Chipsmall Limited consists of a professional team with an average of over 10 year of expertise in the distribution of electronic components. Based in Hongkong, we have already established firm and mutual-benefit business relationships with customers from,Europe,America and south Asia,supplying obsolete and hard-to-find components to meet their specific needs.

With the principle of “Quality Parts,Customers Priority,Honest Operation,and Considerate Service”,our business mainly focus on the distribution of electronic components. Line cards we deal with include Microchip,ALPS,ROHM,Xilinx,Pulse,ON,Everlight and Freescale. Main products comprise IC,Modules,Potentiometer,IC Socket,Relay,Connector.Our parts cover such applications as commercial,industrial, and automotives areas.

We are looking forward to setting up business relationship with you and hope to provide you with the best service and solution. Let us make a better world for our industry!

Contact us

Tel: +86-755-8981 8866 Fax: +86-755-8427 6832
Email & Skype: info@chipsmall.com Web: www.chipsmall.com
Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China

TS2509

3A / 500KHz PWM Buck Converter

SOP-8

Pin Definition:

1. FB	8. Vss
2. EN	7. Vss
3. Comp	6. SW
4. Vcc	5. SW

General Description

TS2509 is step-down switching regulator with PWM control and with build in internal PMOS. TS2509 provides low-ripple power, high efficiency, and excellent transient characteristics. The PWM control circuit can be duty ratio linearly form 0 up to 100%. This converter also contains an error amplifier circuit as well as a soft-start circuit that prevents overshoot at startup.

An enable, over current protect and short circuit protect functions are built inside. When OCP or SCP activated, the operation frequency will be reduced. The internal compensation block is built in to minimum external components and internal PMOS is complete 3A step down switching regulator ideally for portable devices with outstanding features as low current consumption.

Features

- Input Voltage: 3.6V~23V
- Output Voltage: 0.8V~Vcc
- Duty Ratio: 0%~100% PWM Control
- Oscillation Frequency: 500kHz typ.
- Soft-Start (SS), Current Limit (CL), Enable Function
- Thermal Shutdown Function
- Short Circuit Protect (SCP)
- Internal SW P-Channel MOSFET
- Low ESR output capacitor (MLCC application)

Ordering Information

Part No.	Package	Packing
TS2509CS RL	SOP-8	2.5Kpcs / 13" Reel

Application

- Simple High-efficiency Step down Regulator
- On-Card Switching Regulators

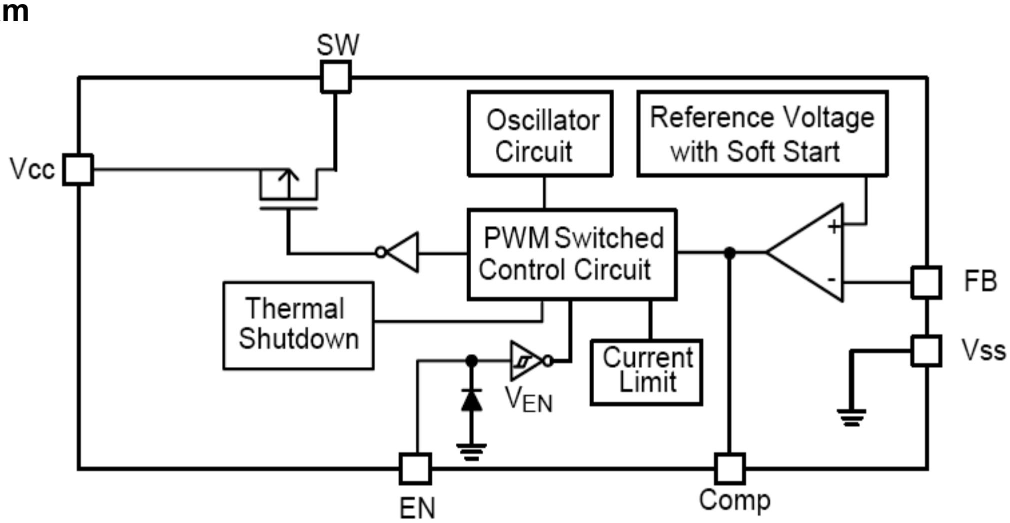
Absolute Maximum Rating

Parameter	Symbol	Rating	Unit
VCC Pin Voltage	V_{CC}	V_{SS} - 0.3 to V_{SS} + 25	V
Feedback Pin Voltage	V_{FB}	V_{SS} - 0.3 to V_{CC}	V
ON/OFF Pin Voltage	V_{EN}	V_{SS} - 0.3 to V_{CC} + 0.3	V
Switch Pin Voltage	V_{SW}	V_{SS} - 0.3 to V_{CC} + 0.3	V
Power Dissipation	P_D	Internally limited	mW
Storage Temperature Range	$T_{ST G}$	-40 to +150	°C
Operating Temperature Range	T_{OP}	-20 to +125	°C
Operating Supply Voltage	V_{OP}	+3.6 to +23	V
Thermal Resistance from Junction to case	θ_{JC}	40	°C/W
Thermal Resistance from Junction to ambient	θ_{JA}	70	°C/W

Electrical Specifications (V_{IN}=12V, Ta=25°C unless otherwise noted)

Characteristics	Symbol	Conditions		Min	Typ	Max	Units
Feedback Voltage	V_{FB}	I_{OUT} =0.1A		0.784	0.800	0.816	V
Quiescent Current	I_q	V_{FB} =1.2V force driver off		--	3	5	mA
Feedback Bias Current	I_{FB}	I_{OUT} =0.1A		--	0.1	0.5	uA
Shutdown Supply Current	I_{SD}	V_{EN} =0V		--	2	10	uA
Current limit	I_{SW}			4	--	--	A
Line Regulation	$\Delta V_{OUT}/V_{OUT}$	V_{CC} = 5V~23V, I_{OUT} =0.2A		--	0.6	1.2	%
Load Regulation	$\Delta V_{OUT}/V_{OUT}$	I_{OUT} = 0.1 to 3A		--	0.2	0.4	%
Oscillation Frequency	F_{OSC}	SW pin		400	500	600	KHz
EN Pin Logic input threshold voltage	V_{SH}	High (regulator ON)		2.0	--	--	V
	V_{SL}	Low (regulator OFF)		--	--	0.8	
EN Pin Input Current	I_{SH}	V_{EN} =2.5V (ON)		--	20	--	uA
	I_{SL}	V_{EN} =0.3V (OFF)		--	-10	--	uA
Soft-Start Time	T_{SS}			0.3	4	8	ms
Internal MOSFET	R_{DSON}	V_{CC} = 5V, V_{FB} =0V		--	90	140	mΩ
		V_{CC} = 12V, V_{FB} =0V		--	60	90	
Efficiency	E_{FFI}	V_{OUT} = 5V	I_{OUT} = 2A	--	91	--	%
			I_{OUT} = 3A	--	90	--	
Thermal Shutdown Temp.	T_{SD}			--	125	--	ºC

Block Diagram

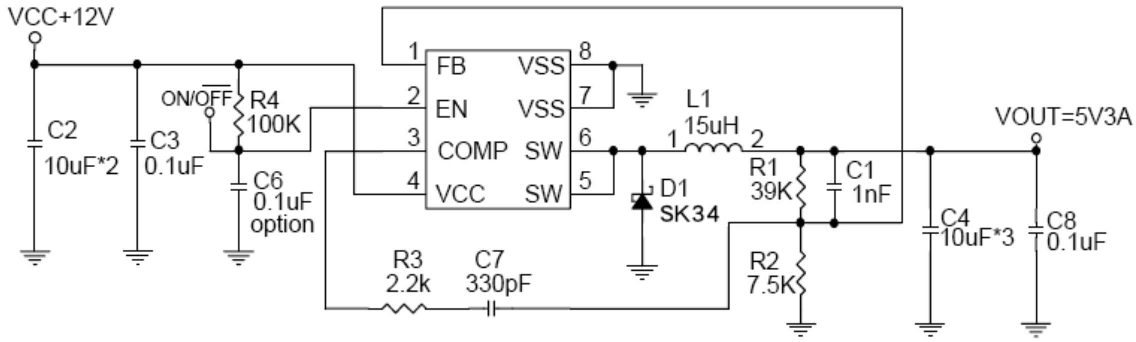


Pin Assignment

Name	Description
FB	Feedback pin
EN	H: Normal operation (Step-down) L: Step-down operation stopped (All circuit deactivated)
Comp	Compensation pin
SW	Switch pin. Connect external inductor/diode here
Vcc	IC power supply pin
Vss	Gnd pin

Application Circuit

MLCC

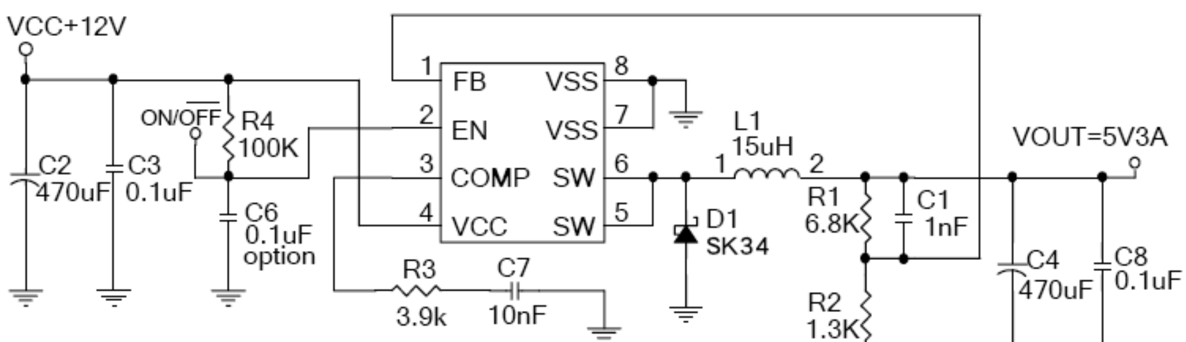


$$VOUT = VFB \times \left(1 + \frac{R1}{R2}\right)$$

VFB = 0.8V ; R1 suggest 10K ~ 50K

Compensation Capacitor Selection (MLCC)					
VIN	**VOUT**	**L1**	**R3**	**C7**	**C1**
7~23V	5.0/3.3/2.5V	15uH	2.2K	330pF	1nF
7~20V	1.8/1.5V	10uH	2K	330pF	1nF
9~20V	1.2V	10uH	2K	330pF	820pF
9~18V	1.1V	10uH	2K	560pF	820pF
9~18V	1.0V	10uH	2K	560pF	680pF
4~10V	3.3/2.5V	15uH	6.8K	330pF	1nF
4~10V	1.8/1.5/1.2/ 1.1/1.0V	10uH	4.7K	330pF	1nF

EL CAP



$$VOUT = VFB \times \left(1 + \frac{R1}{R2}\right)$$

VFB = 0.8V ; R2 suggest 0.8K ~ 6.0K

Compensation Capacitor Selection (EL CAP)					
VIN	**VOUT**	**L1**	**R3**	**C7**	**C1**
7-20V	5.0/3.3/2.5/1.8V	Coil	3.9K	10nF	1nF
7-20V	1.8/1.5V	Coil	2K	10nF	1nF
5-7V	3.3/2.5/1.8/1.5/1.2V	Coil	2K	10nF	1nF
5-20V	3.3/2.5/1.8/1.5/1.2V	SMD	0.82K	10nF	1nF

Function Descriptions

PWM Control

The TS2509 is a pulse-width modulation (PWM) system with a range from 0 to 100% according to different load current. The ripple voltage produced by the switching can easily be removed through a filter because the switching frequency remains constant.

Setting the Output Voltage

TS2509 is adjustable output version. With different output voltage setting, following tables are for external resistor value setting as reference:

$$VOUT = 0.8V \times \left(1 + \frac{R1}{R2}\right)$$

(EL CAP) Resistor select for output voltage setting

V_{OUT}	R2	R1
5V	1.3K	6.8K
3.3V	1.5K	4.7K
2.5V	2.2K	4.7K
1.8V	2K	2.5K
1.5V	2.2K	2K
1.2V	3K	1.5K
1V	10K	2.5K

(MLCC) Resistor select for output voltage setting

V_{OUT}	R2	R1
5V	7.5K	39K
3.3V	15K	47K
2.5V	22K	47K
1.8V	27K	33K
1.5V	30K	27K
1.2V	30K	15K
1V	56K	13K

Inductor Selection

For most designs are operates with inductors of 10µH to 22µH. The inductor value can be derived from the following table:

$$L = \frac{VOUT \times (VIN - VOUT)}{VIN \times \Delta IL \times Fosc}$$

L1 Recommend Value (V_{IN}=12V, I_{OUT}=3A)				
V_{OUT}	1.8V	2.5V	3.3V	5V
L1 Value	10~15uH	10~15uH	15~22uH	15~22uH

Large value inductors can lower ripple current and small value inductors will gets higher ripple currents. Choose inductor ripple current approximately 15% of the maximum load current 3A.

Input Capacitor Selection

(EL CAP)

This capacitor should be located close to the IC using short leads and the voltage rating should be approximately 1.5 times the maximum input voltage. The RMS current rating should be approximately ½ the DC load current. A low ESR input capacitor sized for maximum RMS current must be used. A 220µF low ESR capacitor for most sufficient for applications

(MLCC)

A 22µF MLCC or two 10uF MLCC capacitors for most sufficient for applications

Function Descriptions (Continue)

Output Capacitor Selection

(EL CAP)

The output capacitor is required to maintain the DC output voltage stability. The important capacitor parameters are; the 100KHz ESR (Equivalent Series Resistance), the RMS ripples current rating, voltage rating, and capacitance value. For the output capacitor, the ESR value is the most important parameter, the ESR can be calculated from the following formula.

$$V_{RIPPLE} = \Delta I_L \times ESR = 0.4A \times 110m\Omega = 44mV$$

An aluminum electrolytic capacitor's ESR value is related to the capacitance and its voltage rating. In most case, higher voltage electrolytic capacitors have lower ESR values. Most of the time, capacitors with much higher voltage ratings may be needed to provide the low ESR values required for low output ripple voltage. It is recommended to replace this low ESR capacitor by using a 330µF low ESR values < 110mΩ

(MLCC)

A 33µF MLCC or three 10uF MLCC capacitors is most sufficient for applications.

$R_{DS(ON)}$ Current Limiting

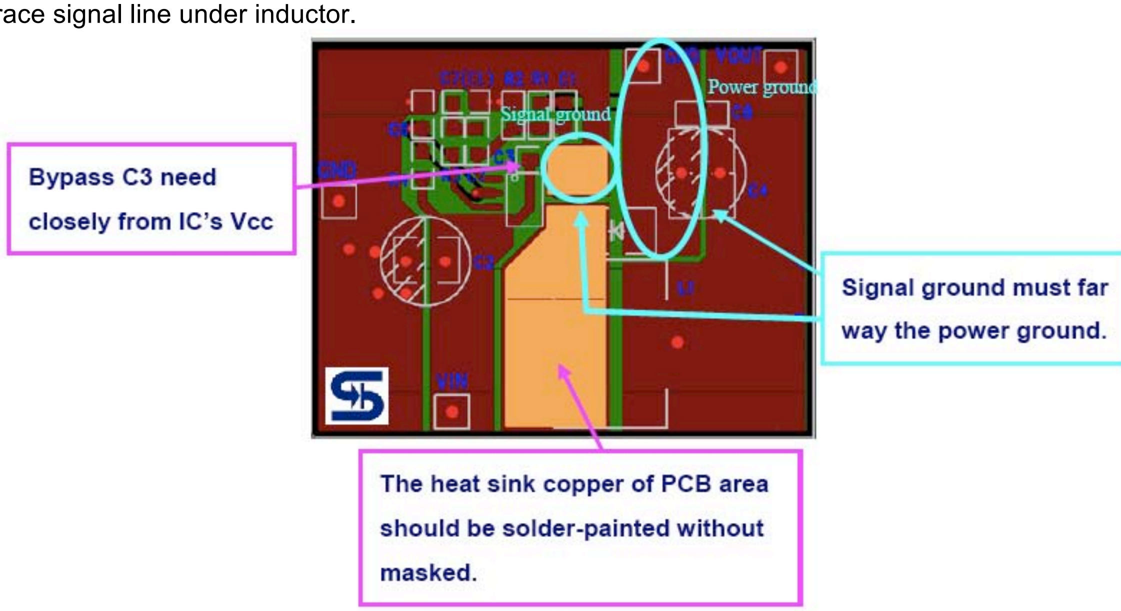
The current limit threshold is setting by the internal circuit.

V_{IN}	4.6V~6V	6V~10V	10V~23V
$I_{CL(MIN)}$	3A	3.8A	4.0A
$I_{OUT(MAX)}$	2.5A	3A	3A

Layout Guidance

When laying out the PC board, the following suggestions should be taken to ensure proper operation of the TS2509.

1. The power traces, including the PMOS Drain & Source trace, the Schottky and the C2 trace should be kept short, direct and wide to allow large current flow.
2. Connect the C5 to the V_{CC} & EN pins of the TS2509 as closely as possible to get good power filter effect.
3. Keep the switching node, away from the sensitive FB node.
4. Connect ground side of the C2 & D1 as closely as possible.
5. Connect PMOS Source and R3 as closely as possible.
6. Do not trace signal line under inductor.



Electrical Characteristics Curve

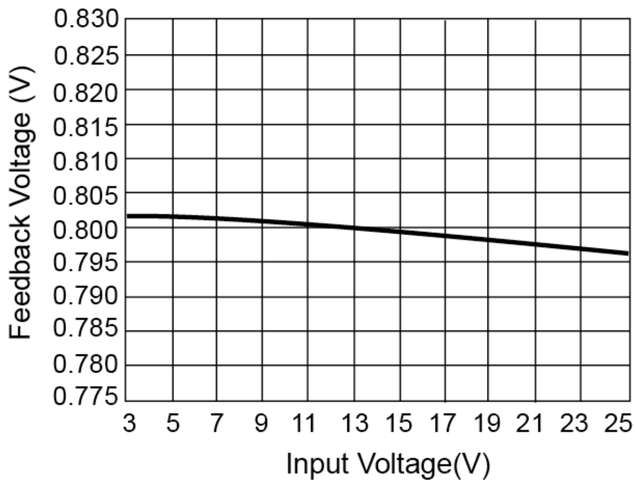


Figure 1. Feedback Voltage vs. Input Voltage

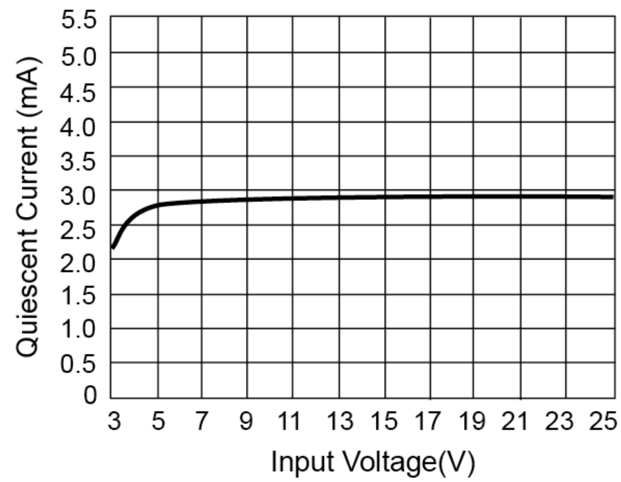


Figure 2.Quiescent Current vs. Input Voltage

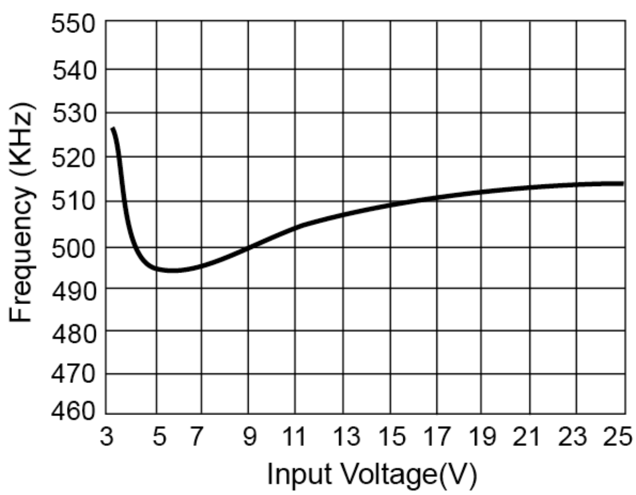


Figure 3. Frequency vs. Input Voltage

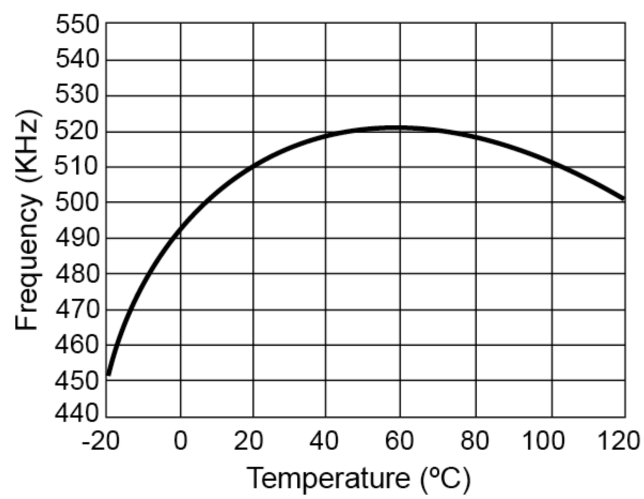


Figure 4. Frequency vs. Temperature

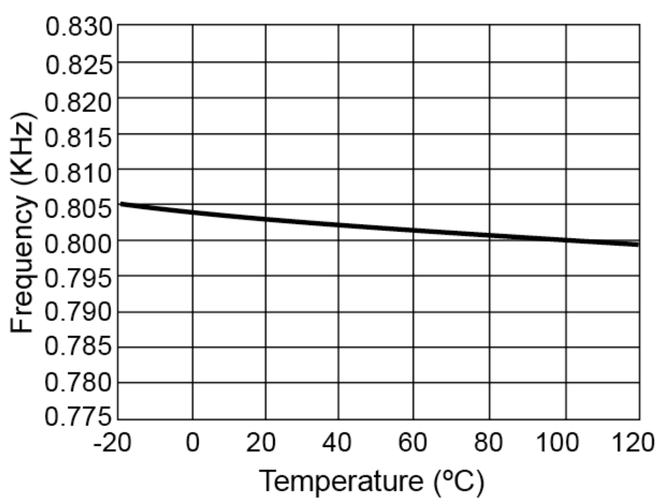


Figure 5. Feedback Voltage vs. Temperature

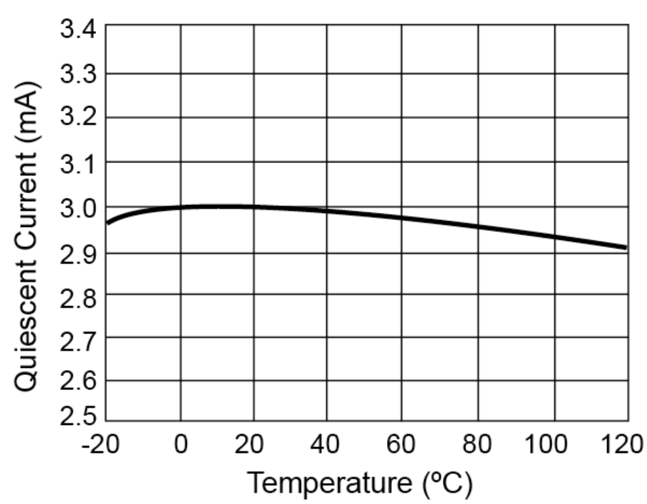


Figure 6. Quiescent Current vs. Temperature

Electrical Characteristics Curve

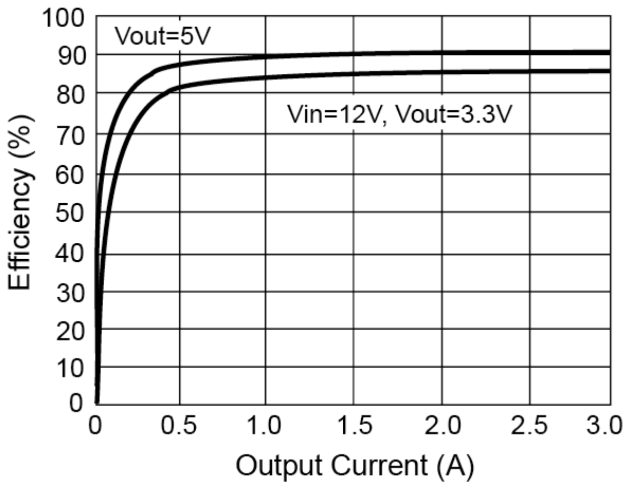


Figure 7. Efficiency

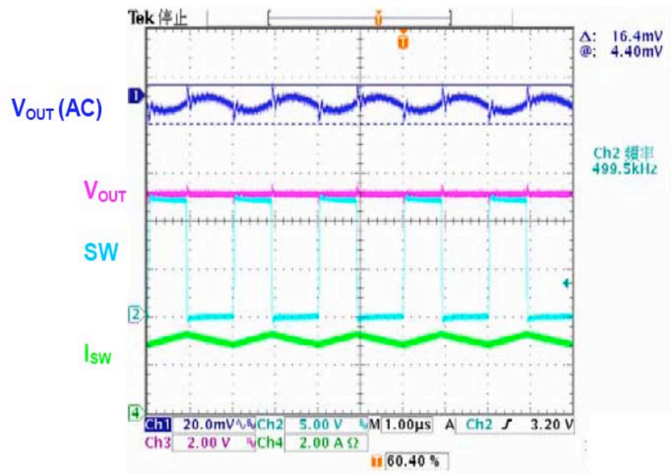
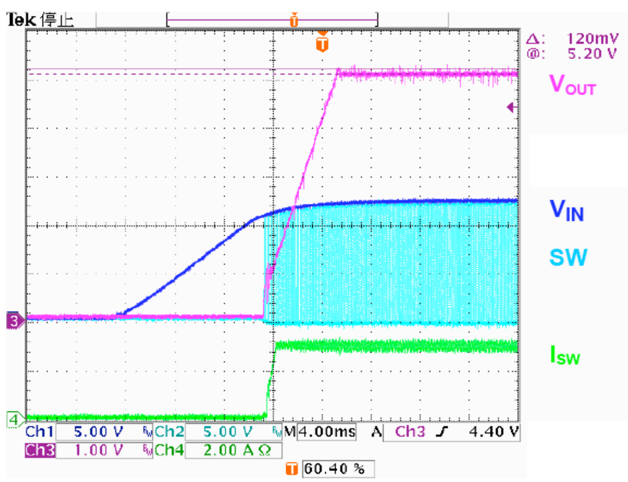
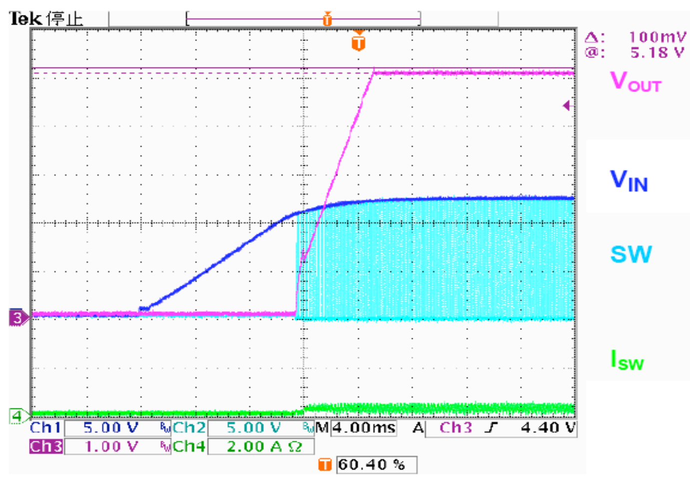


Figure 8.Output Ripple (V_{IN}=12V, V_{OUT}=5V, I_{OUT}=3A)



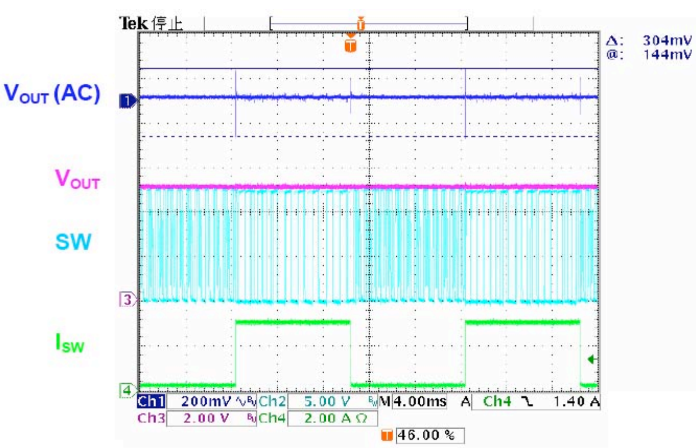
(V_{IN}=12V, V_{OUT}=5V, I_{OUT}=3A)

Figure 9.Power On test Wave



(V_{IN}=12V, V_{OUT}=5V, I_{OUT}=0.2A)

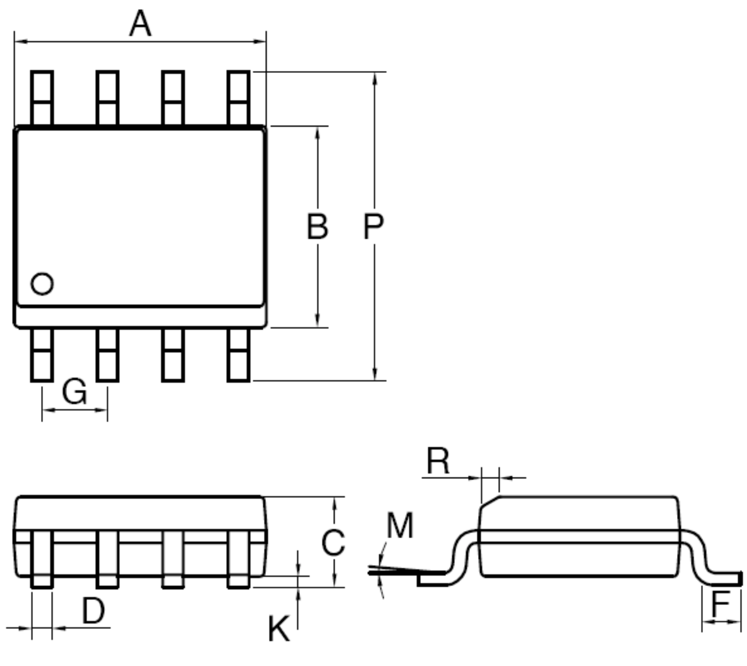
Figure 10.Power On test Wave



(V_{IN}=12V, V_{OUT}=5V, I_{OUT}=0.1~3A)

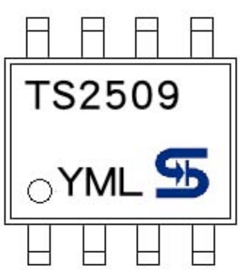
Figure 11. Load Transient Response

SOP-8 Mechanical Drawing



SOP-8 DIMENSION				
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX.
A	4.80	5.00	0.189	0.196
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.054	0.068
D	0.35	0.49	0.014	0.019
F	0.40	1.25	0.016	0.049
G	1.27BSC		0.05BSC	
K	0.10	0.25	0.004	0.009
M	0º	7º	0º	7º
P	5.80	6.20	0.229	0.244
R	0.25	0.50	0.010	0.019

Marking Diagram



Y = Year Code
M = Month Code
(**A**=Jan, **B**=Feb, **C**=Mar, **D**=Apl, **E**=May, **F**=Jun, **G**=Jul, **H**=Aug, **I**=Sep, **J**=Oct, **K**=Nov, **L**=Dec)
L = Lot Code

Notice

Specifications of the products displayed herein are subject to change without notice. TSC or anyone on its behalf, assumes no responsibility or liability for any errors or inaccuracies.

Information contained herein is intended to provide a product description only. No license, express or implied, to any intellectual property rights is granted by this document. Except as provided in TSC's terms and conditions of sale for such products, TSC assumes no liability whatsoever, and disclaims any express or implied warranty, relating to sale and/or use of TSC products including liability or warranties relating to fitness for a particular purpose, merchantability, or infringement of any patent, copyright, or other intellectual property right.

The products shown herein are not designed for use in medical, life-saving, or life-sustaining applications. Customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify TSC for any damages resulting from such improper use or sale.