PD Solution for Fast Charge Application

1. General Description

The SW3528 is a highly integrated power management IC for fast charge application, and supports Type-C or Type-A port output. It integrates 3.5A synchronous buck, PPS/ PD/ QC/ AFC /FCP/ SCP/PE/SFCP/VOOC fast charge protocol, CC/CV mode. With simple external components, The SW3528 provides a turn-key high efficiency solution for fast charge application.

2. Applications

- Car Charger
- Adapter

3. Features

- **Synchronous Buck**
  - ➢ Current up to 3.5A
  - ➢ Input Voltage 6~35V
  - ➢ Support CC/CV Mode
  - ➢ Support Wire Drop Compensation
- **Output Fast Charge Protocol**
  - ➢ Support PPS/PD3.0/PD2.0
  - ➢ Support QC4+/QC4/QC3.0/QC2.0
  - ➢ Support AFC
  - ➢ Support FCP
  - ➢ Support Low Voltage/High Voltage SCP
  - ➢ Support PE2.0/PE1.1
  - ➢ Support SFCP
  - ➢ Support VOOC
- **Type-C Interface**
  - ➢ Support USB Type-C Specification
  - ➢ Support DFP Role

- **BC1.2 Module**
  - ➢ Support BC1.2 DCP
  - ➢ Support Apple & Samsung Device
- **Fast Charge LED**
  - ➢ Support Fast Charge LED Driver
- **Protection**
  - ➢ Softstart
  - ➢ Input Over Voltage Protection
  - ➢ Input Under Voltage Protection
  - ➢ Output Over Current Protection
  - ➢ Output Short Protection
  - ➢ Over Temperature Protection
- **I2C Interface**
- **QFN-24(4x4mm) Package**

4. Functional Block Diagram

Type-C Port Output

Type-A Port Output
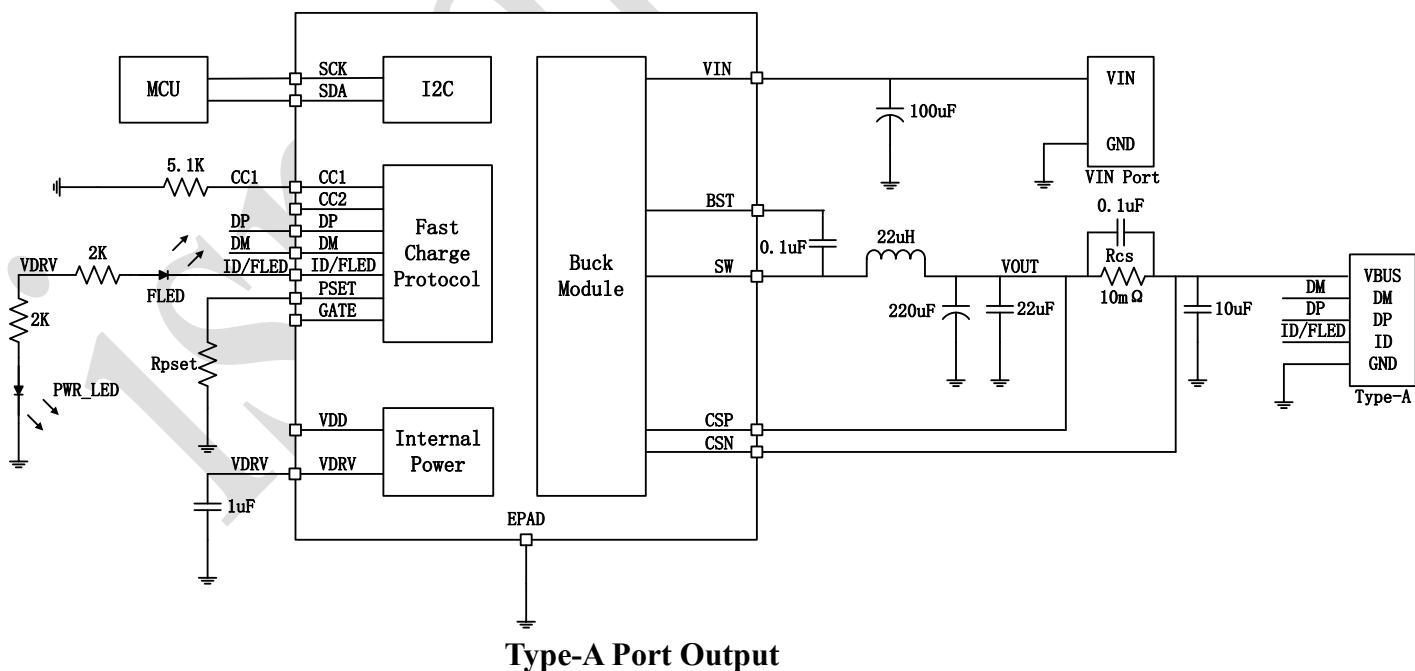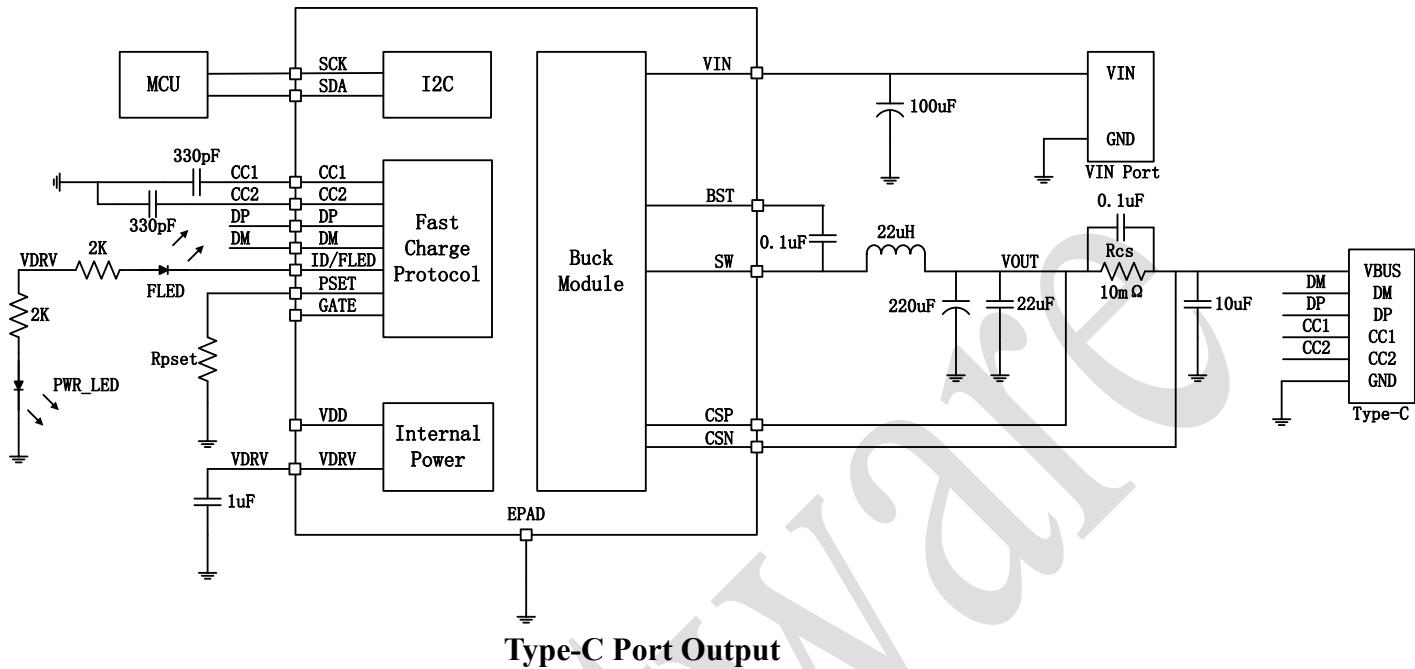
5. Pin Configuration and Function

5.1. Pin Configuration
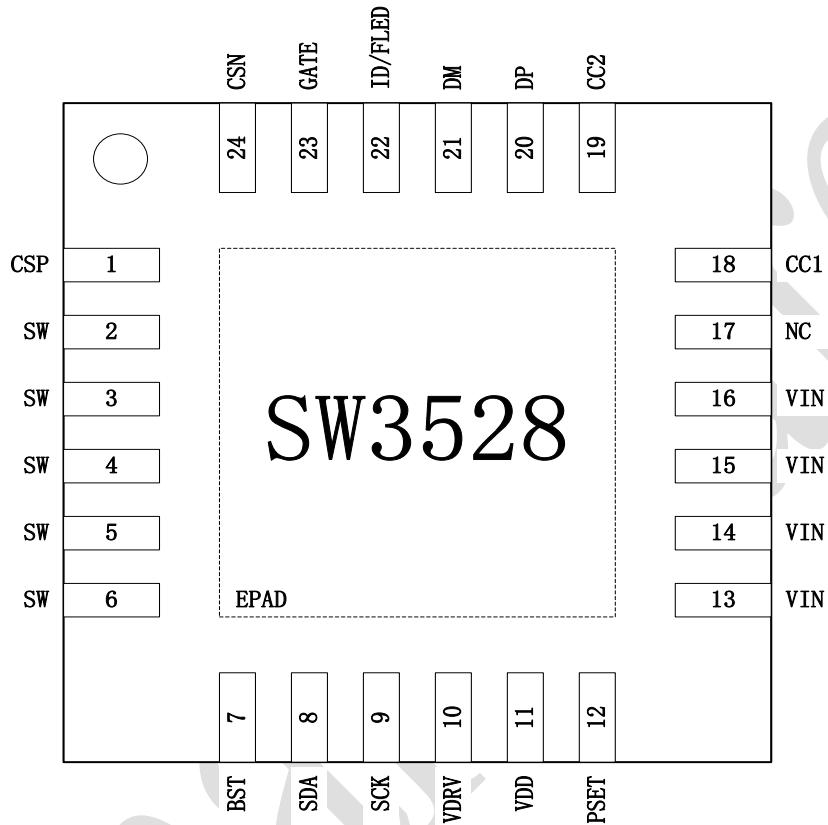
5.2. Pin Descriptions

Pin	Name	Function Description
1	CSP	Current sense positive/voltage sense pin.
2, 3, 4, 5, 6	SW	Switching node.
7	BST	Bootstrap pin for high side NMOS.
8	SDA	I2c data.
9	SCK	I2c clock.
10	VDRV	Driver power, connect a 1uF ceramic capacitor to ground, and external device such as mcu can power from this pin.
11	VDD	Internal power, do not connect ceramic capacitor and power external device from this pin.
12	PSET	Output power set pin, connect a 1% accuracy resister to ground to configure output power, do not float.

13, 14, 15, 16	VIN	Input power.
17	NC	Floating.
18	CC1	Type-C port configure channel CC1.
19	CC2	Type-C port configure channel CC2.
20	DP	Type-C port DP pin.
21	DM	Type-C port DM pin.
22	ID/FLED	Type-A port ID pin and Fast charge led driver.
23	GATE	Power path control pin.
24	CSN	Current sense negative pin.
	EPAD	Exposed pad.

6. Absolute Maximum Ratings

Parameters	Symbol	MIN	MAX	UNIT
Input Voltage	VIN	-0.3	35	V
Output Voltage	CSP/CSN	-0.3	22	V
SW Voltage	SW	-0.3	35	V
BST Voltage	BST-SW	-0.3	6	V
Power Path Control Voltage	GATE	-0.3	27	V
CC1/CC2/DP/DM Voltage	CC1/CC2/DP/DM	-0.3	25	V
Other Pin Voltage		-0.3	6	V
Junction Temperature		-40	+150	°C
Storage Temperature Range		-60	+150	°C
ESD（HBM）		-4	+4	KV

【Notice】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 under recommended operating conditions is not implied. Exposure to absolute-maximum-rated conditions for extended periods my affect device reliability.

7. Recommended Operating Conditions

Parameters	Symbol	MIN	Typical	MAX	UNIT
Input Voltage	VIN	5		32	V

8. Electrical Characteristics

(V_{IN} = 12V, T_A = 25°C, unless otherwise specified.)

Parameters	Symbol	Test Conditions	MIN	TYP	MAX	UNIT
Power Supply						
VIN Input Voltage	V_{IN}		5		32	V
VIN Input UVLO Threshold	V_{IN_UVLO}	VIN Voltage Falling	5.2	5.3	5.4	V
VIN Input UVLO Hysteresis	$V_{IN\_UVLO\_HYS}$	VIN Voltage Rising	0.4	0.6	0.8	V
VIN Input OVP Threshold	V_{IN_OVP}	VIN Voltage Rising	29.6	30.8	32	V
VIN Input OVP Hysteresis	$V_{IN\_OVP\_HYS}$	VIN Voltage Falling	0.4	0.8	1.2	V
VDRV Output Voltage	V_{DRV}	V_{IN}=12V	4.9	5	5.1	V
VDRV Output current	I_{DRV}	V_{IN}=12V		50		mA
VDD Output Voltage	V_{DD}	V_{IN}=12V	4.9	5	5.1	V
Quiescent Current	I_Q	V_{IN}=12V, I_{OUT}=0mA		2	4	mA
Synchronous Buck						
Switching Frequency	F_{CHG}		110	125	140	KHz
Output Voltage	V_{OUT}	V_{OUT}=5V	5.0	5.1	5.2	V
		V_{OUT}=9V	8.9	9.1	9.3	V
		V_{OUT}=12V	11.9	12.1	12.3	V
		V_{OUT}=15V	14.8	15.1	15.4	V
		V_{OUT}=20V	19.8	20.1	20.4	V
CC Current Limited	I_{CC}	R_{CS}=10mΩ	3.0	3.3	3.6	A
Wire Drop Compensation	V_{OUT_WDC}	R_{CS}=10mΩ			200	mV
High Side NMOS	R_{DSON_H}		28	30	34	mΩ
Low Side NMOS	R_{DSON_L}		18	20	24	mΩ
Type-C						
CC Current Source	I_{CC_SOURCE}	Power Level=3.0A	310	330	350	uA
BC1.2						
DP/DM Voltage	DP	Apple 2.4A Mode	2.55	2.7	2.85	V
	DM	Apple 2.4A Mode	2.55	2.7	2.85	V
PE						
Current Threshold	I_{REF}		150	250	350	mA

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Quit Time	t$_{PLUG\_OUT}$		160	200	240	mS
I2C						
Rate	f$_{CLK}$			100	400	Kbit/S
Thermal Shutdown						
Thermal Shutdown Threshold	T$_{SHDT}$	Temperature Rising	135	150	165	℃
Thermal Shutdown Hysteresis	T$_{SHDT\_HYS}$	Temperature Falling	35	50	65	℃

9. Functional Description

9.1. Synchronous Buck

The SW3528 integrates a high efficiency synchronous buck with inner NMOS and output current up to 3.5A and efficiency up to 94%(VIN=12V, VOUT=5V, IOUT=3A).

The synchronous buck works in PSM/PWM mode with switching frequency of 125KHz. It works in PSM mode when in light load and in PWM mode in heavy load to make a better efficiency. It will automatically change in these two modes base on output current.

The synchronous buck supports CC/CV mode. When output current is lower than CC limited current, output voltage will keep constant. When output current reaches CC limited current, output voltage will drop to keep output current constant.

The synchronous buck supports wire drop compensation. Output voltage will linear increase according to output current and the maximum increased voltage is limited to 200mV.

The synchronous buck integrates input over voltage, input under voltage, output over current and short protection.

9.2. Power Configuration

The SW3528 supports output power configuration, and sets output power with a resister from PSET Pin to ground.

Resister	Output power
0	18W
3.9K	24W
9.1K	30W

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16K	45W
24K	60W
33K	65W

9.3. Type C Interface

The SW3528 integrates Type-C logic controller and supports DFP/SOURCE role. When UFP is attached, Type-C port will automatically turn on to supply device. When UFP is detached, Type-C port will automatically turn off.

When SINK is attached and Type-C port turns on , the SW3528 will broadcast power level of 3A.

When CC1 is connected a 5.1K resister to ground, the SW3528 works as Type-A port.

9.4. PD Fast Charge

The SW3528 integrates PPS/PD3.0/PD2.0 fast charge protocol. PPS supports 3.3~21V@3A output voltage. PD3.0/PD2.0 supports 5V/9V/12V/15V@3A.

9.5. QC Fast Charge

The SW3528 integrates QC4+/QC4/QC3.0/QC2.0 fast charge protocol. It supports Class A/Class B, while QC2.0 supporting 5V/9V/12V/20V output voltage and QC3.0 supporting 3.6V~20V output voltage, 200mV/Step.

QC2.0/QC3.0 will output voltage base on DP/DM voltage:

Device		SW3528	
DP	DM	VOUT	Note
3.3V	3.3V	20V	
0.6V	0.6V	12V	
3.3V	0.6V	9V	

0.6V	3.3V	continuous mode	0.2V/Step
0.6V	GND	5V	

9.6. AFC Fast Charge

The SW3528 integrates AFC fast charge protocol, and supports 5V/9V/12V output voltage.

9.7. FCP Fast Charge

The SW3528 integrates FCP fast charge protocol, and supports 5V/9V/12V output voltage.

9.8. SCP Fast Charge

The SW3528 integrates SCP fast charge protocol, and supports 5V@3.5A low voltage SCP and 10V@2A high voltage SCP.

9.9. PE Fast Charge

The SW3528 integrates PE2.0/PE1.1 fast charge protocol. PE1.1 supports 5V/7V/9V/12V output voltage. PE2.0 supports 5V~12V output voltage, 500mV/Step.

9.10. SFCP Fast Charge

The SW3528 integrates SFCP fast charge protocol, and supports 5V/9V/12V output voltage.

9.11. VOOC Fast Charge

The SW3528 integrates VOOC fast charge protocol, and supports 5V@3.5A.

9.12. BC1.2 Module

The SW3528 integrates BC1.2 controller, and automatically detects apple and samsung devices:

Apple 2.4A mode: DP=2.7V, DM=2.7V;

Samsung 2A mode: DP=1.2V, DM=1.2V;

9.13. Fast Charge Led

The SW3528 integrates fast charge LED driver through ID/FLED pin. ID/FLED pin will drive low to turn on fast charge led in fast charge status.

9.14. ADC

The SW3528 integrates 12 bit ADC, and samples input voltage/output voltage/output current.

ADC channel	Range	Step
Input voltage	0~40.96V	10mV
Output voltage	0~24.576V	6mV
Output current	0~6.4A	1.5625mA

9.15. I2C Interface

The SW3528 integrates I2C interface, and supports 100K/400K rate.

Read Timing:

Slave address ：0x3C
Register address：0xB0
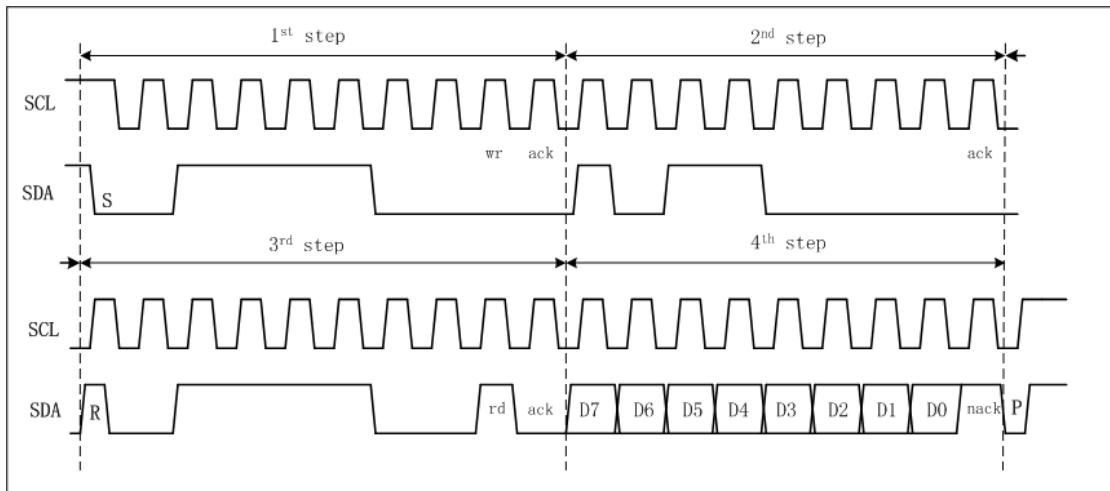
Write Timing:

Slave address ： 0x3C
Register address： 0xB0
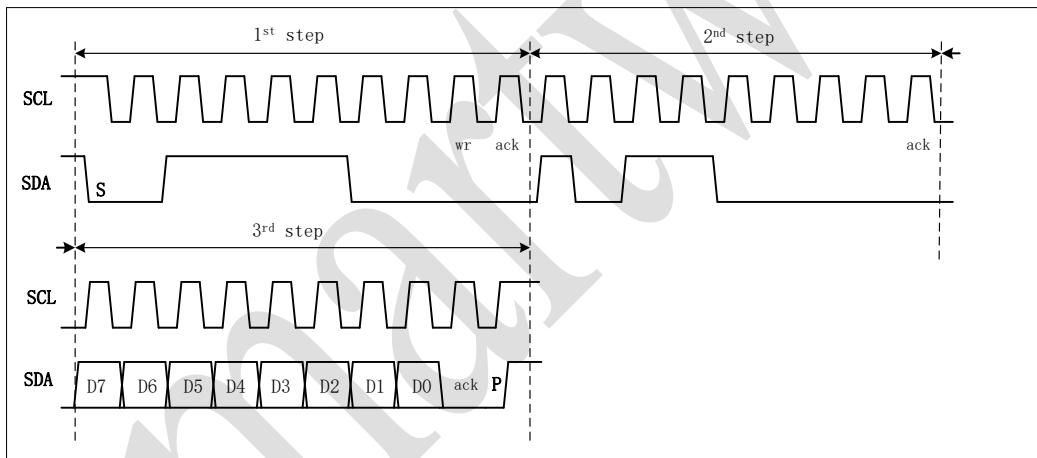
10. Typical Application Circuits
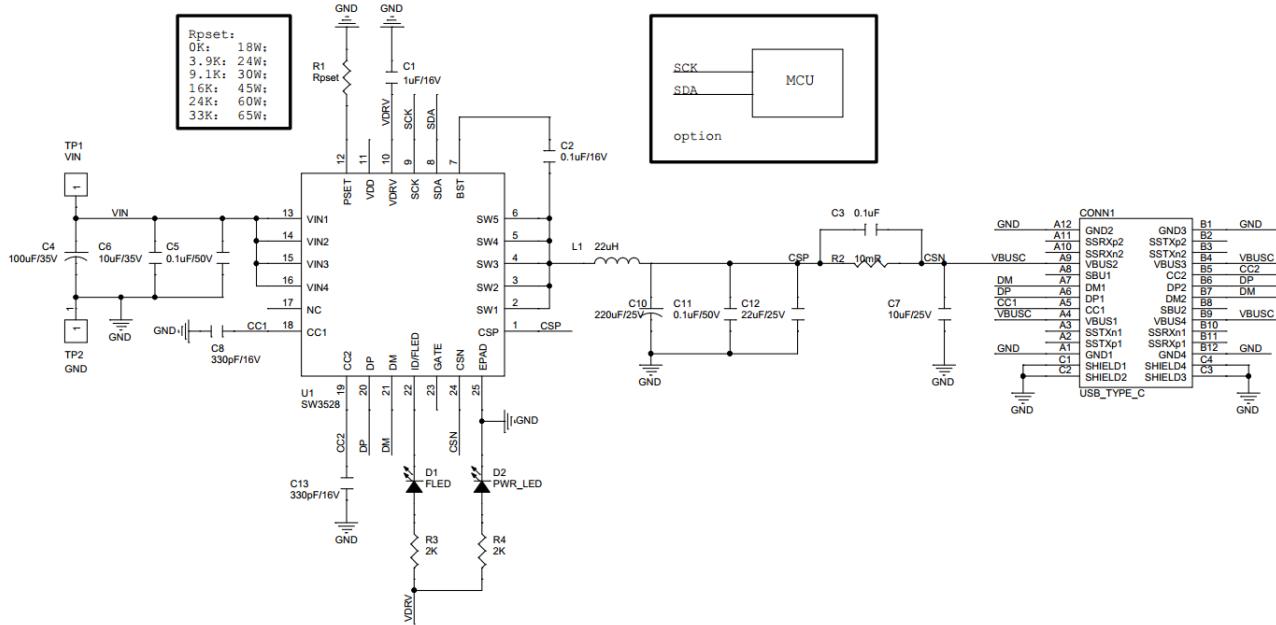
Type-C Port Output Application
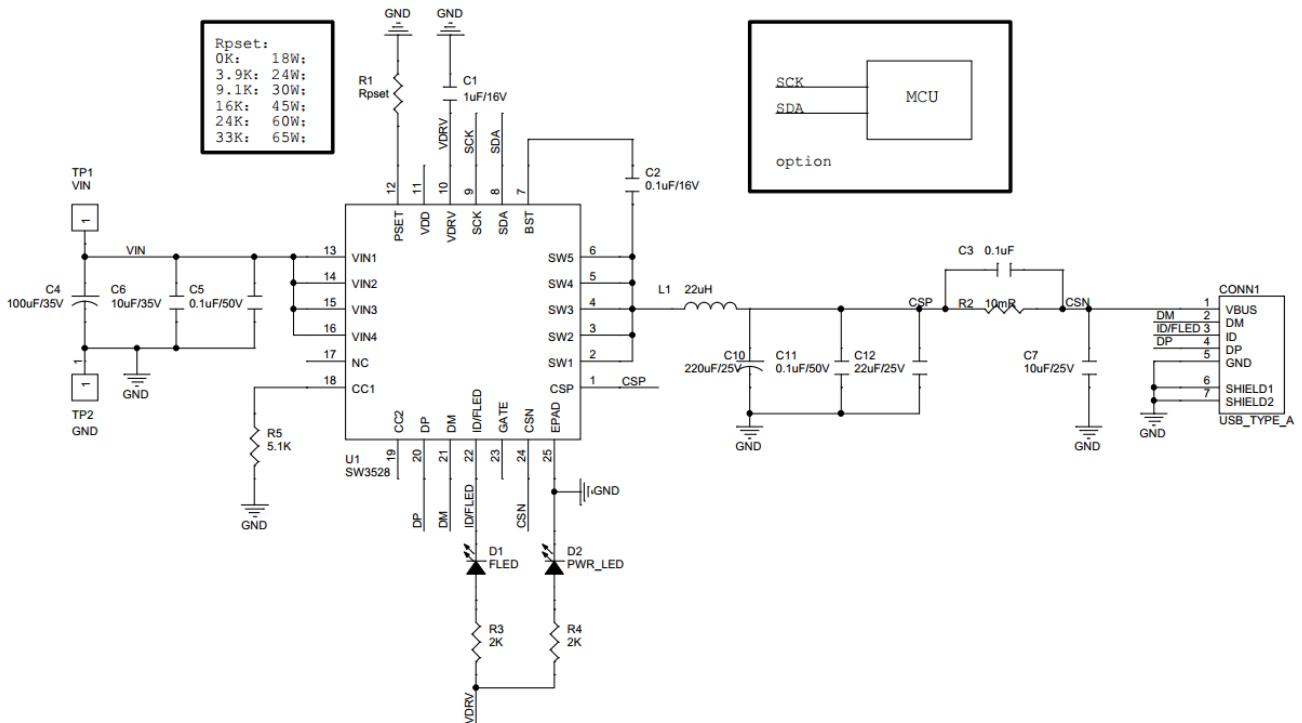
Type-A Port Output Application

11. Mechanical and Packaging

11.1. Package Summary

BOTTOM VIEW
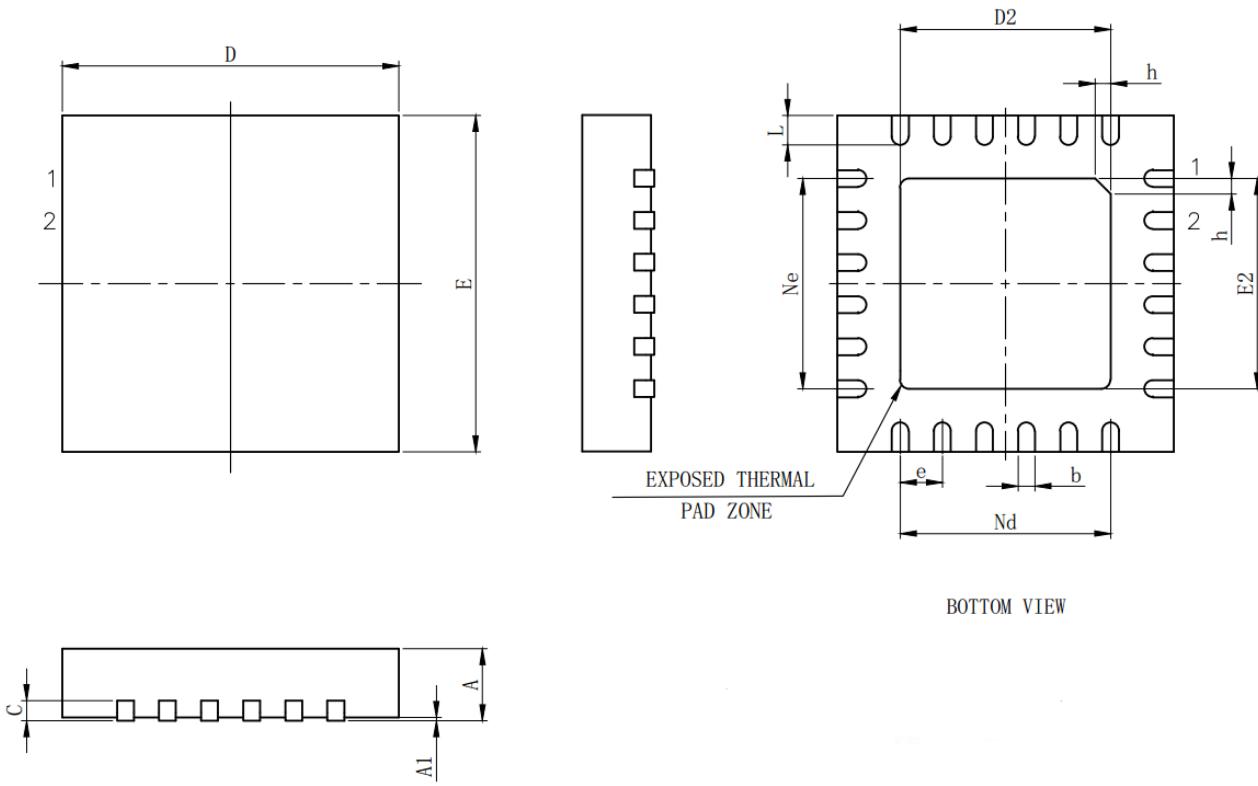
11.2. Package Outline and Dimensions

Symbol	Dimension in Millimeters		
	MIN	**NOM**	**MAX**
A	0.70	0.75	0.80
A1	0	0.02	0.05
b	0.18	0.25	0.30
c	0.18	0.20	0.25
D	3.90	4.00	4.10
D2	2.40	2.50	2.60
e	0.50BSC		
Ne	2.50BSC		
Nd	2.50BSC		
E	3.90	4.00	4.10
E2	2.40	2.50	2.60
L	0.35	0.40	0.45
h	0.30	0.35	0.40

12. Revision History

V1.0   Initial version.

V1.1   Add drain-source on resistance of power MOS.

V1.2   Modify company logo.

V1.3   Update document template.

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