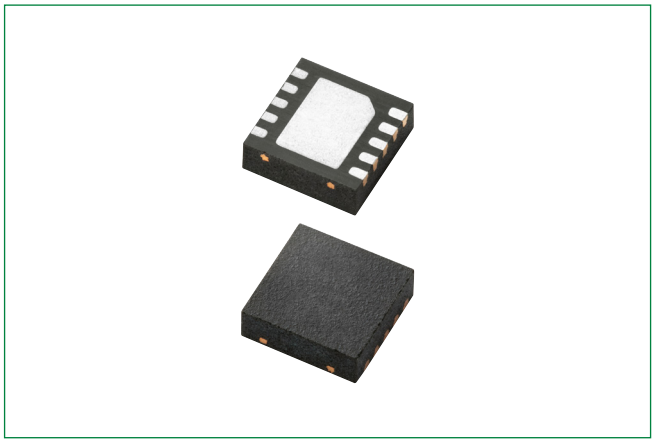
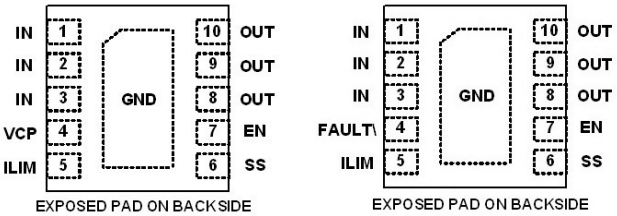
LS1205ExD33 Series

18V, 5A eFuse with Programmable Current Limit and Output Voltage Clamp



Pinout Designation



LS1205EV Top View

LS1205EF Top View

Pin Description

LS1205EV	LS1205EF	Pin Name	Description
1, 2, 3	1, 2, 3	IN	Power input pin.
4	-	VCP	LS1205EV only output clamp voltage selection based on the input voltage.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 0.1μF capacitor.
-	4	FAULT\	LS1205EF Only. Fault event indicator. Open-drain output that asserts low to indicate input under-voltage, input over-voltage, output short and thermal shutdown fault events.
5	5	ILIM	Current limit program pin. Program the current limit by connecting a resister to ground.
6	6	SS	Soft Start time program pin. Connect a capacitor to ground to program the soft start time.
7	7	EN	Enable interface pin. EN has accurate ON/OFF threshold of 1.29V and 1.19V respectively. Pull it above ON threshold to enable the IC. Pull it below OFF threshold to disable the IC.
8, 9,10	8, 9,10	OUT	Power output pin.
EP	EP	GND	Ground pin.

VCP	VIN		V_{OUT} Clamping Threshold Typ
Low	3.3V	>4V	3.8V
High	5V	>6V	5.7V
FLOAT	12V	>16V	14.4V

Description

The LS1205E integrated load switch provides an easy circuit protection to power the system. The devices use few external components and provide multiple protection modes. They are a robust defense against overload, short circuit, input voltage surge and excessive inrush current. The switch's low $R_{DS(ON)}$ helps to reduce power loss during normal operation. Set the current limit level with an external resistor. Protect against input over-voltage events via internal clamp circuitry to a safe output voltage. Programmable soft-start controls the slew rate of the output voltage to limit inrush current during plug in. It integrates thermal fold-back function and over temperature shutdown protection. They are available in low profile 10 leads DFN 3mm x 3mm package.

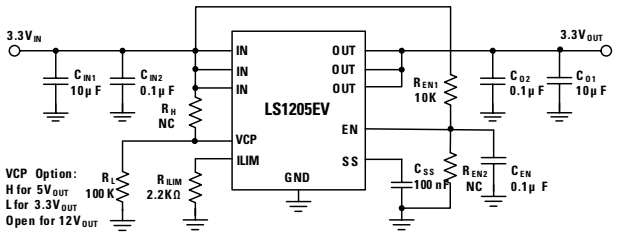
Features & Benefits

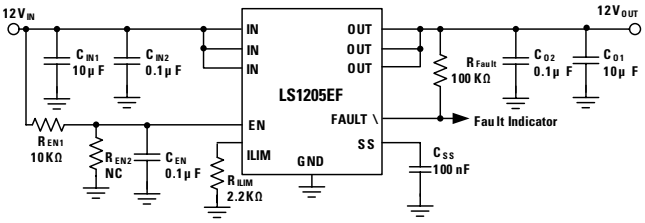
- Wide Input Voltage Range from 2.7V to 18V
- LS1205EV: External Selectable Input Range and Clamping Output Voltage Threshold
- LS1205EF: Open Drain Fault Indicator FAULT\
- Output Discharging Function
- Integrate a 25mΩ Low RDS(ON) Protection Switch
- External Programmable Soft-Start Time
- External Programmable Current Limit up to 5A
- Short-circuit Protection
- Enable Control Pin
- Thermal Shutdown Protection & Auto Recovery
- DFN3×3_10L Package
- Pb-Free RoHS compliant

Applications

- HDD and SSD Drives
- Adapter Powered Devices
- PC / Notebook
- FAN Control
- Networking

Typical Applications





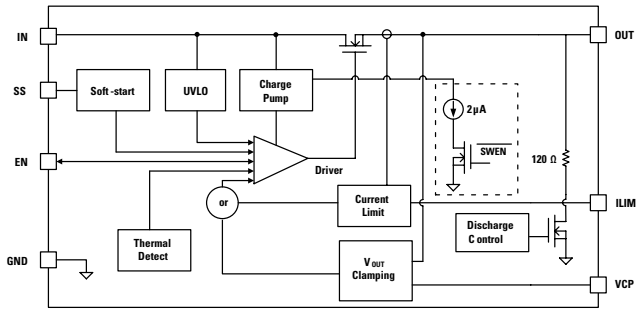
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LS1205ExD33 Series

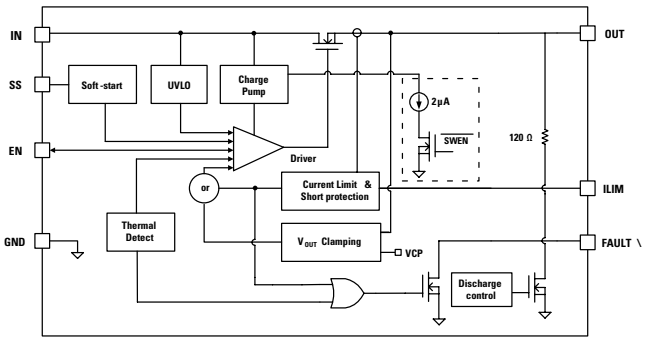
18V, 5A eFuse with Programmable Current Limit and Output Voltage Clamp

Functional Block Diagram

LS1205EV



LS1205EF



Absolute Maximum Rating (Reference to GND)

Symbol	Value	Units
VIN, EN, VCP, FAULT\	-0.3 to +20	V
The other Pins	-0.3 to +6.5	V
ESD, Human Body Model (HBM)	±2000	V
Junction Temperature Range	-40 to +125	°C
Storage Temperature Range	-65 to +125	°C
Lead Temperature (Soldering 10s)	260	°C

Notes:

1. Stress exceeding those listed "Absolute Maximum Ratings" may damage the device.
2. ESD HBM testing per JESD22-A114F

Recommend Operating Conditions

Symbol	Value	Units
Input Voltage (V_{IN})	+2.7 to +18	V
Junction Temperature Range	+125	°C

Notes: The device is not guaranteed to function outside of the recommended operating conditions.

Thermal information

Symbol	Value	Units
Maximum Power Dissipation (T_A=25°C)	1.89	W
Thermal Resistance (θ_{JA})	53	°C/W
Thermal Resistance (θ_{JC})	25	°C/W

Notes:

1. Measured on JESD51-7, 4-Layer PCB.

2. The maximum allowable power dissipation is a function of the maximum junction temperature T_{J_MAX}, the junction to ambient thermal resistance θ_{JA}, and the ambient temperature TA. The maximum allowable continuous power dissipation at any ambient temperature is calculated by $P_{D_MAX}=(T_{J_MAX}-T_A)/\theta_{JA}$. Exceeding the maximum allowable power dissipation will cause excessive die temperature, and the regulator will go into thermal shutdown. Internal thermal shutdown circuitry protects the device from permanent damage.

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LS1205ExD33 Series

18V, 5A eFuse with Programmable Current Limit and Output Voltage Clamp

Electrical Characteristics (T_A = +25°C, V_{IN}=5V, R_{LIM}=10kΩ, C_{SST}=100nF, C_{IN}=10µF, unless otherwise specified)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{IN}	Input Voltage Range		2.7		18	V
I_{BIAS}	Quiescent Current			200	240	µA
I_{SHDN}	Shutdown Current	V_{EN}=0V		6.5	10	µA
V_{ENR}	EN Turn-on Threshold	EN Rising		1.29		V
V_{ENF}	EN Turn-off Threshold	EN Falling		1.19		V
V_{ENHYS}	EN Hysteresis			100		mV
I_{EN}	EN Input Leakage Current	0V ≤ VEN ≤ 5V	-200		200	nA
V_{CLP}	Clamping Output Voltage	LS1205EV VCP=LOW		3.8		V
		LS1205EV VCP=HIGH		5.7		V
		LS1205EV VCP=FLOAT		14.4		V
		LS1205EF		14.4		V
V_{UVLO}	Input UVLO Threshold	LS1205EV VCP=LOW	2.4	2.55	2.72	V
		LS1205EV VCP=HIGH	3.4	3.6	3.8	V
		LS1205EV VCP=FLOAT	3.4	3.6	3.8	V
		LS1205EF	3.4	3.6	3.8	V
V_{HYS}	UVLO hysteresis	LS1205EV VCP=LOW		150		mV
		LS1205EV VCP=HIGH		300		mV
		LS1205EV VCP=FLOAT		300		mV
		LS1205EF		300		mV
I_{Flkg}	FAULT\ Leakage Current	LS1205EF, No Fault, $V_{FAULT\backslash}$=5V		0.01	1	µA
	FAULT\ Output Low Voltage	LS1205EF, Fault, I_{SINK}=1mA			0.5	V
R_{DSON}	Protection FET RON			25		mΩ
I_{INLIM}	Current Limit Program Range		1		5	A
I_{INLIM}	Current Limit	R_{LIM}=2.7kΩ	3.6	4	4.5	A
K_{LIM}	Current Limit Setting Factor	I_{INLIM}=1A~5A		10.5		A*kΩ
T_{SS}	Soft-start Time	C_{SS}=100nF		25		msec
		SS float	1.2	1.7	2.2	msec
$R_{Discharge}$	OUT Discharging Resistance	V_{IN}=5V and V_{EN}=0V		120		Ω
T_{SD}	Thermal Shutdown Temperature			140		°C
T_{HYS}	Thermal Shutdown Hysteresis			20		°C
T_{LIIM}	Junction Temperature Regulation			125		°C

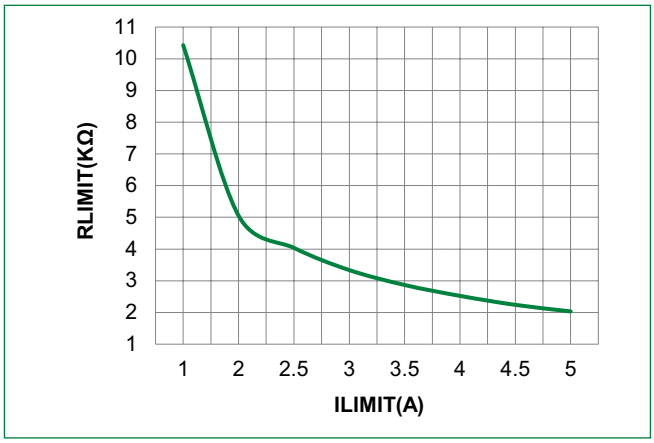
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LS1205ExD33 Series

18V, 5A eFuse with Programmable Current Limit and Output Voltage Clamp

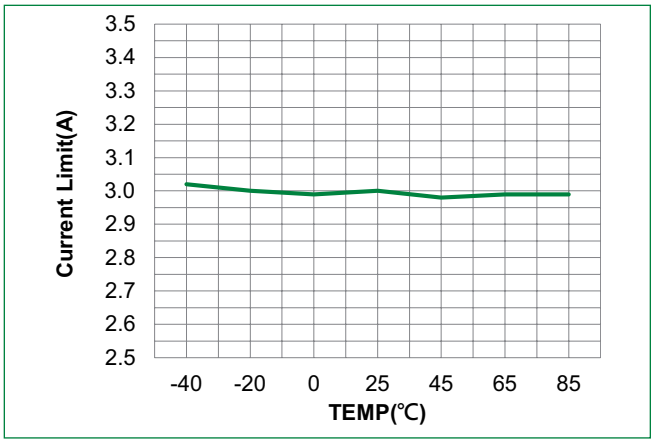
Programmable Current Limit

(V_{IN}=3.3V, 5V and 12V)



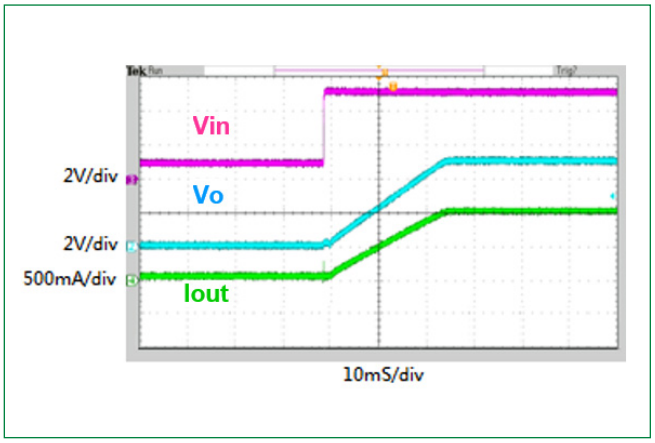
Programmable Current Limit

(RLIM=3.3K)



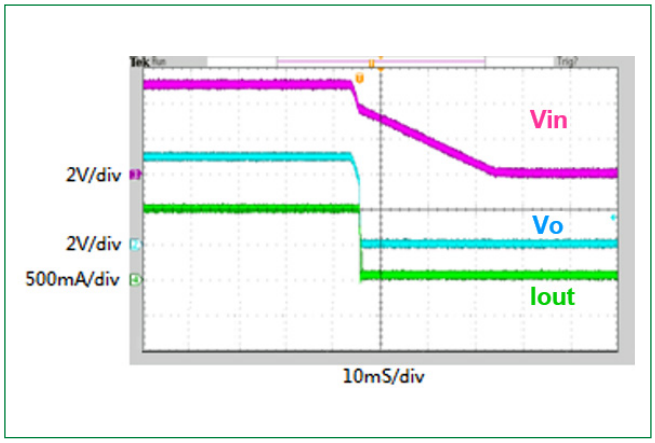
Programmable Soft-start Time

(3.3V Mode, I_O=1A, C_{SS}=100nF)



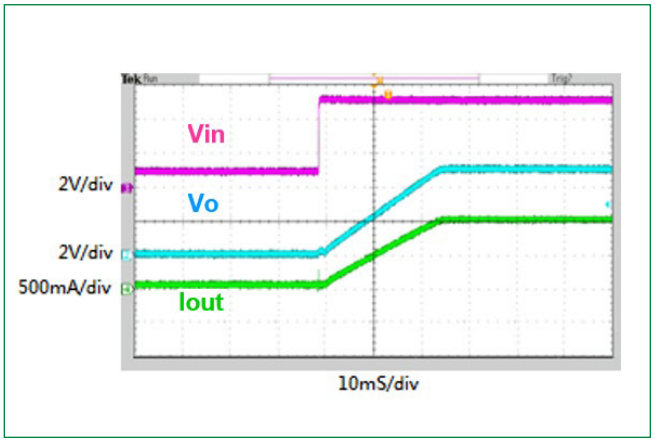
Shutdown

(3.3V Mode, I_O=1A, C_{SS}=100nF)



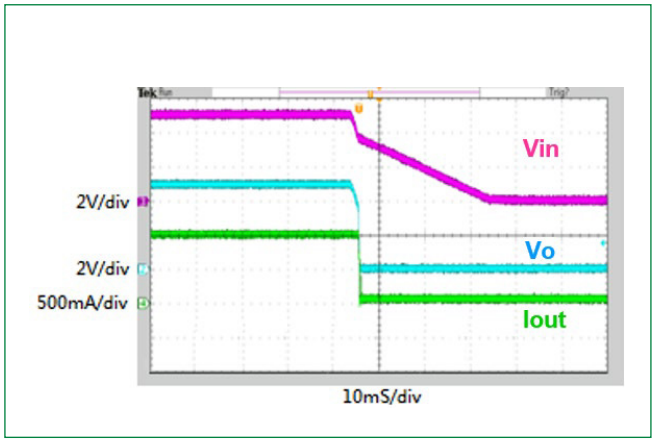
Programmable Soft-start Time

(5V Mode, I_O=1A, C_{SS}=100nF)



Shutdown

(5V Mode, I_O=1A, C_{SS}=100nF)

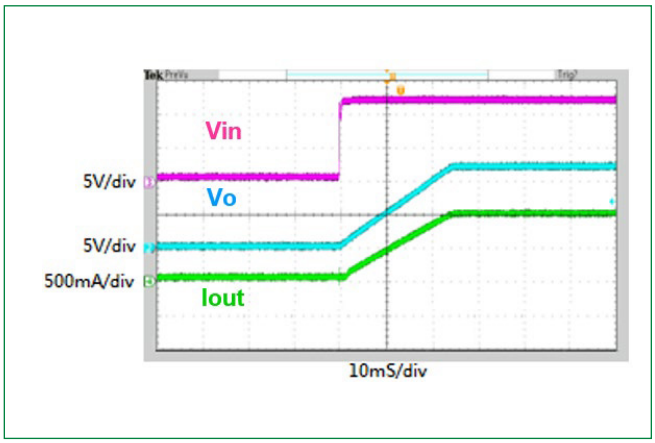


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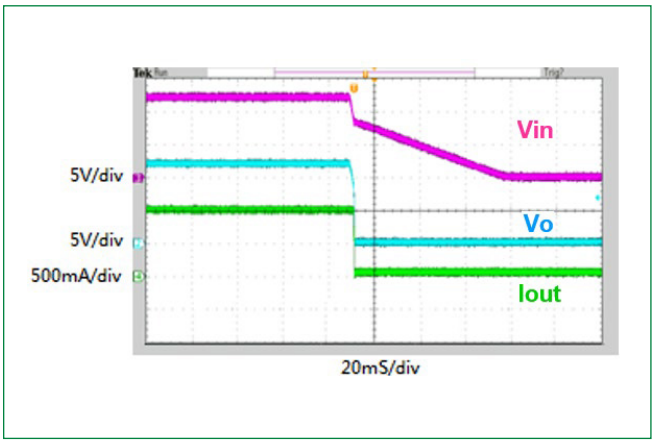
LS1205ExD33 Series

18V, 5A eFuse with Programmable Current Limit and Output Voltage Clamp

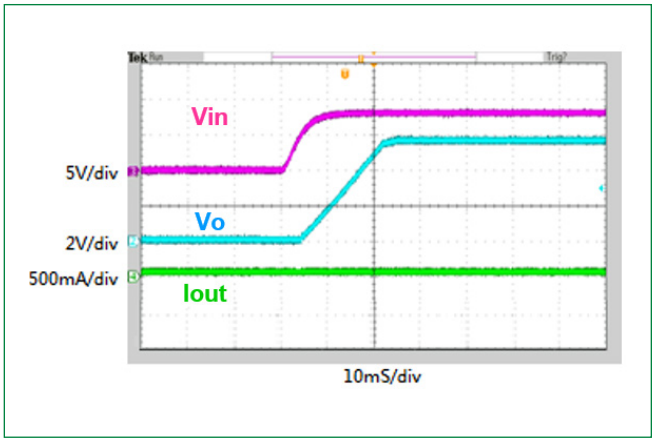
Programmable Soft-start Time
(12V Mode, I_O=1A, C_{SS}=100nF)



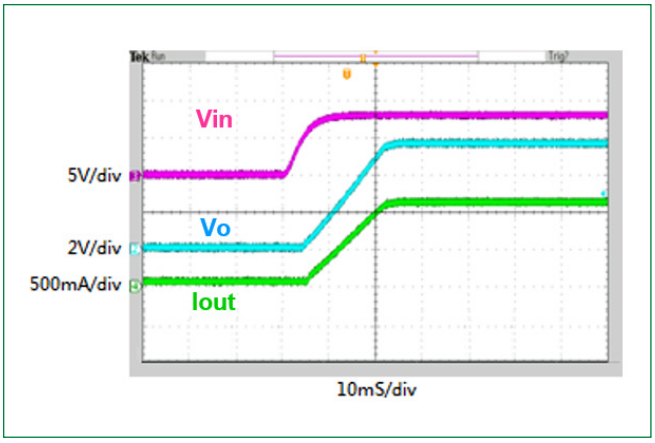
Shutdown
(12V Mode, I_O=1A, C_{SS}=100nF)



Over Voltage Protection
(5V Mode, V_{IN}=8V, I_O=0A)



Over Voltage Protection
(5V Mode, V_{IN}=8V, I_O=1A)



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LS1205ExD33 Series

18V, 5A eFuse with Programmable Current Limit and Output Voltage Clamp

Detailed Description

The LS1205E is a current limit switch with integrated power switch that is used to manage current/voltage/start-up voltage ramp to connected load. A high level on EN pin enables the internal MOSFET. As VIN rises, the internal MOSFET of the device will start conducting and allow current to flow from VIN to OUT. The internal MOSFET turns off when EN is held low. The user also can control the output voltage ramp time by connecting a program capacitor between SS pin and GND.

After a successful start-up sequence, the device will actively monitors its load current and input voltage, ensuring that the overload current limit ILIMT programmed by pin ILIMT is not exceeded. It also monitors input voltage and ensures any spikes are safely clamped to pre-determined level at the output which is selected by pin VCP. This keeps the output device safe from harmful voltage and current transients. The device also has built-in thermal sensor. In the event device temperature (T_J) exceeds thermal regulation point, current limit will be decreased until T_J is regulated at around 125°C and when device temperature (T_J) exceeds T_{SHDN}, typically 140°C, the thermal shutdown circuitry will shut down the internal MOSFET thereby disconnecting the load from the supply. The LS1205E device will remain off during a cooling period until device temperature falls below T_{SHDN} -20°C, after which it will attempt to restart.

Application Information

Input and Output Capacitor Selection

Bypass IN to GND with 0.1µF input capacitor. The LS1205E require ≥10µF Input and output capacitor connected to GND. X7R type capacitors are recommended, but X5R and others may be used.

Enable

Enable interface pin. EN has accurate ON/OFF threshold of 1.29V and 1.19V respectively. Pull it above ON threshold High to enable the IC. Pull it below OFF threshold to disable the IC.

Soft Start

Connect a program capacitor from this pin to GND to control the slew rate of the output voltage at power-on. This pin can be left floating to obtain a predetermined slew rate (minimum TSS) on the output. The soft start time with different capacitor is below:

$$T_{SS} = \begin{cases} T_{SS_INT}, \text{No external } C_{SS} \\ C_{SS} * R_{INT}, T_{SS} > T_{SS_INT} \end{cases}$$

SS cap (nF)	None	10	56	100
Rise time (msec)	1.7	2.5	14	25

Where, T_{SS_INT} is the internally fixed default soft-start time, about 1.7ms, which means there's no any external C_{SS}, R_{INT} is the internal resistor, about 250kΩ

Selectable Output Clamping Voltage (LS1205EV Only)

Output clamp voltage selection based on the input voltage. 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 decouple VCP pin with a 0.1µF capacitor to GND.

VCP	IN		Clamping Threshold
			TYP.
Low	3.3V	>4V	3.8V
High	5V	>6V	5.7V
Float	12V	>16V	14.4V

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LS1205ExD33 Series

18V, 5A eFuse with Programmable Current Limit and Output Voltage Clamp

Current Limit

The user can program the input current limit level for current limited adaptors or sources to prevent the load current from overloading the source. When the input current limit loop is engaged, the input current will be automatically reduced to the programmed level to satisfy the limited input power.

Input current limit can be programmed with below equation:

$$I_{INLIM} = \frac{10.5A * k\Omega}{R_{ILIM}}$$

Where R_{LIM} is the program resistor at the I_{LIM} pin.

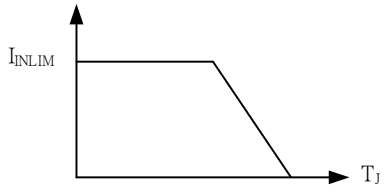
Program Current Limit Resistance (kΩ)	10.5	5.2	4.2	3.5	3	2.7	2.4	2.1
Current Limit I_{INLIM}(A)	1	2	2.5	3	3.5	4	4.5	5

For the stable system operation, it is recommended to set the current limit level 1.2~1.5 times of the maximum system load current to avoid mis-triggering the current limit and causing system malfunctions.

Thermal Foldback

The device continuously monitors the load current and keeps it limited to the value programmed by R_{ILIM}. In any event, normal operation or current limit protection.

If power dissipation in the internal MOSFET PD = (V_{IN} – V_{OUT}) × I_{OUT} is too high, LS1205E will engage thermal foldback to reduce the current limit value so that the case temperature is maintain at around 105°C. In the event device temperature (T_J) exceeds T_{SHDN}, typically 140°C, the thermal shutdown circuitry shuts down the internal MOSFET thereby disconnecting the load from the supply.(the TJ below should be $T_{Ambient}$, and the cross point should be 105°C, and fix the curve as black line)



Thermal Foldback in Current Limit

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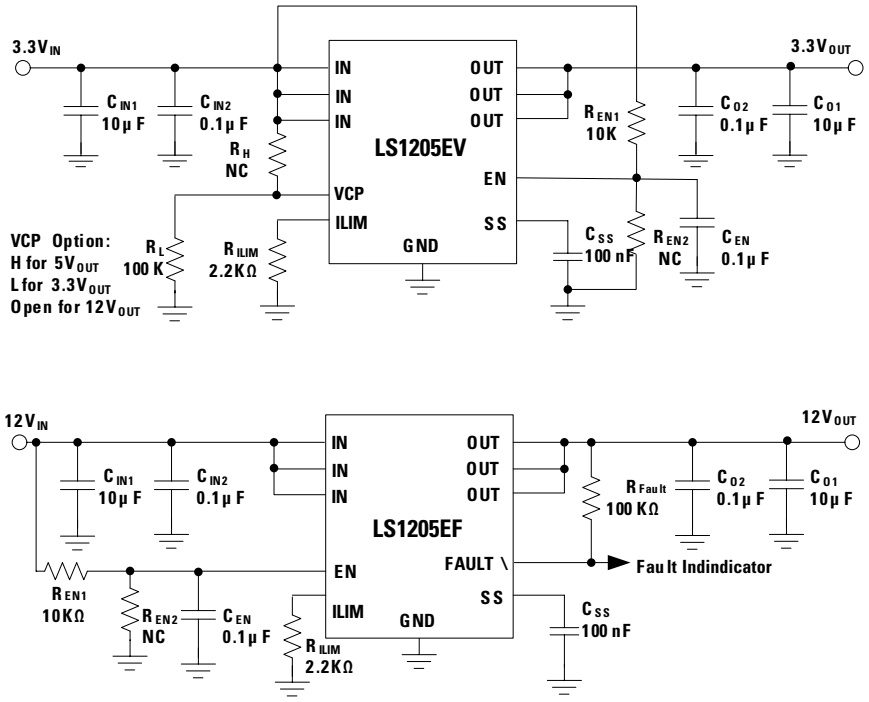
LS1205ExD33 Series

18V, 5A eFuse with Programmable Current Limit and Output Voltage Clamp

PCB Layout Guideline

- For all applications, a 0.1µF or greater ceramic decoupling capacitor is recommended between IN terminal and GND, and a 0.1µF or greater ceramic decoupling capacitor is recommended between OUT terminal. For hot-plug applications, where input power path inductance is negligible, this capacitor can be eliminated/minimized.
- The optimum placement of decoupling capacitor is closest to the IN and GND terminals of the device. Care must be taken to minimize the loop area formed by the bypass-capacitor connection, the IN terminal, and the GND terminal of the IC.
- High current carrying power path connections should be as short as possible and should be sized to carry at least twice the full-load current.
- The GND terminal must be tied to the PCB ground plane at the terminal of the IC. The PCB ground should be a copper plane or island on the board.
- Locate all support components: R_{ILIM}, C_{SS} and resistors for EN, close to their connection pin. Connect the other end of the component to the GND pin of the device with shortest trace length. The trace routing for the R_{ILIM} and CSS components to the device should be as short as possible to reduce parasitic effects on the current limit and soft start timing. These traces should not have any coupling to switching signals on the board.
- Obtaining acceptable performance with alternate layout schemes is possible; however, this layout has been shown to produce good results and is intended as a guideline.

Application Schematic



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LS1205ExD33 Series

18V, 5A eFuse with Programmable Current Limit and Output Voltage Clamp

Bill of Materials

Qty	Ref	Value	Description	Package
1	C_{IN1}	10µF	Ceramic Capacitor, 10V, X5R	0805
1	C_{O1}	10µF	Ceramic Capacitor, 10V, X5R	0805
3	C_{IN2}, C_{O2}, C_{EN}	0.1µF	Ceramic Capacitor, 10V, X5R	0603
1	R_{EN1}	10 KΩ	Resistor, ±1%	0603
1	R_{EN2}	NC	Resistor, ±1%	0603
1	R_L or R_{Fault}	100KΩ	Resistor, ±1%	0603
0	R_H	NA	Resistor, ±1%	0603
1	C_{SS}	1nF	Ceramic Capacitor, 10V, X5R	0603
1	R_{ILIM}	2.2kΩ	Resistor, ±1%	0603
1	U1	LS1205E	eFuse IC	DFN3x3_10L

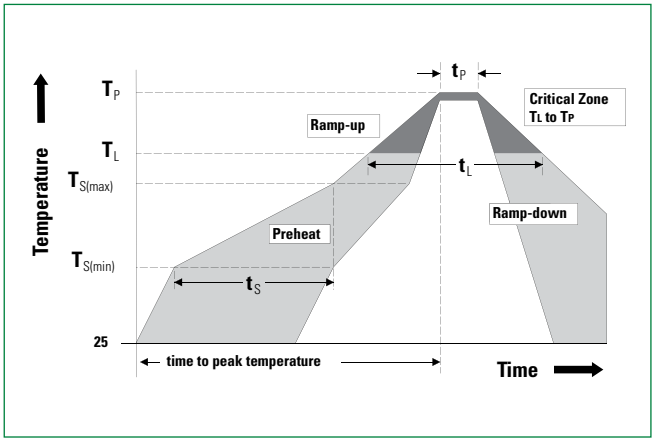
Soldering Parameters

Average ramp up rate (Tsmin to T_P)		1~2°C/second, 3°C/second max.
Preheat & Soak	**- Temperature Min ($T_{s(min)}$)**	150°C
	- Temperature Max ($T_{s(max)}$)	200°C
	- Time (min to max) (t_s)	60 – 120 secs
Time maintained above	**- Temperature(T_L)**	217°C
	- Time(t_L)	60~150 seconds
Peak Temperature (T_P)		See Classification Temp intable1
Time within 5°C of actual peak Temperature (t_p)		30 seconds max
Ramp-down Rate		6°C/second max
Time 25°C to peak Temperature (T_P)		8 minutes Max.

Notes:

1. Tolerance for peak profile Temperature(T_p) is defined as a supplier minimum and a user maximum.

2. Tolerance for time at peak profile temperature (t_p)is defined as a supplier minimum and a user maximum.



Ordering Information

Part Number	Marking	Package	Min. Order Qty.
LS1205EVD33	1205EV	DFN3x3_10L	5000/Tape & Reel
LS1205EFD33	1205EF	DFN3x3_10L	5000/Tape & Reel

Pb-freeProcess –Classification Temperatures (T_C)

Package Thickness	Volume mm^3 <350	Volume mm^3 350-2000	Volume mm^3 >2000
<1.6mm	260°C	260°C	260°C
1.6mm–2.5mm	260°C	250°C	245°C
>2.5mm	250°C	245°C	245°C

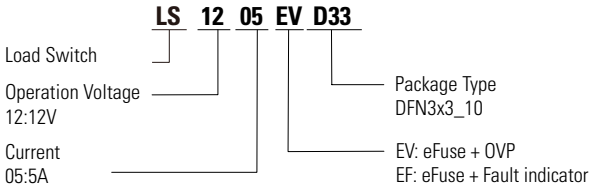
Note: For all temperature information, please refer to topside of the package, measured on the package body surface.

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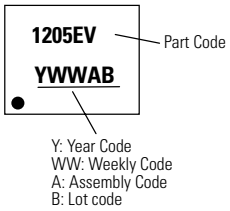
LS1205ExD33 Series

18V, 5A eFuse with Programmable Current Limit and Output Voltage Clamp

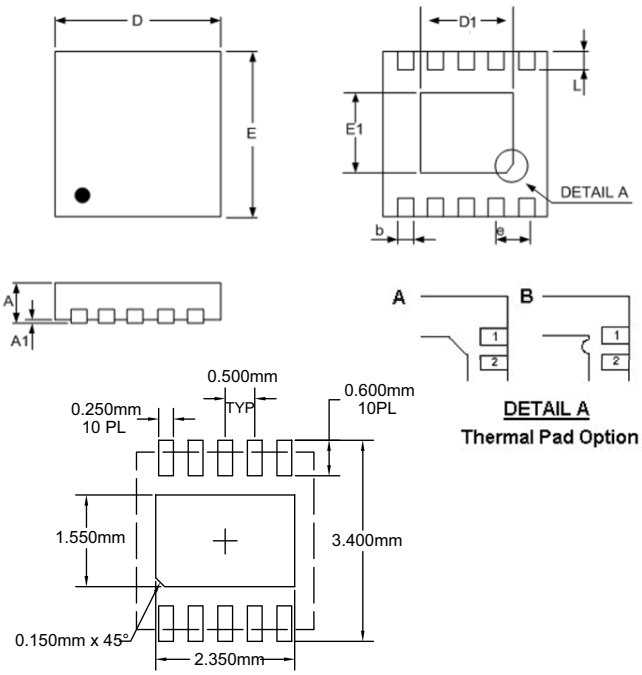
Part Numbering



Part Marking



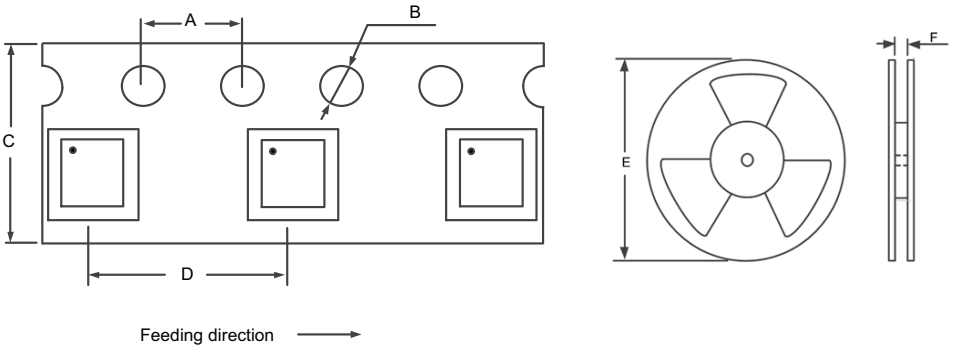
Dimensions — DFN3x3_10L



Recommended Soldering Pad Layout

Dimension	Millimeters		Inches	
	MIN	MAX	MIN	MAX
A	0.70	0.80	0.028	0.031
A1	0.00	0.05	0.000	0.002
b	0.18	0.30	0.007	0.012
D	2.90	3.10	0.114	0.122
D1	2.10	2.60	0.083	0.102
E	2.90	3.10	0.114	0.122
E1	1.35	1.75	0.053	0.069
e	0.50		0.020	
L	0.30	0.50	0.012	0.020

Carrier Tape & Reel Specification — DFN3x3_10L



Feeding direction →

Symbol	Millimeters
A	4.0
B	1.5
C	12.0
D	8.0
E	13 inch
F	13.0

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