

# FUSB303 Autonomous USB Type-C™ Port Controller with I<sup>2</sup>C and GPIO Control

## FUSB303

### Description

The FUSB303 device is a fully autonomous USB Type-C™ controller optimized for 15 W or less applications. The FUSB303 offers CC logic detection for Source Port role, Sink Port role, DRP, and accessory detection support, as well as Dead Battery support as defined in USB-C specifications. The FUSB303 features configurable address I<sup>2</sup>C access to support multiple ports per system or it can operate autonomously configured by just pins. The FUSB303 features ultra-low power during operation, and an ultra-thin, 12-Lead QFN package.

### Features

- Fully Autonomous USB-C™ Port Controller
- Supports Latest Type-C™ Specification Release 1.3
- Source, Sink, and DRP Port role Configuration with Optional Accessory Support
- Try.SRC and Try.SNK Modes for Preferring Source Role or Sink Role Respectively
- V<sub>DD</sub> Operating Range, 2.85 V – 5.5 V
- Typical Low Power Operation: I<sub>CC</sub> < 10 μA
- GPIO and I<sup>2</sup>C Configuration
- Max 28 V DC Tolerance on ID, VBUS\_DET, CC1 and CC2
- Dead Battery Support (Sink Port Role when No Power Applied)
- 4 kV HBM ESD Protection for Connector Pins
- Small Packaging, 12 Lead QFN (1.6 mm × 1.6 mm × 0.375 mm)

### Applications

- Smartphones
- Tablets
- Laptops
- Accessories
- Industrial
- Power Banks



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QFN12  
CASE 722AG

### MARKING DIAGRAM



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UD	= FUSB303 Device Code
KK	= Lot Trace Code
_	= Pin #1 Identifier
XY	= Two Digit Date Code
Z	= Assembly Plant Code

### ORDERING INFORMATION

See detailed ordering and shipping information on page 3 of this data sheet.

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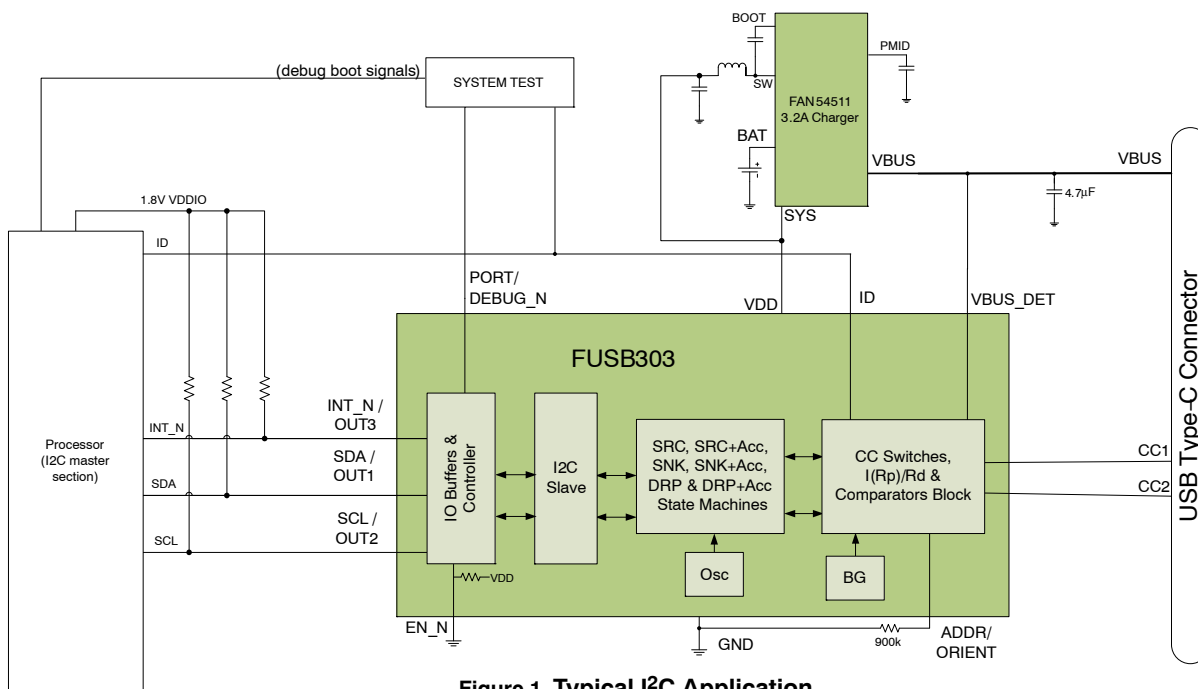


Figure 1. Typical I<sup>2</sup>C Application

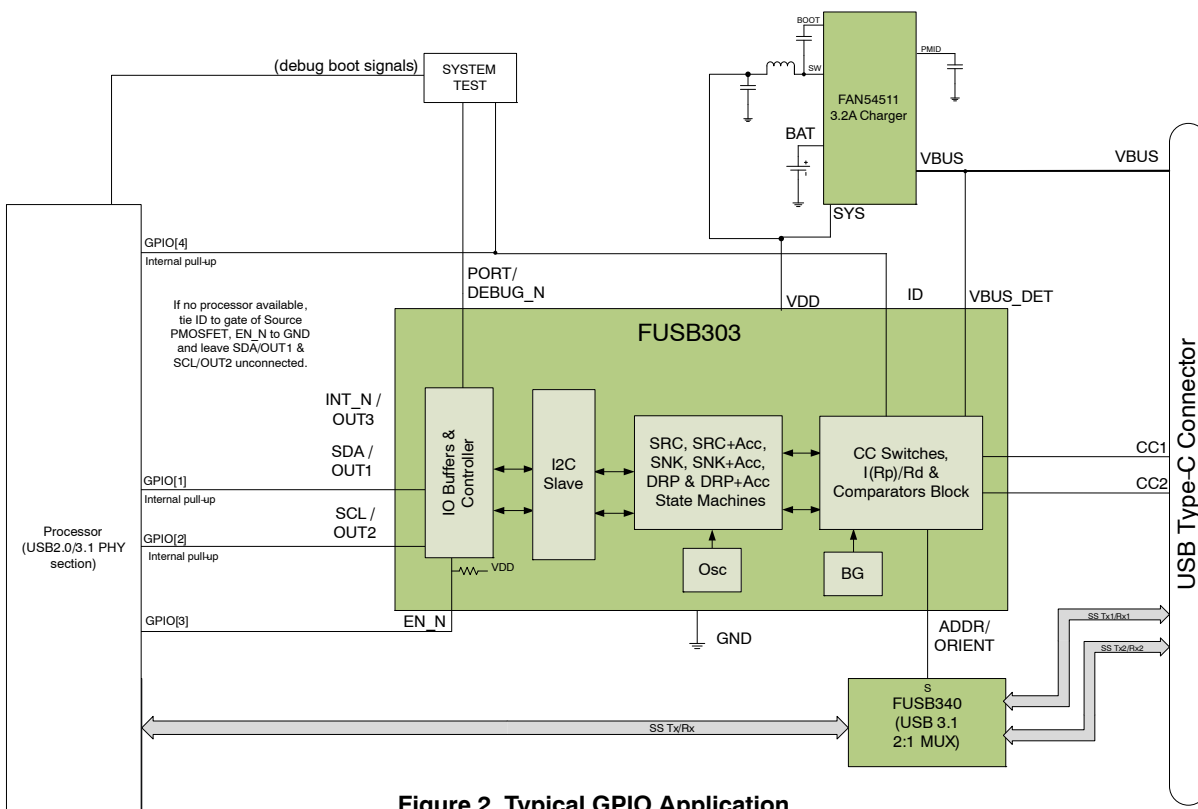


Figure 2. Typical GPIO Application

# FUSB303

## ORDERING INFORMATION TABLE

Table 1. AVAILABLE PART NUMBERS

Part Number	Top Mark	Operating Temperature Range	Package	Packing Method†
FUSB303TMX	UD	-40 to 85°C	12-Lead Ultra-thin Molded Leadless Package (QFN) 1.6 mm x 1.6 mm x 0.375 mm	Tape and Reel

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

## BLOCK DIAGRAM

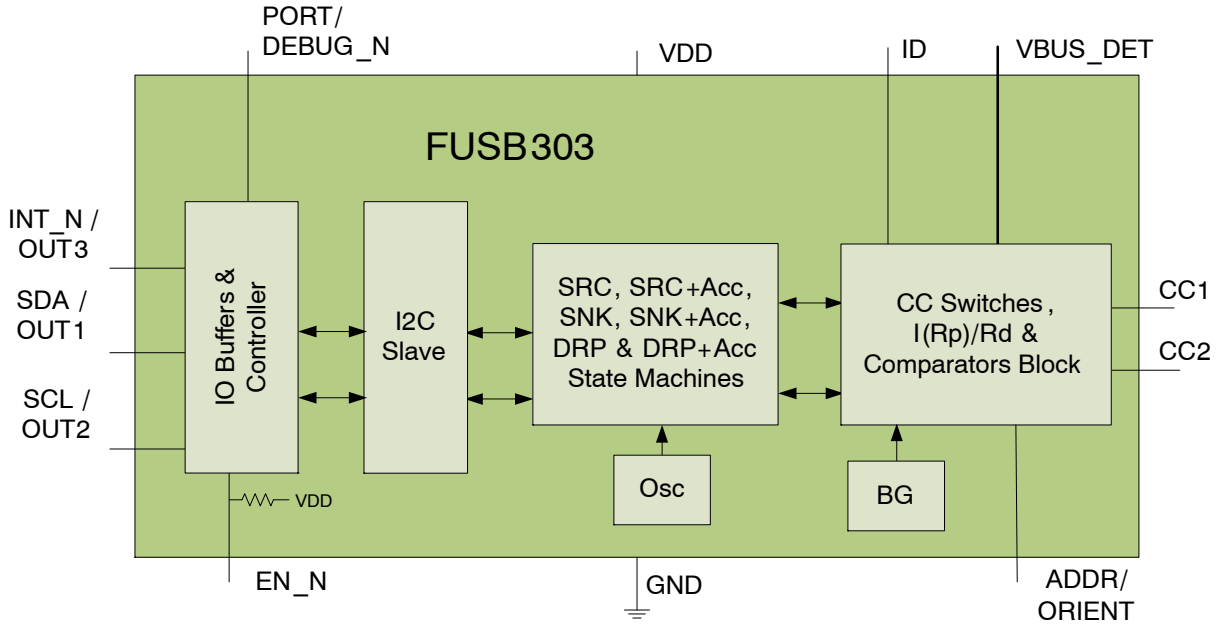


Figure 3. FUSB303 Block Diagram

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## PIN CONFIGURATION

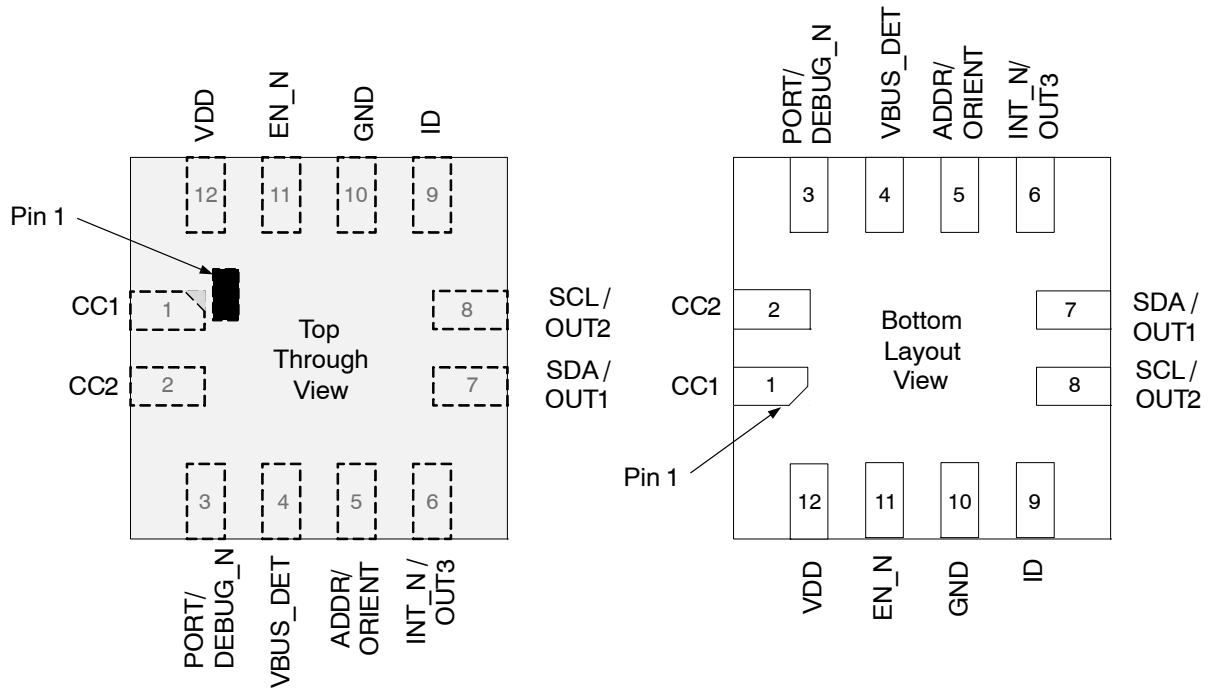


Figure 4. FUSB303 Pin Assignment (Top Through and Bottom Views)

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## PIN DESCRIPTIONS

**Table 2. PIN DESCRIPTIONS**

Pin #	Name	Type	Description																																				
<b>USB TYPE-C CONNECTOR INTERFACE</b>																																							
1, 2	CC1, CC2	I/O	Type-C Configuration Channel pins used for USB-C receptacles																																				
4	VBUS_DET	Input	VBUS input pin for attach and detach detection																																				
<b>POWER AND GROUND</b>																																							
10	GND	Ground	Ground																																				
12	VDD	Power	Input Supply Voltage																																				
<b>I<sup>2</sup>C SIGNAL INTERFACE</b>																																							
6	INT_N/OUT3	Open-Drain Output	INT_N/OUT3 is a dual function pin. When in I <sup>2</sup> C mode (see ADDR/ORIENT pin), it is the active LOW open drain interrupt output used to prompt the processor to read the I <sup>2</sup> C register bits. When the device is in GPIO mode (see ADDR/ORIENT pin), this pin is OUT3, an open drain output LOW = Audio Accessory detected HIGH-Z = Audio Accessory not detected																																				
7	SDA/OUT1	Open Drain I/O	<p>SDA/OUT1 and SCL/OUT2 are dual function pins. When in I<sup>2</sup>C mode (see ADDR/ORIENT pin), SDA/OUT1 is the SDA data signal and SCL/OUT2 is the SCL clock signal of the I<sup>2</sup>C interface. When the device is in GPIO mode (see ADDR/ORIENT pin), these pins are OUT1 and OUT2 inputs (I) or outputs (O) are shown below:</p> <table border="1"> <thead> <tr> <th>ID pin</th> <th>OUT1 (I/O)</th> <th>OUT2 (I/O)</th> <th>Functionality</th> </tr> </thead> <tbody> <tr> <td>HIGH-Z</td> <td>HIGH-Z (O)</td> <td>LOW (O)</td> <td>No Device Attached</td> </tr> <tr> <td>HIGH-Z</td> <td>HIGH-Z (O)</td> <td>HIGH-Z (O)</td> <td>Sink with Default Current</td> </tr> <tr> <td>HIGH-Z</td> <td>LOW (O)</td> <td>HIGH-Z (O)</td> <td>Sink with 1.5 A Current</td> </tr> <tr> <td>HIGH-Z</td> <td>LOW (O)</td> <td>LOW (O)</td> <td>Sink with 3 A Current</td> </tr> <tr> <td>LOW</td> <td>HIGH (I)</td> <td>HIGH (I)</td> <td>Source with Default Current</td> </tr> <tr> <td>LOW</td> <td>LOW (I)</td> <td>HIGH (I)</td> <td>Source with 1.5 A Current</td> </tr> <tr> <td>LOW</td> <td>LOW (I)</td> <td>LOW (I)</td> <td>Source with 3 A Current</td> </tr> <tr> <td>LOW</td> <td>HIGH (I)</td> <td>LOW (I)</td> <td>Reserved (Do Not Use)</td> </tr> </tbody> </table>	ID pin	OUT1 (I/O)	OUT2 (I/O)	Functionality	HIGH-Z	HIGH-Z (O)	LOW (O)	No Device Attached	HIGH-Z	HIGH-Z (O)	HIGH-Z (O)	Sink with Default Current	HIGH-Z	LOW (O)	HIGH-Z (O)	Sink with 1.5 A Current	HIGH-Z	LOW (O)	LOW (O)	Sink with 3 A Current	LOW	HIGH (I)	HIGH (I)	Source with Default Current	LOW	LOW (I)	HIGH (I)	Source with 1.5 A Current	LOW	LOW (I)	LOW (I)	Source with 3 A Current	LOW	HIGH (I)	LOW (I)	Reserved (Do Not Use)
ID pin	OUT1 (I/O)	OUT2 (I/O)		Functionality																																			
HIGH-Z	HIGH-Z (O)	LOW (O)		No Device Attached																																			
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LOW	LOW (I)	LOW (I)	Source with 3 A Current																																				
LOW	HIGH (I)	LOW (I)	Reserved (Do Not Use)																																				
8	SCL/OUT2	Open Drain I/O																																					
<b>GPIO PIN INTERFACE</b>																																							
3	PORT/DEBUG_N	Input then Push/Pull Output	PORT/DEBUG_N is a dual function pin: 3 state input to set the port role. On the falling edge of EN_N and when VDD is active or during power up when EN_N is LOW, the state of this pin is sampled. This pin is also sampled on a SW_RES soft reset via I <sup>2</sup> C. HIGH = FUSB303 as a Source Only port Float = FUSB303 as a Dual Role Port (DRP) LOW = FUSB303 as a Sink Only port <b>Note: a 900 kΩ resistor should be used when connecting to VDD or GND to reduce standby current.</b> Subsequently, this pin is the DEBUG_N push-pull output LOW = Debug Accessory detected HIGH = Debug Accessory not detected																																				
5	ADDR/ORIENT	Input then Push/Pull Output	ADDR/ORIENT is a dual function pin: 3 state input to set to I <sup>2</sup> C mode and the I <sup>2</sup> C address or for GPIO mode. On the falling edge of EN_N and when VDD is active or during power up when EN_N is LOW, the state of this pin is sampled. This pin is also sampled on a SW_RES soft reset via I <sup>2</sup> C. HIGH = I <sup>2</sup> C mode with address 62h Float = GPIO mode LOW = I <sup>2</sup> C mode with address 42h <b>Note: a 900 kΩ resistor should be used when connecting to VDD or GND to reduce standby current.</b> Subsequently, this pin is the ORIENT push-pull output LOW = CC is CC1 or A5 of the USB-C receptacle HIGH = CC is CC2 or B5 of the USB-C receptacle																																				
9	ID	Open-Drain Output	Open drain output that indicate FUSB303's detection state as a Source or Sink LOW = FUSB303 attached as a Source HIGH-Z = FUSB303 attached as a Sink																																				
11	EN_N	Input	Active LOW device enable input (has internal pull up resistor)																																				

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**Table 3. ORIENT PIN VERSUS ORIENT [1:0] REGISTER BITS MAPPING**

CC1 (A5)	CC2 (B5)	STATUS. ORIENT[1] Bit	STATUS. ORIENT[0] Bit	ADDR/ORIENT Pin Output
<b>FUSB303 CONNECTED AS A SINK</b>				
SNK. Open	SNK. Open	0	0	LOW
SNK. Open	SNK. Rp	1	0	HIGH
SNK. Rp	SNK. Open	0	1	LOW
SNK. Rp (Note 2)	SNK. Rp	0	1	LOW
SNK. Rp	SNK. Rp (Note 2)	1	0	HIGH
<b>FUSB303 CONNECTED AS SOURCE</b>				
SRC. Open	SRC. Open	0	0	LOW
SRC. Open or SRC. Ra	SRC. Rd	1	0	HIGH
SRC. Rd	SRC. Open or SRC. Ra	0	1	LOW
SRC. Rd (Note 1)	SRC.Rd	0	1	LOW
SRC. Rd	SRC. Rd (Note 1)	1	0	HIGH

1. Orientation decoded on this pin after a Sink Debug Test System (DTS) attached to FUSB303.
2. Orientation decoded on this pin after a Source Debug Test System (DTS) attached to FUSB303.

## High Voltage Tolerance on CCx and VBUS pins

The FUSB303 has additional protection for the type C connector pins where it can tolerate up to 28V on VBUS, CC1 and CC2 to protect against any misbehaving Type C device connect to the FUSB303. If VBUS tolerance is needed higher than 28V, a 900kΩ resistor can be used externally along with a Transient Voltage Suppressor (TVS) to achieve almost any higher voltage tolerance dictated by the TVS chosen.

## Dead Battery

If power is not applied to FUSB303 and it is attached to a Source device, then the Source would pull up the CC line connected through the cable. The FUSB303 in response will turn on the pull-down that will bring the CC voltage to a range that the Source can detect an attached device and turn on VBUS.

## GPIO Mode, Debug and Audio Accessories

When VDD is active and on the trailing edge of EN\_N, the FUSB303 will sample PORT/DEBUG\_N to determine if the FUSB303 operates as a Source (HIGH), Sink (LOW) or DRP (floating). Subsequently the PORT/DEBUG\_N will be set LOW when a Debug Test System is detected.

If the FUSB303 is configured as a Sink (PORT/DEBUG\_N= LOW upon enable), the FUSB303 will detect a Debug Test System if Rp is detected on both CC1 and CC2. Devices that support orientation detection will also have ADDR/ORIENT set based on the levels detected for CC1 and CC2. ID will be set HIGH-Z.

If the device is configured as a Source (PORT/DEBUG\_N= HIGH upon enable), the FUSB303 will detect a Debug Test System if Rd is detected on both CC1 and CC2. Devices that support orientation detection

will also have ADDR/ORIENT set based on the levels detected for CC1 and CC2. ID will be set LOW.

The FUSB303 also supports DRP toggling for detecting debug test systems. When PORT/DEBUG\_N= float upon enable, the FUSB303 can detect both Source and Sink debug test systems depending on how it resolves its role as a Source or Sink. Then it acts either as a Source or Sink as described above.

The FUSB303 will report Debug Test System detection via the Type I<sup>2</sup>C register as well. The detection is the same as described above except Source, Sink and DRP roles are configured via the Portrole register. This Portrole register setting has higher priority over the PORT/DEBUG\_N pin state for Source/Sink/DRP port role.

The FUSB303 will set INT\_N/OUT3 = LOW in GPIO mode when an Audio Accessory is detected. The FUSB303 will report Audio Accessory detection via the Type I<sup>2</sup>C register as well when Audio Accessory detection is configured via the Portrole register.

## FORCE.SNK and FORCE.SRC Functionality

In some cases, a device may need to force its role to a Sink or a Source especially if two DRP devices are connected together and they have connected in the wrong device role. In that case, the FUSB303 has incorporated a function that allows it to be forced into either Sink or Source. However, if it cannot complete this role change, the FUSB303 will resume its previous role and flag success or failure with I\_FRC\_SUCC and I\_FRC\_FAIL interrupts respectively.

## Remedial Actions

In some cases, a device may start to detect a Source or Sink but get caught in a loop trying to resolve the detected device. In that case the FUSB303 provides functionality to resolve

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to a stable attached state. This functionality can be turned on and off via the REMEDY\_EN and DCABLE\_EN bits. Multiple cases are tried and some of the register settings will be changed to try to achieve stable attach. The I\_REMEDY interrupt will allow the processor to know that this functionality has been triggered.

### AUTOSNK Mode

When the FUSB303 is powered directly from VBAT the AUTO\_SNK\_EN mode can be used to prevent the application from attaching as a Source when the battery is weak or disconnect and attach as a Sink. With AUTO\_SNK\_EN enabled the port will attempt to configure

as a Sink when attached to another DRP. If connected to another Sink, the port will detach. The threshold at which AUTOSNK can be triggered can be programmed via the AUTO\_SNK\_TH bits. The I\_AUTOSNK interrupt is triggered whenever this functionality is invoked.

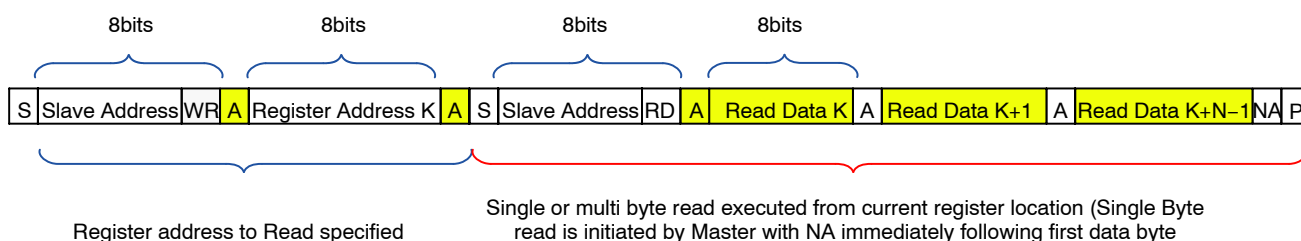
### Power Up, Initialization and Reset, Interrupt Operation, I<sup>2</sup>C Interface

The FUSB303 includes a full I<sup>2</sup>C slave controller. The I<sup>2</sup>C slave fully complies with the I<sup>2</sup>C specification version 6 requirements. This block is designed for fast mode. Examples of an I<sup>2</sup>C write and read sequence are shown Figure 5 and Figure 6 respectively.



NOTE: Single byte write is initiated by Master with P immediately following the first data byte and slave A

Figure 5. I<sup>2</sup>C Write Example



NOTE: If Register is not specified Master will begin read from current register. In this case only sequence showing in Red bracket is needed



	From Master to Slave	<b>S</b> Start Condition	<b>NA</b> NOT Acknowledge (SDA high)	<b>RD</b> Read =1
	From Slave to Master	<b>A</b> Acknowledge (SDA Low)	<b>WR</b> Write=0	<b>P</b> Stop Condition

Figure 6. I<sup>2</sup>C Write Example

When power is first applied, the FUSB303 will power up in the configuration set by the PORT/DEBUG\_N input with Audio Accessory Support enabled and all interrupts masked. If the ADDR/ORIENT input is HIGH or LOW (I<sup>2</sup>C mode) the local processor can then re-configure the FUSB303 to the desired mode and clear the global interrupt mask bit, INT\_MASK using the I<sup>2</sup>C interface. The INT\_N/OUT3 pin is an active LOW, open drain output. This pin indicates to the host processor that an interrupt has occurred in the FUSB303 which needs attention. The INT\_N/OUT3 pin is in a high impedance state by default after power-up or device reset, and the global interrupt mask (INT\_MASK in Control register) is set. After INT\_MASK bit is cleared by the local processor, the INT\_N/OUT3 pin stays high impedance in preparation of future interrupts.

When an interruptible event occurs, INT\_N/OUT3 is driven LOW and is in a high impedance state again when the processor clears the interrupt by writing a one in the position of the interrupt bit that was set. Subsequent to the initial power up or reset; if the processor writes a “1” to global interrupt mask bit when the system is already powered up, the INT\_N/OUT3 pin stays in a high impedance state and ignores all interrupts until the global interrupt mask bit is cleared. If an event happens that would ordinarily cause an interrupt when the global interrupt mask bit is set, the INT\_N/OUT3 pin goes LOW when the global interrupt mask is cleared.

Interrupt bits hold their value and to clear a specific interrupt, a “1” needs to be written to that interrupt bit.

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## I<sup>2</sup>C Address

The ADDR/ORIENT bit HIGH or LOW is indicated in bit 5 of the slave address shown in Table 4.

**Table 4. FUSB303 I<sup>2</sup>C SLAVE ADDRESS**

Name	Size (Bits)	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Slave Address	8	0	1	ADDR/ORIENT state	0	0	0	1	R/W

**Table 5. ABSOLUTE MAXIMUM RATINGS**

Symbol	Parameter		Min	Max	Unit
V <sub>VDD</sub>	Supply Voltage from V <sub>DD</sub>		-0.5	6.0	V
V <sub>CON</sub>	ID, VBUS_DET, CC1 and CC2 voltage		-0.5	28.0	V
V <sub>IO</sub>	PORT/DEBUG_N, ADDR/ORIENT, INT_N/OUT3, SDA/OUT1, SCL/OUT2 pins voltage		-0.5	6.0	V
V <sub>IO</sub>	EN_N		-0.5	2.0	V
T <sub>STORAGE</sub>	Storage Temperature Range		-65	+150	C
T <sub>J</sub>	Maximum Junction Temperature			+150	C
T <sub>L</sub>	Lead Temperature (Soldering, 10 seconds)			+260	C
ESD	IEC 61000-4-2 System ESD with external TVS	Connector Pins (VBUS, CC1 & CC2)	Air Gap	15	kV
			Contact	8	
	Human Body Model, JEDEC JESD22-A114	Connector Pins (VBUS_DET, CC1 and CC2)		4	kV
		Others		2	
	Charged Device Model, JEDEC LESD22-C101	All Pins	1		

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

**Table 6. RECOMMENDED OPERATING CONDITIONS**

Symbol	Parameter	Min	Typ	Max	Unit
V <sub>VBUS</sub>	VBUS_DET Voltage	4.0	5.0	22	V
V <sub>VDD</sub>	Supply Voltage	2.85	3.3	5.5	V
T <sub>A</sub>	Operating Temperature	-40		+85	C

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.



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**Table 7. DC AND TRANSIENT CHARACTERISTICS** (Unless otherwise specified: Recommended  $T_A$  and  $T_J$  temperature ranges. All typical values are at  $T_A = 25^\circ\text{C}$  and  $V_{DD} = 3.3\text{ V}$  unless otherwise specified.)

Symbol	Parameter	$T_A = -40\text{ to }+85^\circ\text{C}$ $T_J = -40\text{ to }+125^\circ\text{C}$			Unit
		Min	Typ	Max	
<b>TYPE C SPECIFIC PARAMETERS</b>					
$I_{80\_CCX}$	Source 80 $\mu\text{A}$ CC Current (Default) HOST_CUR1 = 0, HOST_CUR0 = 1 or via GPIO mode	64	80	96	$\mu\text{A}$
$I_{180\_CCX}$	Source 180 $\mu\text{A}$ CC Current (1.5 A) HOST_CUR1 = 1, HOST_CUR0 = 0 or via GPIO mode	166	180	194	$\mu\text{A}$
$I_{330\_CCX}$	Source 330 $\mu\text{A}$ CC Current (3 A) HOST_CUR1 = 1, HOST_CUR0 = 1 or via GPIO mode (Note 3)	304	330	356	$\mu\text{A}$
$V_{SNKDB}$	Sink Pull-Down Voltage in Dead Battery Under all Pull-up Source Loads			2.18	V
$R_d$	Sink Pull-Down Resistance when VDD is within Operating Range	4.6	5.1	5.6	$\text{k}\Omega$
$z_{OPEN}$	CC Resistance for Disabled State	126			$\text{k}\Omega$
$v_{Ra-SRCdef}$	Ra Detection Threshold for CC Pin for Source for Default Current on VBUS (HOST_CUR1/0 = 01) or via GPIO mode	0.15	0.20	0.25	V
$v_{Ra-SRC1.5A}$	Ra Detection Threshold for CC Pin for Source for 1.5 A Current on VBUS (HOST_CUR1/0 = 10) or via GPIO mode	0.35	0.40	0.45	V
$v_{Ra-SRC3A}$	Ra Detection Threshold for CC Pin for Source for 3 A Current on VBUS (HOST_CUR1/0 = 11) or via GPIO mode	0.75	0.80	0.85	V
$v_{Rd-SRCdef}$	Rd Detection Threshold for Source for Default Current (HOST_CUR1/0 = 01) or via GPIO mode	1.50	1.60	1.65	V
$v_{Rd-SRC1.5A}$	Rd Detection Threshold for Source for 1.5 A Current (HOST_CUR1/0 = 10) or via GPIO mode	1.50	1.60	1.65	V
$v_{Rd-SRC3A}$	Rd Detection Threshold for Source for 3 A Current (HOST_CUR1/0 = 11) or via GPIO mode (Note 3)	2.45	2.60	2.75	V
$v_{Ra-SNK}$	Ra Detection Threshold for CC Pin for Sink	0.15	0.20	0.25	V
$v_{Rd-def}$	Rd Default Current Detection Threshold for Sink	0.61	0.66	0.70	V
$v_{Rd-1.5A}$	Rd 1.5 A Current Detection Threshold for Sink	1.16	1.23	1.31	V
$v_{Rd-3.0A}$	Rd 3 A Current Detection Threshold for Sink	2.04	2.11	2.18	V
$v_{VBUSthr}$	VBUS_DET Threshold when VBUSOK is deasserted	2.9	3.3	3.67	V
$t_{VBUSdeb}$	VBUS_DET debounce time before VBUSOK is deasserted only (see $t_{Deb}$ below for VBUSOK being asserted)	10		20	ms
$v_{VBthLH}$	VBUS_DET Threshold when VBUSOK is asserted	3.67	4.07	4.48	V
$t_{Deb}$	VBUS_DET debounce time before VBUSOK is asserted	250		500	$\mu\text{s}$
$v_{VSAFEthr}$	vSafe0V VBUS_DET Threshold			0.8	V
$v_{VSAFEthrHys}$	VSAFE0V VBUS_DET Threshold hysteresis		50		mV
$r_{VBUSleak}$	Leakage between VBUS and GND when VBUS not sourced	72.4			$\text{k}\Omega$
$r_{VBUSdschg}$	Effective resistance from VBUS and GND when VBUS is being discharged from vSafe5V $V_{DD} (V) = 2.85\text{ to }5.5$			2	$\text{k}\Omega$
$r_{Pullup}$	Pull up resistor to VDD value on EN_N pin $V_{DD} (V) = 2.85\text{ to }5.5$		6		$\text{M}\Omega$
$v_{AUTOSNKthr}$	Weak Battery VDD Threshold	-3%	AUTOSNK_TH	+3%	V
$R_a$	Resistor for discharging VCONN $V_{DD} (V) = 2.85\text{ to }5.5$		1		$\text{k}\Omega$

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

3. VDD = 3 V when 3 A current advertised.

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**Table 8. CURRENT CONSUMPTION**

Symbol	Parameter	VDD (V)	Conditions	TA = -40 to +85°C TJ = -40 to +125°C			Unit
				Min	Typ	Max	
Idisable	Disabled Current	2.85 to 4.35	Disabled State EN N = HIGH or not connected			5	μA
Istby	Unattached Sink (3.3 V I <sup>2</sup> C mode without AUTOSNK or accessories)	2.85 to 4.35	Nothing attached		5	10	μA
	Unattached DRP or Source (3.3 V I <sup>2</sup> C mode without AUTOSNK or accessories)		Nothing attached, Internally Toggling		10	15	μA
Iattach	Attached Source or Sink (3.3 V I <sup>2</sup> C mode without AUTOSNK or accessories. Not including Ixxx_CCX current)	2.85 to 4.35	Attached as a Sink or Source		10	15	μA

**Table 9. TIMING PARAMETERS**

Symbol	Parameter	TA = -40 to +85°C TJ = -40 to +125°C			Unit
		Min	Typ	Max	
tCCDebounce	Debounce Time for CC Attach Detection (TCCDEB[2:0] = 011)	-33%	TCCDEB	+33%	ms
tPDebounce	Time a Sink port shall wait before it can determine it is detached	10	15	20	ms
tTryCCDebounce	Time a port shall wait before it can determine it is re-attached during the try-wait process	10		20	ms
tRpValueChange	Time a Sink port shall wait before it can determine there has been a change in Rp	10		20	ms
tSRCDisconnect	Time a Source shall detect the SRC.Open state	10		20	ms
tErrorRecovery	Time staying in the ErrorRecovery State if sent there via the ERROR_REC bit or by a change of port roles	25	50	100	ms
tDRPTry	Time staying in the Try.SRC/SNK prior to transition to TryWait.SRC/SNK State	75		150	ms
tTryTimeout	Time to discharge VBUS before giving up for cases where VBUS is always on.	550		1100	ms
tDRP	Sum of tDRPTogSNK and tDRPTogSRC	-33%	T_DRP	+33%	ms
tDRPTransition	Time DRP shall complete transitions between Source and Sink roles	0		1	ms
tDRPTogSNK	For DRP Operation, Time Spent in Unattached.SNK before going to Unattached.SRC State	DRPTOGGLE = 00 (Note 4)	70		%
		DRPTOGGLE = 01	60		%
		DRPTOGGLE = 10	50		%
		DRPTOGGLE = 11	40		%
tDRPTogSRC	For DRP Operation, Time Spent in Unattached.SRC before going to Unattached.SNK State	DRPTOGGLE = 00 (Note 4)	30		%
		DRPTOGGLE = 01	40		%
		DRPTOGGLE = 10	50		%
		DRPTOGGLE = 11	60		%
tEN	Time from EN_N LOW and VDD active to I <sup>2</sup> C access available	2.85 to 5.5		100	ms

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**Table 9. TIMING PARAMETERS** (continued)

Symbol	Parameter		T <sub>A</sub> = -40 to +85°C T <sub>J</sub> = -40 to +125°C			Unit
			Min	Typ	Max	Unit
tRESET	Soft Reset Duration	2.85 to 5.5			100	ms
tAUTOSNK	Debounce time to detect Weak Battery VDD Threshold to trigger I_AUTOSNK if AUTOSNK mode enabled for both entering AUTOSNK and exiting AUTOSNK V <sub>DD</sub> (V) = 2.85 to 5.5		10	15	20	ms

4. Default Value when Configured in GPIO Mode (ADDR/ORIENT = Float)

**Table 10. IO SPECIFICATIONS**

Symbol	Parameter	V <sub>DD</sub> (V)	Conditions	T <sub>A</sub> = -40 to +85°C T <sub>J</sub> = -40 to +125°C			Unit
				Min	Typ	Max	

**OPEN DRAIN OUTPUT PINS (ID, INT\_N/OUT3)**

V <sub>OLID</sub>	Output Low Voltage	2.85 to 5.5	I <sub>OL</sub> = 4 mA			0.4	V
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**INPUT PIN (EN\_N)**

V <sub>IEN</sub>	Low-Level Input Voltage	2.85 to 5.5				0.4	V
V <sub>IHEN</sub>	High-Level Input Voltage	2.85 to 5.5		1.2			V
I <sub>CCTEN</sub>	VDD Current when EN_N is HIGH	2.85 to 5.5	Worst Input Voltage			2	μA

**3-STATE INPUT AND PUSH/PULL OUTPUT PINS (PORT/DEBUG\_N, ADDR/ORIENT)**

V <sub>ILADDR</sub>	Low-Level Input Voltage	2.85 to 5.5				0.2V <sub>DD</sub>	V
V <sub>IMADDR</sub>	Middle-Level Input Voltage	2.85 to 5.5		0.4V <sub>DD</sub>		0.6V <sub>DD</sub>	V
V <sub>IHADDR</sub>	High-Level Input Voltage	2.85 to 5.5		0.8V <sub>DD</sub>			V
Z <sub>float</sub>	Impedance to VDD or GND detected as a FLOAT including when VDD = 0	2.85 to 5.5		1		4	MΩ
V <sub>OLOUT</sub>	Low-Level Input Voltage	2.85 to 5.5	I <sub>OL</sub> = 1 mA			0.2V <sub>DD</sub>	V
V <sub>OHOUT</sub>	High-Level Input Voltage	2.85 to 5.5	I <sub>OL</sub> = -1 mA	0.8V <sub>DD</sub>			V

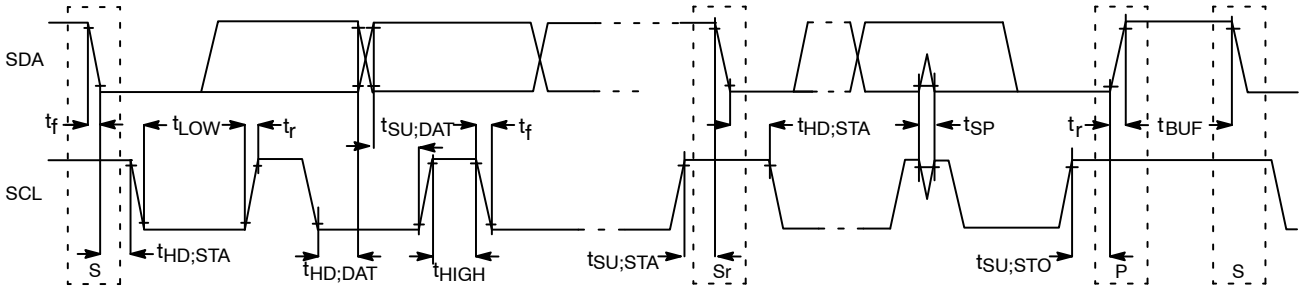
**I<sup>2</sup>C INTERFACE PINS – FAST MODE SDA/OUT1, SCL/OUT2**

V <sub>ILi2C</sub>	Low-Level Input Voltage	2.85 to 5.5				0.4	V
V <sub>IHi2C</sub>	High-Level Input Voltage	2.85 to 5.5		1.2			V
V <sub>HYS</sub>	Hysteresis of Schmitt Trigger Inputs	2.85 to 5.5		0.2			V
I <sub>i2C</sub>	Input Current of SDA/OUT1 and SCL/OUT2 Pins,	2.85 to 5.5	Input Voltage 0 V to 3.6 V			2	μA
I <sub>CCTi2C</sub>	VDD Current when SDA/OUT1 or SCL/OUT2 is HIGH	2.85 to 5.5	Worst Input Voltage			2	μA
V <sub>OLSDA</sub>	Low-Level Output Voltage at 2 mA Sink Current (Open-Drain)	2.85 to 5.5	I <sub>OL</sub> = 2 mA			0.3	V
I <sub>OLSDA</sub>	Low-Level Output Current (Open-Drain)	3.0 to 5.5	V <sub>OLSDA</sub> = 0.4 V	20			mA
C <sub>1</sub>	Capacitance for Each I/O Pin	2.85 to 5.5			5		pF

**Table 11. FAST MODE I<sup>2</sup>C TIMING SPECIFICATIONS** (see Figure 7)

Symbol	Parameter	Fast Mode		
		Min	Max	Unit
f <sub>SCL</sub>	SCL/OUT2 Clock Frequency		400	kHz
t <sub>HD;STA</sub>	Hold Time (Repeated) START Condition	0.6		μs
t <sub>LOW</sub>	Low Period of SCL/OUT2 Clock	1.3		μs
t <sub>HIGH</sub>	High Period of SCL/OUT2 Clock	0.6		μs
t <sub>SU;STA</sub>	Set-up Time for Repeated START Condition	0.6		μs
t <sub>HD;DAT</sub>	Data Hold Time		0.9	μs
t <sub>SU;DAT</sub>	Data Set-up Time (Note 5)	100		ns
t <sub>r</sub>	Rise Time of SDA/OUT1 and SCL/OUT2 Signals (Note 6)	20×(V <sub>DD</sub> /5.5 V)	250	ns
t <sub>f</sub>	Fall Time of SDA/OUT1 and SCL/OUT2 Signals (Note 6)	20×(V <sub>DD</sub> /5.5 V)	250	ns
t <sub>SU;STO</sub>	Set-up Time for STOP Condition	0.6		μs
t <sub>BUF</sub>	Bus-Free Time between STOP and START Conditions	1.3		μs
t <sub>SP</sub>	Pulse Width of Spikes that Must Be Suppressed by the Input Filter		50	ns

- A fast-mode I<sup>2</sup>C-bus device can be used in a standard-mode I<sup>2</sup>C-bus system, but the requirement t<sub>SU;DAT</sub> ≥ 250 ns must be met. This is automatically the case if the device does not stretch the LOW period of the SCL/OUT2 signal. If such a device does stretch the LOW period of the SCL/OUT2 signal, it must output the next data bit to the I<sup>2</sup>C\_line t<sub>r\_max</sub> + t<sub>SU;DAT</sub> = 1000 + 250 = 1250 ns (according to the standard-mode I<sup>2</sup>C bus specification) before the SCL/OUT2 line is released.
- C<sub>b</sub> equals the total capacitance of one bus line in pF. If mixed with high-speed devices, faster fall times are allowed according to the I<sup>2</sup>C specification.



**Figure 7. Definition of Timing for Full/Speed Mode Devices on the I<sup>2</sup>C Bus**

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## REGISTER DEFINITIONS

**Table 12. REGISTER MAP**

Address	Register Name	Type	Rst Val	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
00h	Reserved	N/A	N/A	Do Not Use							
01h	Device ID	R	10h	VER_ID[3:0]				REV_ID[3:0]			
02h	Device Type	R	01h	DEVICE_TYPE[7:0]							
03h	Portrole	R/W	4nh (see below)		ORIENTDE B	TRY[1:0]		AUDIOACC	DRP	SNK	SRC
04h	Control	R/W	4Bh	T_DRP		DRPTOGGLE[1:0]		DCABLE_EN	HOST_CUR[1:0]		INT_MASK
05h	Control1	R/W	B3h	REMEDY_EN	AUTO_SNK_TH[1:0]		AUTO_SNK_EN	ENABLE	TCCDEB[2:0]		
06h-08h	Reserved	N/A	N/A	Do Not Use							
09h	Manual	W/C & R/W	00h			FORCE_S RC	FORCE_S NK	UNATT_S NK	UNATT_S RC	DISABLED	ERROR_REC
0Ah	Reset	W/C	00h								SW_RES
0Bh-0Dh	Reserved	N/A	N/A	Do Not Use							
0Eh	Mask	R/W	00h		M_ORIENT	M_FAULT	M_VBUS_CHG	M_AUTO_SNK	M_BC_LVL	M_DETACH	M_ATTACH
0Fh	Mask1	R/W	00h		M_REM_VBOFF	M_REM_VBON		M_REM_FAIL	M_FRC_FAIL	M_FRC_SUCC	M_REMEDY
10h	Reserved	N/A	N/A	Do Not Use							
11h	Status	R	40h	AUTOSNK	VSAFE0V	ORIENT[1:0]		VBUSOK	BC_LVL[1:0]		ATTACH
12h	Status1	R	00h							FAULT	REMEDY
13h	Type	R	00h		DEBUGSRC	DEBUGSNK	SINK	SOURCE	ACTIVECAPABLE	AUDIOVBUS	AUDIO
14h	Interrupt	R/W1C	00h		I_ORIENT	I_FAULT	I_VBUS_CHG	I_AUTOSNK	I_BC_LVL	I_DETACH	I_ATTACH
15h	Interrupt1	R/W1C	00h		I_REM_VBOFF	I_REM_VBON		I_REM_FAIL	I_FRC_FAIL	I_FRC_SUCC	I_REMEDY
16h-1Fh	Reserved	N/A	N/A	Do Not Use							

7. Do not use registers that are blank

8. Values read from undefined register bits are not defined and invalid. Do not write to undefined registers

**Table 13. DEVICE ID** (Address: 01h, Reset Value: 0001\_0000b, Type: Read Only)

Bit #	Name	Size (Bits)	Description
7:4	VER_ID	4	Device version ID by Trim, etc. A_[REV_ID]: 0001 (FUSB303 A)
3:0	REV_ID	4	Revision History of each version [VER_ID]_revA: 0000

**Table 14. DEVICE TYPE** (Address: 02h, Type: Read Only)

Bit #	Name	Size (Bits)	Description
7:0	DEVICE_TYPE[7:0]	8	01h: FUSB303

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**Table 15. PORTROLE** (See Note 9)

(Address: 03h, Reset Value: 0100\_1nnnb (Reset value for bits nnn will be set by the state of the PORT/DEBUG\_N pin either during power up when EN\_N is LOW or when Vdd is valid and EN\_N goes HIGH to LOW) or when SW\_RES is set HIGH. In dead battery mode, nnn = 010 or configured as SNK) Type: Read/Write)

Bit #	Name	Size (Bits)	Description
7	Reserved	1	Do Not Use
6	ORIENTDEB	1	1: When a Debug Accessory is found, continue to orientation detection if CC is on CC1 or CC2 (result is in Status.Orient[1:0])
5:4	TRY[1:0]	2	00: Disable (normal DRP detection for DRPs) 01: Enable Try.SNK state machine detection for DRP only 10: Enable Try.SRC state machine detection for DRP only 11: Disable (cannot have Try.SNK and Try.SRC active together)
3	AUDIOACC	1	1: Enable Audio Accessory Support (Debug Accessory support is always enabled)
2	DRP	1	1: Configure device as a Dual Role Port (see reset value text above)
1	SNK	1	1: Configure device as a Sink (see reset value text above)
0	SRC	1	1: Configure device as a Source (see reset value text above)

9. If DRP bit, SNK bit and SRC bit are all set to 1, then the priority of which Portrole the FUSB303 assumes is first priority is DRP, second priority is SNK and last priority is SRC. See Manual register note below for priority between Manual register bits and Portrole register.

**Table 16. CONTROL**

Address: 04h, Reset Value: 0100\_1011b, Type: Read/Write

Bit #	Name	Size (Bits)	Description
7:6	T_DRP[:0]	2	Sets the total period of the DRP toggle cycle (i.e. Unattached.SNK period + Unattached.SRC period): 00: 60 ms 01: 70 ms 10: 80 ms 11: 90 ms
5:4	DRPTOGGLE[1:0]	2	Selects different timing for Dual Role Port Toggle between Unattached.SNK State and Unattached.SRC State. 00: 60% in Unattached.SNK and 40% in Unattached.SRC 01: 50% in Unattached.SNK and 50% in Unattached.SRC 10: 40% in Unattached.SNK and 60% in Unattached.SRC 11: 30% in Unattached.SNK and 70% in Unattached.SRC
3	DCABLE_EN	1	1: Enable Dangling Cable internal methods to achieve a stable attach
2:1	HOST_CUR[1:0]	2	Controls the pull-up current when device enabled as a Source 00: Reserved. Do not use. 01: 80 $\mu$ A – Default USB Power 10: 180 $\mu$ A – Medium Current Mode: 1.5 A 11: 330 $\mu$ A – High Current Mode: 3 A
0	INT_MASK	1	1: Global interrupt mask to mask all interrupts

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**Table 17. CONTROL1**

(Address: 05h, Reset Value: 1011\_0011b, Type: Read/Write)

Bit #	Name	Size (Bits)	Description
7	REMEDY_EN	1	1: Enable the Remedy detection to employ internal methods to achieve stable attach
6:5	AUTO_SNK_TH [1:0]	2	Sets the weak battery VDD threshold voltage when AUTO_SNK_EN is enabled. 00: 3.0 V 01: 3.1 V 10: 3.2 V 11: 3.3 V
4	AUTO_SNK_EN	1	1: Enable automatic Sink port role based on weak battery VDD threshold in bits AUTO_SNK_TH in Control register below
3	ENABLE	1	1: Enable the FUSB303 if the external EN_N pin is LOW in I <sup>2</sup> C mode (that is, not in GPIO mode)
2:0	TCCDEB[2:0]	3	Controls debounce time for attaching a device 000: 120 ms 001: 130 ms 010: 140 ms 011: 150 ms 100: 160 ms 101: 170 ms 110: 180 ms 111: Reserved

**Table 18. Manual** (Note 10)

(Address: 09h, Reset Value: 0000\_0000b, Type: Read/Write (see bits below: W/C = Write one self clearing, R/W = Read/Write and N/A = Not Applicable)

Bit #	Name	R/W/C	Size (Bits)	Description
7:6	Reserved	N/A	2	Do Not Use
5	FORCE_SRC	W/C	1	1: Forces the FUSB303 to behave as a Source
4	FORCE_SNK	W/C	1	1: Forces the FUSB303 to behave as a Sink
3	UNATT_SNK	W/C	1	1: Put device in Unattached.SNK State as defined in the Type C spec
2	UNATT_SRC	W/C	1	1: Put device in Unattached.SRC state as defined in the Type C spec
1	DISABLED (Note 11)	R/W	1	1: Put device in Disabled state as defined in the Type C spec
0	ERROR_REC	W/C	1	1: Put device in ErrorRecovery state as defined in the Type C spec

10. If more than one bit is set to 1b simultaneously then an order of priority will be used. First priority is DISABLED, second is ERROR\_REC, third is FORCE\_SRC, fourth is FORCE\_SNK, fifth is UNATT\_SRC, last is UNATT\_SNK. The highest priority bit will take precedence and all other bits will be cleared automatically.

11. The DISABLED bit must be manually cleared. Also DISABLED bit has a higher priority over Portrole register since the DISABLED bit has to be cleared in order to execute the new Portrole register settings. However, all other Manual register bits don't have a lot of meaning if the Portrole register is changed and so Portrole register setting should have higher priority than all bits except for DISABLED bit.

**Table 19. RESET**

(Address: 0Ah, Reset Value: 0000\_0000b, Type: Write/Clear)

Bit #	Name	Size (Bits)	Description
7:1	Reserved	7	Do Not Use
0	SW_RES	1	1: Reset the FUSB303 and I <sup>2</sup> C Registers

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**Table 20. MASK**

(Address: 0Eh, Reset Value: 0000\_0000b, Type: Read/Write)

Bit #	Name	Size (Bits)	Description
7	Reserved	1	Do Not Use
6	M_ORIENT	1	1: Mask the I_ORIENT interrupt bit from asserting INT_N pin
5	M_FAULT	1	1: Mask the I_FAULT interrupt bit from asserting INT_N pin
4	M_VBUS_CHG	1	1: Mask the I_VBUS interrupt bit from asserting INT_N pin
3	M_AUTOSNK	1	1: Mask the I_AUTOSNK interrupt bit from asserting INT_N pin
2	M_BC_LVL	1	1: Mask the I_BC_LVL interrupt bit from asserting INT_N pin
1	M_DETACH	1	1: Mask the I_DETACH interrupt bit from asserting INT_N pin
0	M_ATTACH	1	1: Mask the I_ATTACH interrupt bit from asserting INT_N pin

12. Masking the interrupt just does not cause INT\_N to be asserted. The interrupt bit will still be asserted in the Interrupt register and so that an all zeroes Interrupt register value is not needed for INT\_N to be deasserted.

**Table 21. MASK1**

(Address: 0Fh, Reset Value: 0000\_0000b, Type: Read/Write)

Bit #	Name	Size (Bits)	Description
7	Reserved	1	Do Not Use
6	M_REM_VBOFF	1	1: Mask the I_REM_VBOFF interrupt bit from asserting INT_N pin
5	M_REM_VBON	1	1: Mask the I_REM_VBON interrupt bit from asserting INT_N pin
4	Reserved	1	Do Not Use
3	M_REM_FAIL	1	1: Mask the I_REM_FAIL interrupt bit from asserting INT_N pin
2	M_FRC_FAIL	1	1: Mask the I_FRC_FAIL interrupt bit from asserting INT_N pin
1	M_FRC_SUCC	1	1: Mask the I_FRC_SUCC interrupt bit from asserting INT_N pin
0	M_REMEDY	1	1: Mask the I_REMEDY interrupt bit from asserting INT_N pin

13. Masking the interrupt just does not cause INT\_N to be asserted. The interrupt bit will still be asserted in the Interrupt register and so that an all zeroes Interrupt register value is not needed for INT\_N to be deasserted.

**Table 22. STATUS**

(Address: 11h, Reset Value: 0000\_0000b, Type: Read Only)

Bit #	Name	Size (Bits)	Description
7	AUTOSNK	1	1: AUTOSNK mode is activated since the VDD voltage is lower than AUTO_SNK_TH voltage
6	VSAFE0V	1	1: Status to indicate VBUS_DET is below vSafe0V max of 0.8 Vpin
5:4	ORIENT[1:0]	2	Status to indicate which CCx pins has the cable CC connection 00: No or unresolved connection detected 01: Cable CC is connected through the CC1 (A5) pin 10: Cable CC is connected through the CC2 (B5) pin 11: A fault has occurred during the detection
3	VBUSOK	1	1: Status to indicate VBUS_DET is in the valid VBUS 5V range
2:1	BC_LVL[1:0]	2	Thresholds that allow detection of current advertisement on CC line 00: (Ra or unattached) Sink or unattached Source 01: Rd threshold for Sink default current advertisement 10: Rd threshold for Sink 1.5 A current advertisement 11: Rd threshold for Sink 3 A current advertisement
0	ATTACH	1	1: Attached to a device or accessory of a type shown in the Type register



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**Table 23. STATUS1**

(Address: 12h, Reset Value: 0000\_0000b, Type: Read Only)

Bit #	Name	Size (Bits)	Description
7:2	Reserved	6	Do Not Use
1	FAULT	1	1: Status to indicate that as a Sink, CC has exceed the normal vRd voltage range
0	REMEDY	1	1: Status to indicate that FUSB303 is employing internal methods to achieve a stable attach

**Table 24. TYPE**

(Address: 13h, Reset Value: 0000\_0000b, Type: Read Only)

Bit #	Name	Size (Bits)	Description
7	Reserved	1	Do Not Use
6	DEBUGSRC	1	1: FUSB303 is attached as a Source Debug Accessory ([Unoriented/Oriented]DebugAccessory.SRC)
5	DEBUGSNK	1	1: FUSB303 is attached as a Sink Debug Accessory (DebugAccessory.SNK)
4	SINK	1	1: FUSB303 is attached as a Sink (Attached.SNK)
3	SOURCE	1	1: FUSB303 is attached as a Source (Attached.SRC)
2	ACTIVECABLE	1	1: FUSB303 is attached to an Active Cable (Ra detected)
1	AUDIOVBUS	1	1: Indicates an Audio Accessory with VBUS has been detected (AudioAccessory with VBUS)
0	AUDIO	1	1: Indicates an Audio Accessory without VBUS has been detected (AudioAccessory without VBUS)

**Table 25. INTERRUPT**

(Address: 14h, Reset Value: 0000\_0000b, Type: Read/Write 1 to Clear)

Bit #	Name	Size (Bits)	Description
7	Reserved	1	Do Not Use
6	I_ORIENT	1	1: Interrupt flagged whenever ORIENT changes from 0,0 to 0,1 or 1,0 but not 1,1. Interrupt not flagged when ORIENT is cleared.
5	I_FAULT	1	1: Interrupt flagged when CC1 or CC2 voltage exceeds normal Rd range when FUSB303 has Rd termination on CC1 and/or CC2
4	I_VBUS_CHG	1	1: Interrupt flagged when VBUS has crossed vVBUSthr or vVBthLH thresholds
3	I_AUTOSNK	1	1: Interrupt flagged when AUTOSNK mode has been activated or deactivated
2	I_BC_LVL	1	1: Interrupt flagged when a change in BC_LVL[1:0] advertised current level has occurred
1	I_DETACH	1	1: Interrupt flagged when a device or accessory has been detached
0	I_ATTACH	1	1: Interrupt flagged when a device or accessory of type indicated in the Type register has been attached

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**Table 26. INTERRUPT1**

(Address: 15h, Reset Value: 0000\_0000b, Type: Read/Write 1 to Clear)

Bit #	Name	Size (Bits)	Description
7	Reserved	1	Do Not Use
6	I_REM_VBOFF	1	1: Interrupt to request VBUS be turned off and discharged while executing internal methods to achieve stable attach
5	I_REM_VBON	1	1: Interrupt to request VBUS be turned on while executing internal methods to achieve stable attach
4	Reserved	1	Do Not Use
3	I_REM_FAIL	1	1: Interrupt to indicate that internal methods to achieve stable attach have failed.
2	I_FRC_FAIL	1	1: Interrupt to indicate that FORCE_SRC or FORCE_SNK has failed to execute either because it was being forced into a state it was already in or for other reasons
1	I_FRC_SUCC	1	1: Interrupt to indicate that FORCE_SRC or FORCE_SNK has successfully being executed.
0	I_REMEDY	1	1: Interrupt to indicate that detection issues caused FUSB303 to employ internal methods to achieve stable attach

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