

# Type-C CC with High Speed Digital (HSD) Port Protection Switch

## FUSB252

### Description

The FUSB252 is an integrated port protection switch for USB Type-C® applications. This product will protect HSD+/- and CCx pins when stressed with voltages up to 20 V. Over-Voltage Protection (OVP) at 5.8 V typical will protect the system for Electrical Overstress (EOS) damage. With a fully integrated USB 2.0 switch for HSD+/-, this product can be easily integrated into existing solutions. The HSD switches can pass USB 2.0 signals with bandwidth 1 GHz to maintain signal integrity and eye compliance.

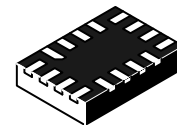
The CC switches have very low RON of 0.3  $\Omega$  to minimize signal attenuation. The FUSB252 also provides Dead Battery support per the Type-C specification. Additional features include Under-Voltage Lockout (UVLO) and thermal shutdown.

### Features

- Fully Type-C Port Protection
- Supports USB Type-C Specification 1.2
- $V_{CC}$  0 V – 5.5 V
- 20 V DC Protection on  $V_{CC}$
- 16 V DC Protection on HSD Port
- $V_{DD}$  Operating Range, 2.7 V – 5.5 V
- Current Capability: 1 A
- CC  $R_{ON}$ : 0.3  $\Omega$  Typical
- HSD  $R_{ON}$ : 5  $\Omega$  Typical
- Wide -3 db Bandwidth: 1 GHz
- Low Power Operation:  $I_{CC}$  = 9  $\mu$ A Typical
- Dead Battery Support (UFP Support when No Power Applied)
- CC Over-Voltage Protection: Typical = 5.6 V
- This is a Pb-Free Device

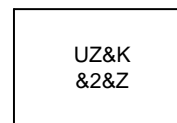
### Applications

- Smartphones
- Tablets
- Laptops



UQFN16 1.8 x 2.6, 0.4P  
CASE 523BF

### MARKING DIAGRAM



UZ	= Device Code
&K	= 2-Digit Lot Run Traceability Code
&2	= 2-Digit Date Code
&Z	= Assembly Location

### ORDERING INFORMATION

See detailed ordering and shipping information on page 2 of this data sheet.

# FUSB252

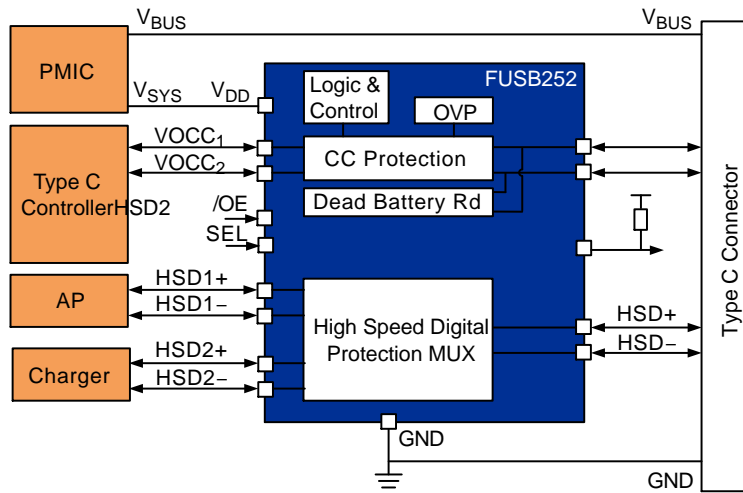


Figure 1. Typical Application



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## PIN CONFIGURATIONS

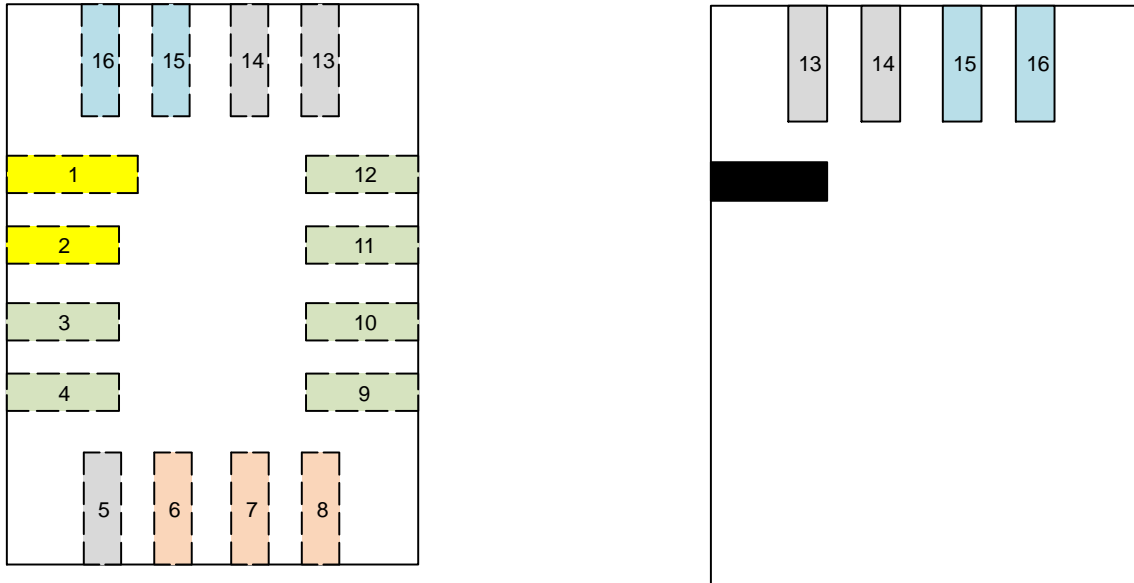


Figure 4. Pin Assignment (Top Through View)



# FUSB252

## ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter		Min	Max	Unit	
V <sub>VDD</sub>	Supply Voltage from V <sub>DD</sub>		-0.5	12.0	V	
V <sub>VICC</sub>	V <sub>ICCx</sub> , to GND		-0.5	24	V	
V <sub>SW</sub>	V <sub>HSD±</sub> , to GND		-5	16	V	
V <sub>OCC</sub> , V <sub>SW</sub>	V <sub>OCCx</sub> V <sub>HSDx±</sub> to GND		-0.5	6	V	
V <sub>CONTROL</sub>	DC Input Voltage (S, /OE)		-0.5	V <sub>VDD</sub>	V	
I <sub>CCSW</sub>	DC CC Switch Current			1.25	A	
I <sub>USBSW</sub>	DC Output Current			100	mA	
I <sub>IK</sub>	DC Input Diode Current		-50		mA	
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	Connector Pins (V <sub>VDD</sub> , V <sub>ICCx</sub> , V <sub>HSD±</sub> )	Air Gap	15		kV
			Contact	8		
	IEC 61000-4-5 Surge ESD	V <sub>ICCx</sub> to GND		-24	24	V
		V <sub>HSD±</sub> to GND		-16	16	V
	Human Body Model, JEDEC JESD22-A114	Power to GND		4		kV
		External Pins to GND (V <sub>HSD±</sub> , V <sub>ICCx</sub> )				
		System Side Pin (V <sub>HSDx±</sub> , V <sub>OCCx</sub> , S, /OE, FLAGB)		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.

## RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Min	Typ	Max	Unit
V <sub>VDD</sub>	Supply Voltage	2.7	4.2	5.5	V
V <sub>VICC</sub>	Type C Input Voltage	0		5.5	V
V <sub>OCC</sub>	Type C Output Voltage	0			

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**DC CHARACTERISTICS** (Unless otherwise specified: Recommended  $T_A$  and  $T_J$  temperature ranges. All typical values are at  $T_A = 25^\circ\text{C}$  and  $V_{DD} = 4.2\text{ V}$  unless otherwise specified.)

Symbol	Characteristic	$V_{DD}$ (V)	Conditions	$T_A = -40^\circ\text{C to } +85^\circ\text{C}$ $T_J = -40^\circ\text{C to } +125^\circ\text{C}$			Unit
				Min	Typ	Max	

## BASIC OPERATION DEVICE

$I_{CC}$	Quiescent Supply Current	2.7 to 5.5	/OE = L, $I_{OUT} = 0$		9		$\mu\text{A}$
			/OE = H, $I_{OUT} = 0$		9		
$I_{OFF}$	Power-Off Leakage Current	0			3		$\mu\text{A}$

## BASIC OPERATION CC SWITCH

$I_{SD(DB)}$	Dead Battery Supply Current	0 to UVLO	Dead Battery State Supply Current		15		$\mu\text{A}$
$R_{ON}$	CC Path On Resistance	2.7 to 5.5	$I_{OUT} = 200\text{ mA}$		350	480	$\text{m}\Omega$
$V_{OV\_TRIP}$	Input OVP Lockout	2.7 to 5.5	$V_{ICC}$ Rising		5.65	6.20	V
			$V_{ICC}$ Falling		5.3		
$V_{OV\_HYS}$	Input OVP Hysteresis	2.7 to 5.5			0.35		V
$V_{UVLO}$	Under-Voltage Lockout	2.7 to 5.5	$V_{DD}$ Rising		2.55	2.70	V
			$V_{DD}$ Falling		2.5		
TSD	Thermal Shutdown (Note 1)		Shutdown Threshold		150		$^\circ\text{C}$
			Return from Shutdown		130		
			Hysteresis		20		
$R_d$	Dead Battery Pull-Down Resistance	0 to UVLO	Dead Battery Resistance	4.08	5.10	6.12	$\text{k}\Omega$
			Voltage on Pin	0.25		2.6	

## BASIC OPERATION HSD SWITCH

$V_{OV\_TRIP}$	Input OVP Lockout	2.7 to 5.5	$V_{HSD\pm}$ Rising		4.4	5.0	V
			$V_{HSD\pm}$ Falling		4.1		
$V_{OV\_HYS}$	Input OVP Hysteresis	2.7 to 5.5			0.3		V
$V_{UV\_TRIP}$	Input Under-Voltage Lockout	2.7 to 5.5			-1.2		V
$V_{IH}$	Input Voltage High	2.7 to 5.5		1.3			V
$V_{IL}$	Input Voltage Low	2.7 to 5.5				0.5	V
$I_{IN}$	Control Input Leakage	2.7 to 5.5	$V_{SW} = 0$ to $V_{DD}$		0.1		$\mu\text{A}$
$I_{OZ}$	Off State Leakage	4.2	$0 \leq \text{HSDn} \leq 3.6\text{ V}$		2		$\mu\text{A}$
		4.2	$0 \leq \text{HSD1n}_\pm, \text{HSD2n}_\pm \leq 3.6\text{ V}$		100		
$R_{ON}$	HS Switch On Resistance	4.2	$V_{SW} = 0.4\text{ V}, I_{ON} = -8\text{ mA}$		5		

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**AC CHARACTERISTICS** (Unless otherwise specified: Recommended  $T_A$  and  $T_J$  temperature ranges. All typical values are at  $T_A = 25^\circ\text{C}$  and  $V_{DD} = 3.8\text{ V}$  unless otherwise specified.)

Symbol	Characteristic	$V_{DD}$ (V)	Conditions	$T_A = -40^\circ\text{C to } +85^\circ\text{C}$ $T_J = -40^\circ\text{C to } +125^\circ\text{C}$			Unit
				Min	Typ	Max	

## CC SWITCH TIMING PARAMETER

$t_{OVP}$	Response Time (Note 2)	2.7 to 5.5	$I_{OUT} = 0.2\text{ A}$ , $C_L = 200\text{ pF}$ , $V_{ICCX} = 5\text{ V to } 6\text{ V}$		0.5	1.0	$\mu\text{s}$
$t_{ON}$	Turn-On Time		$V_{DD}$ Rising 2 V to 3 V		25		ms
$T_{MBB}$	Make-Before-Break	2.7 to 5.5	$V_{DD}$ Rising 2 V to 3 V		600		ns

## CC SWITCH CAPACITANCE

$C_{ON}$	Switch Path On Capacitance (Note 2)	2.7 to 5.5			100		$\mu\text{F}$
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## CC SWITCH BANDWIDTH

BW	PD Traffic Bandwidth (Note 2)	2.7 to 5.5	$R_L = 50\ \Omega$ , $C_L = 200\text{ pF}$		25		MHz
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## HSD SWITCH TIMING PARAMETER

$t_{OVP}$	Response Time (Note 2)	2.7 to 5.5	$I_{OUT} = 0.2\text{ A}$ , $V_{D\pm} = 4\text{ V to } 5\text{ V}$		0.5	1.0	$\mu\text{s}$
$t_{ON}$	Turn-On Time, /OE to Output (Note 2)	2.7 to 5.5	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $V_{SW} = 0.8\text{ V}$		25		ms
$t_{OFF}$	Turn-Off Time, /OE to Output (Note 2)	2.7 to 5.5	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $V_{SW} = 0.8\text{ V}$		100	400	ns
$t_{PD}$	Propagation Delay (Note 2)	2.7 to 5.5	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$		0.25		ns
$T_{BBM}$	Break-Before-Make (Note 2)	2.7 to 5.5	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $V_{SWx} = 0.8\text{ V SEL} = H \leftrightarrow L$		100		$\mu\text{s}$
$O_{IRR}$	Off Isolation	2.7 to 5.5	$R_L = 50\ \Omega$ , $f = 240\text{ MHz}$		-25		dB
Xtalk	Non-Adjacent Channel Crosstalk	2.7 to 5.5	$R_L = 50\ \Omega$ , $f = 240\text{ MHz}$		-40		dB

## HSD SWITCH CAPACITANCE

$C_{IN}$	Control Pin Input Capacitance (Note 2)	0			1.5		$\mu\text{F}$
$C_{ON}$	HSD+ / HSD- On Capacitance (Note 2)	2.7 to 5.5	/OE = L, $f = 240\text{ MHz}$		4		$\mu\text{F}$
$C_{OFF}$	HSD1x / HSD2x Off Capacitance (Note 2)	2.7 to 5.5	/OE = H		2.5		$\mu\text{F}$

## USB SWITCH BANDWIDTH

BW	-3 db Bandwidth (Note 2)	2.7 to 5.5	$R_L = 50\ \Omega$ , $C_L = 0\text{ pF}$		1400		MHz
		2.7 to 5.5	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$		560		

## USB HIGH-SPEED-RELATED

$t_{SK(P)}$	Skew of Opposite Transitions of the Same Output (Note 2)		$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$		25		ps
$t_J$	Total Jitter (Note 2)		$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $t_R = t_F = 500\text{ ps}$ (10-90%) at 480 Mbps (PRBS = $2^{15} - 1$ )		200		ps

2. Guaranteed by characterization, not production tested.



OPERATION AND APPLICATION DESCRIPTION

Out of Spec Surge/Spike Voltage due to Hot Plug

The FUSB252 protects end systems against 20 V DC on the CC pin, in cases where the FUSB252 is tested to mimic a hot plug event, a fully charged cable connected to a power supply set to 20 V is used to zap the VICC pins of the device. In these cases, the inductance of the cable causes voltage spikes that are higher than the absolute maximum ratings of the of the VICC pins. These voltages can cause damage to the VOCC pins. This scenario does not occur in normal usage. The Type-C specification prevents the plug from having 20 V on VBUS from a PD source prior to a PD contract being completed. When the 20 V potential is on VBUS and shorted to the CC pin, it causes a detach and the voltage spikes are less likely to occur. The following reference circuit is required when the application calls for additional protection to protect against such event as hot plug.

Application Specific Schematic

- Place a 5 V to 6 V rated Zener TVS diode such as (CZRF52C5V6 or CD1005-Z5V1) on the VOCC pin, and a 5 Ω resistor to device ground to prevent the FUSB252 from being damaged during these tests. With this additional protection it is also important to select the right external VICC IEC TVS for the best overall performance.
- Without the additional protection the device by itself can withstand up to 9 V under the same hot plug condition.

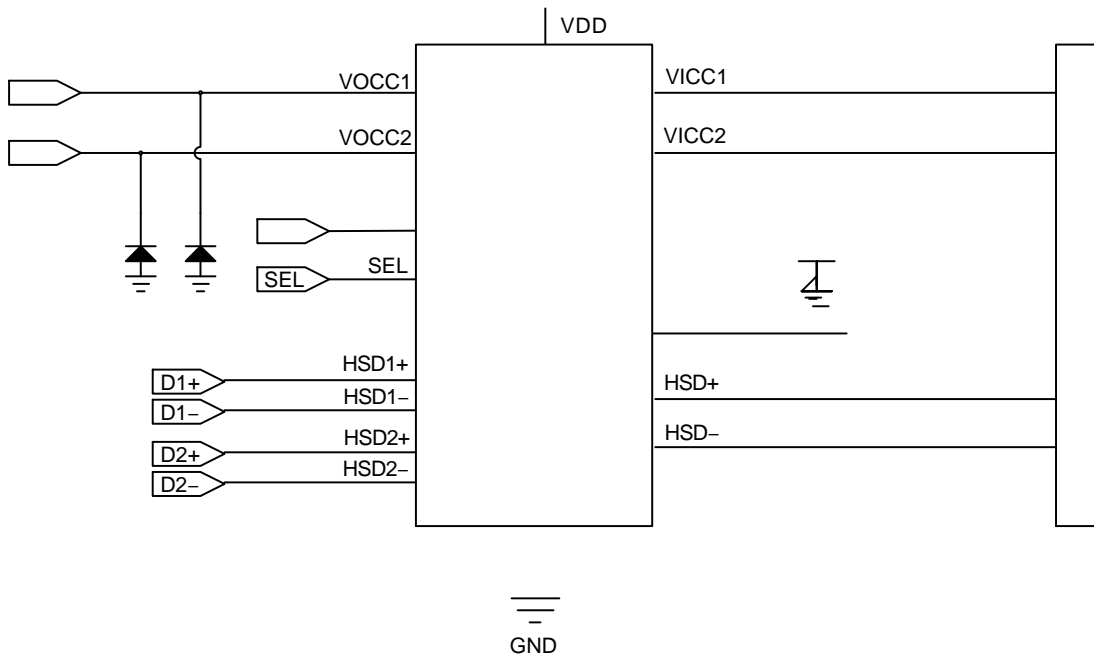


Figure 6. Reference Schematic

# FUSB252

## Type-C Solution Reference

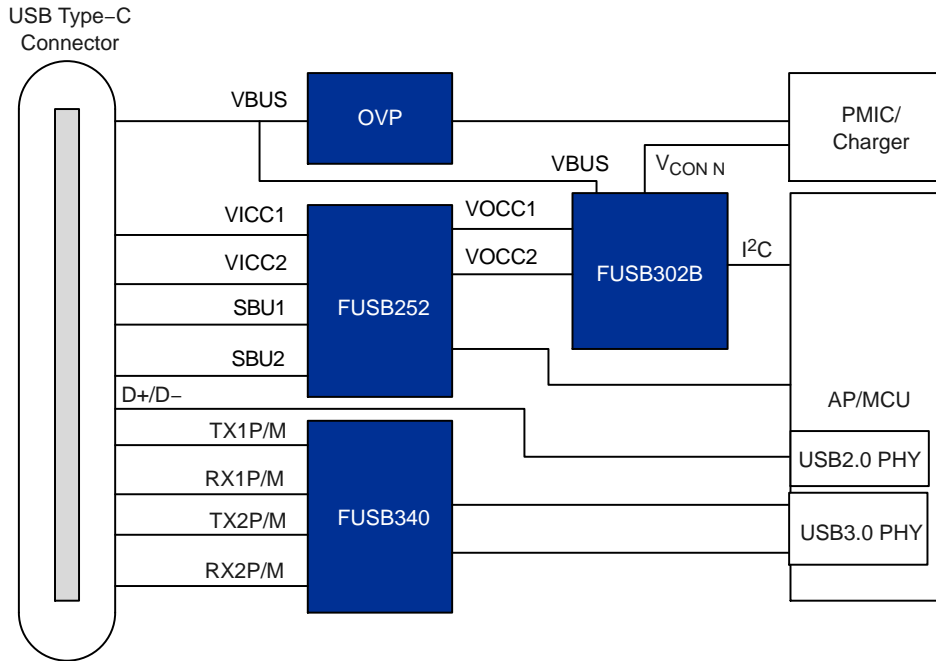


Figure 7. Example of Type-C Solution Reference (SBU)

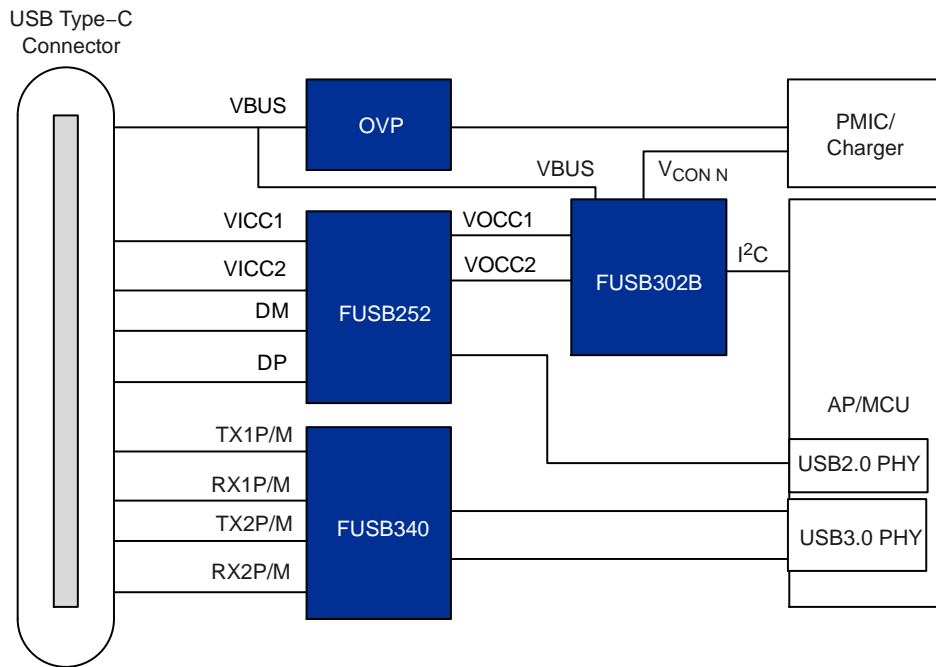


Figure 8. Example of Type-C Solution Reference (USB)

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## TEST DIAGRAMS

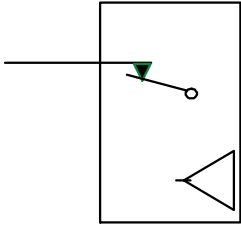


Figure 9. On Resistance

**FUSB252**

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**UQFN16 1.80x2.60x0.50, 0.40P**  
CASE 523BF  
ISSUE A

DATE 06 MAY 2024

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TOLERANCES FOR FEATURE C/D

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