3V - 22V, 50mA - 2A, Current Limit Power Switch

General Description

The ET20135 is a current limit N-Channel MOSFET power switch. It is designed to protect circuitry on the output from transients on the input. It also protects the input from undesired shorts and transients coming on the output.

The current limit magnitude is controlled by an external resistor from ILIMIT to GND. It is fixed 300mA when ILIMIT is floating. Programmable soft-start time controls the slew rate of the output voltage during the start-up time. It can be controlled by the DV/DT pin setting.

The device is available in a TSOT23-6 package.

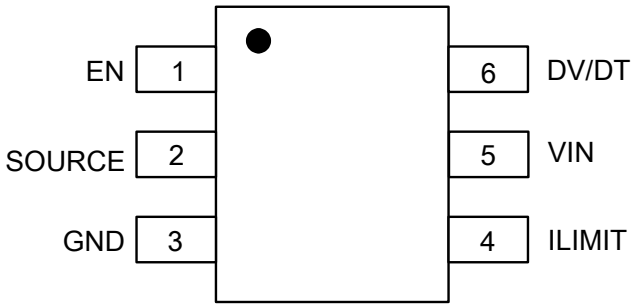
Features

- VIN Operating Range: 3.0V to 22V
- Programmable Current Limit and Soft-Start Time
- Short-Circuit Protection
- Typical R_{ON} is 57mΩ From Input to Output Power Path
- Over-Current Protection
- Internal Thermal Shutdown Protection
- ESD Protected: Human Body Model(JESD22-A114,All pins) ±2KV
- Available in a TSOT23-6 Package

Application

- SSD Hard Disk
- PC Cards
- Wireless Modem Data Cards
- USB Power Distribution
- USB Protection
- USB 3.1 Power Delivery
- Server PC

Pin Configuration

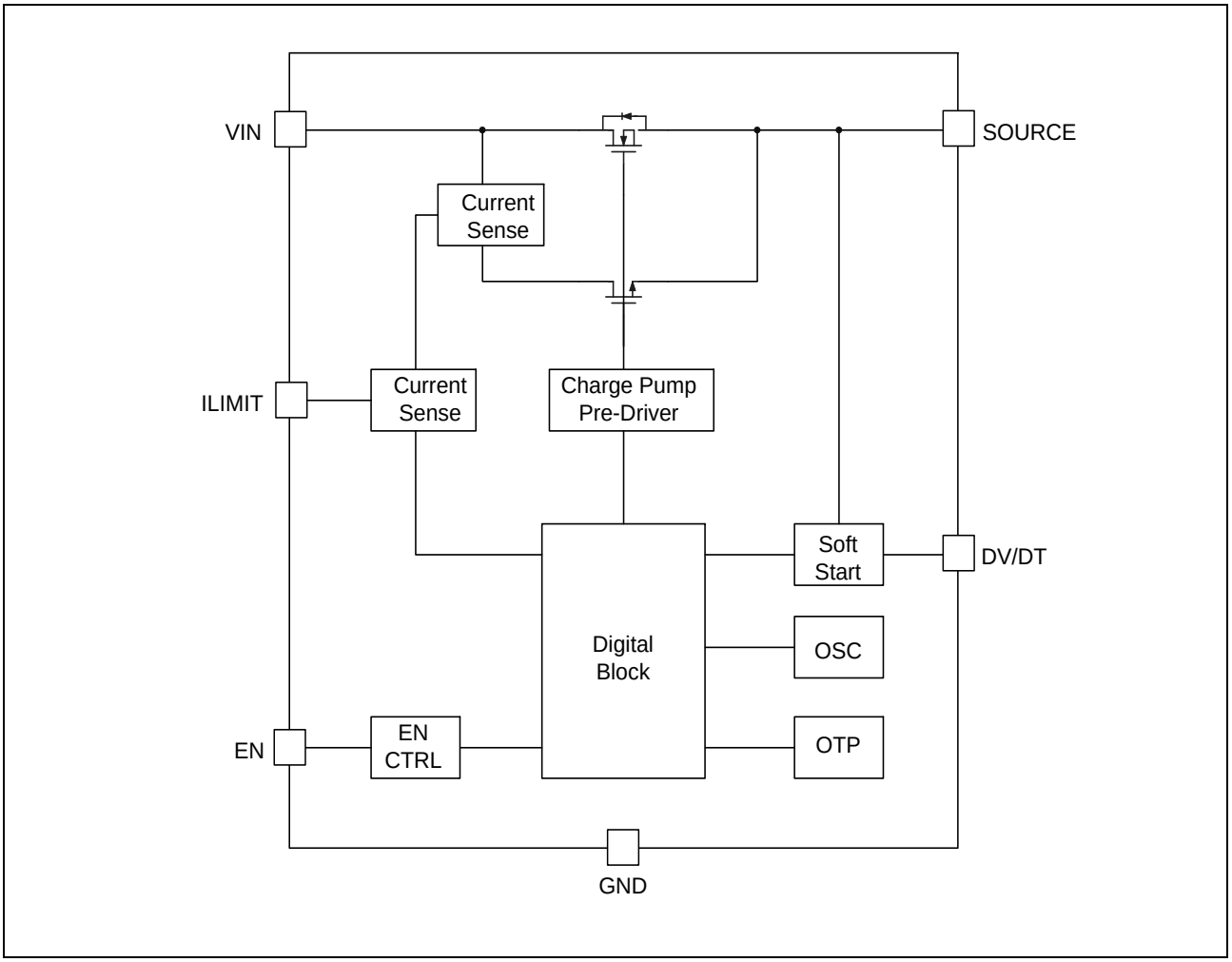


Top View

Pin Function

Pin	Name	Description
1	EN	Enable pin. Force EN high to enable the IC. Floating or pull to GND to disable the IC. Full EN up to VIN through a 300kΩ resistor for quick start-up mode.
2	SOURCE	Source of internal power n-channel MOSFET and the output terminal.
3	GND	Ground pin.
4	ILIMIT	Current limit programming pin. Program the current limit by connecting a resistor to GND. Floating ILIMIT pin to achieve a 0.3A fixed current limit.
5	VIN	Power supply input. Must be closely decoupled to GND pins with a 1uF or greater ceramic capacitor. Connect VIN using a wide PCB trace.
6	DV/DT	Soft start programming pin. Connect a capacity from DV/DT to GND to set the DV/DT slew rate.

Block Diagram



Operation

ET20135 is an integrated power switch with a low R_{DS_ON} N-Channel MOSFET, programmable current limiting. When the ET20135 turns on, it can deliver up to 2A continuous current to load.

Power Supply Considerations

A 10uF MLCC capacitor between V_{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 10uF MLCC capacitor improves the immunity of the device to short-circuit transients.

Current Limit (ILIMIT)

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. ET20135 will limit the current until the overload condition is removed or the device begins to thermal cycle.

The current limit can be programmed by an external resistor. It can be approximated with Equation 1 as below.

$$I_{LIMIT} = \frac{0.58\,(V)}{R_{LIMIT}\,(\Omega)} \times 1940 \qquad (1)$$

If the current limit condition lasts longer than 1.7ms, the ET20135 will enter into Hiccup mode with 700ms of off time.

The ET20135 allows ILIMIT to be floated during operation. The internal fixed current limit threshold is set at 0.3A. The current limit response time is about 40us(1).

When short ILIMIT to GND, the normal current limit function is disabled, but the secondary current limit still works. The secondary current limit is set at 8A. When the OCP is triggered, the power MOSFET will be shutdown immediately.

Short-Circuit Protection (SCP)

The secondary current limit is set at 8A. If the load current reaches 8A rapidly due to a short-circuit event, a fast turn-off circuit activates to turn off the MOSFET. The total short-circuit response time is about 3us(1). After switched off, the MOSFET restarts. If the short still exists, the ET20135 regulates the MOSFET to hold the current at threshold level. If it lasts for 1.7ms, the MOSFET will be turned off again enter into hiccup mode with 700ms of off time.

To prevent safe operating area(SOA) damage during a high input voltage short-circuit protection(SCP) condition, the IC current limit folds back when the power MOSFET VDS voltage is above the typical 11V and the junction temperature is over 100°C.

Soft Start

The soft start time can be set by an external capacity connecting from DV/DT to GND. The soft start time can be calculated with Equation 2:

$$t_{ss}(ms) = \frac{V_{IN}(V)}{DV/DT(V/ms)} \qquad (2)$$

The DV/DT slew rate is determined by external DVDT capacitor.

Thermal Protection

Thermal protection prevents damage to the IC when heavy-overload or short-circuit faults are present for extended periods of time. The ET20135 implements a thermal sensing to monitor the operating junction temperature of the power MOSFET. 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. When the temperature drops below its lower threshold (typically 125°C), the chip is enable again after a 700ms delay.

Note1： Test condition is as V_{IN}=12V, I_{LIM}=0.3A, T_A=25°C, C_{OUT}=0uF. Current Limit Response Time is the time difference between I_{OUT} first exceeding I_{LIM} and falling back to I_{LIM}. Short-circuit Response Time is the time difference between I_{OUT} exceeding 8A and falling back to 0A.

Absolute Maximum Ratings

Symbol	Parameter		Min	Max	Unit
V_{IN}, V_{SOURCE}	VIN, SOURCE to GND		-0.3	26	V
V_{IO}	ILIMIT, EN, DV/DT to GND		-0.3	5.5	V
P_D	Power Dissipation at T_A= +25°C(2)			1.5	W
T_J	Junction Temperature		-40	+150	°C
T_{STG}	Storage Junction Temperature		-65	+150	°C
T_A	Operating Temperature Range		-40	+85	°C
T_{SOLD}	Soldering Temperature (reflow)			+260	°C
V_{ESD}	Electrostatic Discharge Capability	Human Body Mode, ESDA/JEDEC JS-001-2017	2.0		KV
		Charged Device Mode, ESDA/JEDEC JS-002-2018	1.5		KV

Note2 : The maximum allowable Power Dissipation is recording to maximum allowable Junction Temperature. $P_{D(MAX)}@T_A=(T_{J(MAX)}-T_A)/\theta_{JA}$.

Electrical Characteristics

Unless otherwise noted, V_{IN}=12V, R_{LIMIT}=NS, C_{OUT}=10uF, T_A= -40°C to 85°C, typical value is tested at T_A=25°C.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Basic Operation						
V_{IN}	Input Voltage		3.0		22	V
I_Q	V_{IN} Quiescent Current	EN = High		550		μA
I_S	V_{IN} Shutdown Current	EN = GND		17		uA
Power MOSFET						
R_{ON}	On-Resistance of Switch IN-OUT	I_{OUT}=1A		57		mΩ
T_{ON}	Turn-on Delay Time	DV/DT float, V_{OUT} rising 10% V_{IN}		2.5		ms
I_{OFF}	Off-state Leakage Current	V_{IN} = 12V, EN = GND		0.1	1	uA
V_{UVLO_R}	Under Voltage Lockout Threshold	V_{IN} Rising	2.55	2.7	2.85	V
V_{UVLO_HYS}	UVLO Hysteresis			200		mV
DV/DT						
DV/DT	DV/DT slew rate	DV/DT float	1.3	2	2.7	V/ms
$I_{DV/DT}$	DV/DT current (3)	$V_{DV/DT}$ = 0.5V	4.5	6.5	8.5	uA
Current Limit						
I_{LIMIT_NO}	Current Limit at Normal Operation (4)	ILIMIT float, T_A=25°C	0.28	0.3	0.32	A
		R_{LIMIT} = 549Ω, T_A=25°C	1.85	2.0	2.15	A
		R_{LIMIT} = 1.5kΩ, T_A=25°C	0.7	0.75	0.8	A
		R_{LIMIT} = 5.6kΩ, T_A=25°C	0.185	0.2	0.215	A
Enable (EN)						
V_{EN_R}	EN Rising Threshold		1.86	2	2.16	V
V_{EN_HYS}	EN Hysteresis			350		mV
R_{EN}	EN pull-down Resistor		1.4	2.2	3.0	MΩ
Output Discharge						
R_{DIS}	Discharge Resistor			540		Ω
Over-Temperature Protection						
T_{SD}	Thermal Shutdown			155		°C
T_{SD_HYS}	Thermal-shutdown Hysteresis			30		°C

Note3： For cases with an external DV/DT capacitor, the slew rate of V_{SOURCE} can be calculated with Equation 3 as below:

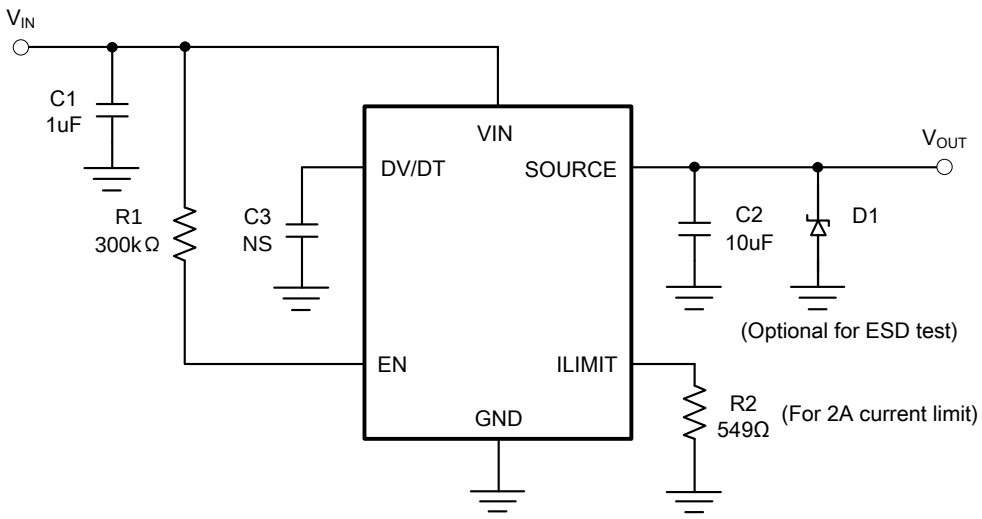
$$DV/DT\left(V/ms\right)=\frac{6.5(uA)\times K1}{C_{DV/DT}(nF)} \qquad (3)$$

- K1=30

Note4： The current limit can be approximated with Equation 4 as below：

$$I_{LIMIT}=\frac{0.58\,(V)}{R_{LIMIT}\,(\Omega)}\times 1940 \qquad (4)$$

Application Circuits

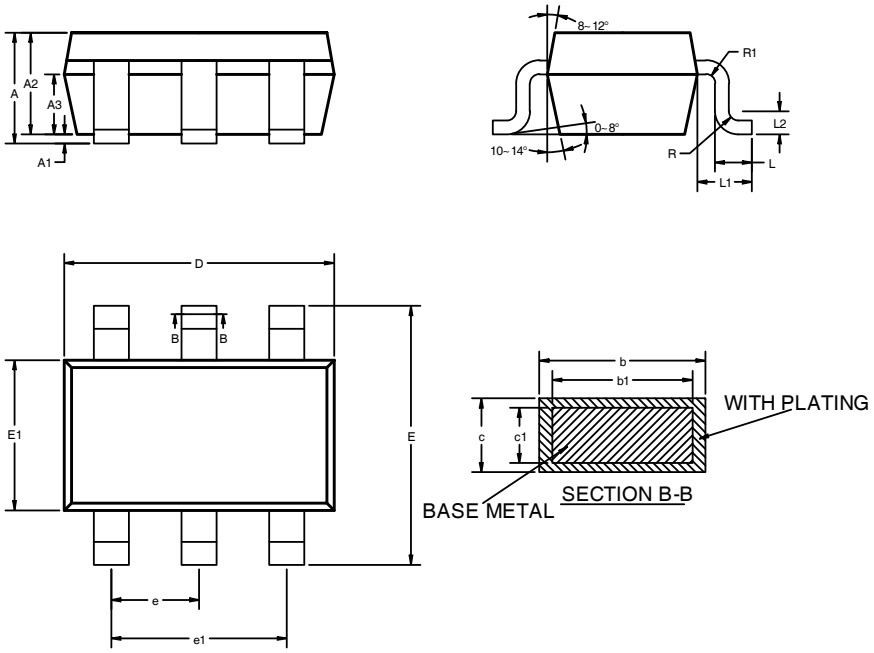


Typical Application Circuit

*：This electric circuit only supplies for reference.

Package Dimension

TSOT23-6

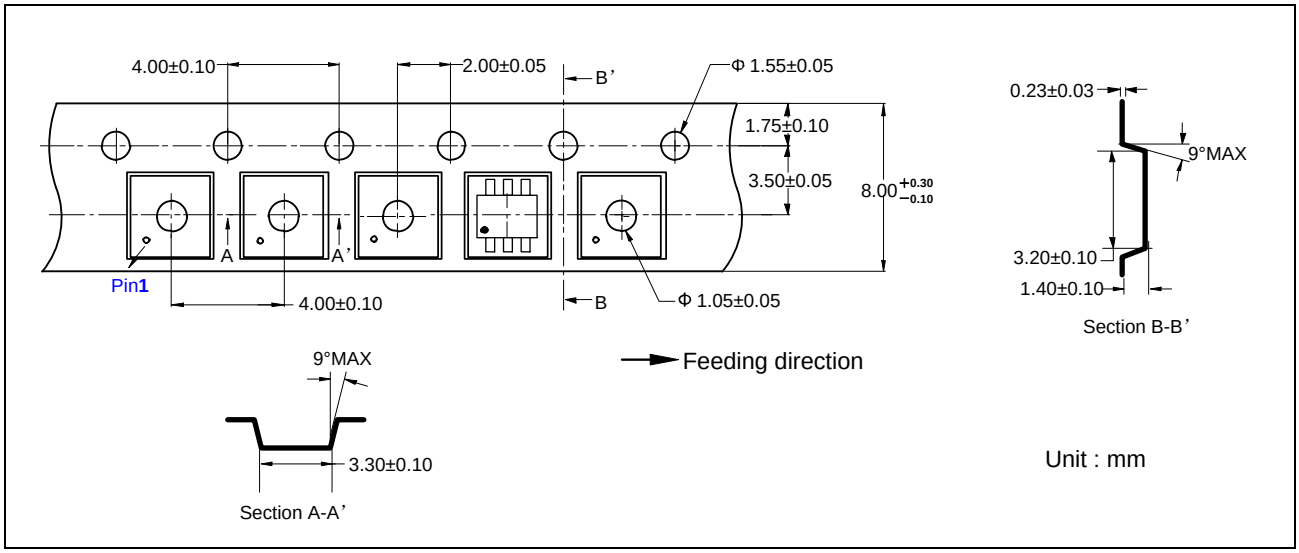


COMMON DIMENSIONS

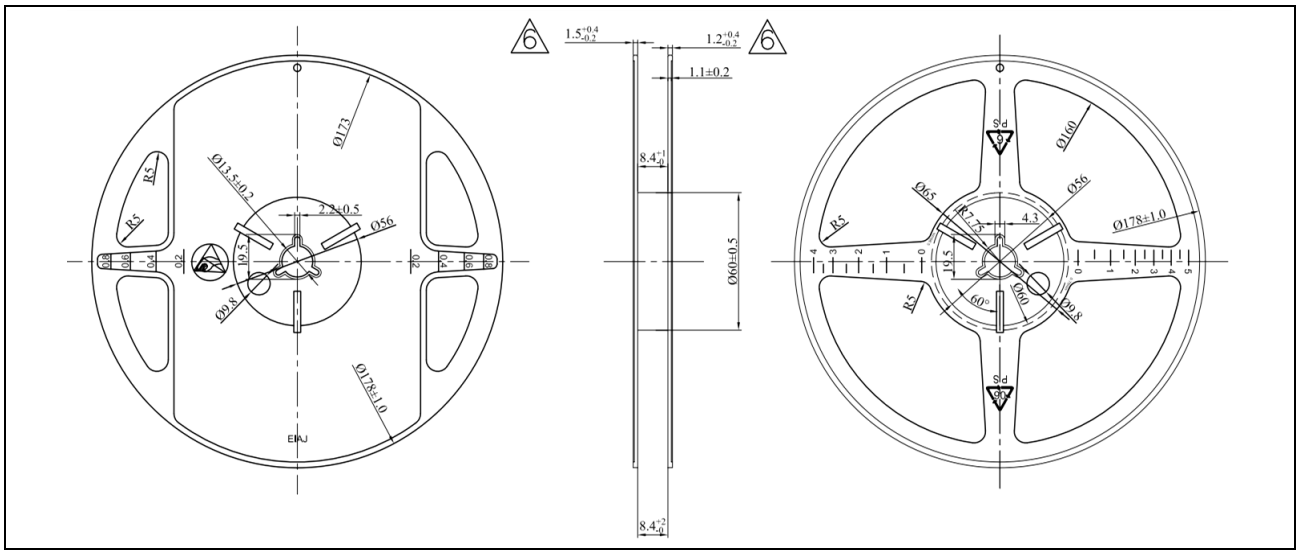
(UNITS OF MEASURE=MILLIMETER)

SYMBOL	MIN	NOM	MAX
A	0.780	0.880	0.980
A1	0.000	0.050	0.100
A2	0.780	0.830	0.880
A3	0.350	0.400	0.450
b	0.320	0.420	0.520
b1	0.350	0.400	0.450
c	0.080	—	0.220
c1	0.097	0.127	0.157
D	2.800	2.900	3.000
E	2.700	2.800	2.900
E1	1.500	1.600	1.700
e	0.950BASE		
e1	1.900BASE		
L	0.300	0.450	0.600
L1	0.600REF		
L2	0.250BSC		
R	0.080	—	0.200
R1	0.080	—	0.200

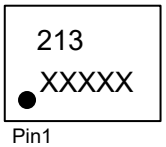
Tape Information



Reel Information



Marking



213 - Part Number

XXXXX - Tracking Number

Revision History and Checking Table

Version	Date	Revision Item	Modifier	Function & Spec Checking	Package & Tape Checking
1.0	2024-02-26	Initial Version	Caojc	Liuks	liujy
1.1	2024-08-26	Modify Package	Caojc	Liuks	liujy