

Fast Charging Physical Layer IC for USB TypeC interfaces with internal load switch integrated

TypeC PD2.0/PD3.0, QC3.0/QC2.0, FCP, AFC, Apple 2.4A, BC1.2

1. Features

- **Support charging standards including :**
 - ◇ Support USB TypeC/PD2.0/PD3.0
 - ◇ Support QC3.0/QC2.0 Class A
 - Support QC3.0 Class A: 3.6V~12V
 - Support QC2.0 Class A: 5V, 9V, 12V
 - ◇ Support Huawei® FCP: 5V, 9V, 12V
 - ◇ Support Samsung® AFC: 5V, 9V, 12V
 - ◇ Support Apple® 2.4A: DP = 2.7V, DM = 2.7V
 - ◇ Support Samsung 2.0A: DP = 1.2V, DM = 1.2V
 - ◇ Support BC1.2: DP short DM automatically
- **Support USB TypeC PD2.0/PD3.0 DFP**
 - ◇ **USB PD3.0 Certificate Number: TID 6173**
 - ◇ Auto-detect TypeC attach and detach
 - ◇ Programmable 20W Source Capabilities
 - ◇ PDO packages: 5V3A,9V2.22A,12V1.67A
 - ◇ Turn on load switch after successful CC connection
- **Auto-determine voltage and signals on CC1, CC2 and DP, DM for different fast charge**
- **Power management**
 - ◇ Integrated power load switch
 - ◇ Integrated bleeder function on VIN pin and VBUS pin
 - ◇ Support VBUS soft start
 - ◇ IP2189 support low power mode and wake up by DPDM plugin detection.
- **Support multi-chip paralleled connection to achieve multi-port fast charging output and management**
- **Multi protection/safety features**
 - ◇ Support OTP (Over Temperature Protection)
 - ◇ Support OCP (Over Current Protection)
 - ◇ Support OVP (Input Over Voltage Protection)
 - ◇ Support DP,DM,CC1,CC2 overvoltage Protection
 - ◇ Support DP,DM weak short to GND protection (optional)

- **IP2189_SP support alternative regulation**
 - ◇ Optocoupler regulation
 - ◇ Non-optocoupler regulation
- **Input voltage range: 3.3V~12V**
- **Package: ESOP8**

2. Description

IP2189 is a fast charging Physical Layer IC dedicated for USB ports, which supports several kinds of fast charging standards, including USB TypeC PD2.0/PD3.0 DFP, HVDCP QC3.0/QC2.0 (Quick Charge) Class A, FCP (Hisilicon® Fast Charge Protocol) , AFC (Samsung® Adaptive Fast Charge) , Apple 2.4A, BC1.2 and 2.0A.

IP2189 automatically detecting the connected device's type and switching standards type to responding for fast charging requirements.

IP2189_SP integrated power load switch for power management, support 20W OCP protection.

IP2189 FB control line support sink or source current for accurate voltage regulation.

3. Typical Application

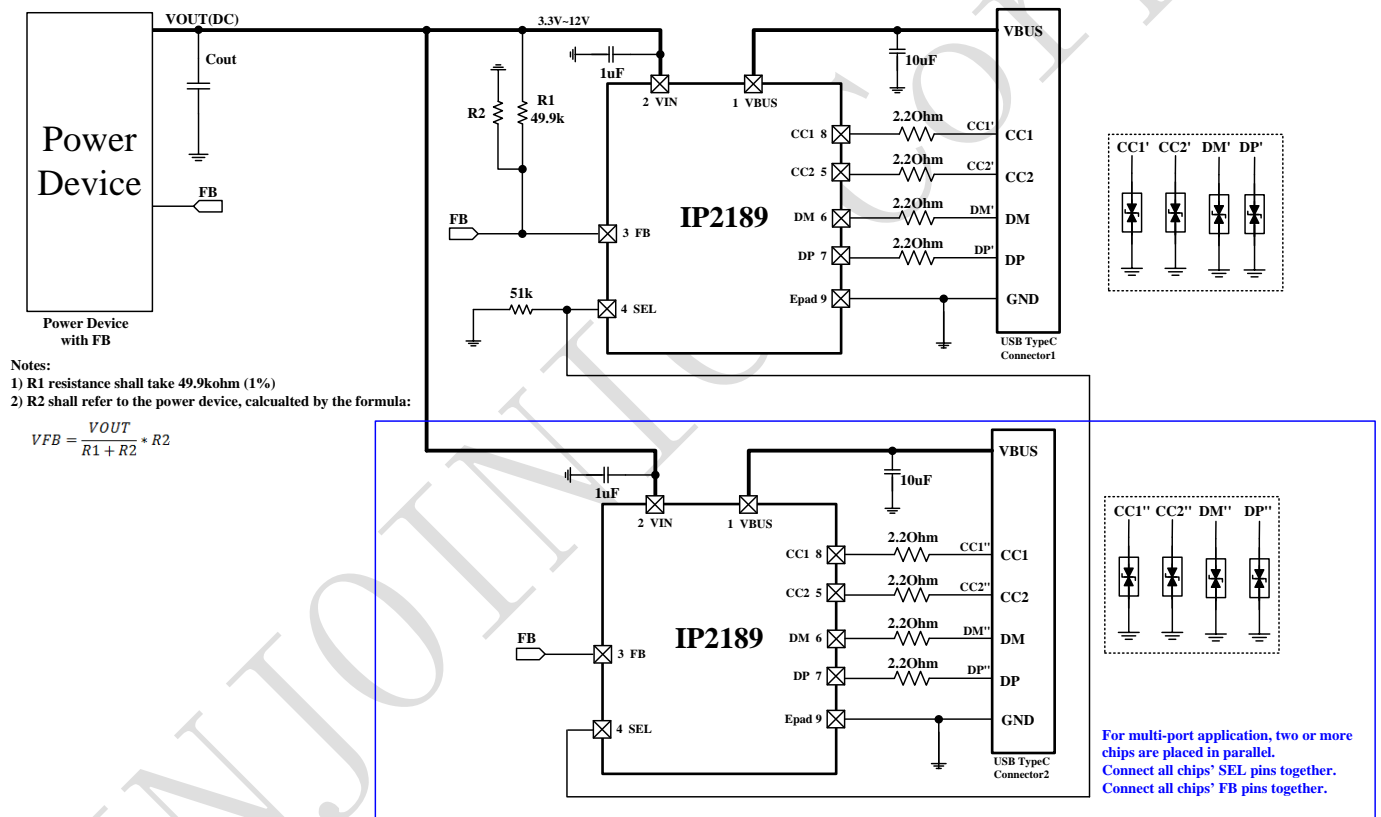
- USB power output ports for AC adapters, Power Bank, Car chargers
- Battery chargers for smart phones, tablets, netbooks, digital cameras, and Bluetooth accessories

4. Device Comparison Table

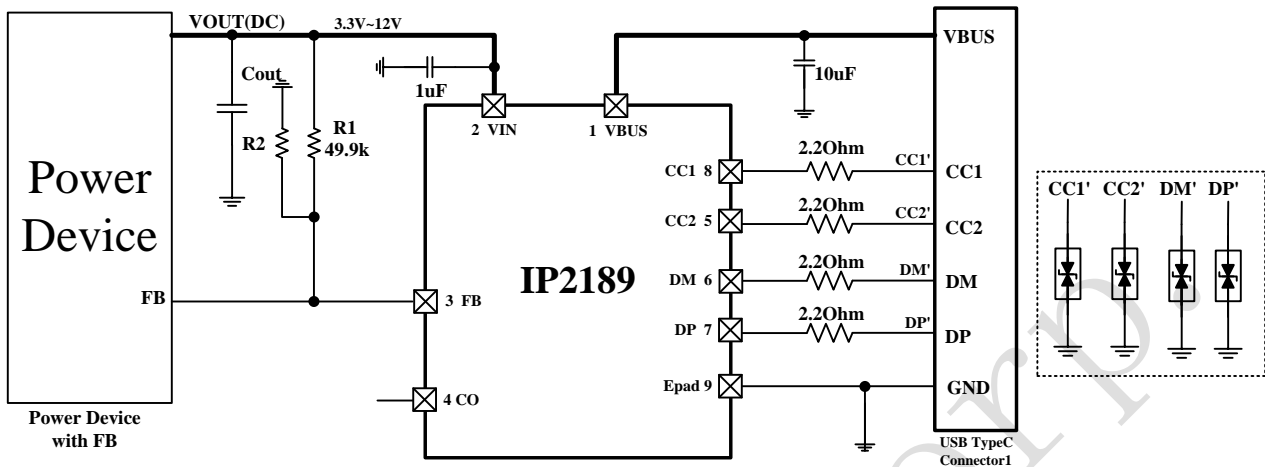
Device	Power	PDO
IP2189/ IP2189_SP	20W	5V3A, 9V2.22A, 12V1.67A
IP2189_9V	20W	5V3A, 9V2.22A

5. Typical Application Schematic

IP2189 multi-port Application—Non-Optocoupler regulation



IP2189_SP—Non-Optocoupler regulation



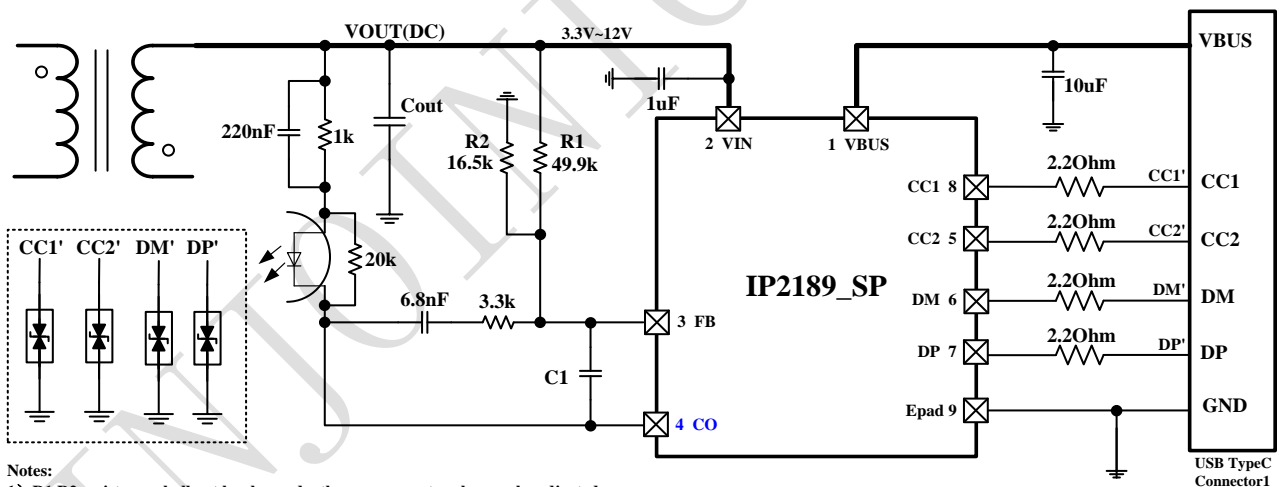
Notes:

- 1) R1 resistance shall take 49.9kohm (1%)
- 2) R2 shall refer to the power device, calculated by the formula:

$$V_{FB} = \frac{V_{OUT}}{R1 + R2} * R2$$

- 3) PIN4(CO) shall be float

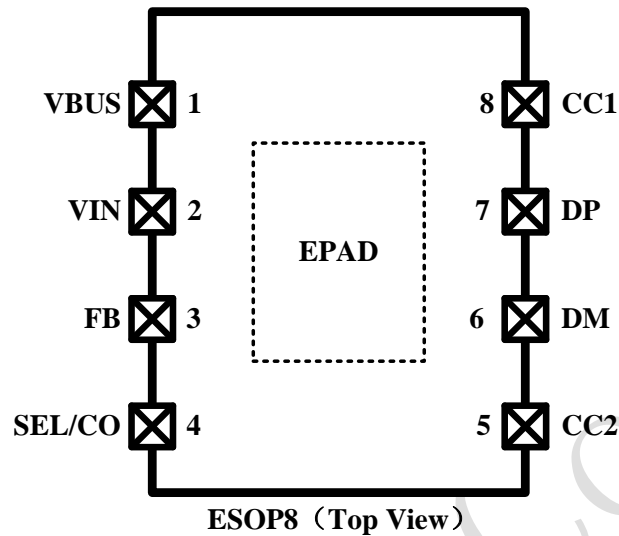
IP2189_SP—Optocoupler regulation



Notes:

- 1) R1,R2 resistance shall not be changed, other components value can be adjusted according to the application;
- 2) C1 is a reserved capacitor, not necessary, when the loop is not stable, a capacitor in tens of pF may be considered to place here.

6. PIN Description



Pin No.	Pin name	Pin description
1	VBUS	VBUS output and discharge PIN.
2	VIN	VIN input and discharge PIN.
3	FB	Feedback PIN.
4	CO	IP2189_SP Optocoupler regulation: Compensate PIN for voltage regulation. Connect to the FB line with compensate network. IP2189 Non-Optocoupler regulation: Float;
	SEL	IP2189 Multi-port: Multi-port detection pin, connect all the paralleled chips' SEL pin together to a 51kohm to GND in multi-port application; connect to GND directly for single port application.
5	CC2	TypeC CC2 line
6	DM	USB DM data line
7	DP	USB DP data line
8	CC1	TypeC CC1 line
9 (Epad)	GND	GND

7. Absolute Maximum Ratings

Parameters	Symbol	Value	Unit
VIN Input Voltage Range	VIN	-0.3 ~ 17	V
VBUS Input Voltage Range	VBUS	-0.3 ~ 17	V
FB Input Voltage Range	V _{FB}	-0.3 ~ 17	V
SEL Input Voltage Range	V _{SEL}	-0.3 ~ 15	V
DP, DM Input Voltage Range	V _{DP} , V _{DM}	-0.3 ~ 15	V
CC1, CC2 input Voltage Range	V _{CC1} , V _{CC2}	-0.3 ~ 15	V
Junction Temperature Range	T _J	-40 ~ 150	°C
Storage Temperature Range	T _{stg}	-60 ~ 150	°C
Lead Temperature Range (Soldering, 10sec)	T _s	260	°C
Package Thermal Resistance	θ _{JA}	90	°C/W
Package Thermal Resistance	θ _{JC}	39	°C/W
Human Body Model (HBM)	ESD	4	KV
Moisture Sensitivity Level (MSL)	MSL	3	Level

*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.

8. Recommended Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit
Input Voltage	VIN	3.6		13	V
Ambient Temperature	T _A	-40		115	°C

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

9. Electrical Characteristics

Unless otherwise specified, T_A=25°C, 4.5V ≤ VIN ≤ 5.5V

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Input Voltage	VIN	Supplied directly	3.6		13	V
Input UVLO Threshold	UVLO	VIN Falling	2.9		3.3	V
Quiescent Current	I _Q	TypeC port floating		0.7		mA

		PD5V		2.2		mA
		PD9V		2.7		mA
		PD12V		2.9		mA
Load swith resistance	$R_{ds(on)}$	Fully on		29		mohm
VIN bleed time	Tleak	CIN=900uF; Detach in 12V, time of VIN voltage from 12V to 5V		30		ms
HVDCP (QC2.0)						
Data Detect Voltage Threshold	V_{DATA_REF}		0.25	0.325	0.4	V
Output Voltage Selection Reference	V_{SEL_REF}		1.8	2	2.2	V
DP High Glitch Filter Time	$T_{GLITCH(BC_DP_H)}$		1000	1160	1500	ms
DM Low Glitch Filter Time	$T_{GLITCH(BC_D_M_L)}$			2		ms
Output Voltage Glitch Filter Time	$T_{GLITCH(V_CHANGE)}$		20	40	60	ms
DM Pull-down Resistance	R_{DM_DOWN}	VDP=0.6V		20		kOhm
DP Pull-down Resistance	R_{DAT_LKG}	VDP=0.6V		1000		kOhm
DCP						
Samsung DP/DM Output Voltage			1.08	1.2	1.32	V
Samsung DP/DM Output Impedance				100		kOhm
Apple 2.4A DP/DM Output Voltage			2.64	2.7	2.76	V
Apple 2.4A DP/DM Output Impedance				30		kOhm
OCP						
OCP	OCP _{HV}	VIN>=11V		2		A
	OCP _{MV}	11V>VIN>=8.6V		2.66		A
	OCP _{LV}	VIN<8.6V		3.6		A

10. Function Description

Quick Charge protocols

IP2189_SP is a fast charging Physical Layer IC dedicated for USB ports, which supports several kinds of fast charging standards, including USB TypeC PD2.0/PD3.0 DFP, HVDCP QC3.0/QC2.0 (Quick Charge) Class A, FCP (Hisilicon® Fast Charge Protocol), AFC (Samsung® Adaptive Fast Charge), Apple 2.4A, BC1.2 and 2.0A.

IP2189_SP auto detect the connected device's type and respond to different fast charging requirements.

IP2189_SP integrated power load switch for power management, support 20W OCP protection.

DP/DM Quick Charge

IP2723T can automatically detects Quick Charge 2.0/3.0 capable devices with handshake by USB D+/D- data line. It's also complaint with BC1.2.

- BC1.2: Shorting D+ Line to D- Line.
- Quick Charge 2.0/3.0: DP and DM line configuration.
- Huawei Fast Charge Protocol: DP line configuration and DM line communication
- Samsung® AFC: DP line configuration and DM line communication

TYPE-C /PD

The USB Type-C connector uses CC pins for configuration including the ability for a Source to advertise to its port partner (Sink) the amount of current it can apply:

- Default values defined by the USB Specification (500 mA for USB 2.0 ports, 900 mA for USB 3.1 ports)
- 1.5A
- 3.0A

Integrated with certification standard USB Power Delivery (PD) controller

Support PD2.0/PD3.0

PDO within 25W can be configured according to customer requirements.

Multi-chip for multi-port application

IP2189 Support multi-chip paralleled connection to achieve multi-port fast charging output and management. When the load switch is on, SEL pin will source 20uA current on the 51kohm resistor and SEL pin voltage will be 1V. When two or more chips' load switch is on, the voltage on SEL pin will be higher than 1.5V and the chips enter multi-port working mode. When entering multi-port working mode, IP2189 exit fast charge mode and restart the load switch for 1second. Under multi-port working mode, IP2189 disables fast charge and the output voltage is 5V.

Once only 1 load switch is on, the SEL pin will fall below 1.5V, IP2189 with load switch on will restart its output, and enters single-port mode. Under single-port working mode, IP2189 react to the fast charge protocol and voltage regulation commands.

IP2189_SP do not support multi-port output function.

Low power mode and plugin detection

IP2189 support low power mode and DPDM plugin wake up. When IP2189 detected the current under standby current threshold for 2 hours under load switch on, it enters low power mode and turn off the load switch for power saving. Under low power mode, once IP2189 detect DP/DM plugin or TypeC plugin, it will wake up and enter normal working mode.

IP2189_SP do not support low power mode and DPDM plugin wake up.

Voltage Regulation

IP2189_SP integrates an optocoupler driver circuit, and the CO pin is connected to the Cathode end of the optocoupler for use in isolated power supplies. The value of external compensation network capacitance, resistance of FB needs to be adjusted according to the specific parameters of the front-end power network, The FB compensation network is used to achieve VBUS output voltage stability. In optocoupler regulate application, the R1 and R2 resistance is fixed referred to the typical application schematic, and shall not be changed.

FB control line is used for accurate voltage regulation by source/sink current with precise accuracy. FB sink 40uA current for 9V output voltage; FB sink 70uA current for 12V output voltage; FB sink 150uA current for 20V output voltage; when the output voltage is default 5V, FB neither source nor sink current.

IP2189/IP2189_SP support non- optocoupler regulation circuit, FB pin shall connect to TL431/TL432 or other power device with FB pin. In non-optocoupler regulate applications, the resistor (R1) should apply 49.9kOhm with high precision (1%), resistor (R2) value between FB and GND should refer to the front regulator, resistance of R2 can be calculated by equation:

$$V_{FB} = \frac{V_{OUT}}{R1 + R2} * R2$$

Cable Drop Compensation

IP2189/IP2189_SP integrates the cable drop compensation function, which can increase the output voltage in a certain proportion according to the current output current to compensate for cable IR drop. The compensation coefficient is 125mV/A.

For example, if the no-load output voltage is 5.0V, when the output current is 3A, then the actual output voltage=5.0V+3A*125mV/A=5.375V.

OCP

IP2189_SP support OCP (over current protection) by detecting the current flowing through the internal sampling load switch. When the current reaches the over-current threshold, the over-current abnormal protection occurs, IP2189_SP will closing the load switch for 1 second, then turn on the switch, if the abnormal condition still remains, then the VBUS will hiccup consistently. If the abnormal event disappears, the Type-C handshake and PD communication will be re-established.

OVP and OTP and CC1/CC2/DP/DM OVP

IP2189_SP support OTP (over temperature protection) and OVP (over voltage protection), CC1,CC2,DP,DM overvoltage protection, when the abnormal conditions above appears, the load switch will turn off for a while, until there's no any abnormalities. Otherwise the load switch will be off all the time. When the load switch off, the Rp pull up of TypeC CC1 and CC2.

OVP (VIN)

IP2189_SP monitors VIN voltage for OVP (over voltage protection), the default OVP threshold voltage is 5.6V, before turning on the load switch if VIN voltage is higher than 5.6V, then the load switch will not turn on and remain off state even if the TypeC connection is successfully established.

When the load switch is turned on, the OVP threshold voltage rise to 14V, if the VIN voltage is higher than 14V, OVP is triggered and the load switch will be turned off for at least 1 second.

OTP (Internal Junction)

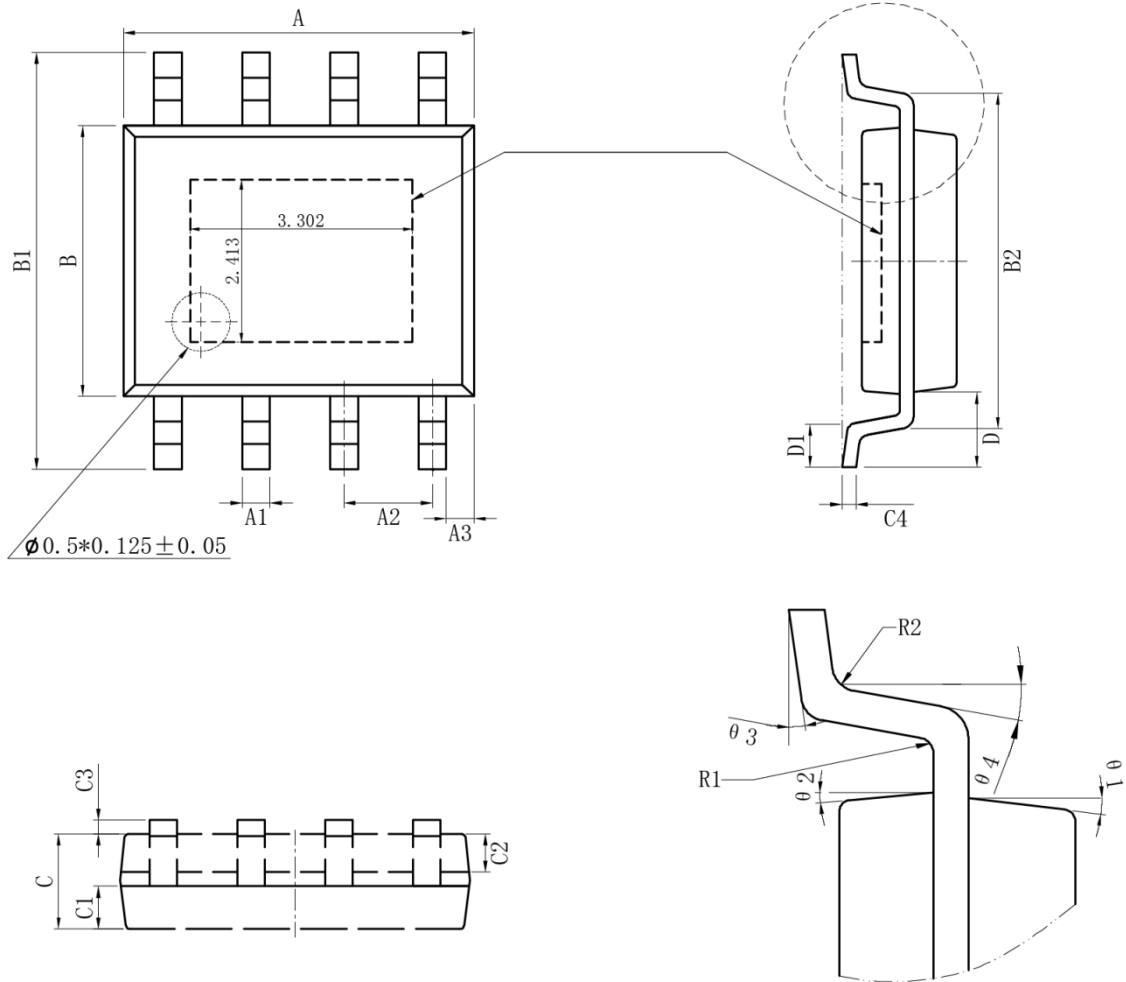
IP2189_SP integrate internal junction over temperature protection, when the junction temperature excesses 145 centigrade, the OTP will be triggered and load switch will be turned off for at least 1 second, until the temperature fall below 70 centigrade.

CC1/CC2/DP/DM OVP

IP2189_SP support CC1,CC2,DP,DM overvoltage protection, when voltage on CC1/CC2 pins is above 6V, the load switch will be turned off and hiccup every 1 second, until the voltage on CC1/CC2 fall below 5.5V.

When the voltage on DP/DM pins is above 4.5V, the load switch will be turned off and hiccup every 1 second, until the voltage on DP/DM fall below 4V.

11.Package



标注	尺寸	最小 (mm)	最大 (mm)	标注	尺寸	最小 (mm)	最大 (mm)
A		4.80	5.00	C3		0.00	0.09
A1		0.356	0.456	C4		0.203	0.233
A2		1.27TYP		D		1.05TYP	
A3		0.345TYP		D1		0.40	0.80
B		3.80	4.00	R1		0.20TYP	
B1		5.80	6.20	R2		0.20TYP	
B2		5.00TYP		$\theta 1$		17° TYP4	
C		1.30	1.60	$\theta 2$		13° TYP4	
C1		0.55	0.65	$\theta 3$		0° ~ 8°	
C2		0.55	0.65	$\theta 4$		4° ~ 12°	

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