USB Type-C Port Protector: Short-to-VBUS Overvoltage and IEC ESD Protection

Features

- **24-VDC Tolerant Short-to-VBUS Overvoltage Protection (CC1, CC2, SBU1, SBU2)**
- **IEC 61000-4-2 ESD Protection (CC1, CC2, SBU1, SBU2, DP, DM)**
- **CC Dead Battery Resistors integrated for handling dead battery use case in mobile devices**
- **CC1, CC2 FETs 600mA capable for passing VCONN power**
- **TQFN3X3-20 Package**

Applications

- Tablets
- Smartphones
- Laptop PC
- Monitors and TVs
- Docking Stations

General Description

The G2330 is a USB Type-C port protection chip that provides Short-to-VBUS overvoltage and IEC ESD protection.

In USB Type-C small connector, mechanical twisting and sliding of the connector could short pins due to the close proximity. This can cause 20V VBUS to be shorted to the CC and SBU pins.

The G2330 provides high voltage FETs in series on the SBU and CC. When a voltage above the OVP threshold, the high voltage FETs are opened, isolating the high voltage condition present on the connector.

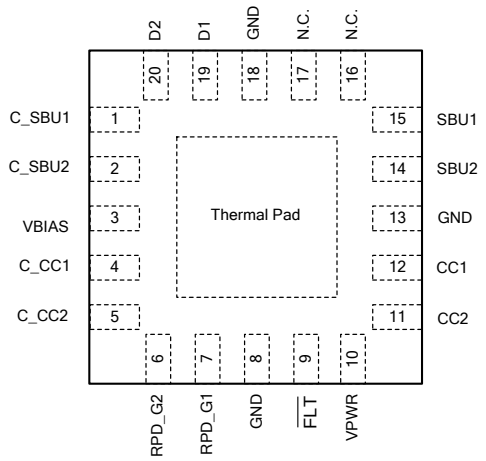
The G2330 integrates IEC 61000-4-2 ESD protection for the CC1, CC2, SBU1, SBU2, D1, D2 pins, removing external ESD device on the connector.

Ordering Information

ORDER NUMBER	MARKING	TEMP. RANGE	PACKAGE (Green)
G2330RZ1U	2330	-40°C~+85°C	TQFN3X3-20
G2330RZ1D	2330	-40°C~+85°C	TQFN3X3-20

Note: RZ: TQFN3X3-20
1: Bonding Code
U : Tape & Reel
Green : Lead Free / Halogen Free.

Pin Configuration



G2330 TQFN3X3-20

Note: Recommend connecting the Thermal Pad to the Ground for excellent power dissipation.

Absolute Maximum Ratings

V_{PWR} . . . . . -0.3V to +6V
RPD_G1, RPD_G2 . . . . . -0.3V to +24V
$\overline{FLT}$ . . . . . -0.3V to +6V
VBIAS . . . . . -0.3V to +24V
D1, D2 . . . . . -0.3V to +6V
CC1, CC2, SBU1, SBU2 . . . . . -0.3V to +6V
C_CC1, C_CC2, C_SBU1, C_SBU2 . . . . -0.3V to +24V
Thermal Resistance Junction to Ambient, (θ_{JA})
TQFN3X3-20 . . . . . 76°C/W
Continuous Power Dissipation (T_A=25°C)
TQFN3X3-20 . . . . . 1.6W
Thermal Resistance Junction to Case, (θ_{JC})
TQFN3X3-20 . . . . . 15°C/W
Operating Ambient Temperature . . . . . -40°C to 85°C
Storage Temperature Range. . . . . -55°C to +150°C
Reflow Temperature (soldering, 10 sec) . . . . . 260°C
EDS Susceptibility (Human Body Mode) 2KV
EDS Susceptibility (Machine Mode) 200V

1. 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 are not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.
2. Device is ESD sensitive. Handling precaution recommended. The Human Body model is a 100pF capacitor discharged through a 1.5KΩ resistor into each pin.

Electrical Characteristics

(T_A=25°C, unless otherwise specified)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT
CC OVP SWITCHES						
Input Voltage	V_{PWR}		2.7	3.3	5.5	V
On resistance of CCx FET	Ron_{CC_X}	CC_X = 5.5V	---	200	300	mΩ
On resistance flatness	$R_{ON(FLAT)}$	Sweep CCx between 0V and 1.2V	---	---	5	mΩ
Equivalent on capacitance	C_{ON_CC}	Capacitance from C_CCx or CCx to GND when device is powered, C_CCx = 0~1.2V, frequency = 400kHz	---	74	---	pF
Dead battery pull-down resistance (device is unpowered). Effective resistance of RD and FET in series	R_D	C_CCx = 2.6V	---	5.1	---	kΩ
Threshold voltage of the pulldown FET in series with RD during dead battery	VTH_DB	I_CC=80μA	---	0.9	---	V
OVP threshold on CCx	V_{OVPCC}	Force 5.5V on C_CCx, Sweep up C_CCx until the $\overline{FLT}$ pin is asserted	5.75	6	6.2	V
Hysteresis on CC OVP	V_{OVPCC_HYS}	Force 6.5V on C_CCx. Sweep down C_CCx until the $\overline{FLT}$ pin is deasserted. Hysteresis is the difference between rising and falling OVP threshold.	---	50	---	mV
On bandwidth single ended (-3dB)	BW_{ON}	Measure the -3dB bandwidth from C_CCx to CCx.	---	100	---	MHz
Short-to-VBUS tolerance on the CC pins	V_{STBUS_CC}	Hot-Plug C_CCx with a 1 meter USB Type C Cable, place a 30Ω on CCx	---	---	24	V
Short-to-VBUS system-side clamping voltage on the CC pins	$V_{STBUS\_CC\_CLAMP}$	Hot-Plug C_CCx with a 1 meter USB Type C Cable, place a 30Ω on CCx. C_CCx = 24V, VPWR = 3.3V	---	8	---	V

Electrical Characteristics (continued)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT
SBU OVP SWITCHES						
On resistance of SBU FET	Ron_{SBU}	SBUx = 3.6V	---	4	6.5	Ω
On resistance flatness	$R_{ON(FLAT)\_SBU}$	Sweep SBUx between 0V and 3.6V	---	0.7	1.5	Ω
Equivalent on capacitance	C_{ON_SBU}	Capacitance from C_SBUx or SBUx to GND when device is powered. C_SBUx = 0.3 ~3.6V.	---	6	---	pF
OVP threshold on SBUx	V_{OVPSBU}	Force 3.6V on C_SBUx, Sweep up C_SBUx uniti the $\overline{FLT}$ pin is asserted	4.35	4.5	4.7	V
Hysteresis on SBU OVP	V_{OVPSBU_HYS}	Force 5V on C_SBUx. Sweep down C_SBUx until the $\overline{FLT}$ pin is deasserted. Hysteresis is the difference between rising and falling OVP threshold.	---	50	---	mV
On bandwidth single ended (-3dB)	BW_{ON_SBU}	Measure the -3dB bandwidth from C_SBUx to SBUx.	---	1000	---	MHz
Crosstalk	X_{TALK}	Measure crosstalk at f=1MHz from SBU1 to C_SBU2 or SBU2 to C_SBU1. Vcm1=3.6V, Vcom2=0.3V. Be sure to terminate open sides to 50Ω	---	-80	---	dB
Short-to-VBUS tolerance on the SBU pins	V_{STBUS_SBU}	Hot-Plug C_SBUx with a 1 meter USB Type C Cable, place a 100nF capacitor in series with a 40Ω resistance to GND onSBUx	---	---	24	V
Short-to-VBUS system-side clamping voltage on the SBU pins	$V_{STBUS\_SBU\_CLAMP}$	Hot-Plug C_CCx with a 1 meter USB Type C Cable, place a 150nF capacitor in series with a 30Ω resistor to GND on SBUx. C_SBUx = 24V, VPWR = 3.3V	---	8	---	V
POWER SUPPLY and LEAKAGE CURRENTS						
V_{PWR} under voltage lockout	V_{PWR_UVLO}	Place 1V on VPWR and raise voltage until SBU or CC FETs turnon	---	2.3	---	V
V_{PWR} UVLO hysteresis	$V_{PWR\_UVLO\_HYS}$	Place 3V on VPWR and lower voltage until SBU or CC FETs turnoff; measure difference between rising and falling UVLO to calculate hysteresis	---	150	---	mV
V_{PWR} supply current	I_{VPWR}	PWR = 3.3V (typical), VPWR = 4.5V (maximum).	---	90	---	μA
Leakage current for CC pins when device is powered	I_{CC_LEAK}	VPWR = 3.3V, VC_CCx = 3.6V, CCx pins are floating, measure leakage into C_CCx pins. Result must be same if CCx side is biased and C_CCx is left floating	---	---	5	μA
Leakage current for SBU pins when device is powered	I_{SBU_LEAK}	VPWR = 3.3V, VC_SBUx = 3.6V, SBUx pins are floating, measure leakge into C_SBUx pins. Result must be same if SBUx side is biased and C_SBUx is left floating.	---	---	3	μA
Leakage current for CC pins when device is in OVP	$I_{C\_CC\_LEAK\_OVP}$	VPWR = 0V or 3.3V, VC_CCx = 24V, CCx pins are set to 0V, measure leakage into C_CCx pins	---	---	1200	μA
Leakage current for SBU pins when device is in OVP	$I_{C\_SBU\_LEAK\_OVP}$	VPWR = 0V or 3.3V, VC_SBUx = 24V, SBUx pins are set to 0V, measure leakage into C_SBUx pins	---	---	400	μA
Leakage current for CC pins when device is in OVP	$I_{CC\_LEAK\_OVP}$	VPWR = 0 V or 3.3 V, VC_CCx = 24V, CCx pins are set to 0 V, measure leakage out of CCx pins	---	---	30	μA
Leakage current for SBU pins when device is in OVP	$I_{SBU\_LEAK\_OVP}$	VPWR = 0V or 3.3V, VC_SBUx = 24V, SBUx pins are set to 0V, measure leakage out of SBUx pins	-1	---	1	μA
Leakage current for Dx pins	I_{Dx_LEAK}	V_Dx = 3.6V, measure leakage into Dx pins	---	---	1	μA

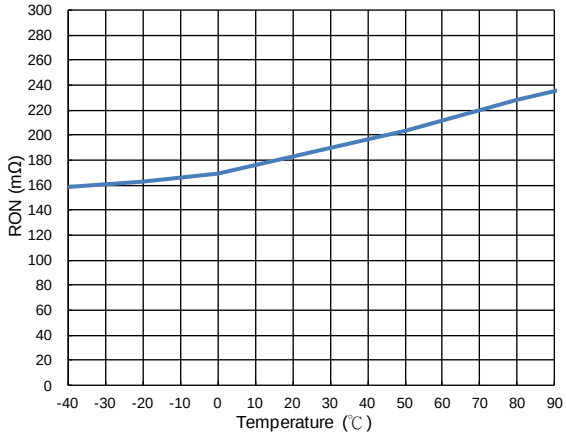
Electrical Characteristics (continued)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT
$\overline{FLT}$ PIN						
Low-level output voltage	V_{OL}	IOL = 3mA. Measure the voltage at the $\overline{FLT}$ pin	---	---	0.4	V
OVER TEMPERATURE PROTECTION						
The rising over-temperature protection shutdown threshold	T_{SD_RISING}		---	175	---	°C
The falling over-temperature protection shutdown threshold	$T_{SD\_FALLING}$		---	140	---	°C
The over-temperature protection shutdown threshold hysteresis	ΔT_{SD}		---	35	---	°C
Dx ESD PROTECTION						
Reverse stand-off voltage from Dx to GND	V_{RWM_POS}	Dx to GND. $I_{DX} \leq 1\mu A$	---	---	5.5	V
Reverse stand-off voltage from GND to Dx	V_{RWM_NEG}	GND to Dx	---	---	0	V
Dx to GND or GND to Dx	C_{IO}	f = 1MHz, VIO = 2.5V	---	1.7	---	pF
Differential capacitance between two Dx pins	ΔC_{IO}	f = 1MHz, VIO = 2.5V	---	0.02	---	pF
Power on and off timings						
Time from crossing rising VPWR UVLO until CC and SBU OVP FETs are on	t_{ON}		---	---	3.5	ms
Minimum Slew rate allowed to guarantee CC and SBU FETs turnoff during a power off	dV_{PWR_OFF}/dt		-0.5	---	---	V/μs
Over voltage protection						
OVP response time on the CC pins. Time from OVP asserted until OVP FETs turnoff	$t_{OVP\_RESPONSE\_CC}$		---	70	---	ns
OVP response time on the SBU pins. Time from OVP asserted until OVP FETs turnoff	$t_{OVP\_RECOVERY\_SBU\_1}$		---	80	---	ns
OVP recovery time on the CC pins. Time from OVP Removal until CC FET turns back on, if device has been in OVP > 0.5 ms	$t_{OVP\_RECOVERY\_CC\_2}$		---	0.5	---	ms
OVP recovery time on the SBU pins. Time from OVP Removal until SBU FET turns back on, if device has been in OVP > 0.5 ms	$t_{OVP\_RECOVERY\_SBU\_2}$		---	0.5	---	ms
Time from OVP asserted to $\overline{FLT}$ assertion	$t_{OVP\_FLT\_ASSERTION}$		---	20	---	μs
Time from CC FET turnon after an OVP to $\overline{FLT}$ deassertion	$t_{OVP\_FLT\_DEASSERTION}$		---	5	---	ms

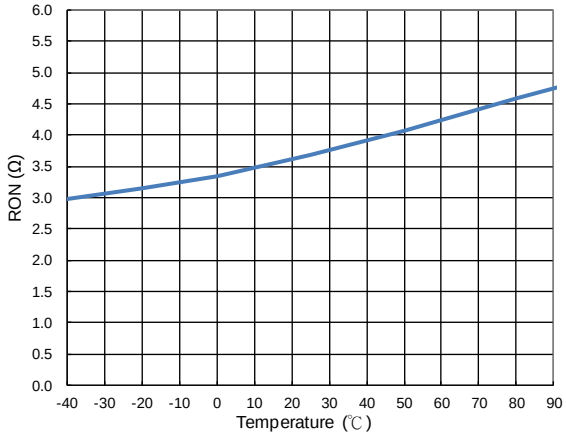
Typical Performance Characteristics

(V_{PWR}=3.3V, T_A=25°C, unless otherwise noted.)

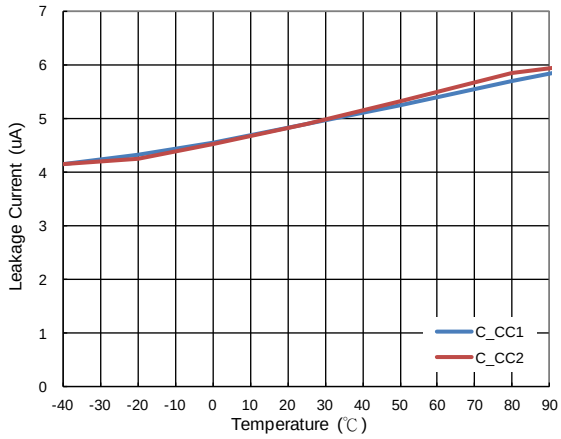
CC On Resistance vs. Temperature



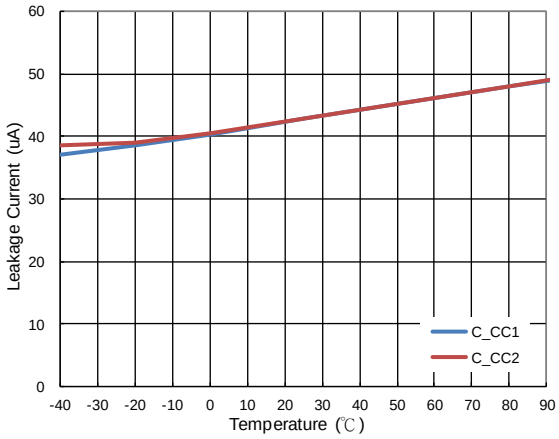
SBU On Resistance vs. Temperature



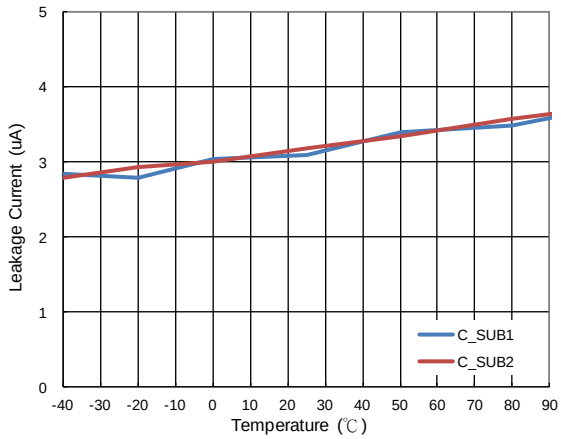
C_CC Leakage Current vs. Temperature



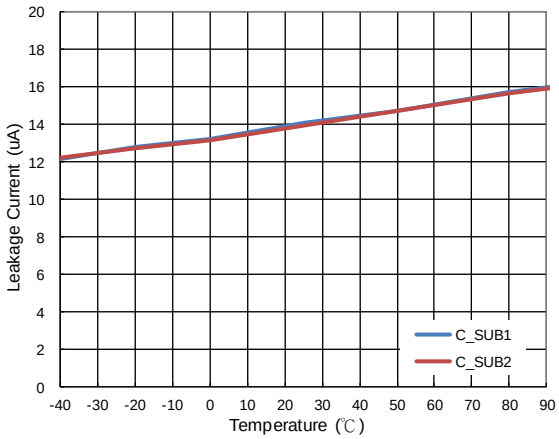
C_CC OVP Leakage Current vs. Temperature



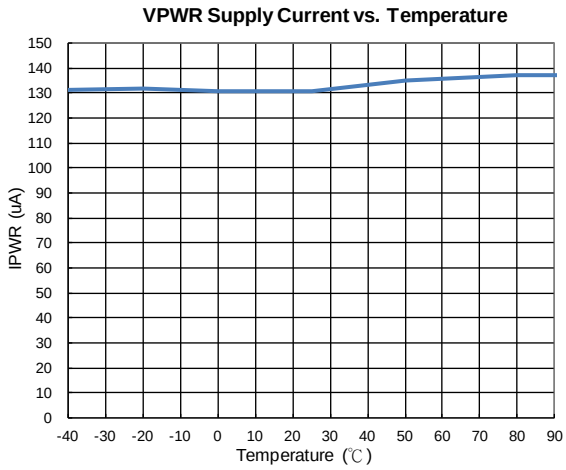
C_SUB Leakage Current vs. Temperature

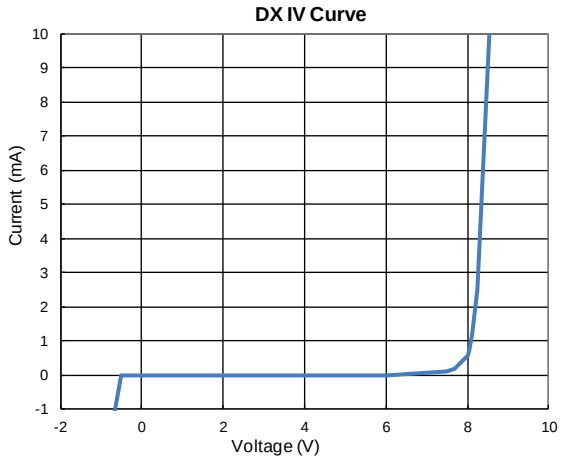


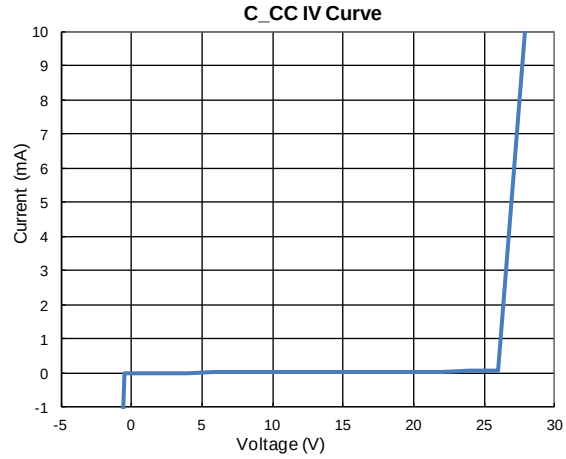
C_SUB OVP Leakage Current vs. Temperature

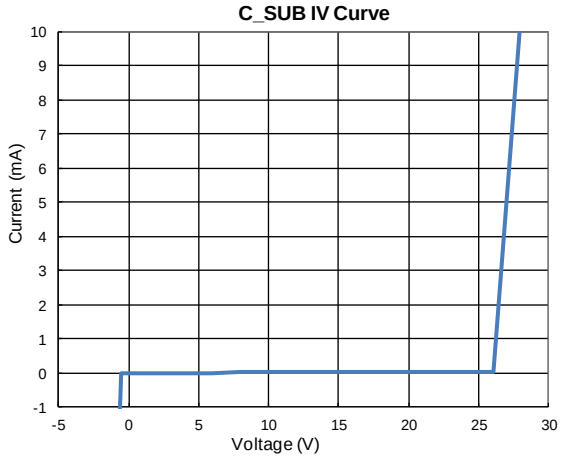


Typical Performance Characteristics (continued)



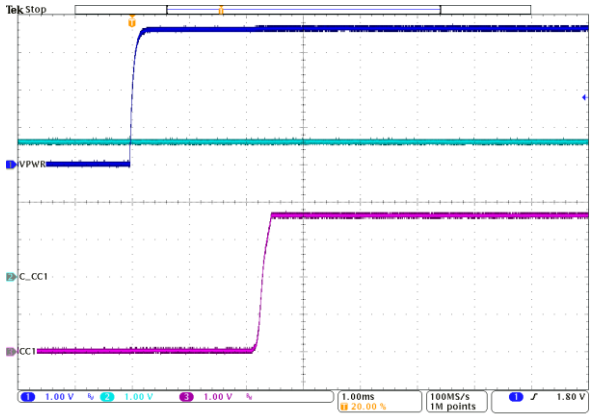




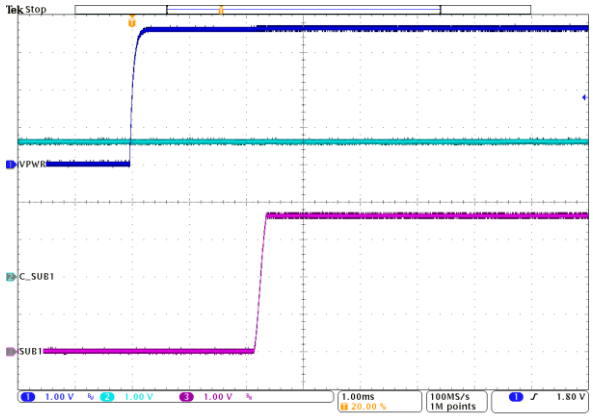


Typical Performance Characteristics (continued)

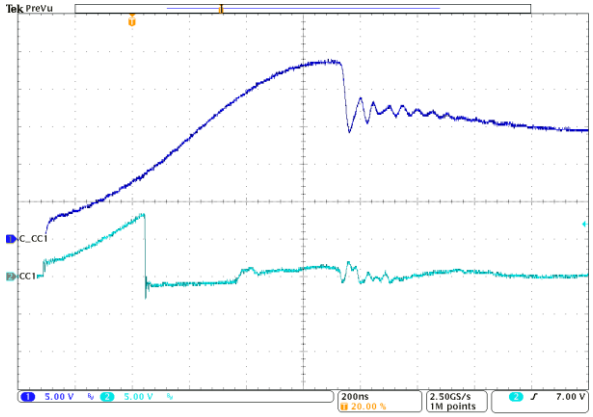
CC Switch Turn On Timing



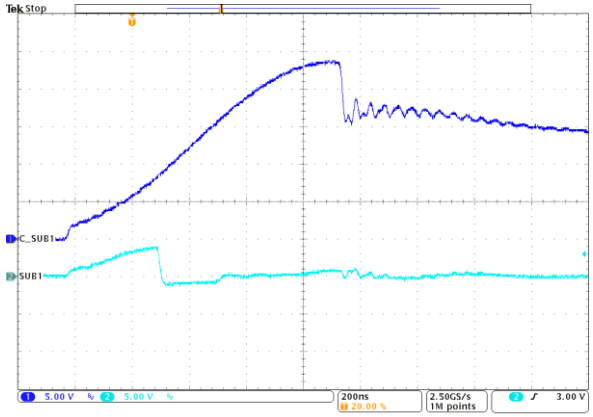
SUB Switch Turn On Timing



CC Clamp Voltage On System Side



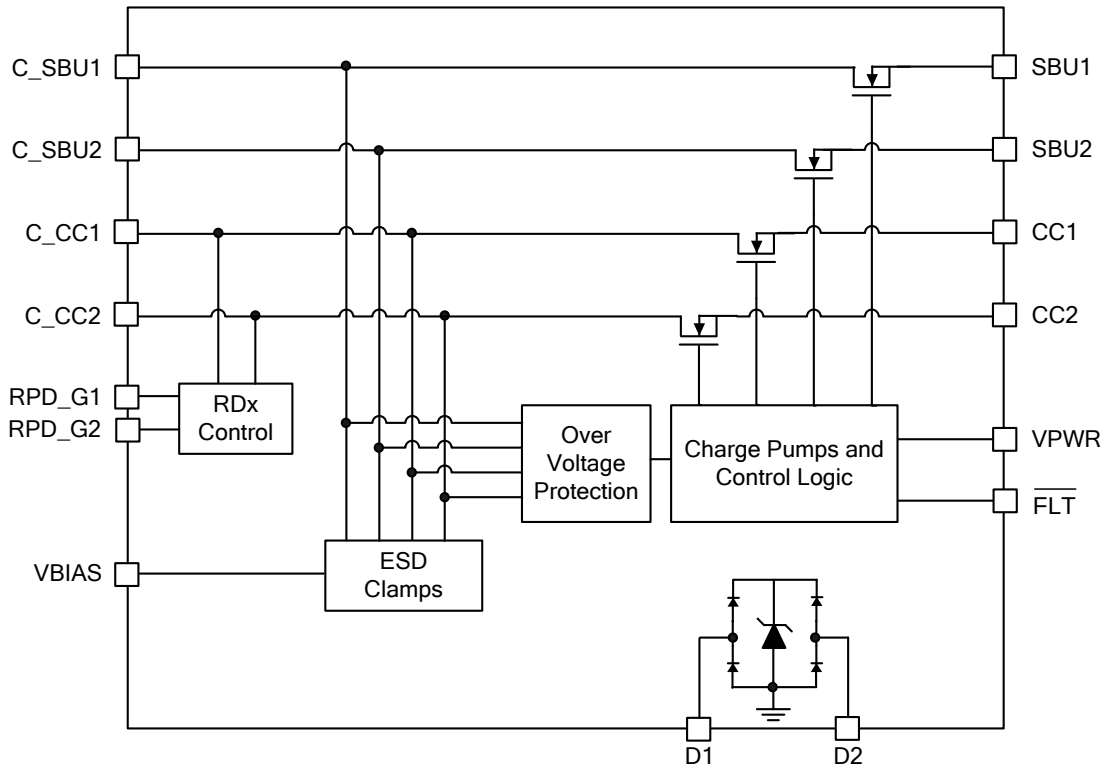
SUB Clamp Voltage On System Side



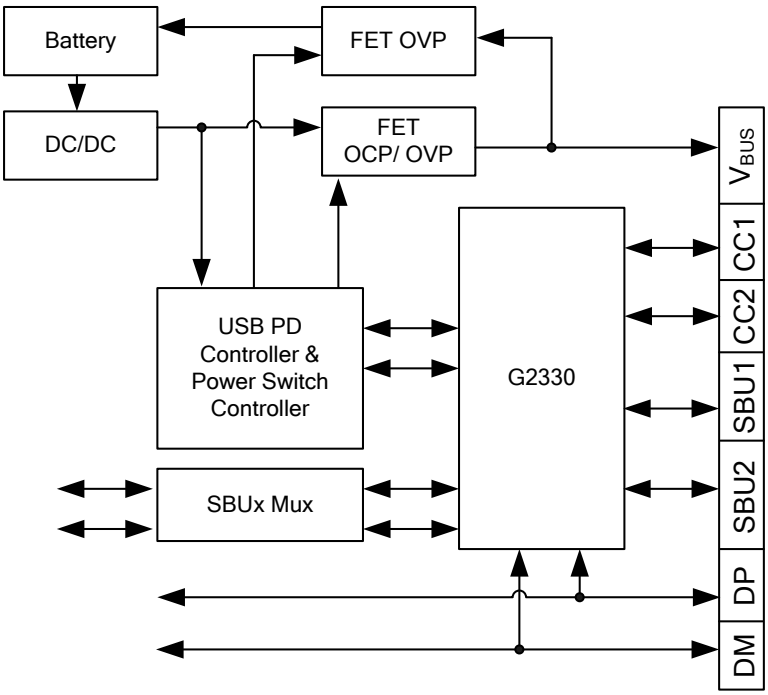
Pin Description

Pin No	Pin Name	Function
1	C_SBU1	Connector side of the SBU1 FET
2	C_SBU2	Connector side of the SBU2 FET
3	VBIAS	Pin for ESD capacitor. Place a 0.1-μF capacitor to ground
4	C_CC1	Connector side of the CC1 FET
5	C_CC2	Connector side of the CC2 FET
6	RPD_G2	Short to C_CC2 if dead battery resistors are needed. If dead battery resistors are not needed, short pin to GND
7	RPD_G1	Short to C_CC1 if dead battery resistors are needed. If dead battery resistors are not needed, short pin to GND
8	GND	Ground
9	$\overline{FLT}$	Open drain for fault pin
10	V_{PWR}	Power supply
11	CC2	System side of the CC2 OVP FET
12	CC1	System side of the CC1 OVP FET
13	GND	Ground
14	SBU2	System side of the SBU2 OVP FET
15	SBU1	System side of the SBU1 OVP FET
16	N.C.	Connect to Ground
17	N.C.	Connect to Ground
18	GND	Ground
19	D2	USB2.0 IEC ESD protection. Connect to any of the USB2.0 pins of the USB Type-C connector
20	D1	USB2.0 IEC ESD protection. Connect to any of the USB2.0 pins of the USB Type-C connector
	Thermal Pad	Connect to the PCB GND

Block Diagram



Application Circuit



Function Description

Over-Voltage Protection

The G2330 have 4-channels of Short to VBUS overvoltage protection for the CC1, CC2, SBU1 and SBU2 pins. When the input voltage exceeds the OVP level, the G2330 will turn off the switch to disconnect the C_CCx pin and CCx pin or C_SBUx pin to SBUx pin to prevent the high input voltage from damaging the end system. When the C_CCx/C_SBUx input voltage returns to normal operation voltage range the G2330 will turn on the switches to turn on channel.

6-Channels of IEC 61000-4-2 ESD Protection (C_CC1, C_CC2, C_SBU1, C_SBU2, D1 and D2)

The G2330 provide 6-Channels of IEC 61000-4-2 system level ESD protection for the CC1, CC2, SBU1, SBU2, D1 and D2 pins. As USB Type-C interface need IEC system level ESD protection in order to provide plenty protection for the ESD events that the connector can be exposed to end users.

Thermal Shutdown

A thermal shutdown is implemented to prevent damage due to excessive heat and power dissipation. Typically, the thermal shutdown happens at a junction temperature of 150°C. When the thermal shutdown is triggered, the chip turn off the switches until the junction temperature fall below typically 130°C, the the chip turn on again.

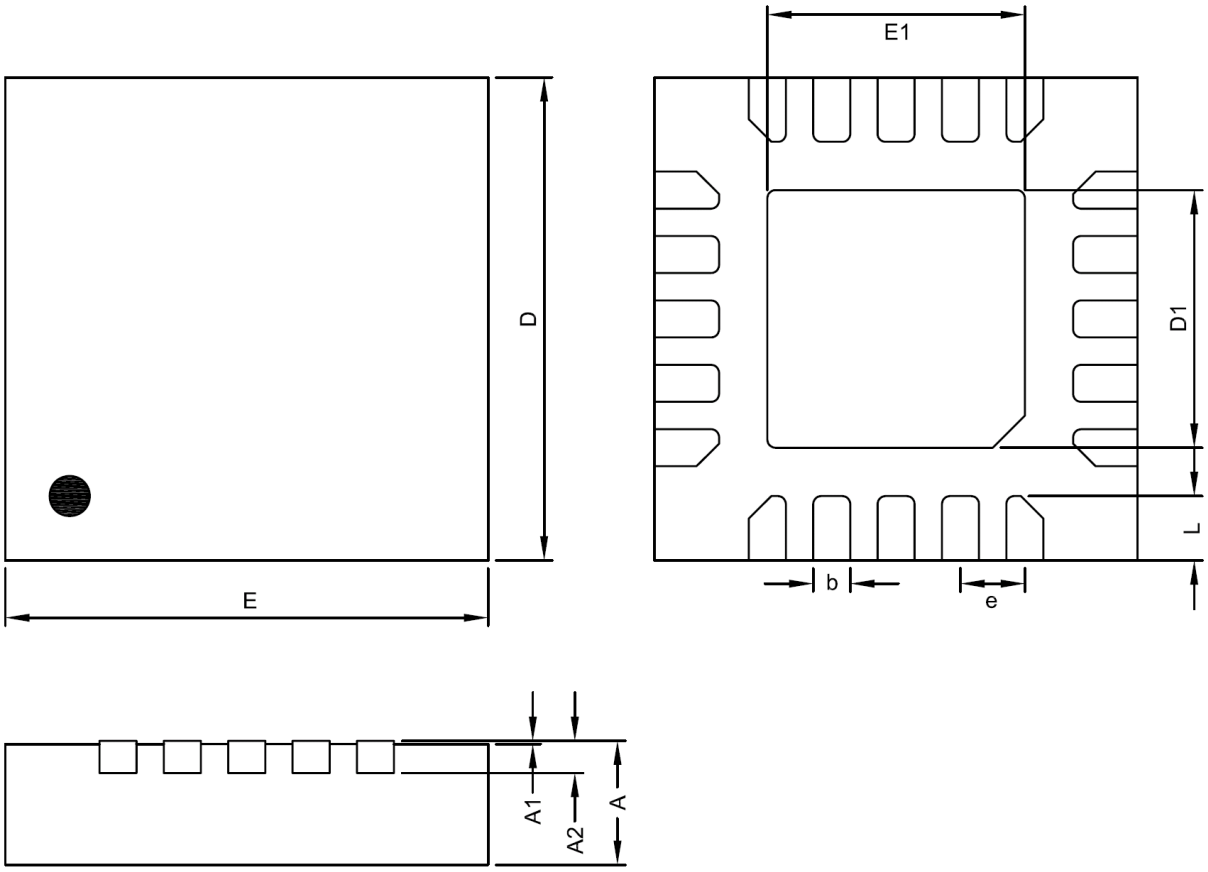
Device Function Modes

Table 1 describes all of the functional modes for the G2330.

Table 1. Device Mode Table

Device Mode Table		Inputs					Outputs		
Mode		VPWR	C_CCx	C_SBUx	RPD_Gx	T j	FLTB	CC MOSFETs	SBU MOSFETs
Normal Operating Conditions	Power Off No dead battery support	<UVLO	X	X	Grounded	X	High-Z	OFF	OFF
	Power Off No dead battery support	<UVLO	X	X	Shorted to C_CCx	X	High-Z	OFF	OFF
	Powered on	>UVLO	<OVP	<OVP	X, Forced OFF	<TSD	High-Z	ON	ON
Fault Conditions	Thermal shutdown	>UVLO	X	X	X, Forced OFF	>TSD	Low	OFF	OFF
	CC ovp	>UVLO	>OVP	X	X, Forced OFF	<TSD	Low	OFF	OFF
	SBU ovp	>UVLO	X	>OVP	X, Forced OFF	<TSD	Low	OFF	OFF

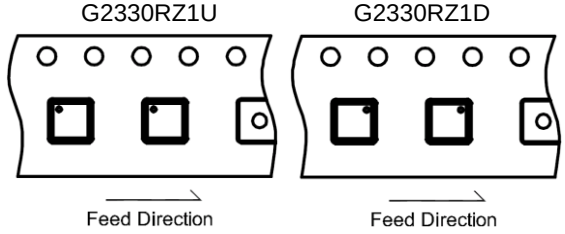
Package Information



TQFN3X3-20 Package

Symbol	DIMENSION IN MM			DIMENSION IN INCH		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	0.70	0.75	0.80	0.0276	0.0295	0.0315
A1	0.00	- - -	0.05	0.0000	- - -	0.0020
A2	0.20 REF			0.0079 REF		
D	2.95	3.00	3.05	0.1161	0.1181	0.1201
E	2.95	3.00	3.05	0.1161	0.1181	0.1201
D1	1.45	1.60	1.75	0.0571	0.0630	0.0689
E1	1.45	1.60	1.75	0.0571	0.0630	0.0689
b	0.15	0.20	0.25	0.0059	0.0079	0.0098
e	0.40 BSC			0.0157 BSC		
L	0.35	0.40	0.45	0.0138	0.0157	0.0177

Taping Specification



PACKAGE	Q'TY/BY REEL
TQFN3X3-20	3,000 ea