

5.5V, 7A Low $R_{DS(on)}$ Load Switch with Current Monitoring

General Description

The ET3587 is a load switch to provide 7A load protection covering 0.5V to 5.5V voltage range. The device equipped with the very accurate current monitor function. The gain of the current monitor can be scaled to different applications. With the soft start function, the ET3587 can avoid inrush current during circuit start up. This device also provides different functions, like programmable soft start time, output discharge function, OCP and thermal shutdown features.

Tiny QFN12 (2mm×2mm) of ET3587 is available in space saving package. With the small $R_{DS(on)}$ in tiny package, ET3587 provides very high efficient and space saving solution in notebook and tablet or other portable devices application.

Features

- Large V_{IN} Range from 0.5V to 5.5V
- < 1 μ A Shutdown Current
- Integrated 10m Ω Low $R_{DS(on)}$ FETs
- Typical 7A Load Current Range
- Output Current Monitoring Accurate High to 5%
- Push Pull PG Indicator
- Adjustable Start Up Slew Rate
- Output Discharge Function
- < 200ns Short-Circuitry Response Protection
- Thermal Protection
- Small QFN12 (2mm × 2mm) Package for Space Saving
- Safety Approvals
- ESD Protection Exceeds JESD22
 - HBM: $\pm 4000V$ pass(JEDEC JS-001)
 - CDM: $\pm 2000V$ pass(JEDEC JS-002)
- Latch-up Performance Exceeds $\pm 200mA$ per JEDEC JESD78F
- Part No. and Package Information

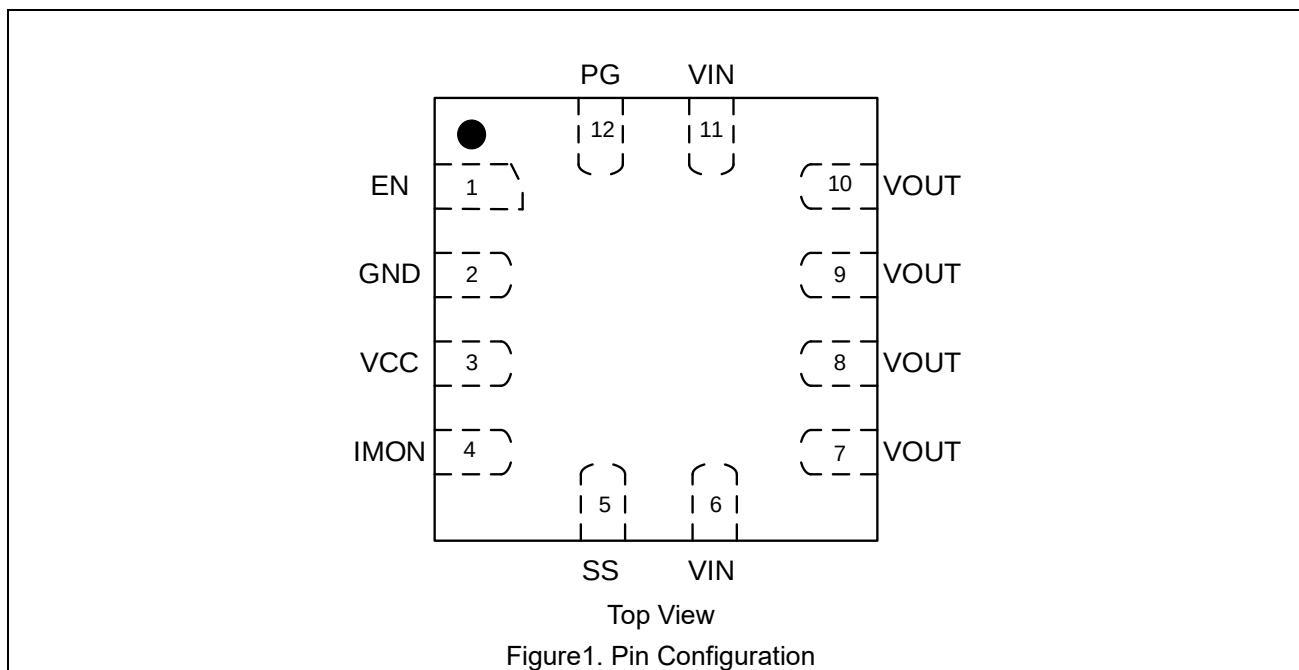
Part No.	Package	Packing Option	MSL
ET3587	QFN12 (2.0mm × 2.0mm)	Tape and Reel, 3K/Reel	1

Application

- Notebook and Tablet Computers
- Portable Devices
- Solid State Drivers
- Handheld Devices

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Pin Configuration



Pin Function

Pin No.	Pin Name	Description
1	EN	Enable Input. Pulling this pin below the specified threshold shuts the chip down.
2	GND	Ground.
3	VCC	Supply Voltage to the Control Circuitry.
4	IMON	Output Current Monitor. Provides a voltage proportional to the current flowing through the power device. Place a resistor to ground to set the gain.
5	SS	Soft Start Pin. An external capacitor connected to this pin sets the slew rate of the output voltage soft start period.
6,11	VIN	Input Power Supply.
7,8,9,10	VOUT	Output to the Load.
12	PG	Power Good Pin. Push-Pull output.

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Block Diagram

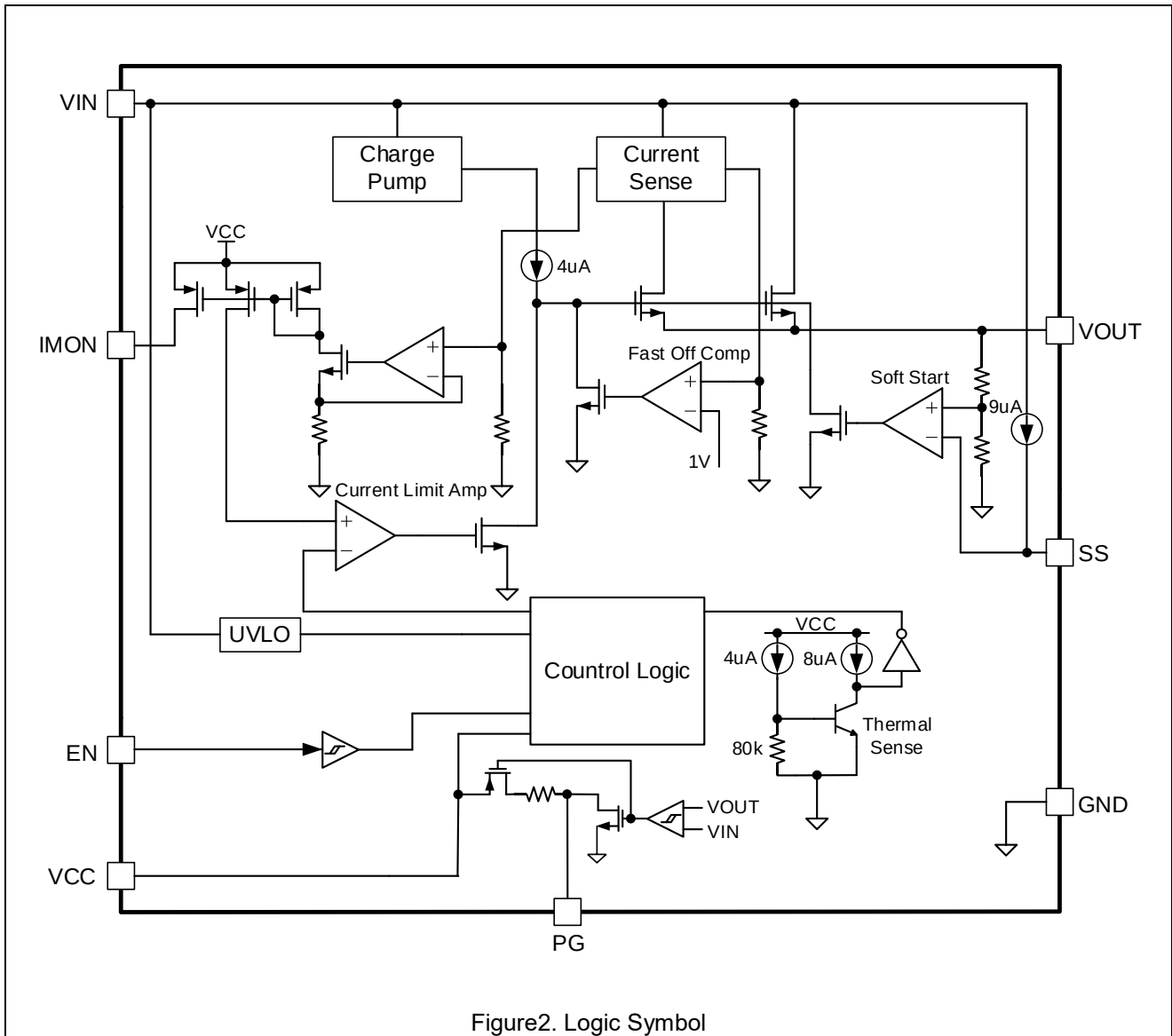


Figure2. Logic Symbol

Functional Description

The ET3587 is designed to limit the in-rush current to the load when a circuit card is inserted into a live backplane power source, thereby limiting the backplane's voltage drop and the slew rate of the voltage to the load. It provides an integrated solution to monitor the input voltage, output voltage and output current to eliminate the need for an external current power MOSFET, and current sense device.

Input Capacitor

A 44μF ceramic capacitor is recommended to connect between V_{IN} and GND pins to decouple input power supply glitch and noise. The amount of the capacitance may be increased without limit. This input capacitor must be located as close as possible to the device to assure input stability and less noise. For PCB layout, a wide copper trace is required for both V_{IN} and GND.

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Output Capacitor

An output capacitor is required for the stability of the load switch output. The recommended output capacitance is 44μF or larger, the effective capacitance needs to take the DC-Bias characteristic, tolerance and temperature into consideration, and temperature characteristics is X7R or X5R. Higher capacitance values help to improve load/line transient response. The output capacitance may be increased to keep low undershoot/overshoot. Place output capacitor as close as possible to OUT and GND pins.

Enable

When input voltage is greater than the under-voltage lockout threshold (UVLO), typically 0.5V, ET3587 can be enabled by pulling EN pin to higher than 1.5V. Pulling down to ground will disable ET3587.

Current Limit

The ET3587 provides a constant current limit that can be programmed by an external resistor. Once the device reaches its current limit threshold, the internal circuit regulates the gate voltage to hold the current in the power FET constant. The typical response time is about 20μs and the output current may have a small overshoot during this time period.

The preset current limit value can be calculated by below Equation 1:

$$I_{Limit} = (1 \div R_{IMON}) \times S$$

S is the current sense ratio of ET3587, and this value is typically 82000 in VIN=3.6V. The S is almost a constant value when VIN is changing from 1.2V to 5.5V, and when VIN is smaller than 1.2V, a step change will come to S value, the value will change from 82000 to about 80000. Meanwhile, when VCC is changing, there is also a little shift on S value, for more information, please refer the curves in typical performance characteristics.

If the current limit block starts to regulate the output current, the power loss on power MOSFET will cause the IC temperature rise. If the junction temperature rose to high enough, it will trigger thermal shutdown. After thermal shutdown happened, it will disable the output until the over temperature fault remove. The over temperature threshold is 155°C and hysteresis is 40°C.

Power-Good Function

The PG pin is the push pull of a MOSFET that can be pulled high to VCC. The MOSFET turns on with the application of an input voltage so that the PG pin is pulled to GND. After the voltage gap between VIN and VOUT is smaller than 150mV, the PG pin is pulled high after a 90μs delay. When the voltage gap is higher than 166mV, the PG pin will be pulled low. The PG pin has a nominal pull down resistance of 200Ω and a pull-up resistance of 250KΩ. The maximum sink current when the pin is pulled to GND through the internal pull-down resistor should be < 10mA.

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Short-Circuit Protection

If the load current increases rapidly due to a short circuit, the current may exceed the current limit threshold by a lot before the control loop can respond. If the current reaches an internal secondary current limit level (about 13A), a fast turn-off circuit activates to turn off the power FET. This limits the peak current through the switch to limit the input voltage drop. The total short circuit response time is about 200ns. If fast off works, it will keep off the power FET for 80μs. After that time period, it will re-turn on power FET, if the part is still in short-circuit condition. ET3587 will reduce the current limit to 2/3 of preset value, and hold it until the part is so hot and thermal shutdown. After the short circuit condition removed, the current limit will recover to the preset value automatically.

Output Discharge

ET3587 has output discharge function. This function can discharge the V_{OUT} by internal pull down resistance when IC disabled and the load is very light.

Soft-Start

A capacitor connected to the SS pin determines the soft-start time. There is an internal 9μA constant current source charge SS cap and ramps up the voltage on the SS pin. The output voltage rises at 3 times the slew rate to the SS voltage.

The soft-start time can be calculated by below Equation 2:

$$t_{ss}(ms) = \frac{1}{3} \times \frac{V_{OUT}(V) \cdot C_{SS}(nF)}{I_{SS}(uA)}$$

t_{ss} is the soft-start time, I_{SS} is internal 9μA constant current, C_{SS} is external soft-start cap. The suggestion minimum SS cap should be bigger than 4.7nF. If the SS pin is floated or SS cap is too small, the V_{OUT} rising time will be just limited by power MOS charge time.

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Absolute Maximum Ratings

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 in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Symbol	Parameter		Value	Unit
V _{CC}	DC Supply Voltage (VCC Pin)		-0.3 to 6.5	V
V _I	DC Input Voltage ⁽¹⁾		-0.3 to 6.5	V
V _O	DC Output Voltage Output in Higher or Low State		-0.3 to 6.5	V
V _{EN}	Enable Input		-0.3 to V _{CC} +0.3	V
V _{SS}	Soft Start Pin		-0.3 to V _{CC} +0.3	V
V _{IMON}	Output Current Monitor Pin		-0.3 to V _{CC} +0.3	V
T _J	Max Junction Temperature		150	°C
T _{LEAD}	Lead Temperature (Soldering 10s)		260	°C
T _{STG}	Storage Temperature		-65 to 150	°C
V _{ESD}	ESD Classification	Human Body Model ⁽²⁾	±4000	V
		Charged Device Model ⁽³⁾	±2000	
I _{LU}	Max Latch Up Current Above V _{CC} and GND at 125°C ⁽⁴⁾		±200	mA

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

Note1: I_O absolute maximum rating must be observed.

Note2: HBM tested per JEDEC JS-001;

Note3: CDM tested per JEDEC JS-002;

Note4: Latch up Current Maximum Rating tested per JEDEC JESD78F.

Recommended Operating Conditions

Symbol	Parameter	Min	Max	Unit
V _{IN}	Input Voltage Range	0.5	5.5	V
V _{OUT}	Output Voltage Range	0	5.5	V
V _{CC}	Supply Voltage	3	5.5	V
V _{EN}	EN Pin Voltage Range	0	V _{IN}	V
T _A	Operating Free Air Temperature Range	-40	125	°C

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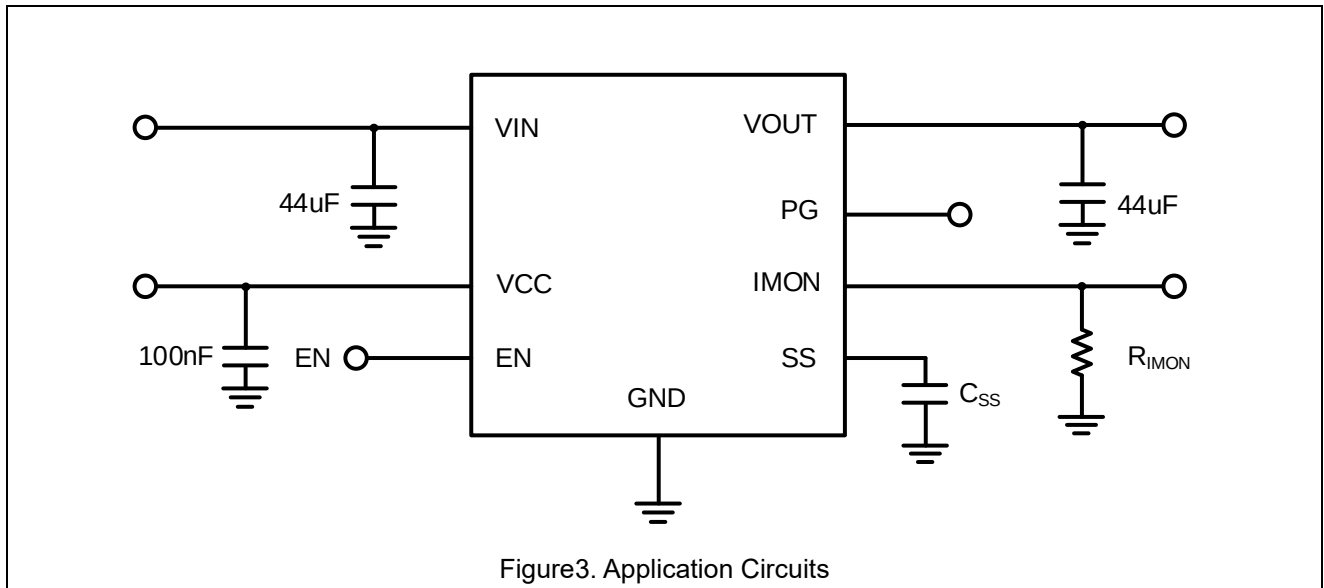
Electrical Characteristics

$V_{IN} = 3.6V$, $V_{CC} = 3.6V$, $T_A = 25^{\circ}C$, unless otherwise noted.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
V _{IN}	Input Voltage			0.5		5.5	V
V _{CC}	Supply Voltage			3		5.5	V
I _{OFF}	Off State Leakage Current	V _{IN} =5V, EN=0			0.2	1	μA
I _{STBY}	VCC Standby Current	V _{CC} =5V, EN=0			0.01	1	μA
		V _{CC} =5V, Enable,No load			220	300	
R _{DSON}	ON Resistance	V _{CC} =5.0V			10		mΩ
		V _{CC} =3.3V			12		
T _{STD}	Shutdown Temperature				155		°C
T _{HYS}	Hysteresis				40		°C
V _{CC_UVLO}	VCC Under Voltage Lockout Threshold	UVLO Rising Threshold			2.6	2.8	V
V _{UVLO_HYS}	UVLO Hysteresis				150		mV
I _{SS}	SS pull-up current	Fixed slew rate			9		μA
V _{ENH}	EN Rising Threshold			1.3	1.5	1.7	V
V _{EN_HYS}	EN Hysteresis				450		mV
I _{OUT}	Current limit	R _{IMON} =50kΩ, ramp Iout record peak current limit		1.54	1.64	1.74	A
I _{MON}	Current Monitor Accuracy	V _{IN} =3.6V	I _{OUT} =3.75A	44.88	47.25	49.61	μA
			I _{OUT} =3A	35.82	37.70	39.58	
			I _{OUT} =1.5A	17.39	18.3	19.22	
		V _{IN} =1.2V	I _{OUT} =3.75A	44.3	46.65	49	
			I _{OUT} =3A	35.43	37.3	39.2	
			I _{OUT} =1.5A	17.54	18.66	19.78	
R _{DIS}	Discharge Resistance				180		Ω
V _{PG_R}	Power Good Rising Threshold	Voltage gap between V _{OUT} and V _{IN}		110	150	250	mV
V _{PG_H}	Power Good Hysteresis				16		mV
t _{PG D}	Power Good Delay				90		μs
V _{PG H}	Power Good High	V _{CC} =3.3V		3.2			V
V _{PG L}	Power Good Low	Sink 1mA				0.2	V

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Application Circuits



Application Information

IMON Resistor Selection

The current limit value can be set by IMON resistor. The current limit can be gotten by equation 1.

The current limit threshold is suggested to 10% ~ 20% higher than maximum load current. For example, if the system's full load is 7A, set the current limit to 7.7A.

IMON Capacitor Selection

The internal advanced auto-zero comparator bring a high accuracy of current monitor. The auto-zero will also cause some little jitter on IMON pin. To get a more stable IMON, a small ceramic capacitor can be mounted between IMON and ground. Suggested place an IMON capacitor less than 1nF.

Soft Start Capacitor Selection

There is an internal 9 μ A constant current source charge SS cap and ramps up the voltage on the SS pin. The output voltage rises follow the slew rate of SS voltage.

If the inrush on output current reached the current limit during start up (like with large output cap or very large load), ET3587 will limit the output current and the same time, SS time will be increased.

Design Example

Some design example and are provided below. See Table 1.

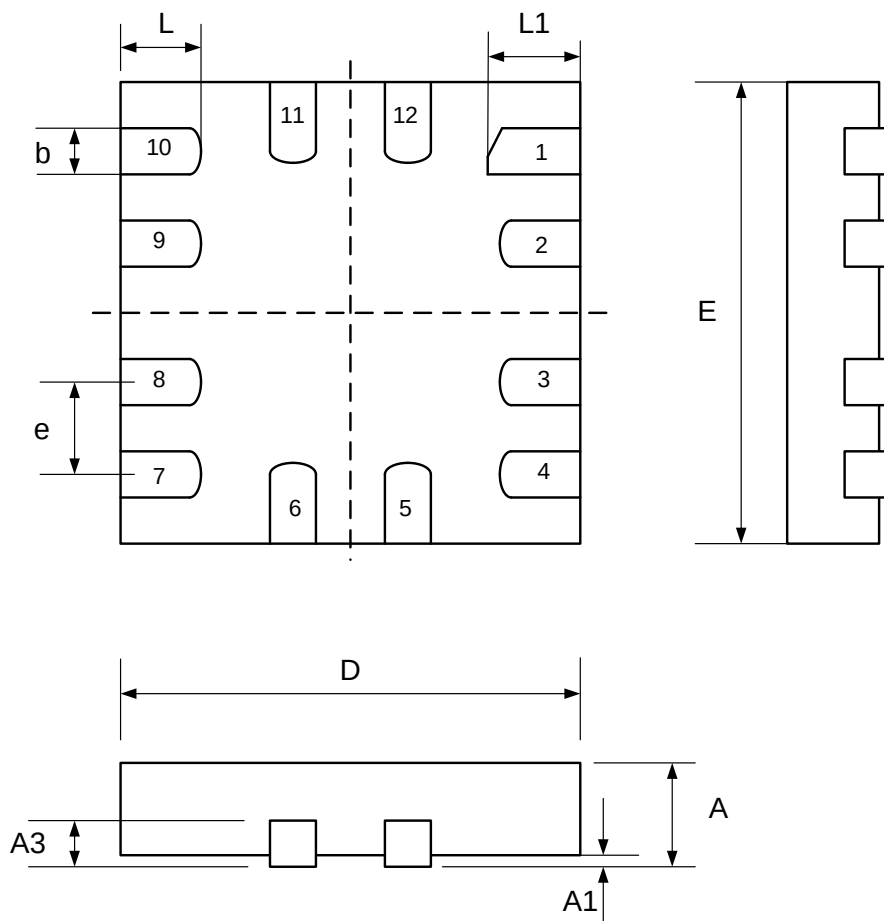
Table1.Design Example

V _{IN} (V)	Max Load Range(A)	R _{IMON} (k Ω)	SS Cap(nF)	SS Time(ms)
5	3	26.1	22	4
5	5	15.8	47	9
5	7.5	10.5	100	20

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Package Dimension

QFN12(2.0mm × 2.0mm)



COMMON DIMENSIONS

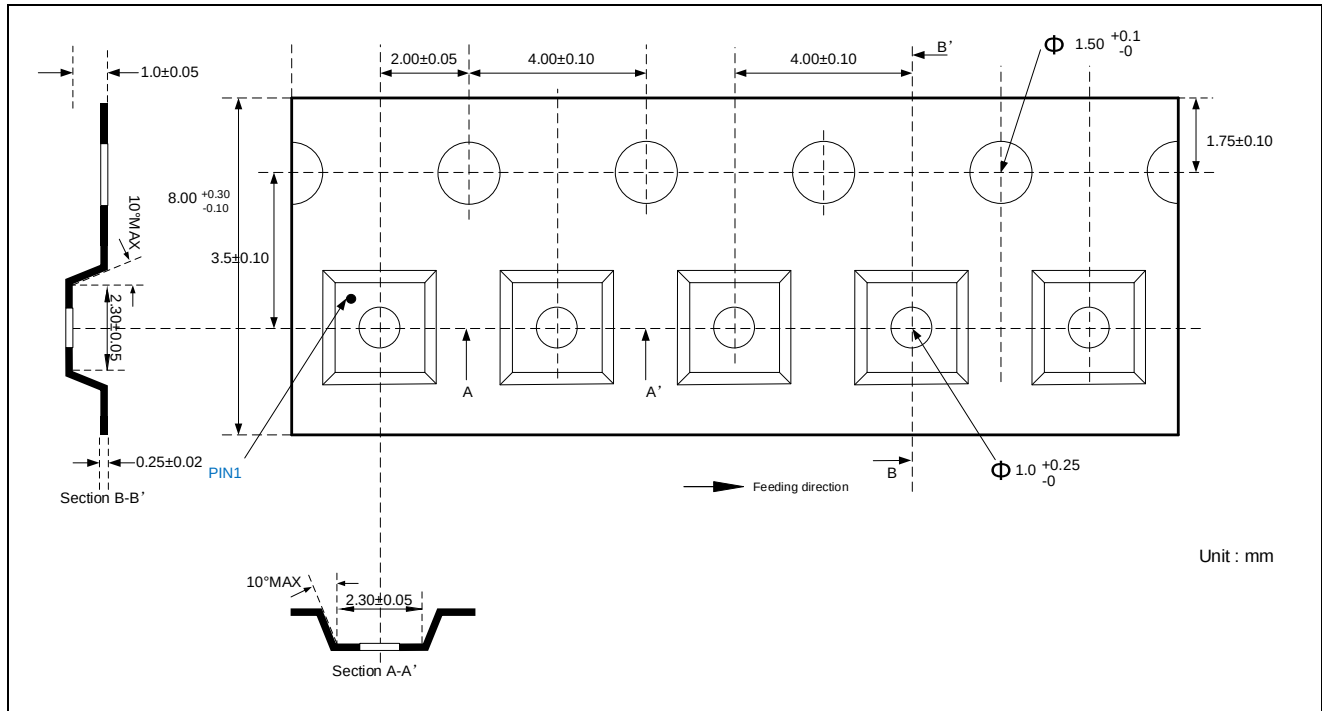
(Unit: mm)

Symbol	Min	Typ	Max
A	0.80	--	1.00
A1	0.00	--	0.05
A3	0.20 REF		
b	0.15	--	0.25
D	1.90	2.00	2.10
E	1.90	2.00	2.10
e	0.40 BSC		
L	0.30	--	0.40
L1	0.35	--	0.45

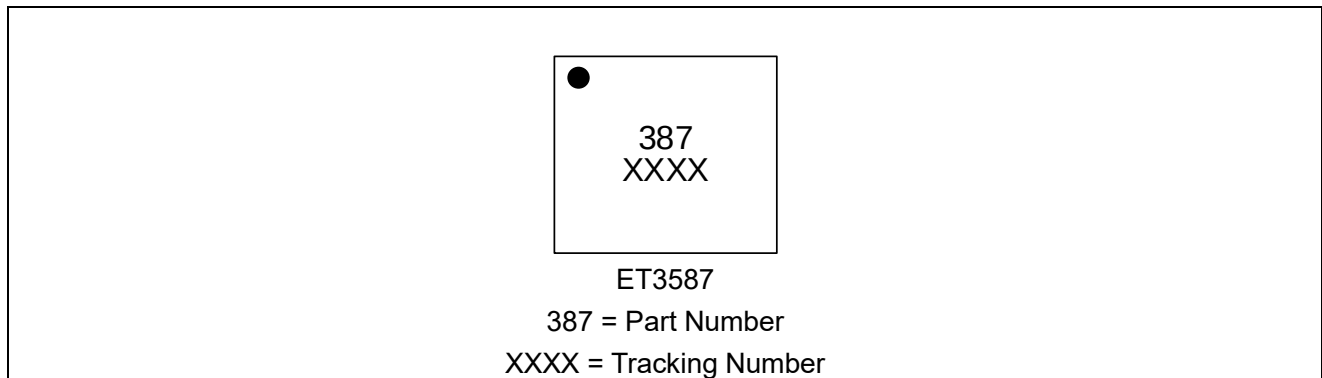
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Tape Information

QFN12 (2.0mm × 2.0mm)



Marking Information



Revision History and Checking Table

Version	Date	Revision Item	Modifier	Function & Spec Checking	Package & Tape Checking
0.0	2025-12-4	Preliminary Version	Wang qifan	Yang xiaoxu	Liu jiaying
0.1	2026-4-29	Official Version	Lu shaojie	Yang xiaoxu	Liu jiaying
1.0	2026-6-15	Update Tape Information and Marking Information	Lu shaojie	Yang xiaoxu	Liu jiaying