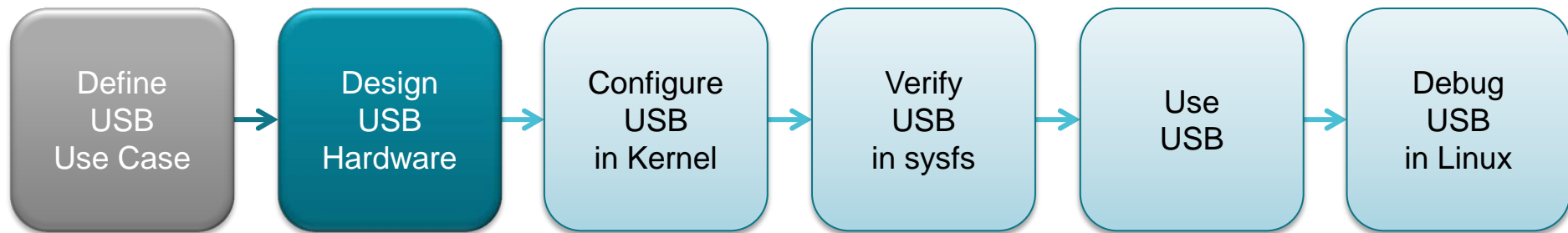# USB System Design in Sitara Devices Using Linux

[Part 1]: Design USB Hardware (Digital-only Focused)

Bin Liu (EP, Processors)

Agenda

- Overview of USB subsystem in Sitara devices
  - USB on AM335x, AM437x, and AM57x
  - ROM USB boot
  - USB on Sitara EVMs
- USB hardware design (digital-only focused)
  - Reference design
  - Hardware design checklist
  - Common mistakes

Sitara USB subsystem overview

- Two DRD-capable USB modules
    DRD = Dual-role* Device

- Supports host-only, device-only, and DRD mode

- Integrated PHY

- 15 TX,15 RX endpoints, and bidirectional endpoint 0

USB Host

USB Hub

USB Devices
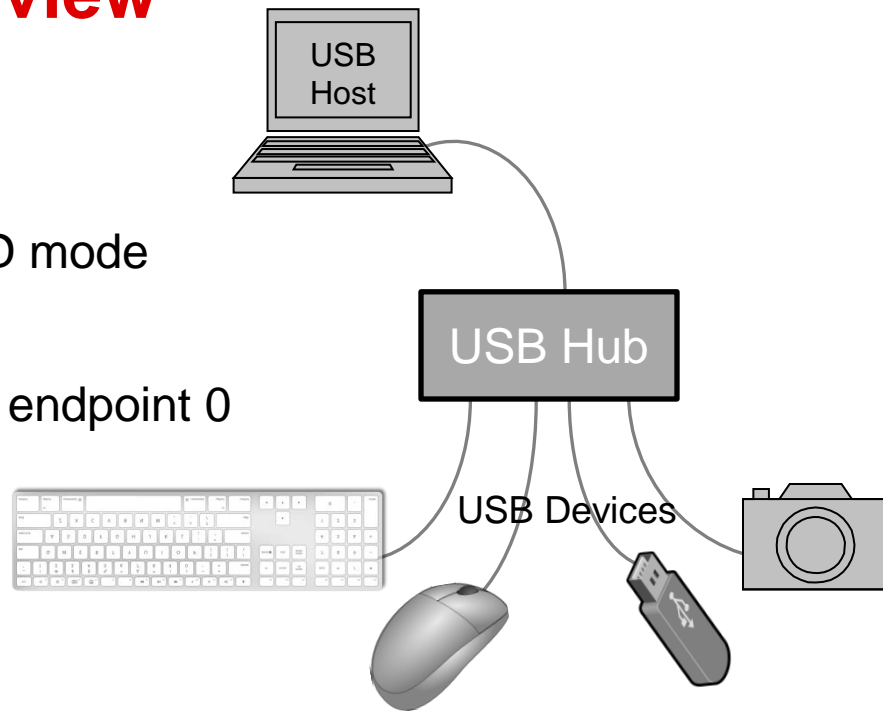
*Dual-Role: A USB controller can work in host or device mode, depending on the type of the USB cable attached.

Feature comparison

Feature	AM335x	AM437x	AM57x
Host Controller	MUSB	xHCI 1.0	xHCI 1.0
Host Mode Speed	HS/FS/LS	HS/FS/LS	SS/HS/FS/LS*
Device Controller	MUSB	DWC3	DWC3
Device Mode Speed	HS/FS	HS/FS	SS/HS/FS*
Number of Modules	2	2	2*

Note: * AM57x second USB module (USB2) does not support SuperSpeed USB.

TEXAS INSTRUMENTS

ROM USB boot

	AM335x	AM437x		AM57x
Module	USB0	USB0	USB1	USB1**
Mode	Peripheral Boot	Peripheral Boot	Memory Boot	Peripheral Boot
Protocol	RNDIS Ethernet	RNDIS Ethernet	Mass Storage (SCSI)*	Proprietary
Speed	Full-speed	Full-speed	High-speed	High-/Full-speed

NOTES:

  * Does not support USB hubs
 ** USB1 is the first USB module on AM57x

USB design on AM335x EVMs

	GP EVM		Starter Kit		BeagleBone Black	
Module	USB0	USB1	USB0	USB1	USB0	USB1
Mode	DRD	Host-only	Device-only	Host-only	Device-only	Host-only

USB design on AM437x EVMs

Module	GP EVM		Starter Kit		ePOS EVM	
	USB0	USB1	USB0	USB1	USB0	USB1
Mode	DRD	Host-only	DRD	Host-only	DRD	Host-only

USB design on AM57x EVMs

	AM572x GP EVM		AM572x IDK		AM571x IDK	
Module	USB1	USB2	USB1	USB2	USB1	USB2
Mode	Host-only*	Device-only	Host-only	DRD	Host-only	DRD
Max Speed	SS	HS	SS	HS	HS	HS

* NOTE: A SuperSpeed USB hub is on the board.
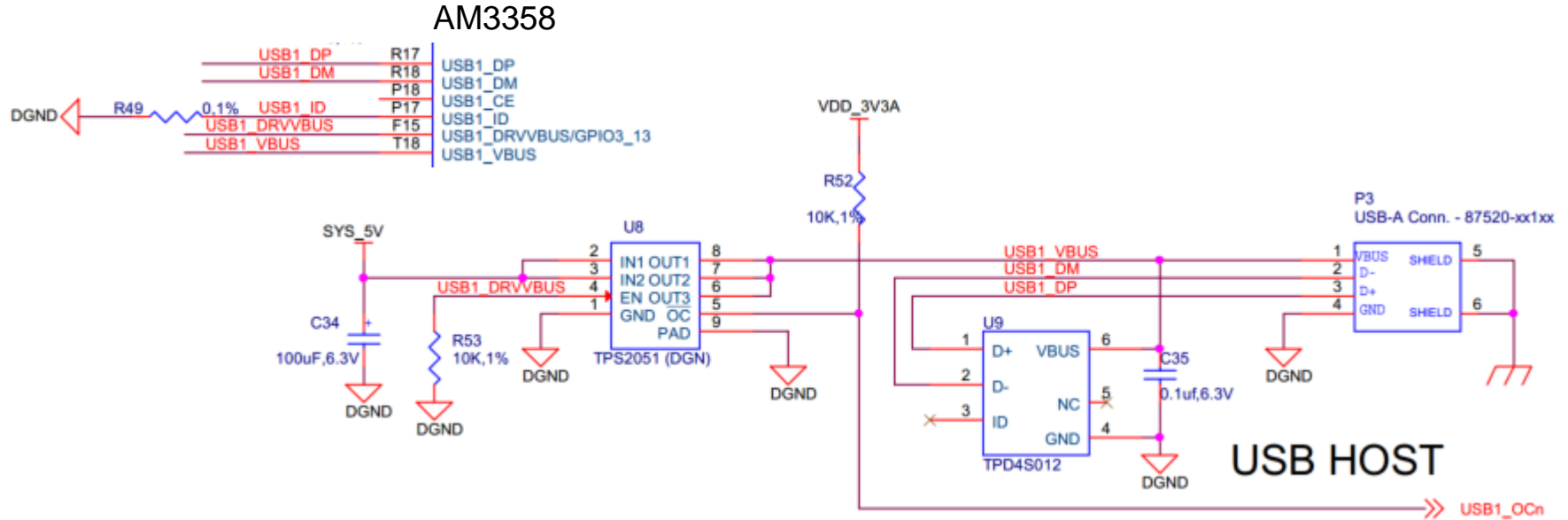
TEXAS INSTRUMENTS

USB pins

Pin Name	Notes
USBx_DP/USBx_DM	USB2.0 data lines
USBx_TXN/USBx_TXP USBx_RXN/USBx_RXP	USB3.x data lines
USBx_DRVVBUS	To drive USB power switch in host mode
USBx_VBUS*	To sense VBUS power in device mode
USBx_ID**	To control operation mode in DRD mode: - Grounded: to host mode - Float: to device mode

NOTES: *   AM335x also senses VBUS power while transitioning to host mode.

　　　　　** AM57x does not have dedicated pins for USBx_VBUS and USBx_ID.
　　　　　PMIC/GPIO pins must be used for the purpose.

TEXAS INSTRUMENTS

Device-only mode reference design for AM335x/AM47x

AM3358

NOTE: Pin USB0_ID can be unconnected to the receptacle.

From BeagleBone Black A4

TEXAS INSTRUMENTS

Host-only mode reference design for AM335x/AM47x

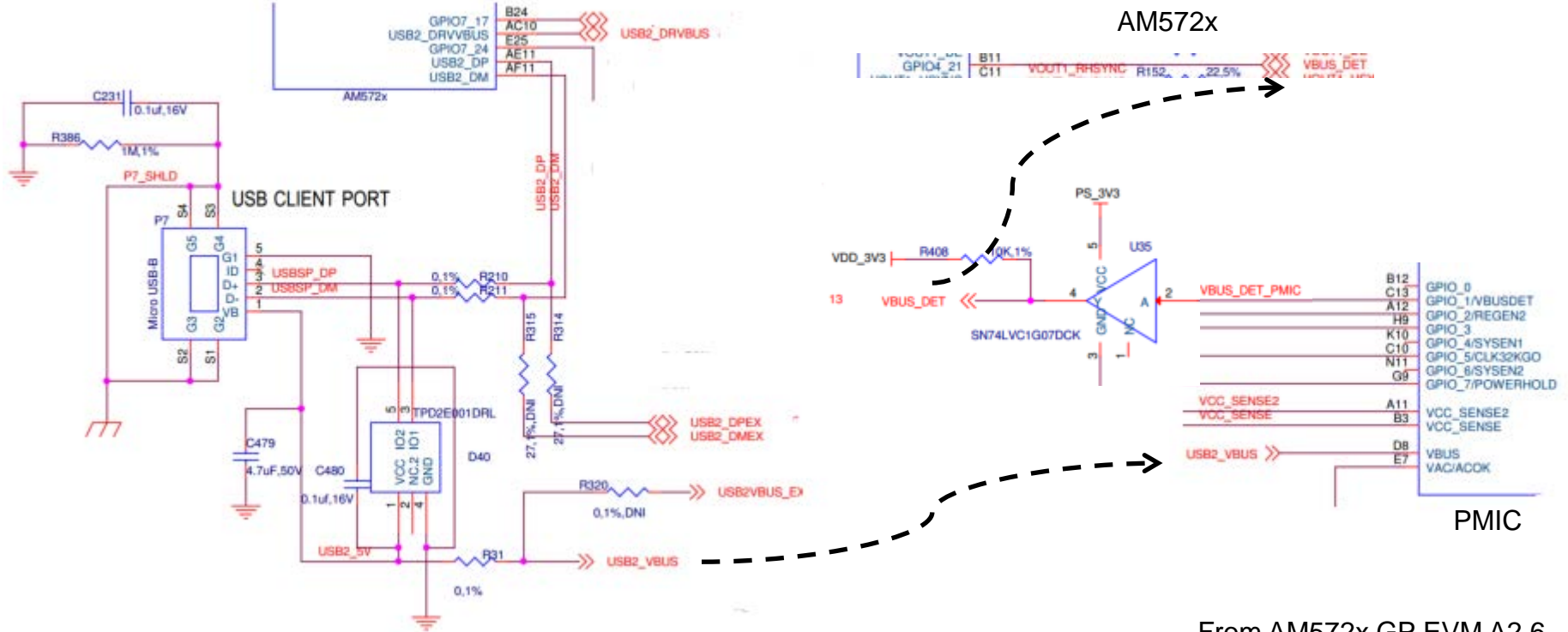NOTE: Missing VBUS capacitor (120uF) next to the receptacle.

From BeagleBone Black A4

TEXAS INSTRUMENTS

DRD mode reference design for AM335x/AM47x
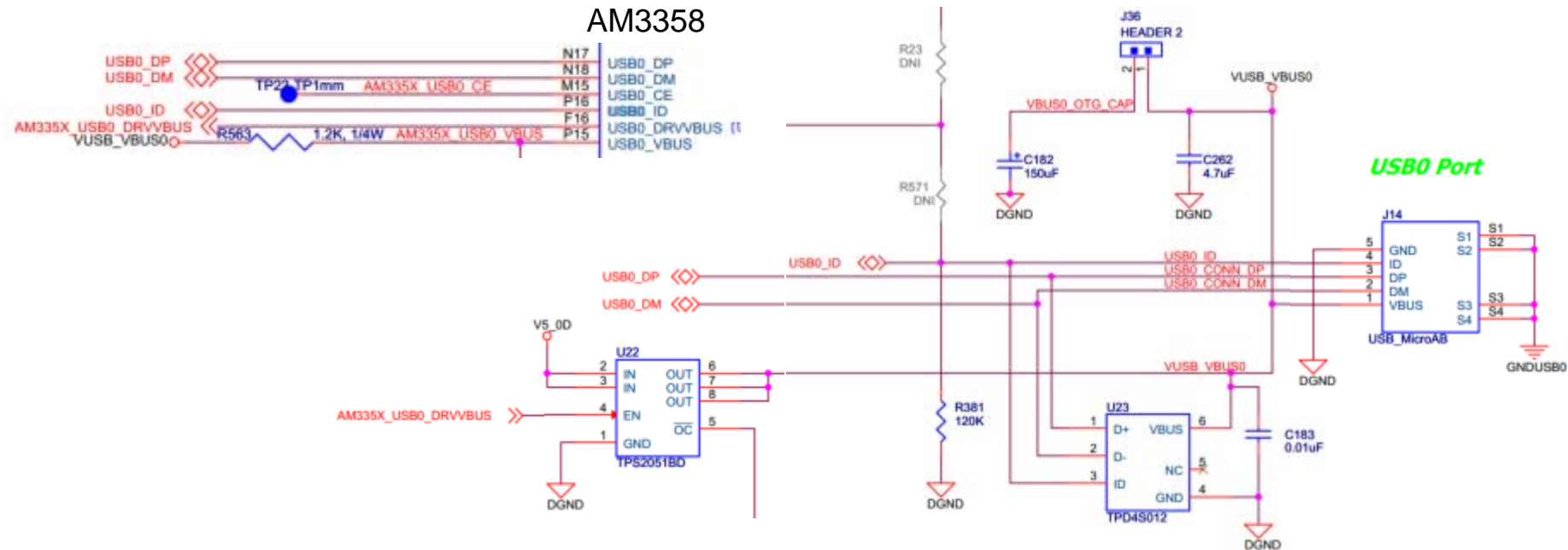
AM3358

From AM335x GP EVM v1.2a

TEXAS INSTRUMENTS
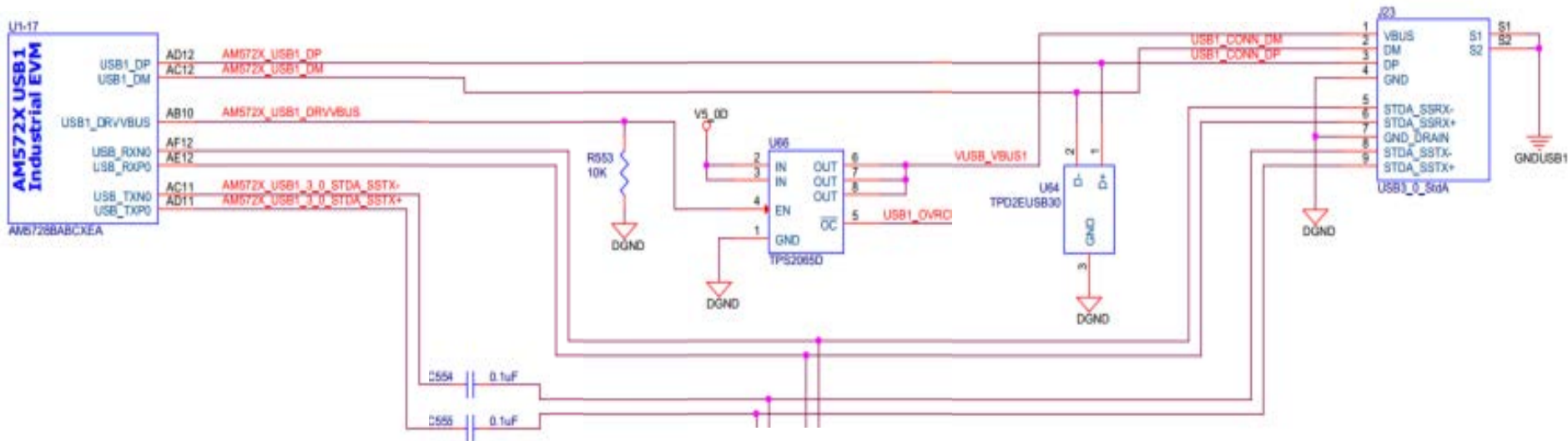
Device-only mode reference design for AM57x

From AM572x GP EVM A2.6

Host-only mode reference design for AM57x

From AM572x IDK EVM v1.3B

TEXAS INSTRUMENTS

DRD mode reference design for AM57x

AM572x

From AM572x IDK EVM v1.3B

TEXAS INSTRUMENTS

USB design checklist

- AM335x Schematic Checklist:
  http://processors.wiki.ti.com/index.php/AM335x_Schematic_Checklist#USB

- AM437x Schematic Checklist:
  http://processors.wiki.ti.com/index.php/AM437x_Schematic_Checklist#USB

- AM57x Schematic Checklist:
  http://processors.wiki.ti.com/index.php/AM57xx_Schematic_Checklist#USB

- High-Speed Interface Layout Guidelines:
  http://www.ti.com/lit/pdf/spraar7

Common mistakes in USB hardware design

- Missing pinout:
  - Did not bring out USBx_ID pin for DRD mode
  - Did not bring out USBx_DRVVBUS pin
  - AM335x: Did not bring out USBx_VBUS pin for device-only mode
  - AM57x: Did not bring VBUS line to SoC for device-only mode
- Resistor is added on AM335x USBx_ID pin
- Single USB power switch is shared for both USB ports
- Missing 120uF capacitor on VBUS for host-only mode
- Signal integrity:
  - Test points on DP/DM lines
  - Resistors on DP/DM lines
  - AM335x: USB Mux which serial resistance > 3ohm
- Crystal frequency misconfigured

For more information

- For questions about this training, refer to the E2E Community Forums at
  http://e2e.ti.com