



LA5774

Monolithic Linear IC Separately-excited Step-down Switching Regulator (Variable Type)

Overview

The LA5774 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 | $P_d\ max1$ | No heat sink | 1.75 | W |
| | $P_d\ max2$ | Infinite heat sink | 7.5 | W |
| Operating temperature | T_{opr} | | -30 to +125 | $^\circ\text{C}$ |
| Storage temperature | T_{stg} | | -40 to +150 | $^\circ\text{C}$ |

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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LA5774

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

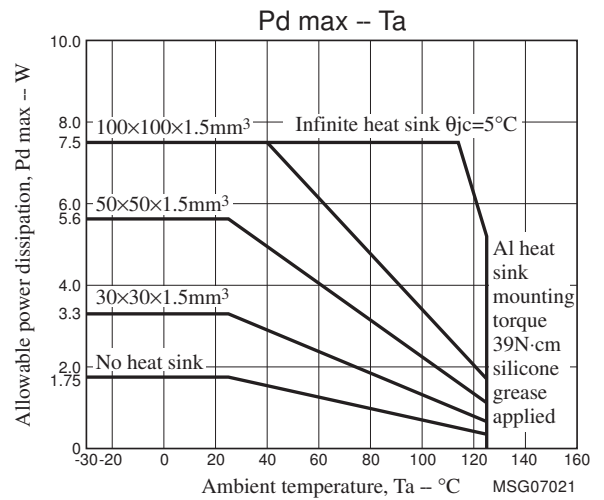
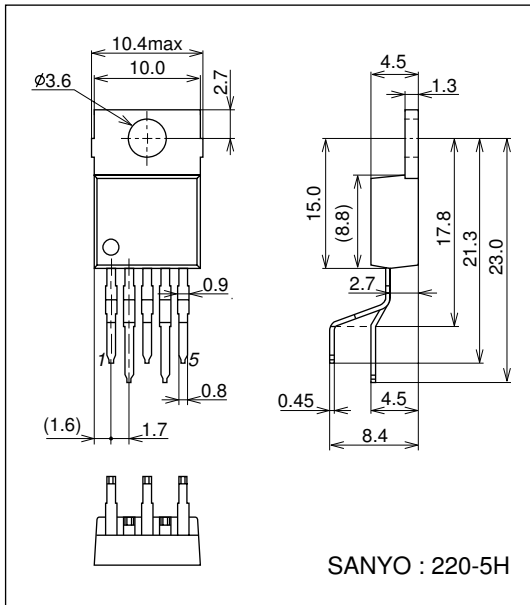
| Parameter | Symbol | Conditions | Ratings | | | Unit |
|--|---------------------------|--|---------|-----------|-------|----------------------|
| | | | min | typ | max | |
| Reference voltage | V_{OS} | $V_{IN} = 15\text{V}$, $I_O = 1.0\text{A}$ | 1.235 | 1.26 | 1.285 | V |
| Efficiency | η | $V_{IN} = 15\text{V}$, $I_O = 1.0\text{A}$ | | 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)

3079C

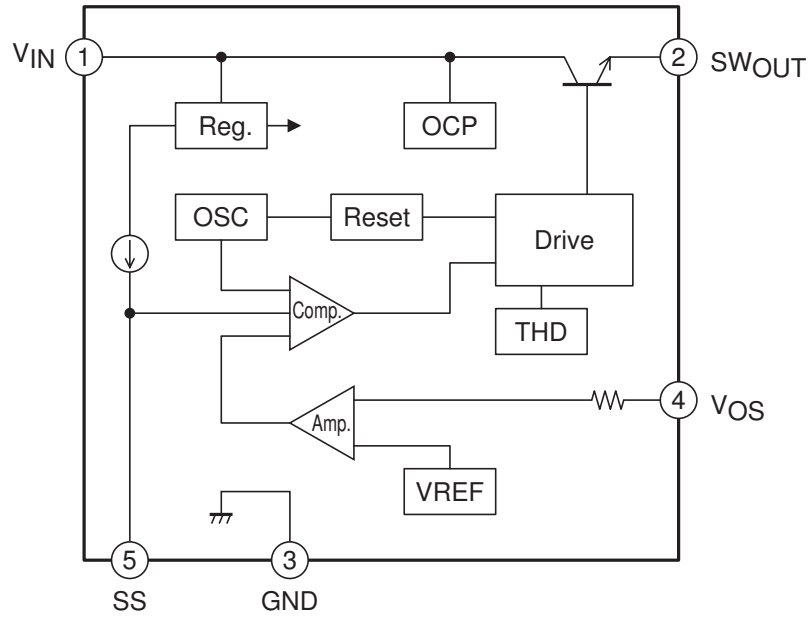


Pin Assignment

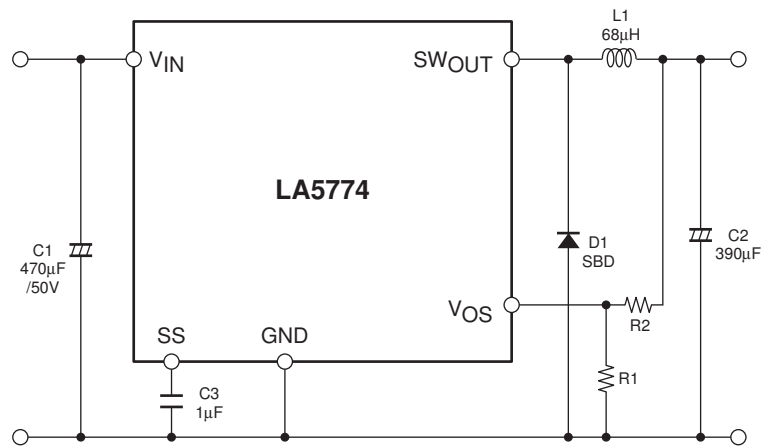
(1) V_{IN} (2) SW_{OUT} (3) GND (4) V_{OS} (5) SS

LA5774

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

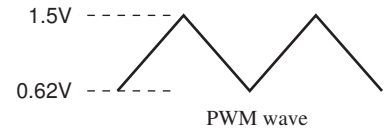
The SS pin has the internally-connected 22μA (typ) constant-current supply. When the voltage of SS pin exceeds the threshold voltage, the regulator starts operation. As the threshold voltage is 0.62V (typ), the start delay time can be calculated as follows:

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.

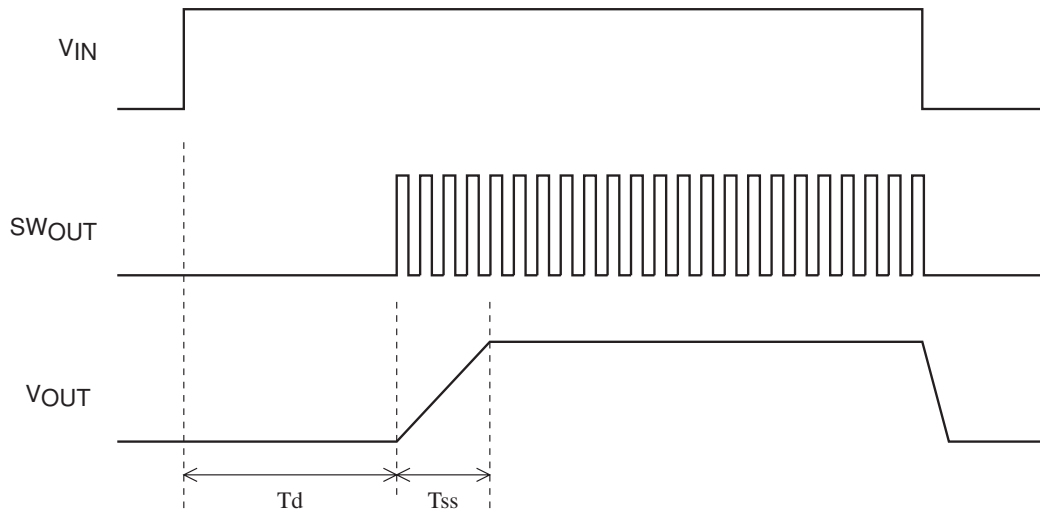
Therefore, the soft start time is calculated as follows:

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

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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