USB PD Source Controller with N-FET Driver

Hynetek Semiconductor Co., Ltd.

HUSB360

FEATURES

- **USB Type C PD DFP supported**
- **USB Power Delivery (PD3.0 with PPS) Compliant, TID 5053**
  - **Max 6 Programmable FPDOs available**
  - **Max 3 Programmable APDOs available**
  - **Integrated Ra Detection and VCONN Source for e-Marker Detection**
- **Integrated N-MOSFET Driver with Softstart**
- **Built-in Shunt Regulation**
  - **Programmable Constant Voltage Control**
  - **Programmable Constant Current Control**
  - **Programmable Cable Compensation**
- **Multiple Protection Integrated**
  - **Over-Current Protection (OCP)**
  - **Over-Voltage Protection (OVP)**
  - **Short-Circuit Protection (SCP)**
  - **Over-Temperature Protection (OTP)**
  - **Under-Voltage Protection (UVP)**
- **Low Operation Current**
- **±4 kV HBM ESD Rating for USB IO pins**

APPLICATIONS

PD Adaptor

GENERAL DESCRIPTION

HUSB360 is designed for a USB Type-C PD product. It is a USB PD source only controller and can support up to 6 FPDOs with programmable voltage and current for different applications. Additionally, 3 APDOs options are also implemented to support the PPS Mode in PD3.0. All of PDOs are fully compliant with PD3.0 Rev.2.0 specs.

HUSB360 integrates an N-FET driver to enable the VBUS from VIN to perform the USB Type C connection and fault protections. It monitors the voltage and current at the connected USB Type-C port. HUSB360 implements multiple protections including OCP, SCP, OVP, OTP, UVP to turn off the power path once there is any fault triggered during normal operation.

HUSB360 also integrates the discharge path for VIN and VBUS during voltage transition. With the high integration, this simple pin count and less external components can save much board space and BOM cost.

Only 400 μA operation current is needed for HUSB360. The high ESD rating provides more reliability for the system.

TYPICAL APPLICATION CIRCUIT

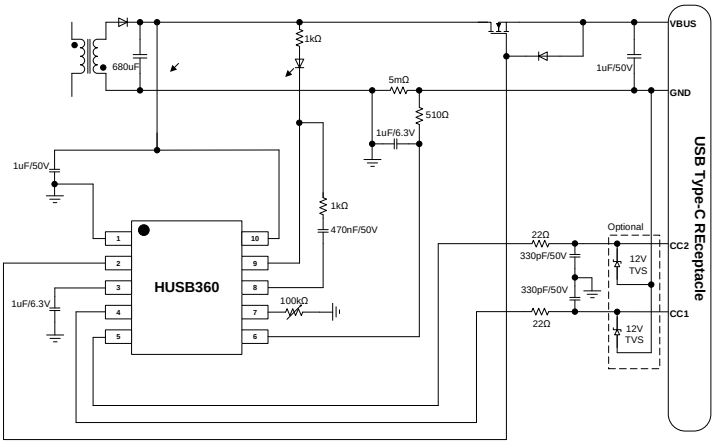


Figure 1. HUSB360 Typical Application Circuit

TABLE OF CONTENTS

REVISION HISTORY

Version	Date	Owner	Descriptions
Rev. 1.0	08/2022	Yingyang Ou	Initial version

PIN CONFIGURATION AND FUNCTION DESCRIPTIONS

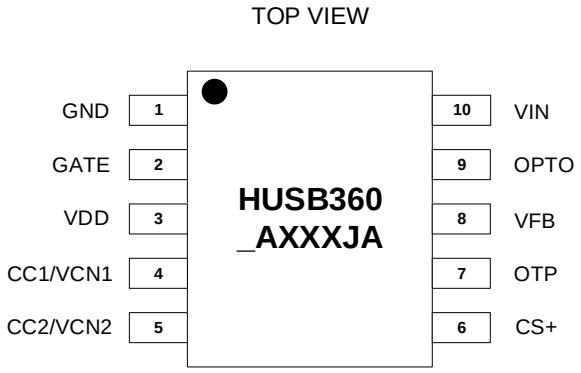


Figure 2. HUSB360_AXXXJA Pin Assignment

Table 1. HUSB360_AXXXJA Pin Function Descriptions

Pin No.	Pin Name	Type	Description
1	GND	P	Ground plane, as well as the negative sensing point for current sensing (CS+)
2	GATE	IO	N-FET gate driver output. As well as discharge path for VBUS
3	VDD	P	Output of internal LDO, connect a 1 μF decoupled ceramic cap to GND
4	CC1/VCN1	IO	CC1 line of USB type C connector. An internal pull up current source is connected to this pin to detect whether this pin is connected to the Sink. Once a valid connection is NOT detected at this pin, the internal current source is disabled or the VCONN source outputs if the eMarker detection is enabled
5	CC2/VCN2	IO	This pin is CC2 line of USB type C connector. An internal pull up current source is connected to this pin to detect whether this pin is connected to the Sink. Once a valid connection is NOT detected at this pin, the internal current source is disabled or the VCONN source outputs if the eMarker detection is enabled
6	CS+	A	Positive current sensing input of load current. Refer to GND
7	OTP	A	External temperature sensing pin. An internal current source for external temperature sensing. A 100 kΩ NTC thermistor with $B_{50/25}$=4250 K is recommended or A 200 kΩ NTC thermistor with $B_{85/25}$=4100 K also works
8	VFB	A	Voltage loop feedback point
9	OPTO	A	Connect to the opto-coupler for Isolated AC-DC coverter
10	VIN	P	Input for internal power supply. It is also the voltage sensing point for voltage regulation

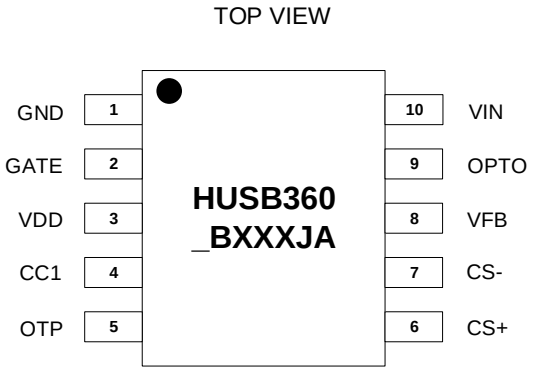


Figure 3. HUSB360_BXXXJA Pin Assignment

Table 2. HUSB360_BXXXJA Pin Function Descriptions

Pin No.	Pin Name	Type[1]	Description
1	GND	P	Ground plane, as well as the negative sensing point for current sensing (CS+)
2	GATE	IO	N-FET gate driver output. As well as discharge path for VBUS
3	VDD	P	Output of internal LDO, connect a 1 μF decoupled ceramic cap to GND
4	CC1	IO	CC1 line of USB type C connector. An internal pull up current source is connected to this pin to detect whether this pin is connected to the Sink. Once a valid connection is NOT detected at this pin, the internal current source is disabled
5	OTP	A	External temperature sensing pin. An internal current source for external temperature sensing. A 100 kΩ NTC thermistor with $B_{50/25}$=4250 K is recommended or A 200 kΩ NTC thermistor with $B_{85/25}$=4100 K also works
6	CS+	A	Positive current sensing input of load current. Refer to CS-
7	CS-	A	Reference of current sensing input of load current
8	VFB	A	Voltage loop feedback point
9	OPTO	A	Connect to the opto-coupler for Isolated AC-DC coverter
10	VIN	P	Input for internal power supply. It is also the voltage sensing point for voltage regulation

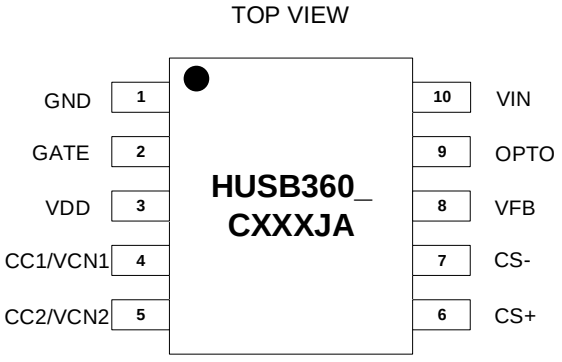


Figure 4. HUSB360_CXXXJA Pin Assignment

Table 3. HUSB360C Pin Function Descriptions

Pin No.	Pin Name	Type[1]	Description
1	GND	P	Ground plane, as well as the negative sensing point for current sensing (CS+)
2	GATE	IO	N-FET gate driver output. As well as discharge path for VBUS
3	VDD	P	Output of internal LDO, connect a 1 μF decoupled ceramic cap to GND
4	CC1/VCN1	IO	CC1 line of USB type C connector. An internal pull up current source is connected to this pin to detect whether this pin is connected to the Sink. Once a valid connection is NOT

Pin No.	Pin Name	Type[1]	Description
			detected at this pin, the internal current source is disabled or the VCONN source outputs if the eMarker detection is enabled
5	CC2/VCN2	IO	This pin is CC2 line of USB type C connector. An internal pull up current source is connected to this pin to detect whether this pin is connected to the Sink. Once a valid connection is NOT detected at this pin, the internal current source is disabled or the VCONN source outputs if the eMarker detection is enabled
6	CS+	A	Positive current sensing input of load current. Refer to CS-
7	CS-	A	Reference of current sensing input of load current
8	VFB	A	Voltage loop feedback point
9	OPTO	A	Connect to the opto-coupler for Isolated AC-DC coverter
10	VIN	P	Input for internal power supply. It is also the voltage sensing point for voltage regulation

TOP VIEW

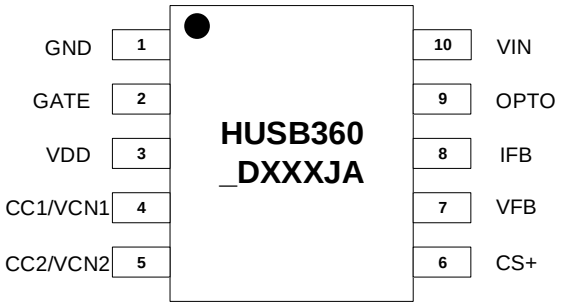


Figure 5. HUSB360_DXXXJA Pin Assignment

Table 4. HUSB360_DXXXJA Pin Function Descriptions

Pin No.	Pin Name	Type[1]	Description
1	GND	P	Ground plane, as well as the negative sensing point for current sensing (CS+)
2	GATE	IO	N-FET gate driver output. As well as discharge path for VBUS
3	VDD	P	Output of internal LDO, connect a 1 μF decoupled ceramic cap to GND
4	CC1/VCN1	IO	CC1 line of USB type C connector. An internal pull up current source is connected to this pin to detect whether this pin is connected to the Sink. Once a valid connection is NOT detected at this pin, the internal current source is disabled or the VCONN source outputs if the eMarker detection is enabled
5	CC2/VCN2	IO	This pin is CC2 line of USB type C connector. An internal pull up current source is connected to this pin to detect whether this pin is connected to the Sink. Once a valid connection is NOT detected at this pin, the internal current source is disabled or the VCONN source outputs if the eMarker detection is enabled
6	CS+	A	Positive current sensing input of load current. Refer to CS-
7	VFB	A	Voltage loop feedback point
8	IFB	A	Current loop feedback point
9	OPTO	A	Connect to the opto-coupler for Isolated AC-DC coverter
10	VIN	P	Input for internal power supply. It is also the voltage sensing point for voltage regulation

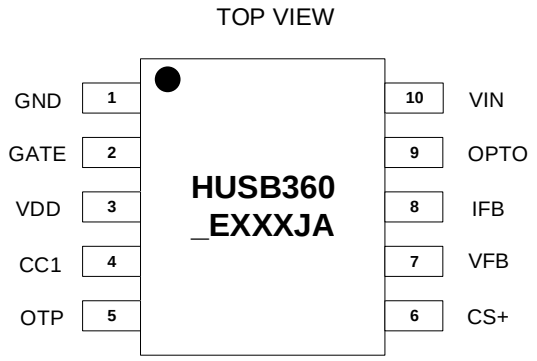


Figure 6. HUSB360_CXXXJA Pin Assignment

Table 5. HUSB360_EXXXJA Pin Function Descriptions

Pin No.	Pin Name	Type[1]	Description
1	GND	P	Ground plane, as well as the negative sensing point for current sensing (CS+)
2	GATE	IO	N-FET gate driver output. As well as discharge path for VBUS
3	VDD	P	Output of internal LDO, connect a 1 μF decoupled ceramic cap to GND
4	CC1	IO	CC1 line of USB type C connector. An internal pull up current source is connected to this pin to detect whether this pin is connected to the Sink. Once a valid connection is NOT detected at this pin, the internal current source is disabled
5	OTP	A	External temperature sensing pin. An internal current source for external temperature sensing. A 100 kΩ NTC thermistor with $B_{50/25}$=4250 K is recommended or A 200 kΩ NTC thermistor with $B_{85/25}$=4100 K also works
6	CS+	A	Positive current sensing input of load current. Refer to CS-
7	VFB	A	Voltage loop feedback point
8	IFB	A	Current loop feedback point
9	OPTO	A	Connect to the opto-coupler for Isolated AC-DC coverter
10	VIN	P	Input for internal power supply. It is also the voltage sensing point for voltage regulation

1 Legend:
A = Analog Pin
P = Power Pin
D = Digital Pin
I = Input Pin
O=Output Pin

RECOMMENDED OPERATING CONDITIONS

Table 6.

Parameter	Rating
VIN Input Voltage	3.15 V to 22.05 V
Operating Junction Temperature Range	-20°C to 125°C
Operating Ambient Temperature Range	-20°C to 105°C

SPECIFICATIONS

V_{IN} = 3.15 V to 22.05 V, T_A = −20°C to 105°C for minimum and maximum specifications and T_A = 25°C for typical specifications, unless otherwise noted.

Table 7. Electrical Characteristics Table

Parameter	Symbol	Test Conditions/Comments	Min	Typ	Max	Unit
Power Supply						
Supply Voltage UVLO Threshold	V_{IN_UVLO}	Rising edge		3.1		V
Supply Voltage UVLO Hysteresis	$V_{IN\_UVLO\_Hys}$			0.4		V
Supply Current	I_{IN}	CC is attached, V_{IN}=5V		2.5		mA
Quiescent Current	I_Q	CC1,CC2 are unattached, V_{IN}=5V		0.4		mA
VDD						
Internal Regulator Output	V_{DD}			1.8		V
Type C Pull up Current Source						
Default Current Source	I_{RP_DFT}		64	80	96	µA
1.5A Current Source	$I_{RP\_1.5A}$		166	180	194	µA
3A Current Source	I_{RP_3A}		304	330	356	µA
Rd detection threshold 1	$vR_{d\_OPEN\_1.5A}$	80 µA and 180 µA R_p current source is enabled		1.6		V
Rd detection threshold 2	$vR_{d\_OPEN\_3A}$	330 µA R_p current source is enabled		2.6		V
Ra detection threshold 0	vR_{a_DEF}	80 µA R_p current source is enabled		0.2		V
Ra detection threshold 1	$vR_{a\_1.5A}$	180 µA R_p current source is enabled		0.4		V
Ra detection threshold 2	vR_{a_3A}	330 µA Rp current source is enabled		0.8		V
VCONN Source (HUSB360_A/C/D)						
VCONN Voltage Range	V_{VCONN}	V_{IN}=3.3 V to5.5 V and VCONN is enabled	3	5	5.5	V
VCONN Current Limit	I_{VCONN}	Current Limit when VCONN is sourcing		60		mA
VCONN Discharge Resistor	R_{dch}	Discharge resistance applied in Discharge Mode		1		kΩ
Type C PD BMC Receiver						
Receiver Input Impedance	z_{BmcRx}	Input impedance of Rx	1			MΩ
Type C PD BMC Transmitter						
Bit Rate	$f_{BitRate}$		270	300	330	kbps
Fall Time	t_{Fall}	10 % and 90 % amplitude points, unloaded condition	300			ns
Rise Time	t_{Rise}	10 % and 90 % amplitude points, unloaded condition	300			ns
Voltage Swing	v_{Swing}	CC pull down resistor >800 Ω	1.05	1.125	1.2	V
Voltage Low	v_{Low}	CC pull down resistor >800 Ω	-75	0	75	mV
Transmitter output impedance	z_{Driver}	Tx output impedance at 750 kHz with CC attached	30		75	Ω
Voltage Control						
Voltage Sense Scaling Factor				10		
VIN Step LSB	V_{LSB}			20		mV

Parameter	Symbol	Test Conditions/Comments	Min	Typ	Max	Unit
Regulation Accuracy	$v_{SRCValid}$	V_{IN}=5 V to 20 V	-3		3	%
Cable Compensation	R_{comp}	VIN compensation when Cable Comp=00b, V_{CS+}=5 mV		0		V
		VIN compensation when Cable Comp=01b, V_{CS+}=5 mV		0.05		V
		VIN compensation when Cable Comp=10b, V_{CS+}=5 mV		0.1		V
		VIN compensation when Cable Comp=11b, V_{CS+}=5 mV		0.15		V
Active load for transition	I_{ALD}	ALD is enabled if implemented as a current source	68	80	92	mA
ALD Timeout	t_{ALDTM}	Timeout of ALD conduction		300		ms
Current Control						
Current Sense Amplifier Gain	I_{GAIN}			53		
Current Sense Reference LSB	I_{LSB}			10		mA
Constant Current Accuracy		RDO current is 3 A, T_A=25°C	-5		5	%
		RDO current is 3 A, T_A=-20°C to 105°C	-10		10	%
Sensing Resistor	R_{CS}	GND Return Current Sensing, CS+ refer to GND		5		mΩ
GATE						
GATE Driver Voltage	V_{GATE}	With respect to VIN	4	7	10	V
GATE Sourcing Current	I_{GATE_ON}	EN_GATE=1 to drive the external FET		20		µA
GATE Discharger Current Source	I_{DISG}	EN_GATE=0, Discharger Current from GATE to GND		60		mA
Over Voltage Protection						
Over-voltage Protection Threshold	V_{IN_OV}	OVP Option 1, refer to VREF	103	110	117	%
		OVP Option 2, refer to VREF	108	115	122	%
		OVP Option 3, refer to VREF, Default	113	120	127	%
		OVP Option 4, refer to VREF	118	125	132	%
OVP Debounce	t_{OVP}	From OVP trigger to GATE is turned off		5		µs
OVP Hysteresis	OV_{Hys}			1		%
CC1 OV Threshold	V_{CC_OV1}			6.5		V
CC2 OV Threshold	V_{CC_OV2}			6.5		V
CC_OV Debounce Time	t_{CC_OV}			50		µs
Under Voltage Protection						
UVP Threshold	V_{IN_UV}	UVP is enabled, refer to VREF	75	80	85	%
UVP Debounce	t_{UVP}			1		ms
UVP Hysteresis	UV_{Hys}			1		%
Over Current Protection						
OCP threshold option 1	I_{INOCP1}	OC Rate=110%, T_A=25°C	105	110	115	%
		OC Rate=110%, T_A=-20°C to 105°C	100	110	120	%
OCP threshold option 1 debounce	tocp1	Peak Current Cap=00b		5		ms
		Peak Current Cap=01b		10.5		ms
OCP threshold option 2	I_{INOCP2}	OC Rate=115%, T_A=25°C	110	115	120	%
		OC Rate=115%, T_A=-20°C to 105°C	105	115	125	%
OCP threshold option 2 debounce	tocp2	Peak Current Cap=00b		5		ms
OCP threshold option 3	I_{INOCP3}	OC Rate=120%, T_A=25°C	115	120	125	%
		OC Rate=120%, T_A=-20°C to 105°C	110	120	130	%
OCP threshold option 3 debounce	tocp3	Peak Current Cap=00b		5		ms
OCP threshold option 4	I_{INOCP4}	OC Rate=125%, T_A=25°C	120	125	130	%
		OC Rate=125%, T_A=-20°C to 105°C	115	125	135	%

Parameter	Symbol	Test Conditions/Comments	Min	Typ	Max	Unit
OCP threshold option 4 debounce	tocp4	Peak Current Cap=00b		5		ms
		Peak Current Cap=01b		2.5		ms
		Peak Current Cap=10b		10.5		ms
OCP threshold option 5	I_{INOCP5}	OC Rate=150%, T_A=25°C	140	150	160	%
		OC Rate=150%, T_A=-20°C to 105°C	135	150	165	%
OCP threshold option 5 debounce	tocp5	Peak Current Cap=01b		1.5		ms
		Peak Current Cap=10b		2.5		ms
		Peak Current Cap=11b		10.5		ms
OCP threshold option 6	I_{INOCP6}	OC Rate=175%, T_A=25°C	165	175	185	%
		OC Rate=175%, T_A=-20°C to 105°C	160	175	190	%
OCP threshold option 6 debounce	tocp6	Peak Current Cap=11b		2.5		ms
OCP threshold option 7	I_{INOCP7}	OC Rate=200%, T_A=25°C	190	200	210	%
		OC Rate=200%, T_A=-20°C to 105°C	185	200	215	%
OCP threshold option 7 debounce	tocp7	Peak Current Cap=10b or 11b		1.5		ms
Short-circuit Protection Threshold	I_{IN_SCP}			12		A
SCP Debounce	tSCP_DEB	From SCP trigger to GATE is turned off		50		μs
Over Temp Protection						
TSD Protection Threshold	TSD	Internal temperature sense		140		℃
TSD Hysteresis	TSD_{Hys}	Falling edge to recover		20		℃
OTP Current Source	I_{OTP}			80		μA
Default OTP Threshold	V_{OTP_DEF}	Falling edge voltage at OTP pin, for 100 kΩ NTC thermistor		0.21		V
		Falling edge voltage at OTP pin, for 200 kΩ NTC thermistor		0.42		V
OTP Hysteresis		For 100 kΩ NTC thermistor		0.21		V
		For 200 kΩ NTC thermistor		0.42		V
OTP Debounce time		From OTP trigger to GATE is turned off		100		ms

1

ABSOLUTE MAXIMUM RATINGS

Table 8.

Parameter	Rating
VIN, OPTO, CC1,CC2 to GND	−0.3 V to 30 V
GATE to GND	−0.3 V to 35 V
VFB, IFB, CS+, OTP, CS- to GND	−0.3 V to 6.5 V
VDD to GND	−0.3 V to 2 V
Operating Junction Temperature Range	−40°C to 125°C
Soldering Conditions	JEDEC J-STD-020
Electrostatic Discharge (ESD)	
Human Body Model	±4000 V
Charged Device Model	±500 V

Stresses at or above those listed under Absolute Maximum Ratings may cause permanent damage to the product. This is a stress rating only; functional operation of the product at these or any other conditions above those indicated in the operational section of this specification is not implied. Operation beyond the maximum operating conditions for extended periods may affect product reliability.

THERMAL RESISTANCE

Thermal performance is directly linked to printed circuit board (PCB) design and operating environment. Close attention to PCB thermal design is required.

θ_{JA} is the natural convection junction to ambient thermal resistance measured in a one cubic foot sealed enclosure.

θ_{JC} is the junction to case thermal resistance.

Table 9. Thermal Resistance

Package Type	θ_{JA}	θ_{JC}	Unit
SSOP-10	86	37	°C/W

ESD CAUTION

Electrostatic Discharge Sensitive Device.

Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

FUNCTIONAL BLOCK DIAGRAM

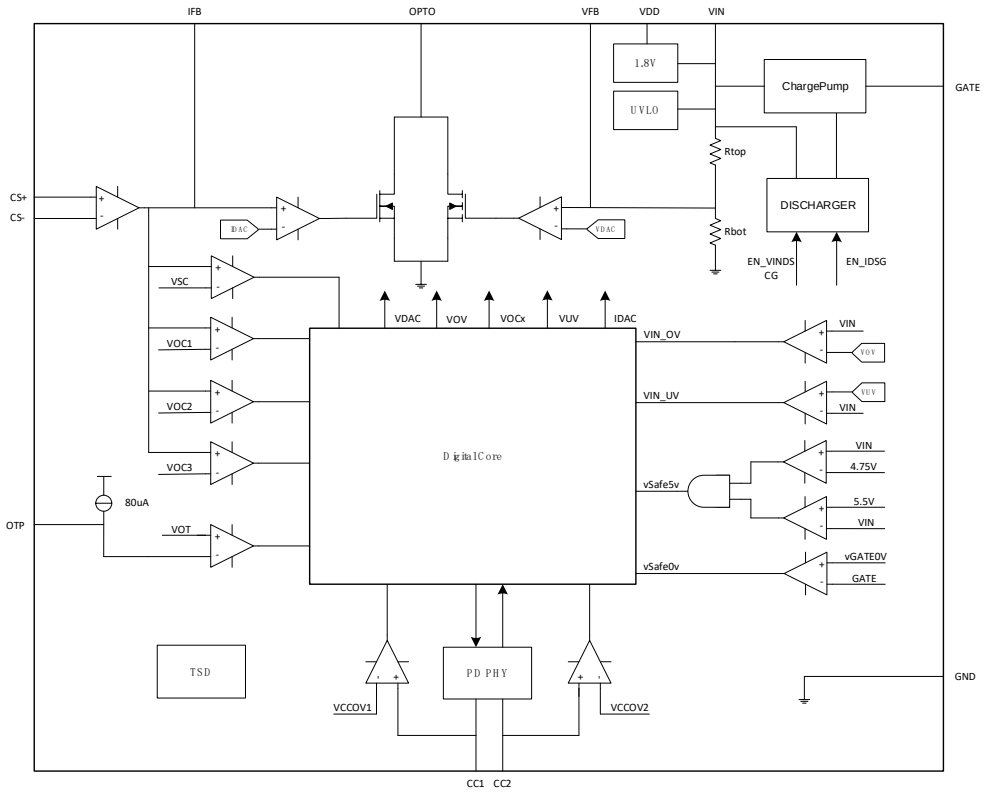


Figure 7. HUSB360 Functional Block Diagram

THEORY OF OPERATION

VIN PIN

VIN pin is the power supply input, which is derived from the output of the AC-DC or DC-DC converter. Connect a 1 μF decoupling MLCC between VIN pin and GND pin.

The VIN pin is also connected to an internal MOSFET and source current, which is used as a bleeder to help discharge the energy stored in the output capacitor. With this bleeder, VIN can be regulated to vSafe5V upon the detachment of a connected device, or to a lower desired output voltage level upon a request command received from the Sink, such as from 20 V to 5 V.

VDD PIN

An internal liner regulator is used to provide 1.8 V for internal circuits. Connect a 1 μF MLCC to VDD pin for decoupling.

CONTROL LOOP COMPENSATION CIRCUIT (VFB, CS+, CS−, IFB, OPTO PINS)

In the HUSB360, the constant voltage loop (CV loop) compensation and constant current loop (CC loop) compensation are implemented. VIN voltage is scaled by a resistor divider to be as the feedback voltage. It is compared with the internal voltage reference to generate an error signal. The CV loop can compensate this error signal. And then the compensated signal is employed to drive the primary side of the opto-coupler and control the AC-DC power loop.

SLEW RATE CONTROL

The HUSB360 implements multiple fixed voltage slew rates for positive direction, which are 15 V/ms, 7.5 V/ms, 3.75 V/ms, 250 mV/ms, 150 mV/ms, 100 mV/ms, 83 mV/ms and 71 mV/ms. The default slew rate for positive direction is 250 mV/ms. The HUSB360 also implements multiple fixed voltage slew rates for negative direction, which are 1 V/ms, 0.5 V/ms, 250 mV/ms, 187.5 mV/ms, 150 mV/ms, 125 mV/ms, 100 mV/ms, and 83 mV/ms. The default slew rate for negative direction is 100mV/ms.

IR COMPENSATION

IR compensation is available in all PDOs. The default IR compensation is 50 mV/A.

For example, if 50 mV/A IR compensation is selected in 5 V/3 A condition, the actual VIN voltage is:

$$5\ V + 3\ A \times 50\ mV/A = 5.15\ V$$

CURRENT SENSE RESISTOR

The recommended current sense resistor is 5 mΩ. The sensed current information is employed to perform OCP, SCP and Constant Current Control.

CC1 AND CC2 PINS

CC1 and CC2 pins are used to detect Type-C connection, BMC communication.

TYPE-C CC FUNCTION

CC1 and CC2 are the Configuration Channel pins used for connection and attachment detection, plug orientation determination and system configuration management across USB Type-C cable.

The HUSB360 monitors the status of CC1 and CC2 pins and decide which state the HUSB360 should enter.

CC1 and CC2 are configured as Source mode with default, 1.5 A and 3 A current advertising. The default R_p current on CC1 and CC2 is I_{CC_3P0}, which means 3 A current advertising.

The CC1 and CC2 can tolerance a voltage up to 30 V. This is helpful for the HUSB360 to survive in the failure when the CC1 or CC2 is shorted to the VBUS pin.

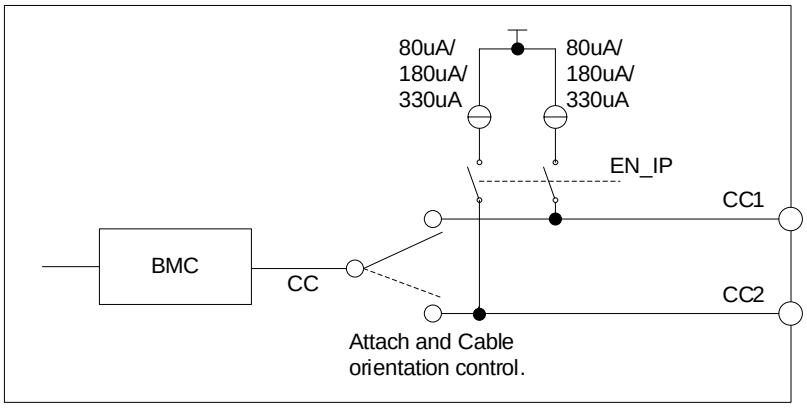


Figure 8. CCx Hardware Diagram

BMC DRIVER

Through the Type-C detection, one of the CC pins will be connected to the internal BMC block to achieve PD communication.

VCONN POWER AND EMARKER DETECTION

The HUSB360 supports VCONN power and USB eMarker (such as HUSB330, HUSB331 or HUSB332) detection function. The USB PD protocol defines that if an adapter is not with a captive cable, when the adapter has a PD output current more than 3 A, it's PD controller must support VCONN power supply and eMarker detection function.

For example, in a 90 W PD power adapter, when the HUSB360 detects the eMarker IC in the cable which indicates that the cable current rating is 5 A current, the HUSB360 can advertise a preset 20 V/4.5 A output capability, and then the sink device can draw 90 W power. If the HUSB360 does not detect an eMarker IC or the current rating indicated by the eMarker IC is only 3 A, the HUSB360 can only advertise maximum 3A output current capability, and the sink device can only draw maximum power of 60W.

VSAFE0V DETECTION

When the HUSB360 is attached with a Sink, it detects whether the VBUS voltage is within vSafe0V. If yes, the HUSB360 enters Attached.SRC state. If no, it will stay at AttachWait.SRC state.

GATE PIN

GATE pin has two main purposes. One is to drive an external N-MOSFET. When the HUSB360 is attached , HUSB360 enables the charge pump (Refer to VIN) so that the N-FET driver is charged to drive the external N-FET to be conducted. The GATE pin controls the power path from VIN to VBUS, as well as the PD device. The other is the discharger path of VBUS integrates an internal current source IDISG to dissipate the energy stored in the VBUS capacitors. The current source can be configures as 60mA.

OVER VOLTAGE PROTECTION

The HUSB360 detects the VIN pin voltage to achieve over-voltage protection function. The thresholds to trigger over-voltage protection are 110%, 115%, 120% and 125% of the V_{IN_REF}. When the over-voltage condition occurs, the HUSB360 disables the GATE pin. When the over-voltage condition is removed, the HUSB360 is reset to default mode and will automatic recover again.

UNDER VOLTAGE PROTECTION

The HUSB360 detects the VIN pin voltage to achieve under-voltage protection function. The threshold to trigger under-voltage protection is 80% of the VIN_REF. When the under-voltage condition occurs, the HUSB360 disables the GATE pin. When the over-voltage condition is removed, the HUSB360 is reset to default mode and will automatic recover again.

OVER CURRENT PROTECTION

When the current sensed by the sense resistor exceeds the thresholds, which are 110%, 120%, 125%, 150%, 175% and 200% of I_{IN_REF}, the over-current protection takes action and the GATE is also disabled. When the over-current condition is removed, the HUSB360 is reset to default mode and will automatic recover again.

HUSB360 supports additional debounce time options in PD mode, which are 1/2/4 times of the t_{ocp}.

SHORT CIRCUIT PROTECTION

The HUSB360 integrates SCP protection function. When the VBUS is hard shorted to GND by fault, the output current increases sharply. When the output current reaches the SCP threshold, the protections circuit takes action and turns off the external load switch. When the short condition is removed, the HUSB360 is reset to default mode and will automatic recover again.

OVER TEMPERATURE PROTECTION

HUSB360 uses the OTP pin to sense the external temperature with higher accuracy. There is an internal current source I_{OTP} at the OTP pin. With an external NTC resistor from OTP pin to ground, HUSB360 can detect the voltage across this NTC resistor and calculate the temperature per the T-R characteristics. The external NTC resistor is required to be 100 kΩ with $B_{50/25}$=4250 K. The second NTC resistor is required to be 200 kΩ with $B_{85/25}$=4100 K.

THERMAL SHUT DOWN

When the junction temperature rises across T_{TSD}, thermal shut down takes action and the GATE is disabled. When the junction temperature falls across T_{TSD}-T_{TSD_HYS}, the HUSB360 is reset to default mode and will automatic recover again.

TYPICAL APPLICATION CIRCUITS

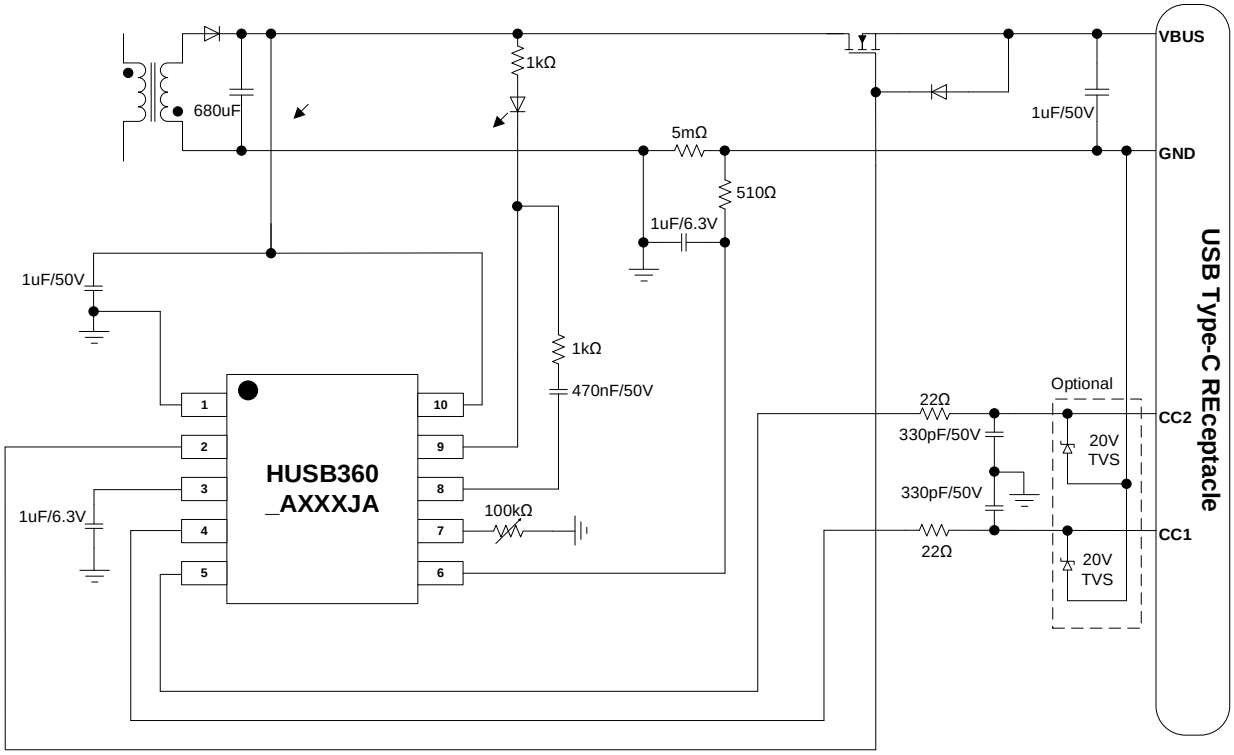


Figure 9. Typical Configuration: PD Adaptor with Type C Receptacle (HUSB360_AXXXJA)

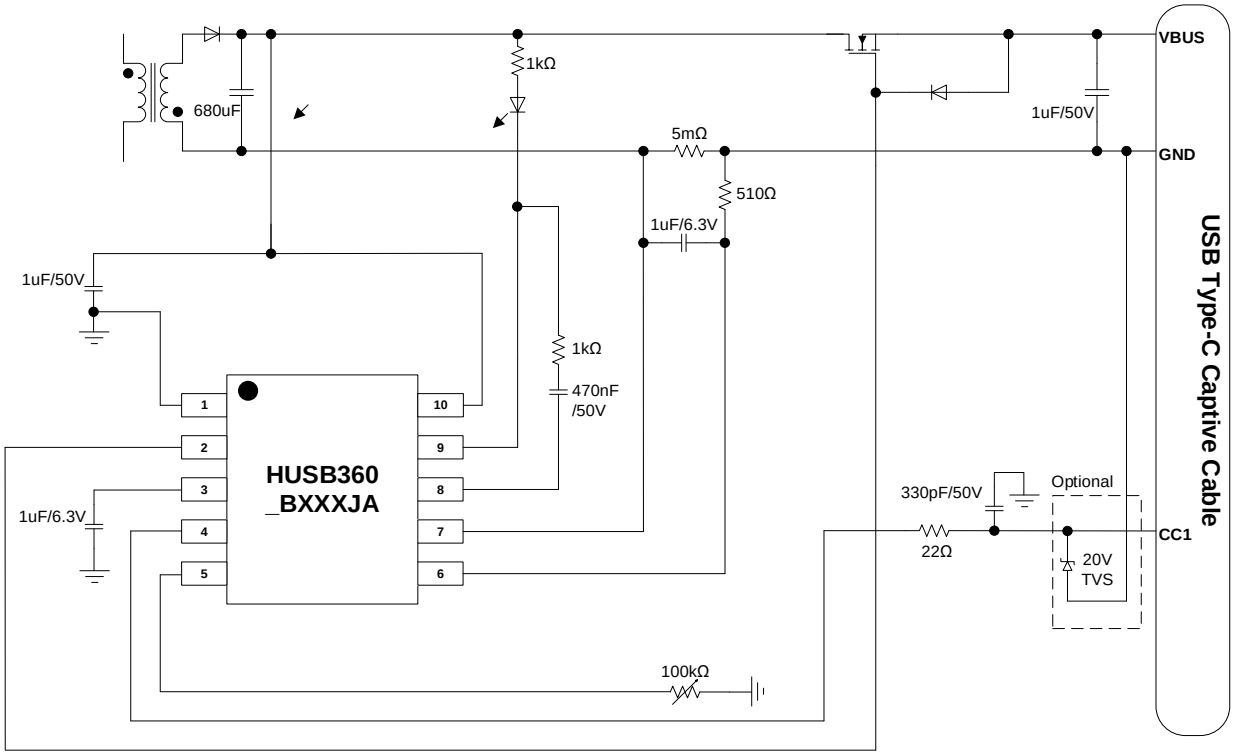


Figure 10. Typical Configuration: PD Adaptor with Type C Captive Cable (HUSB360_BXXXJA)

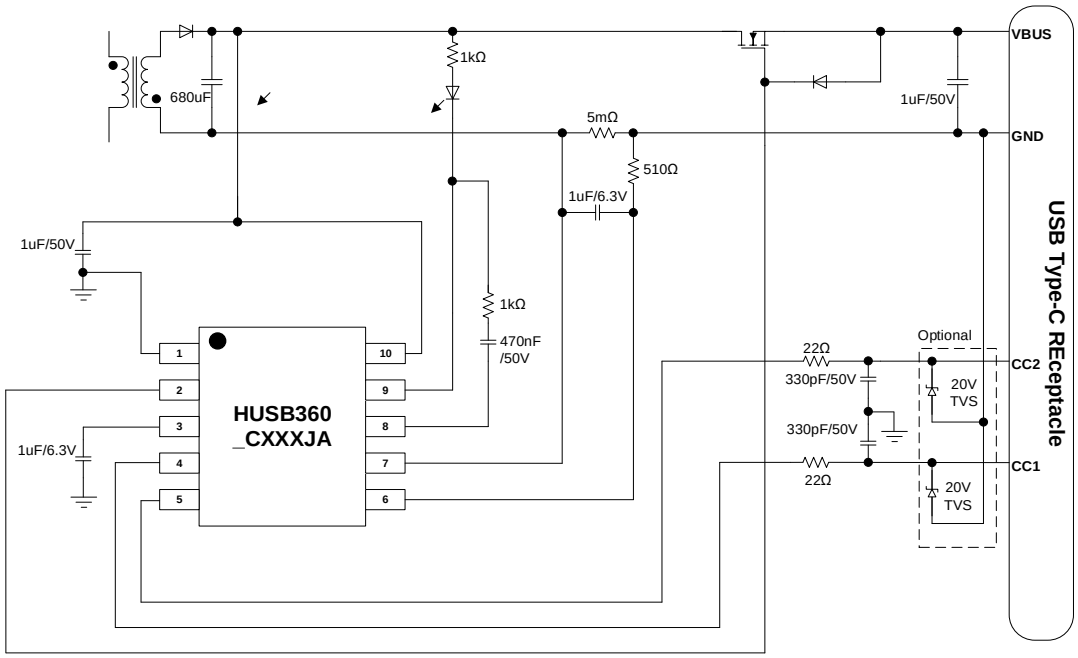


Figure 11. Typical Configuration: PD Adaptor with Type C Receptacle (HUSB360_CXXXJA)

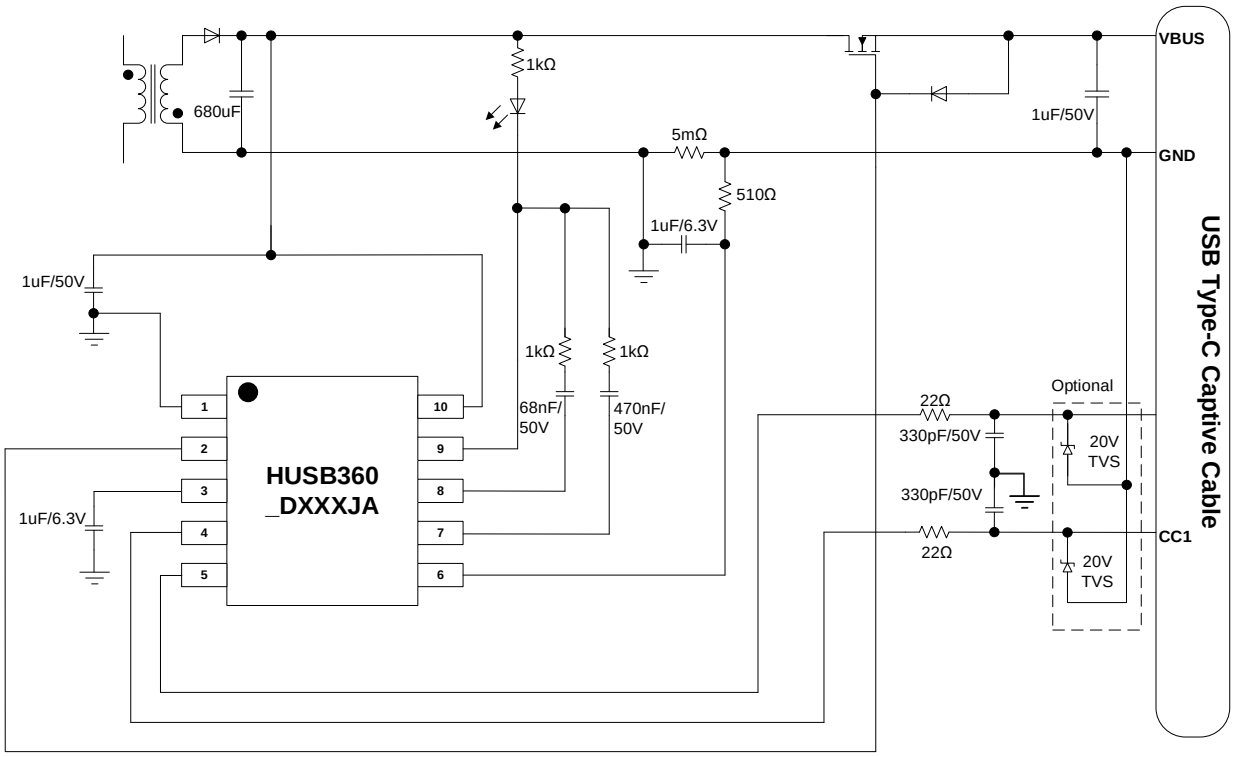


Figure 12. Typical Configuration: PD Adaptor with Type C Receptacle (HUSB360_DXXXJA)

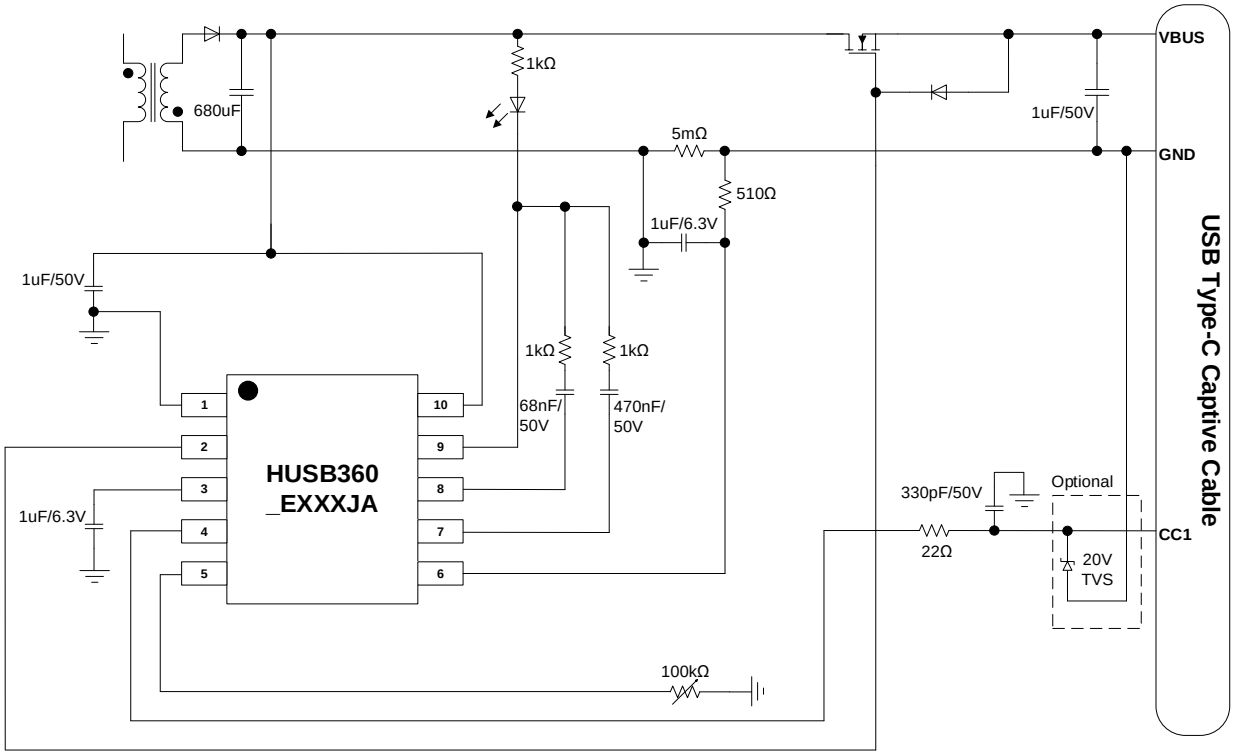
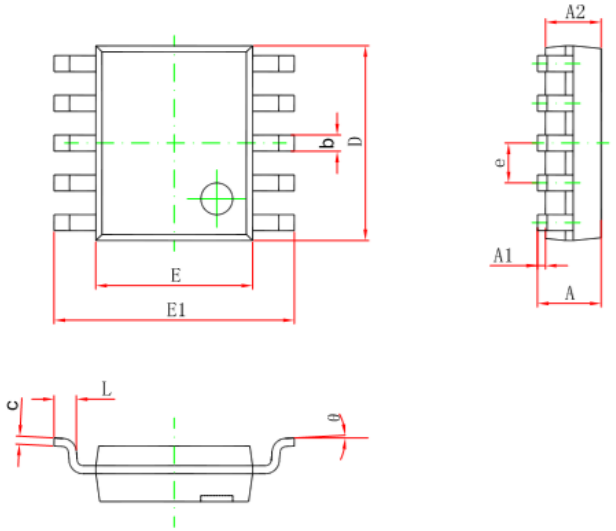


Figure 13. Typical Configuration: PD Adaptor with Type C Captive Cable(HUSB360_EXXXJA)

PACKAGE OUTLINE DIMENSIONS



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.300	0.450	0.012	0.018
c	0.170	0.250	0.007	0.010
D	4.700	5.100	0.185	0.201
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.000(BSC)		0.039(BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	1°	8°

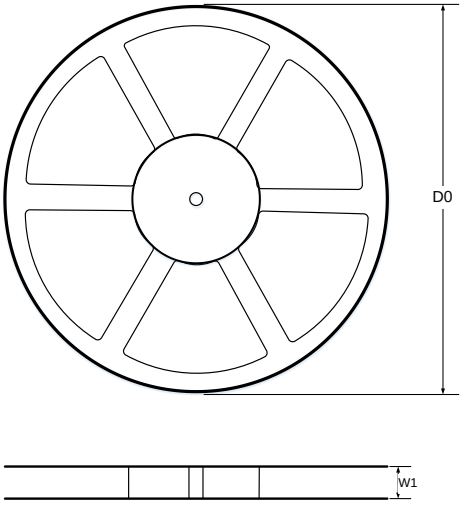
Figure 14. HUSB360 Dimension

ORDERING GUIDE

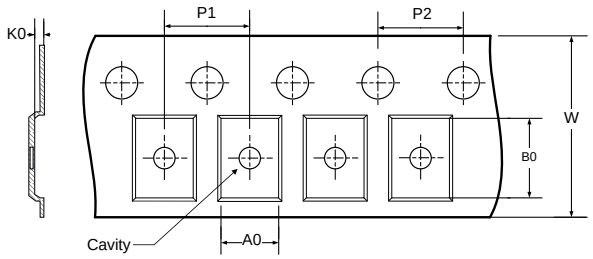
Model	Package	Power Settings							MSL	Quantity
HUSB360_E001JA	SSOP10	5V3A	9V3A	15V3A	20V3.25A	/	5-11V/3A	5-21V/3A	MSL3	Tape & Reel, 4K
HUSB360_E002JA	SSOP10	5V3A	9V3A	15V3A	20V3.25A	/	5-11V/3A	5-21V/3A	MSL3	Tape & Reel, 4K
HUSB360_E003JA	SSOP10	5V3A	9V3A	15V3A	20V3.25A	/	5-11V/3A	5-21V/3A	MSL3	Tape & Reel, 4K
HUSB360_E005JA	SSOP10	5V3A	9V3A	15V3A	20V3.25A	/	5-11V/3A	5-21V/3A	MSL3	Tape & Reel, 4K

TAPE AND REEL INFORMATION

REEL DIMENSIONS

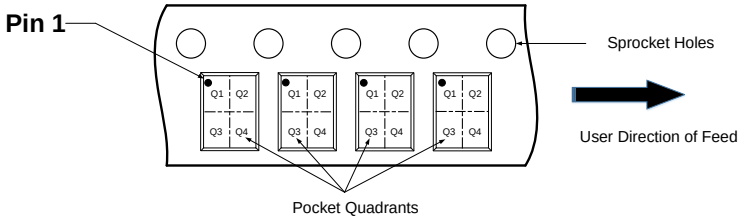


TAPE DIMENSIONS



A0：Dimension designed to accommodate the component width
B0：Dimension designed to accommodate the component length
K0：Dimension designed to accommodate the component thickness
W： Overall width of the carrier tape
P1：Pitch between successive cavity centers
P2：Pitch between sprocket hole
D0：Reel Diameter
W1：Reel Width

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



DIMENSIONS AND PIN1 ORIENTATION

D0 (mm)	W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
330.00	12.40	6.40	5.40	2.10	8.00	4.00	12.00	Q1

All dimensions are nominal

Figure 15. Tape and Reel Information

IMPORTANT NOTICE

Hynetek Semiconductor Co., Ltd. and its subsidiaries (Hynetek) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as “components”) are sold subject to Hynetek’s terms and conditions of sale supplied at the time of order acknowledgment.

Hynetek warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in Hynetek’s terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent Hynetek deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

Hynetek assumes no liability for applications assistance or the design of Buyers’ products. Buyers are responsible for their products and applications using Hynetek components. To minimize the risks associated with Buyers’ products and applications, Buyers should provide adequate design and operating safeguards.

Hynetek does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which Hynetek components or services are used. Information published by Hynetek regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from Hynetek under the patents or other intellectual property of Hynetek.

Reproduction of significant portions of Hynetek information in Hynetek data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Hynetek is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of Hynetek components or services with statements different from or beyond the parameters stated by Hynetek for that component or service voids all express and any implied warranties for the associated Hynetek component or service and is an unfair and deceptive business practice.

Hynetek is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of Hynetek components in its applications, notwithstanding any applications-related information or support that may be provided by Hynetek. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify Hynetek and its representatives against any damages arising out of the use of any Hynetek components in safety-critical applications.

In some cases, Hynetek components may be promoted specifically to facilitate safety-related applications. With such components, Hynetek’s goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No Hynetek components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those Hynetek components which Hynetek has specifically designated as military grade or “enhanced plastic” are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of Hynetek components which have not been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

Hynetek has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, Hynetek will not be responsible for any failure to meet ISO/TS16949.

Please refer to below URL for other products and solutions of Hynetek Semiconductor Co., Ltd.