

MAX20323/MAX20323A/ MAX20323B/MAX20323C/ MAX20323D/MAX20323E/MAX20323F

USB Type-C CC-Pin Overvoltage Protector

General Description

The MAX20323/MAX20323A/MAX20323B/MAX20323C/MAX20323D/MAX20323E/MAX20323F overvoltage protectors feature internal overvoltage threshold and surge protection to turn off the switches and prevent damage to USB type-C CC/SBU pins.

The devices have two channels switches with 0.27Ω (typ) on-resistance that are turned on when inputs are below overvoltage threshold. When overvoltage threshold is exceeded on one of the channels, the corresponding switch is turned off and replaced by an accurate pullup current to output (CC1_O/CC2_O) that is sourced from input (CC1_I/CC2_I). (The MAX20323A/F do not have the pullup current feature).

The devices are available in a 12-bump (0.4mm pitch, 1.7mm x 1.32mm) WLP package and operate over the -40°C to $+85^{\circ}\text{C}$ extended temperature range.

Applications

- Smart Phones
- Tablets
- Phablets
- Industrial PCs

Benefits and Features

- Flexible System Design
 - Wide Operating Supply Voltage Range: 2.5V to 5.5V
 - Integrated $270\text{m}\Omega$ (typ) Switch per Channel with 1A Continuous Current Capability
 - Low Supply Current of $20\mu\text{A}$ (typ) when CC Inputs Are Under Overvoltage Threshold
 - Accurate Pullup Currents to CC Outputs When CC Inputs Exceed Overvoltage Threshold (Except MAX20323A/F)
- Reliable Protection
 - Accurate OVLO Threshold: $5.75\text{V}\pm 0.2\text{V}$
 - Surge Immunity
 - MAX20323/A/B/C/E/F: Over $\pm 90\text{V}$
 - MAX20323D: $\pm 80\text{V}$ with No V_{ENCC} or $\pm 60\text{V}$ with Valid V_{ENCC}
 - Ultra-Fast Turn Off: 100ns (typ) Response Time
 - Thermal Shutdown Protection
- Space Saving
 - 12-Bump 0.4mm Pitch 1.7mm x 1.32mm WLP

Ordering Information appears at end of data sheet.

MAX20323/MAX20323A/
 MAX20323B/MAX20323C/
 MAX20323D/MAX20323E/MAX20323F

USB Type-C CC-Pin
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Absolute Maximum Ratings

(All voltages referenced to GND.)

V _{ENCC} , EN_TST	-0.3V to +6V
CC1_I, CC2_I (MAX20323, MAX20323A, MAX20323B)	-0.3V to +13.5V
CC1_I, CC2_I (MAX20323C, MAX20323D, MAX20323E, MAX20323F)	-0.3V to +21.0V
CC1_O, CC2_O	-0.3V to +6V
Continuous Current through CC1_I-CC1_O, CC2_I-CC2_O	±1A

Continuous Power Dissipation (T _A = +70°C) WLP (derate 13.73mW/°C above +70°C).....	1098.4mW
Operating Temperature Range	-40°C to +85°C
Junction Temperature	+150°C
Storage Temperature Range	-65°C to +150°C
Soldering Temperature (reflow)	+260°C

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Package Information

PACKAGE TYPE: 12 WLP	
Package Code	N121M1+1
Outline Number	21-100167
Land Pattern Number	Refer to Application Note 1891
THERMAL RESISTANCE, FOUR-LAYER BOARD	
Junction to Ambient (θ _{JA})	72.82°C/W

For the latest package outline information and land patterns (footprints), go to www.maximintegrated.com/packages. Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

Package thermal resistances were obtained using the method described in JEDEC specification JESD51-7, using a four-layer board. For detailed information on package thermal considerations, refer to www.maximintegrated.com/thermal-tutorial.

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Electrical Characteristics

($V_{ENCC} = 2.5V$ to $5.5V$, $T_A = -40^{\circ}C$ to $+85^{\circ}C$, unless otherwise noted. Typical values are at $V_{ENCC} = 4.3V$, $T_A = +25^{\circ}C$) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	
SUPPLY OPERATION							
Operating Voltage	V_{ENCC}		2.5		5.5	V	
Supply Current	I_{VENCC}	$V_{CC1_I} = V_{CC2_I} = 0V$		20	35	μA	
		$V_{CC1_I} = V_{CC2_I} = 9V$, (MAX20323, MAX20323C, MAX20323D)		140	170		
Power On Reset	$V_{POR_R/F}$	V_{ENCC} rising and falling	2.1		2.5	V	
	V_{POR_H}	Hysteresis		23		mV	
CC INPUTS TO CC OUTPUTS							
On Resistance	R_{ON}	$I_{OUT} = 0.1A$		270	500	$m\Omega$	
Internal Overvoltage Lockout and Switchover Threshold	V_{OVLO_R}	V_{CC1_I}, V_{CC2_I} rising	5.55	5.75	5.95	V	
	V_{OVLO_F}	V_{CC1_I}, V_{CC2_I} falling	5.5			V	
	V_{OVLO_H}	Hysteresis		50		mV	
CC1_I, CC2_I Power-On Input Impedance	R_{CC_I}	$V_{CC1_I}, V_{CC2_I} = 5.5V$	1			$M\Omega$	
Current Source CC1_I to CC1_O CC2_I to CC2_O	I_{SRC_180}	$V_{CC1_I}, V_{CC2_I} > V_{OVLO_R},$ $V_{CC1_O}, V_{CC2_O} = 0$ to $3V$	MAX20323 MAX20323C MAX20323D	165.6	180	194.4	μA
	I_{SRC_80}			MAX20323B MAX20323E	72	80	
Current Source CC1_O, CC2_O Voltage Clamp	V_{CLP_ISRC}	CC1_O, CC2_O open, $C_{LOAD} \leq 1nF$ (not present in MAX20323A/F)	5.5	5.75	6	V	
CC1_I, CC2_I Power Off Voltage Clamp	$V_{CLP_CC_I}$	$V_{ENCC} = 0$ to $2.1V$, $I_{CC1_I}, I_{CC2_I} = 356.4\mu A$ (not present in MAX20323F)			2.18	V	
		$V_{ENCC} = 0$ to $2.1V$, $I_{CC1_I}, I_{CC2_I} = 200\mu A$ (not present in MAX20323F)			1.6		
CC1_I, CC2_I Power Off R_D	R_D	$V_{ENCC} = 0$ to $2.1V$, $V_{CC1_I}, V_{CC2_I} = 2.18V$ to $5.5V$ (not present in MAX20323F)		5.1		$k\Omega$	
On Capacitance	C_{ON}	$R_{SOURCE} = R_{LOAD} = 50\Omega$, $0-1.2V$, 50MHz signal		62		pF	

MAX20323/MAX20323A/
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Electrical Characteristics (continued)

($V_{ENCC} = 2.5V$ to $5.5V$, $T_A = -40^{\circ}C$ to $+85^{\circ}C$, unless otherwise noted. Typical values are at $V_{ENCC} = 4.3V$, $T_A = +25^{\circ}C$) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
TIMING CHARACTERISTICS (NOTE 2)						
Switch Turn-on Time	t_{ON_SW}	V_{CC1_I}, V_{CC2_I} falling below OVLO to $V_{CC1_O}, V_{CC2_O} = 90\%$ of V_{CC1_I}, V_{CC2_I} , $R_L = 1k\Omega, C_L = 400pF$		90		μs
Switch Turn-Off Time	t_{OFF_SW}	V_{CC1_I}, V_{CC2_I} rising at $1V/10ns$ above OVLO until V_{CC1_O}, V_{CC2_O} stop rising, $R_L = 100\Omega$		0.1		μs
Current Source Turn-on Time	$t_{CC_ISRC_ON}$			150		μs
Current Source Turn-off Time	$t_{CC_ISRC_OFF}$			2		μs
THERMAL PROTECTION						
Thermal Shutdown	T_{SHDWN_R}			135		$^{\circ}C$
Thermal Shutdown Hysteresis	T_{SHDWN_H}			20		$^{\circ}C$
ESD PROTECTION						
IEC 61000-4-2 Contact Discharge		CC1_I, CC2_I		± 8		kV
IEC 61000-4-2 Air Gap Discharge		CC1_I, CC2_I		± 15		kV
Human Body Model		CC1_I, CC2_I		± 20		kV
		All other pins		± 2		

Note 1: All devices are 100% production tested at $T_A = +25^{\circ}C$. Specifications over the operating temperature range are guaranteed by design.

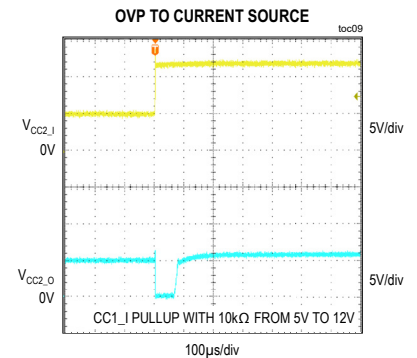
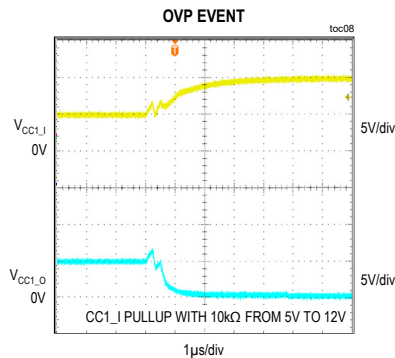
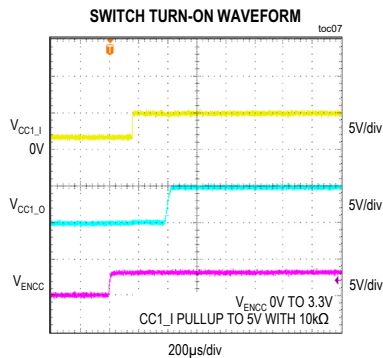
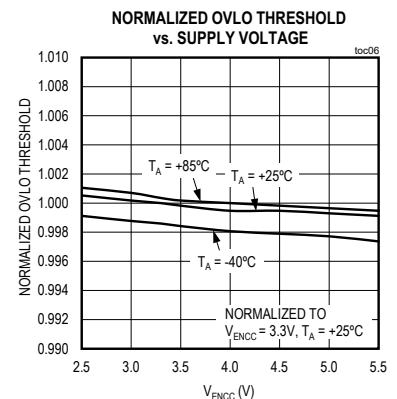
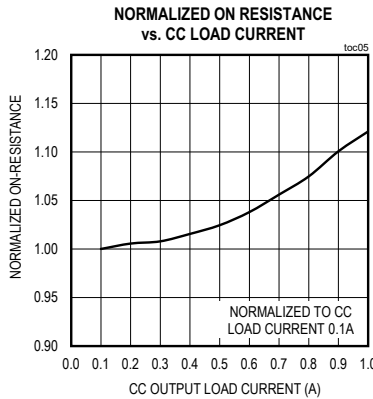
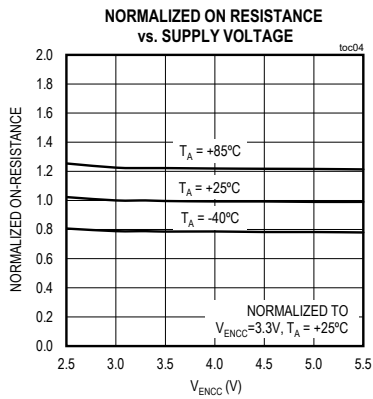
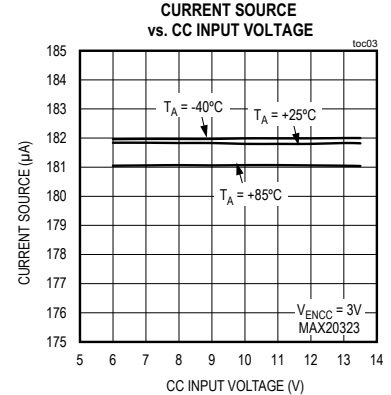
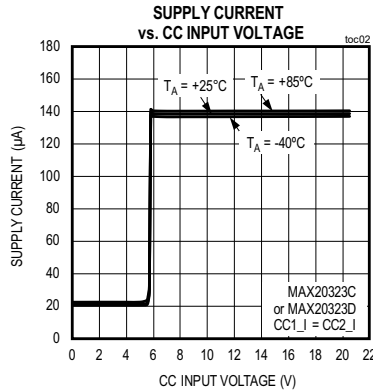
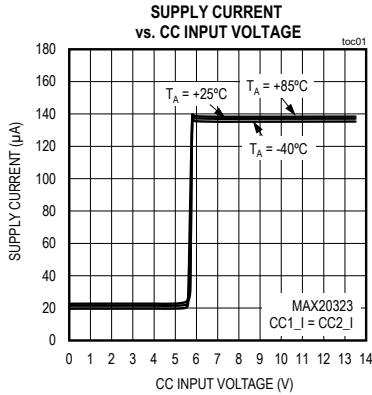
Note 2: All timing characteristics are measured using 20% and 80% level unless otherwise specified.

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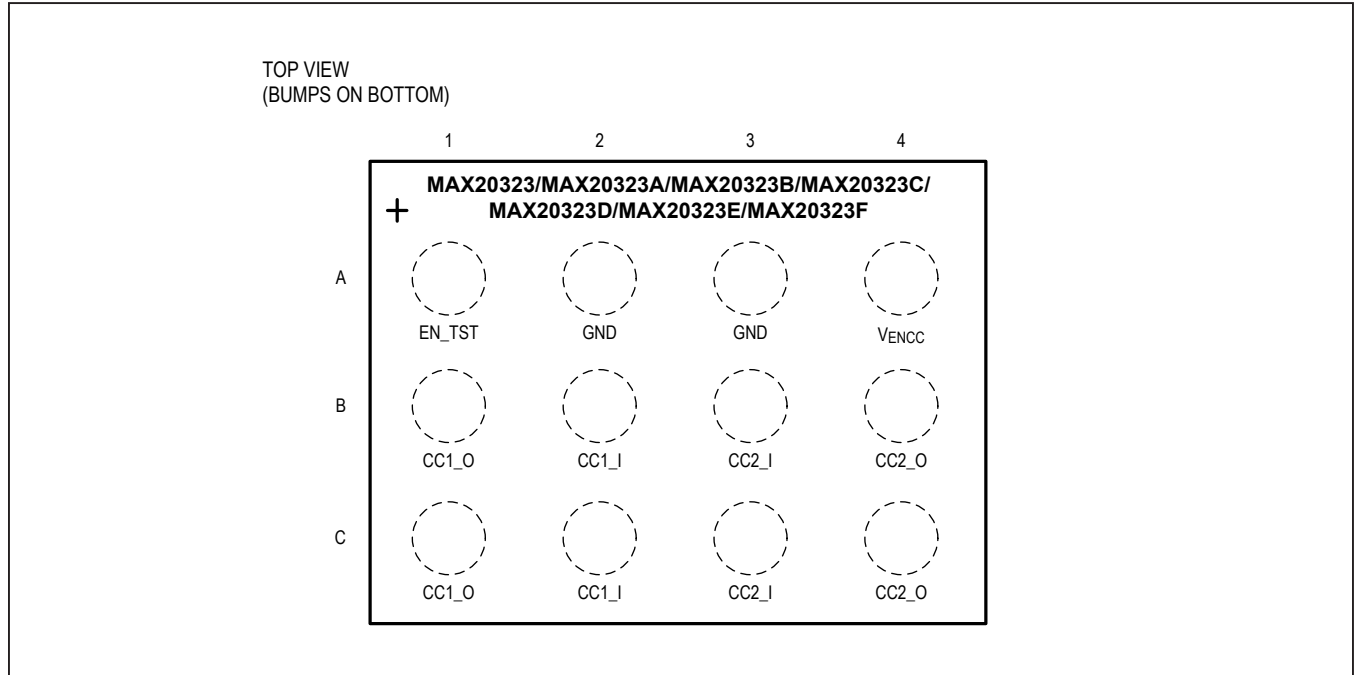
USB Type-C CC-Pin
 Overvoltage Protector

Typical Operating Characteristics

($V_{ENCC} = 4.3V$, $T_A = +25^\circ C$, unless otherwise noted.)



Bump Configurations



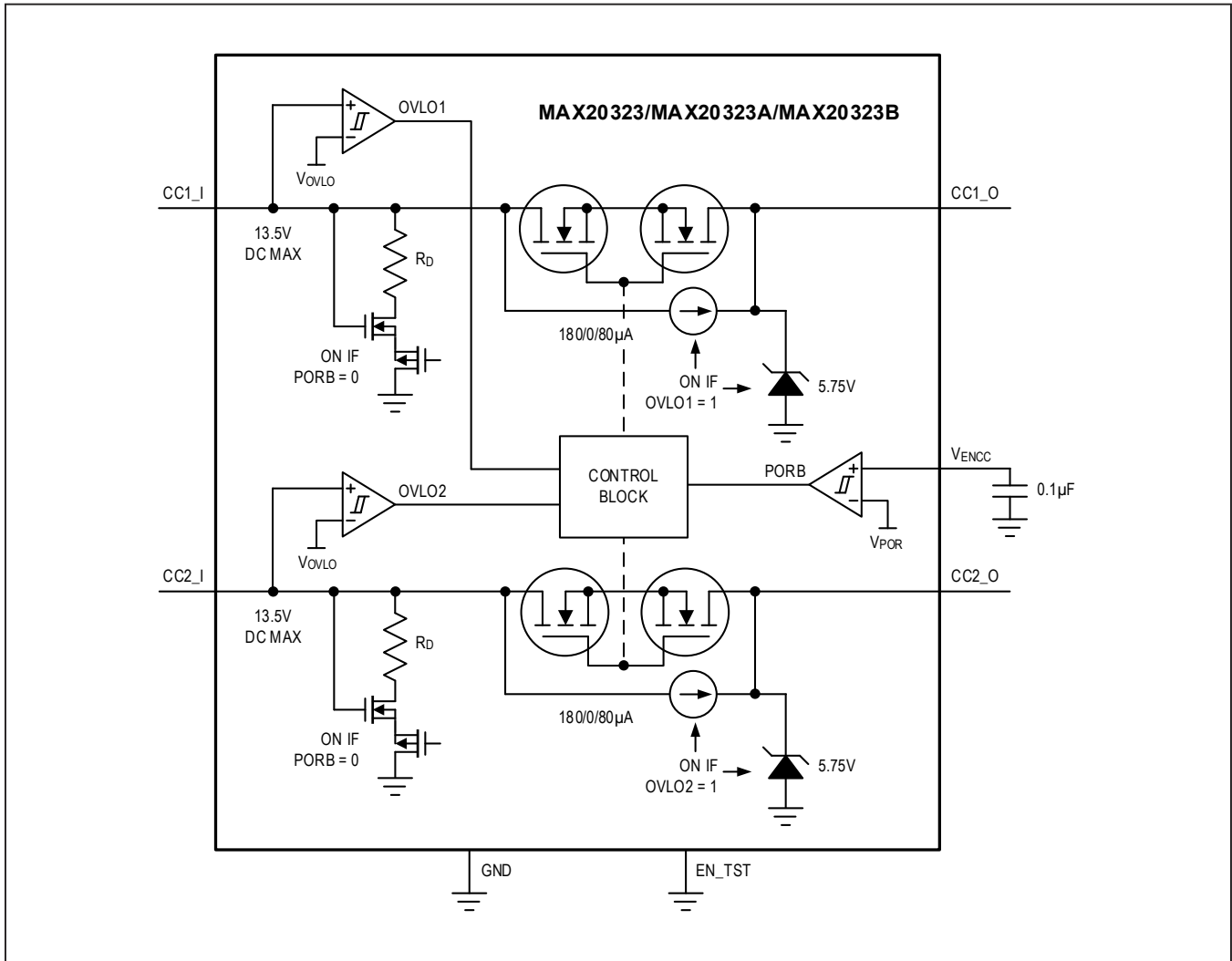
Bump Descriptions

BUMP	NAME	FUNCTION
A1	EN_TST	Test Input. Used only for test purposes. Connect EN_TST to ground for normal operation.
A2, A3	GND	Ground.
A4	V _{ENCC}	Supply and Active-High Enable Input. Bypass V _{ENCC} to GND with a 0.1µF ceramic capacitor as close as possible to the device.
B1, C1	CC1_O	Overvoltage Protected CC1 Output.
B2, C2	CC1_I	Overvoltage Protected CC1 Input.
B3, C3	CC2_I	Overvoltage Protected CC2 Input.
B4, C4	CC2_O	Overvoltage Protected CC2 Output.

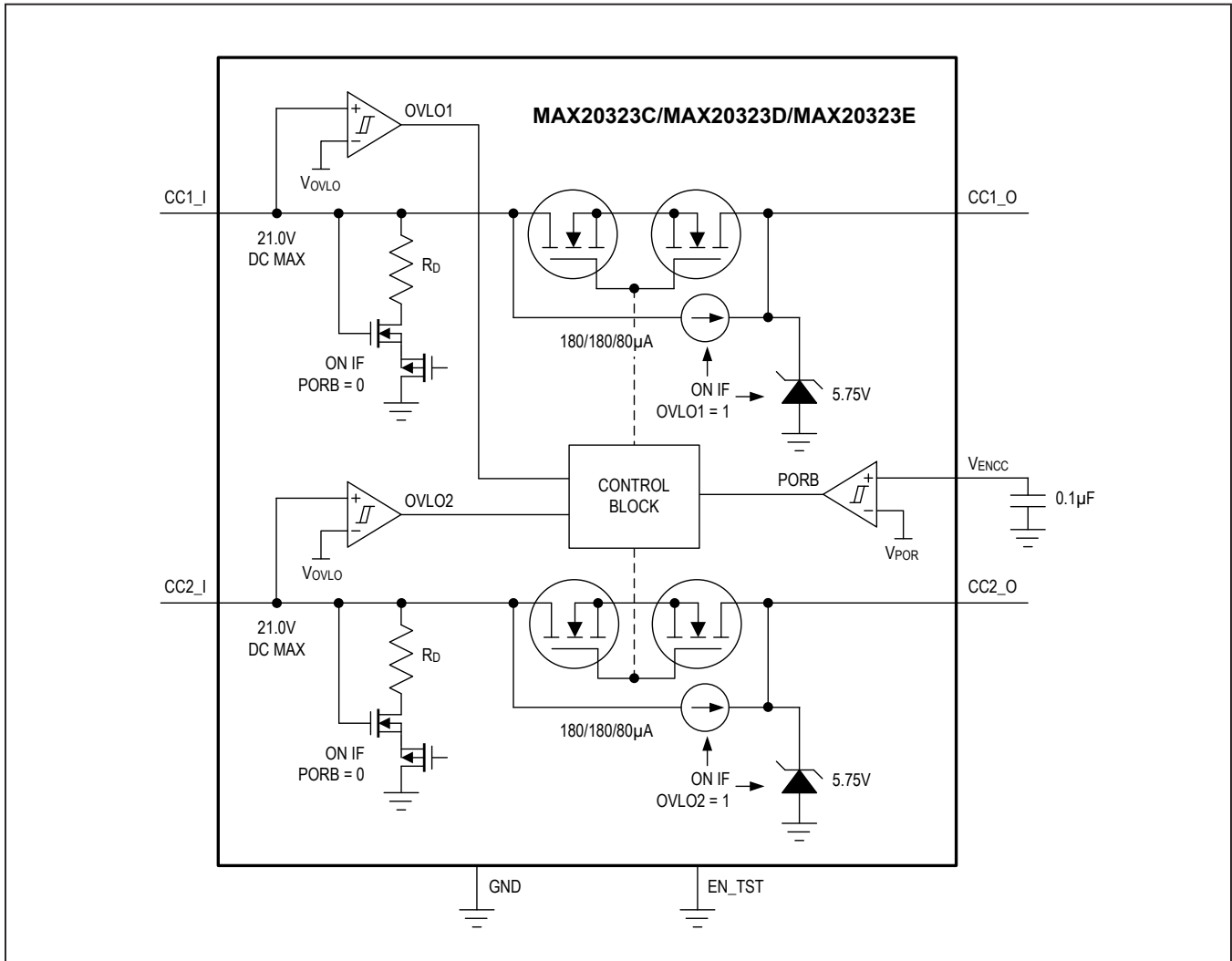
MAX20323/MAX20323A/
 MAX20323B/MAX20323C/
 MAX20323D/MAX20323E/MAX20323F

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Functional Diagram



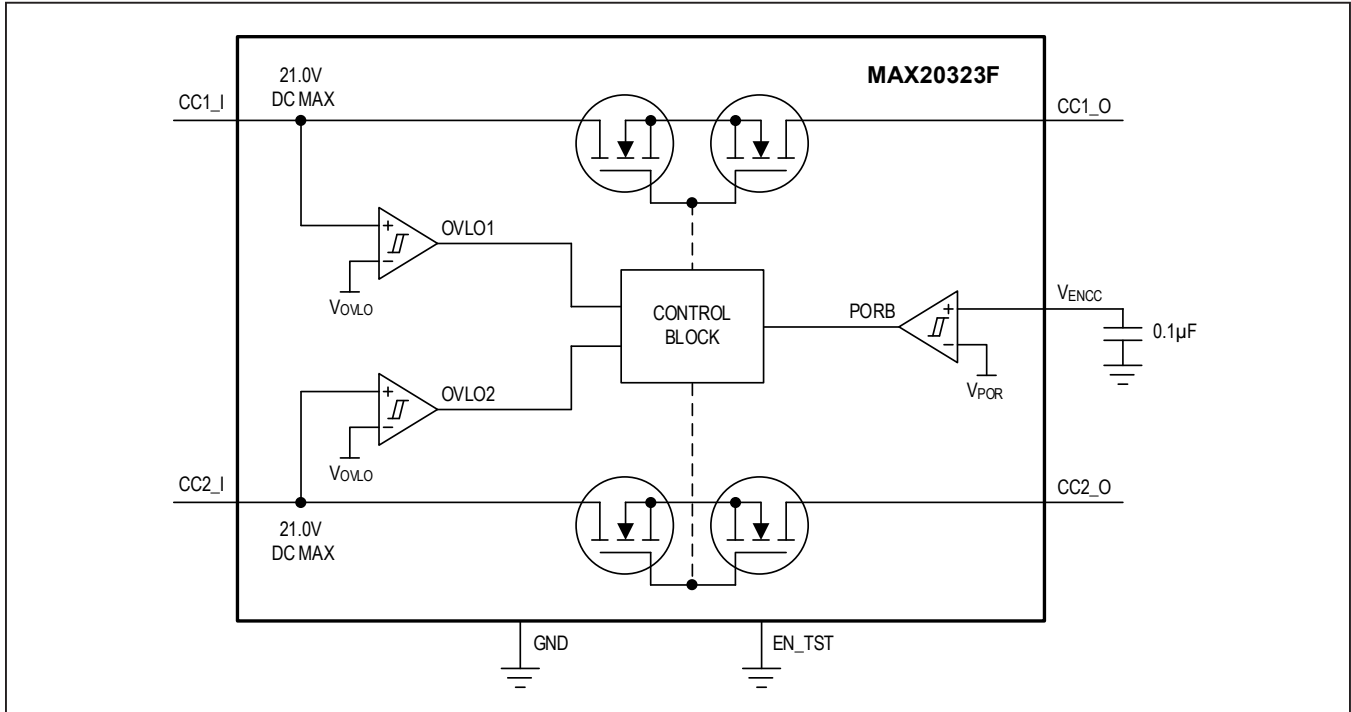
Functional Diagram (continued)



MAX20323/MAX20323A/
MAX20323B/MAX20323C/
MAX20323D/MAX20323E/MAX20323F

USB Type-C CC-Pin
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Functional Diagram (continued)



Detailed Description

The MAX20323 family has two channel switches that are turned on when inputs are below overvoltage threshold. When overvoltage threshold is exceeded on one of the channels, the corresponding switch is turned off and replaced by an accurate pullup current to output (CC1_O/CC2_O) that is sourced from input (CC1_I/CC2_I), except MAX20323A/F.

The MAX20323 family (except MAX20323F) provide the R_D with a clamp when no power is available at V_{ENCC} and automatically disable R_D when there is power available at V_{ENCC} .

Switches

The MAX20323 family features 270m Ω typ on-resistance back-to-back switches between CC inputs and CC outputs. Each switch is turned on when the correspondent CC input is below overvoltage threshold.

Overvoltage Lockout

When CC1_I/CC2_I is below overvoltage threshold (V_{OVLO_R}), the correspondent switch to CC1_O/CC2_O is enabled. When CC1_I/CC2_I goes above overvoltage threshold, the correspondent switch to CC1_O/CC2_O is disabled.

During an overvoltage condition, a pullup current sourced from CC1_I/CC2_I to CC1_O/CC2_O is enabled. The MAX20323/MAX20323C/MAX20323D have 180 μ A pullup current. The MAX20323B/MAX20323E have 80 μ A pullup current. The MAX20323A/F do not have a pullup current feature. The accuracy of the pullup current is guaranteed when the voltage on CC1_O/CC2_O is below 3V. Output voltage clamp (5.75V typ) is also enabled during the overvoltage condition (except in MAX20323A/F). It is capable of drawing the entire pullup current to avoid the output voltage exceeds absolute maximum rating in case the pin is left open.

Input Voltage Clamp

When V_{ENCC} is below power on reset threshold, the clamp resistors R_D on CC1_I and CC2_I are enabled. The MAX20323F does not have the input voltage clamp feature.

The clamp voltage is as follow:

- 1) Input clamp voltage < 2.18V, when:
 - a. Pullup current 356.4 μ A (330 μ A + 8%)
 - b. 5.5V pullup voltage and 9.5k Ω (10k Ω - 5%) pullup resistor
 - c. 3.465V (3.3V + 5%) pullup voltage and 4.465k Ω (4.7k Ω - 5%) pullup resistor
- 2) Input clamp voltage < 1.6V, pullup current 200 μ A

When input voltage goes above 2.18V, the R_D is 5.1k Ω (typ) equivalent resistance.

When V_{ENCC} is above power on reset threshold, the clamp resistors R_D are disabled.

Thermal Shutdown

Thermal shutdown circuitry protects the devices from overheating. The switches turn off when the junction temperature exceeds +135 $^{\circ}$ C (typ). The switches turn on again after the device temperature drops by approximately 20 $^{\circ}$ C (typ).

Application Information

Surge Protection

The MAX20323/MAX20323A/MAX20323B have DC tolerance up to 13.5V and surge protection up to \pm 90V. The MAX20323C/MAX20323E/MAX20323F have DC tolerance up to 21.0V and surge protection up to \pm 90V. The MAX20323D has DC tolerance up to 21.0V and surge protection up to \pm 80V without V_{ENCC} and up to \pm 60V with valid V_{ENCC} .

Extended ESD

ESD protection structures are incorporated on all pins to protect against electrostatic discharges up to \pm 2kV (Human Body Model) encountered during handling and assembly. CC1_I, CC2_I are further protected against ESD up to \pm 20kV (Human Body Model), \pm 15kV (Air Gap Discharge method described in IEC 61000-4-2), and \pm 8kV (Contact Discharge method described in IEC61000-4-2) without damage.

The ESD structures withstand high ESD both in normal operation and when the device is powered down. After an ESD event, the MAX20323 family continues to function without latchup.

ESD Test Condition

ESD performance depends on a variety of conditions. Contact Maxim for a reliability report that documents test setup, test methodology, and test results.

Human Body Model

Figure 1 shows the Human Body Model. Figure 2 shows the current waveform it generates when discharged into a low impedance. This model consists of a 100pF capacitor charged to the ESD voltage of interest that is then discharged into the device through a 1.5kΩ resistor.

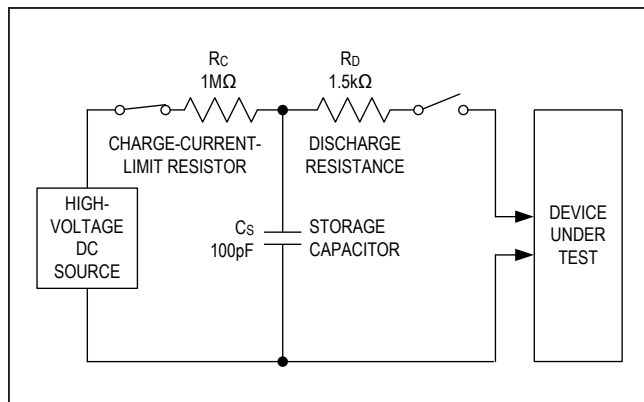


Figure 1. Human Body ESD Test Model

IEC 61000-4-2

The IEC 61000-4-2 standard covers ESD testing and performance of finished equipment. However, it does not specifically refer to integrated circuits. The major difference between tests done using the Human Body Model and IEC 61000-4-2 is higher peak current in IEC 61000-4-2 because series resistance is lower in the IEC 61000-4-2 model. Hence, the ESD withstand voltage measured to IEC 61000-4-2 is generally lower than that measured using the Human Body Model. Figure 3 shows the IEC 61000-4-2 model, and Figure 4 shows the current waveform for the IEC 61000-4-2 ESD Contact Discharge test.

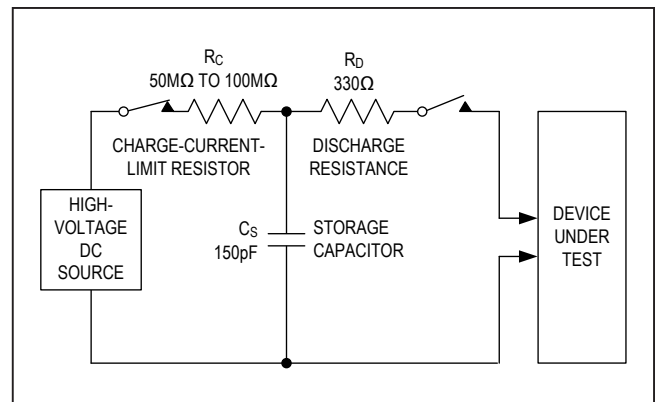


Figure 3. IEC 61000-4-2 ESD Test Model

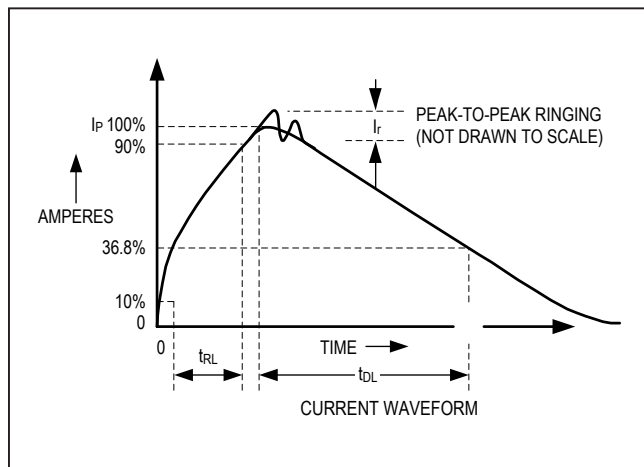


Figure 2. Human Body Current Waveform

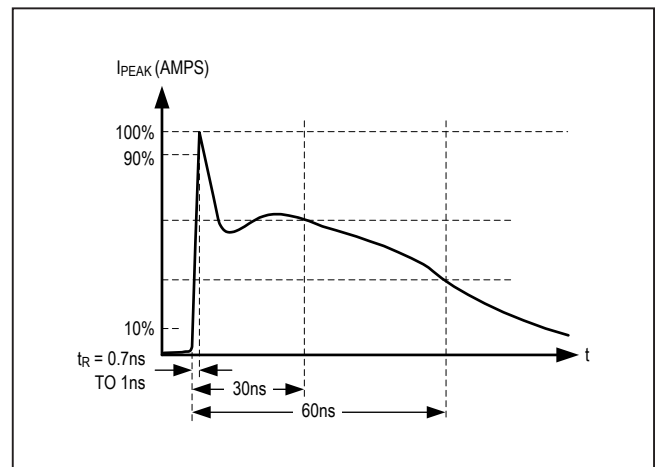


Figure 4. IEC 61000-4-2 ESD Generator Current Waveform

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Ordering Information/Selector Guide

PART	DC CC INPUT ABSMAX (V)	PULLUP CURRENT (μA)	TOP MARK	TEMP RANGE	PIN- PACKAGE
MAX20323ENC+T	13.5	180	AAD	-40°C to +85°C	12 WLP
MAX20323AENC+T*	13.5	—	AAE	-40°C to +85°C	12 WLP
MAX20323BENC+T*	13.5	80	AAF	-40°C to +85°C	12 WLP
MAX20323CENC+T	21.0	180	AAG	-40°C to +85°C	12 WLP
MAX20323DENC+T	21.0	180	AAH	-40°C to +85°C	12 WLP
MAX20323EENC+T*	21.0	80	AAI	-40°C to +85°C	12 WLP
MAX20323FENC+T	21.0	—	AAJ	-40°C to +85°C	12 WLP

+Denotes lead(Pb)-free/RoHS-compliant package.

T = Tape and reel.

*Future product—Contact Maxim for availability.

Chip Information

PROCESS: BiCMOS

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Overvoltage Protector

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	6/17	Initial release	—
1	11/17	Updated surge voltage and modified pullup current level of MAX20323A/C	1, 2, 6, 7, 9, 11
2	7/18	Updated <i>Benefits and Features</i> , <i>Absolute Maximum Ratings</i> , <i>Functional Diagrams</i> , <i>Application Information</i> , and <i>Ordering Information/Selector Guide</i>	1, 2, 7–9, 11
3	1/19	Updated the <i>General Description</i> , <i>Benefits and Features</i> , <i>Electrical Characteristics</i> , <i>Detailed Description</i> , and <i>Surge Protection</i> sections; Updated TOC02, Functional Diagram for MAX20323C/MAX20323D/MAX20323E, and removed future product designation from MAX20323CENC+T	1, 3–4, 8 10, 12
4	2/19	Updated the <i>Overvoltage Lockout</i> section	10

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