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LA5774MP

Monolithic Linear IC

Separately-excited Step-down Switching Regulator (Variable Type)

Overview

The LA5774MP is a Separately-excited step-down switching regulator (variable type).

Functions

- Low-ESR capacitor with increased reliability applicable as the output smoothing capacitor.
- High efficiency.
- Four external parts.
- Time-base generator (160kHz) incorporated.
- Current limiter incorporated.
- Thermal shutdown circuit incorporated.
- Soft start circuit incorporated.

Specifications

Absolute Maximum Ratings at $T_a = 25^\circ\text{C}$

Parameter	Symbol	Conditions	Ratings	Unit
Maximum Input voltage	$V_{IN\ max}$		30	V
Maximum Output current	$I_O\ max$		3	A
SW pin application reverse voltage	V_{SW}		-1	V
Allowable power dissipation	$P_d\ max$	Mounted on a substrate.*	3.9	W
Operating temperature	T_{opr}		-30 to +125	$^\circ\text{C}$
Storage temperature	T_{stg}		-40 to +150	$^\circ\text{C}$

* Specified substrate : $76.1 \times 114.3 \times 1.6\text{mm}^3$: Copper foil ratio 60% FR4

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

Recommended Operating Conditions at $T_a = 25^\circ\text{C}$

Parameter	Symbol	Conditions	Ratings	Unit
Input voltage range	V_{IN}		4.5 to 28	V

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Electrical Characteristics at $T_a = 25^\circ\text{C}$, $V_O = 3.3\text{V}$

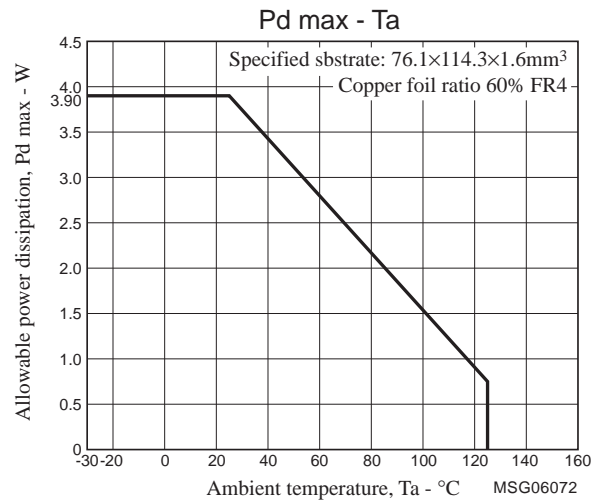
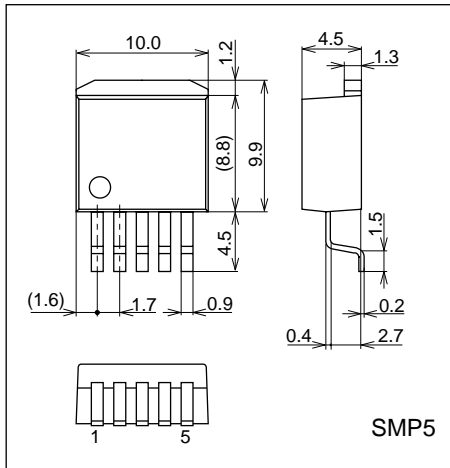
Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Reference voltage	V_{OS}	$V_{IN} = 15\text{V}$, $I_O = 1.0\text{A}$	1.235	1.26	1.285	V
Efficiency	η	$V_{IN} = 15\text{V}$, $I_O = 1.0\text{A}$		78		%
Switching frequency	f	$V_{IN} = 15\text{V}$, $I_O = 1.0\text{A}$	128	160	192	kHz
Line regulation	$\Delta V_{O\text{LINE}}$	$V_{IN} = 8$ to 20V , $I_O = 1\text{A}$		40	100	mV
Load regulation	$\Delta V_{O\text{LOAD}}$	$V_{IN} = 15\text{V}$, $I_O = 0.5$ to 1.5A		10	30	mV
Output voltage temperature coefficient	$\Delta V_O/\Delta T_a$	Designed target value. *		± 0.5		mV/ $^\circ\text{C}$
Ripple attenuation factor	RREJ	$f = 100$ to 120Hz		45		dB
Current limiter operating voltage	I_S	$V_{IN} = 15\text{V}$	3.1			A
Thermal shutdown operating temperature	TSD	Designed target value. *		165		$^\circ\text{C}$
Thermal shutdown Hysteresis width	ΔTSD	Designed target value. *		15		$^\circ\text{C}$

* Design target value: No measurement made.

Package Dimensions

unit : mm (typ)

3275

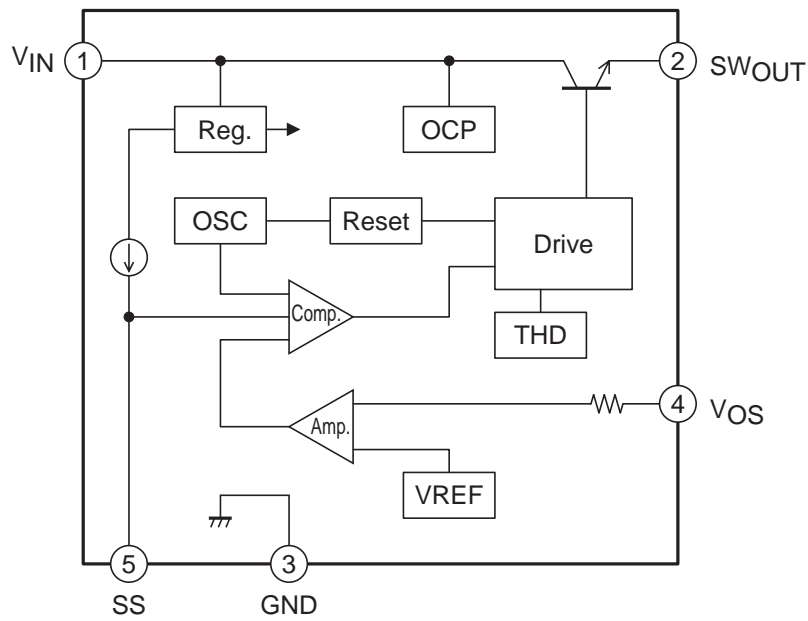


Pin Assignment

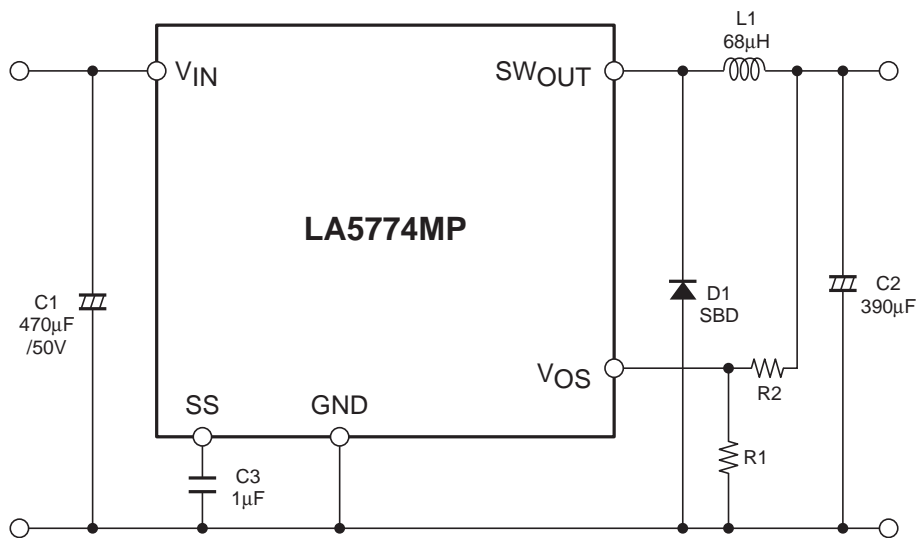
(1) V_{IN} (2) SW_{OUT} (3) GND (4) V_{OS} (5) SS

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Block Diagram



Application Circuit Example



Notes: $C3$ is for the soft start function. Delete $C3$ and keep the SS pin open when the soft start function is not necessary.

Description of Functional Settings

1. Calculation equation to set the output voltage

This IC controls the switching output so that the V_{OS} pin voltage becomes 1.26V (typ).

The equation to set the output voltage is as follows:

$$V_O = \left(1 + \frac{R_2}{R_1}\right) \times 1.26V(\text{typ})$$

The V_{OS} pin has the inrush current of 1μA (typ). Therefore, the error becomes larger when R₁ and R₂ resistance values are large.

2. Start delay function

The SS pin has the internally-connected 22μA (typ) constant-current supply. When the voltage of SS pin exceeds the threshold voltage, the regulator starts operation. As the threshold voltage is 0.62V (typ), the start delay time can be calculated as follows:

ex. For setting at 1μF

$$Td = \frac{C \times V}{i} = \frac{1\mu F \times 0.62}{22\mu A} = 28.2 \text{ ms}$$

3. Soft start function

The internal PWM waveform has the voltage value as shown in the right.

If down-conversion from the voltage of V_{IN} = 15 V to V_{IN} = 3.3V is to be made, for example, the PWM-ON duty has the value as shown below.



$$PWMduty = \frac{V_{OUT}}{V_{IN} - V_{sat} + V_F} = 23 \%$$

(Note that calculation is made with V_{sat} = 1V and V_F = 0.2V)

The output voltage of error amplifier, which is 3.3 V, is the value with PWM = 23%, as calculated in the above equation, so that this voltage is determined as follows:

$$V_{er} = (\Delta VPWM) \times PWMduty + VPWML = 0.88V \times 0.23 + 0.62V = 0.82V$$

(ΔVPWM is the PWM amplitude value or 0.88V(typ) while VPWML is the lower limit voltage of PWM waveform or 0.62V(typ))

SS pin and error amplifier output voltages are designed to prefer the lower voltages, so that V_{OUT} will reach the designed regulation voltage in timing when the SS pin voltage exceeds the error amplifier output.

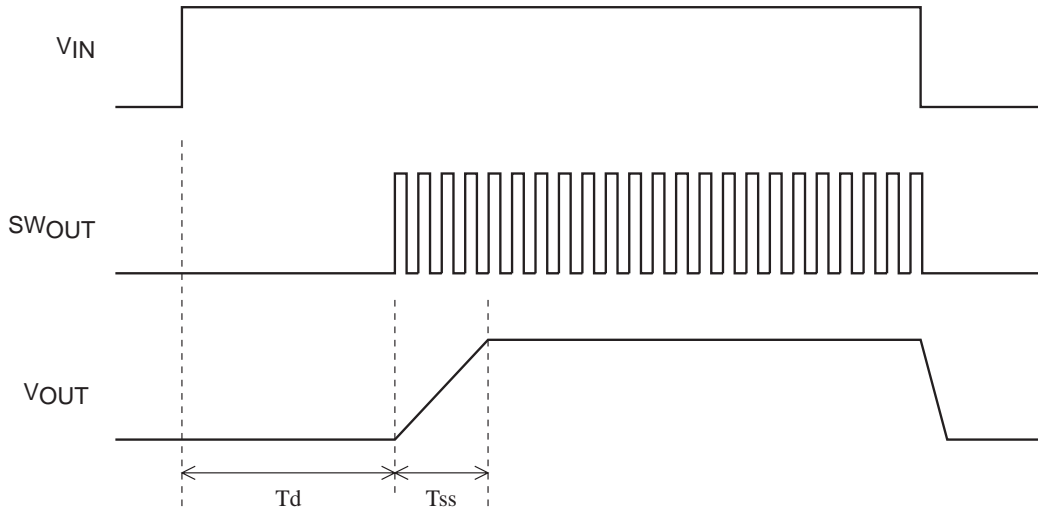
Therefore, the soft start time is calculated as follows:

$$T_{ss} = \frac{C \times \Delta VPWM \times PWMduty}{i} = \frac{C \times 0.88 \times PWMduty}{22\mu A}$$

For the set conditions of C = 1μF and PWMduty = 23%:

$$T_{ss} = \frac{1\mu F \times 0.88V \times 0.23}{22\mu A} = 9.2ms$$

Timing Chart



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