

LM2670

SIMPLE SWITCHER® High Efficiency 3A Step-Down Voltage Regulator with Sync

General Description

The LM2670 series of regulators are monolithic integrated circuits which provide all of the active functions for a step-down (buck) switching regulator capable of driving up to 3A loads with excellent line and load regulation characteristics. High efficiency (>90%) is obtained through the use of a low ON-resistance DMOS power switch. The series consists of fixed output voltages of 3.3V, 5V and 12V and an adjustable output version.

The SIMPLE SWITCHER concept provides for a complete design using a minimum number of external components. The switching clock frequency can be provided by an internal fixed frequency oscillator (260KHz) or from an externally provided clock in the range of 280KHz to 400KHz which allows the use of physically smaller sized components. A family of standard inductors for use with the LM2670 are available from several manufacturers to greatly simplify the design process. The external Sync clock provides direct and precise control of the output ripple frequency for consistent filtering or frequency spectrum positioning.

The LM2670 series also has built in thermal shutdown, current limiting and an ON/OFF control input that can power down the regulator to a low 50µA quiescent current standby condition. The output voltage is guaranteed to a ±2% tolerance.

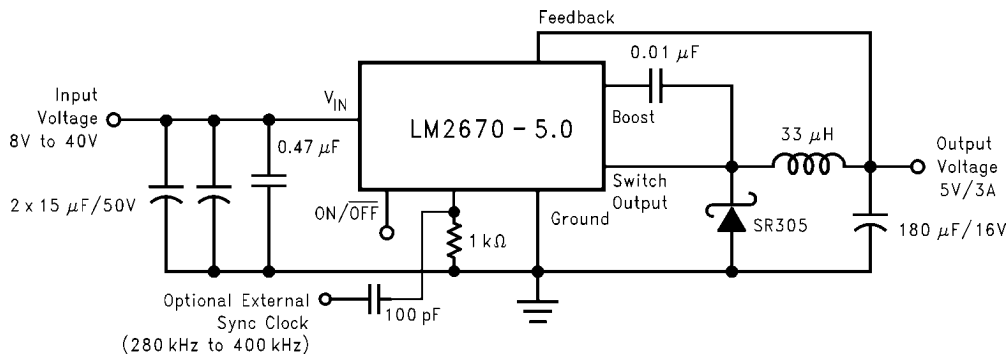
Features

- Efficiency up to 94%
- Simple and easy to design with (using off-the-shelf external components)
- 150 mΩ DMOS output switch
- 3.3V, 5V and 12V fixed output and adjustable (1.2V to 37V) versions
- 50µA standby current when switched OFF
- ±2% maximum output tolerance over full line and load conditions
- Wide input voltage range: 8V to 40V
- External Sync clock capability (280KHz to 400KHz)
- 260 KHz fixed frequency internal oscillator
- -40 to +125°C operating junction temperature range

Applications

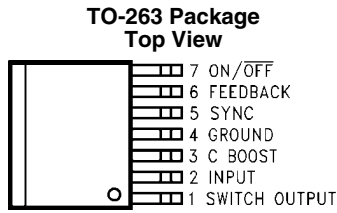
- Simple to design, high efficiency (>90%) step-down switching regulators
- Efficient system pre-regulator for linear voltage regulators
- Battery chargers
- Communications and radio equipment regulator with synchronized clock frequency

Typical Application



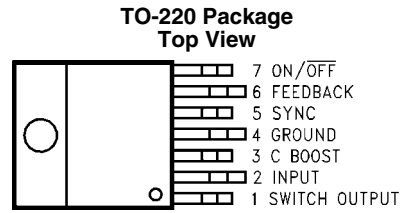
10094203

Connection Diagrams and Ordering Information



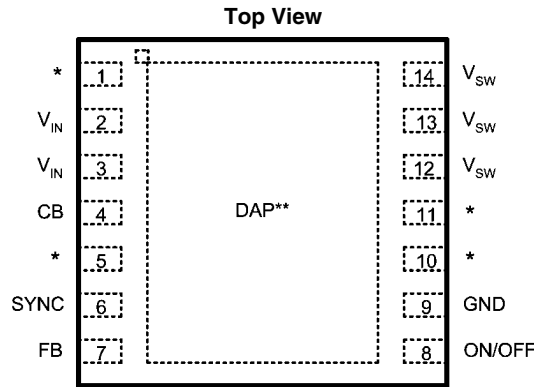
10094201

Order Number
LM2670S-3.3, LM2670S-5.0,
LM2670S-12 or LM2670S-ADJ
See NSC Package Number TS7B



10094202

Order Number
LM2670T-3.3, LM2670T-5.0,
LM2670T-12 or LM2670T-ADJ
See NSC Package Number TA07B



* No Connections

** Connect to Pin 9 on PCB

10094241

LLP-14
See NS package Number SRC14A

Ordering Information for LLP Package

Output Voltage	Order Information	Package Marking	Supplied As
12	LM2670SD-12	S0002LB	250 Units on Tape and Reel
12	LM2670SDX-12	S0002LB	2500 Units on Tape and Reel
3.3	LM2670SD-3.3	S0002NB	250 Units on Tape and Reel
3.3	LM2670SDX-3.3	S0002NB	2500 Units on Tape and Reel
5.0	LM2670SD-5.0	S0002PB	250 Units on Tape and Reel
5.0	LM2670SDX-5.0	S0002PB	2500 Units on Tape and Reel
ADJ	LM2670SD-ADJ	S0002RB	250 Units on Tape and Reel
ADJ	LM2670SDX-ADJ	S0002RB	2500 Units on Tape and Reel

Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Input Supply Voltage	45V
ON/OFF Pin Voltage	-0.1V to 6V
Switch Voltage to Ground (Note 12)	-1V to V_{IN}
Boost Pin Voltage	$V_{SW} + 8V$
Feedback Pin Voltage	-0.3V to 14V
Power Dissipation	Internally Limited

ESD (Note 2)	2 kV
Storage Temperature Range	-65°C to 150°C
Soldering Temperature	
Wave	4 sec, 260°C
Infrared	10 sec, 240°C
Vapor Phase	75 sec, 219°C

Operating Ratings

Supply Voltage	8V to 40V
Junction Temperature Range (T_J)	-40°C to 125°C

Electrical Characteristics Limits appearing in **bold type face** apply over the entire junction temperature range of operation, -40°C to 125°C. Specifications appearing in normal type apply for $T_A = T_J = 25^\circ\text{C}$. Sync pin open circuited.

LM2670-3.3

Symbol	Parameter	Conditions	Typical (Note 3)	Min (Note 4)	Max (Note 4)	Units
V_{OUT}	Output Voltage	$V_{IN} = 8V$ to 40V, $100\text{mA} \leq I_{OUT} \leq 3A$	3.3	3.234/ 3.201	3.366/ 3.399	V
η	Efficiency	$V_{IN} = 12V$, $I_{LOAD} = 3A$	86			%

LM2670-5.0

Symbol	Parameter	Conditions	Typical (Note 3)	Min (Note 4)	Max (Note 4)	Units
V_{OUT}	Output Voltage	$V_{IN} = 8V$ to 40V, $100\text{mA} \leq I_{OUT} \leq 3A$	5.0	4.900/ 4.850	5.100/ 5.150	V
η	Efficiency	$V_{IN} = 12V$, $I_{LOAD} = 3A$	88			%

LM2670-12

Symbol	Parameter	Conditions	Typical (Note 3)	Min (Note 4)	Max (Note 4)	Units
V_{OUT}	Output Voltage	$V_{IN} = 15V$ to 40V, $100\text{mA} \leq I_{OUT} \leq 3A$	12	11.76/ 11.64	12.24/ 12.36	V
η	Efficiency	$V_{IN} = 24V$, $I_{LOAD} = 3A$	94			%

LM2670-ADJ

Symbol	Parameter	Conditions	Typ (Note 3)	Min (Note 4)	Max (Note 4)	Units
V_{FB}	Feedback Voltage	$V_{IN} = 8V$ to 40V, $100\text{mA} \leq I_{OUT} \leq 3A$ V_{OUT} Programmed for 5V	1.21	1.186/ 1.174	1.234/ 1.246	V
η	Efficiency	$V_{IN} = 12V$, $I_{LOAD} = 3A$	88			%

All Output Voltage Versions Electrical Characteristics

Limits appearing in **bold type face** apply over the entire junction temperature range of operation, -40°C to 125°C .

Specifications appearing in normal type apply for $T_A = T_J = 25^{\circ}\text{C}$. Unless otherwise specified $V_{IN}=12\text{V}$ for the 3.3V, 5V and Adjustable versions and $V_{IN}=24\text{V}$ for the 12V version, Sync pin open circuited..

Symbol	Parameter	Conditions	Typ	Min	Max	Units
DEVICE PARAMETERS						
I_Q	Quiescent Current	$V_{FEEDBACK} = 8\text{V}$ For 3.3V, 5.0V, and ADJ Versions $V_{FEEDBACK} = 15\text{V}$ For 12V Versions	4.2		6	mA
I_{STBY}	Standby Quiescent Current	ON/OFF Pin = 0V	50		100/150	μA
I_{CL}	Current Limit		4.5	3.8/3.6	5.25/5.4	A
I_L	Output Leakage Current	$V_{IN} = 40\text{V}$, ON/OFF Pin = 0V $V_{SWITCH} = 0\text{V}$ $V_{SWITCH} = -1\text{V}$	16		200 15	μA mA
$R_{DS(ON)}$	Switch On-Resistance	$I_{SWITCH} = 3\text{A}$	0.15		0.17/0.29	Ω
f_O	Oscillator Frequency	Measured at Switch Pin	260	225	280	kHz
D	Duty Cycle	Maximum Duty Cycle Minimum Duty Cycle	91 0			% %
I_{BIAS}	Feedback Bias Current	$V_{FEEDBACK} = 1.3\text{V}$ ADJ Version Only	85			nA
$V_{ON/OFF}$	ON/OFF Threshold Voltage		1.4	0.8	2.0	V
$I_{ON/OFF}$	ON/OFF Input Current	ON/OFF Input = 0V	20		45	μA
F_{SYNC}	Synchronization Frequency	$V_{SYNC}(\text{Pin } 5)=3.5\text{V}$, 50% Duty Cycle	400			KHz
V_{SYNC}	SYNC Threshold Voltage		1.4			V
θ_{JA}	Thermal Resistance	T Package, Junction to Ambient (Note 5)	65			$^{\circ}\text{C/W}$
θ_{JA}		T Package, Junction to Ambient (Note 6)	45			
θ_{JC}		T Package, Junction to Case	2			
θ_{JA}		S Package, Junction to Ambient (Note 7)	56			
θ_{JA}		S Package, Junction to Ambient (Note 8)	35			
θ_{JA}		S Package, Junction to Ambient (Note 9)	26			
θ_{JC}		S Package, Junction to Case	2			
θ_{JA}		SD Package, Junction to Ambient (Note 10)	55			
θ_{JA}		SD Package, Junction to Ambient (Note 11)	29			

Note 1: Absolute Maximum Ratings are limits beyond which damage to the device may occur. Operating Ratings indicate conditions under which of the device is guaranteed. Operating Ratings do not imply guaranteed performance limits. For guaranteed performance limits and associated test condition, see the electrical Characteristics tables.

Note 2: ESD was applied using the human-body model, a 100pF capacitor discharged through a 1.5 k Ω resistor into each pin.

Note 3: Typical values are determined with $T_A = T_J = 25^\circ\text{C}$ and represent the most likely norm.

Note 4: All limits are guaranteed at room temperature (standard type face) and at **temperature extremes (bold type face)**. All room temperature limits are 100% tested during production with $T_A = T_J = 25^\circ\text{C}$. All limits at temperature extremes are guaranteed via correlation using standard standard Quality Control (SQC) methods. All limits are used to calculate Average Outgoing Quality Level (AOQL).

Note 5: Junction to ambient thermal resistance (no external heat sink) for the 7 lead TO-220 package mounted vertically, with ½ inch leads in a socket, or on a PC board with minimum copper area.

Note 6: Junction to ambient thermal resistance (no external heat sink) for the 7 lead TO-220 package mounted vertically, with ½ inch leads soldered to a PC board containing approximately 4 square inches of (1 oz.) copper area surrounding the leads.

Note 7: Junction to ambient thermal resistance for the 7 lead TO-263 mounted horizontally against a PC board area of 0.136 square inches (the same size as the TO-263 package) of 1 oz. (0.0014 in. thick) copper.

Note 8: Junction to ambient thermal resistance for the 7 lead TO-263 mounted horizontally against a PC board area of 0.4896 square inches (3.6 times the area of the TO-263 package) of 1 oz. (0.0014 in. thick) copper.

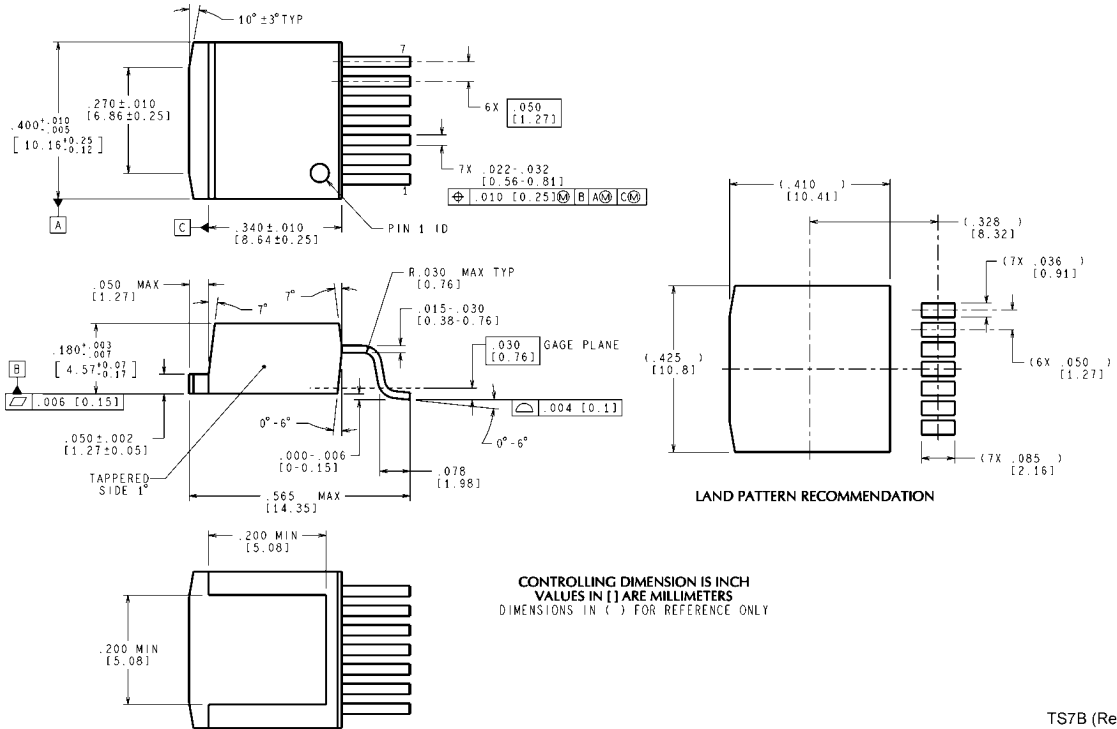
Note 9: Junction to ambient thermal resistance for the 7 lead TO-263 mounted horizontally against a PC board copper area of 1.0064 square inches (7.4 times the area of the TO-263 package) of 1 oz. (0.0014 in. thick) copper. Additional copper area will reduce thermal resistance further. See the thermal model in Switchers Made Simple® software.

Note 10: Junction to ambient thermal resistance for the 14-lead LLP mounted on a PC board copper area equal to the die attach paddle.

Note 11: Junction to ambient thermal resistance for the 14-lead LLP mounted on a PC board copper area using 12 vias to a second layer of copper equal to die attach paddle. Additional copper area will reduce thermal resistance further. For layout recommendations, refer to Application Note AN-1187.

Note 12: The absolute maximum specification of the 'Switch Voltage to Ground' applies to DC voltage. An extended negative voltage limit of -8V applies to a pulse of up to 20 ns, -6V of 60 ns and -3V of up to 100 ns.

Physical Dimensions inches (millimeters) unless otherwise noted



CONTROLLING DIMENSION IS INCH
VALUES IN [] ARE MILLIMETERS
DIMENSIONS IN () FOR REFERENCE ONLY

TO-263 Surface Mount Power Package
Order Number LM2670S-3.3, LM2670S-5.0,
LM2670S-12 or LM2670S-ADJ
NS Package Number TS7B

TS7B (Rev E)