

LM1577/LM2577 SIMPLE SWITCHER® Step-Up Voltage Regulator

General Description

The LM1577/LM2577 are monolithic integrated circuits that provide all of the power and control functions for step-up (boost), flyback, and forward converter switching regulators. The device is available in three different output voltage versions: 12V, 15V, and adjustable.

Requiring a minimum number of external components, these regulators are cost effective, and simple to use. Listed in this data sheet are a family of standard inductors and flyback transformers designed to work with these switching regulators.

Included on the chip is a 3.0A NPN switch and its associated protection circuitry, consisting of current and thermal limiting, and undervoltage lockout. Other features include a 52 kHz fixed-frequency oscillator that requires no external components, a soft start mode to reduce in-rush current during start-up, and current mode control for improved rejection of input voltage and output load transients.

Features

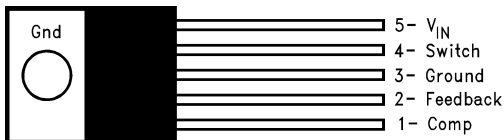
- Requires few external components
- NPN output switches 3.0A, can stand off 65V
- Wide input voltage range: 3.5V to 40V
- Current-mode operation for improved transient response, line regulation, and current limit
- 52 kHz internal oscillator
- Soft-start function reduces in-rush current during start-up
- Output switch protected by current limit, under-voltage lockout, and thermal shutdown

Typical Applications

- Simple boost regulator
- Flyback and forward regulators
- Multiple-output regulator

Connection Diagrams

**Straight Leads
5-Lead TO-220 (T)**

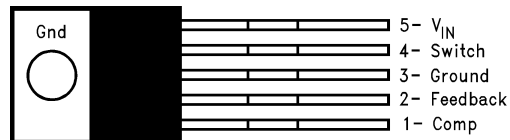


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Top View

Order Number LM2577T-12, LM2577T-15,
or LM2577T-ADJ
See NS Package Number T05A

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



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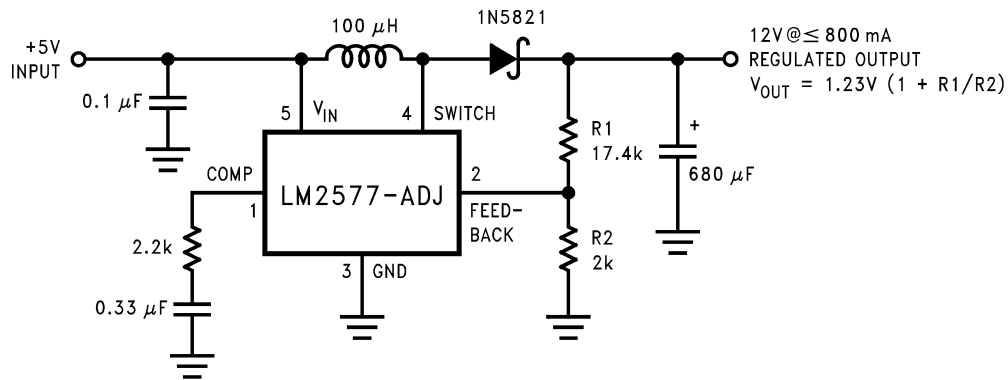
Top View

Order Number LM2577T-12 Flow LB03, LM2577T-15
Flow LB03, or LM2577T-ADJ Flow LB03
See NS Package Number T05D

Ordering Information

Temperature Range	Package Type	Output Voltage			NSC Package Drawing	Package
		12V	15V	ADJ		
$-40^{\circ}\text{C} \leq T_A \leq +125^{\circ}\text{C}$	24-Pin Surface Mount	LM2577M-12	LM2577M-15	LM2577M-ADJ	M24B	SO
	16-Pin Molded DIP	LM2577N-12	LM2577N-15	LM2577N-ADJ	N16A	N
	5-Lead Surface Mount	LM2577S-12	LM2577S-15	LM2577S-ADJ	TS5B	TO-263
	5-Straight Leads	LM2577T-12	LM2577T-15	LM2577T-ADJ	T05A	TO-220
	5-Bent Staggered Leads	LM2577T-12	LM2577T-15	LM2577T-ADJ	T05D	TO-220
$-55^{\circ}\text{C} \leq T_A \leq +150^{\circ}\text{C}$	4-Pin TO-3	LM1577K-12/883	LM1577K-15/883	LM1577K-ADJ/883	K04A	TO-3

Typical Application



Note: Pin numbers shown are for TO-220 (T) package.

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Absolute Maximum Ratings (Note 1)

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

Supply Voltage	45V
Output Switch Voltage	65V
Output Switch Current (Note 2)	6.0A
Power Dissipation	Internally Limited
Storage Temperature Range	-65°C to +150°C
Lead Temperature	
(Soldering, 10 sec.)	260°C
Maximum Junction Temperature	150°C

Minimum ESD Rating

(C = 100 pF, R = 1.5 kΩ)

2 kV

Operating Ratings

Supply Voltage	$3.5V \leq V_{IN} \leq 40V$
Output Switch Voltage	$0V \leq V_{SWITCH} \leq 60V$
Output Switch Current	$I_{SWITCH} \leq 3.0A$
Junction Temperature Range	
LM1577	$-55^\circ C \leq T_J \leq +150^\circ C$
LM2577	$-40^\circ C \leq T_J \leq +125^\circ C$

Electrical Characteristics—LM1577-12, LM2577-12

Specifications with standard type face are for $T_J = 25^\circ C$, and those in **bold type face** apply over full **Operating Temperature Range**. Unless otherwise specified, $V_{IN} = 5V$, and $I_{SWITCH} = 0$.

Symbol	Parameter	Conditions	Typical	LM1577-12 Limit (Notes 3, 4)	LM2577-12 Limit (Note 5)	Units (Limits)
SYSTEM PARAMETERS Circuit of Figure 1 (Note 6)						
V_{OUT}	Output Voltage	$V_{IN} = 5V$ to 10V $I_{LOAD} = 100$ mA to 800 mA (Note 3)	12.0	11.60/11.40 12.40/12.60	11.60/11.40 12.40/12.60	V V(min) V(max)
$\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	Line Regulation	$V_{IN} = 3.5V$ to 10V $I_{LOAD} = 300$ mA	20	50/100	50/100	mV mV(max)
$\frac{\Delta V_{OUT}}{\Delta I_{LOAD}}$	Load Regulation	$V_{IN} = 5V$ $I_{LOAD} = 100$ mA to 800 mA	20	50/100	50/100	mV mV(max)
η	Efficiency	$V_{IN} = 5V$, $I_{LOAD} = 800$ mA	80			%
DEVICE PARAMETERS						
I_S	Input Supply Current	$V_{FEEDBACK} = 14V$ (Switch Off)	7.5	10.0/14.0	10.0/14.0	mA mA(max)
		$I_{SWITCH} = 2.0A$	25			mA
		$V_{COMP} = 2.0V$ (Max Duty Cycle)		50/85	50/85	mA(max)
V_{UV}	Input Supply Undervoltage Lockout	$I_{SWITCH} = 100$ mA	2.90	2.70/2.65 3.10/3.15	2.70/2.65 3.10/3.15	V V(min) V(max)
f_O	Oscillator Frequency	Measured at Switch Pin $I_{SWITCH} = 100$ mA	52	48/42 56/62	48/42 56/62	kHz kHz(min) kHz(max)
V_{REF}	Output Reference Voltage	Measured at Feedback Pin $V_{IN} = 3.5V$ to 40V $V_{COMP} = 1.0V$	12	11.76/11.64 12.24/12.36	11.76/11.64 12.24/12.36	V V(min) V(max)
$\frac{\Delta V_{REF}}{\Delta V_{IN}}$	Output Reference Voltage Line Regulator	$V_{IN} = 3.5V$ to 40V	7			mV
R_{FB}	Feedback Pin Input Resistance		9.7			kΩ
G_M	Error Amp Transconductance	$I_{COMP} = -30$ μA to +30 μA $V_{COMP} = 1.0V$	370	225/145 515/615	225/145 515/615	μmho μmho(min) μmho(max)

Electrical Characteristics—LM1577-15, LM2577-15 (Continued)

Specifications with standard type face are for $T_J = 25^\circ\text{C}$, and those in **bold type face** apply over full **Operating Temperature Range**. Unless otherwise specified, $V_{IN} = 5\text{V}$, and $I_{\text{SWITCH}} = 0$.

Symbol	Parameter	Conditions	Typical	LM1577-15 Limit (Notes 3, 4)	LM2577-15 Limit (Note 5)	Units (Limits)
DEVICE PARAMETERS						
	NPN Switch Current Limit	$V_{\text{COMP}} = 2.0\text{V}$	4.3	3.7/ 3.0 5.3/ 6.0	3.7/ 3.0 5.3/ 6.0	A A(min) A(max)

Electrical Characteristics—LM1577-ADJ, LM2577-ADJ

Specifications with standard type face are for $T_J = 25^\circ\text{C}$, and those in **bold type face** apply over full **Operating Temperature Range**. Unless otherwise specified, $V_{IN} = 5\text{V}$, $V_{\text{FEEDBACK}} = V_{\text{REF}}$, and $I_{\text{SWITCH}} = 0$.

Symbol	Parameter	Conditions	Typical	LM1577-ADJ Limit (Notes 3, 4)	LM2577-ADJ Limit (Note 5)	Units (Limits)
SYSTEM PARAMETERS Circuit of <i>Figure 3</i> (Note 6)						
V_{OUT}	Output Voltage	$V_{IN} = 5\text{V to } 10\text{V}$ $I_{\text{LOAD}} = 100\text{ mA to } 800\text{ mA}$ (Note 3)	12.0	11.60/ 11.40 12.40/ 12.60	11.60/ 11.40 12.40/ 12.60	V V(min) V(max)
$\Delta V_{\text{OUT}} / \Delta V_{\text{IN}}$	Line Regulation	$V_{IN} = 3.5\text{V to } 10\text{V}$ $I_{\text{LOAD}} = 300\text{ mA}$	20	50/ 100	50/ 100	mV mV(max)
$\Delta V_{\text{OUT}} / \Delta I_{\text{LOAD}}$	Load Regulation	$V_{IN} = 5\text{V}$ $I_{\text{LOAD}} = 100\text{ mA to } 800\text{ mA}$	20	50/ 100	50/ 100	mV mV(max)
η	Efficiency	$V_{IN} = 5\text{V}$, $I_{\text{LOAD}} = 800\text{ mA}$	80			%

DEVICE PARAMETERS

I_S	Input Supply Current	$V_{\text{FEEDBACK}} = 1.5\text{V}$ (Switch Off)	7.5	10.0/ 14.0	10.0/ 14.0	mA mA(max)
		$I_{\text{SWITCH}} = 2.0\text{A}$	25	50/ 85	50/ 85	mA mA(max)
		$V_{\text{COMP}} = 2.0\text{V}$ (Max Duty Cycle)				
V_{UV}	Input Supply Undervoltage Lockout	$I_{\text{SWITCH}} = 100\text{ mA}$	2.90	2.70/ 2.65 3.10/ 3.15	2.70/ 2.65 3.10/ 3.15	V V(min) V(max)
f_O	Oscillator Frequency	Measured at Switch Pin $I_{\text{SWITCH}} = 100\text{ mA}$	52	48/ 42 56/ 62	48/ 42 56/ 62	kHz kHz(min) kHz(max)
V_{REF}	Reference Voltage	Measured at Feedback Pin $V_{IN} = 3.5\text{V to } 40\text{V}$ $V_{\text{COMP}} = 1.0\text{V}$	1.230	1.214/ 1.206 1.246/ 1.254	1.214/ 1.206 1.246/ 1.254	V V(min) V(max)
$\Delta V_{\text{REF}} / \Delta V_{\text{IN}}$	Reference Voltage Line Regulation	$V_{IN} = 3.5\text{V to } 40\text{V}$	0.5			mV
I_B	Error Amp Input Bias Current	$V_{\text{COMP}} = 1.0\text{V}$	100	300/ 800	300/ 800	nA nA(max)
G_M	Error Amp Transconductance	$I_{\text{COMP}} = -30\text{ }\mu\text{A to } +30\text{ }\mu\text{A}$ $V_{\text{COMP}} = 1.0\text{V}$	3700	2400/ 1600 4800/ 5800	2400/ 1600 4800/ 5800	μmho μmho (min) μmho (max)
A_{VOL}	Error Amp Voltage Gain	$V_{\text{COMP}} = 1.1\text{V to } 1.9\text{V}$ $R_{\text{COMP}} = 1.0\text{ M}\Omega$ (Note 7)	800	500/ 250	500/ 250	V/V V/V(min)

Electrical Characteristics—LM1577-ADJ, LM2577-ADJ (Continued)

Specifications with standard type face are for $T_J = 25^\circ\text{C}$, and those in **bold type face** apply over full **Operating Temperature Range**. Unless otherwise specified, $V_{IN} = 5\text{V}$, $V_{FEEDBACK} = V_{REF}$, and $I_{SWITCH} = 0$.

Symbol	Parameter	Conditions	Typical	LM1577-ADJ Limit (Notes 3, 4)	LM2577-ADJ Limit (Note 5)	Units (Limits)
DEVICE PARAMETERS						
	Error Amplifier Output Swing	Upper Limit	2.4	2.2/2.0	2.2/2.0	V
		$V_{FEEDBACK} = 1.0\text{V}$				V(min)
		Lower Limit	0.3	0.40/0.55	0.40/0.55	V
		$V_{FEEDBACK} = 1.5\text{V}$				V(max)
	Error Amp Output Current	$V_{FEEDBACK} = 1.0\text{V}$ to 1.5V $V_{COMP} = 1.0\text{V}$	± 200	$\pm 130/\pm 90$ $\pm 300/\pm 400$	$\pm 130/\pm 90$ $\pm 300/\pm 400$	μA $\mu\text{A}(\text{min})$ $\mu\text{A}(\text{max})$
I_{SS}	Soft Start Current	$V_{FEEDBACK} = 1.0\text{V}$ $V_{COMP} = 0\text{V}$	5.0	2.5/1.5 7.5/9.5	2.5/1.5 7.5/9.5	μA $\mu\text{A}(\text{min})$ $\mu\text{A}(\text{max})$
D	Maximum Duty Cycle	$V_{COMP} = 1.5\text{V}$ $I_{SWITCH} = 100\text{ mA}$	95	93/90	93/90	% %(min)
$\Delta I_{SWITCH}/\Delta V_{COMP}$	Switch Transconductance		12.5			A/V
I_L	Switch Leakage Current	$V_{SWITCH} = 65\text{V}$ $V_{FEEDBACK} = 1.5\text{V}$ (Switch Off)	10	300/600	300/600	μA $\mu\text{A}(\text{max})$
V_{SAT}	Switch Saturation Voltage	$I_{SWITCH} = 2.0\text{A}$ $V_{COMP} = 2.0\text{V}$ (Max Duty Cycle)	0.5	0.7/0.9	0.7/0.9	V V(max)
	NPN Switch Current Limit	$V_{COMP} = 2.0\text{V}$	4.3	3.7/3.0 5.3/6.0	3.7/3.0 5.3/6.0	A A(min) A(max)
THERMAL PARAMETERS (All Versions)						
θ_{JA}	Thermal Resistance	K Package, Junction to Ambient	35			$^\circ\text{C/W}$
θ_{JC}		K Package, Junction to Case	1.5			
θ_{JA}		T Package, Junction to Ambient	65			
θ_{JC}		T Package, Junction to Case	2			
θ_{JA}		N Package, Junction to Ambient (Note 8)	85			
θ_{JA}		M Package, Junction to Ambient (Note 8)	100			
θ_{JA}		S Package, Junction to Ambient (Note 9)	37			

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: Due to timing considerations of the LM1577/LM2577 current limit circuit, output current cannot be internally limited when the LM1577/LM2577 is used as a step-up regulator. To prevent damage to the switch, its current must be externally limited to 6.0A. However, output current is internally limited when the LM1577/LM2577 is used as a flyback or forward converter regulator in accordance to the Application Hints.

Note 3: All limits guaranteed at room temperature (standard type face) and at temperature extremes (boldface type). All limits are used to calculate Outgoing Quality Level, and are 100% production tested.

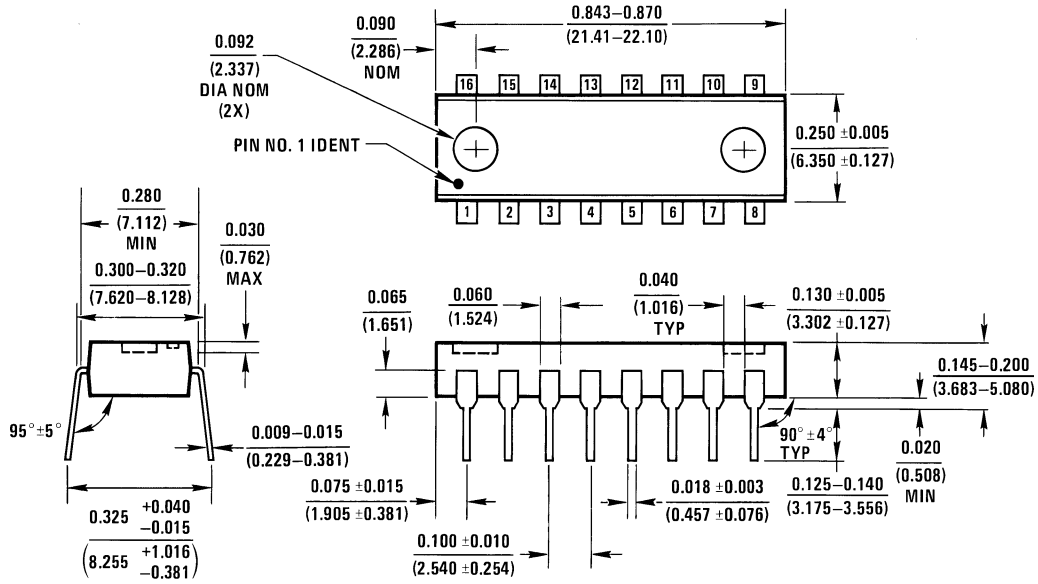
Note 4: A military RETS electrical test specification is available on request. At the time of printing, the LM1577K-12/883, LM1577K-15/883, and LM1577K-ADJ/883 RETS specifications complied fully with the boldface limits in these columns. The LM1577K-12/883, LM1577K-15/883, and LM1577K-ADJ/883 may also be procured to Standard Military Drawing specifications.

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

Note 6: External components such as the diode, inductor, input and output capacitors can affect switching regulator performance. When the LM1577/LM2577 is used as shown in the Test Circuit, system performance will be as specified by the system parameters.

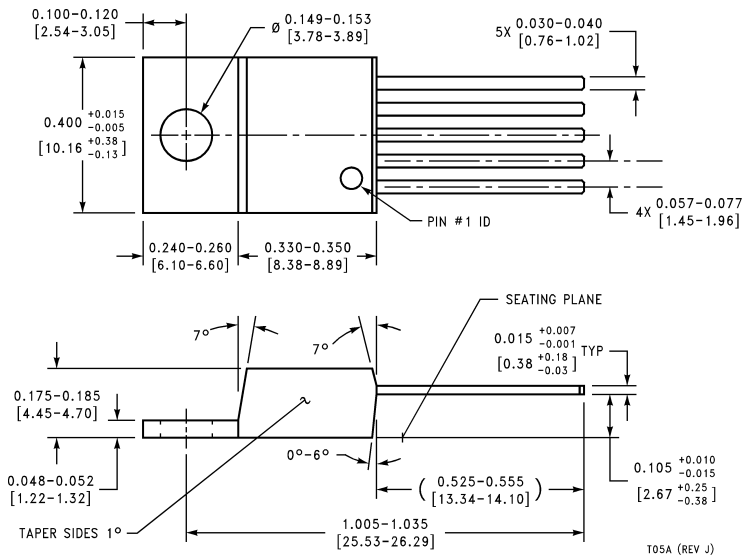
Note 7: A 1.0 M Ω resistor is connected to the compensation pin (which is the error amplifier's output) to ensure accuracy in measuring A_{VOL} . In actual applications, this pin's load resistance should be $\geq 10\text{ M}\Omega$, resulting in A_{VOL} that is typically twice the guaranteed minimum limit.

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



N16A (REV E)

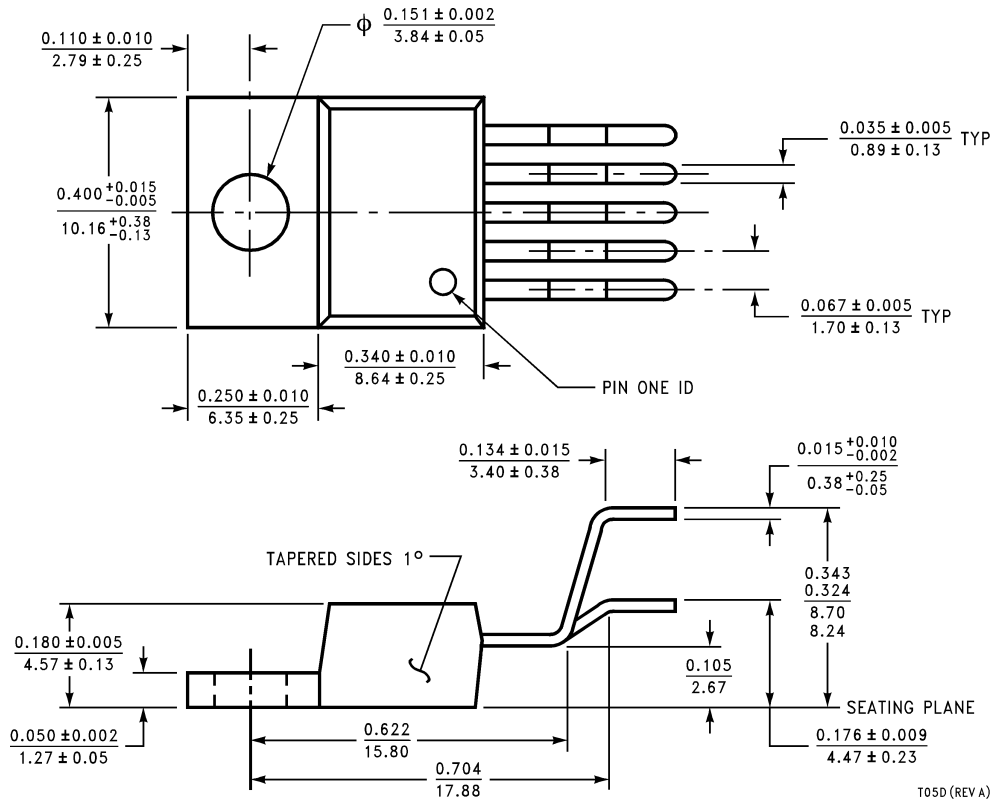
Molded Dual-In-Line Package (N)
Order Number LM2577N-12, LM2577N-15, or LM2577N-ADJ
NS Package Number N16A



TO5A (REV J)

TO-220, Straight Leads (T)
Order Number LM2577T-12, LM2577T-15, or LM2577T-ADJ
NS Package Number TO5A

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



T05D (REV A)

TO-220, Bent Staggered Leads (T)
Order Number LM2577T-12 Flow LB03, LM2577T-15 Flow LB03, or LM2577T-ADJ Flow LB03
NS Package Number T05D