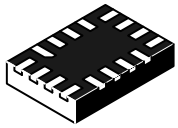
Type-C CC with High Speed Digital (HSD) Port Protection Switch

FUSB252



UQFN16 1.8 x 2.6, 0.4P
CASE 523BF

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 Ω 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.

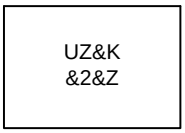
Features

- 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 Ω Typical
- HSD R_{ON}: 5 Ω Typical
- Wide −3 db Bandwidth: 1 GHz
- Low Power Operation: I_{CC} = 9 μA 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

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.

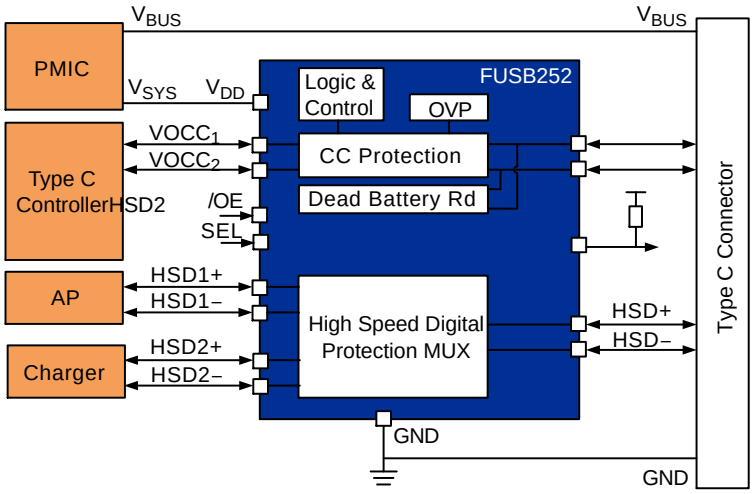


Figure 1. Typical Application

PIN CONFIGURATIONS

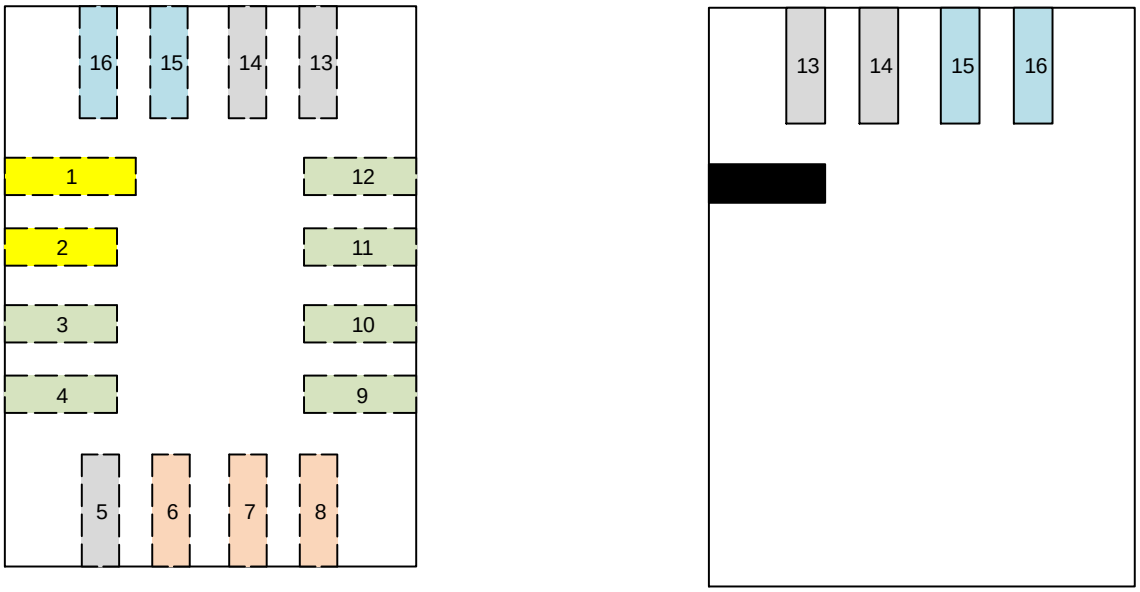


Figure 4. Pin Assignment (Top Through View)

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter			Min	Max	Unit
V_{VDD}	Supply Voltage from V_{DD}			−0.5	12.0	V
V_{VICC}	V_{ICCx}, to GND			−0.5	24	V
V_{SW}	$V_{HSD±}$, to GND			−5	16	V
V_{OCC}, V_{SW}	V_{OCCx} $V_{HSDx±}$ to GND			−0.5	6	V
$V_{CONTROL}$	DC Input Voltage (S, /OE)			−0.5	V_{VDD}	V
I_{CCSW}	DC CC Switch Current				1.25	A
I_{USBSW}	DC Output Current				100	mA
I_{IK}	DC Input Diode Current			−50		mA
$T_{STORAGE}$	Storage Temperature Range			−65	+150	°C
T_J	Maximum Junction Temperature				+150	°C
T_L	Lead Temperature (Soldering, 10 seconds)				+260	°C
ESD	IEC 61000−4−2 System ESD	Connector Pins (V_{VDD}, V_{ICCx}, $V_{HSD±}$)	Air Gap	15		kV
			Contact	8		
	IEC 61000−4−5 Surge ESD	V_{ICCx} to GND		−24	24	V
		$V_{HSD±}$ to GND		−16	16	V
	Human Body Model, JEDEC JESD22−A114	Power to GND		4		kV
		External Pins to GND ($V_{HSD±}$, V_{ICCx})				
		System Side Pin ($V_{HSDx±}$, V_{OCCx}, 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_{VDD}	Supply Voltage	2.7	4.2	5.5	V
V_{ICC}	Type C Input Voltage	0		5.5	V
V_{OCC}	Type C Output Voltage	0			

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

Symbol	Characteristic	V_{DD} (V)	Conditions	T_A = −40°C to +85°C, T_J = −40°C to +125°C			Unit
				Min	Typ	Max	
BASIC OPERATION DEVICE							
I_{CC}	Quiescent Supply Current	2.7 to 5.5	/OE = L, I_{OUT} = 0		9		μA
			/OE = H, I_{OUT} = 0		9		
I_{OFF}	Power−Off Leakage Current	0			3		μA
BASIC OPERATION CC SWITCH							
$I_{SD(DB)}$	Dead Battery Supply Current	0 to UVLO	Dead Battery State Supply Current		15		μA
R_{ON}	CC Path On Resistance	2.7 to 5.5	I_{OUT} = 200 mA		350	480	mΩ
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		°C
			Return from Shutdown		130		
			Hysteresis		20		
Rd	Dead Battery Pull−Down Resistance	0 to UVLO	Dead Battery Resistance	4.08	5.10	6.12	kΩ
			Voltage on Pin	0.25		2.6	V
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		μA
I_{OZ}	Off State Leakage	4.2	0 ≤ HSDn ≤ 3.6 V		2		μA
		4.2	0 ≤ HSD1n$_{\pm}$, HSD2n$_{\pm}$ ≤ 3.6 V		100		nA
R_{ON}	HS Switch On Resistance	4.2	V_{SW} = 0.4 V, I_{ON} = −8 mA		5		

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

Symbol	Characteristic	V_{DD} (V)	Conditions	T_A = −40°C to +85°C, T_J = −40°C to +125°C			Unit
				Min	Typ	Max	
CC SWITCH TIMING PARAMETER							
t_{OVP}	Response Time (Note 2)	2.7 to 5.5	I_{OUT} = 0.2 A, C_L = 200 pF, V_{ICCx} 5 V to 6 V		0.5	1.0	μs
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		pF
CC SWITCH BANDWIDTH							
BW	PD Traffic Bandwidth (Note 2)	2.7 to 5.5	R_L = 50 Ω, C_L = 200 pF		25		MHz
HSD SWITCH TIMING PARAMETER							
t_{OVP}	Response Time (Note 2)	2.7 to 5.5	I_{OUT} = 0.2 A, $V_{D\pm}$ 4 V to 5V		0.5	1.0	μs
t_{ON}	Turn−On Time, /OE to Output (Note 2)	2.7 to 5.5	R_L = 50 Ω, C_L = 5 pF, V_{SW} = 0.8 V		25		ms
t_{OFF}	Turn−Off Time, /OE to Output (Note 2)	2.7 to 5.5	R_L = 50 Ω, C_L = 5 pF, V_{SW} = 0.8 V		100	400	ns
t_{PD}	Propagation Delay (Note 2)	2.7 to 5.5	R_L = 50 Ω, C_L = 5 pF		0.25		ns
T_{BBM}	Break−Before−Make (Note 2)	2.7 to 5.5	R_L = 50 Ω, C_L = 5 pF, V_{SWx} = 0.8 V SEL = H ↔ L		100		μs
O_{IRR}	Off Isolation	2.7 to 5.5	R_L = 50 Ω, f = 240 MHz		−25		dB
Xtalk	Non−Adjacent Channel Crosstalk	2.7 to 5.5	R_L = 50 Ω, f = 240 MHz		−40		dB
HSD SWITCH CAPACITANCE							
C_{IN}	Control Pin Input Capacitance (Note 2)	0			1.5		pF
C_{ON}	HSD+ / HSD− On Capacitance (Note 2)	2.7 to 5.5	/OE = L, f = 240 MHz		4		pF
C_{OFF}	HSD1x / HSD2x Off Capacitance (Note 2)	2.7 to 5.5	/OE = H		2.5		pF
USB SWITCH BANDWIDTH							
BW	−3 db Bandwidth (Note 2)	2.7 to 5.5	R_L = 50 Ω, C_L = 0 pF		1400		MHz
		2.7 to 5.5	R_L = 50 Ω, C_L = 5 pF		560		
USB HIGH−SPEED−RELATED							
$t_{SK(P)}$	Skew of Opposite Transitions of the Same Output (Note 2)		R_L = 50 Ω, C_L = 5 pF		25		ps
t_J	Total Jitter (Note 2)		R_L = 50 Ω, C_L = 5 pF, t_R = t_F = 500 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 if 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.

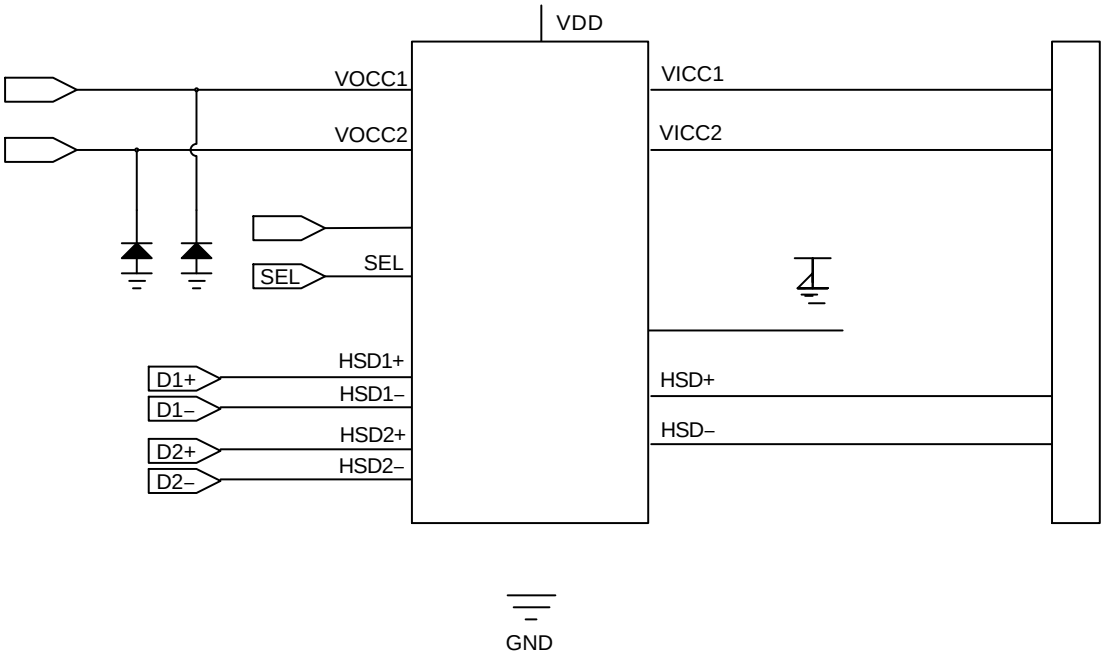


Figure 6. Reference Schematic

Type−C Solution Reference

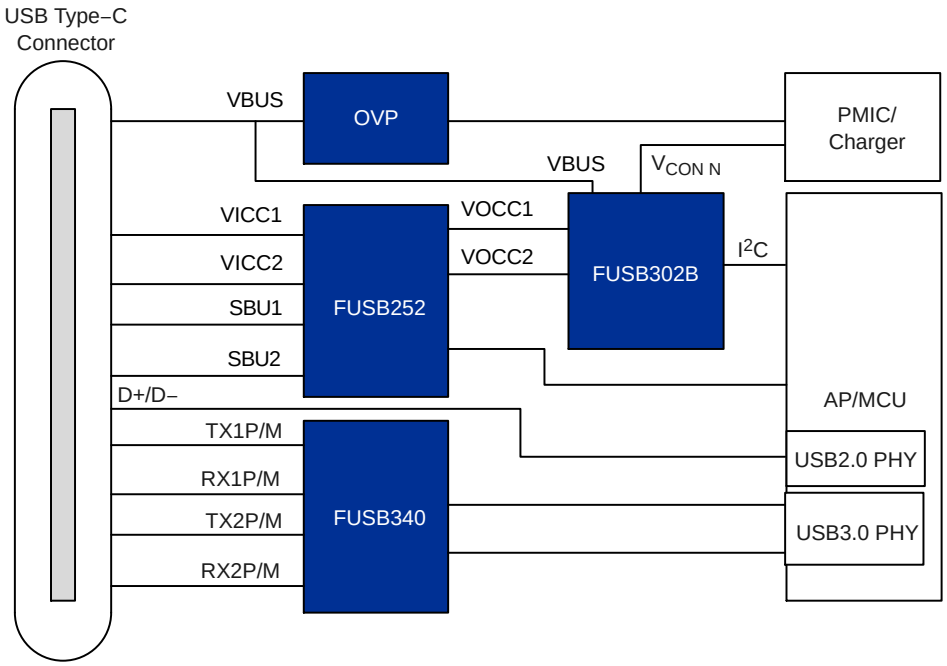


Figure 7. Example of Type−C Solution Reference (SBU)

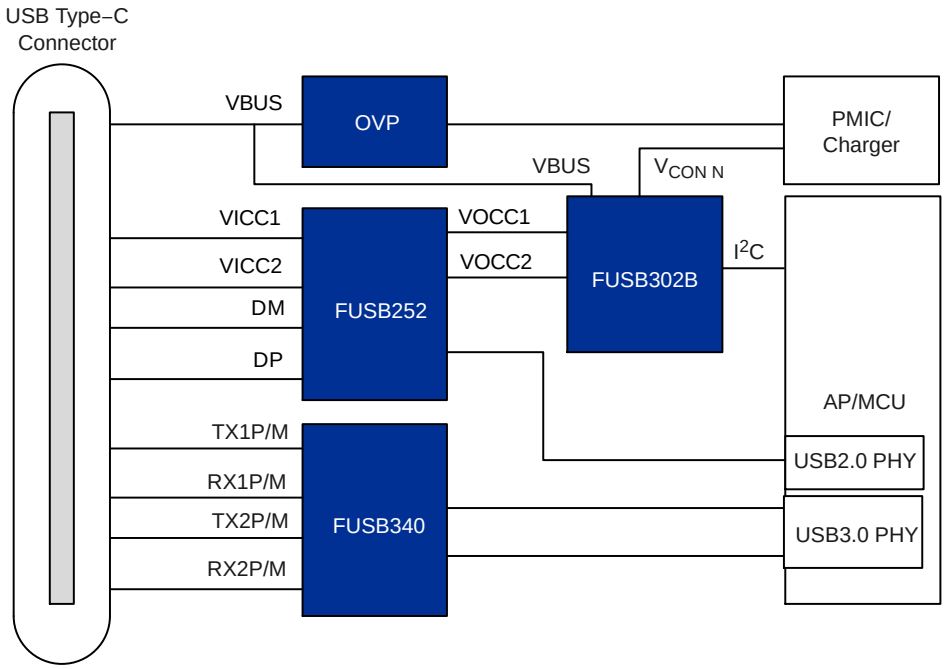


Figure 8. Example of Type−C Solution Reference (USB)

TEST DIAGRAMS

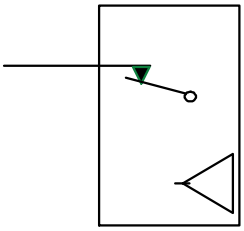


Figure 9. On Resistance

FUSB252

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

DATE 06 MAY 2024

DIM	MILLIMETERS		
	MIN	NOM	MAX
A	0.45	0.50	0.5

SIDE VIEW

BOTTOM VIEW