Total Solution Include PD for Dual Type-C Ports Fast Charge Application

1. General Description

The SW3556 is a highly integrated power management IC for dual Type-C ports fast charge application. It integrates a 7A synchronous buck, PPS/PD/QC/AFC/FCP/SCP/PE/SFCP/TFCP fast charge protocols, and a dual ports controller, supporting PD 140W maximum output power, CC/CV mode and power dynamic distribution. With simple external components, the SW3556 provides a turn-key high efficiency solution for dual Type-C ports fast charge application.

2. Applications

- Car Charger
- Adapter

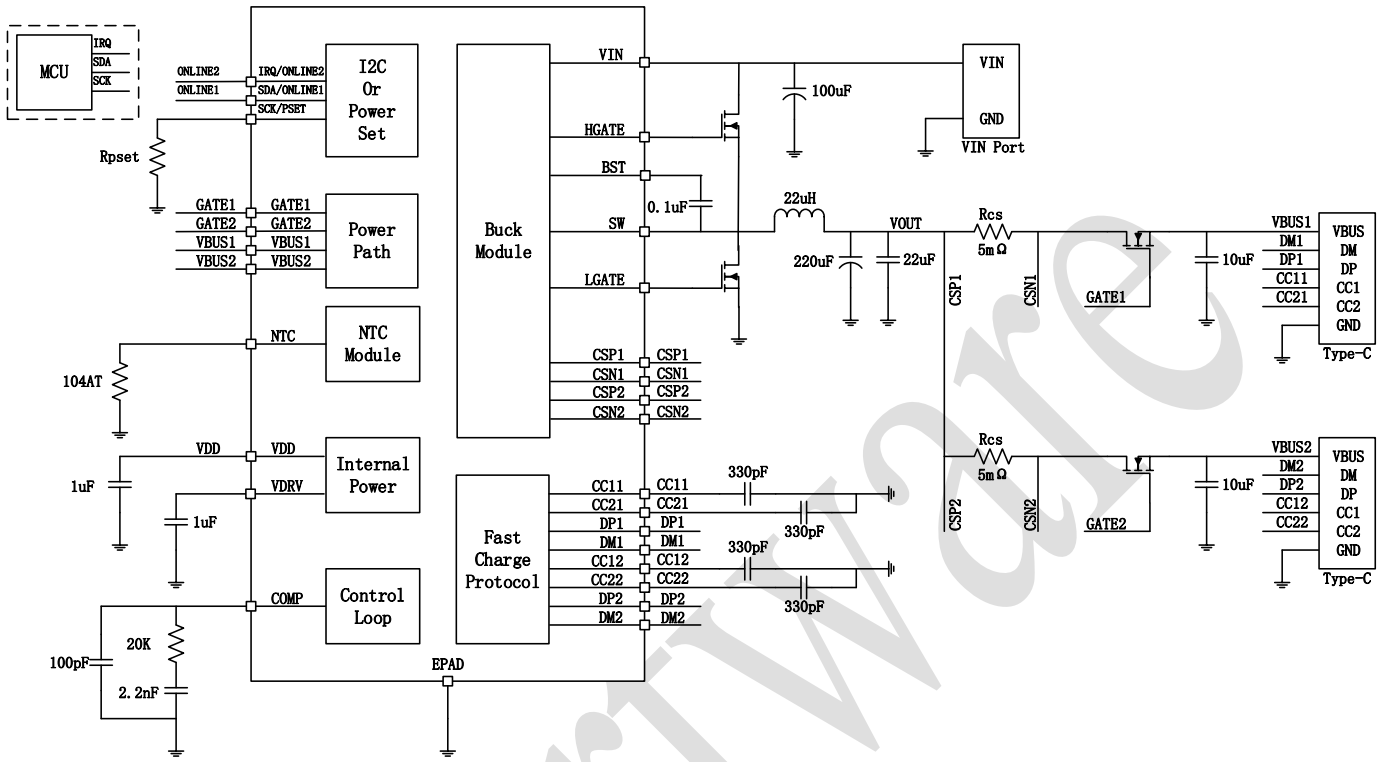
3. Features

- **Synchronous Buck**
  - Current up to 7A
  - Operating Voltage 5~36V
  - Support CC/CV Mode
  - Support Dual Ports Current Limited
  - Support Wire Drop Compensation
  - Thermal Regulation
- **Output Fast Charge Protocol**
  - Support PPS/PD3.0/PD2.0
  - Support QC5/QC4+/QC3+/QC3.0/QC2.0
  - Support AFC
  - Support FCP
  - Support HV/LV SCP
  - Support PE2.0/PE1.1
  - Support SFCP
  - Support TFCP
  - Support MCU Customization of PD/SCP
- **Power Distribution**
  - Support Power Setting by Resistance
  - Support Dual ICs Power Distribution
- **Type-C Interface**
  - Support Type-C Specification
  - Support DFP Role
- **BC1.2 Module**
  - Support BC1.2 DCP
  - Support Apple & Samsung Device
- **Protection**
  - Soft-start
  - Input Over Voltage Protection
  - Input Under Voltage Protection
  - Output Over Voltage Protection
  - Output Under Voltage Protection
  - Output Over Current Protection
  - Output Short Protection
  - DP/DM/CC Over Voltage Protection
  - Over Temperature Protection
- **I2C Interface**
- **QFN-28(4x4mm) Package**

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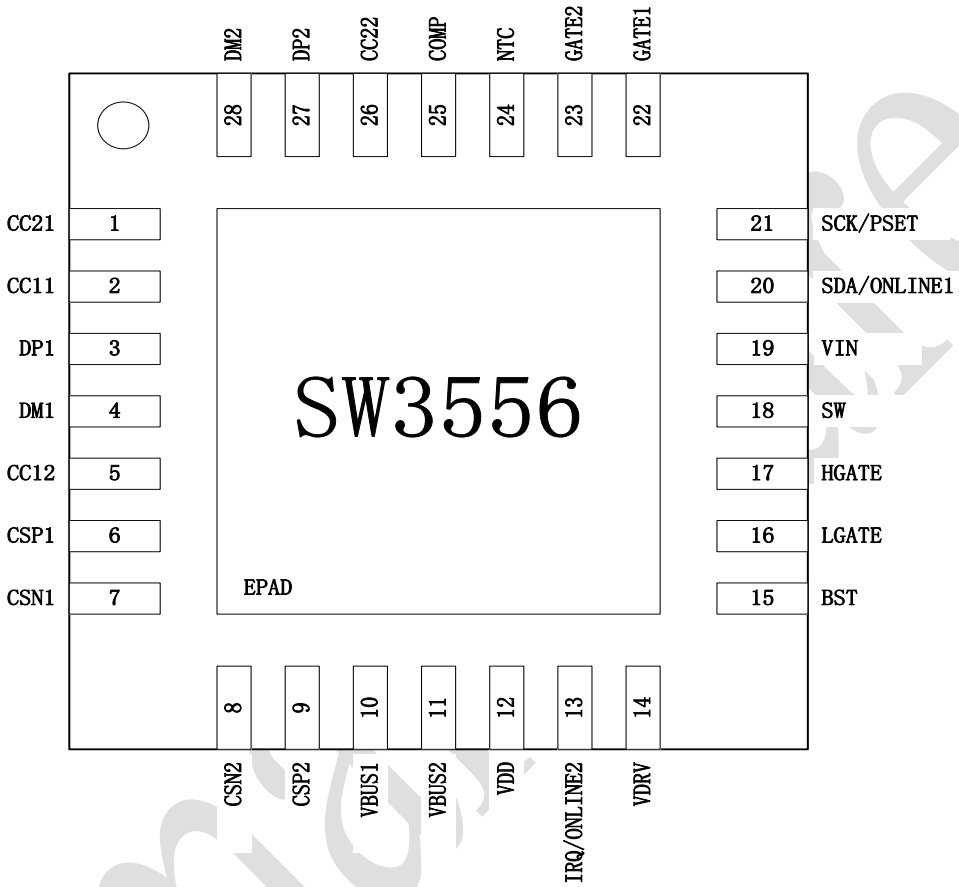
4. Functional Block Diagram



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5. Pin Configuration and Function

5.1. Pin Configuration



5.2. Pin Descriptions

Pin	Name	Function Description
1	CC21	Type-C1 configure channel CC2.
2	CC11	Type-C1 configure channel CC1.
3	DP1	Type-C1 port DP pin.
4	DM1	Type-C1 port DM pin.
5	CC12	Type-C2 configure channel CC1.
6	CSP1	Type-C1 port current sense positive pin.
7	CSN1	Type-C1 port current sense negative pin.
8	CSN2	Type-C2 port current sense negative pin.
9	CSP2	Type-C2 port current sense positive pin.
10	VBUS1	Type-C1 port load detect pin.

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11	VBUS2	Type-C2 port load detect pin.
12	VDD	Internal power.
13	IRQ/ ONLINE2	Device online signal, or irq.
14	VDRV	Driver power.
15	BST	Bootstrap pin for high side NMOS.
16	LGATE	Low side NMOS driver.
17	HGATE	High side NMOS driver.
18	SW	Switching node.
19	VIN	Input power.
20	SDA/ ONLINE1	I2C data, or control signal for power dynamic distribution.
21	SCK/PSET	I2C clock, or output power setting.
22	GATE1	Type-C1 port power path control pin.
23	GATE2	Type-C2 port power path control pin.
24	NTC	Negative temperature coefficient (NTC) thermistor input.
25	COMP	External compensation pin.
26	CC22	Type-C2 configure channel CC2.
27	DP2	Type-C2 port DP pin.
28	DM2	Type-C2 port DM pin.
	EPAD	Exposed pad.

6. Absolute Maximum Ratings

Parameters	Symbol	MIN	MAX	UNIT
Input Voltage	VIN	-0.3	48	V
Output Voltage	CSP1/CSN1/CSP2/ CSN2/VBUS1/VBUS2	-0.3	30	V
SW Voltage	SW	-0.3	40	V
BST/HGATE Voltage	BST/HGATE-SW	-0.3	6	V
Power Path Control Voltage	GATE1/GATE2	-0.3	30	V
Fast Charge Signal Voltage	DP1/DM1/CC11/CC21/ DP2/DM2/CC12/CC22	-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

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conditions is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

7. Recommended Operating Conditions

Parameters	Symbol	MIN	Typical	MAX	UNIT
Input Voltage	VIN	5		36	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		36	V
VIN Input UVLO Threshold	V_{IN_UVLO}	VIN Voltage Falling		4.9	5	5.1	V
VIN Input UVLO Hysteresis	$V_{IN_UVLO_HYS}$	VIN Voltage Rising		0.85	1	1.15	V
VIN Input OVP Threshold	V_{IN_OVP}	VIN Voltage Rising		36	37.5	39	V
VIN Input OVP Hysteresis	$V_{IN_OVP_HYS}$	VIN Voltage Falling		1.2	1.5	1.8	V
VDD Output Voltage	V_{DD}	V_{IN}=12V		4.9	5	5.1	V
VDD Output Current	I_{DD}	V_{IN}=12V			50		mA
VDRV Output Voltage	V_{DRV}	V_{IN}=12V		4.9	5	5.1	V
Quiescent Current	I_Q	V_{IN}=12V, I_{OUT}=0mA			600	1000	uA
Synchronous Buck							
Switching Frequency	F_{CHG}	F_{CHG_SET}=125KHz		110	125	140	KHz
		F_{CHG_SET}=200KHz		180	200	220	KHz
		F_{CHG_SET}=333KHz		310	333	360	KHz
		F_{CHG_SET}=500KHz		470	500	530	KHz
Output Voltage	V_{OUT}	V_{OUT}=5V, I_{OUT}=0A		5.0	5.1	5.2	V
		V_{OUT}=9V, I_{OUT}=0A		8.9	9.1	9.3	V
		V_{OUT}=12V, I_{OUT}=0A		11.7	12.1	12.3	V
		V_{OUT}=15V, I_{OUT}=0A		14.6	15.1	15.4	V
		V_{OUT}=20V, I_{OUT}=0A		19.5	20.1	20.5	V
CC Current Limited	I_{CC}	R_{CS}=5mΩ	Single Port	3.0	3.3	3.6	A
			Dual Ports	2.4	2.7	3.0	A

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Wire Drop Compensation	V_{OUT_WDC}	R_{CS}=5mΩ	50	65	80	mV/A
Thermal Regulation Threshold	T_{REGU}		105	120	135	℃
Light Load Detect						
Light Load Current	I_{LIGHT_LOAD}	R_{CS}=5mΩ	5	10	20	mA
Light Load Time	t_{LIGHT_LOAD}		1.5	2	3	S
Type-C						
CC Current Source	I_{CC_SOURCE}	Power Level=1.5A	160	180	200	uA
		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
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 SW3556 integrates a high-efficiency synchronous buck with output current up to 7A and efficiency up to 95%(VIN=12V, VOUT=5V, IOUT=5A).

The synchronous buck works in PSM/PWM mode. 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. When working in single port mode, the CC limited current is set to 3.3A, while in dual ports mode, the CC limited current is set to 2.7A for each port.

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The synchronous buck supports wire drop compensation. Output voltage will increase linearly according to output current and the increased voltage is 65mV/A.

The synchronous buck integrates thermal regulation. When die temperature rises to 120℃, output voltage will automatically fall so as die temperature stops increasing. If die temperature still rises to 150℃, buck will stop and turn off. When die temperature falls to thermal shutdown hysteresis, buck will automatically restart.

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

9.2. Power Path

The SW3556 supports dual Type-C ports output, and each port supports fast charge output.

Each Type-C port supports PPS/PD3.0/PD2.0/QC5/QC4+/QC3+/QC3.0/QC2.0/AFC/FCP/SCP/PE2.0/PE1.1/ SFCP/TFCP fast charge output.

Type-C ports turn off in default mode. When working in single port mode, it supports fast charge output. When working in dual ports mode, it supports 5V output and current limiting for each port.

When a SINK is attached, the Type-C port will turn on to supply device. When a SINK is detached, or light load is detected, Type-C port will turn off. The light load current will be about 10mA.

9.3. Type C Interface

The SW3556 integrates a Type-C logic controller and supports DFP/SOURCE role. When a UFP is attached, the Type-C port will automatically turn on to supply device. When the UFP is detached, the Type-C port will automatically turn off.

When s UFP is attached and the Type-C port turns on , the SW3556 will broadcast a power level of 3A or 1.5A.

9.4. PD Fast Charge

The SW3556 integrates PPS/PD3.0/PD2.0 fast charge protocols. PPS supports 3.3~21V output voltage. PD3.0/PD2.0 supports 5V/9V/12V/15V/20V output voltage, and 140W(20V@7A) maximum output power.

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9.5. QC Fast Charge

The SW3556 integrates QC5/QC4+/QC3+/QC3.0/QC2.0 fast charge protocols. It supports Class A/Class B, while QC2.0 supports 5V/9V/12V/20V output voltage and QC3.0 supports 3.6V~20V output voltage, 200mV/Step.

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

Device		SW3556	
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 SW3556 integrates a AFC fast charge protocol, and supports 5V/9V/12V output voltage.

9.7. FCP Fast Charge

The SW3556 integrates a FCP fast charge protocol, and supports 5V/9V/12V output voltage.

9.8. SCP Fast Charge

The SW3556 integrates a SCP fast charge protocol, and supports low voltage SCP(5V@4.5A/4.5V@5A) and high voltage SCP(10V@2A).

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9.9. PE Fast Charge

The SW3556 integrates PE2.0/PE1.1 fast charge protocols. PE1.1 supports 5V/7V/9V/12V output voltage. PE2.0 supports 5V~12V output voltage, 500mV/Step.

9.10. SFCP Fast Charge

The SW3556 integrates a SFCP fast charge protocol, and supports 5V/9V/12V output voltage.

9.11. TFCP Fast Charge

The SW3556 integrates a TFCP fast charge protocol, and supports 25W/33W/45W/65W output power.

9.12. BC1.2 Module

The SW3556 integrates a 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. Power Setting and Distribution

The SW3556 integrates output power setting and power dynamic distribution.The output power can be set by SCK/PSET pin, and power dynamic distribution can be set by SDA/ONLINE1 pin.

When SCK/PSET pin is connected to a power rail via a pull up resister, SCK/PSET and SDA/ONLINE1 pins are configured to I2C SCK and SDA. Output power setting and power dynamic distribution are configured by I2C.

When SCK/PSET pin is connected to ground via a pull down resister, SCK/PSET pin is configured to PSET function for output power setting, and SDA/ONLINE1 pin is configured to ONLINE1 function for power dynamic distribution.

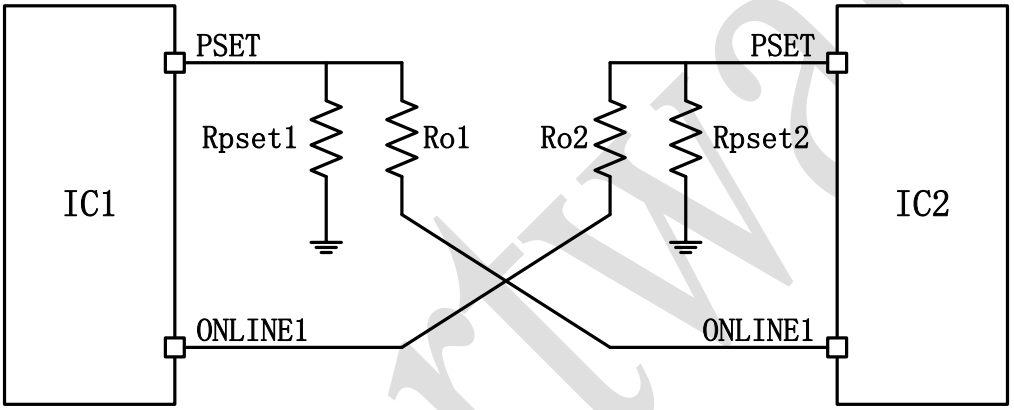
Output power is set according to the resister of PSET pin. The corresponding relationship between resister value and output power is shown in the table below:

Output Power	Resister Value(1% accuracy)
100W	NC

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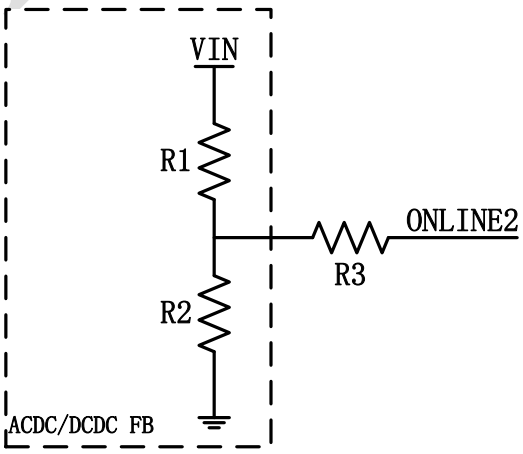
65W	90.9K
60W	68K
45W	49.9K
30W	37.4K
25W	27.4K
24W	17.4K
20W	7.5K
18W	Ground

The ONLINE1 function realizes the power dynamic distribution between the two ICs, as shown in the figure below. When a device is attached to IC, IC will pull down ONLINE1 pin, so as to change the resister value connecting to PSET pin of another IC and adjust the output power of another IC.



9.14. Device Online Indication

IRQ/ONINE2 pin is device online indication signal by default. It can be used to connect to the voltage feedback point of the front stage ACDC or DCDC through a resister, so as to adjust the output voltage of the front stage ACDC or DCDC and improve the system efficiency. When a device is attached, ONLINE2 pin is pulled down. When the device is detached or in light load, ONLINE2 pin remains in high resistance state. IRQ/ONINE2 pin can also be configured as an interrupt signal.



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9.15. ADC

The SW3556 integrates a 12 bit ADC, and samples input voltage/output voltage/Type-C1 output current/Type-C2 output current/board temperature. Board temperature can be calculated by NTC thermistor of 104AT.

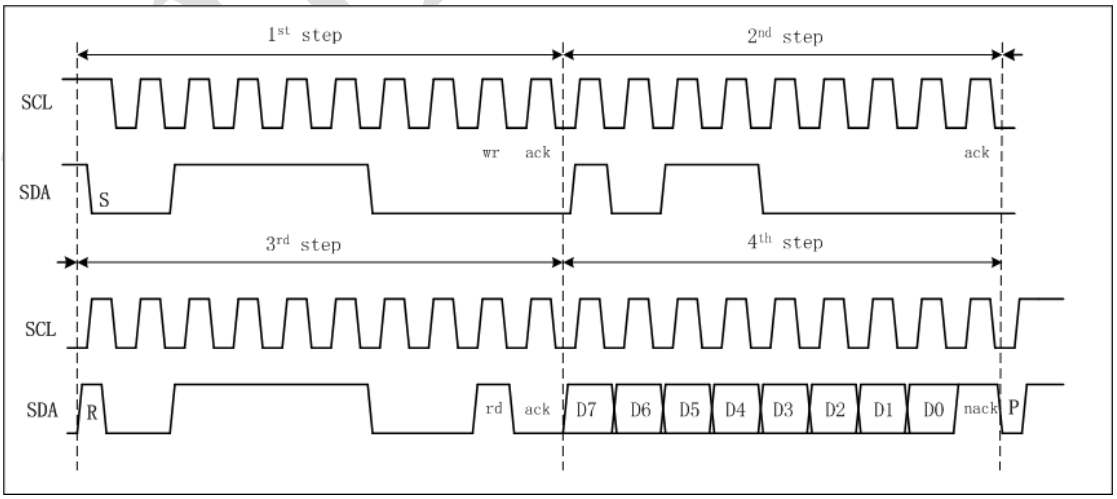
ADC channel	Range	Step
Input voltage	0~40.96V	10mV
Output voltage	0~24.576V	6mV
Type-C1 output current	0~10.24A@5mΩ	2.5mA@5mΩ
Type-C2 output current	0~10.24A@5mΩ	2.5mA@5mΩ
NTC voltage	0~4.9152V	1.2mV

9.16. I2C Interface

The SW3556 integrates I2C interface, and supports 100K/400K rate.

Read Timing:

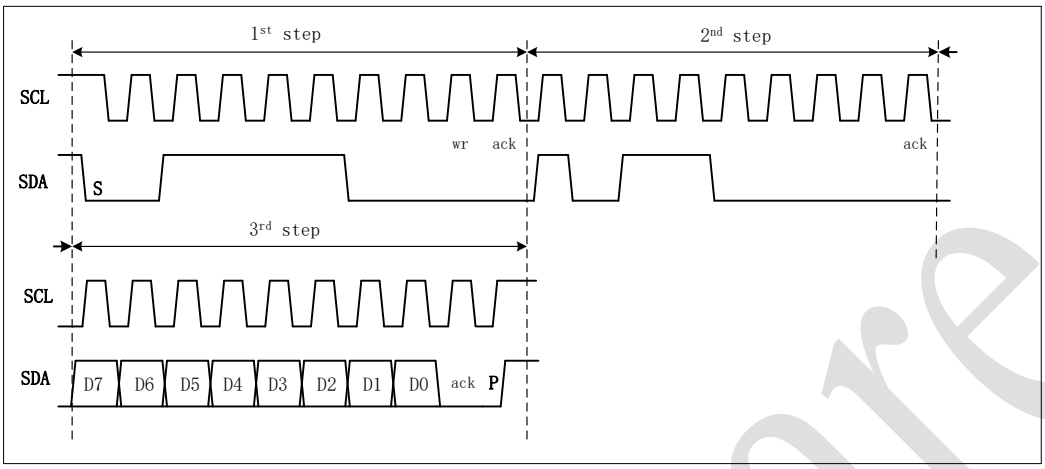
Slave address ： 0x3C
Register address： 0xB0



Write Timing:

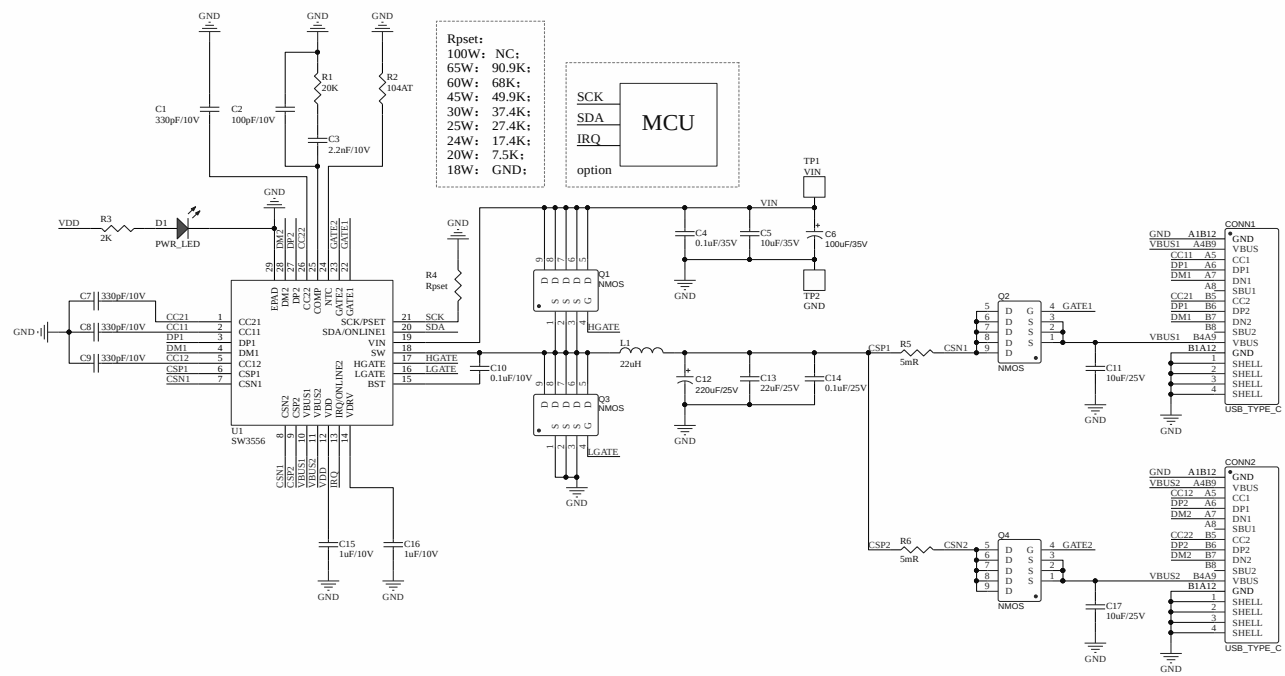
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Slave address ： 0x3C
Register address： 0xB0



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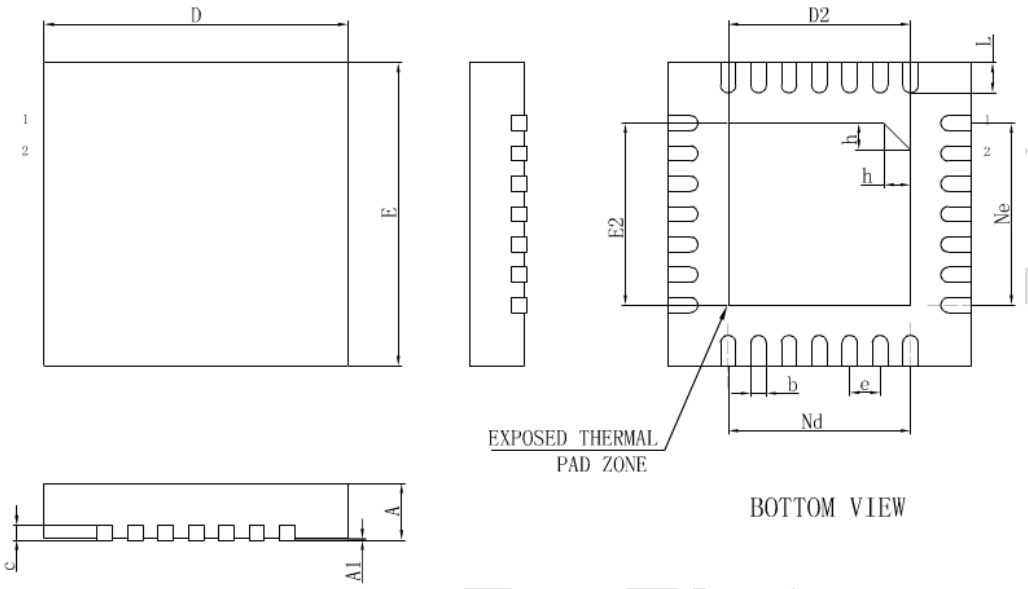
10. Typical Application Circuits



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11. Mechanical and Packaging

11.1. Package Summary



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	0.15	0.20	0.25
c	0.18	0.20	0.25
D	3.90	4.00	4.10
D2	2.30	2.40	2.50
e	0.40BSC		
Nd	2.40BSC		
E	3.90	4.00	4.10
E2	2.30	2.40	2.50
Ne	2.40BSC		
L	0.35	0.40	0.45
h	0.30	0.35	0.40

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12. Revision History

V1.0 Initial version.

V1.1 Add frequency parameter of buck converter.

V1.2 Update document template.

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