1A-5A Adjustable Current Limited Power Switch with Output Over-voltage Clamp

General Description

The ET20175Y1 are current limited N-channel MOSFET power switch with input voltage range selection and output voltage clamping. This switch operates with inputs ranging from 2.5V to 15V with surge up to 30V. Programmable soft-start time controls the slew rate of the output voltage during the start-up time. Independent enable control allows the complicated system sequencing control.

An integrated current-limiting circuit protects the input supply against large currents which may cause the supply to fall out of regulation. The ET20175Y1 is also protected from thermal overload which limits power dissipation and junction temperatures. Current limit threshold is programmed with a resistor from SET to ground. The quiescent supply current in active mode is only 200uA. In shutdown mode, the supply current decreases to 10uA.

The ET20175Y1 is available in Pb-free packages and is specified over the -40° C to +85° C ambient temperature range.

Features

- Input Voltage Range: 2.5V to 15V (surge up to 30V)
- Programmable Current Limit and programmable Soft-Start Time
- Extremely Low $R_{DS(ON)}$ for the Integrated Protection Switch: 40mΩ
- Selectable Input Range and Clamping Output Voltage Threshold
- Short-Circuit Protection
- 10uA Typ Shutdown Supply Current
- Under-Voltage Lockout
- Thermal Shutdown Protection and Auto Recovery
- Part No. and Package

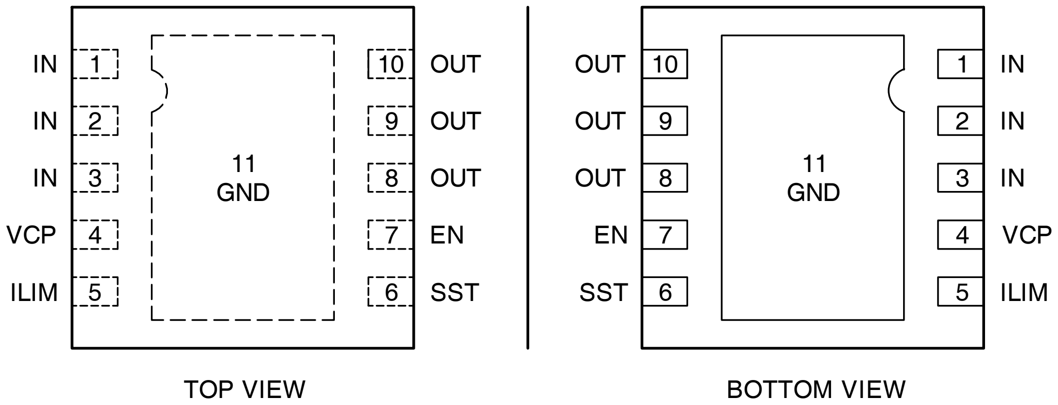
Part No.	Package	MSL
ET20175Y1	DFN10 (3mm x 3mm)	Level 3

- Ambient Temperature Range: -40°C to +85°C

Applications

- Laptop/Desktop Computers and Net Books
- Server PC, SSD Hard Disk
- LCD TVs and Monitors
- Set-Top-Boxes

Pin Configuration

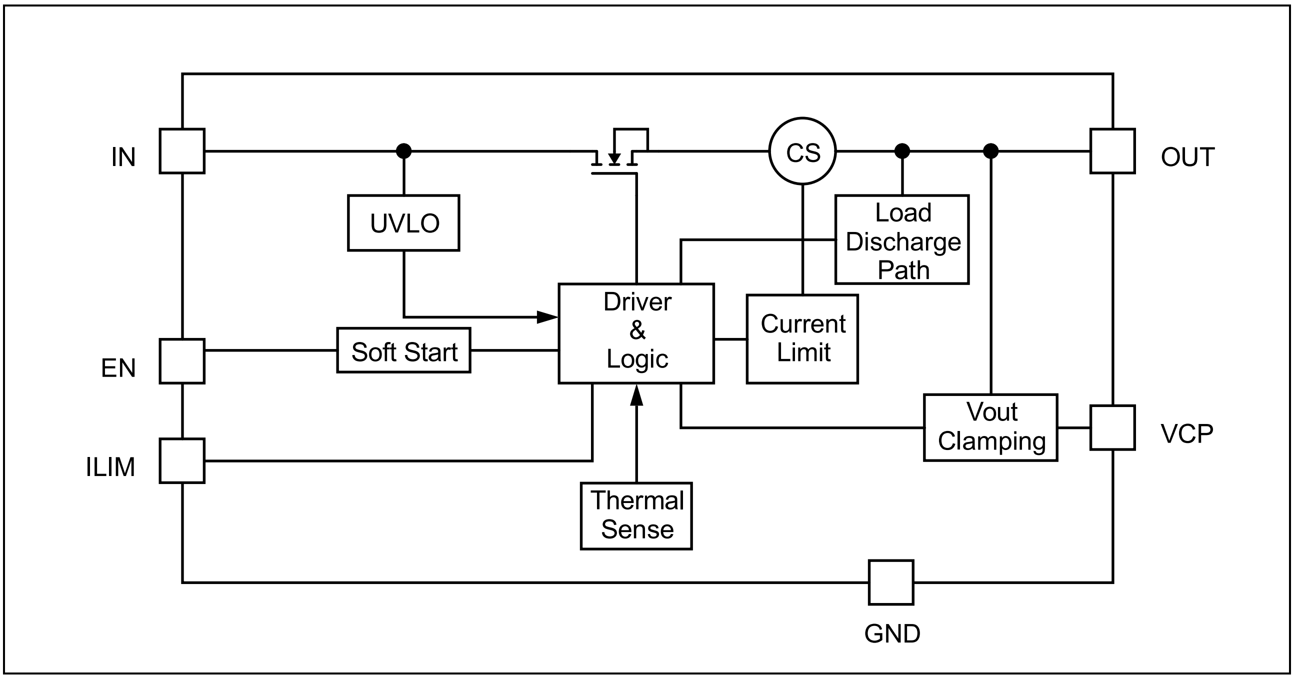


DFN3x3-10(ET20175Y1)

Pin Function

Pin No.	Pin Name	Pin Function
1 ,2,3	IN	Power supply input. Must be closely decoupled to GND pins with a 1μF or greater ceramic capacitor.
4	VCP	Output clamp voltage selection based on the input voltage.
5	ILIM	Current limit programming pin. Program the current limit by connecting a resister to ground.
6	SST	Soft-start time program pin. Connect a capacitor to ground to program the soft start time.
7	EN	Enable input.
8,9,10	OUT	Power output.
11	GND	Ground Pin.

Block Diagram



Operation

ET20175Y1 is an integrated power switch with a low R_{DS_ON} N-Channel MOSFET, programmable current limiting. When the ET20175Y1 turns on, it can deliver up to 5A continuous current to load. When the device is active, if there is no load, the device only consumes 200uA supply current.

Power Supply Considerations

A 10µF MLCC capacitor between IN and GND, close to the device, is recommended. Placing a high-value electrolytic capacitor on the output pin(s) is recommended when the output load is heavy. This precaution reduces power-supply transients that may cause ringing on the input and minimize the input voltage droops. Additionally, bypassing the output with a 10µF MLCC capacitor improves the immunity of the device to short-circuit transients.

Over Current

A sense FET is employed to check for over-current conditions. When an over-current condition is detected, the device maintains a constant output current and reduces the output voltage accordingly. ET20175Y1 will limit the current until the overload condition is removed or the device begins to thermal cycle.

Three possible overload conditions can occur. In the first condition, the output has been shorted before the device is enabled or before V_{IN} has been applied. The ET20175Y1 senses the short and immediately switches into a constant-current output.

In the second condition, a short or an overload occurs while the device is enabled. At the instant the overload occurs, high currents may flow for a short period of time before the current-limit circuit can react.

After the current-limit circuit reached the over-current trip threshold, the device switches into constant-current mode.

In the third condition, the load has been gradually increased beyond the recommended operating current. The current is permitted to rise until the current-limit threshold is reached or until the thermal limit of the device is exceeded. The ET20175Y1 is capable of delivering current up to the current-limit threshold without damaging the device. Once the threshold has been reached, the device switches into its constant-current mode.

Thermal Protection

Thermal protection prevents damage to the IC when heavy-overload or short-circuit faults are present for extended periods of time. The ET20175Y1 implements a thermal sensing to monitor the operating junction temperature of the power distribution switch. In an over-current or short-circuit condition, the junction temperature rises due to excessive power dissipation. Once the die temperature rises to approximately 155°C due to over-current conditions, the internal thermal sense circuitry turns the power switch off, thus preventing the power switch from damage. Hysteresis is built into the thermal sense circuit, and after the device has cooled approximately 20°C, the switch turns back on. The switch continues to cycle in this manner until the load fault or input power is removed.

Absolute Maximum Ratings

Symbol	Item	Rating	Unit
V_{IN}	IN Voltage	-0.3 to 30	V
V_{EN}	EN Voltage	-0.3 to 30	V
V_{CP}	VCP Voltage	-0.3 to 30	V
V_{OUT}	OUT Voltage	-0.3 to 30	V
V_{IO}	Other PIN Voltage	-0.3 to 6	V

Thermal Characteristics

Symbol	Package	Ratings	Value	Unit
$R_{\theta JA}$	DFN10(3x3)	Thermal Characteristics, Thermal Resistance, Junction-to-Air	38	°C/W
P_D		Max Power Dissipation，T_A=25°C	2600	mW
T_J		Operating Junction Temperature	-40 to 150	°C
T_{STG}		Storage Temperature	-55 to 150	°C
T_{LEAD}		Lead Temperature (Soldering, 10 sec)	300	°C

Note：The thermal limit is set above the maximum thermal rating. It is not recommended the device to operate at temperatures greater than the maximum ratings for extended periods of time.

Electrical Characteristics

(V_{IN} = +5.0V, V_{EN} = 0V or V_{EN} = V_{IN} , R_{LIM}=11kΩ, C_{SST}=105nF, C_{IN} = 10uF, C_{OUT} = 10uF, T_A = -40°C to 85°C, typical values at T_A=25°C, unless otherwise stated)

Symbol	Item	Conditions	Min	Typ	Max	Unit
V_{IN}	Input Voltage Range		2.5		30	V
V_{UVLO}	Input UVLO	VCP=LOW	2.2	2.3	2.4	V
		VCP=HGH	3.4	3.6	3.8	V
		VCP=OPEN	8.0	8.5	9.0	V
$V_{UVLOHYS}$	UVLO Hysteresis	VCP=LOW		0.09		V
		VCP=HGH		0.1		V
		VCP=OPEN		0.2		V
I_{SHDN}	Input Shutdown Quiescent Current	Disabled, OUT floating or shorted to ground		10		μA
I_Q	Input Quiescent Current /Channel	Enabled, I_{OUT}= 0		200		μA
$R_{DS(ON)}$	Switch On-resistance	V_{IN}=5V, I_{OUT}=1A		40	70	mΩ
I_{LMT}	Current Limit Range [(1)]		-30		+30	%
I_{LMT} (range)			1		5	A
V_{CLP}	Clamping Output Voltage [(2)]	VCP=LOW	3.6	3.8	4.0	V
		VCP=HGH	5.4	5.7	6.0	V
		VCP=OPEN	12.6	13.3	14.0	V
V_{IL}	EN Input Logic Low Voltage				0.4	V
V_{IH}	EN Input Logic High Voltage		2			V
I_{SINK}	EN Input Leakage	V_{EN} = 5V		0.01	1	μA
T_{SST}	Soft-start Time	C_{SST}=105nF [(3)]		29.4		ms
T_{ACC}	Soft-start Time Accuaracy			±30		%
R_{DIS}	Output discharge FET Rdson	Disabled, V_{IN} = 5V		30		Ω
T_{SHDN}	Thermal Shutdown Threshold	V_{IN} = 5V	135	155	175	°C
T_{HYS}	Thermal Shutdown Hysteresis	V_{IN} = 5V		20		°C

Note1: Recommended Current Limit Program Table:

Current Limit Resistance(kΩ)	11	5.5	4.4	3.7	3.1	2.8	2.4	2.2
Current Limit (A)	1.0	2.0	2.5	3.0	3.5	4.0	4.5	5.0

Recommended Formula for R_{LIM} & Current Limit Calculation:

$$R_{LIM} = \frac{11K}{I_{LIM}}(\Omega)$$

Note2: Pull VCP pin to High by connecting a resistor to IN, or pull VCP pin to Low by connecting a resistor to ground, or float VCP Pin to select different output clamping thresholds. Recommend to decoupling this pin with 0.1uF capacitor.

VCP	**IN**	**Clamping Threshold**		
		Min	**Typ**	**Max**
VCP=LOW	3.3V	3.6V	3.8V	4.0V
VCP=HGH	5V	5.4V	5.7V	6.0V
VCP=OPEN	12V	12.6V	13.3V	14V

Note3: Recommended Soft-start Time Program Table

SST cap (nF)	None	10	55	105
Rise time (ms)	1.4	2.8	15.4	29.4

Recommended Formula for C_{SST} & Soft-start Time Calculation:

$$T_{SS} = \begin{cases} T_{SS\_DLT}, \text{No external } C_{SST} \\ \frac{C_{SST}}{I_{INT}}, T_{SS} > T_{SS\_DLT} \end{cases}$$

Where, TSS_DLT is the internally fixed default soft-start time, about 1.4ms, which means there's no any external C_{SST}; I_{INT} is the internal current source, about 3.6uA.

Typical Performance Characteristics

(The following plots are referred to the typical application circuit and, unless otherwise noted, at T_A = 25 °C)

Programmable Soft-start Time(3.3V mode)-Start up

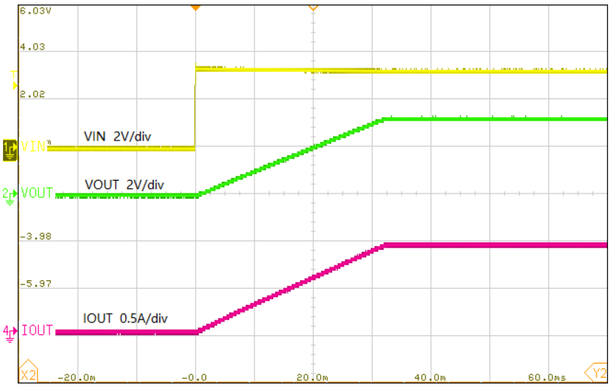


Figure1. V_{IN}=3.3V, C_{SST}=100nF, I_{OUT}=1A

(3.3V mode)-Shutdown

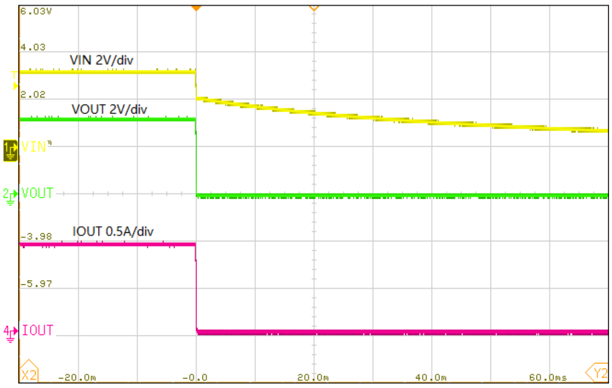


Figure2. V_{IN}=3.3V, C_{SST}=100nF, I_{OUT}=1A

Programmable Soft-start Time(5V mode)-Start up

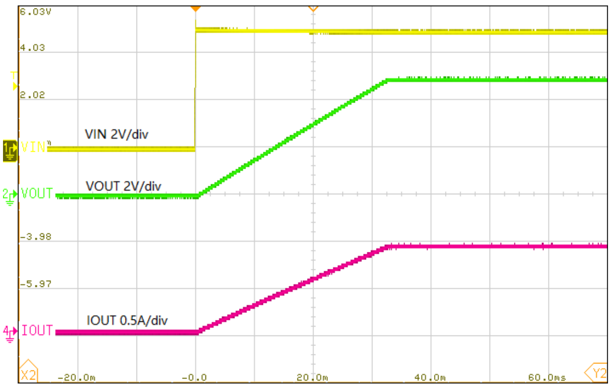


Figure3. V_{IN}=5V, C_{SST}=100nF, I_{OUT}=1A

(5V mode)-Shutdown

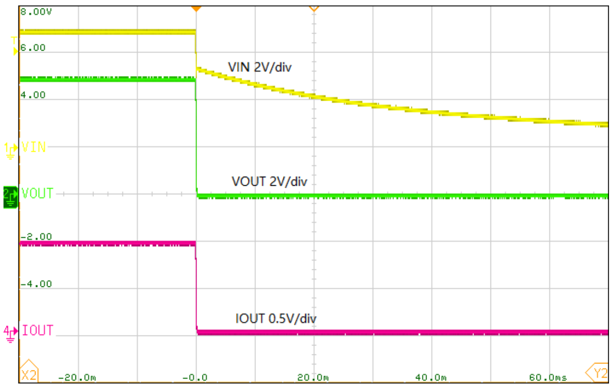


Figure4. V_{IN}=5V, C_{SST}=100nF, I_{OUT}=1A

Programmable Soft-start Time(12V mode)-Start up

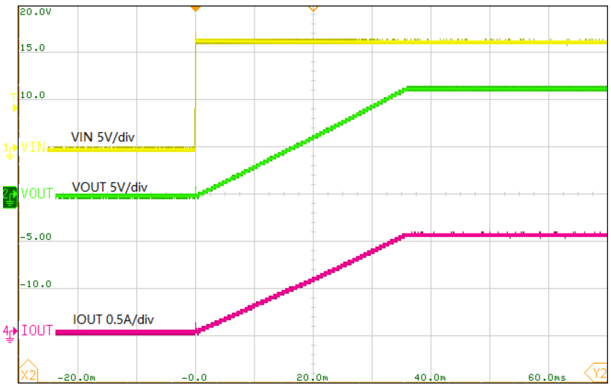


Figure5. V_{IN}=12V, C_{SST}=100nF, I_{OUT}=1A

(12V mode)-Shutdown

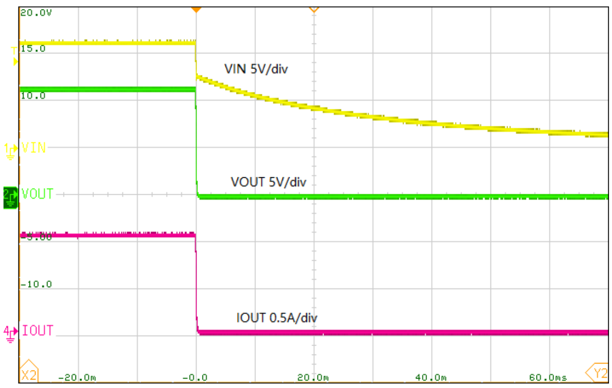


Figure6. V_{IN}=12V, C_{SST}=100nF, I_{OUT}=1A

VOUT Over Voltage Clamp(3.3V mode)

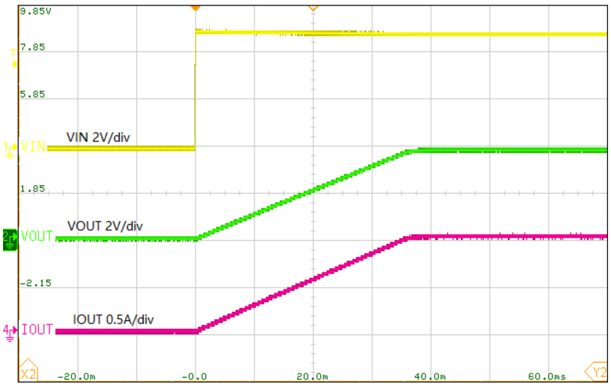


Figure7. V_{IN}=5V, C_{SST}=100nF, I_{OUT}=1A

VOUT Over Voltage Clamp(5V mode)

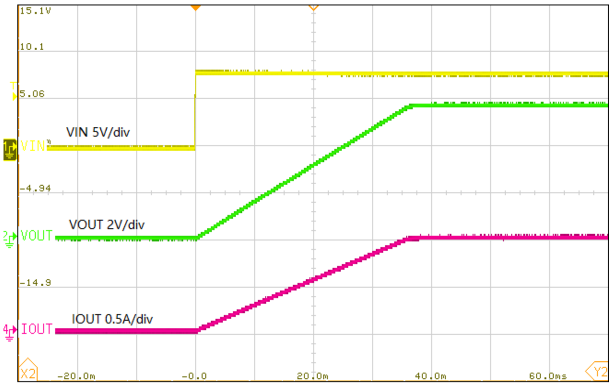


Figure8. V_{IN}=8V, C_{SST}=100nF, I_{OUT}=1A

VOUT Over Voltage Clamp(12V mode)

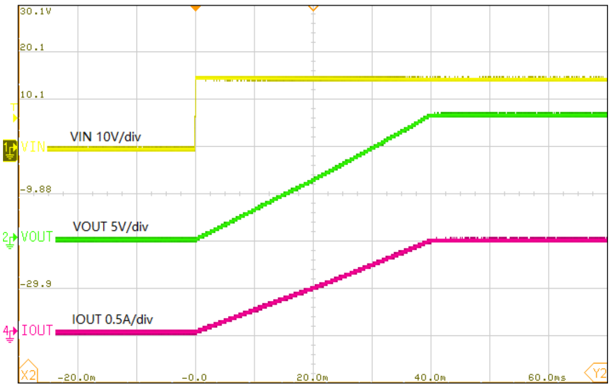


Figure9. V_{IN}=15V, C_{SST}=100nF, I_{OUT}=1A

Current Limit ILIM Resistor

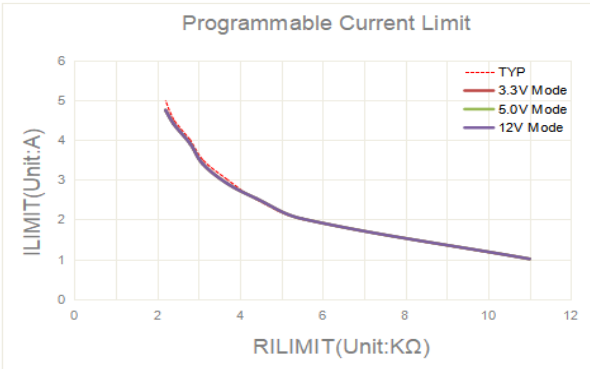
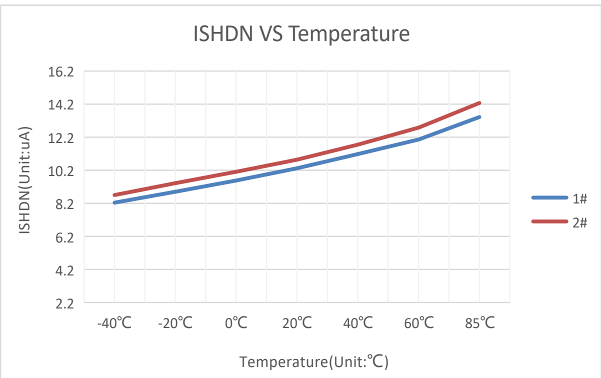
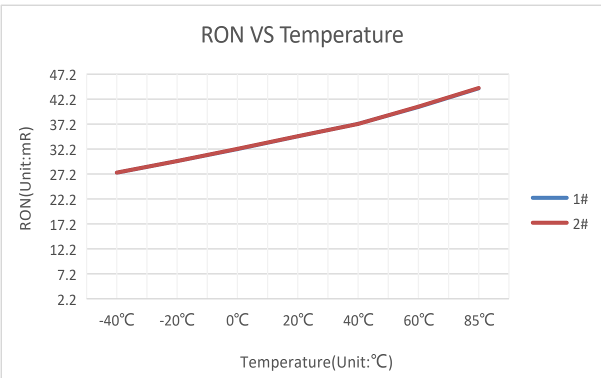


Figure10. T_A=25°C

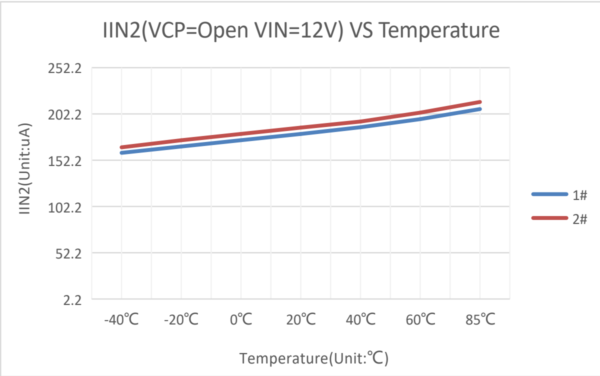
Application Curves



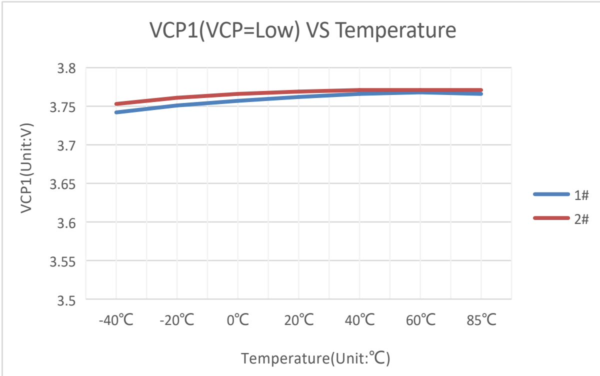
The I_{SHDN} test VS Temperature



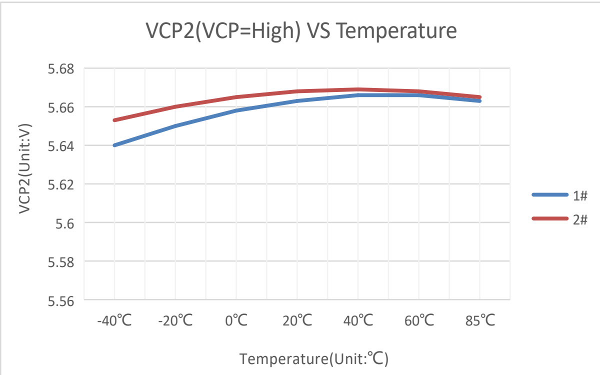
The R_{ON} test VS Temperature



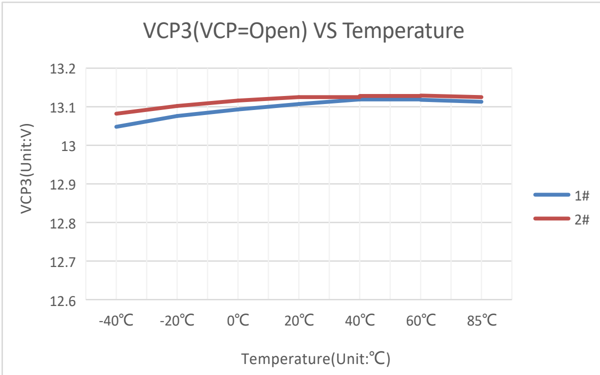
The I_{IN} test VS Temperature



The V_{CLAMP} test VS Temperature

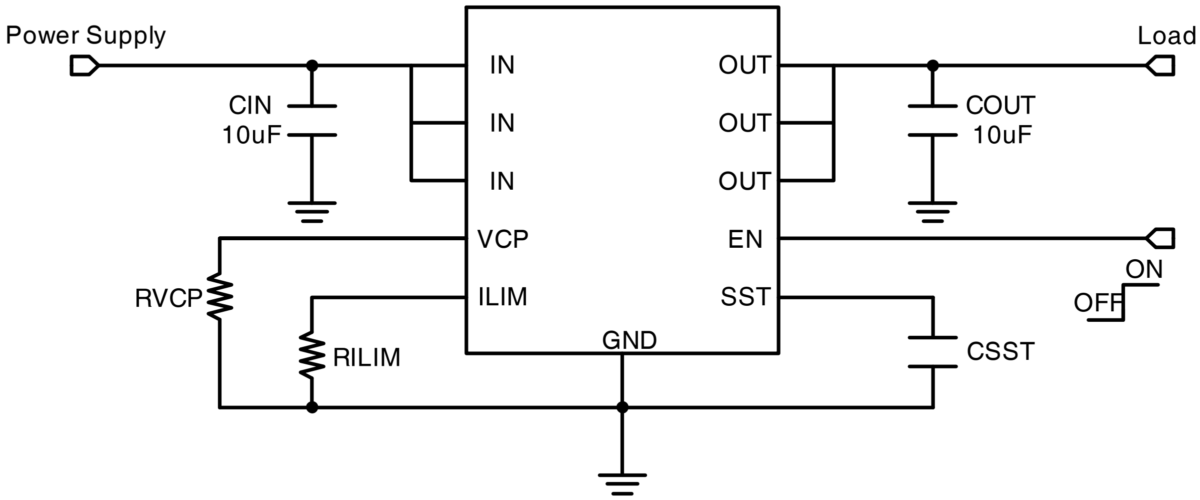


The V_{CLAMP} test VS Temperature



The V_{CLAMP} test VS Temperature

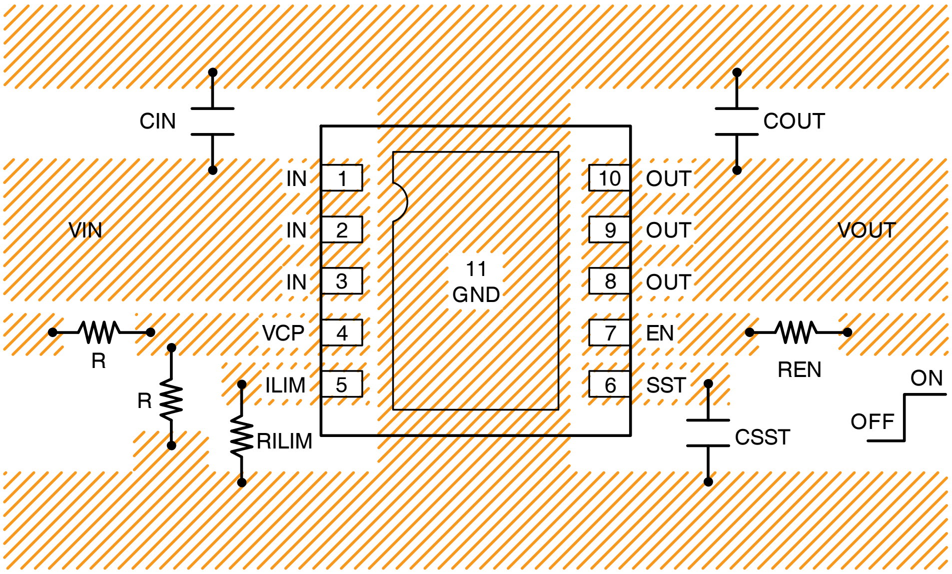
Application Circuits



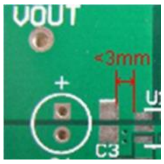
Note: Tantalum or Aluminum Electrolytic capacitors (C_{IN} and C_{OUT}) may be required.

PCB Layout Guide

PCB layout is very important to achieve stable operation. It is highly recommended to duplicate EVB layout for optimum performance. If change is necessary, please follow these guidelines for reference.



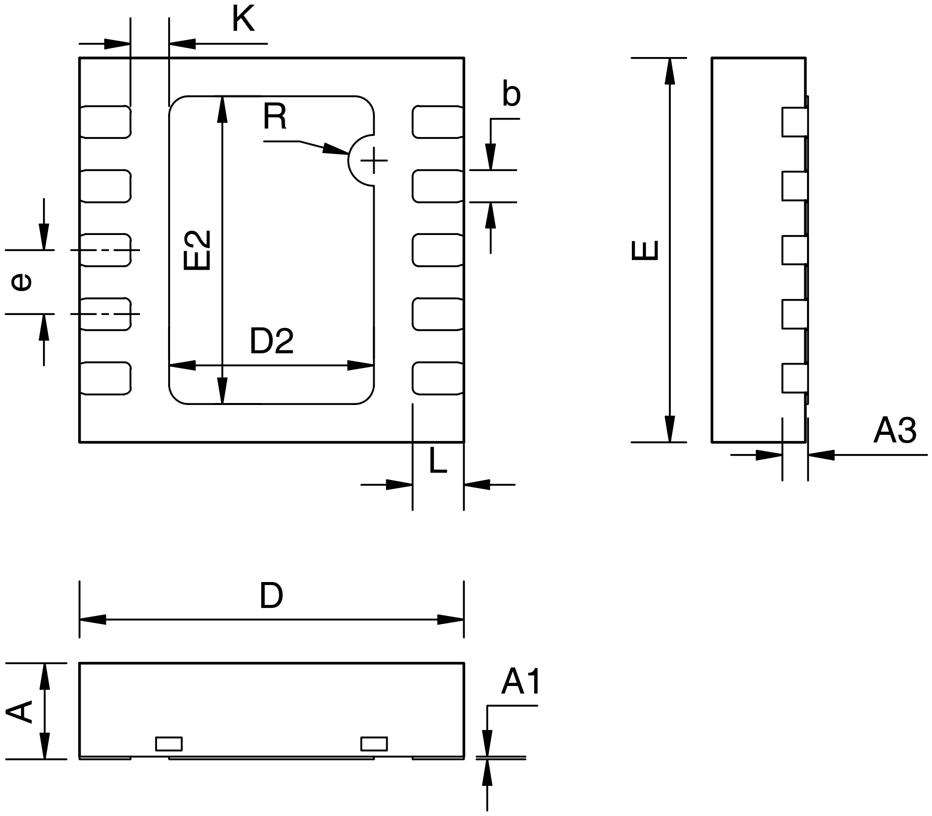
1. Keep the path of current short and minimize the loop area formed by Input and output capacitor.
2. Output capacitor and IC must be on the same side. The distance of out pin and output capacitor <3mm is recommended.



1. Bypass ceramic capacitors are suggested to be put close to the V_{IN} Pin.
2. Connect IN, OUT, and especially GND respectively to a large copper area to cool the chip to improve thermal performance and long-term reliability.
3. A 2-layer PCB layout is recommended.

Package Dimension

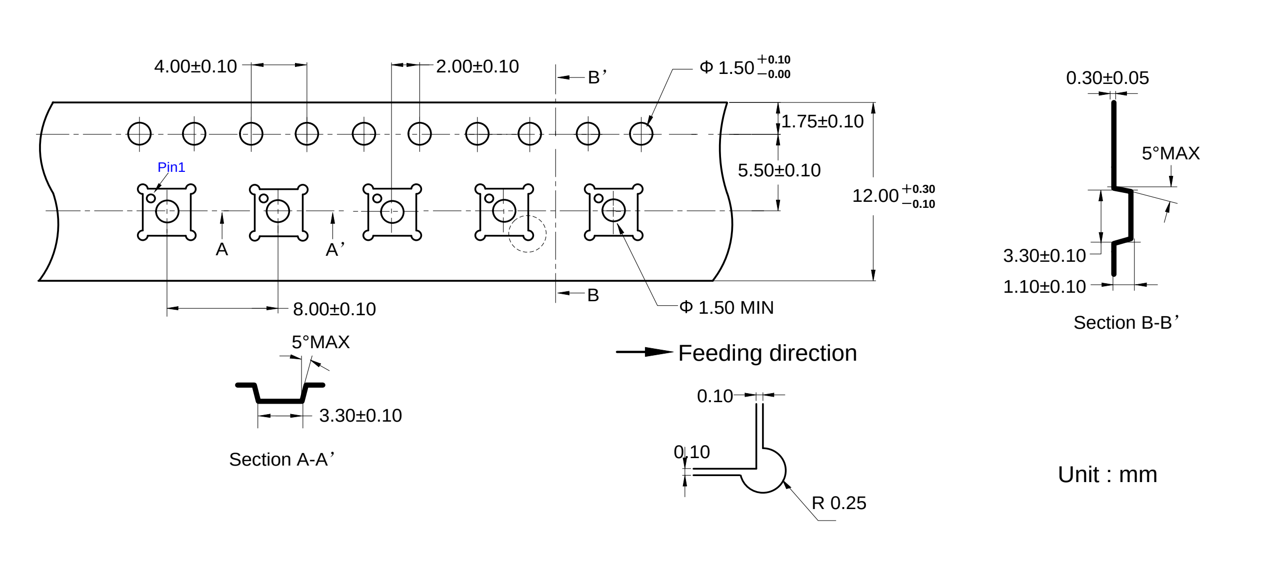
DFN10-3x3 Package



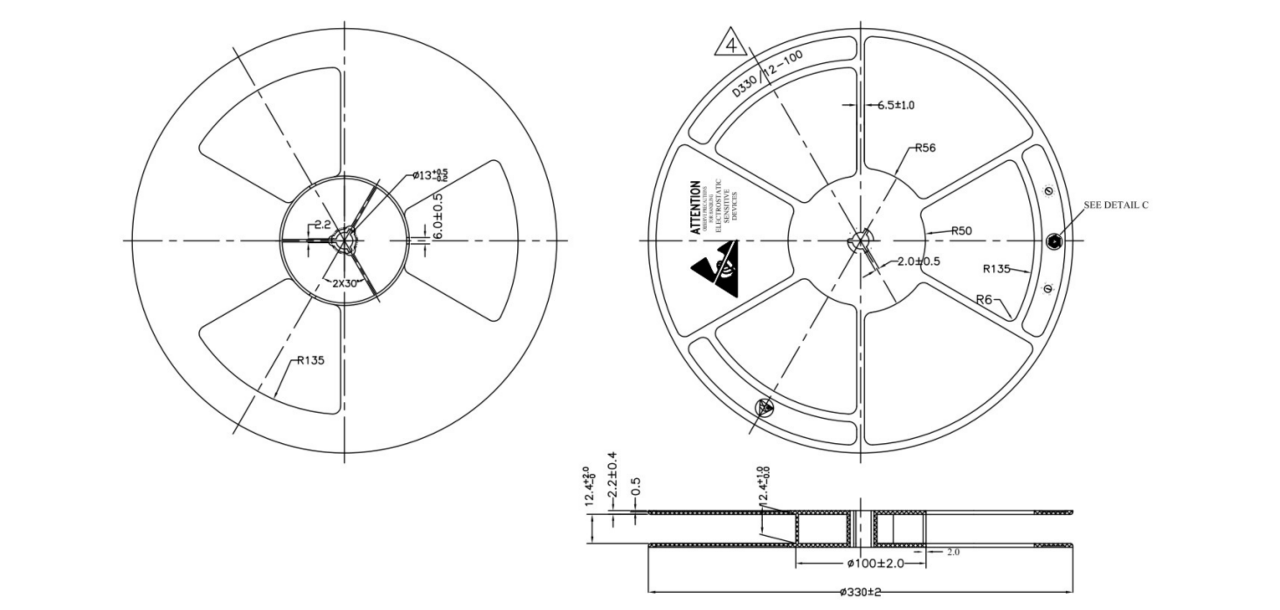
COMMON DIMENSIONS
(UNITS OF MEASURE=MILLIMETER)

SYMBOL	MIN	NOM	MAX
A	0.7	0.75	0.80
A1	0	0.02	0.05
A3	0.20REF		
b	0.20	0.25	0.3
D	2.90	3.00	3.10
E	2.90	3.00	3.10
D2	1.50	1.60	1.70
E2	2.40	2.50	2.60
e	0.45	0.50	0.55
L	0.25	0.30	0.35

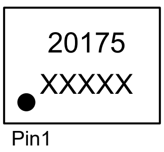
Tape Information



Reel Information



Marking



20175 - Part Number

XXXXX - Tracking Number

Revision History and Checking Table

Version	Date	Revision Item	Modifier	Function & Spec Checking	Package & Tape Checking
1.0	2022.06.10	Update TSHDN	Liu Yi Guo	Liu Yi Guo	Liu Jia Ying
1.1	2024.01.11	Change to MSL3	Shi Bo	Liu Yi Guo	Liu Jia Ying
1.2	2024.07.18	Add up Data	Cao Jia Chen	Liu Yi Guo	Liu Jia Ying