National Semiconductor

LM2585
SIMPLE SWITCHER® 3A Flyback Regulator

General Description

The LM2585 series of regulators are monolithic integrated circuits specifically designed for flyback, step-up (boost), and forward converter applications. The device is available in 4 different output voltage versions: 3.3V, 5.0V, 12V, and adjustable.

Requiring a minimum number of external components, these regulators are cost effective, and simple to use. Included in the datasheet are typical circuits of boost and flyback regulators. Also listed are selector guides for diodes and capacitors and a family of standard inductors and flyback transformers designed to work with these switching regulators.

The power switch is a 3.0A NPN device that can stand-off 65V. Protecting the power switch are current and thermal limiting circuits, and an undervoltage lockout circuit. This IC contains a 100 kHz fixed-frequency internal oscillator that permits the use of small magnetics. Other features include soft start mode to reduce in-rush current during start up, current mode control for improved rejection of input voltage and output load transients and cycle-by-cycle current limiting. An output voltage tolerance of ±4%, within specified input voltages and output load conditions, is guaranteed for the power supply system.

Features

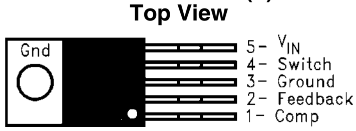
- Requires few external components
- Family of standard inductors and transformers
- NPN output switches 3.0A, can stand off 65V
- Wide input voltage range: 4V to 40V
- Current-mode operation for improved transient response, line regulation, and current limit
- 100 kHz switching frequency
- Internal soft-start function reduces in-rush current during start-up
- Output transistor protected by current limit, under voltage lockout, and thermal shutdown
- System Output Voltage Tolerance of ±4% max over line and load conditions

Typical Applications

- Flyback regulator
- Multiple-output regulator
- Simple boost regulator
- Forward converter

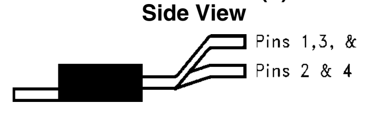
Connection Diagrams

Bent, Staggered Leads
5-Lead TO-220 (T)
Top View



1251514

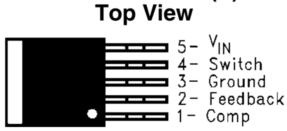
Bent, Staggered Leads
5-Lead TO-220 (T)
Side View



1251515

Order Number LM2585T-3.3, LM2585T-5.0,
LM2585T-12 or LM2585T-ADJ
See NS Package Number T05D

5-Lead TO-263 (S)
Top View



1251516

Order Number LM2585S-3.3, LM2585S-5.0,
LM2585S-12 or LM2585S-ADJ

5-Lead TO-263 (S)
Side View

1251517

See NS Package Number TS5B

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 Voltage	$-0.4V \leq V_{IN} \leq 45V$
Switch Voltage	$-0.4V \leq V_{SW} \leq 65V$
Switch Current (Note 2)	Internally Limited
Compensation Pin Voltage	$-0.4V \leq V_{COMP} \leq 2.4V$
Feedback Pin Voltage	$-0.4V \leq V_{FB} \leq 2V$
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 10 sec.)	260°C
Maximum Junction Temperature (Note 3)	150°C
Power Dissipation (Note 3)	Internally Limited
Minimum ESD Rating (C = 100 pF, R = 1.5 kΩ)	2 kV

Operating Ratings

Supply Voltage	$4V \leq V_{IN} \leq 40V$
Output Switch Voltage	$0V \leq V_{SW} \leq 60V$
Output Switch Current	$I_{SW} \leq 3.0A$
Junction Temperature Range	$-40°C \leq T_J \leq +125°C$

Electrical Characteristics LM2585-3.3

Specifications with standard type face are for T_J = 25°C, and those in **bold type face** apply over full **Operating Temperature Range.** Unless otherwise specified, V_{IN} = 5V.

Symbol	Parameters	Conditions	Typical	Min	Max	Units
SYSTEM PARAMETERS Test Circuit of *Figure 2* (Note 4)						
V_{OUT}	Output Voltage	V_{IN} = 4V to 12V I_{LOAD} = 0.3A to 1.2A	3.3	3.17/**3.14**	3.43/**3.46**	V
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation	V_{IN} = 4V to 12V I_{LOAD} = 0.3A	20		50/**100**	mV
$\Delta V_{OUT}/\Delta I_{LOAD}$	Load Regulation	V_{IN} = 12V I_{LOAD} = 0.3A to 1.2A	20		50/**100**	mV
η	Efficiency	V_{IN} = 5V, I_{LOAD} = 0.3A	76			%
UNIQUE DEVICE PARAMETERS (Note 5)						
V_{REF}	Output Reference Voltage	Measured at Feedback Pin V_{COMP} = 1.0V	3.3	3.242/**3.234**	3.358/**3.366**	V
ΔV_{REF}	Reference Voltage Line Regulation	V_{IN} = 4V to 40V	2.0			mV
G_M	Error Amp Transconductance	I_{COMP} = −30 µA to +30 µA V_{COMP} = 1.0V	1.193	**0.678**	**2.259**	mmho
A_{VOL}	Error Amp Voltage Gain	V_{COMP} = 0.5V to 1.6V R_{COMP} = 1.0 MΩ (Note 6)	260	151/**75**		V/V

LM2585-5.0

Symbol	Parameters	Conditions	Typical	Min	Max	Units
SYSTEM PARAMETERS Test Circuit of *Figure 2* (Note 4)						
V_{OUT}	Output Voltage	V_{IN} = 4V to 12V I_{LOAD} = 0.3A to 1.1A	5.0	4.80/**4.75**	5.20/**5.25**	V
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation	V_{IN} = 4V to 12V I_{LOAD} = 0.3A	20		50/**100**	mV
$\Delta V_{OUT}/\Delta I_{LOAD}$	Load Regulation	V_{IN} = 12V I_{LOAD} = 0.3A to 1.1A	20		50/**100**	mV
η	Efficiency	V_{IN} = 12V, I_{LOAD} = 0.6A	80			%
UNIQUE DEVICE PARAMETERS (Note 5)						
V_{REF}	Output Reference Voltage	Measured at Feedback Pin V_{COMP} = 1.0V	5.0	4.913/**4.900**	5.088/**5.100**	V

Symbol	Parameters	Conditions	Typical	Min	Max	Units
ΔV_{REF}	Reference Voltage Line Regulation	V_{IN} = 4V to 40V	3.3			mV
G_M	Error Amp Transconductance	I_{COMP} = −30 µA to +30 µA V_{COMP} = 1.0V	0.750	**0.447**	**1.491**	mmho
A_{VOL}	Error Amp Voltage Gain	V_{COMP} = 0.5V to 1.6V R_{COMP} = 1.0 MΩ (Note 6)	165	99/**49**		V/V

LM2585-12

Symbol	Parameters	Conditions	Typical	Min	Max	Units
SYSTEM PARAMETERS Test Circuit of *Figure 3* (Note 4)						
V_{OUT}	Output Voltage	V_{IN} = 4V to 10V I_{LOAD} = 0.2A to 0.8A	12.0	11.52/**11.40**	12.48/**12.60**	V
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation	V_{IN} = 4V to 10V I_{LOAD} = 0.2A	20		100/**200**	mV
$\Delta V_{OUT}/\Delta I_{LOAD}$	Load Regulation	V_{IN} = 10V I_{LOAD} = 0.2A to 0.8A	20		100/**200**	mV
η	Efficiency	V_{IN} = 10V, I_{LOAD} = 0.6A	93			%
UNIQUE DEVICE PARAMETERS (Note 5)						
V_{REF}	Output Reference Voltage	Measured at Feedback Pin V_{COMP} = 1.0V	12.0	11.79/**11.76**	12.21/**12.24**	V
ΔV_{REF}	Reference Voltage Line Regulation	V_{IN} = 4V to 40V	7.8			mV
G_M	Error Amp Transconductance	I_{COMP} = −30 µA to +30 µA V_{COMP} = 1.0V	0.328	**0.186**	**0.621**	mmho
A_{VOL}	Error Amp Voltage Gain	V_{COMP} = 0.5V to 1.6V R_{COMP} = 1.0 MΩ (Note 6)	70	41/**21**		V/V

LM2585-ADJ

Symbol	Parameters	Conditions	Typical	Min	Max	Units
SYSTEM PARAMETERS Test Circuit of *Figure 3* (Note 4)						
V_{OUT}	Output Voltage	V_{IN} = 4V to 10V I_{LOAD} = 0.2A to 0.8A	12.0	11.52/**11.40**	12.48/**12.60**	V
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation	V_{IN} = 4V to 10V I_{LOAD} = 0.2A	20		100/**200**	mV
$\Delta V_{OUT}/\Delta I_{LOAD}$	Load Regulation	V_{IN} = 10V I_{LOAD} = 0.2A to 0.8A	20		100/**200**	mV
η	Efficiency	V_{IN} = 10V, I_{LOAD} = 0.6A	93			%
UNIQUE DEVICE PARAMETERS (Note 5)						
V_{REF}	Output Reference Voltage	Measured at Feedback Pin V_{COMP} = 1.0V	1.230	1.208/**1.205**	1.252/**1.255**	V
ΔV_{REF}	Reference Voltage Line Regulation	V_{IN} = 4V to 40V	1.5			mV
G_M	Error Amp Transconductance	I_{COMP} = −30 µA to +30 µA V_{COMP} = 1.0V	3.200	**1.800**	**6.000**	mmho
A_{VOL}	Error Amp Voltage Gain	V_{COMP} = 0.5V to 1.6V R_{COMP} = 1.0 MΩ (Note 6)	670	400/**200**		V/V

Symbol	Parameters	Conditions	Typical	Min	Max	Units
I_B	Error Amp Input Bias Current	V_{COMP} = 1.0V	125		425/**600**	nA

Electrical Characteristics (All Versions)

Symbol	Parameters	Conditions	Typical	Min	Max	Units
COMMON DEVICE PARAMETERS for all versions (Note 5)						
I_S	Input Supply Current	(Switch Off) (Note 8)	11		15.5/**16.5**	mA
		I_{SWITCH} = 1.8A	50		100/**115**	mA
V_{UV}	Input Supply Undervoltage Lockout	R_{LOAD} = 100Ω	3.30	**3.05**	**3.75**	V
f_O	Oscillator Frequency	Measured at Switch Pin R_{LOAD} = 100Ω V_{COMP} = 1.0V	100	85/**75**	115/**125**	kHz
f_{SC}	Short-Circuit Frequency	Measured at Switch Pin R_{LOAD} = 100Ω $V_{FEEDBACK}$ = 1.15V	25			kHz
V_{EAO}	Error Amplifier Output Swing	Upper Limit (Note 7)	2.8	2.6/**2.4**		V
		Lower Limit (Note 8)	0.25		0.40/**0.55**	V
I_{EAO}	Error Amp Output Current (Source or Sink)	(Note 9)	165	110/**70**	260/**320**	µA
I_{SS}	Soft Start Current	$V_{FEEDBACK}$ = 0.92V V_{COMP} = 1.0V	11.0	8.0/**7.0**	17.0/**19.0**	µA
D	Maximum Duty Cycle	R_{LOAD} = 100Ω (Note 7)	98	93/**90**		%
I_L	Switch Leakage Current	Switch Off V_{SWITCH} = 60V	15		300/**600**	µA
V_{SUS}	Switch Sustaining Voltage	dV/dT = 1.5V/ns		65		V
V_{SAT}	Switch Saturation Voltage	I_{SWITCH} = 3.0A	0.45		0.65/**0.9**	V
I_{CL}	NPN Switch Current Limit		4.0	**3.0**	**7.0**	A
θ_{JA}	Thermal Resistance	T Package, Junction to Ambient (Note 10)	65			°C/W
θ_{JA}		T Package, Junction to Ambient (Note 11)	45			
θ_{JC}		T Package, Junction to Case	2			
θ_{JA}		S Package, Junction to Ambient (Note 12)	56			
θ_{JA}		S Package, Junction to Ambient (Note 13)	35			
θ_{JA}		S Package, Junction to Ambient (Note 14)	26			
θ_{JC}		S Package, Junction to Case	2			

Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating ratings indicate conditions the device is intended to be functional, but device parameter specifications may not be guaranteed under these conditions. For guaranteed specifications and test conditions, see the Electrical Characteristics.

Note 2: Note that switch current and output current are not identical in a step-up regulator. Output current cannot be internally limited when the LM2585 is used as a step-up regulator. To prevent damage to the switch, the output current must be externally limited to 3A. However, output current is internally limited when the LM2585 is used as a flyback regulator (see the Application Hints section for more information).

Note 3: The junction temperature of the device (T_J) is a function of the ambient temperature (T_A), the junction-to-ambient thermal resistance (θ_{JA}), and the power dissipation of the device (P_D). A thermal shutdown will occur if the temperature exceeds the maximum junction temperature of the device: $P_D \times \theta_{JA} + T_{A(MAX)} \geq T_{J(MAX)}$. For a safe thermal design, check that the maximum power dissipated by the device is less than: $P_D \leq [T_{J(MAX)} - T_{A(MAX)}]/\theta_{JA}$. When calculating the maximum allowable power dissipation, derate the maximum junction temperature—this ensures a margin of safety in the thermal design.

Note 4: External components such as the diode, inductor, input and output capacitors can affect switching regulator performance. When the LM2585 is used as shown in Figures *Figure 2* and *Figure 3* , system performance will be as specified by the system parameters.

Note 5: All room temperature limits are 100% production tested, and all limits at temperature extremes are guaranteed via correlation using standard Statistical Quality Control (SQC) methods.

Note 6: A 1.0 MΩ resistor is connected to the compensation pin (which is the error amplifier output) to ensure accuracy in measuring A_{VOL}.

Note 7: To measure this parameter, the feedback voltage is set to a low value, depending on the output version of the device, to force the error amplifier output high. Adj: V_{FB} = 1.05V; 3.3V: V_{FB} = 2.81V; 5.0V: V_{FB} = 4.25V; 12V: V_{FB} = 10.20V.

Note 8: To measure this parameter, the feedback voltage is set to a high value, depending on the output version of the device, to force the error amplifier output low. Adj: V_{FB} = 1.41V; 3.3V: V_{FB} = 3.80V; 5.0V: V_{FB} = 5.75V; 12V: V_{FB} = 13.80V.

Note 9: To measure the worst-case error amplifier output current, the LM2585 is tested with the feedback voltage set to its low value (specified in (Note 7) and at its high value (specified in (Note 8) .

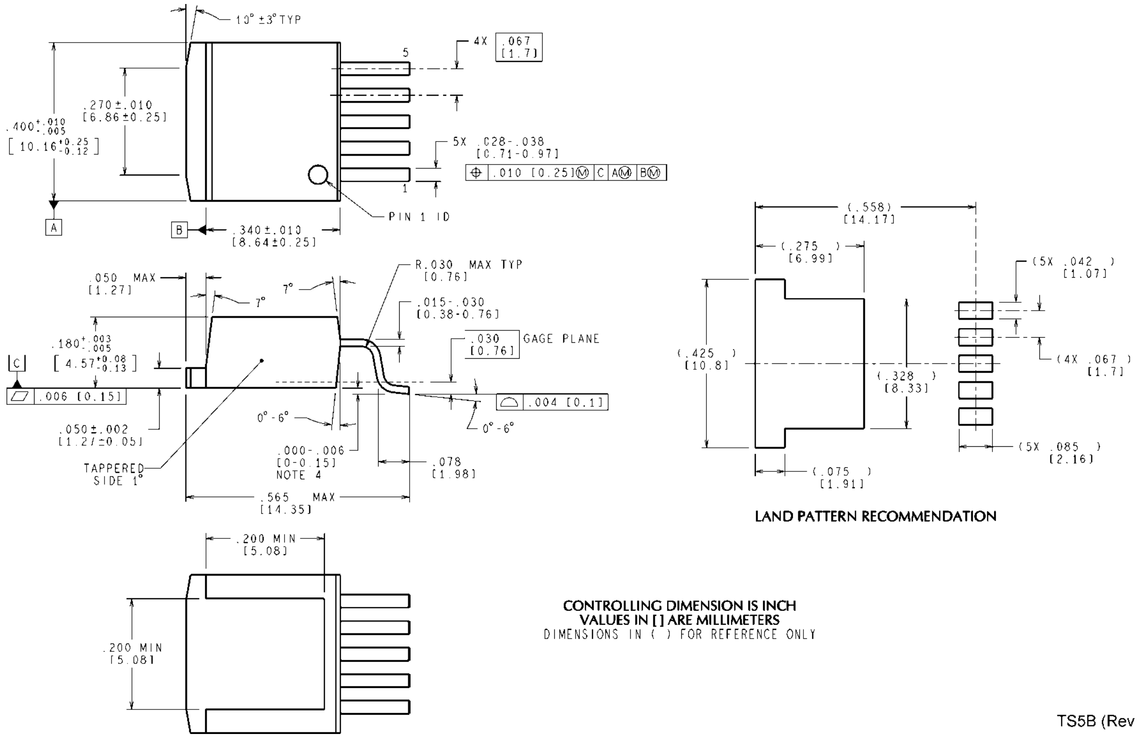
Note 10: Junction to ambient thermal resistance (no external heat sink) for the 5 lead TO-220 package mounted vertically, with ½ inch leads in a socket, or on a PC board with minimum copper area.

Note 11: Junction to ambient thermal resistance (no external heat sink) for the 5 lead TO-220 package mounted vertically, with ½ inch leads soldered to a PC board containing approximately 4 square inches of (1oz.) copper area surrounding the leads.

Note 12: Junction to ambient thermal resistance for the 5 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 13: Junction to ambient thermal resistance for the 5 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 14: Junction to ambient thermal resistance for the 5 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.



TS5B (Rev D)

Order Number LM2585S-3.3, LM2585S-5.0, LM2585S-12 or LM2585S-ADJ
NS Package Number TS5B