Managing USB-C port status with the STUSB4500L
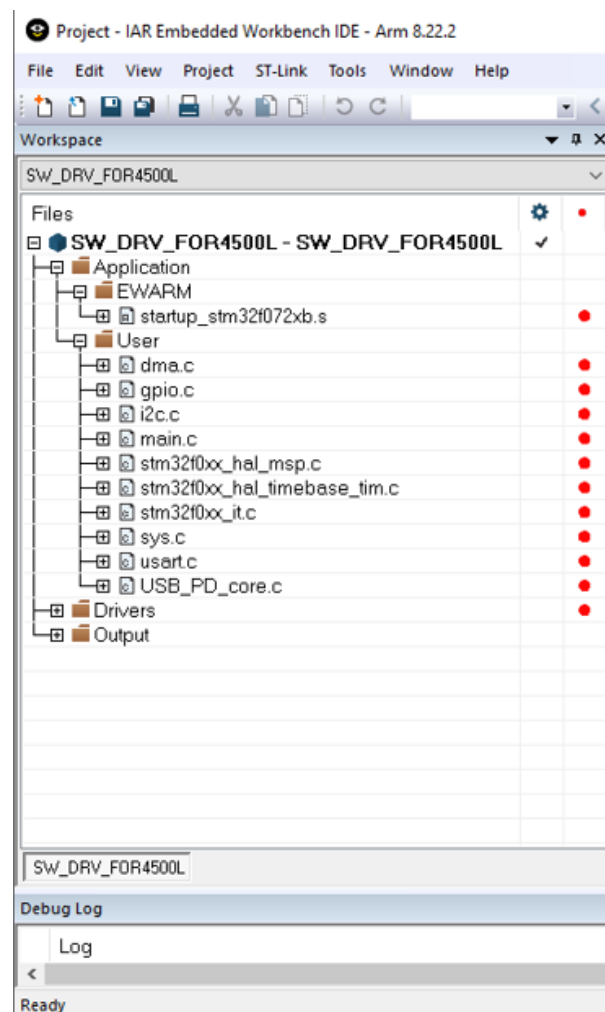
Introduction

This document describes how to read USB-C port status by executing a few I^{2}C commands on top of the STUSB4500L from an application processor. Open source software is available to speed up the application software development. The code is available as an example only.

Table 1. **Minimal configuration**

|	
STSW-STUSB007	Software library including the STUSB4500L hardware abstraction layers, drivers and Code example
EVAL-SCS002V1	STUSB4500L evaluation board and reference design
NUCLEO-F072RB	STM32 Nucleo-64 development board with ARM Cortex M0
IAR 8.x	C code compiler

Figure 1. **STUSB4500L software library**

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1 Hardware configuration

The SCL, SDA and GND signals from the EVAL-SCS002V1 board (or custom application board) must be connected to their counterpart signals from the NUCLEO-F072RB board (see connections below).

Figure 2. NUCLEO-F072RB
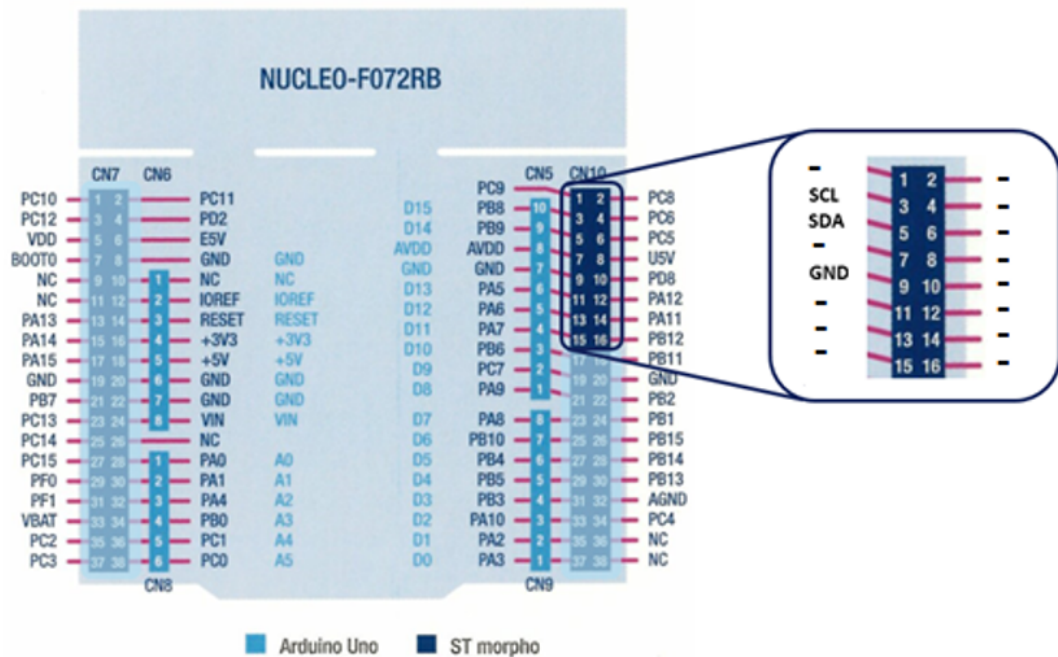
Note: *The EVAL-SCS002V1 board is automatically powered by VBUS when a SOURCE is attached.*

The proposed software assumes that a dedicated pull-up of 4.7 kOhms is externally implemented on SDA/SCL lines. Take care that without dedicated pull-up resistors, max. bandwidth on I²C bus is limited.

2 Main files

The library is composed of the following files:

- USB_PD_defines_STUSB-GEN1S.h
- USB_PD_core.h
- USB_PD_core.c
- Main.c

USB_PD_defines_STUSB-GEN1S.h

- Contains register definition of the STUSB4500L

USB_PD_core.h

- Contains main structures used to handle the STUSB4500L configuration

USB_PD_core.c

- Contains generic functions to be used to build applications

Main.c

- Illustrates how to use the functions and build applications

3 Drivers

Here is the list of available functions developed for the STUSB4500L software functions:

void usb_pd_init(uint8_t Port);

void ALARM_MANAGEMENT(uint8_t Port);

void HW_Reset_state(uint8_t Port);

void SW_reset_by_Reg(uint8_t Port);

void Print_Type_C_Only_Status(uint8_t Usb_Port);

3.1 usb_pd_init(Port)

This function clears all interrupts and unmasks the useful interrupts

3.2 ALARM_MANAGEMENT(Port)

This is the device interrupt handler.

3.3 HW_Reset_state(Port)

This function asserts and de-asserts the STUSB4500L hardware reset pin if connected to the appropriate MCU GPIO.

3.4 SW_Reset_by_Reg(Port)

This function resets the STUSB4500L type-C state machine. It also clears any ALERT.

3.5 Print_Type_C_Only_Status (Port)

This function prints the USB-C information received by the STUSB4500L, such as CC pin orientation and Rp value from source:

•   CC pin information is useful for USB3.x data signal routing (SSTX/SSRX)

•   Rp value information is useful to limit application consumption and/or to set application charging current accordingly

Figure 3. USB port


```
---- Usb_Port #0: CONNECTION STATUS    ----------
- ATTACHED to USB-C only device
- PIN   : CC2
- Power : Rp = 3A
```

4   How to read the USB-C connection STATUS?

Connection status can be known by accessing the two registers below:

- PORT_STATUS_1 (@0x0E)
- CC_STATUS (@0x11)

It is possible to report the following information to the application processor:

1. the plug orientation (CC pin attached to CC1 or CC2)
2. the USB-C source current (Rp resistor value)

For further details, see function: **Print_Type_C_Only_Status**

5 Register map

Offset	Register name	Description
0x06	BCD_TYPEC_REV_LOW	BCD_TYPEC_REV_LOW register
0x07	BCD_TYPEC_REV_HIGH	BCD_TYPEC_REV_HIGH register
0x08	reserved	reserved
0x09	reserved	reserved
0x0A	reserved	reserved
0x0B	ALERT_STATUS_1	ALERT_STATUS_1 register
0x0C	ALERT_STATUS_1_MASK	ALERT_STATUS_1_MASK register
0x0D	PORT_STATUS_0	PORT_STATUS_0 register
0x0E	PORT_STATUS_1	PORT_STATUS_1 register
0x0F	TYPEC_MONITORING_STATUS_0	TYPEC_MONITORING_STATUS_0 register
0x10	TYPEC_MONITORING_STATUS_1	TYPEC_MONITORING_STATUS_1 register
0x11	CC_STATUS	CC_STATUS register
0x12	CC_HW_FAULT_STATUS_0	CC_HW_FAULT_STATUS_0 register
0x13	CC_HW_FAULT_STATUS_1	CC_HW_FAULT_STATUS_1 register
0x14	reserved	reserved
0x15	TYPEC_STATUS	TYPEC_STATUS register
0x16 to 0x1F	reserved	reserved
0x20	MONITORING_CTRL_0	MONITORING_CTRL_0 register
0x21	reserved	reserved
0x22	MONITORING_CTRL_2	MONITORING_CTRL_2 register
0x23	RESET_CTRL	RESET_CTRL register
0x24 to 0x1C	reserved	reserved
0x2D	GPIO_SW_GPIO	GPIO_SW_GPIO register

5.1 BCD_TYPEC_REV_LOW register

Address: STUSB_BLOCKBaseAddress + 0x06

Type: R

Reset: 0x12

7	6	5	4	3	2	1	0
			BCD_TYPEC_REV_7_0				
			R				

[7:0]	**BCD_TYPEC_REV_7_0**: Defined Type-C release supported by the device

5.2 BCD_TYPEC_REV_HIGH register

Address: STUSB_BLOCKBaseAddress + 0x07

Type: R

Reset: 0x00

7	6	5	4	3	2	1	0
			BCD_TYPEC_REV_15_8				
			R				

[7:0]	**BCD_TYPEC_REV_15_8**: Defined Type-C release supported by the device

5.3 ALERT_STATUS_1 register

Address: STUSB_BLOCKBaseAddress + 0x0B

Type: R

Reset: 0x00

7	6	5	4	3	2	1	0
reserved	PORT_STATUS_AL	TYPEC_MONITORING_STATUS_AL	CC_HW_FAULT_STATUS_AL	reserved	reserved	reserved	reserved
R	R	R	R	R	R	R	R

[7]	reserved
[6]	**PORT_STATUS_AL**
[5]	**TYPEC_MONITORING_STATUS_AL**
[4]	**CC_HW_FAULT_STATUS_AL**
[3]	reserved
[2]	reserved
[1]	reserved
[0]	reserved

5.4 ALERT_STATUS_1_MASK register

Address: STUSB_BLOCKBaseAddress + 0x0C

Type: R/W

Reset: 0xFB (initialized by NVM)

7	6	5	4	3	2	1	0
reserved	PORT_STATUS_AL_MASK	TYPEC_MONITORING_STATUS_MASK	CC_FAULT_STATUS_AL_MASK	reserved	reserved	reserved	reserved
R/W	R/W	R/W	R/W	R/W	R	R/W	R/W

[7]	reserved
[6]	**PORT_STATUS_AL** 0: (UNMASKED) Interrupt unmasked 1: (MASKED) Interrupt masked
[5]	**TYPEC_MONITORING_STATUS_AL** 0: (UNMASKED) Interrupt unmasked 1: (MASKED) Interrupt masked
[4]	**CC_HW_FAULT_STATUS_AL** 0: (UNMASKED) Interrupt unmasked 1: (MASKED) Interrupt masked
[3]	reserved 1
[2]	reserved 1
[1]	reserved 1
[0]	reserved 1

5.5 PORT_STATUS_0 register

Address: STUSB_BLOCKBaseAddress + 0x0D

Type: R

Reset: 0x00

7	6	5	4	3	2	1	0
			reserved				ATTACH_TRANS
			R				RC

[7:1]	reserved
[0]	**ATTACH_TRANS**: 0: (NO_TRANS) no transition detected in attached states 1: (TRANS) transition detected in attached state

5.6 PORT_STATUS_1 register

Address: STUSB_BLOCKBaseAddress + 0x0E

Type: R

Reset: 0x00

7	6	5	4	3	2	1	0
ATTACHED_DEVICE			reserved	reserved	reserved	reserved	ATTACH
R			R	R	R	R	R

[7:5]	**ATTACHED_DEVICE**: 000: (NONE_ATT) No device connected 001: reserved 010: reserved 011: (DBG_ATT) Debug accessory device connected 100: reserved 101: reserved Others: do not use
[4]	reserved
[3]	reserved
[2]	reserved
[1]	reserved
[0]	**ATTACH**: 0: UNATTACHED 1: ATTACHED

5.7 TYPEC_MONITORING_STATUS_0 register

Address: STUSB_BLOCKBaseAddress + 0x0F

Type: R

Reset: 0x0F

7	6	5	4	3	2	1	0
reserved		VBUS_HIGH_STATUS	VBUS_LOW_STATUS	VBUS_READY_TRANS	VBUS_VSAFE0V_TRANS	VBUS_VALID_SNK_TRANS	reserved
R		RC	RC	RC	RC	RC	R

[7:6]	reserved
[5]	**VBUS_HIGH_STATUS**: VBUS_HIGH status updated during VBUS_READY transition from HIGH to LOW 0: (VBUS_HIGH_OK) VBUS below high threshold 1: (VBUS_HIGH_KO) VBUS above high threshold (overvoltage condition)
[4]	**VBUS_LOW_STATUS**: VBUS_LOW status updated during VBUS_READY transition from HIGH to LOW 0: (VBUS_LOW_OK) VBUS above low threshold 1: (VBUS_LOW_KO) VBUS below low threshold (undervoltage condition)
[3]	**VBUS_READY_TRANS**: 0: (NO_TRANS) status cleared 1: (TRANS_DETECTED) transition detected on VBUS_READY bit
[2]	**VBUS_VSAFE0V_TRANS**: 0: (NO_TRANS) status cleared 1: (TRANS_DETECTED) Transition detected on VBUS_VSAFE0V bit
[1]	**VBUS_VALID_SNK_TRANS**: 0: (NO_TRANS) status cleared 1: (TRANS_DETECTED) transition detected on VBUS_VALID_SNK bit
[0]	reserved

5.8   TYPEC_MONITORING_STATUS_1 register

Address: STUSB_BLOCKBaseAddress + 0x10

Type: R

Reset: 0x00

7	6	5	4	3	2	1	0
		reserved		VBUS_READY	VBUS_VSAFE0V	VBUS_VALID_SNK	reserved
		R		R	R	R	R

[7:4]	reserved
[3]	**VBUS_READY**: 0: (NO_VBUS_READY) VBUS disconnected (Unpowered or vSafe0V) 1: (VBUS_READY) VBUS connected (vSafe5V)
[2]	**VBUS_VSAFE0V**: 0: (NO_VSAFE0V) VBUS is higher than 0.8 V 1: (VSAFE0V) VBUS is lower than 0.8 V
[1]	**VBUS_VALID_SNK**: 0: (NO_VBUS_VALID_SNK) VBUS is lower than 1.9 V or 3.5 V (depending on VBUS_SNK_DISC_THRESHOLD value) 1: (VBUS_VALID_SNK) VBUS is higher than 1.9 V or 3.5 V (depending on VBUS_SNK_DISC_THRESHOLD value)
[0]	reserved

5.9 CC_STATUS register

Address: STUSB_BLOCKBaseAddress + 0x11

Type: R

Reset: 0x00

7	6	5	4	3	2	1	0
reserved		LOOKING_4_CONNECTION	CONNECT_RESULT	CC2_STATE		CC1_STATE	
R		R	R	R		R	

[7:6]	reserved
[5]	**LOOKING_4_CONNECTION:** 0: (NOT_LOOKING) The device is not actively looking for a connection. A transition from '1' to '0' indicates a potential connection has been found. When the device is in power-up sequence or when TYPE-C FSM is in the following states: Attached.SNK, DebugAccessory.SNK 1: (LOOKING) The device is looking for a connection
[4]	**CONNECT_RESULT:** 0: reserved 1: (PRESENT_RD) The device is presenting Rd. When TYPE-C FSM is in the following states: Attached.SNK, DebugAccessory.SNK
[3:2]	**CC2_STATE: (available when CONNECT_result =1)** 00: reserved 01: SNK.Default (Above minimum vRd-Connect) 10: SNK.Power1.5 (Above minimum vRd-Connect) 11: SNK.Power3.0 (Above minimum vRd-Connect) This field returns 00b if (LOOKING_4_CONNECTION=1)
[1:0]	**CC1_STATE: (available when CONNECT_result =1)** 00: reserved 01: SNK.Default (Above minimum vRd-Connect) 10: SNK.Power1.5 (Above minimum vRd-Connect) 11: SNK.Power3.0 (Above minimum vRd-Connect) This field returns 00b if (LOOKING_4_CONNECTION=1)

5.10   CC_HW_FAULT_STATUS_0 register

Address: STUSB_BLOCKBaseAddress + 0x12

Type: R

Reset: 0x10

7	6	5	4	3	2	1	0
reserved	reserved	VPU_OVP_FAULT_TRANS	VPU_VALID_TRANS	reserved	reserved	reserved	reserved
R	R	RC	RC	R	R	R	R

[7:6]	reserved
[5]	**VPU_OVP_FAULT_TRANS**: 0: (NO_TRANS) cleared 1: (TRANS_DETECTED) transition occurred on VPU_OVP_FAULT bit
[4]	**VPU_VALID_TRANS**: 0: (NO_TRANS) cleared 1: (TRANS_DETECTED) transition occurred on VPU_VALID bit
[3]	reserved

5.11 CC_HW_FAULT_STATUS_1 register

Address: STUSB_BLOCKBaseAddress + 0x13

Type: R

Reset: 0x40

7	6	5	4	3	2	1	0
VPU_OVP_FAULT	VPU_VALID	reserved	VBUS_DISCH_FAULT	reserved	reserved	reserved	reserved
R	R	R	R	R	R	R	R

[7]	**VPU_OVP_FAULT:** 0: (NO_FAULT) no overvoltage condition on CC pins when in pull-up mode (CC pins voltage is below overvoltage threshold of 6.0 V) 1: (FAULT) overvoltage condition has occurred on CC pins when in pull-up mode (CC pins voltage is above overvoltage threshold of 6.0 V)
[6]	**VPU_VALID:** 0: (NO_VALID) CC pins pull-up voltage is below UVLO threshold of 2.8 V when in pull-up mode 1: (VALID) CC pins pull-up voltage is above UVLO threshold of 2.8 V when in pull-up mode (normal operating condition)
[5]	reserved
[4]	**VSRC_DISCH_FAULT:** 0: (NO_FAULT) No VBUS discharge issue 1: (FAULT) VBUS discharge issue has occurred
[3:0]	reserved

5.12 TYPEC_STATUS register

Address: STUSB_BLOCKBaseAddress + 0x15

Type: R

Reset: 0x00

7	6	5	4	3	2	1	0
REVERSE	reserved	reserved	TYPEC_FSM_STATE				
R	R	R	R				

[7]	**REVERSE**: Connection orientation, indicates CC pin used for PD communication 0: (STRAIGHT_CC1) CC1 is attached 1: (TWISTED_CC2) CC2 is attached
[6:5]	reserved
[4:0]	**TYPEC_FSM_STATE**: Indicates Type-C FSM state 00000: (UNATTACHED_SNK) 00001: (ATTACHWAIT_SNK) 00010: (ATTACHED_SNK) 00011: (DEBUGACCESSORY_SNK) 00100: reserved 00101: reserved 00110: reserved 00111: reserved 01000: reserved 01001: reserved 01010: reserved 01011: reserved 01100: reserved 01101: (UNATTACHED_ACCESSORY) 01110: (ATTACHWAIT_ACCESSORY) 01111: (AUDIOACCESSORY) 10000: reserved 10001: reserved 10010: (UNSUPPORTED_ACCESSORY) 10011: (TYPEC_ERRORRECOVERY) 10100: reserved 10101: reserved 10110: reserved 10111: reserved 11000: reserved 11001: reserved

5.13 MONITORING_CTRL_0 register

Address: STUSB_BLOCKBaseAddress + 0x20

Type: R/W

Reset: 0x10

7	6	5	4	3	2	1	0
reserved				VBUS_SNK_DISC_THRESHOLD	reserved	reserved	reserved
R				R/W	R	R	R

[7:4]	reserved
[3]	**VBUS_SNK_DISC_THRESHOLD**: VBUS threshold for TYPE-C state machine disconnection 0: (SNK_DISC_HIGH) Select a VBUS threshold at 3.5 V - Reset value 1: (SNK_DISC_LOW) Select a VBUS threshold at 1.9 V
[2:0]	reserved

5.14 MONITORING_CTRL_2 register

Address: STUSB_BLOCKBaseAddress + 0x22

Type: R/W

Reset: 0xFF

7	6	5	4	3	2	1	0
VSHIFT_HIGH				reserved			
R/W				R/W			

[7:4]	**VSHIFT_HIGH**: shift register initialisation high level (set OVP level) with 1% step. 0000: (default) +5% 0001:+6% …. 1111:+20%
[3:0]	reserved

5.15 RESET_CTRL register

Address: STUSB_BLOCKBaseAddress + 0x23

Type: R/W

Reset: 0x00

7	6	5	4	3	2	1	0
reserved							RESET_SW_EN
R/W							R/W

[7:1]	reserved
[0]	**RESET_SW_EN**: Software reset 0: (SW_RESET_OFF) Software reset disabled 1: (SW_RESET_ON) Software reset enabled

5.16 GPIO_SW_GPIO register

Address: STUSB_BLOCKBaseAddress + 0x2D

Type: R/W

Reset: 0x00

7	6	5	4	3	2	1	0
reserved							GPIO_SW_GPIO
R							R/W

[7:1]	reserved
[0]	**GPIO_SW_GPIO**: GPIO output value 0: (DISABLE) GPIO value is Hi-Z 1: (ENABLE) GPIO value is 0b

Revision history

Table 2. Document revision history

Date	Version	Changes
02-Feb-2020	1	Initial release.

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