



SANYO Semiconductors

DATA SHEET

An ON Semiconductor Company

LA5724MC

Monolithic Linear IC Separately-Excited Step-Down Switching Regulator (Variable Type)

Overview

The LA5724MC is a separately-excited step-down switching regulator (variable type).

Functions

- Time-base generator (160kHz) incorporated.
- Current limiter incorporated.
- Thermal shutdown circuit incorporated.

Specifications

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

| Parameter | Symbol | Conditions | Ratings | Unit |
|------------------------------------|-------------------|------------------------------|-------------|------------------|
| Input voltage | V_{IN} | | 30 | V |
| SW pin application reverse voltage | V_{SW} | | -1 | V |
| VOS pin application voltage | V_{VOS} | | -0.2 to 7 | V |
| Allowable power dissipation | $P_d \text{ max}$ | Mounted on a circuit board.* | 0.8 | W |
| Operating temperature | T_{opr} | | -30 to +125 | $^\circ\text{C}$ |
| Storage temperature | T_{stg} | | -40 to +150 | $^\circ\text{C}$ |
| Junction temperature | $T_j \text{ max}$ | | 150 | $^\circ\text{C}$ |

* Specified circuit board : 114.3×76.1×1.6mm³, glass epoxy board.

Caution 1) Absolute maximum ratings represent the value which cannot be exceeded for any length of time.

Caution 2) Even when the device is used within the range of absolute maximum ratings, as a result of continuous usage under high temperature, high current, high voltage, or drastic temperature change, the reliability of the IC may be degraded. Please contact us for the further details.

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 |

■ Any and all SANYO Semiconductor Co.,Ltd. products described or contained herein are, with regard to "standard application", intended for the use as general electronics equipment. The products mentioned herein shall not be intended for use for any "special application" (medical equipment whose purpose is to sustain life, aerospace instrument, nuclear control device, burning appliances, transportation machine, traffic signal system, safety equipment etc.) that shall require extremely high level of reliability and can directly threaten human lives in case of failure or malfunction of the product or may cause harm to human bodies, nor shall they grant any guarantee thereof. If you should intend to use our products for new introduction or other application different from current conditions on the usage of automotive device, communication device, office equipment, industrial equipment etc. , please consult with us about usage condition (temperature, operation time etc.) prior to the intended use. If there is no consultation or inquiry before the intended use, our customer shall be solely responsible for the use.

■ Specifications of any and all SANYO Semiconductor Co.,Ltd. products described or contained herein stipulate the performance, characteristics, and functions of the described products in the independent state, and are not guarantees of the performance, characteristics, and functions of the described products as mounted in the customer's products or equipment. To verify symptoms and states that cannot be evaluated in an independent device, the customer should always evaluate and test devices mounted in the customer's products or equipment.

LA5724MC

Electrical Characteristics at $T_a = 25^\circ\text{C}$, $V_{IN} = 15\text{V}$

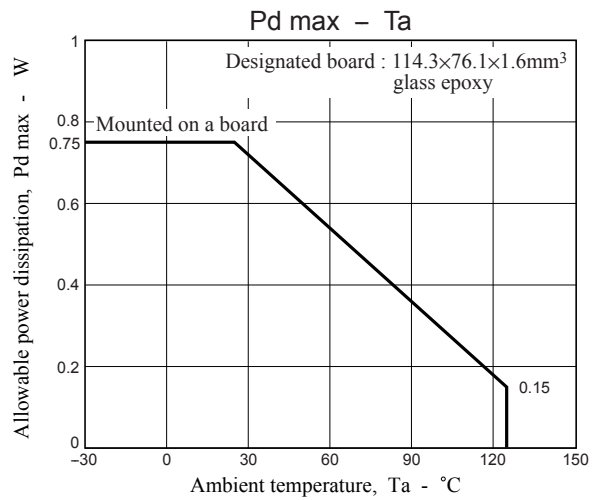
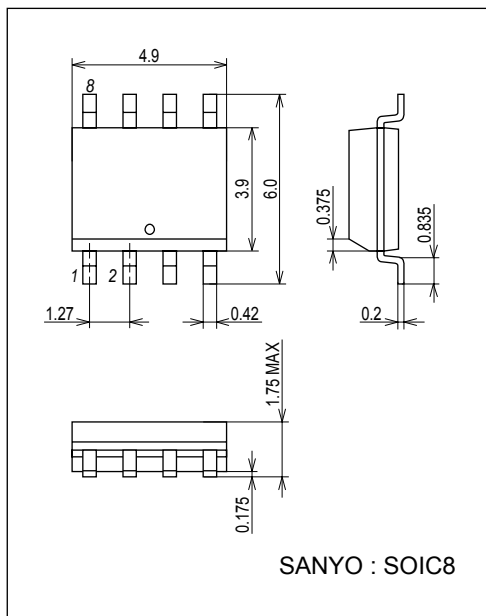
| Parameter | Symbol | Conditions | Ratings | | | Unit |
|--|--------------------|--|---------|------|------|------------------|
| | | | min | typ | max | |
| Reference voltage | V_{OS} | $I_O = 0.3\text{A}$ | 1.20 | 1.23 | 1.26 | V |
| Reference pin bias current | I_{FB} | | | 1 | 2 | μA |
| Switching frequency | fosc | | 128 | 160 | 192 | kHz |
| Efficiency | η | $V_{OUT} = 5\text{V}$, $I_O = 0.3\text{A}$ | | 82 | | % |
| Short-circuit protection circuit operating switching frequency | fscp | | | 30 | | kHz |
| Saturation voltage | Vsat | $I_{OUT} = 0.3\text{A}$, $V_{OS} = 0\text{V}$ | | 1.2 | | V |
| Maximum on duty | D max | $V_{OS} = 0\text{V}$ | | 100 | | % |
| Minimum on duty | D min | $V_{OS} = 5\text{V}$ | | 0 | | % |
| Output leakage current | Ilk | $SW_{OUT} = -1\text{V}$ | | | 200 | μA |
| Supply current | I_{in} | $V_{OS} = 2\text{V}$ | | 5 | 10 | mA |
| Current limiter operating current | I_S | | 0.7 | | | 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

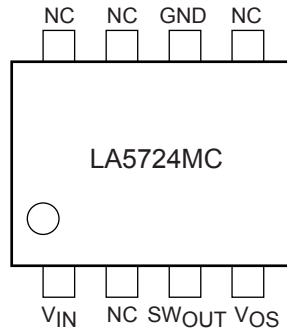
unit : mm (typ)

3424

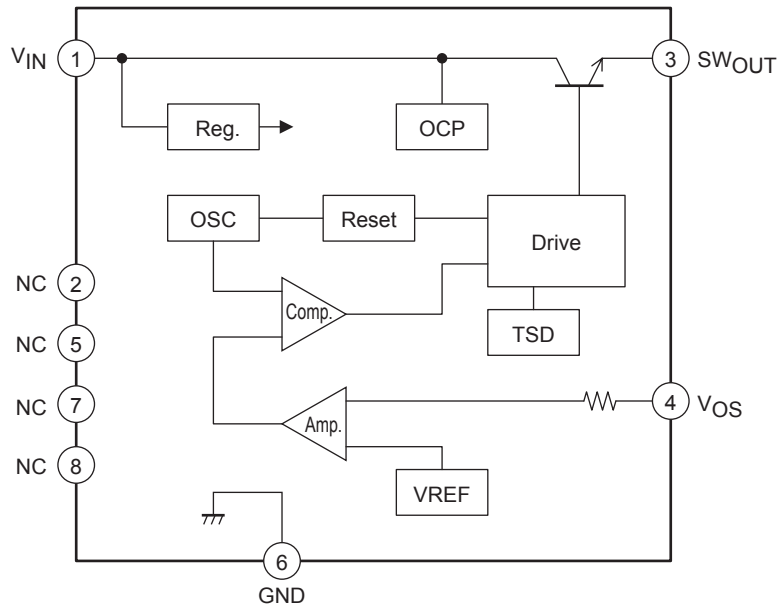


LA5724MC

Pin Assignment

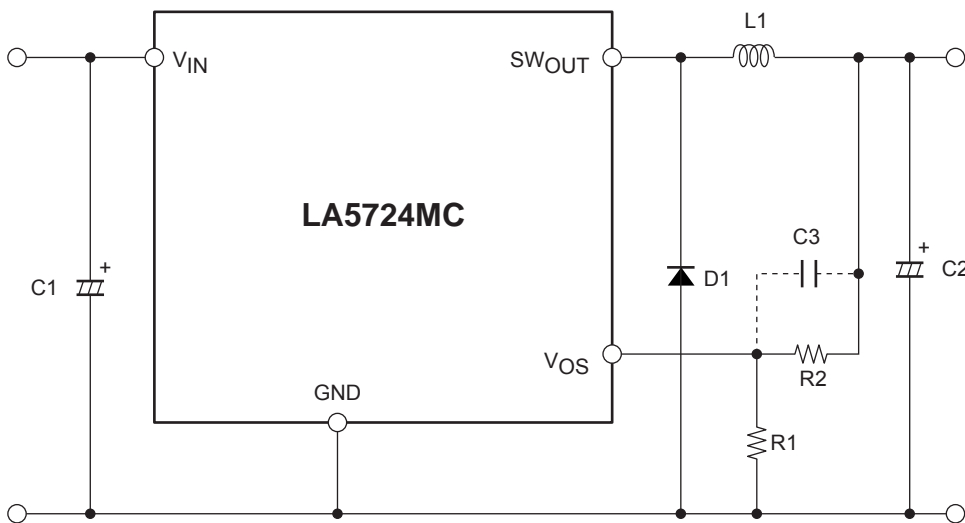


Block Diagram



Note : Since the NC pins are not connected within the IC package, they can be used as connection points.

Application Circuit Example

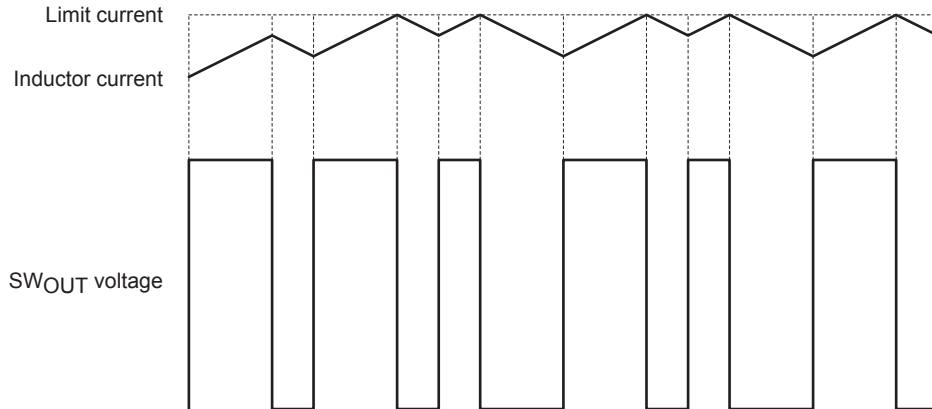


Note : In some cases, the output may not turn on if power is applied when a load is connected. If this is a problem, increase the value of the inductor.

Protection Circuit Functional Descriptions

Overcurrent protection function

The overcurrent protection function detects, on a pulse-by-pulse basis, the output transistor current and turns off that output transistor current if it exceeds 0.7A in a pulse-by-pulse manner.

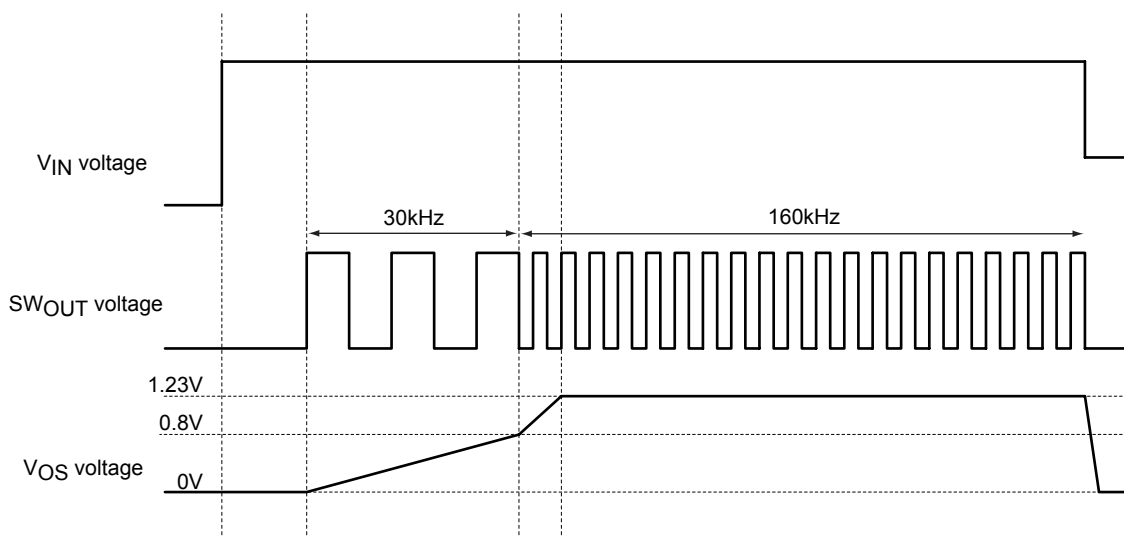


Short circuit protection function

This IC prevents the current from increasing when the outputs are shorted by setting the switching frequency to 30kHz if the V_{OS} pin voltage falls below 0.8V.

Note : At startup, since the switching frequency will be 30kHz while the V_{OS} pin voltage is 0.8V or lower, the current capacity is reduced. If the load is applied at startup and the applications has trouble starting, increase the value of the inductor to resolve this problem.

Timing Chart



Part selection and set

1. Resistors R1 and R2

R1 and R2 are resistors to set the output voltage. When the large resistance value is set, the error of set voltage increases due to the VOS pin current. The output voltage may also increase due to the leak current of switching transistor at light load. In consequence, it is essential to set R1 and R2 currents to around 500µA.

$$R1 = \frac{1.23V}{500\mu A} \approx 2.4k\Omega \quad 2.0k\Omega \text{ to } 2.4k\Omega \text{ recommended}$$

$$R2 = \left(\frac{V_{OUT}}{1.23V} - 1\right) \times R1$$

The calculation equation gives the output voltage set by R1 and R2.

$$V_{OUT} = \left(1 + \frac{R2}{R1}\right) \times 1.23V(\text{typ})$$

2. Capacitor C1, C2 and C3

The large ripple current flows through C1 and C2, so that the high-frequency low-impedance product for switching power supply must be used. Do not use, for C2, a capacitor with extremely small equivalent series resistance (ESR), such as ceramic capacitor, tantalum capacitor. Otherwise, the output waveform may develop abnormal oscillation. The C2 capacitance and ESR value stabilization conditions are as follows:

$$\frac{1}{2 \times \pi \times C2 \times ESR} \leq 20kHz$$

C3 is a capacitor for phase compensation of the feedback loop. Abnormal oscillation may occur when the C2 capacitance value is small or the equivalent series resistance is small. In this case, addition of the capacitance of C3 enables phase compensation, contributing to stabilization of power supply.

3. Input capacitor: Effective-value current

The AC ripple current flowing in the input capacitor is larger than that in the output capacitor. The equation expressing the effective-value current is as follows. Use the capacitor within the rated current range.

$$I_{C1} = \sqrt{\frac{V_{out}}{V_{in}} \left(I_{out}^2 \left(1 - \frac{V_{out}}{V_{in}} \right) + \frac{1}{12} \times \Delta I_R^2 \right)} \quad [\text{Arms}]$$

4. Output capacitor: Effective-value current

The AC ripple current flowing in the capacitor is the triangular wave. Therefore, its effective value is obtained from the following equation. Select the output capacitor so that it does not exceed the allowable ripple current value.

$$I_{C2} = \frac{1}{\sqrt{3}} \times \frac{V_{OUT}(V_{IN}-V_{OUT})}{L \times f_{SW} \times V_{IN}} \quad [\text{Arms}]$$

f_{SW} = switching frequency ... 160kHz

5. Choke coil

Note that choke coil heating due to overload or load shorting may be a problem. The inductance value can be determined from the following equation once the input voltage, output voltage, and current ripple conditions are known. ΔI_R indicates the ripple current value.

Reference example: $V_{IN} = 12V$, $V_{OUT} = 5V$, $\Delta I_R = 150mA$

$$L = \frac{V_{IN} - V_{OUT} - V_{sat}}{\Delta I_R} \times T_{on}$$

$$= \frac{12 - 5.0 - 0.4}{0.15} \times 2.8 \times 10^{-6}$$

$$\approx 120\mu H$$

$$\left\{ \begin{array}{l} T_{on} = \frac{T}{(V_{IN} - V_{OUT} - V_{sat}) / (V_{OUT} + V_F) + 1} \\ T_{off} = T - T_{on} \\ T: \text{Switching repetition period} \quad \dots \quad 6.25\mu s \text{ is assumed for the calculation} \\ V_F: \text{Schottky diode forward voltage} \quad \dots \quad 0.4V \text{ is assumed for the calculation} \end{array} \right\}$$

6. Inductance current: peak value

The ripple current peak value must be held within the rated current values for the inductor used. Here, IRP is the ripple current. IRP can be determined from the following equation.

$$\begin{aligned} \text{IRP} &= I_{\text{OUT}} + \frac{V_{\text{IN}} - V_{\text{OUT}} - V_{\text{sat}}}{2L} \times T_{\text{on}} \\ &= 0.5 + \frac{12 - 5.0 - 0.4}{2 \times 120 \times 10^{-6}} \times 2.8 \times 10^{-6} \\ &\approx 0.57\text{A} \end{aligned}$$

7. Inductance current: ripple current value

Here ΔIR is the ripple current. ΔIR can be determined from the following equation. If the load current becomes less than one half the ripple current, the inductor current will become discontinuous.

$$\begin{aligned} \Delta\text{IR} &= \frac{V_{\text{IN}} - V_{\text{OUT}} - V_{\text{sat}}}{L} \times T_{\text{on}} \\ &= \frac{12 - 5.0 - 0.4}{120 \times 10^{-6}} \times 2.8 \times 10^{-6} \\ &\approx 0.15\text{A} \end{aligned}$$

8. Diode D1

A Schottky barrier diode must be used for the diode. If a fast recovery diode is used, it is possible that the IC could be destroyed by the applied reverse voltage due to the recovery and the on-state voltage.

9. Diode current: peak current

Applications must be designed so that the peak value of the diode current remains within the rated current of the diode. The peak value of the diode current will be the same current as the peak value of the inductor current.

10. Repetitive peak reverse voltage

Application must be designed so that the repetitive peak reverse voltage remains within the voltage rating of the diode. Here, VRRM is the repetitive peak reverse voltage. VRRM can be determined from the following equation.

$$V_{\text{RRM}} \geq V_{\text{CC}}$$

Since noise voltage and other terms will be added in actual in actual operation, the voltage handling capacity of the device should be about 1.5 times that given by the above calculation.

- SANYO Semiconductor Co.,Ltd. assumes no responsibility for equipment failures that result from using products at values that exceed, even momentarily, rated values (such as maximum ratings, operating condition ranges, or other parameters) listed in products specifications of any and all SANYO Semiconductor Co.,Ltd. products described or contained herein.
- SANYO Semiconductor Co.,Ltd. strives to supply high-quality high-reliability products, however, any and all semiconductor products fail or malfunction with some probability. It is possible that these probabilistic failures or malfunction could give rise to accidents or events that could endanger human lives, trouble that could give rise to smoke or fire, or accidents that could cause damage to other property. When designing equipment, adopt safety measures so that these kinds of accidents or events cannot occur. Such measures include but are not limited to protective circuits and error prevention circuits for safe design, redundant design, and structural design.
- In the event that any or all SANYO Semiconductor Co.,Ltd. products described or contained herein are controlled under any of applicable local export control laws and regulations, such products may require the export license from the authorities concerned in accordance with the above law.
- No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying and recording, or any information storage or retrieval system, or otherwise, without the prior written consent of SANYO Semiconductor Co.,Ltd.
- Any and all information described or contained herein are subject to change without notice due to product/technology improvement, etc. When designing equipment, refer to the "Delivery Specification" for the SANYO Semiconductor Co.,Ltd. product that you intend to use.
- Upon using the technical information or products described herein, neither warranty nor license shall be granted with regard to intellectual property rights or any other rights of SANYO Semiconductor Co.,Ltd. or any third party. SANYO Semiconductor Co.,Ltd. shall not be liable for any claim or suits with regard to a third party's intellectual property rights which has resulted from the use of the technical information and products mentioned above.

This catalog provides information as of March, 2012. Specifications and information herein are subject to change without notice.