HYASiC
Digital Power ASIC

PD3.1 USB TYPE-C ROTOCOL CONTROLLER HYC5320

REVISION 0.3

DOCUMENTATION NUMBER:
DS_HYC5320_R0.3

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Integration Path Power Switch Daul Ports Controller

1 Features

- USB PD3.1 SPR with PPS certified, **TID 10544**
- USB Type-C 2.2 and USB PD 3.1 / 2.0 Compliant
  - Support 5V, 9V, 12V FPDOs
  - Support 2 programmable APDOs
  - Support USB Type-C 2.2 DFP
- Support BC1.2 DCP and HVDCP Protocols
  - QC2.0 / QC3.0 / QC3.0+ Class A
  - Huawei FCP / SCP
  - Samsung AFC
  - Apple 2.4 A
  - BC1.2 DCP
  - PE+ 1.1 / 2.0
- Safety Integration
  - Over voltage protection
  - Over current protection
  - Output short protection
  - Over-temperature Protection
  - CC1 / CC2 / DP / DM overvoltage protection
  - NTC
  - UVLO
- Integration Low R_{DSON} Path Power Load-switch
- Support External 10 mΩ current sense
- As low as 10 mA light load detection
- Integration discharge
- Programable Cable drop compensation
- Support Constant Current and Constant Voltage Loop
- Adaptive power control by Temperature
- Support Dual Chip Power Link
- Support Online Update
- HBM ESD ± 4 kV rating for all pins
- QFN-28L (4 mm x 4 mm)

2 Applications

- Adaptor
- Power Strip

3 Description

The HYC5320 is a high performance, high integration USB Type-C Power Delivery and Type-A Daul Ports Controller. It integrates two ultra-low impedance Path Power Switch. The HYC5320 supports 3 FPDOs and 2 APDOs with programmable current and voltage which are fully compliant with USB Power Delivery Specification Revision 3.1, Version 1.8. Besides, the HYC5320 also supports BC1.2 DCP, Apple 2.4A, QC2.0 / QC3.0 / QC3.0+, AFC, FCP, SCP and PE+ 1.1 / 2.0 protocols.

The HYC5320 designed for dual ports controller, which can easily use to a USB Type-C and a USB Type-A dual port application. Each port operates independently in fast charging mode and power is shared when both ports-working.

The HYC5320 integrates Chip-Link technology, making it easy to achieve multiple port applications.

The HYC5320 integrates perfect protection such as Over Voltage Protection (OVP), Under Voltage Lockout (UVLO), Over Current Protection (OCP), output short protection, CC or DP DM Over Voltage Protection and Over-temperature Protection.

The HYC5320 is available in QFN-28L (4 mmx4 mm) package.

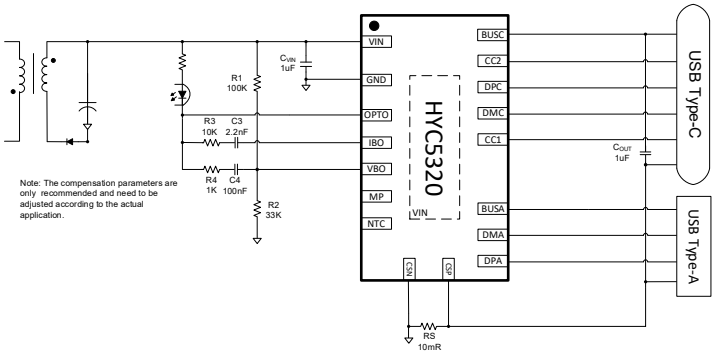
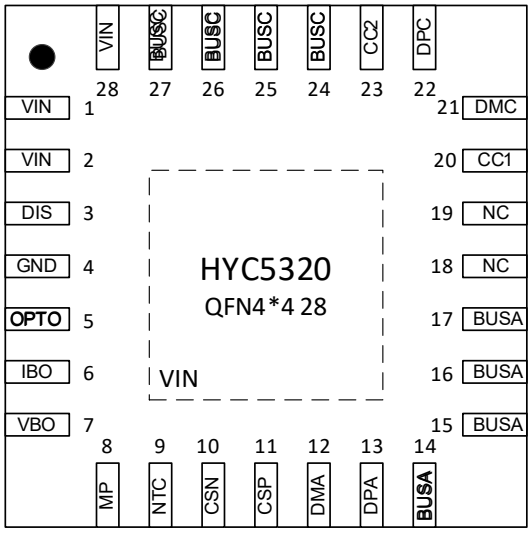


Fig. 1. Typical Application Schematic

4 Pin Configurations and Function Descriptions



QFN-28L (4 mmx4 mm)

Fig. 2. Packages Top View

Table 1. Pin Function Descriptions

Pin	Name	Description
1, 2, 28	VIN	Power supply for internal circuits and the input voltage sense, connect a 1 uF capacitor from this pin to GND
3	DIS	External discharge loop control, could connect a resistor to VIN when used. When used for car charging, it can be used as bus voltage detection
4	GND	Ground
5	OPTO	Optical coupler
6	IBO	Current feedback compensation
7	VBO	Output voltage feedback and compensation
8	MP	Communication with another chip through this pin if Power link function enable. If not used must tie to GND net
9	NTC	An external negative temperature coefficient resistor connected to this pin for remote temperature sensing
10	CSN	Current detection negative point
11	CSP	Current detection positive point
12	DMA	USB Type-A DM
13	DPA	USB Type-A DP
14, 15, 16, 17	BUSA	Internal N-MOSFET Source and the BUSA voltage sense, connected to USB Type-A VBUS
18, 19	NC	
20	CC1	Configuration channel interface pin to USB Type-C
21	DMC	USB Type-C DM
22	DPC	USB Type-C DP
23	CC2	Configuration channel interface pin to USB Type-C
24, 25, 26, 27	BUSC	Internal N-MOSFET Source and the BUSC voltage sense, connected to USB Type-C VBUS
EP	VIN	Internal N-MOSFET Drin, must connected to Vin net

5 Specification

5.1 Absolute Maximum Ratings

Table 2. Absolute Maximum Ratings

Parameter	Min	Max	Unit
VBO, IBO, CSN, CSP, NTC, MP	-0.3	6.5	V
VIN, BUSC, BUSA, OPTO, DIS, CC1, CC2, DPC, DMC, DPA, DMA	-0.3	16	V
Junction Temperature Range	-40	150	°C
Ambient Temperature Range	-40	85	°C
Storage Temperature Range	-55	150	°C
Lead Temperature Range (Soldering 10 sec)		260	°C
ESD Human Body Model (100 pF Capacitance, Series 1.5 KΩ)	-4000	+4000	V

Note: Exceeding the specified limits for the operating conditions of the device can result in permanent damage to the device. The parameters provided are only the limit values for the operating conditions, and operating the device outside of the recommended working conditions is not advisable. The device's reliability may be affected by prolonged operation under extreme conditions.

5.2 Recommended Operating Conditions

Table 3. Recommended Operating Conditions

Parameter	Min	Max	Unit
Input Voltage VIN	3	13.8	V
Junction Temperature Range	-40	150	°C

5.3 Electrical Characteristics

V_{in} = 5 V, T_{AMB} = 25 °C (unless noted otherwise)

Table 4. Electrical Characteristics

Symbol	Parameter	Test Conditions	Min	Typ.	Max	Unit
VIN						
V_{IN}	Input Voltage		3		13.8	V
V_{IN_UVLO}		Rising		3.27		V
$V_{IN\_UVLO\_HYS}$	Input Under-Voltage Lockout (UVLO)			0.2		V
I_Q	Input Quiescent Current	CC Locked		2.5		mA
		CC Unlocked		200		uA
VOUT						
V_{OVP_TH}	V_{OUT} = 5V	For fixed PDO. For the continuous mode, it will select the threshold based on the range		6		V
	V_{OUT} = 9V			10.5		V
	V_{OUT} = 12V			13.8		V
R_{DSON} of Internal Switch MOSFEET						
R_{DSONC}	Internal N-MOSFET			11		mΩ
R_{DSONA}	Internal N-MOSFET			11		mΩ
Discharge						
I_{DIS}	Discharge Current	VOUT=12V			130	mA
R_{VBUS}	Bleeding resistor			100		kΩ
BMC Transmitter (CC1, CC2)						
$_{Z}$Driver	TX Output Impedance		30	54	70	Ω
V_{Swing}	BMC Amplitude		1.050	1.125	1.200	V
V_{TXLOW}	Transmit LOW				75	mV
$f_{BitRate}$	BMC Rate		270	300	330	kbps
BMC Receiver (CC1, CC2)						
V_{RXHI}	Receiver HIGH	Rising edge		840		mV
V_{RXLOW}	Receiver LOW	Falling edge		530		mV
Type-C DFP specification (CC1, CC2)						
V_{D_SRC3A}	Detach threshold when detached in 3A DFP mode	Rising threshold	2.5	2.625	2.75	V
		Hysterias		0.05		V
V_{Rd_SRC3A}	Ra, Rd detection threshold in 3A mode (falling)	0V ⩽ V_{CCx} ⩽ 2.5V	0.75	0.79	0.83	V
		Hysterias		0.02		V
I_{RP_SRC}	CC1/CC2 Broadcasting current	3A DFP, R_D=5.1K	1.6	1.68	1.76	V
$T_{CCDebounce}$	Deglitch filter for UFP attach detection		120	150	180	ms
$T_{PDDebounce}$	Deglitch filter for UFP detach detection		12	15	18	ms
Constant Current						
CC	Constant current point	Configurable				
OCP	Short current protection	Rsense = 10 mΩ		16		A
HVDCP interface (DP, DM)						

Symbol	Parameter	Test Conditions	Min	Typ.	Max	Unit
V_{DAT_REF}	Data threshold voltage		0.25	0.325	0.4	V
$T_{DP\_DEGLTICH\_HIGH}$	Denounce time for DP high detection			1.1		s
$T_{DM\_DEGLTICH\_LOW}$	Denounce time for DM low detection			1		ms
T_{VOUT_CHG}	Denounce time for VOUT variation		20	40	60	ms
R_{DP_LKG}	DP Leakage resistor			650		kΩ
R_{DM_DWN}	DM Pull down resistor			20		kΩ
V_{TH_PD}	Device connection threshold		0.25	0.325	0.4	V
TD_{PD}	Debounce time for device connection detection		120	160	200	ms
ΔI_{UP}	Voltage step up current	R1= 100 kΩ		0.2		μA
ΔI_{DOWN}	Voltage step down current	R1 = 100 kΩ		0.2		μA
T_{DUR_STEP}	Step time for continuous mode	QC3.0 mode		120		μs
Apple 2.4A Mode						
V_{DAT_2P7}	VDP/VDM	Apple 2.4A mode Voltage	2.57	2.7	2.84	V
FCP mode						
V_{TX_VOH}	DM FCP TX valid high		1.8			V
V_{TX_VOL}	DM FCP TX valid low				0.3	V
V_{RX_VOH}	DM FCP RX valid high			1.2		V
V_{RX_VOL}	DM FCP RX valid low			0.9		V
UI	Unit interval for PHY	F_{CLK} = 125 kHz	144	160	176	μs
NTC						
I_{NTC}	NTC source current			48		μA
V_{NTC_TH}	NTC Protection Threshold	Rising		0.6		V
		Falling		0.3		V
V_{NTC_HYS}		Hysterias		0.3		V
OTP						
T_{J1}	Over temperature protection	Rising edge		145		°C
		Hysteresis		20		°C

6 Function Description

6.1 Overview

The HYC5320 is a high performance, high integration USB Type-C Power Delivery and Type-A Daul Ports Controller. It integrates two ultra-low impedance Path Power Switch. The HYC5320 support 3 PDOs and 2 APDOs with programmable current and voltage which are fully compliant with USB Power Delivery Specification Revision 3.1, Version 1.8. Besides, the HYC5320 also supports BC1.2 DCP, Apple 2.4A, QC2.0 / QC3.0 / QC3.0+, AFC, FCP, SCP and PE+ 1.1 / 2.0 protocols. It is an ideal solution for power supply devices liking car chargers, quick charger adapters, and smart power strips.

The HYC5320 integrates the CV and CC loop control, to eliminate TL431, so that the BOM is minimized.

A current sampling resistor is connected to a 10 mΩ alloy resistor on CSN and CSP for current sampling.

The output voltage of the HYC5320 has a programmable line compensation function. After the output current increases, the output voltage will be correspondingly increased to compensate for the voltage drop caused by the connection line impedance. For specific configuration requirements, please contact HYASiC.

The HYC5320 has multiple protection functions, including output over-voltage protection, output short circuit protection, data pin short circuit protection, over-current protection and over-temperature protection.

6.2 Function Block

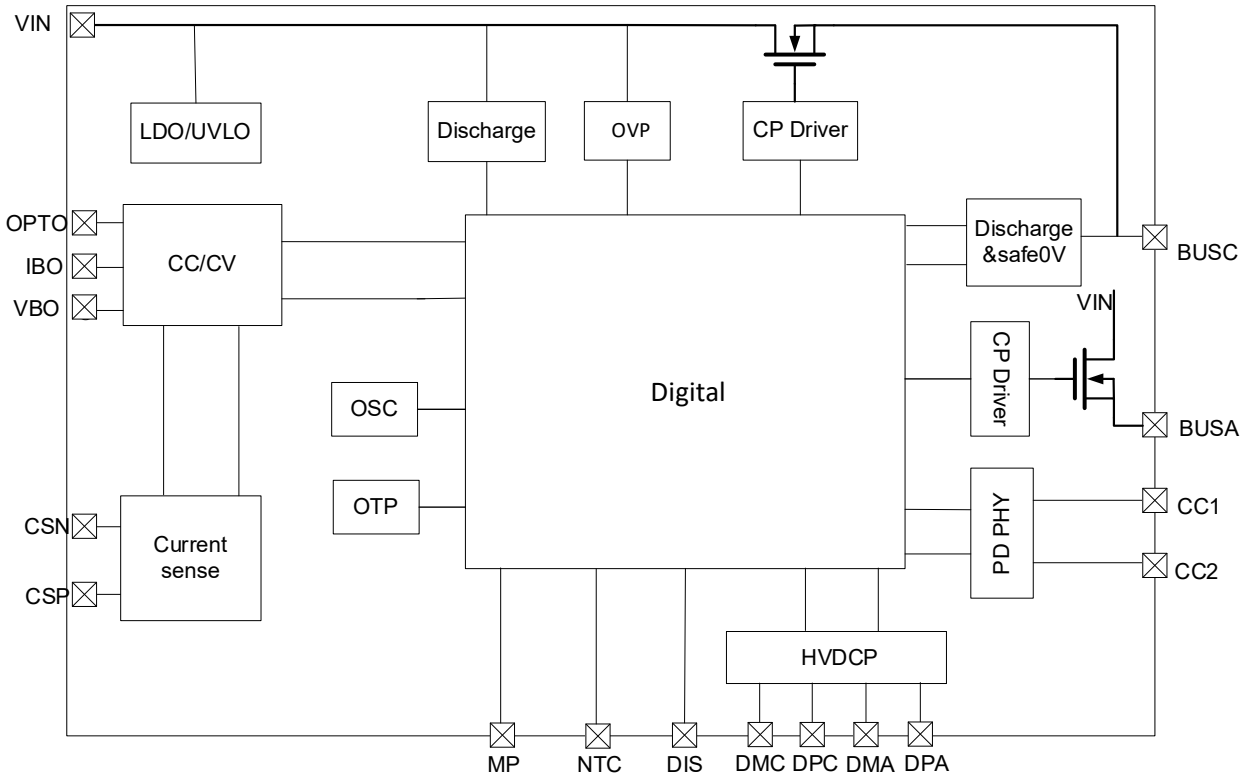


Fig. 3. Function Block

7 Application Notes

7.1 VIN PIN & BUSC PIN & BUSA PIN

The VIN pin is the chip's internal power supply input and voltage sense input, connected to the AC-DC or DC-DC output, it is recommended to connect an external 1 uF capacitor to GND near this pin. It is also an internal discharge drain pathway. Used to drain the charge stored by the output capacitor of the external AC/DC power supply when the device is removed or the device requests a step-down, so that the voltage is regulated to safe 5 V or the target voltage. This pin is also the internal N-MOSFET Drin, so we need use copper tie to power out when layout.

The BUSC pin is used to sense the USB Type-C port voltage, and is also used as a USB Type-C port discharge path, and it is recommended to connect an external 1uF capacitor to GND. This pin is also the internal N-MOSFET Source, so we need use copper tie to USB Type-C VBUS when layout.

The BUSA pin is used to sense the USB Type-A port voltage. This pin is also used to detect whether there is a device inserted on USB Type-A receptacle side. The capacitance connected BUSA PIN to GND is not allowed. This pin is also the internal N-MOSFET Source, so we need use copper tie to USB Type-C VBUS when layout.

7.2 MP PIN

This pin is used to perform communication between two chips if Chip-Link function enable.

7.3 Constant Voltage and Constant Current

The HYC5320 integrates CV and CC loop control. As shown in the figure below, CV loop control is realized through VBO and OPTO, where OPTO is connected to an external optocoupler and VBO is connected to a voltage divider network point composed of R1 and R2. When the device requests a voltage to step-up or step-down, the HYC5320 feeds back the network node according to sink or source current in 0.2 uA/step through VBO. Whether it is VBO feedback or OPTO feedback, R1 must be 100 K, R2 is 33 K in OPTO feedback applications, and R2 is calculated based on the actual situation of the front-end power supply in FB feedback applications.

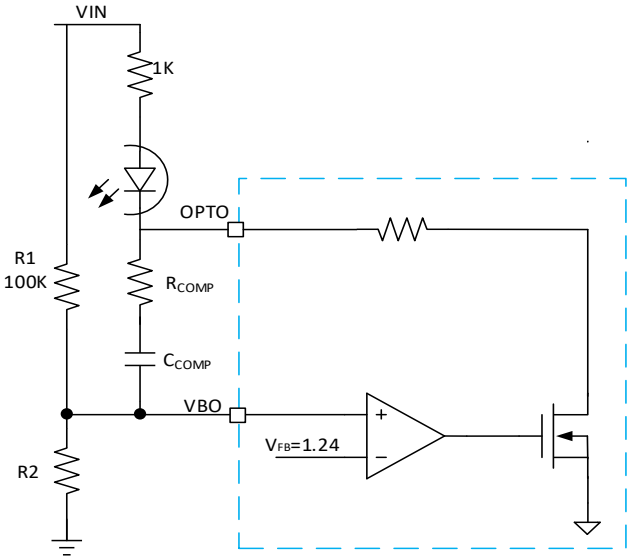


Fig. 4. OPTO Feedback

To suppose the input voltage is VIN, and VBO of the power source is regulated to V_{FB}, then there is how to calculate the resistance of R2:

$$R2 = \frac{V_{FB} \times \mathrm{R1}}{\mathrm{VIN} - V_{FB}}$$

Equation 1

The HYC5320 implements constant current control and current sampling via OPTO, IBO, and CSN and CSP with an external sampling resistor of 10 mΩ. The sampling resistor should be layout in Kelvin connection, with one end being the CSP and the other end being the CSN of the chip. The sampled current information is also used by the HYC5320 to determine whether is over current or short circuit. The compensation network between OPTO and IBO needs to be adjusted for the specified application.

7.4 Line-Drop compensation

The Built-in line drop compensation function of the HYC5320 has programmable compensation coefficient to meet different application, according to output current. The HYC5320 currently supports five types of line drop compensation coefficients: 0 mV/A, 50 mV/A, 100 mV/A, 150 mV/A, 200 mV/A. The default configuration is 100 mV/A.

7.5 NTC Protection

The HYC5320 uses the NTC pin to sense the external temperature. As show in Fig.5, there is an internal current source 48 μA at the NTC pin. With an external NTC resistor from NTC pin to ground, the HYC5320 can detect the voltage across this NTC resistor and calculate the temperature per the T-R characteristics. When the NTC PIN is used to power reduction function, the threshold is 0.6 V, when it used to protection function, the rising threshold is 0.6 V and the falling threshold 0.3 V.

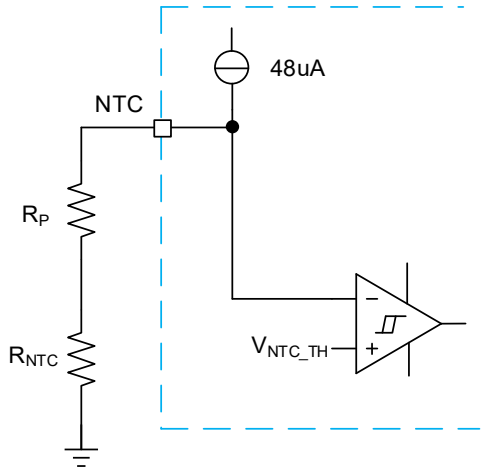


Fig. 5. NTC Protection

7.6 Over Voltage Protection

The HYC5320 supports OVP by monitoring the voltage of VIN pin, once the voltage exceeds the over voltage threshold of the required the OVP procedure will be triggered, and then the HYC5320 turns off internal NMOS FET quickly.

7.7 OCP and short protection

The HYC5320 monitors output current through the external 10 mΩ sense resistor connected to CSP and CSN for over current and short-circuit protection. When the output current exceeds the over current protection threshold or short-circuit protection threshold corresponding to the requested, the over current or short-circuit protection procedure is triggered, and then the HYC5320 turns off internal NMOS FET quickly.

8 Typical Application Circuit

8.1 AC/DC - OPTO feedback

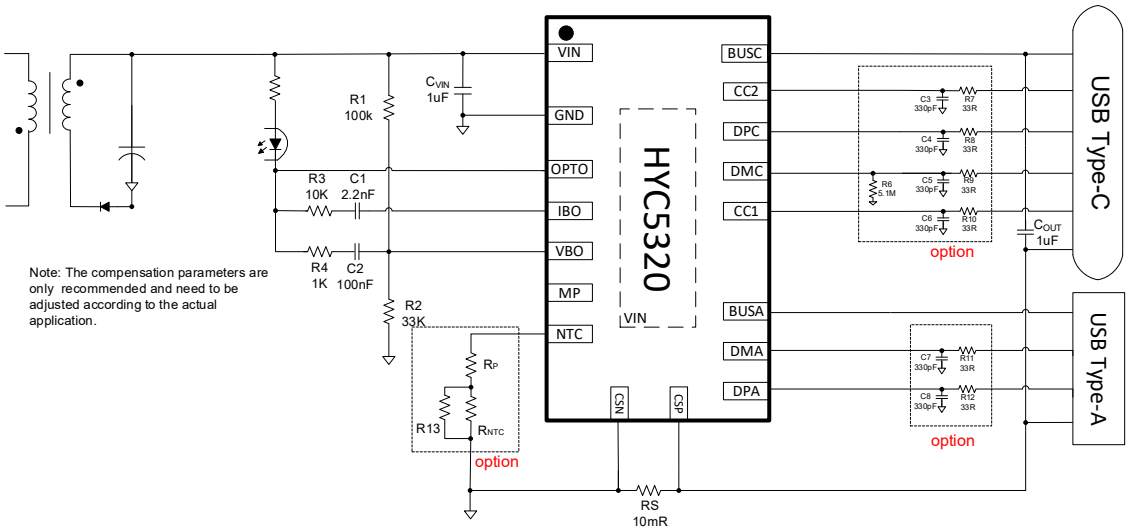


Fig. 6. Application for ACDC

Note: Must using Kelvin Connect to connect current sense resistor RS.

Table 5. OPTO feedback Application BOM list

No.	Part Name	Description	Unit	Qty	Location
1	IC	HYC5320	PCS	1	
2	SMD capacitor	0603, 1 uF, +/-20%, 25 V, X5R	PCS	2	C_{VIN}, C_{OUT}
3	SMD capacitor	0603, 2.2 nF, +/-20%, 25 V, X5R	PCS	1	C1
4	SMD capacitor	0603, 100 nF, +/-20%, 25 V, X5R	PCS	1	C2
5	SMD resistor	0603, 330 pF, +/-20%, 50 V, X5R, for option	PCS	6	C3, C4, C5, C6, C7, C8
6	SMD resistor	0603, 100 K, 1%	PCS	1	R1
7	SMD resistor	0603, 33 K, 1%	PCS	1	R2
8	SMD resistor	0603, 5.1 M, 5%	PCS	1	R6
9	SMD resistor	0603, 10 K, 5%	PCS	1	R3
10	SMD resistor	0603, 1 K, 5%	PCS	1	R4
11	SMD resistor	1206, 10 mohm, 1%, temperature coefficient less than 100 ppm	PCS	1	RS
12	SMD resistor	0603, 33 R, 5%, for option	PCS	6	R7, R8, R9, R10, R11, R12

8.2 DC/DC - FB feedback

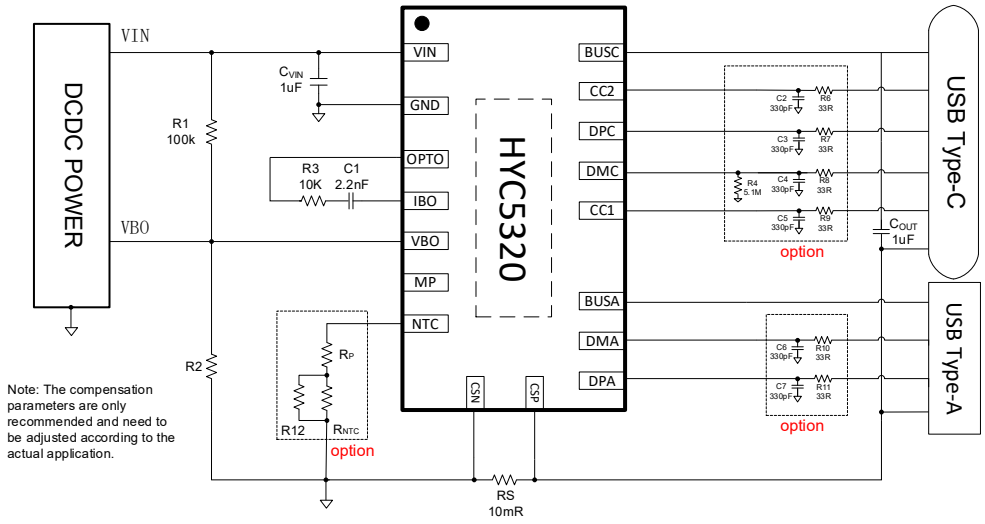


Fig. 7. Application for DCDC

Note: Must using Kelvin Connect to connect current sense resistor RS.

Table 6. FB feedback Application BOM list

No.	Part Name	Description	Unit	Qty	Location
1	IC	HYC5320	PCS	1	
2	SMD capacitor	0603, 1 uF, +/-20%, 25 V, X5R	PCS	2	C_{VIN}, C_{OUT}
3	SMD capacitor	0603, 2.2 nF, +/-20%, 25 V, X5R	PCS	1	C1
4	SMD resistor	0603, 330 pF, +/-20%, 50 V, X5R, for option	PCS	6	C2, C3, C4, C5, C6, C7
5	SMD resistor	0603, 100 K, 1%	PCS	1	R1
6	SMD resistor	Calculated by FB voltage of VIN power	PCS	1	R2
7	SMD resistor	0603, 10 K, 5%	PCS	1	R3
8	SMD resistor	0603, 5.1 M, 5%	PCS	1	R4
9	SMD resistor	1206, 10 mohm, 1%, temperature coefficient less than 100 ppm	PCS	1	RS
10	SMD resistor	0603, 33 R, 5%, for option	PCS	6	R6, R7, R8, R9, R10, R11

8.3 Multi-Port Applications

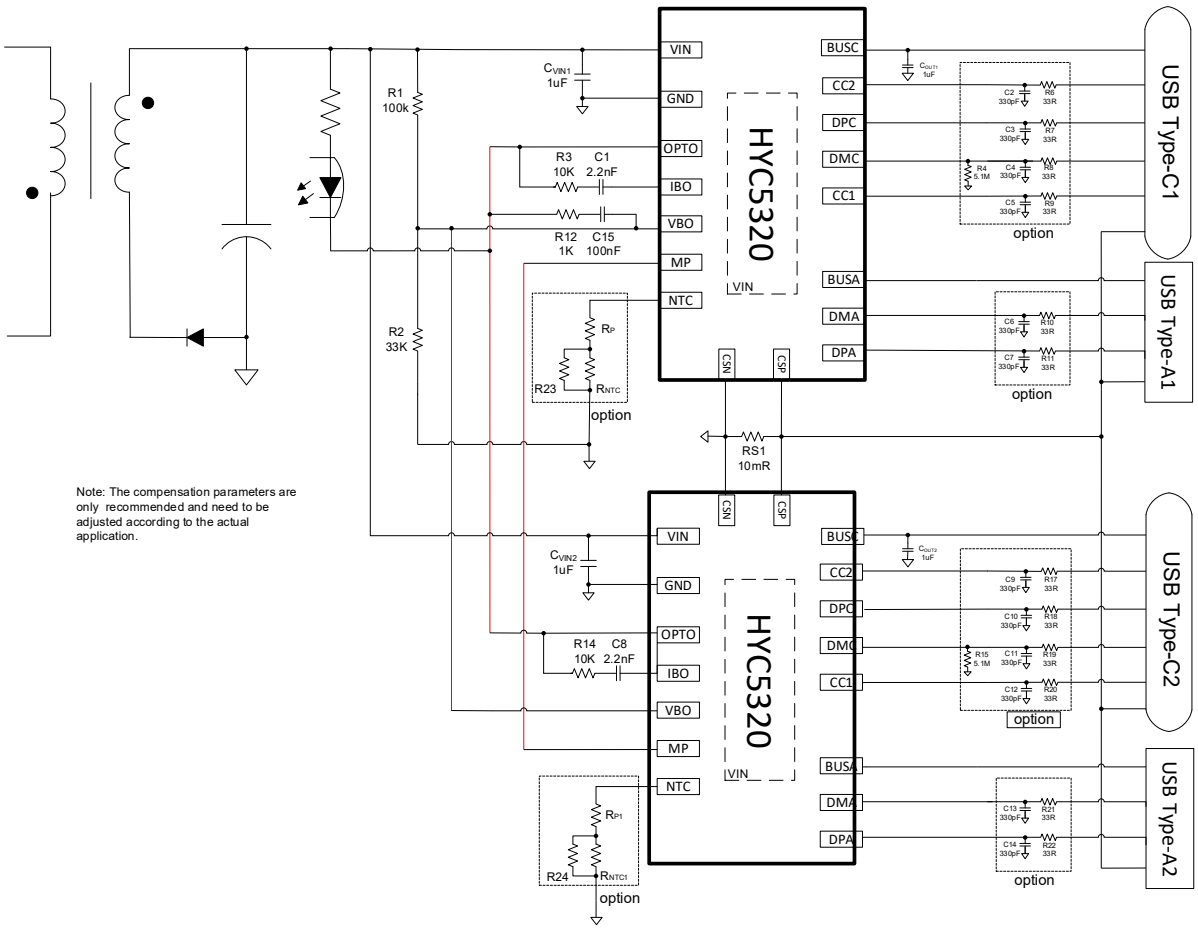


Fig. 8. Multi-Port Applications

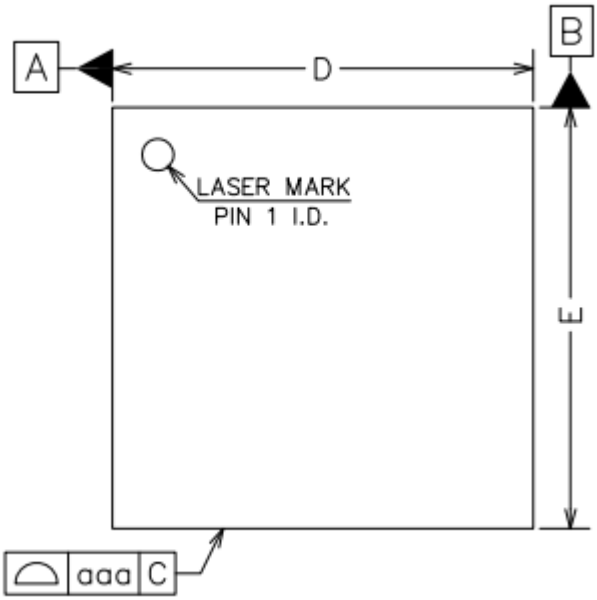
The following are introduction to shared power applications:

1、 When any port is working, it can charge quickly.

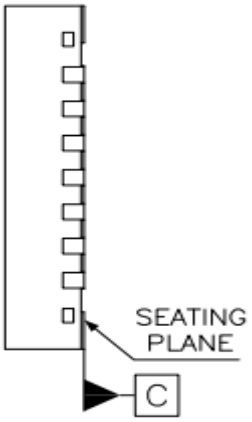
2、 When two or more ports are working, they share the power of AC-DC.

9 Mechanical, Packaging & Orderable Info

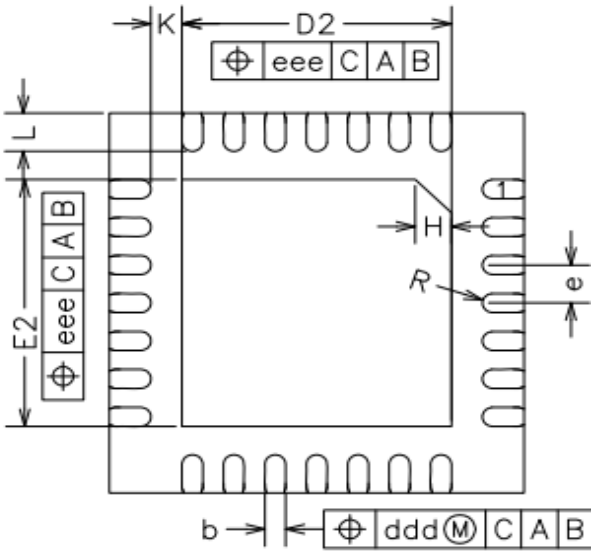
9.1 Package Outline: QFN4X4-28L



Top View



Side View



Bottom View

COMMON DIMENSIONS
(UNITS OF MEASURE=MILLIMETER)

SYMBOL	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	0.00	0.02	0.05
A2	0.50	0.55	0.60
A3		0.203RFF	
b	0.13	0.18	0.23
D	3.90	4.00	4.10
E	3.90	4.00	4.10
D2	2.50	2.60	2.70
E2	2.50	2.60	2.70
e	0.30	0.40	0.50
H		0.35REF	
K		0.30REF	
L	0.325	0.40	0.475
R		0.09RFF	
aaa		0.10	
bbb		0.10	
ccc		0.08	
ddd		0.10	
eee		0.10	

Legend

QFN4X4-28L

Fig. 9. Package Outline

9.2 Ordering Information

Part Number	Configuration	Package	MOD
HYC5320B20001Q	FPDO:5V/3A,9V/2.22A,12V/1.67A	QFN-28L	6K/Reel
	PPS:3.3-5.9V/3A,3.3-11V/2A		
	QC2.0/QC3.0/QC3.0+(class A)/FCP/SCP/AFC/APPLE2.4A/BC1.2		
	Line drop compensation:100mV/A		
	OCP:110%		
HYC5320XXXXXXX	For part numbers not listed above, please contact Hyasic		

9.3 Tape and Reel Information

Package Type	PCs/Reel	Reel/Reel Box	Reel Box/Carton Box	PCs/Carton Box
QFN 4X4-28L	6K	1	5	30K

9.4 Marking and Date Code Information

XXXXXXX

Product Number

A BC XX

Year Code Week Code Internal Code

Year		Year Code
2009	2024	A
2010	2025	B
2011	2026	C
2012	2027	D
2013	2028	E
2014	2029	F
2015	2030	G
2016	2031	H
2017	2032	J
2018	2033	K
2019	2034	L
2020	2035	M
2021	2036	N
2022	2037	P
2023	2038	Q

10 Revision History

Revision	Date	Changes
0.1	2024-06-12	Initial datasheet
0.2	2024-08-15	Optimize parameters
0.3	2024-09-27	Update Junction Temperature Range to 150 °C

11 Important Notice

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12 Contact Information