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# LA5757TP

Monolithic Linear IC

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

### Overview

The LA5757TP is a separately-excited step-down switching regulator (variable type).

### Features

- Output smoothing condenser can use a Low ESR condenser for the reliability improvement
- High efficiency
- Four external parts
- Time-base generator (300kHz) incorporated
- Current limiter incorporated
- Thermal shutdown circuit incorporated
- Soft start circuit incorporated

### Specifications

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

Parameter	Symbol	Conditions	Ratings	Unit
Input voltage	$V_{IN\ max}$		34	V
Output current	$I_O\ max$		1.5	A
SW pin application reverse	$V_{SW}$		-1	V
Allowable power dissipation	$P_d\ max$	Mounted on a specified board*	1.1	W
Operating temperature	$T_{opr}$		-30 to +125	$^\circ\text{C}$
Storage temperature	$T_{stg}$		-40 to +150	$^\circ\text{C}$

\* Specified board: 114.3mm × 76.1mm × 1.6mm, glass epoxy board.

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 32	V

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## Electrical Characteristics at $T_a = 25^\circ\text{C}$ , $V_O = 5\text{V}$

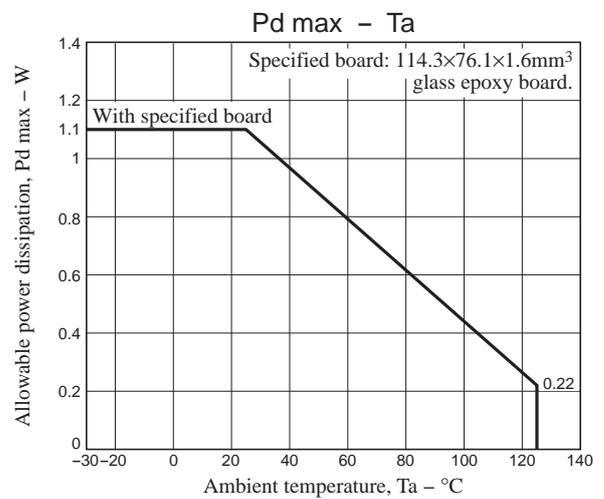
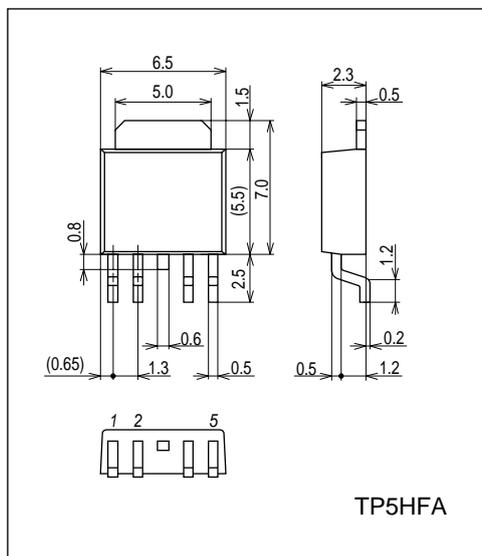
Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Reference voltage	$V_{OS}$		1.230	1.255	1.280	V
Efficiency	$\eta$			83		%
Switching frequency	$f$	$V_{IN} = 15\text{V}$ , $I_O = 1.0\text{A}$	240	300	360	kHz
Line regulation	$\Delta V_{O\text{LINE}}$	$V_{IN} = 8 \text{ to } 20\text{V}$ , $I_O = 1.0\text{A}$		40	100	mV
Load regulation	$\Delta V_{O\text{LOAD}}$	$V_{IN} = 15\text{V}$ , $I_O = 0.5 \text{ to } 1.5\text{A}$		10	30	mV
Output voltage temperature coefficient	$\Delta V_O/\Delta T_a$	Designed target value*		$\pm 0.5$		$\text{mV}/^\circ\text{C}$
Ripple attenuation factor	RREJ	$f = 100 \text{ to } 120\text{Hz}$		45		dB
Current limiter operating voltage	$I_S$	$V_{IN} = 15\text{V}$	1.6			A
Thermal shutdown operating temperature	TSD	Designed target value*		165		$^\circ\text{C}$
Thermal shutdown hysteresis width	$\Delta TSD$	Designed target value*		15		$^\circ\text{C}$

\* Designed target value: No measurement made.

## Package Dimensions

unit : mm (typ)

3332

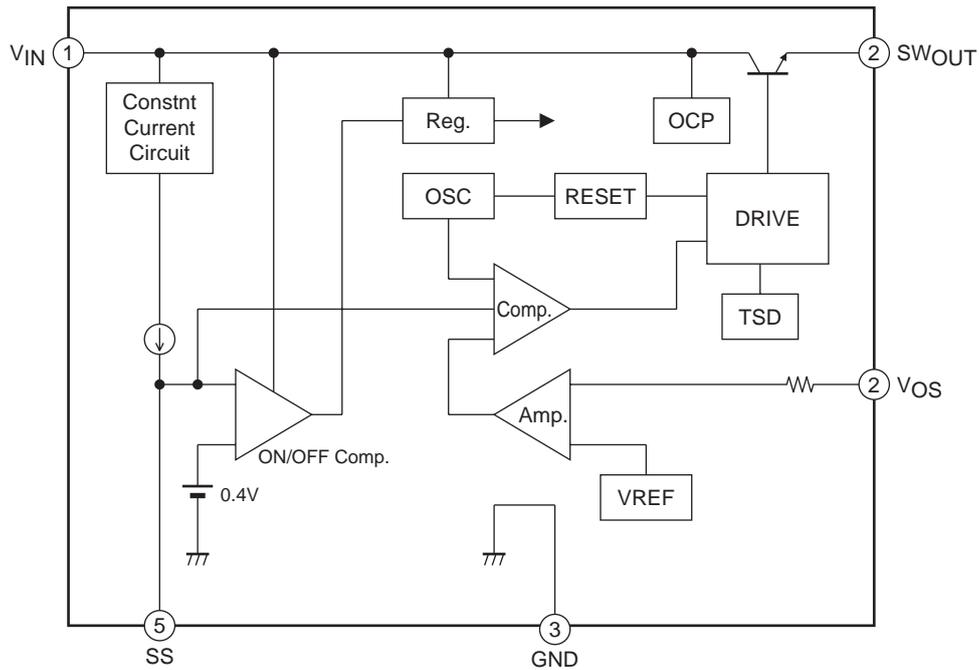


## Pin Assignment

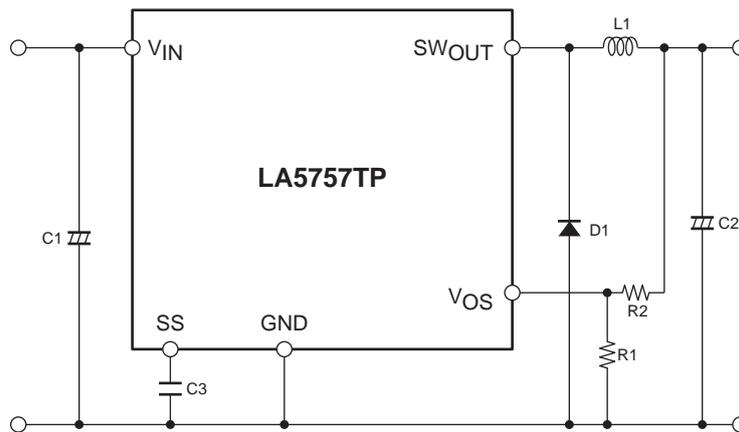
(1) $V_{IN}$  (2) $SW_{OUT}$  (3)GND (4) $V_{OS}$  (5)SS

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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 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 VOS pin voltage becomes 1.255V (typ).

The equation to set the output voltage is as follows:

$$V_O = \left(1 + \frac{R_2}{R_1}\right) \times 1.255V(\text{typ})$$

The VOS 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

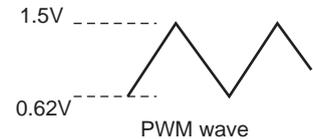
The SS pin has the internally-connected 10μA (typ) constant-current supply. When the voltage of SS pin exceeds the threshold voltage, the regulator starts operation. As the threshold is 0.62V(typ), the start delay time can be calculated as follows:

ex. For setting at 1μF

$$T_d = \frac{C \times V}{i} = \frac{1\mu \times 0.62}{22\mu} = 28.2 \text{ msec}$$

## 3. Soft start function

The internal PWM waveform has the voltage value as shown in the right. If down-conversion from the voltage of  $V_{IN} = 15V$  to 3.3V output to be made, for example, the PWM-ON duty has the value as shown below.



$$PWMduty = \frac{V_{OUT} + V_F}{V_{IN} - V_{sat} + V_F} = 25\%$$

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

The output voltage of error amplifier, which is 3.3V, is the value with PWM = 25%, as calculated in the above equation, so that this voltage is determined as follows:

$$V_{er} = (\Delta VPWM) \times PWMduty + VPWML = 0.88V \times 0.25 + 0.62V = 0.84V$$

( $\Delta VPWM$  is the PWM amplitude value or 0.88V(typ) while  $VPWML$  is the lower limit voltage of PWM waveform or 0.62V(typ))

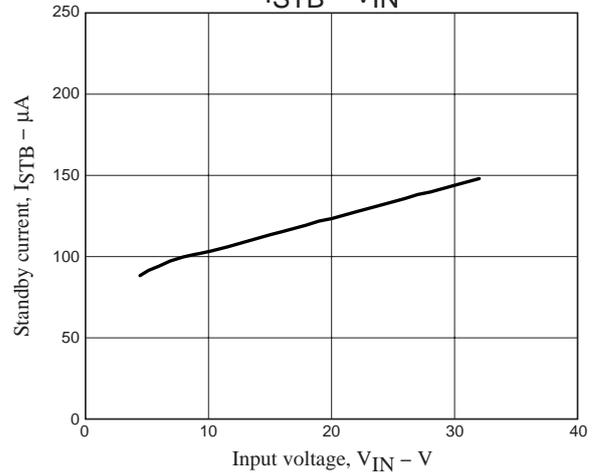
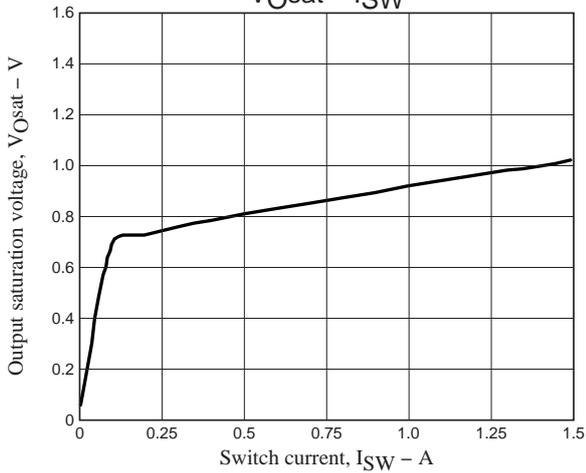
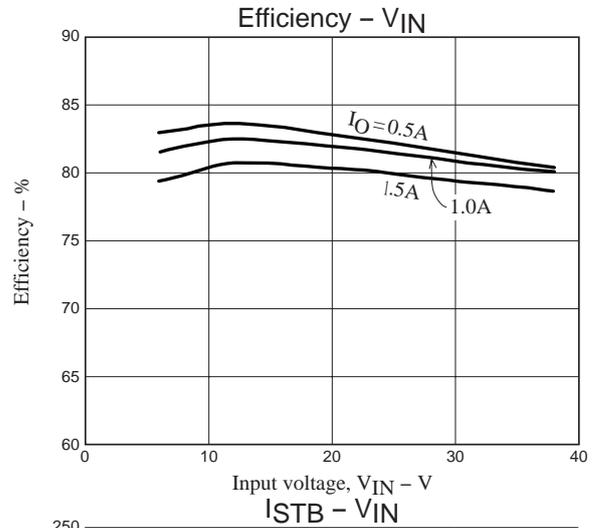
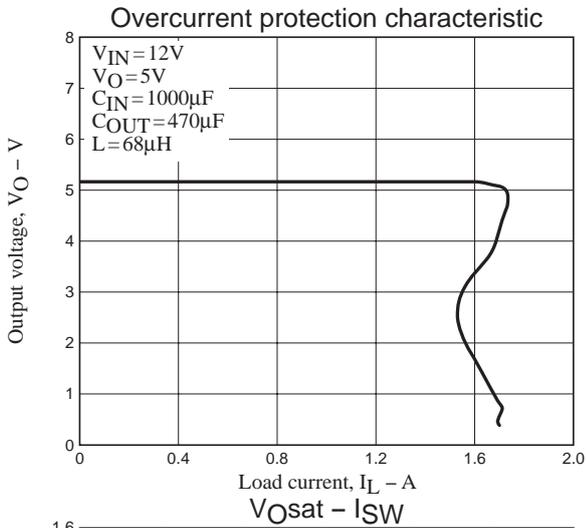
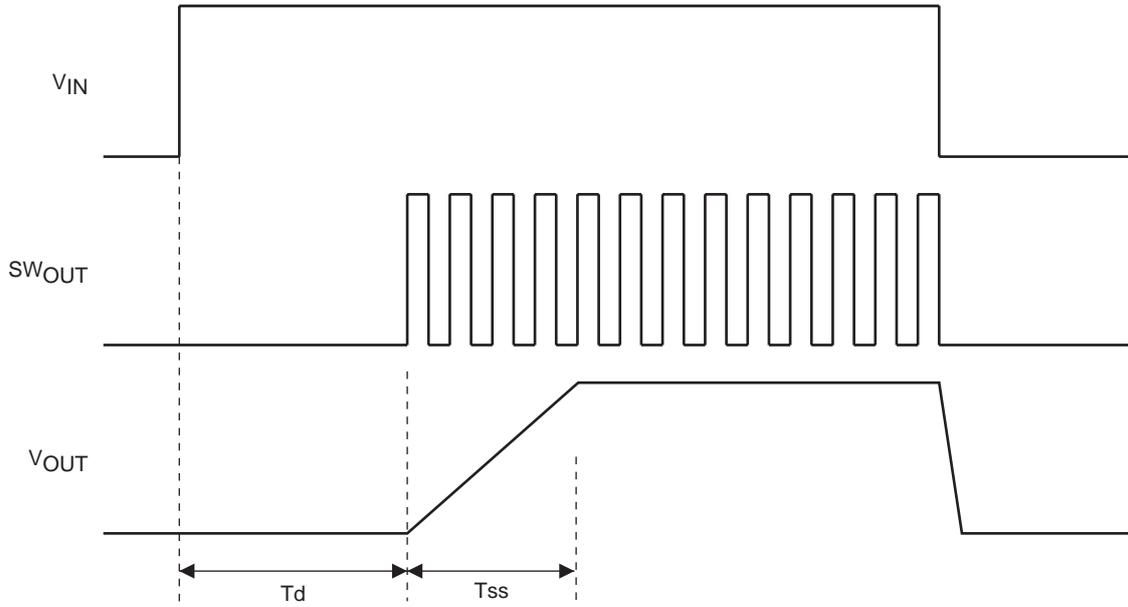
SS pin and error amplifier output voltages are designed to prefer the lower voltages, so that  $V_{OUT}$  will reach the designed regulation voltage in timing when the SS pin voltage exceeds the error amplifier output. Therefore, the soft start time is calculated as follows:

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

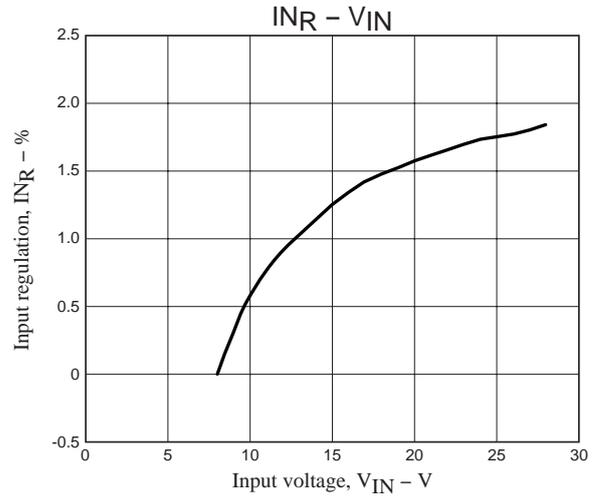
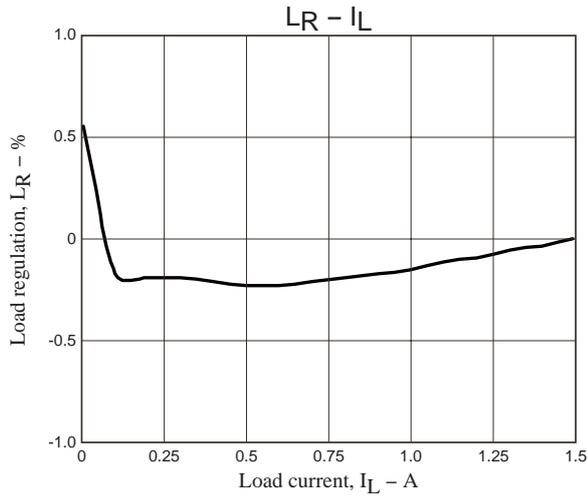
For the set conditions of  $C = 1\mu F$  and  $PWMduty = 25\%$ :

$$T_{ss} = \frac{1\mu \times 0.88V \times 0.25}{22\mu A} = 10msec$$

Timing Chart



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