speed Detection

2.1 USB Speed Identification

A USB device must indicate its speed by pulling either the D+ or D- line high to 3.3 volts. The device uses a 1.5 Ohm pull-up resistor attached to D+ to indicate as a full-speed device and attached to D- to indicate as a low-speed device. The pull-up resistors at the device end are used by the host or hub to detect the presence of a device connected to its port.

The high-speed devices identification starts by connecting as a full-speed device first. Once it has been attached, it will do a high-speed chirp during reset and establish a high speed connection if the hub supports it. Once the device operates in high-speed mode, then the pull-up resistor is removed to balance the USB signal line.

On the LPC55xx and iMXRTxxx family MCUs, the pull-up resistors are built into the USB Physical Layer (PHY) controller.

2.2 Using Software to Correctly Identify the USB Speed

Inside USB HS PHY, there is a squelch detector, also called envelope detector. The purpose of this detector is to invalidate the HS differential receiver when the incoming signal is too low to receive reliably.

To correctly identify the USB speed when attached to the USB host regardless whether the USB hub is connected in between or not and the speed of the hub, the software approach can do the following:

1. When the device is attached to the USB host (or hub), change the trip level voltage of the squelch detector, ENVADJ bits of the USB PHY Receiver (RX) Register, to ensure we can detect the incoming USB signal reliably.
2. On USB Bus Reset condition, identify the operating speed of the connected USB device by reading the SPEED field (bit 22 and 23) of the DEVCMDSTAT register. If the operating speed of the device is full-speed, (bit 22/23 = 01B), force the

USB device to operate in full-speed mode by setting FORCE_FS (bit 21) of DEVCMDSTAT register to 1. Otherwise, do nothing.

3. When the first SETUP packet is received, reset ENVADJ bits of USB PHY RX register to POR default value (000B) to minimize false squelch detection.
4. When the device is detached to the USB host (or hub), clear FORCE_FS (bit 21) of DEVCMDSTAT register to zero as well as reset ENVADJ bits of USB PHY RX register to POR default value.

Based on SDK 2.8.2 for LPC55S28, mouse.c file under “usb_device_hid_mouse” example, also attached as part of the technical note, has been modified as described above:

In event handler in USB_DeviceCallback(),

- On “kUSB_DeviceEventAttach” event, set PHY_RX register trip-level voltage to the highest.
USBPHY->RX &= ~(USBPHY_RX_ENVADJ_MASK);
USBPHY->RX |= 0x2;
- On “kUSB_DeviceEventBusReset” event, check the DEVCMDSTAT[SPEED] to determine the connected bus speed. (SPEED are bits 22 and 23). If DEVCMDSTAT[SPEED]=FS, FORCE_FS (bit 21) of DEVCMDSTAT should be set to force the device operating in full-speed mode. Otherwise, do nothing.
- On “kUSB_DeviceEventGetDeviceDescriptor” event, or first SETUP packet has arrived, Set the USBPHY_RX[ENVADJ] field back to default 0. Otherwise, USBPHY_RX[ENVADJ] field will remains as 2 unless a disconnect event occurs.
- On “kUSB_DeviceEventDetach” event, Clear FORCE_FS (bit 21) of DEVCMDSTAT register to zero. Reset USBPHY_RX[ENVADJ] field back to default 0.

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