英集芯科技 INJOINIC TECHNOLOGY

IP6527

Type-C Buck Converter with Fast Charge Protocols of

PD3.0/PPS/PD2.0, QC3.0/QC2.0, FCP, AFC, MTK PE+2.0/PE+1.1

1 Features

- **Synchronous-rectified buck converter**
  - ✧ Built-in power MOSFET
  - ✧ Input voltage range: 8.2V~32V
  - ✧ Output voltage range: 3V~20V, adjustable according to the fast charge protocol
  - ✧ Output voltage has line compensate function of 50mV/A
  - ✧ Support CV/CC output mode: CV mode (output current < preset value); CC mode (output current > preset value)
  - ✧ conversion efficiency up to 96.5% with VIN=12V, VOUT=5V/3A
- **Type-C USB PD protocol output**
  - ✧ Support 5V, 9V, 12V,15V,20V voltage output
  - ✧ Support PD2.0/PD3.0(PPS) output protocol
  - ✧ PPS support 3.3~21V adjustable voltage with 20mV/step output
- **Fast charge output protocol**
  - ✧ Support Type-C PD output
  - ✧ Support BC1.2, Apple, Samsung
  - ✧ Support QC3.0 and QC2.0
  - ✧ Support MTK PE+2.0 and PE+ 1.1
  - ✧ Support FCP and SCP
  - ✧ Support Samsung fast charge: AFC
- **Multi protection and high reliability**
  - ✧ Support input over voltage and under voltage protection, support output short circuit, over current and over temperature protection
  - ✧ DP/DM/CC over voltage protection
  - ✧ DP/DM/CC withstand voltage of 30V
  - ✧ ESD 4KV, DC withstand voltage of 40V
- **Package: 5*5mm QFN32**

2 Application

- Car charger
- Fast charge adaptor
- Smart power strip

3 Description

IP6527 is a Synchronous-Rectified Buck Converter which supports multiple fast charge output protocols. It provides solutions for car charger, fast charge adaptor and smart power strip.

IP6527 has built-in power MOSFET, input voltage range is 4.5V to 32V, output voltage ranges from 3V to 20V with up to 45W power supply. The output voltage and current is auto adjusted dynamically based on the fast charge requirement. IP6527 has a conversion efficiency of up to 96.5% when output 5V/3A.

IP6527 output has CV/CC mode, when the output current is lower than preset value, the output voltage will be constant in CV output mode; when the output current is higher than preset value, the output voltage will decrease in CC output mode.

IP6527 supports output line compensation, when output current increases, the output voltage will increase accordingly that makes up the resistive voltage drop introduced by connection, wire, and PCB traces.

IP6527 supports soft start function that protects the input power source from inrush current at start up.

4 IP6527 Series Product Introduction

IP6527_C	**USB Type-C**	**PDO**	5V/2.4A	9V/3A	12V/2.25A
		QC(1)	5V/3.6A	9V/3A	12V/2.25A
IP6527_C_S_18W	**USB Type-C**	**PDO**	5V/2.4A	9V/2A	12V/1.5A
		QC(1)	5V/3.6A	9V/2A	12V/1.5A
IP6527_A	**USBA**	**QC(1)**	5V/3.6A	9V/2.5A	12V/2A

Notes:

(1) QC represents the output power of high voltage fast charge.

(2) IP6527_A supports SCP protocol, the output power is 5V/4.5A,4.5A/5A.

(3) IP6527_C supports PD3.0 and PPS, it can be customized to support PPS.

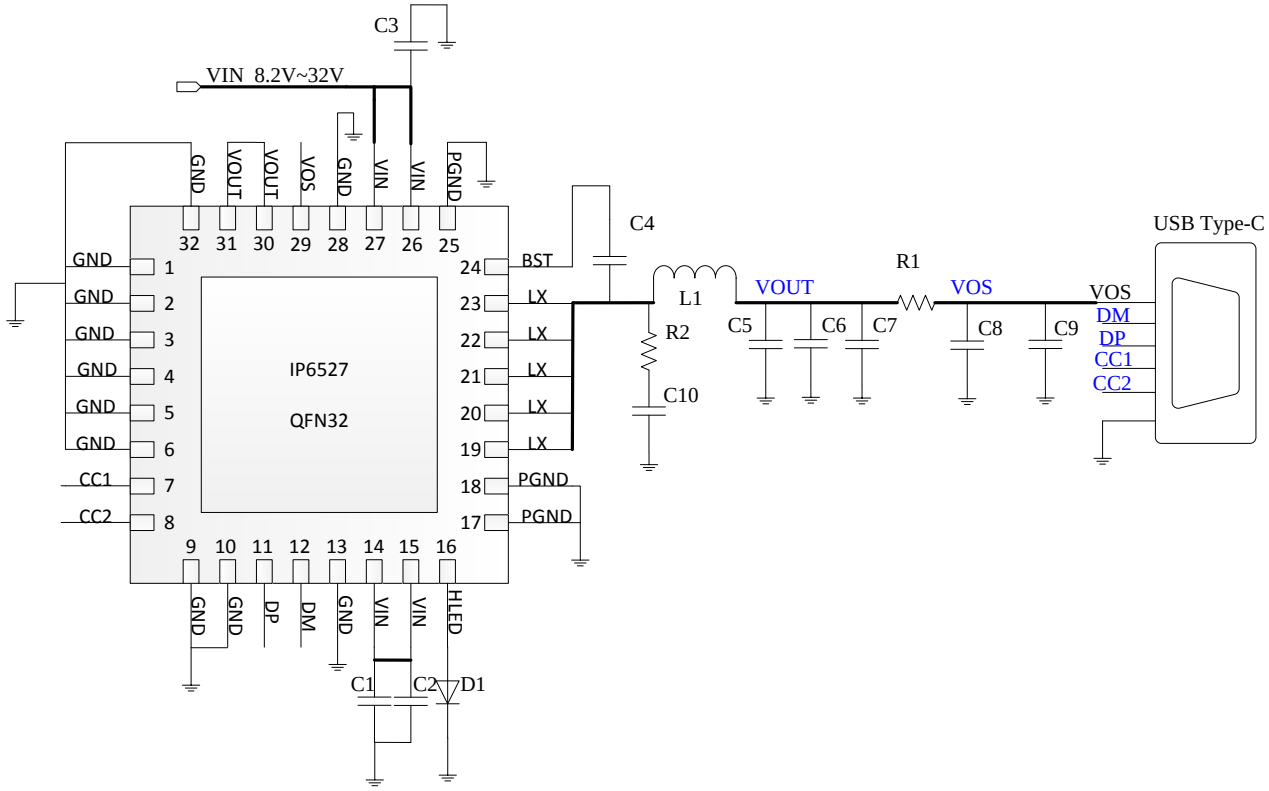


Figure 1. IP6527_C simplified application schematic diagram

5 Pin Functions

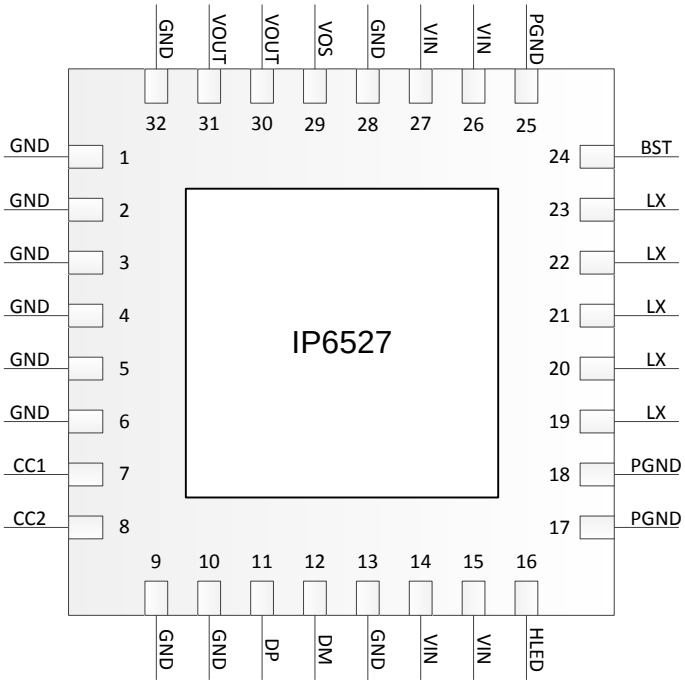


Figure 2. Pin Functions

Pins		Description
Pin No.	Pin Name	
1/2/3/4/5/6/9/10/13/28/32	GND	Ground
7	CC1	Type-C CC1
8	CC2	Type-C CC2
11	DP	DP
12	DM	DM
14/15/26/27	VIN	Power input
16	HLED	Fast charge state indicator LED drive
17/18/25	PGND	Power ground
19/20/21/22/23	LX	DCDC switch point, connect to inductor
24	BST	Connect to bootstrap capacitor
29	VOS	VOUT output current negative sense pin
30/31	VOUT	VOUT output current positive sense pin
33	EPAD	Power Ground

6 Absolute Maximum Ratings

Parameters	Symbol	Value	Unit
Input Voltage Range	V_{IN}	-0.3 ~ 40	**V**
LX Voltage Range	V_{LX}	-0.3 ~ VIN+0.3	**V**
DM/DP/CC Voltage Range	$V_{DM/DP/CC1/CC2}$	-0.3 ~ 30	**V**
Junction Temperature Range	T_J	-40 ~ 150	℃
Storage Temperature Range	Tstg	-60 ~ 150	℃
Package Thermal Resistance	θ_{JA}	40	**℃/W**
Human Body Model (HBM)	ESD	4	**KV**

*Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to Absolute Maximum Rated conditions for extended periods may affect device reliability.

*Voltages are referenced to GND unless otherwise noted.

7 Recommended Operating Conditions

Parameters	Symbol	Min.	Typ.	Max	Unit
Input Voltage	V_{IN}	8.2	12/24	32	V

*Devices' performance cannot be guaranteed when working beyond those Recommended Operating Conditions.

8 Electrical Characteristics

Unless otherwise specified, TA =25℃, L=10uH, VIN=12V, VOUT=5V

Parameters	Symbol	Test Condition	Min.	Typ.	Max	Unit
Input system						
Input voltage	V_{IN}		8.2	12	32	V
Input under voltage	V_{IN-UV}	Rising voltage	8.1	8.2	8.3	V
		Falling voltage	7.8	7.9	8	V
Input over voltage	V_{IN-OV}	Rising voltage	32.7	32.8	33	V
		Falling voltage	32.3	32.5	32.6	V
Input quiescent current	I_Q	VIN=12V, VOUT=5V/0A	--	3	--	mA
Power system						
High-side MOS Ron resistance	$R_{DS(ON)}$		--	9	--	mΩ
Low-side MOS Ron resistance	$R_{DS(ON)}$		--	8	--	mΩ
Switching frequency	F_S		--	150	--	KHz
Maximum duty cycle	D_{MAX}	VIN=12V	--	97	--	%
Output system						
Output voltage	V_{OUT}		3	5	20	V
Output voltage ripple	ΔV_{OUT}	VIN=12V, VOUT=5V/3A COUT: 220uF+22uF	80	85	90	mV
		VIN=12V, VOUT=9V/3A COUT: 220uF+22uF	65	70	80	mV
		VIN=24V, VOUT=12V/2.25A COUT: 220uF+22uF	115	125	150	mV
Soft start time	T_{SS}	VIN=12V, VOUT=5V	--	4	--	ms
Output line compensate voltage	V_{COMP}	VIN=12V, VOUT=5V, IOUT=1A	--	50	--	mV
Single port max output current in CC mode	I_{OUT}	VIN=12V, VOUT<=4V	--	3.6	--	A
		VIN=12V, 4V<VOUT<=5V	--	3.6	--	A
		VIN=12V, 7V<VOUT<=9V	--	3	--	A
		VIN=24V, 9V<VOUT<=12V	--	2.25	--	A
Output hiccup restart voltage	V_{OUT}	Hiccup restart voltage when output enter CC mode (VOUT preset voltage >=	--	3.2	--	V

		5V)				
		Hiccup restart voltage when output enter CC mode (VOUT preset voltage < 5V)	--	2.7	--	V
DPDM over voltage protection voltage	V_{OVP_DPDM}	VIN=12V, VOUT=5V	--	4.8	--	V
CC over voltage protection voltage	V_{OVP_CC}	VIN=12V, VOUT=5V	--	6.5	--	V
Thermal shutdown temperature	T_{OTP}	Rising temperature	--	155	--	℃
Thermal shutdown temperature hysteresis	ΔT_{OTP}		--	35	--	℃

9 Function Description

Synchronous-Rectified Buck Converter

IP6527 integrate a Synchronous-Rectified Buck Converter, input voltage range is 8.2V~32V, output voltage range is 3V~20V, maximum output current is 4.8A.

IP6527 integrate power switch MOSFET with 150kHz working frequency.

The conversion efficiency is 96.5% at VIN=24V, VOUT=5V/3A. The conversion efficiency is 95.3% at VIN=24V, VOUT=5V/3A.

IP6527 auto adjust output voltage and current according to the fast charge requirement.

IP6527 has soft start function, preventing the huge inrush current cause damage to the IC.

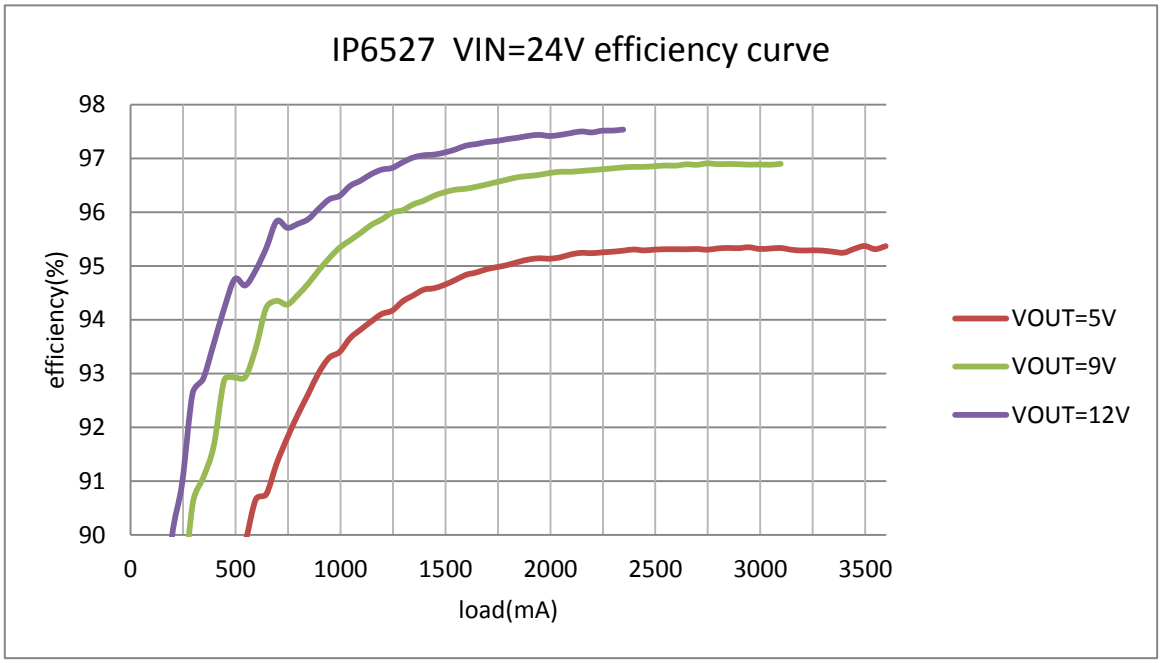


Figure 3. IP6527 output efficiency curve when VIN = 24V

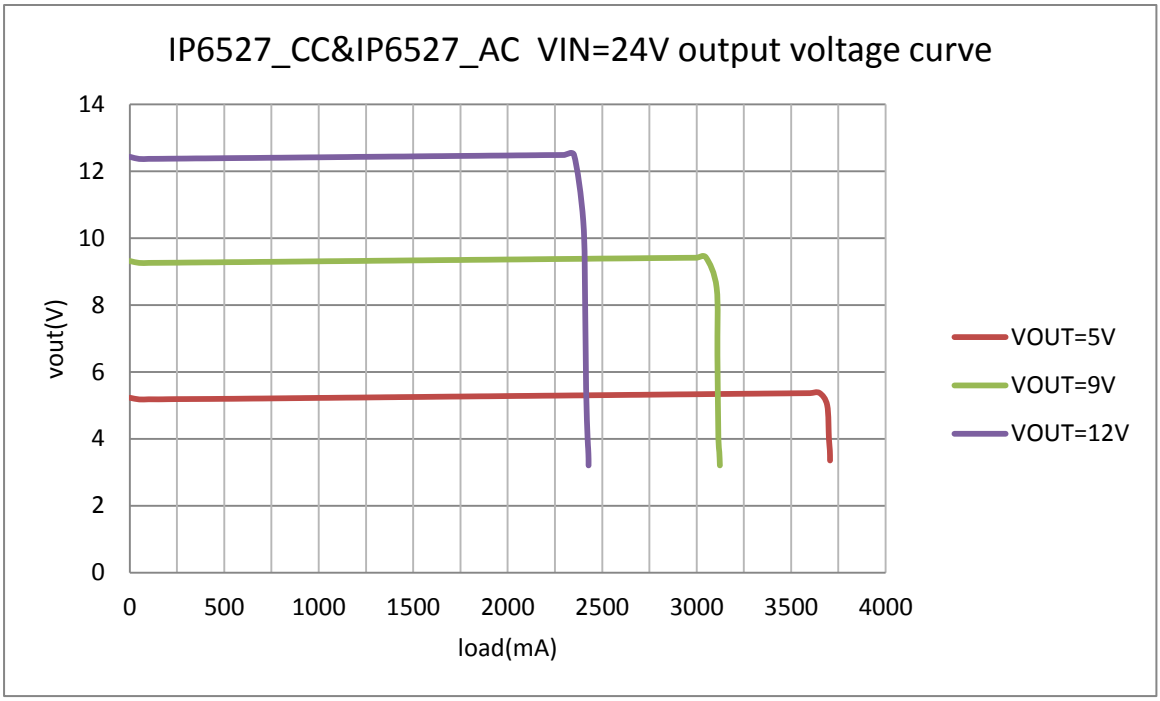


Figure 4. IP6527_C Vout-Iout cureve when VIN=24V

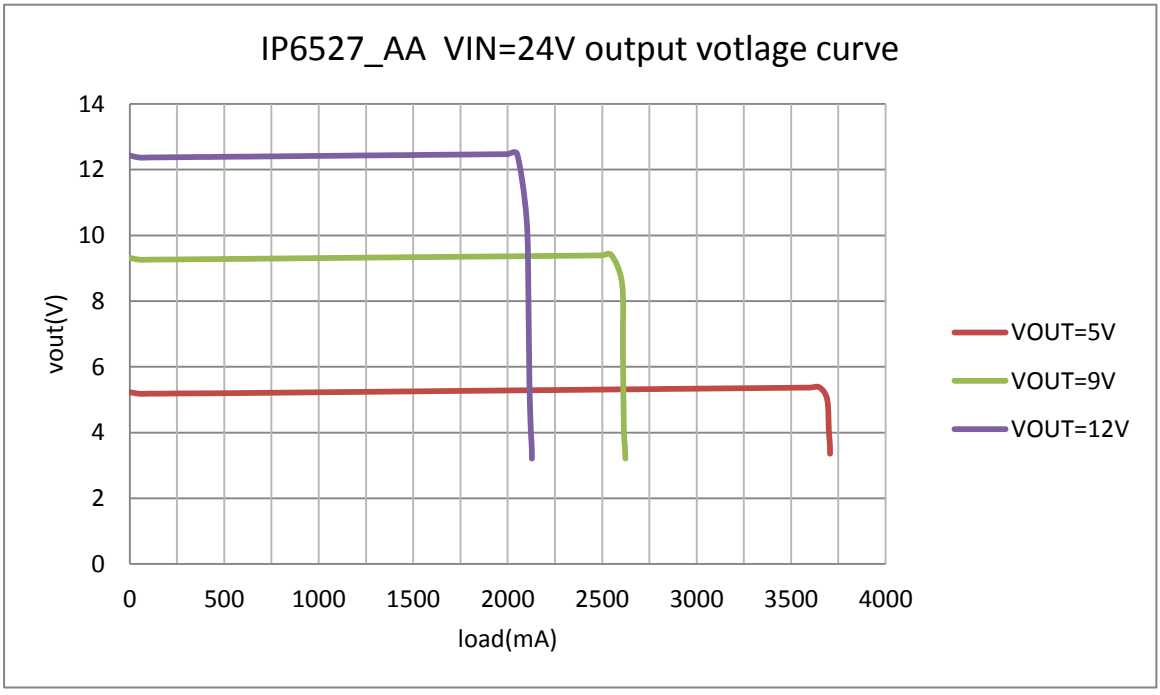


Figure 5. IP6527_A Vout-Iout curve when VIN=24V

Output Voltage Line Compensation Function

IP6527 output support line compensation function: the output voltage will increase 50mV as output current increase 1A.

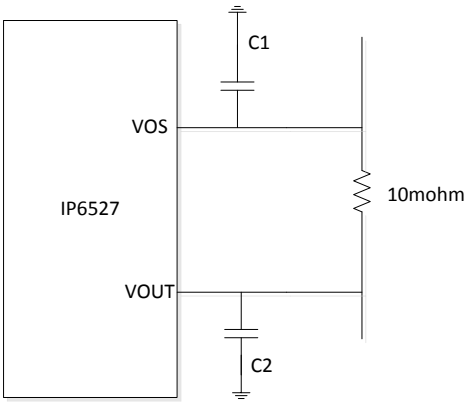
Output CC/CV Character

IP6527 output has CV/CC mode: when the output current is lower than preset value, the output is in CV mode with constant voltage; when the output current is higher than preset value, the output is in CC mode with decreasing output voltage.

When VOUT preset voltage is higher or equal to 5V, if the output voltage is lower than 3.2V, the output will be shut down and hiccup restart after 2sec; When VOUT preset voltage is lower than 5V, if the output voltage is lower than 2.7V, the output will be shut down and hiccup restart after 2sec.

Output CC Current Set

IP6527 VOUT output current limit can be adjusted by regulate the 10mOhm sensing resistor between VOUT and VOS. The load current is measured by detect the voltage drop between VOUT and VOS.



For IP6527_C, different voltage is mapped to different current limit value shown below:

Vout (V) voltage	5V	9V	12V
Iout(A) current limit	3.6A	3A	2.25A
VOUT-VOS	36mV	30mV	22.5mV

When the value of 10mOhm current detect resistor is changed, the current limit of VOUT will change accordingly.

In PCB layout, pay attention to the trace routing of VOS and VOUT, the trace should go out directly from the two side of 10mOhm resistor, avoiding introduce current limit deviation because of additional PCB trace resistor. Other than that, the 10mOhm resistor should use alloy resistor with good temperature coefficient (100ppm) and high precision of 1%.

Protection Funciton

IP6527 will detect the VIN voltage, if VIN voltage is lower than 7.9V, IP6527 will enter standby mode and shut down the output.

IP6527 support input over voltage protection: when the VIN voltage is higher than 32.8V, IP6527 determines

the VIN is over voltage and shutdown the output; when VIN decrease under 32.5V, IP6527 determines the input voltage recovers and opens the output.

IP6527 support output under voltage protection: when VOUT voltage is lower or equals 5V, if the VOUT voltage is lower than 3.2V, IP6527 determines the output is under voltage and will shut down the output and hiccup restart after 2sec.

IP6527 support short circuit protect, 4ms after the circuit is started, if VOUT voltage is under 3.2V, IP6527 determines the output is short circuit and will shut down the output and hiccup restart after 2sec.

IP6527 support DP/DM/CC over voltage protection, when the DP/DM voltage is higher than 4.8V, or when the CC1/CC2 voltage is higher than 6.5V, IP6527 determines the signals are over voltage and will shut down the output and hiccup restart after 2sec.

IP6527 support over temperature protection: when the temperature detected is higher than 155℃, the output will be shut down. When the temperature decreases below 120℃, IP6527 determines the temperature has recovered and will restart the output.

Output Fast Charge Protocol

IP6527 support fast charge protocol:

- ✧ Support BC1.2, Apple, Samsung
- ✧ Support Qualcomm QC2.0, QC3.0
- ✧ Support MTK PE+1.1 and MTK PE+2.0
- ✧ Support Huawei Fast charge: FCP and SCP
- ✧ Support Samsung fast charge : AFC

Type-C Port and USB PD Protocol

IP6527_C support Type-C output and USB PD2.0/PD3.0 (PPS) protocol, USB PD protocol output 27W; Package broadcast: 5V/3A, 9V/3A, 12V/2.25A and PPS 3.3V-5.9V/3A, 3.3V-11V/3A.

IP6527_A do not support Type-C output or PD2.0/PD3.0 (PPS) protocol.

IP6527 detects the fast charge requirement automatically through DP/DM and CC1/CC2 pins and adjusts the output voltage and current accordingly.

10 Typical Application Schematic Diagram

IP6527 car charging solution only needs MOSFET, inductor, capacitor and resistor.

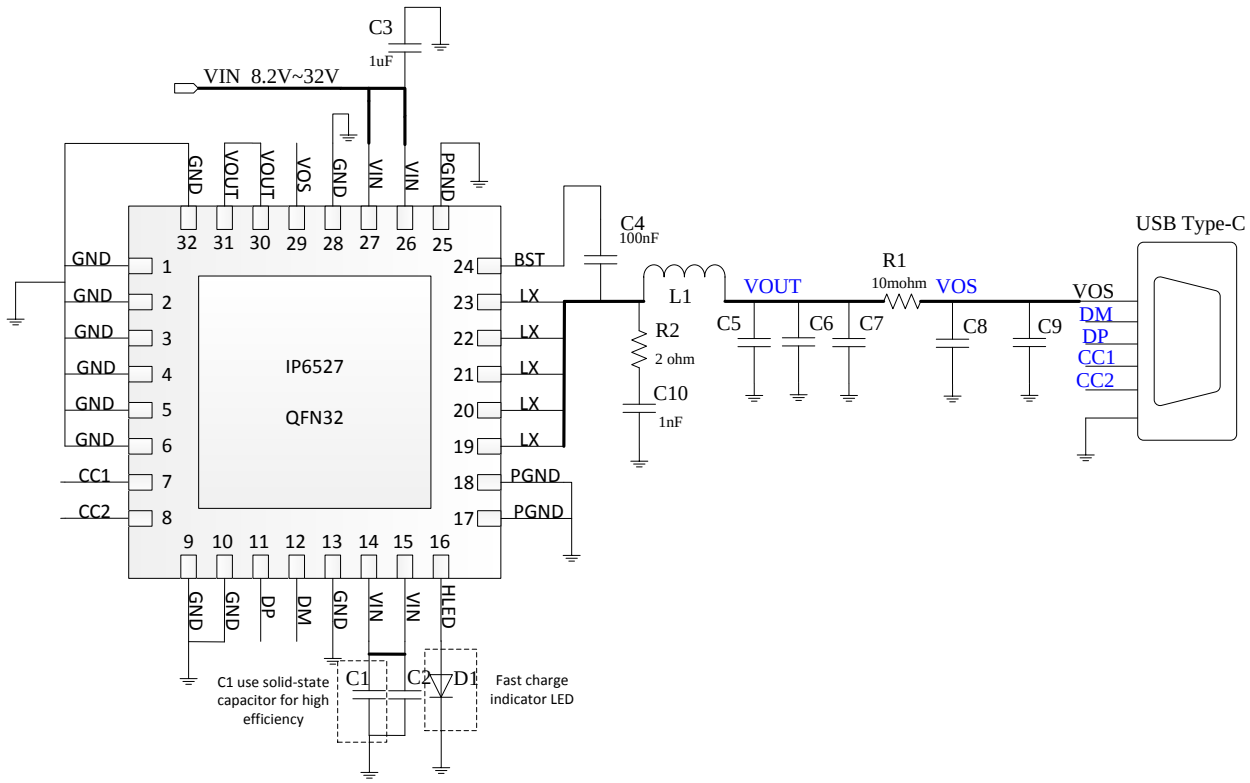


Figure 6. IP6527_C Type-C output ports fast charge application schematic diagram

NOTES:

1. C2 should be placed close to the PIN14/PIN15;
2. C3 should be placed close to the PIN26/PIN27;
3. C7 and C8 should be placed close to the PIN;

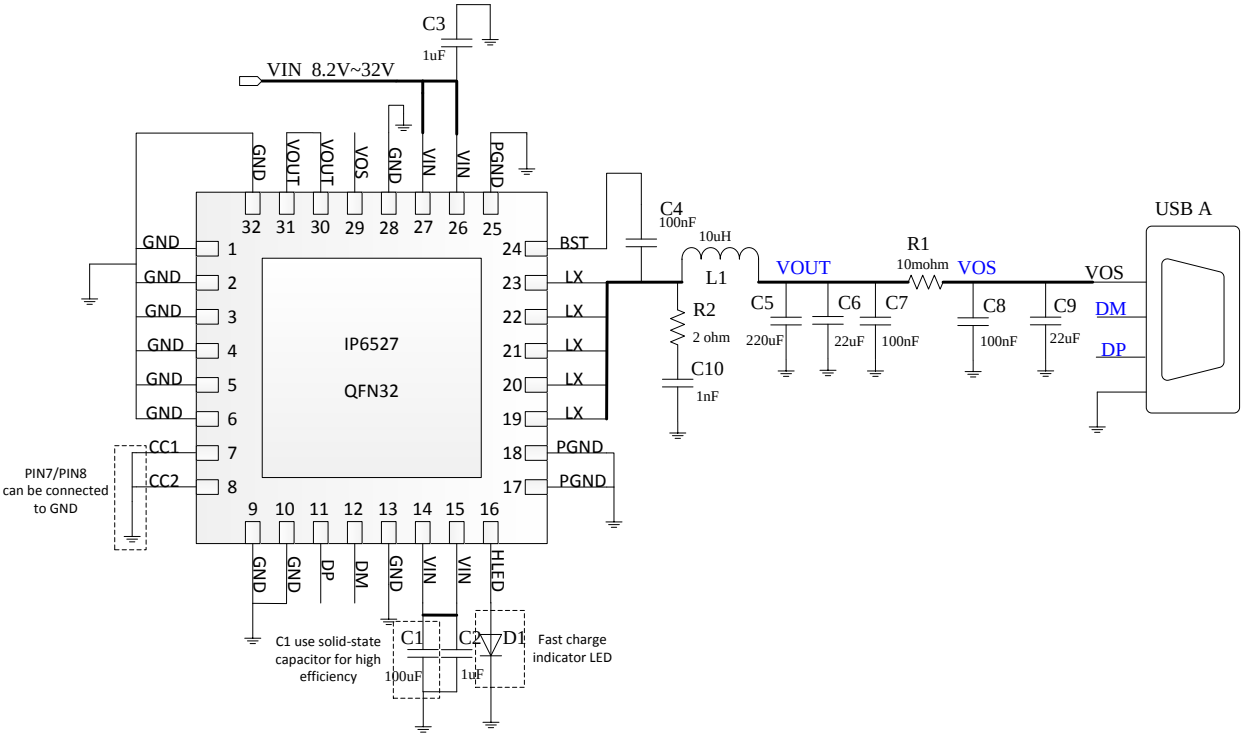


Figure 7. IP6527_A USBA output ports fast charge application schematic diagram

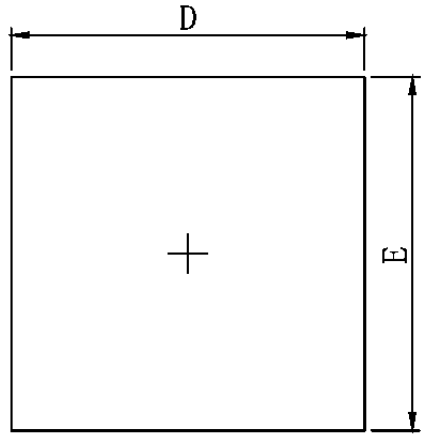
11 BOM List

No.	Part Name	Type	Unit	Qty	Location	Notes
1	IC	IP6527	PCS	1		
2	TC-220M-4.5A-CS137125	10uH+/-20%, current 5A DCR<12mohm	PCS	1	L1	3L Electronic
3	SMD capacitor	0603 0.1uF 10%	PCS	2	C7, C8	Withstand voltage higher than 25V
4	SMD capacitor	0603 0.1uF 10%	PCS	1	C4	Withstand voltage higher than 10V
5	SMD capacitor	0805 22uF 10%	PCS	2	C6,C9	Withstand voltage higher than 25V
6	SMD LED	0603	PCS	1	D1	
7	Electrolytic capacitor	100uF/35V	PCS	1	C1	Withstand voltage higher than 35V Use solid-state capacitor will increase efficiency
8	Electrolytic capacitor	220uF/25V	PCS	1	C5	Withstand voltage higher than 25V
9	SMD capacitor	0603 1uF 10%	PCS	2	C2, C3	Withstand voltage higher than 35V
10	SMD resistor	0603 2R 5%	PCS	1	R2	
11	SMD capacitor	0603 1nF, 50V 10%	PCS	1	C1	
12	SMD resistor	1206 10mohm 1% precision, temperature coefficient less than 100ppm	PCS	1	R1	Current sense resistor

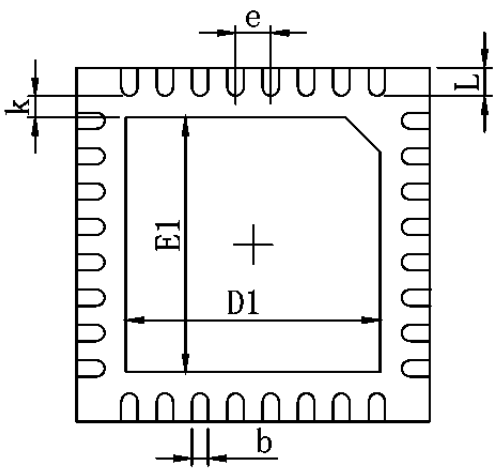
12 IP series IC Products List

IC 型号	放电电流	双路	支持的协议										封装	
			DCP	QC2.0	QC3.0	FCP	SCP	AFC	MTK PE	SFCP	PD2.0	PD3.0 (PPS)	规格	兼容
IP6502	2.4A	–	√	–	–	–	–	–	–	–	–	–	SOP8	PIN2PIN
IP6503	3.1A	–	√	–	–	–	–	–	–	–	–	–	ESOP8	
IP6503_2A4	2.4A	–	√	–	–	–	–	–	–	–	–	–	ESOP8	
IP6503S	3.1A	–	√	–	–	–	–	–	–	–	–	–	ESOP8	PIN2PIN
IP6503S_2A4	2.4A	–	√	–	–	–	–	–	–	–	–	–	ESOP8	
IP6523S_N	3.4A	–	√	–	–	–	–	–	–	–	–	–	ESOP8	
IP6505	24W	–	√	√	√	√	√	√	√	√	–	–	ESOP8	
IP6505T	24W	–	√	√	√	√	√	√	√	√	–	–	ESOP8	PIN2PIN
IP6525T_N	18W	–	√	√	√	√	–	√	–	–	–	–	ESOP8	
IP6510	18W	–	√	√	√	√	–	√	–	–	√	–	ESOP8	
IP6518C	36W	–	√	√	√	√	√	√	√	√	√	–	QFN24	PIN2PIN
IP6518	45W	–	√	√	√	√	√	√	√	√	√	–	QFN24	
IP6515	4.8A	√	√	–	–	–	–	–	–	–	–	–	QFN32	
IP6538_CC	27W	√	√	√	√	√	–	√	√	–	√	√	QFN32	PIN2PIN
IP6538_AC	27W	√	√	√	√	√	√	√	√	–	√	√	QFN32	
IP6538_AA	24W	√	√	√	√	√	√	√	√	–	–	–	QFN32	
IP6527_A	24W	–	√	√	√	√	√	√	√	–	–	–	QFN32	PIN2PIN
IP6527_C	27W	–	√	√	√	√	–	√	√	–	√	√	QFN32	
IP6527_C_S_18W	18W	–	√	√	√	√	–	√	√	–	√	√	QFN32	

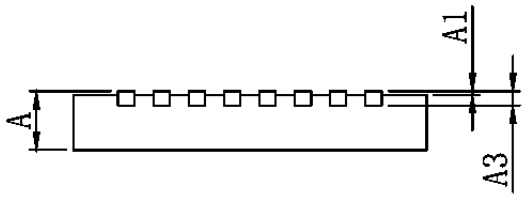
13 Package



TOP VIEW



BOTTOM VIEW



SIDE VIEW

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	0.700	0.800	0.028	0.031
A1	0.000	0.050	0.000	0.002
A3	0.203REF.		0.008REF.	
D	4.924	5.076	0.194	0.200
E	4.924	5.076	0.194	0.200
D1	3.300	3.500	0.130	0.138
E1	3.300	3.500	0.130	0.138
k	0.200MIN.		0.008MIN.	
b	0.200	0.300	0.008	0.012
e	0.500TYP.		0.020TYP.	
L	0.324	0.476	0.013	0.019

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