

16.8V, 14A High Efficiency Asynchronous Boost Converter

TD1218

General Description

The TD1218 is a high-power asynchronous boost converter with an integrated 20mΩ power switch to provide a high efficiency small size solution for portable systems.

The TD1218 has a wide input voltage range from 2.7V to 16V and suitable for the applications with a single or two lithium batteries, or 12V lead-acid batteries. The device has a 14A switching current capability and is capable of providing an output voltage of up to 16.8V.

The TD1218 implements a programmable soft-start function and an adjustable switching peak current limit. The TD1218 also supports two different tr/tf to accommodate different EMI and efficiency needs. In addition, the device provides 18V output overvoltage protection, and thermal shutdown protection.

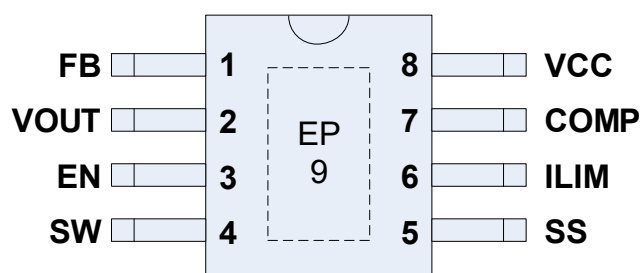
Features

- Input voltage range: 2.7V-16V
- Output Voltage Range: Up to 16.8V
- Fixed switching frequency: 360KHz
- Programmable peak current: 14A max
- High Efficiency
- Low shutdown power consumption with a shutdown current of 1uA
- Supports two tr/tf modes to meet EMI challenges
- Programmable soft start
- Output overvoltage (18V), thermal shutdown, and other protections
- ESOP8 package

Applications:

- Wireless speaker
- Portable speakers
- Power bank
- Chargers
- USB Type-C Power Delivery
- Trolley speaker
- Tablets, laptops
- POS Terminals

Pin Configuration



(Top View)

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Pin function description

Pin number	Pin Name	Description
1	FB	Feedback Input. Setting output voltage through the external resistor divider.
2	VOUT	Power supply.
3	EN	Enable input, Logic high level enables the device. Logic low level disables the device and turns it into shutdown mode.
4	SW	Switching output node.
5	SS/EMI	Soft-start programming pin, connect a capacitor C _{ss} to ground sets the ramp rate. 100nF recommended. Also used as mode setting for different tr/tf, an external 330K resistor connected to ground sets a flatter tr/tf
6	ILIM	Switch peak current setting pin. An external resistor connected between this pin and the GND pin.
7	COMP	Loop compensation network pin.
8	VCC	Output of internal regulator, 1uF capacitor is required between this pin and ground.
EP (9)	GND	Thermal PAD. For proper electrical operation, this ground pad must be connected to the system ground.

Ordering Information

	TD1218	□	□	
Circuit Type	_____	_____	_____	Packing :
Package	_____	_____	_____	Blank: Tube
M: ESOP-8				R: Tape and Reel

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Absolute Maximum Ratings (Note 1)

Parameter		Symbol	Min.	Max.	Unit
Voltage range	V _{OUT}	/	-0.3	18	V
	SW		-0.3	22	
	EN, VCC, COMP		-0.3	7	
	FB		-0.3	3.6	
Operating ambient temperature range		T _A	-40	85	°C
Operating junction temperature range		T _J	-40	150	°C
Storage temperature range		T _{STG}	-50	150	°C

Note 1: 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 under "recommended operating conditions" is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Recommended Operating Conditions

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Supply voltage range	V _{OUT}		2.7		16.8	V
Operating ambient temperature	T _A		-40	25	85	°C
Operating junction temperature	T _J		-40		125	°C

Electrical characteristic parameters

T_A = +25°C, VIN = 2.7V-13.2V, V_{OUT}=4.5-13.2V, unless otherwise noted

Power supply part

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Power supply range	V _{OUT}		2.7		16.8	V
Undervoltage Lockout (UVLO) Threshold	V _{UVLO}	Rising		2.7		V
		Falling		2.5		V
Quiescent current	I _Q	V _{FB} = 1.3V, No switching		0.3		mA
Shutdown current	I _{SD}	Chip disabled, no load, no feedback		1		uA
VCC output	VCC	VIN = 3.6V, VOUT = 12V, light load		5.4		V
		VIN = 3.6V, VOUT = 12V, I _{LOAD} = 0.5A		5.2		V
FB pin reference voltage	V _{REF}			1.204		V
Outputs overvoltage protection	V _{OV} P			18		V
Soft-start charging current	I _{SS}			5		uA

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EN Input

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
EN pin threshold voltage high	V_{ENH}		1.5			V
EN pin threshold voltage low	V_{ENL}				0.4	V
EN internal Pull-down Resistor	R_{EN}			800		K Ω

Power Switch

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
MOSFETs on-resistance	$R_{DS(on)}$	Including wire bond		20		m Ω
Operating Frequency	F_{osc}			360		KHz

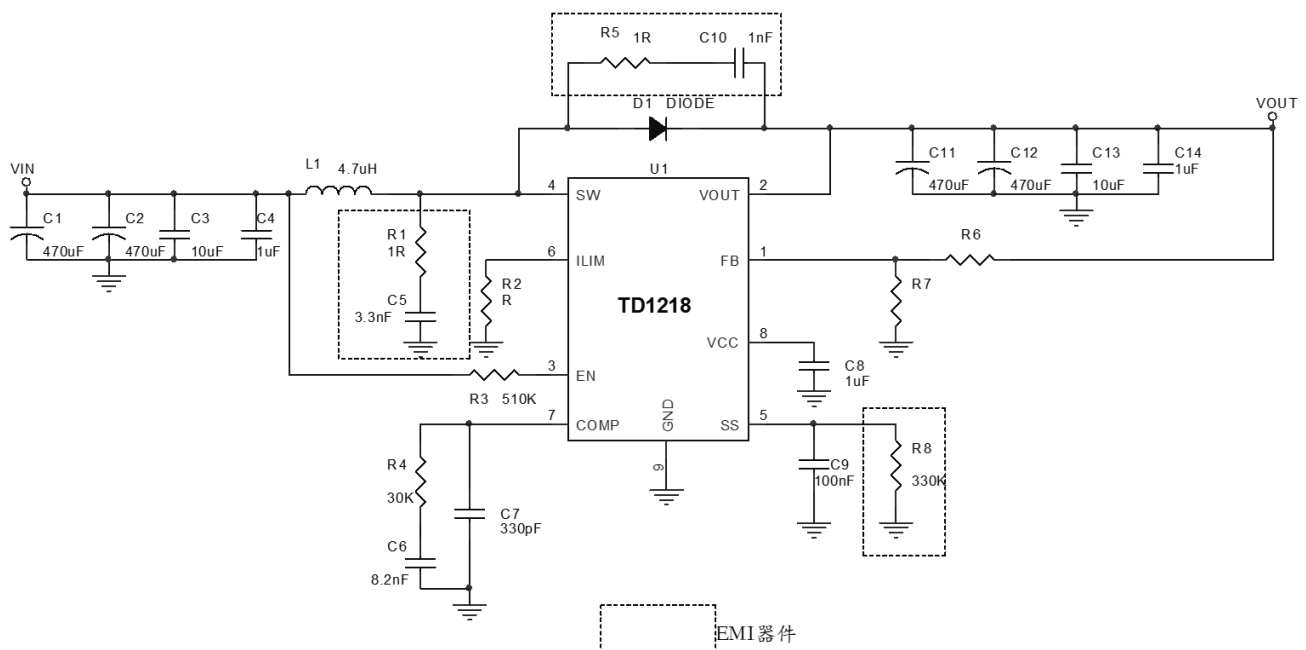
Current Limit

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Peak switch current limit	I_{LIM}				14	A

Thermal Shutdown

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Thermal shutdown threshold	T_{SD}			150		$^{\circ}\text{C}$
Thermal shutdown threshold hysteresis	T_{SD_HYS}			20		$^{\circ}\text{C}$

Typical Application Circuit



Application Information

The TD1218 is a high-power asynchronous boost converter with an integrated 20mΩ power switch to provide a high efficient and small size solution for portable systems. The switching frequency is 360KHz. The TD1218 operates in PWM mode under heavy load and in PFM mode at light load to improve efficiency.

Enable, Start-up, and tr/tf (EN and SS/EMI pin)

The TD1218 has an adjustable soft-start function to prevent high inrush current during start-up, which is achieved through SS/EMI pin with an external capacitor (C_{SS}), the larger the C_{SS} , the longer the soft-start time, and the slower the output voltage start-up. The capacitance of 100nF is usually sufficient for most applications.

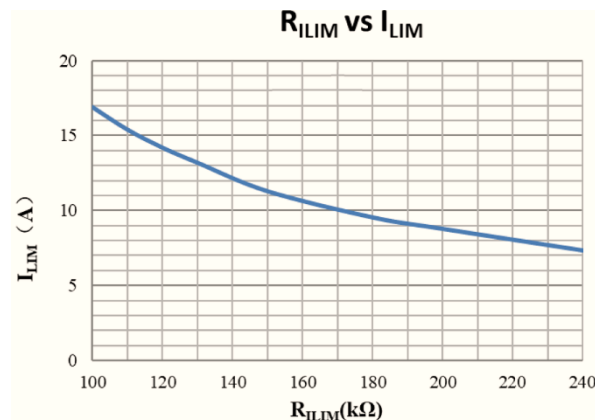
The TD1218 has two modes with different tr/tf. With a single capacitor(C_{SS}) connected between SS/EMI pin and GND, the mode with steep tr/tf will be selected, TD1218 operates with a higher efficiency and poorer EMI performance. However, if a capacitor(C_{SS}) paralleled with a resistor 330K is placed between SS/EMI pin and GND, The mode with flatter tr/tf is selected, TD1218 operates with a lower efficiency and better EMI performance.

When the EN pin is pulled low(Typ.0.4V), the TD1218 goes into shutdown mode and stops switching. When EN pin is pulled high level(above 1.5V), the TD1218 works.

Adjustable Peak Current Limit (ILIM pin)

To avoid possible sudden spikes in high current, the TD1218 has built-in cycle-by-cycle overcurrent limiting protection. Once the switching current reaches the set peak current limit, the low-side switch is turned off immediately to prevent damage to the chip from high current.

The peak current limit can be set via the ILIM pin-attached resistor (R_{ILIM}), as shown in the figure below. The peak current limit should be set lower than 14A.



Peak Current Limit (I_{LIM}) vs. R_{ILIM}

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Output Voltage Setting (FB pin)

The output voltage V_{OUT} can be set by the R_{UP} , R_{DN} resistor at the FB pin:

$$V_{OUT} = V_{REF} \times \left(1 + \frac{R_{UP}}{R_{DN}}\right)$$

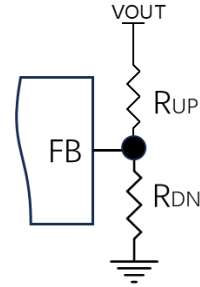


Figure 1

where $V_{REF} = 1.204V$.

Some typical output voltages can be set as the following parameters

Table 1 Output Voltage Setting

$V_{OUT}(V)$	$R_{UP}(\Omega)$	$R_{DN}(\Omega)$
9.4	510k	75k
12.2	510k	56k
15.5	510k	43k

Under-voltage Lockout (UVLO).

The undervoltage lockout circuit prevents device failure at low input voltage and the battery over-discharge. This feature is available on both the VIN and VCC sides of the TD1218. When the voltage falls below the UVLO threshold (2.5V typ.), the device will shut-down. When the rising voltage at the VOUT pin is above the V_{UVLO} (2.7V typ.), the device starts operating.

Over-voltage Protection

If the output voltage at the V_{OUT} pin is detected above 18V (typ.), the TD1218 stops switching immediately until the voltage at the V_{OUT} drops the hysteresis value lower than the output overvoltage protection threshold.

Thermal Protection

When the internal junction temperature of the device is higher than 150°C (typ.), the over-temperature shutdown protection is triggered, the device stops switching until the internal junction temperature falls below 130°C (typ.), then the device starts switching again.

Inductor Selection

The choice of inductor directly affects the stability of the power supply, transient performance, loop stability, and boost conversion efficiency. Therefore, the inductor is the most important component in SMPS regulator design. Three most important parameters to the performance of the inductor are the inductor value, saturation current, and DC resistance.

To be simplified, the inductor value can be set as 4.7uH which can be used in most cases.

The rated current, especially the saturation current should be larger than the peak current during the whole operation. The peak current can be calculated as follows:

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$$I_{Lpeak} = I_{DC} + \frac{I_{PP}}{2}$$

$$I_{DC} = \frac{V_{OUT} \times I_{OUT}}{V_{IN} \times \eta}$$

$$I_{PP} = \frac{1}{L \times \left(\frac{1}{V_{OUT} - V_{IN}} + \frac{1}{V_{IN}} \right) \times f_{SW}}$$

The boost conversion efficiency is affected significantly by the inductor's DC resistance(DCR), equivalent series resistance(ESR) at the switching frequency, and the core loss. So choosing an inductor with lower DCR and ESR would increase the efficiency greatly.

In addition, the inductor should be placed as close as possible to the SW pin. For a lower EMI radiation, connecting an RC series circuit to the ground at the SW pin would be helpful. R = 1Ω, C = 3.3nF (it is recommended to use a package not more than 1206) would be recommended in most cases.

Output Capacitor Selection (C_{OUT}).

To achieve good filtering and reduce supply ripple, general, low-ESR 1uF//10uF//10uF//470uF are placed as close as possible to the Schottky diode.

It should be noted that the capacitor has a serious loss of capacitance value at the rated voltage, so the rated voltage of the capacitor should have a margin, which is greater than the maximum output voltage.

In detailed, minimum required capacitance values should meet the following conditions:

$$V_{ripple_dis} = \frac{(V_{OUT} - V_{IN_MIN}) \times I_{OUT}}{V_{OUT} \times f_{SW} \times C_{OUT}}$$

$$V_{ripple_ESR} = I_{Lpeak} \times R_{C_ESR}$$

Where:

- V_{ripple_dis} is the output voltage ripple caused by the charging and discharging of the output capacitor.
- V_{ripple_ESR} is the output voltage ripple caused by the output capacitor ESR.
- V_{IN_MIN} is the minimum input voltage.
- V_{OUT} is the output voltage.
- I_{OUT} is the output current.
- I_{Lpeak} is the peak current of the inductor.
- f_{SW} is the switching frequency.
- R_{C_ESR} is the ESR of the output capacitor

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Diode Selection

Schottky diodes with fast recovery times and low forward voltages are recommended. The average and peak current rating exceed the average output current and the peak inductor current. In addition, the reverse breakdown voltage of the diode should be greater than the output voltage.

Loop Stability (COMP pin)

The COMP pin is the output of the internal error amplifier. An external compensation network comprised of resistor R_C , ceramic capacitor C_C and C_P is connected to the COMP pin.

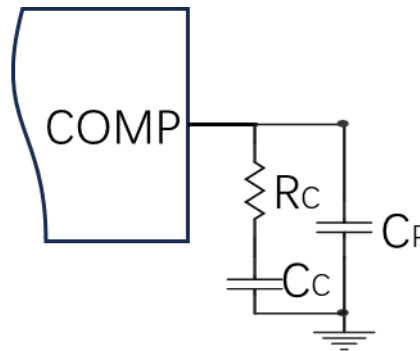


Figure 2

In general, $R_C = 30K\Omega$, $C_C = 8.2nF$, $C_P = 330pF$, which can meet most cases. In detail, the compensation network parameters can be calculated through the following steps:

(1) Set the crossover frequency, f_c

The higher f_c frequency, the faster the loop response, but it cannot be greater than $1/10 f_{sw}$ and $1/5 f_{RHPZ}$, and the value of 10KHz can generally be taken directly .

$$f_{RHPZ} = \frac{R_O \times (1 - D)^2}{2\pi \times L}$$

(2) Set the compensation resistor, R_C .

$$R_C = \frac{2\pi \times V_{OUT} \times R_{sense} \times f_c \times C_O}{(1 - D) \times V_{REF} \times G_{EA}}$$

(3) Set the compensation zero capacitor, C_C .

$$C_C = \frac{R_O \times C_O}{2 \times R_C}$$

(4) Set the compensation pole capacitor, C_P .

$$C_P = \frac{R_{ESR} \times C_O}{R_C}$$

If the C_P is less than 10pF, it can be left open.

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- R_o is the output load.
- D is the duty cycle, $1 - D = V_{IN} / V_{OUT}$.
- R_{sense} is an internal equivalent current sense resistor of 0.084Ω .
- C_o is output capacitor.
- V_{REF} is the reference voltage at the FB pin, which is $1.204V$.
- G_{EA} is the error amplifier transimpedance, which is $190\mu A/V$.
- R_{ESR} is the equivalent series resistance of the output capacitor.

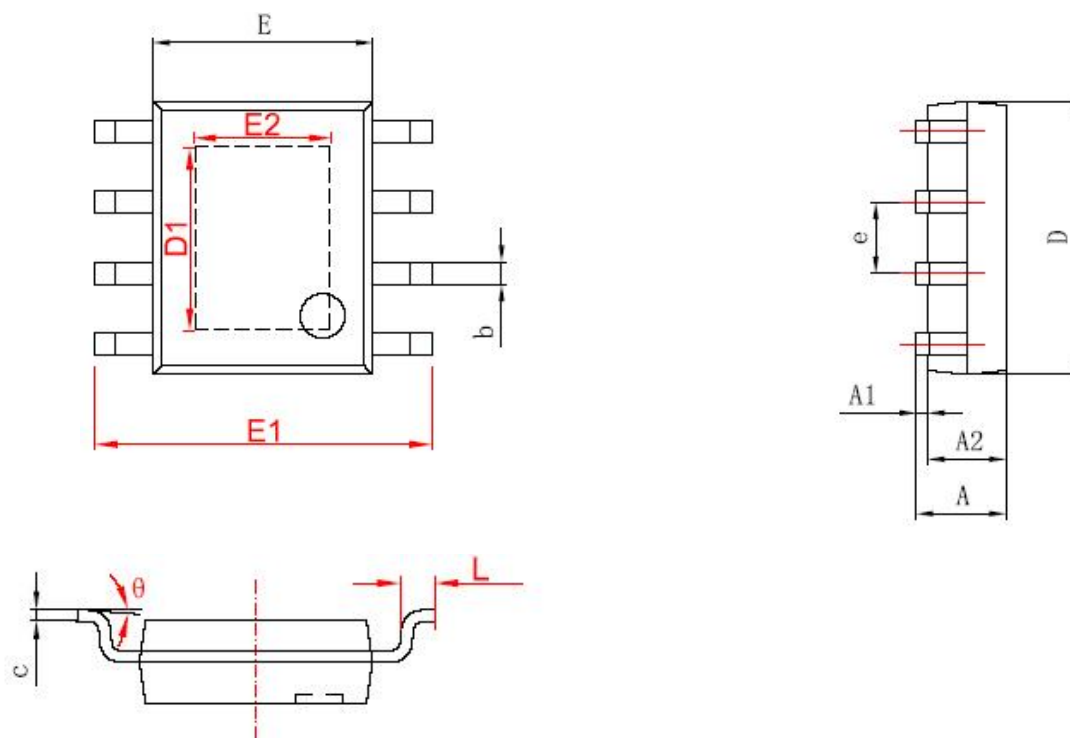
PCB Layout Guidelines

For DC/DC power supplies, especially when operating at high currents and high frequencies, layout is an important design step, and poor layout may affect the system stability.

- Use integral GND ground plane under the chip.
- Minimize the length and area of all traces connected to the SW pin.
- Power traces, including GND, SW, VIN, VOUT, should be as short and thick as possible.
- The input capacitor needs to be closed to inductor L and GND pin in order to reduce the input supply ripple. The output capacitor needs to be close to Diode and GND pin in order to reduce the output supply ripple.
- RUP and RDN are placed as close to the FB pin as possible.
- The layout should also be done with well consideration of the thermal as this is a high-power density device. A thermal pad that improves the thermal capabilities of the package should be soldered to the large ground plate, using thermal vias underneath the thermal pad.

Package Information

ESOP-8 package size



	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.050	0.150	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
D1	3.202	3.402	0.126	0.134
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
E2	2.313	2.513	0.091	0.099
e	1.270 (BSC)		0.050 (BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

Application Notes