LM2587 SIMPLE SWITCHER® 5A Flyback Regulator

Check for Samples: LM2587

FEATURES

- Requires few external components
- Family of standard inductors and transformers
- NPN output switches 5.0A, 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

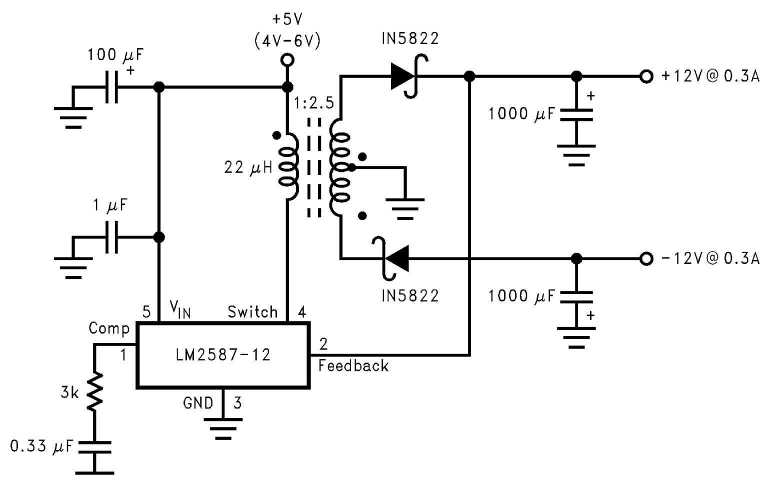
DESCRIPTION

The LM2587 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 5.0A 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.

Flyback Regulator



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

Absolute Maximum Ratings (1)

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

(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.

(2) Note that switch current and output current are not identical in a step-up regulator. Output current cannot be internally limited when the LM2587 is used as a step-up regulator. To prevent damage to the switch, the output current must be externally limited to 5A. However, output current is internally limited when the LM2587 is used as a flyback regulator (see the Application Hints section for more information).

(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.

Operating Ratings

Supply Voltage	4V ≤ V_{IN} ≤ 40V
Output Switch Voltage	0V ≤ V_{SW} ≤ 60V
Output Switch Current	I_{SW} ≤ 5.0A
Junction Temperature Range	−40°C ≤ T_J ≤ +125°C

LM2587-3.3 Electrical Characteristics

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 6 [(1)]						
V_{OUT}	Output Voltage	V_{IN} = 4V to 12V	3.3	3.17/**3.14**	3.43/**3.46**	V
		I_{LOAD} = 400 mA to 1.75A				
$\Delta V_{OUT}/$	Line Regulation	V_{IN} = 4V to 12V	20		50/**100**	mV
ΔV_{IN}		I_{LOAD} = 400 mA				
$\Delta V_{OUT}/$	Load Regulation	V_{IN} = 12V	20		50/**100**	mV
ΔI_{LOAD}		I_{LOAD} = 400 mA to 1.75A				
η	Efficiency	V_{IN} = 12V, I_{LOAD} = 1A	75			%
UNIQUE DEVICE PARAMETERS [(2)]						
V_{REF}	Output Reference	Measured at Feedback Pin	3.3	3.242/**3.234**	3.358/**3.366**	V
	Voltage	V_{COMP} = 1.0V				
ΔV_{REF}	Reference Voltage	V_{IN} = 4V to 40V	2.0			mV
	Line Regulation					
G_M	Error Amp	I_{COMP} = −30 μA to +30 μA	1.193	**0.678**	**2.259**	mmho
	Transconductance	V_{COMP} = 1.0V				
A_{VOL}	Error Amp	V_{COMP} = 0.5V to 1.6V	260	151/**75**		V/V
	Voltage Gain	R_{COMP} = 1.0 MΩ [(3)]				

(1) External components such as the diode, inductor, input and output capacitors can affect switching regulator performance. When the LM2587 is used as shown in Figure 6 and Figure 7, system performance will be as specified by the system parameters.
(2) 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.
(3) A 1.0 MΩ resistor is connected to the compensation pin (which is the error amplifier output) to ensure accuracy in measuring A_{VOL}.

LM2587-5.0 Electrical Characteristics

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 6 (1)						
V_{OUT}	Output Voltage	V_{IN} = 4V to 12V	5.0	4.80/**4.75**	5.20/**5.25**	V
		I_{LOAD} = 500 mA to 1.45A				
$\Delta V_{OUT}/$	Line Regulation	V_{IN} = 4V to 12V	20		50/**100**	mV
ΔV_{IN}		I_{LOAD} = 500 mA				
$\Delta V_{OUT}/$	Load Regulation	V_{IN} = 12V	20		50/**100**	mV
ΔI_{LOAD}		I_{LOAD} = 500 mA to 1.45A				
η	Efficiency	V_{IN} = 12V, I_{LOAD} = 750 mA	80			%
UNIQUE DEVICE PARAMETERS (2)						
V_{REF}	Output Reference	Measured at Feedback Pin	5.0	4.913/**4.900**	5.088/**5.100**	V
	Voltage	V_{COMP} = 1.0V				
ΔV_{REF}	Reference Voltage	V_{IN} = 4V to 40V	3.3			mV
	Line Regulation					
G_M	Error Amp	I_{COMP} = −30 μA to +30 μA	0.750	**0.447**	**1.491**	mmho
	Transconductance	V_{COMP} = 1.0V				
A_{VOL}	Error Amp	V_{COMP} = 0.5V to 1.6V	165	99/**49**		V/V
	Voltage Gain	R_{COMP} = 1.0 MΩ (3)				

(1) External components such as the diode, inductor, input and output capacitors can affect switching regulator performance. When the LM2587 is used as shown in Figure 6 and Figure 7, system performance will be as specified by the system parameters.
(2) 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.
(3) A 1.0 MΩ resistor is connected to the compensation pin (which is the error amplifier output) to ensure accuracy in measuring A_{VOL}.

LM2587-12 Electrical Characteristics

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 7 [(1)]						
V_{OUT}	Output Voltage	V_{IN} = 4V to 10V	12.0	11.52/**11.40**	12.48/**12.60**	V
		I_{LOAD} = 300 mA to 1.2A				
$\Delta V_{OUT}/$	Line Regulation	V_{IN} = 4V to 10V	20		100/**200**	mV
ΔV_{IN}		I_{LOAD} = 300 mA				
$\Delta V_{OUT}/$	Load Regulation	V_{IN} = 10V	20		100/**200**	mV
ΔI_{LOAD}		I_{LOAD} = 300 mA to 1.2A				
η	Efficiency	V_{IN} = 10V, I_{LOAD} = 1A	90			%
UNIQUE DEVICE PARAMETERS [(2)]						
V_{REF}	Output Reference	Measured at Feedback Pin	12.0	11.79/**11.76**	12.21/**12.24**	V
	Voltage	V_{COMP} = 1.0V				
ΔV_{REF}	Reference Voltage	V_{IN} = 4V to 40V	7.8			mV
	Line Regulation					
G_M	Error Amp	I_{COMP} = −30 μA to +30 μA	0.328	**0.186**	**0.621**	mmho
	Transconductance	V_{COMP} = 1.0V				
A_{VOL}	Error Amp	V_{COMP} = 0.5V to 1.6V	70	41/**21**		V/V
	Voltage Gain	R_{COMP} = 1.0 MΩ [(3)]				

(1) External components such as the diode, inductor, input and output capacitors can affect switching regulator performance. When the LM2587 is used as shown in Figure 6 and Figure 7, system performance will be as specified by the system parameters.
(2) 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.
(3) A 1.0 MΩ resistor is connected to the compensation pin (which is the error amplifier output) to ensure accuracy in measuring A_{VOL}.

LM2587-ADJ Electrical Characteristics

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 7 (1)						
V_{OUT}	Output Voltage	V_{IN} = 4V to 10V	12.0	11.52/**11.40**	12.48/**12.60**	V
		I_{LOAD} = 300 mA to 1.2A				
$\Delta V_{OUT}/$	Line Regulation	V_{IN} = 4V to 10V	20		100/**200**	mV
ΔV_{IN}		I_{LOAD} = 300 mA				
$\Delta V_{OUT}/$	Load Regulation	V_{IN} = 10V	20		100/**200**	mV
ΔI_{LOAD}		I_{LOAD} = 300 mA to 1.2A				
η	Efficiency	V_{IN} = 10V, I_{LOAD} = 1A	90			%
UNIQUE DEVICE PARAMETERS (2)						
V_{REF}	Output Reference	Measured at Feedback Pin	1.230	1.208/**1.205**	1.252/**1.255**	V
	Voltage	V_{COMP} = 1.0V				
ΔV_{REF}	Reference Voltage	V_{IN} = 4V to 40V	1.5			mV
	Line Regulation					
G_M	Error Amp	I_{COMP} = −30 μA to +30 μA	3.200	**1.800**	**6.000**	mmho
	Transconductance	V_{COMP} = 1.0V				
A_{VOL}	Error Amp	V_{COMP} = 0.5V to 1.6V	670	400/**200**		V/V
	Voltage Gain	R_{COMP} = 1.0 MΩ (3)				
I_B	Error Amp	V_{COMP} = 1.0V	125		425/**600**	nA
	Input Bias Current					

(1) External components such as the diode, inductor, input and output capacitors can affect switching regulator performance. When the LM2587 is used as shown in Figure 6 and Figure 7, system performance will be as specified by the system parameters.
(2) 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.
(3) A 1.0 MΩ resistor is connected to the compensation pin (which is the error amplifier output) to ensure accuracy in measuring A_{VOL}.

All Output Voltage Versions Electrical Characteristics [(1)]

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
I_S	Input Supply Current	(Switch Off)	11		15.5/**16.5**	mA
		(2)				
		I_{SWITCH} = 3.0A	85		140/**165**	mA
V_{UV}	Input Supply	R_{LOAD} = 100Ω	3.30	**3.05**	**3.75**	V
	Undervoltage Lockout					
f_O	Oscillator Frequency	Measured at Switch Pin				
		R_{LOAD} = 100Ω	100	85/**75**	115/**125**	kHz
		V_{COMP} = 1.0V				
f_{SC}	Short-Circuit	Measured at Switch Pin				
	Frequency	R_{LOAD} = 100Ω	25			kHz
		$V_{FEEDBACK}$ = 1.15V				
V_{EAO}	Error Amplifier	Upper Limit	2.8	2.6/**2.4**		V
	Output Swing	(3)				
		Lower Limit	0.25		0.40/**0.55**	V
		(2)				
I_{EAO}	Error Amp	(4)				
	Output Current		165	110/**70**	260/**320**	μA
	(Source or Sink)					
I_{SS}	Soft Start Current	$V_{FEEDBACK}$ = 0.92V	11.0	8.0/**7.0**	17.0/**19.0**	μA
		V_{COMP} = 1.0V				
D	Maximum Duty Cycle	R_{LOAD} = 100Ω	98	93/**90**		%
		(3)				
I_L	Switch Leakage	Switch Off	15		300/**600**	μA
	Current	V_{SWITCH} = 60V				
V_{SUS}	Switch Sustaining	dV/dT = 1.5V/ns		65		V
	Voltage					
V_{SAT}	Switch Saturation	I_{SWITCH} = 5.0A	0.7		1.1/**1.4**	V
	Voltage					
I_{CL}	NPN Switch		6.5	**5.0**	**9.5**	A
	Current Limit					
COMMON DEVICE PARAMETERS [(5)]						
θ_{JA}	Thermal Resistance	T Package, Junction to Ambient [(6)]	65			
θ_{JA}		T Package, Junction to Ambient [(7)]	45			
θ_{JC}		T Package, Junction to Case	2			

(1) 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.
(2) 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.
(3) 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.
(4) To measure the worst-case error amplifier output current, the LM2587 is tested with the feedback voltage set to its low value (specified in Note 7) and at its high value (specified in Note 8).
(5) External components such as the diode, inductor, input and output capacitors can affect switching regulator performance. When the LM2587 is used as shown in Figure 6 and Figure 7, system performance will be as specified by the system parameters.
(6) 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.
(7) 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.

All Output Voltage Versions Electrical Characteristics [1] (continued)

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
θ_{JA}		S Package, Junction to Ambient [8]	56			°C/W
θ_{JA}		S Package, Junction to Ambient [9]	35			
θ_{JA}		S Package, Junction to Ambient [10]	26			
θ_{JC}		S Package, Junction to Case	2			

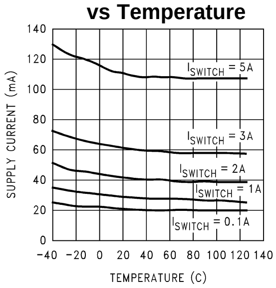
(8) Junction to ambient thermal resistance for the 5 lead TO-263 mounted horizontally against a PC board area of 0.136 square inches (the same size as the TO-263 package) of 1 oz. (0.0014 in. thick) copper.

(9) 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.

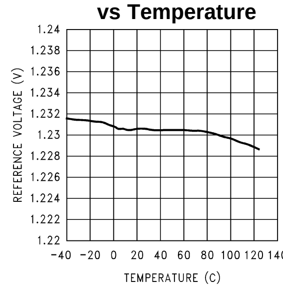
(10) Junction to ambient thermal resistance for the 5 lead TO-263 mounted horizontally against a PC board copper area of 1.0064 square inches (7.4 times the area of the TO-263 package) of 1 oz. (0.0014 in. thick) copper. Additional copper area will reduce thermal resistance further. See the thermal model in Switchers Made Simple® software.

Typical Performance Characteristics

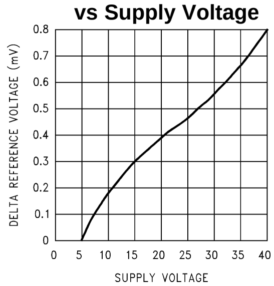
Supply Current vs Temperature



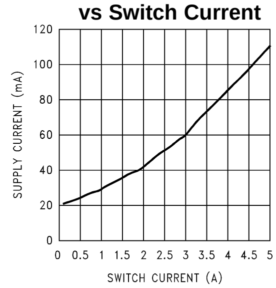
Reference Voltage vs Temperature



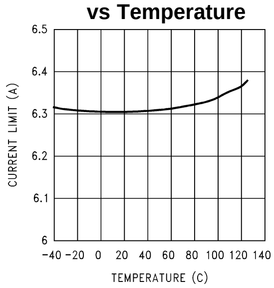
ΔReference Voltage vs Supply Voltage



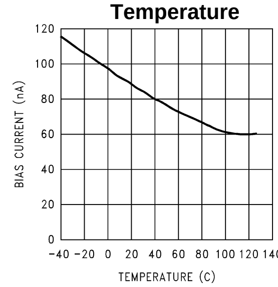
Supply Current vs Switch Current



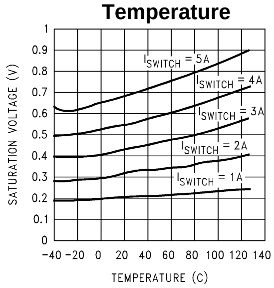
Current Limit vs Temperature



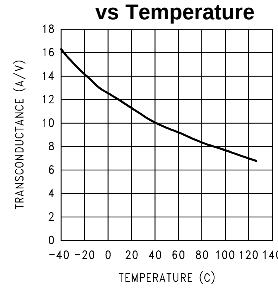
Feedback Pin Bias Current vs Temperature



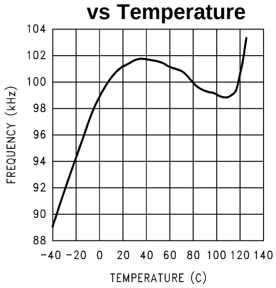
Switch Saturation Voltage vs Temperature



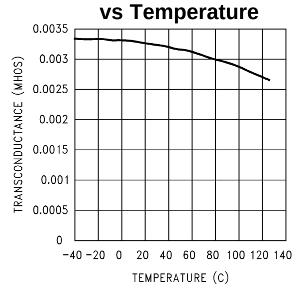
Switch Transconductance vs Temperature



Oscillator Frequency vs Temperature

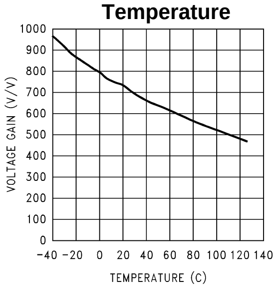


Error Amp Transconductance vs Temperature

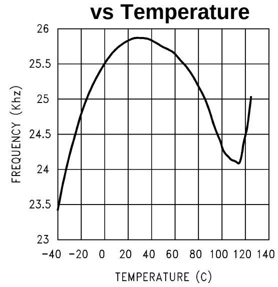


Typical Performance Characteristics (continued)

Error Amp Voltage Gain vs Temperature



Short Circuit Frequency vs Temperature



Connection Diagrams

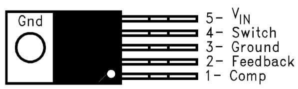


Figure 1. Bent, Staggered Leads 5-Lead TO-220 (T) Top View

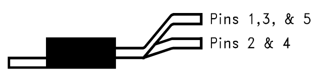


Figure 2. Bent, Staggered Leads 5-Lead TO-220 (T) Side View

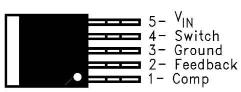
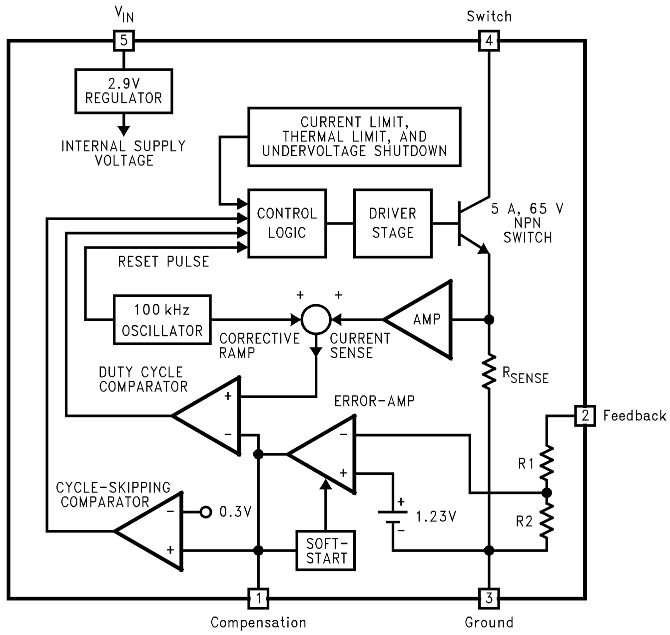


Figure 3. 5-Lead TO-263 (S) Top View

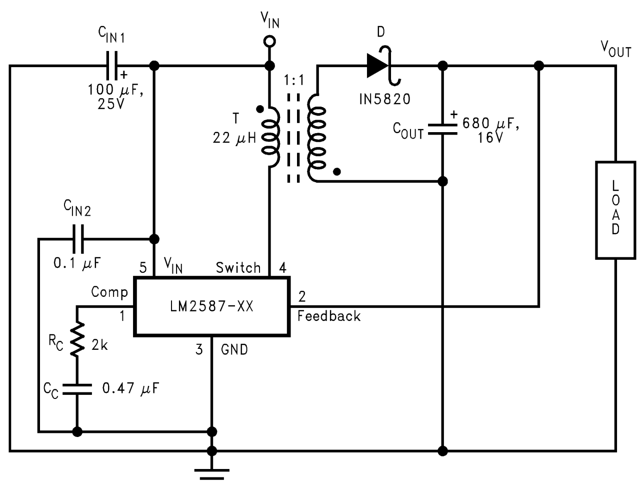
Figure 4. 5-Lead TO-263 (S) Side View



For Fixed Versions3.3V, R1 = 3.4k, R2 = 2k5V, R1 = 6.15k, R2 = 2k12V, R1 = 8.73k, R2 = 1kFor Adj. VersionR1 = Short (0Ω), R2 = Open

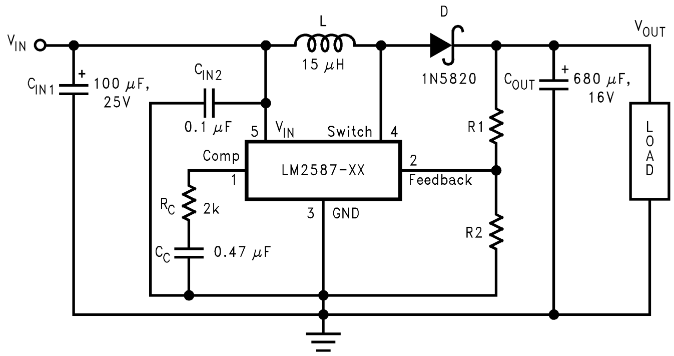
Figure 5. Block Diagram

Test Circuits



C_{IN1}—100 μF, 25V Aluminum ElectrolyticC_{IN2}—0.1 μF CeramicT—22 μH, 1:1 Schott #67141450D—1N5820C_{OUT}—680 μF, 16V Aluminum ElectrolyticC_C—0.47 μF CeramicR_C—2k

Figure 6. LM2587-3.3 and LM2587-5.0 Test Circuit



C_{IN1}—100 µF, 25V Aluminum ElectrolyticC_{IN2}—0.1 µF CeramicL—15 µH, Renco #RL-5472-5D—1N5820C_{OUT}—680 µF, 16V Aluminum ElectrolyticC_C—0.47 µF CeramicR_C—2kFor 12V Devices: R_1 = Short (0Ω) and R_2 = OpenFor ADJ Devices: R_1 = 48.75k, ±0.1% and R2 = 5.62k, ±1%

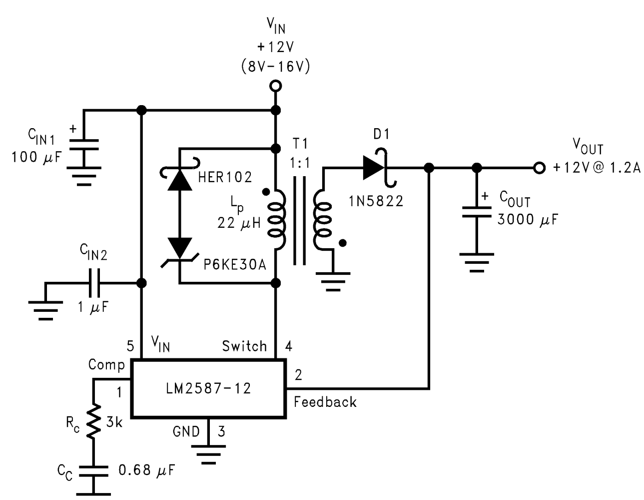
Figure 7. LM2587-12 and LM2587-ADJ Test Circuit

Flyback Regulator Operation

The LM2587 is ideally suited for use in the flyback regulator topology. The flyback regulator can produce a single output voltage, such as the one shown in Figure 8, or multiple output voltages. In Figure 8, the flyback regulator generates an output voltage that is inside the range of the input voltage. This feature is unique to flyback regulators and cannot be duplicated with buck or boost regulators.

The operation of a flyback regulator is as follows (refer to Figure 8): when the switch is on, current flows through the primary winding of the transformer, T1, storing energy in the magnetic field of the transformer. Note that the primary and secondary windings are out of phase, so no current flows through the secondary when current flows through the primary. When the switch turns off, the magnetic field collapses, reversing the voltage polarity of the primary and secondary windings. Now rectifier D1 is forward biased and current flows through it, releasing the energy stored in the transformer. This produces voltage at the output.

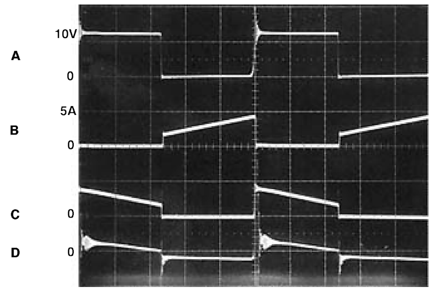
The output voltage is controlled by modulating the peak switch current. This is done by feeding back a portion of the output voltage to the error amp, which amplifies the difference between the feedback voltage and a 1.230V reference. The error amp output voltage is compared to a ramp voltage proportional to the switch current (i.e., inductor current during the switch on time). The comparator terminates the switch on time when the two voltages are equal, thereby controlling the peak switch current to maintain a constant output voltage.



As shown in Figure 8, the LM2587 can be used as a flyback regulator by using a minimum number of external components. The switching waveforms of this regulator are shown in Figure 9. Typical Performance Characteristics observed during the operation of this circuit are shown in Figure 10.

Figure 8. 12V Flyback Regulator Design Example

Performance Characteristics



A: Switch Voltage, 10 V/divB: Switch Current, 5 A/divC: Output Rectifier Current, 5 A/divD: Output Ripple Voltage, 100 mV/div AC-Coupled

Horizontal: 2 μs/div

Figure 9. Switching Waveforms

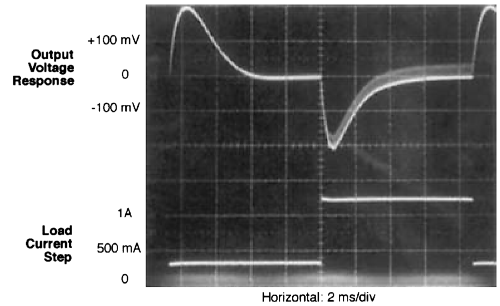


Figure 10. V_{OUT} Load Current Step Response

Typical Flyback Regulator Applications

Figure 11 Figure 12 Figure 13 Figure 15 Figure 16 show six typical flyback applications, varying from single output to triple output. Each drawing contains the part number(s) and manufacturer(s) for every component except the transformer. For the transformer part numbers and manufacturers names, see the table in TRANSFORMER SELECTION (T). For applications with different output voltages—requiring the LM2587-ADJ—or different output configurations that do not match the standard configurations, refer to the ***Switchers Made Simple*** software.

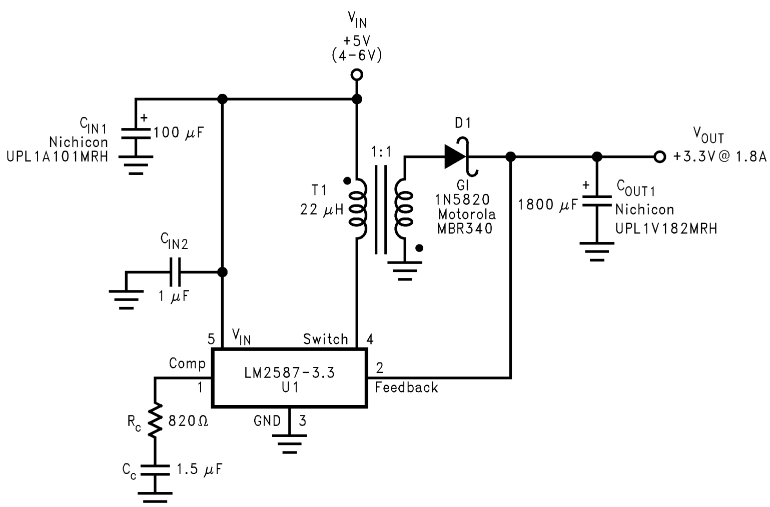


Figure 11. Single-Output Flyback Regulator

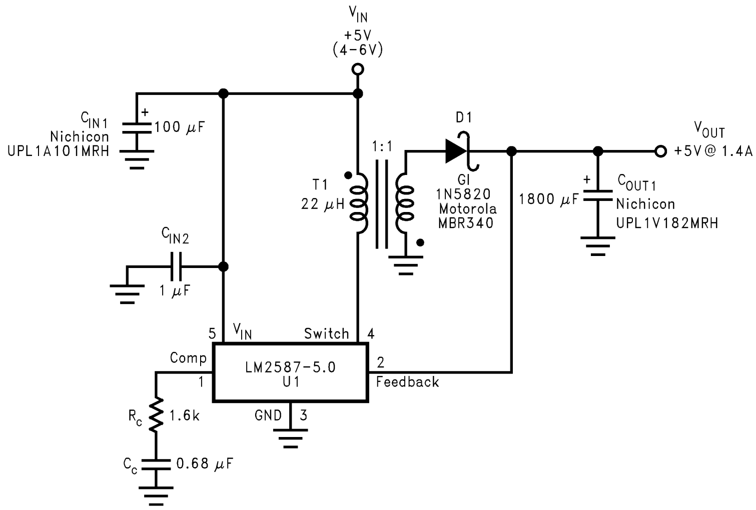


Figure 12. Single-Output Flyback Regulator

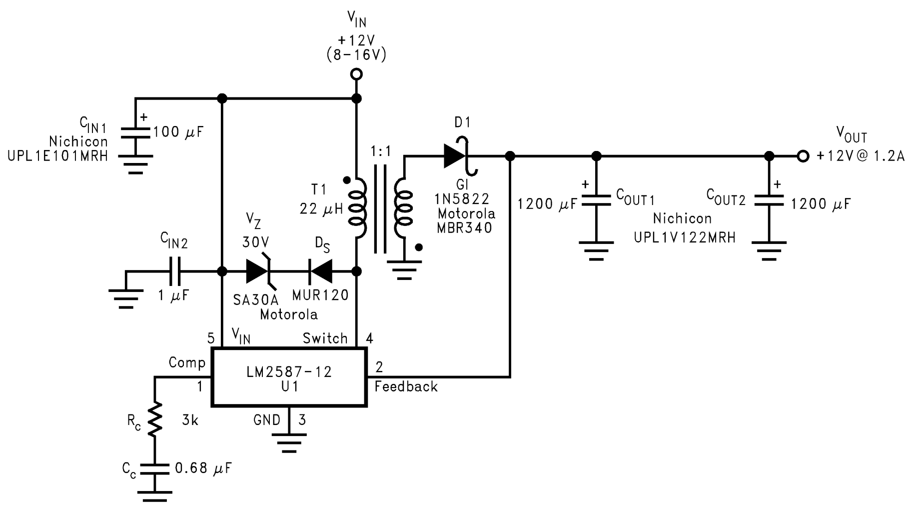


Figure 13. Single-Output Flyback Regulator

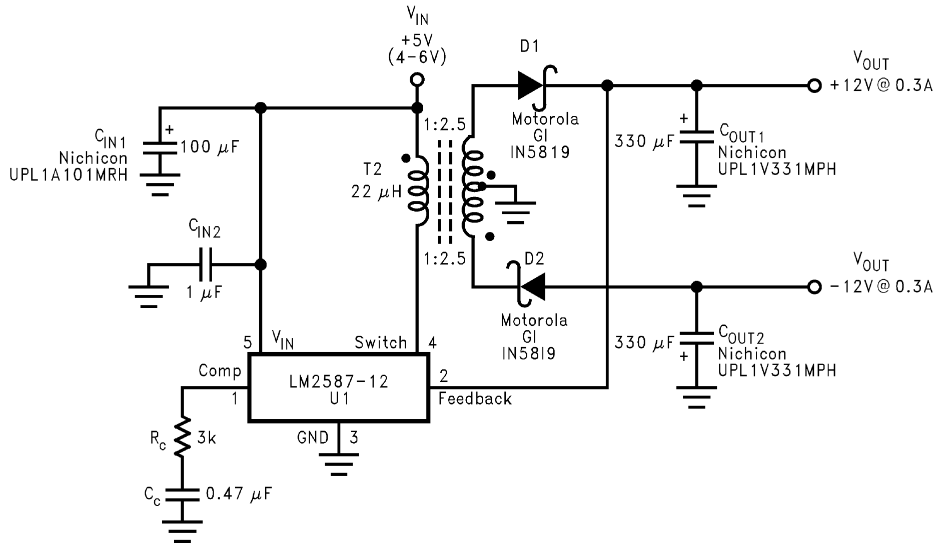


Figure 14. Dual-Output Flyback Regulator

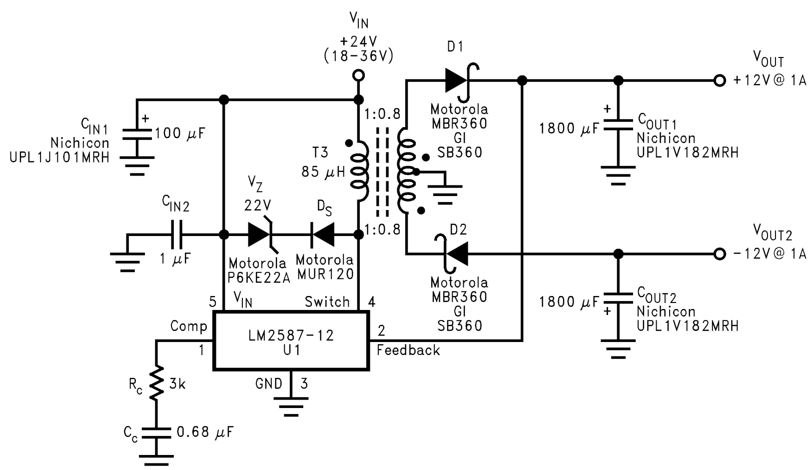


Figure 15. Dual-Output Flyback Regulator

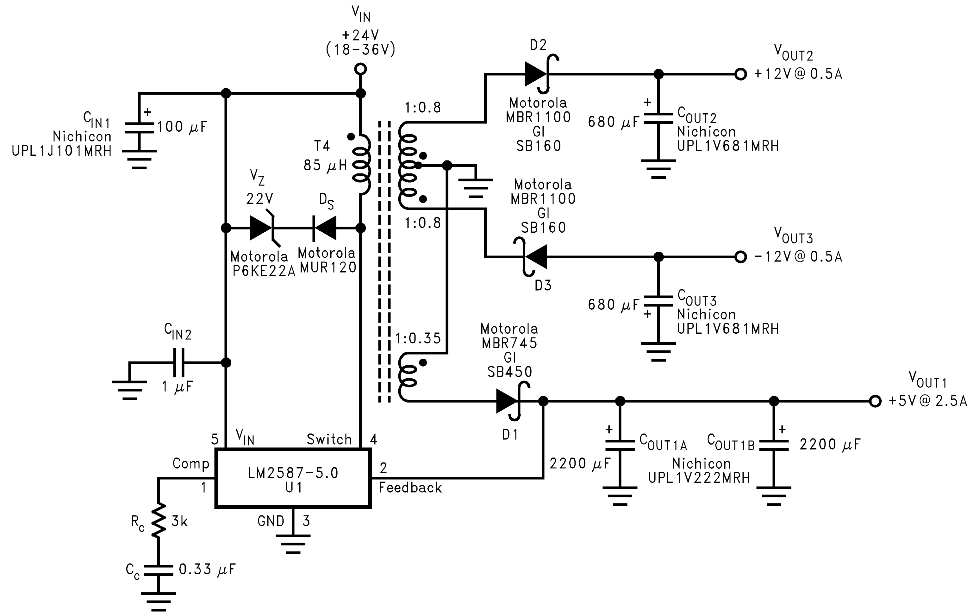


Figure 16. Triple-Output Flyback Regulator

TRANSFORMER SELECTION (T)

Table 1 lists the standard transformers available for flyback regulator applications. Included in the table are the turns ratio(s) for each transformer, as well as the output voltages, input voltage ranges, and the maximum load currents for each circuit.

Table 1. Transformer Selection Table

Applications	**Figure 11**	**Figure 12**	**Figure 13**	**Figure 14**	**Figure 15**	**Figure 16**
Transformers	**T1**	**T1**	**T1**	**T2**	**T3**	**T4**
V_{IN}	4V–6V	4V–6V	8V–16V	4V–6V	18V–36V	18V–36V
V_{OUT1}	3.3V	5V	12V	12V	12V	5V
I_{OUT1} (Max)	1.8A	1.4A	1.2A	0.3A	1A	2.5A
N_1	1	1	1	2.5	0.8	0.35
V_{OUT2}				−12V	−12V	12V
I_{OUT2} (Max)				0.3A	1A	0.5A
N_2				2.5	0.8	0.8
V_{OUT3}						−12V
I_{OUT3} (Max)						0.5A
N_3						0.8

Table 2. Transformer Manufacturer Guide

Transformer Type	**Manufacturers' Part Numbers**				
	Coilcraft (1)	**Coilcraft** (1)	**Pulse** (2)	**Renco** (3)	**Schott** (4)
		Surface Mount	**Surface Mount**		
T1	Q4434-B	Q4435-B	PE-68411	RL-5530	67141450
T2	Q4337-B	Q4436-B	PE-68412	RL-5531	67140860
T3	Q4343-B	—	PE-68421	RL-5534	67140920

(1) Coilcraft Inc.,: Phone: (800) 322-26451102 Silver Lake Road, Cary, IL 60013: Fax: (708) 639-1469
(2) Pulse Engineering Inc.,: Phone: (619) 674-810012220 World Trade Drive, San Diego, CA 92128: Fax: (619) 674-8262
(3) Renco Electronics Inc.,: Phone: (800) 645-582860 Jeffryn Blvd. East, Deer Park, NY 11729: Fax: (516) 586-5562
(4) Schott Corp.,: Phone: (612) 475-11731000 Parkers Lane Road, Wayzata, MN 55391: Fax: (612) 475-1786

Table 2. Transformer Manufacturer Guide (continued)

Transformer Type	Manufacturers' Part Numbers				
	Coilcraft[1]	Coilcraft [1]	Pulse [2]	Renco[3]	Schott[4]
		Surface Mount	Surface Mount		
T4	Q4344-B	—	PE-68422	RL-5535	67140930

TRANSFORMER FOOTPRINTS

Figure 17 Figure 18 Figure 19 Figure 20 Figure 21 Figure 22 Figure 23 Figure 24 Figure 25 Figure 26 Figure 27 Figure 28 Figure 29 Figure 30 Figure 31 Figure 32 Figure 33 and Figure 34 show the footprints of each transformer, listed in Table 1.

T1

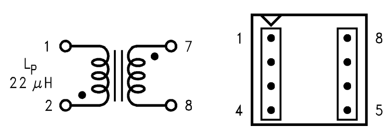


Figure 17. Coilcraft Q4434-B (Top View)

T2

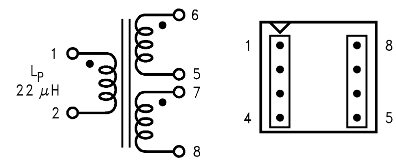


Figure 18. Coilcraft Q4337-B (Top View)

T3

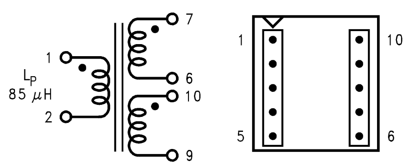


Figure 19. Coilcraft Q4343-B (Top View)

T4

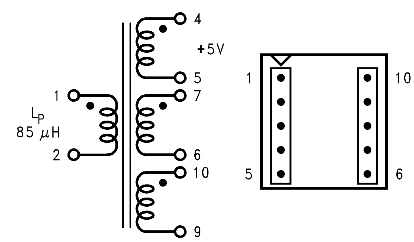


Figure 20. Coilcraft Q4344-B (Top View)

T1

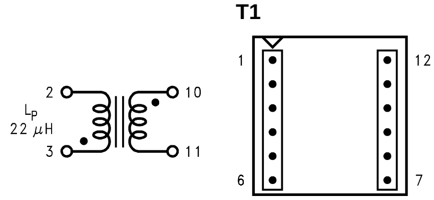


Figure 21. Coilcraft Q4435-B (Surface Mount) (Top View)

T2

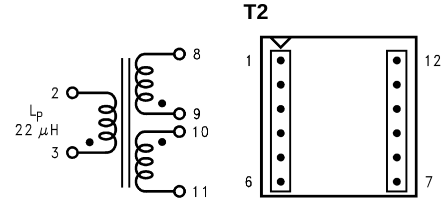


Figure 22. Coilcraft Q4436-B (Surface Mount) (Top View)

T1

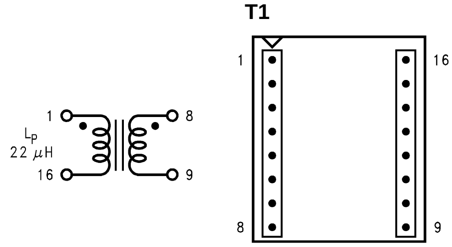


Figure 23. Pulse PE-68411 (Surface Mount) (Top View)

T2

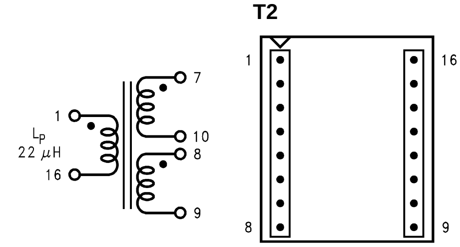


Figure 24. Pulse PE-68412 (Surface Mount) (Top View)

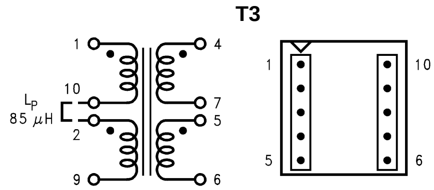


Figure 25. Pulse PE-68421 (Surface Mount) (Top View)

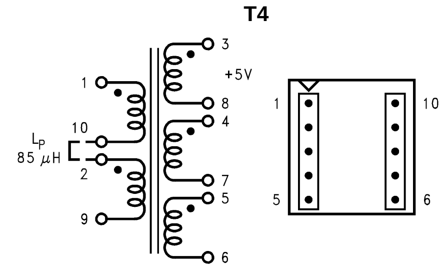


Figure 26. Pulse PE-68422 (Surface Mount) (Top View)

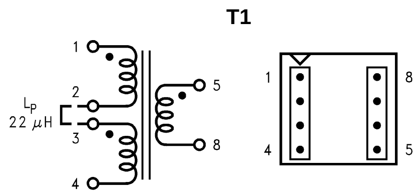


Figure 27. Renco RL-5530 (Top View)

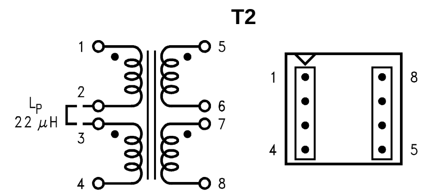


Figure 28. Renco RL-5531 (Top View)

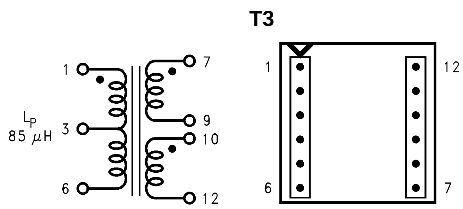


Figure 29. Renco RL-5534 (Top View)

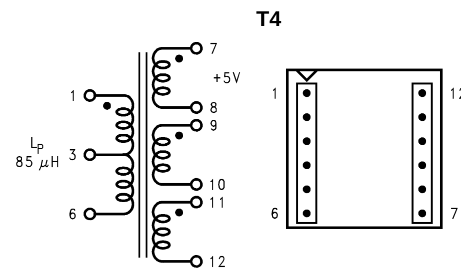


Figure 30. Renco RL-5535 (Top View)

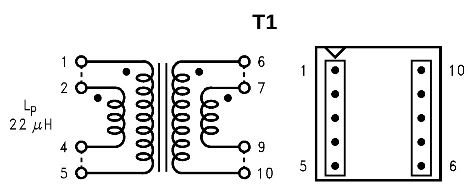


Figure 31. Schott 67141450 (Top View)

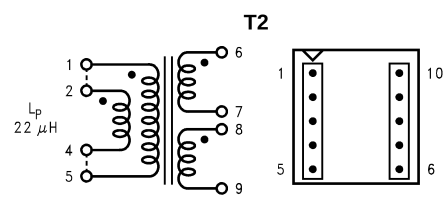


Figure 32. Schott 67140860 (Top View)

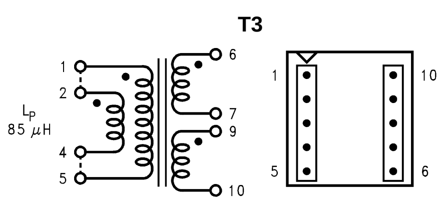


Figure 33. Schott 67140920 (Top View)

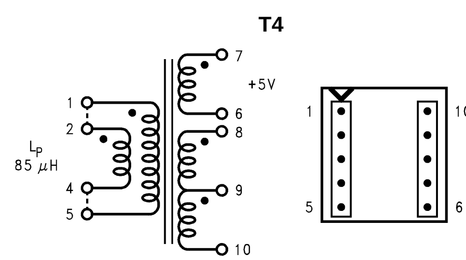
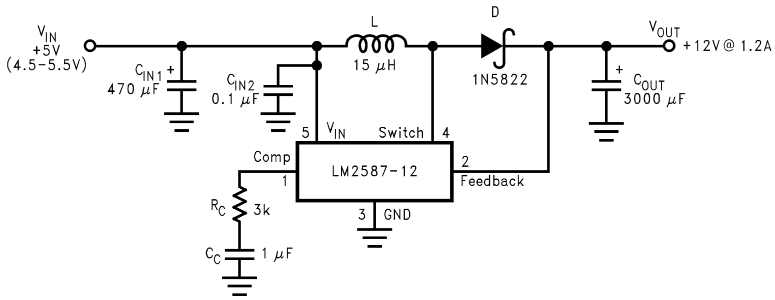


Figure 34. Schott 67140930 (Top View)

Step-Up (Boost) Regulator Operation

Figure 35 shows the LM2587 used as a step-up (boost) regulator. This is a switching regulator that produces an output voltage greater than the input supply voltage.

A brief explanation of how the LM2587 Boost Regulator works is as follows (refer to Figure 35). When the NPN switch turns on, the inductor current ramps up at the rate of V_{IN}/L, storing energy in the inductor. When the switch turns off, the lower end of the inductor flies above V_{IN}, discharging its current through diode (D) into the output capacitor (C_{OUT}) at a rate of (V_{OUT} − V_{IN})/L. Thus, energy stored in the inductor during the switch on time is transferred to the output during the switch off time. The output voltage is controlled by adjusting the peak switch current, as described in the flyback regulator section.

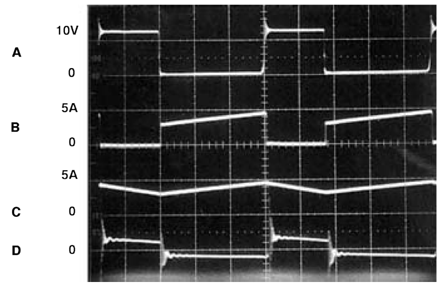


By adding a small number of external components (as shown in Figure 35), the LM2587 can be used to produce a regulated output voltage that is greater than the applied input voltage. The switching waveforms observed during the operation of this circuit are shown in Figure 36. Typical performance of this regulator is shown in Figure 37.

Figure 35. 12V Boost Regulator

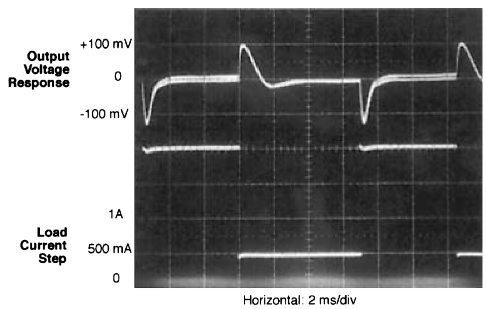
Typical Performance Characteristics

Figure 36. Switching Waveforms



A: Switch Voltage, 10 V/divB: Switch Current, 5 A/divC: Inductor Current, 5 A/divD: Output Ripple Voltage, 100 mV/div, AC-Coupled
Horizontal: 2 μs/div

Figure 37. V_{OUT} Response to Load Current Step



Typical Boost Regulator Applications

Figure 38 and Figure 39 Figure 40 and Figure 41 show four typical boost applications)—one fixed and three using the adjustable version of the LM2587. Each drawing contains the part number(s) and manufacturer(s) for every component. For the fixed 12V output application, the part numbers and manufacturers' names for the inductor are listed in a table in Figure 41. For applications with different output voltages, refer to the ***Switchers Made Simple*** software.

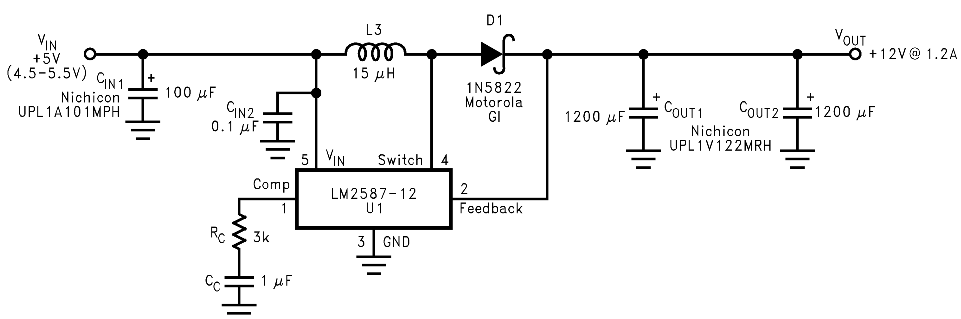


Figure 38. +5V to +12V Boost Regulator

Table 3 contains a table of standard inductors, by part number and corresponding manufacturer, for the fixed output regulator of Figure 38.

Table 3. Inductor Selection Table

Coilcraft [(1)](#fn1)	Pulse [(2)](#fn2)	Renco [(3)](#fn3)	Schott [(4)](#fn4)
R4793-A	PE-53900	RL-5472-5	67146520

(1) Coilcraft Inc.,: Phone: (800) 322-26451102 Silver Lake Road, Cary, IL 60013: Fax: (708) 639-1469
(2) Pulse Engineering Inc.,: Phone: (619) 674-810012220 World Trade Drive, San Diego, CA 92128: Fax: (619) 674-8262
(3) Renco Electronics Inc.,: Phone: (800) 645-582860 Jeffryn Blvd. East, Deer Park, NY 11729: Fax: (516) 586-5562
(4) Schott Corp.,: Phone: (612) 475-11731000 Parkers Lane Road, Wayzata, MN 55391: Fax: (612) 475-1786

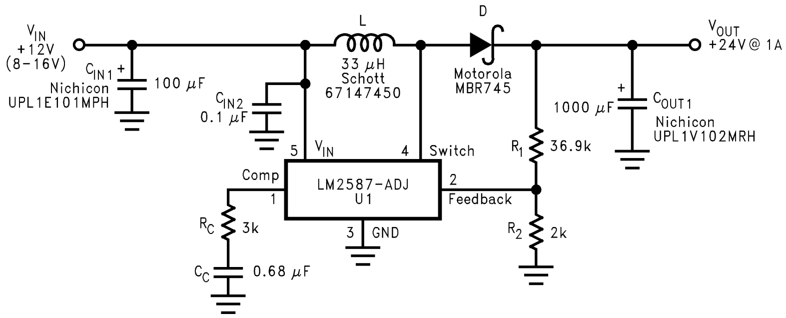


Figure 39. +12V to +24V Boost Regulator

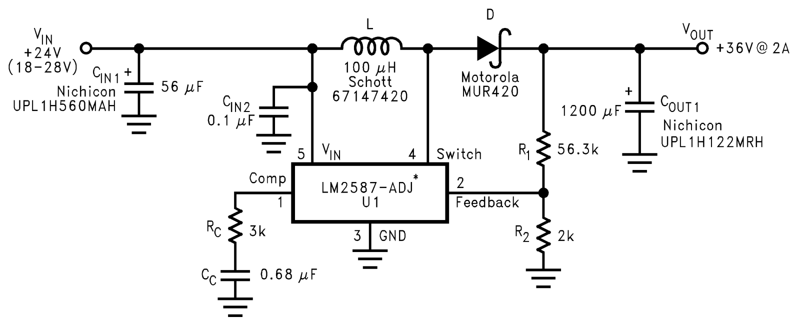
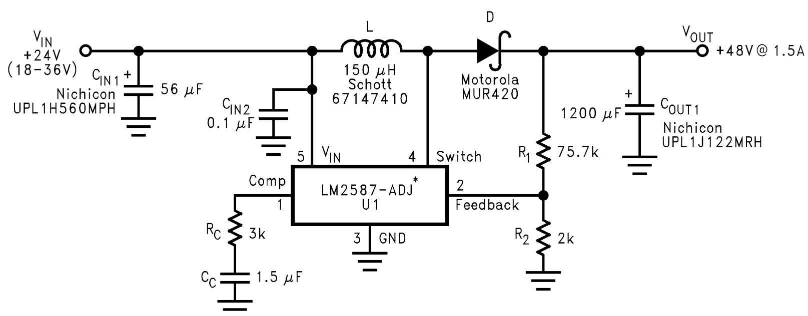


Figure 40. +24V to +36V Boost Regulator



*The LM2587 will require a heat sink in these applications. The size of the heat sink will depend on the maximum ambient temperature. To calculate the thermal resistance of the IC and the size of the heat sink needed, see the "Heat Sink/Thermal Considerations" section in the Application Hints.

Figure 41. +24V to +48V Boost Regulator

Application Hints

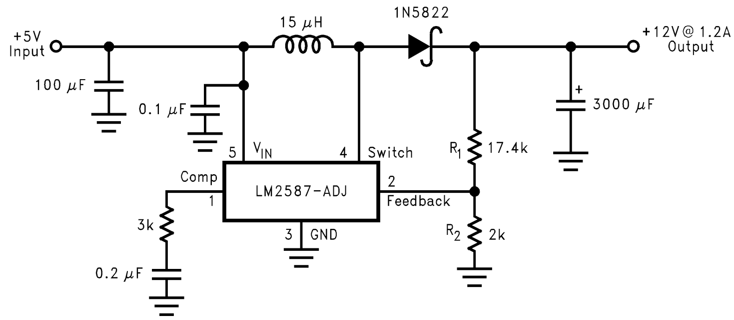


Figure 42. Boost Regulator

PROGRAMMING OUTPUT VOLTAGE (SELECTING R_1 AND R_2)

Referring to the adjustable regulator in Figure 42, the output voltage is programmed by the resistors R_1 and R_2 by the following formula:

$$V_{OUT} = V_{REF} (1 + R_1/R_2) \quad \text{where } V_{REF} = 1.23V \tag{1}$$

Resistors R_1 and R_2 divide the output voltage down so that it can be compared with the 1.23V internal reference. With R_2 between 1k and 5k, R_1 is:

$$R_1 = R_2 (V_{OUT}/V_{REF} - 1) \quad \text{where } V_{REF} = 1.23V \tag{2}$$

For best temperature coefficient and stability with time, use 1% metal film resistors.

SHORT CIRCUIT CONDITION

Due to the inherent nature of boost regulators, when the output is shorted (see Figure 42), current flows directly from the input, through the inductor and the diode, to the output, bypassing the switch. The current limit of the switch *does not* limit the output current for the entire circuit. To protect the load and prevent damage to the switch, the current must be externally limited, either by the input supply or at the output with an external current limit circuit. The external limit should be set to the maximum switch current of the device, which is 5A.

In a flyback regulator application (Figure 43), using the standard transformers, the LM2587 will survive a short circuit to the main output. When the output voltage drops to 80% of its nominal value, the frequency will drop to 25 kHz. With a lower frequency, off times are larger. With the longer off times, the transformer can release all of its stored energy before the switch turns back on. Hence, the switch turns on initially with zero current at its collector. In this condition, the switch current limit will limit the peak current, saving the device.

FLYBACK REGULATOR INPUT CAPACITORS

A flyback regulator draws discontinuous pulses of current from the input supply. Therefore, there are two input capacitors needed in a flyback regulator; one for energy storage and one for filtering (see Figure 43). Both are required due to the inherent operation of a flyback regulator. To keep a stable or constant voltage supply to the LM2587, a storage capacitor (≥100 μF) is required. If the input source is a recitified DC supply and/or the application has a wide temperature range, the required rms current rating of the capacitor might be very large. This means a larger value of capacitance or a higher voltage rating will be needed of the input capacitor. The storage capacitor will also attenuate noise which may interfere with other circuits connected to the same input supply voltage.

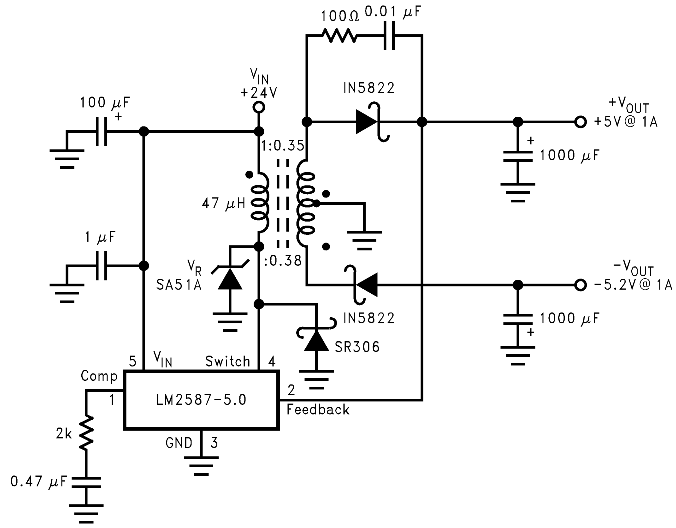


Figure 43. Flyback Regulator

In addition, a small bypass capacitor is required due to the noise generated by the input current pulses. To eliminate the noise, insert a 1.0 μF ceramic capacitor between V_{IN} and ground as close as possible to the device.

SWITCH VOLTAGE LIMITS

In a flyback regulator, the maximum steady-state voltage appearing at the switch, when it is off, is set by the transformer turns ratio, N, the output voltage, V_{OUT}, and the maximum input voltage, V_{IN} (Max):

$$V_{SW(OFF)} = V_{IN}\,(Max) + (V_{OUT} + V_F)/N \quad (3)$$

where V_F is the forward biased voltage of the output diode, and is 0.5V for Schottky diodes and 0.8V for ultra-fast recovery diodes (typically). In certain circuits, there exists a voltage spike, V_{LL}, superimposed on top of the steady-state voltage (see Figure 9, waveform A). Usually, this voltage spike is caused by the transformer leakage inductance and/or the output rectifier recovery time. To “clamp” the voltage at the switch from exceeding its maximum value, a transient suppressor in series with a diode is inserted across the transformer primary (as shown in the circuit on the front page and other flyback regulator circuits throughout the datasheet). The schematic in Figure 43 shows another method of clamping the switch voltage. A single voltage transient suppressor (the SA51A) is inserted at the switch pin. This method clamps the total voltage across the switch, not just the voltage across the primary.

If poor circuit layout techniques are used (see the “Circuit Layout Guideline” section), negative voltage transients may appear on the Switch pin (pin 4). Applying a negative voltage (with respect to the IC's ground) to any monolithic IC pin causes erratic and unpredictable operation of that IC. This holds true for the LM2587 IC as well. When used in a flyback regulator, the voltage at the Switch pin (pin 4) can go negative when the switch turns on. The “ringing” voltage at the switch pin is caused by the output diode capacitance and the transformer leakage inductance forming a resonant circuit at the secondary(ies). The resonant circuit generates the “ringing” voltage, which gets reflected back through the transformer to the switch pin. There are two common methods to avoid this problem. One is to add an RC snubber around the output rectifier(s), as in Figure 43. The values of the resistor and the capacitor must be chosen so that the voltage at the Switch pin does not drop below −0.4V. The resistor may range in value between 10Ω and 1 kΩ, and the capacitor will vary from 0.001 μF to 0.1 μF. Adding a snubber will (slightly) reduce the efficiency of the overall circuit.

The other method to reduce or eliminate the “ringing” is to insert a Schottky diode clamp between pins 4 and 3 (ground), also shown in Figure 43. This prevents the voltage at pin 4 from dropping below −0.4V. The reverse voltage rating of the diode must be greater than the switch off voltage.

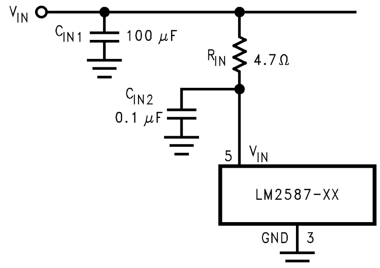


Figure 44. Input Line Filter

OUTPUT VOLTAGE LIMITATIONS

The maximum output voltage of a boost regulator is the maximum switch voltage minus a diode drop. In a flyback regulator, the maximum output voltage is determined by the turns ratio, N, and the duty cycle, D, by the equation:

$$V_{OUT} \approx N \times V_{IN} \times D/(1 - D) \quad (4)$$

The duty cycle of a flyback regulator is determined by the following equation:

$$D = \frac{V_{OUT} + V_F}{N(V_{IN} - V_{SAT}) + V_{OUT} + V_F} \approx \frac{V_{OUT}}{N(V_{IN}) + V_{OUT}} \quad (5)$$

Theoretically, the maximum output voltage can be as large as desired—just keep increasing the turns ratio of the transformer. However, there exists some physical limitations that prevent the turns ratio, and thus the output voltage, from increasing to infinity. The physical limitations are capacitances and inductances in the LM2587 switch, the output diode(s), and the transformer—such as reverse recovery time of the output diode (mentioned above).

NOISY INPUT LINE CONDITION)

A small, low-pass RC filter should be used at the input pin of the LM2587 if the input voltage has an unusual large amount of transient noise, such as with an input switch that bounces. The circuit in Figure 44 demonstrates the layout of the filter, with the capacitor placed from the input pin to ground and the resistor placed between the input supply and the input pin. Note that the values of R_{IN} and C_{IN} shown in the schematic are good enough for most applications, but some readjusting might be required for a particular application. If efficiency is a major concern, replace the resistor with a small inductor (say 10 μH and rated at 100 mA).

STABILITY

All current-mode controlled regulators can suffer from an instability, known as subharmonic oscillation, if they operate with a duty cycle above 50%. To eliminate subharmonic oscillations, a minimum value of inductance is required to ensure stability for all boost and flyback regulators. The minimum inductance is given by:

$$L(Min) = \frac{2.92\,[(V_{IN}(Min) - V_{SAT}) \times (2D(Max) - 1)]}{1 - D(Max)}\ (\mu H) \quad (6)$$

where V_{SAT} is the switch saturation voltage and can be found in the Characteristic Curves.

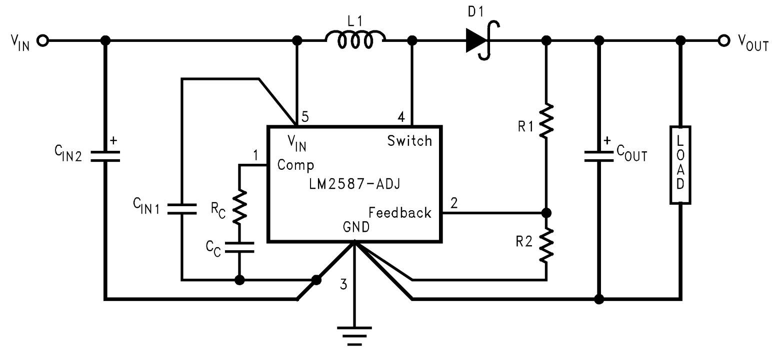


Figure 45. Circuit Board Layout

CIRCUIT LAYOUT GUIDELINES

As in any switching regulator, layout is very important. Rapidly switching currents associated with wiring inductance generate voltage transients which can cause problems. For minimal inductance and ground loops, keep the length of the leads and traces as short as possible. Use single point grounding or ground plane construction for best results. Separate the signal grounds from the power grounds (as indicated in Figure 45). When using the Adjustable version, physically locate the programming resistors as near the regulator IC as possible, to keep the sensitive feedback wiring short.

HEAT SINK/THERMAL CONSIDERATIONS

In many cases, no heat sink is required to keep the LM2587 junction temperature within the allowed operating range. For each application, to determine whether or not a heat sink will be required, the following must be identified:

1) Maximum ambient temperature (in the application).

2) Maximum regulator power dissipation (in the application).

3) Maximum allowed junction temperature (125°C for the LM2587). For a safe, conservative design, a temperature approximately 15°C cooler than the maximum junction temperature should be selected (110°C).

4) LM2587 package thermal resistances θ_{JA} and θ_{JC} (given in the Electrical Characteristics).

Total power dissipated (P_D) by the LM2587 can be estimated as follows:

Boost:

$$P_D = 0.15\Omega \times \left(\frac{I_{LOAD}}{1-D}\right)^2 \times D + \frac{I_{LOAD}}{50 \times (1-D)} \times D \times V_{IN}$$

Flyback:

$$P_D = 0.15\Omega \times \left(\frac{N \times \Sigma I_{LOAD}}{1-D}\right)^2 \times D + \frac{N \times \Sigma I_{LOAD}}{50 \times (1-D)} \times D \times V_{IN} \tag{7}$$

V_{IN} is the minimum input voltage, V_{OUT} is the output voltage, N is the transformer turns ratio, D is the duty cycle, and I_{LOAD} is the maximum load current (and $\sum I_{LOAD}$ is the sum of the maximum load currents for multiple-output flyback regulators). The duty cycle is given by:

Boost:

$$D = \frac{V_{OUT} + V_F - V_{IN}}{V_{OUT} + V_F - V_{SAT}} \approx \frac{V_{OUT} - V_{IN}}{V_{OUT}}$$

Flyback:

$$D = \frac{V_{OUT} + V_F}{N(V_{IN} - V_{SAT}) + V_{OUT} + V_F} \approx \frac{V_{OUT}}{N(V_{IN}) + V_{OUT}} \tag{8}$$

where V_F is the forward biased voltage of the diode and is typically 0.5V for Schottky diodes and 0.8V for fast recovery diodes. V_{SAT} is the switch saturation voltage and can be found in the Characteristic Curves.

When no heat sink is used, the junction temperature rise is:

$$\Delta T_J = P_D \times \theta_{JA}. \quad (9)$$

Adding the junction temperature rise to the maximum ambient temperature gives the actual operating junction temperature:

$$T_J = \Delta T_J + T_A. \quad (10)$$

If the operating junction temperature exceeds the maximum junction temperatue in item 3 above, then a heat sink is required. When using a heat sink, the junction temperature rise can be determined by the following:

$$\Delta T_J = P_D \times (\theta_{JC} + \theta_{Interface} + \theta_{Heat\ Sink}) \quad (11)$$

Again, the operating junction temperature will be:

$$T_J = \Delta T_J + T_A \quad (12)$$

As before, if the maximum junction temperature is exceeded, a larger heat sink is required (one that has a lower thermal resistance).

Included in the ***Switchers Made Simple*** design software is a more precise (non-linear) thermal model that can be used to determine junction temperature with different input-output parameters or different component values. It can also calculate the heat sink thermal resistance required to maintain the regulator junction temperature below the maximum operating temperature.

To further simplify the flyback regulator design procedure, National Semiconductor is making available computer design software. ***Switchers Made Simple*** *software is available on a (3½") diskette for IBM compatable computers from a National Semiconductor sales office in your area or the National Semiconductor Customer Response Center (1-800-272-9959).*

European Magnetic Vendor Contacts

Please contact the following addresses for details of local distributors or representatives:

Coilcraft

21 Napier Place

Wardpark North Cumbernauld, Scotland G68 0LL Phone: +44 1236 730 595 Fax: +44 1236 730 627

Pulse Engineering

Dunmore Road

Tuam Co. Galway, Ireland Phone: +353 93 24 107 Fax: +353 93 24 459

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Samples (Requires Login)
LM2587S-12	ACTIVE	DDPAK/ TO-263	KTT	5	45	TBD	CU SNPB	Level-3-235C-168 HR	
LM2587S-12/NOPB	ACTIVE	DDPAK/ TO-263	KTT	5	45	Pb-Free (RoHS Exempt)	CU SN	Level-3-245C-168 HR	
LM2587S-3.3	ACTIVE	DDPAK/ TO-263	KTT	5	45	TBD	CU SNPB	Level-3-235C-168 HR	
LM2587S-3.3/NOPB	ACTIVE	DDPAK/ TO-263	KTT	5	45	Pb-Free (RoHS Exempt)	CU SN	Level-3-245C-168 HR	
LM2587S-5.0	ACTIVE	DDPAK/ TO-263	KTT	5	45	TBD	CU SNPB	Level-3-235C-168 HR	
LM2587S-5.0/NOPB	ACTIVE	DDPAK/ TO-263	KTT	5	45	Pb-Free (RoHS Exempt)	CU SN	Level-3-245C-168 HR	
LM2587S-ADJ	ACTIVE	DDPAK/ TO-263	KTT	5	45	TBD	CU SNPB	Level-3-235C-168 HR	
LM2587S-ADJ/NOPB	ACTIVE	DDPAK/ TO-263	KTT	5	45	Pb-Free (RoHS Exempt)	CU SN	Level-3-245C-168 HR	
LM2587SX-12	ACTIVE	DDPAK/ TO-263	KTT	5	500	TBD	CU SNPB	Level-3-235C-168 HR	
LM2587SX-12/NOPB	ACTIVE	DDPAK/ TO-263	KTT	5	500	Pb-Free (RoHS Exempt)	CU SN	Level-3-245C-168 HR	
LM2587SX-3.3	ACTIVE	DDPAK/ TO-263	KTT	5	500	TBD	CU SNPB	Level-3-235C-168 HR	
LM2587SX-5.0	ACTIVE	DDPAK/ TO-263	KTT	5	500	TBD	CU SNPB	Level-3-235C-168 HR	
LM2587SX-5.0/NOPB	ACTIVE	DDPAK/ TO-263	KTT	5	500	Pb-Free (RoHS Exempt)	CU SN	Level-3-245C-168 HR	
LM2587SX-ADJ	ACTIVE	DDPAK/ TO-263	KTT	5	500	TBD	CU SNPB	Level-3-235C-168 HR	
LM2587SX-ADJ/NOPB	ACTIVE	DDPAK/ TO-263	KTT	5	500	Pb-Free (RoHS Exempt)	CU SN	Level-3-245C-168 HR	
LM2587T-12	ACTIVE	TO-220	NDH	5	45	TBD	CU SNPB	Level-1-NA-UNLIM	
LM2587T-12/NOPB	ACTIVE	TO-220	NDH	5	45	Pb-Free (RoHS Exempt)	CU SN	Level-1-NA-UNLIM	
LM2587T-3.3	ACTIVE	TO-220	NDH	5	45	TBD	CU SNPB	Level-1-NA-UNLIM	

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Samples (Requires Login)
LM2587T-3.3/NOPB	ACTIVE	TO-220	NDH	5	45	Pb-Free (RoHS Exempt)	CU SN	Level-1-NA-UNLIM	
LM2587T-5.0	ACTIVE	TO-220	NDH	5	45	TBD	CU SNPB	Level-1-NA-UNLIM	
LM2587T-5.0/NOPB	ACTIVE	TO-220	NDH	5	45	Pb-Free (RoHS Exempt)	CU SN	Level-1-NA-UNLIM	
LM2587T-ADJ	ACTIVE	TO-220	NDH	5	45	TBD	CU SNPB	Level-1-NA-UNLIM	
LM2587T-ADJ/NOPB	ACTIVE	TO-220	NDH	5	45	Pb-Free (RoHS Exempt)	CU SN	Level-1-NA-UNLIM	

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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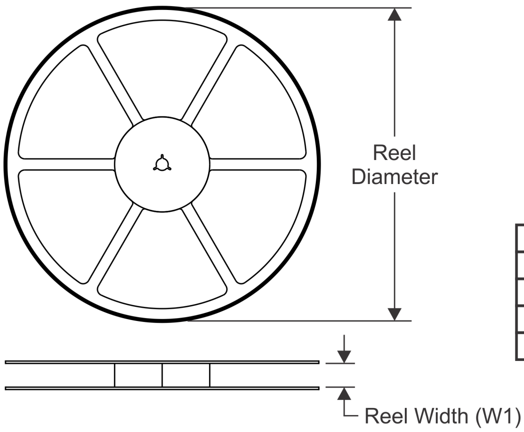
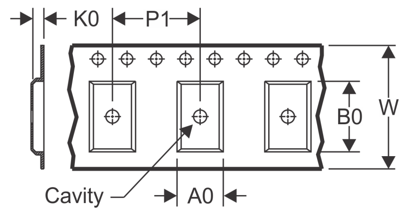
TAPE AND REEL INFORMATION

REEL DIMENSIONS

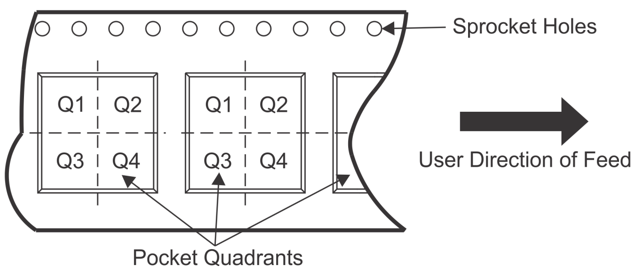


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

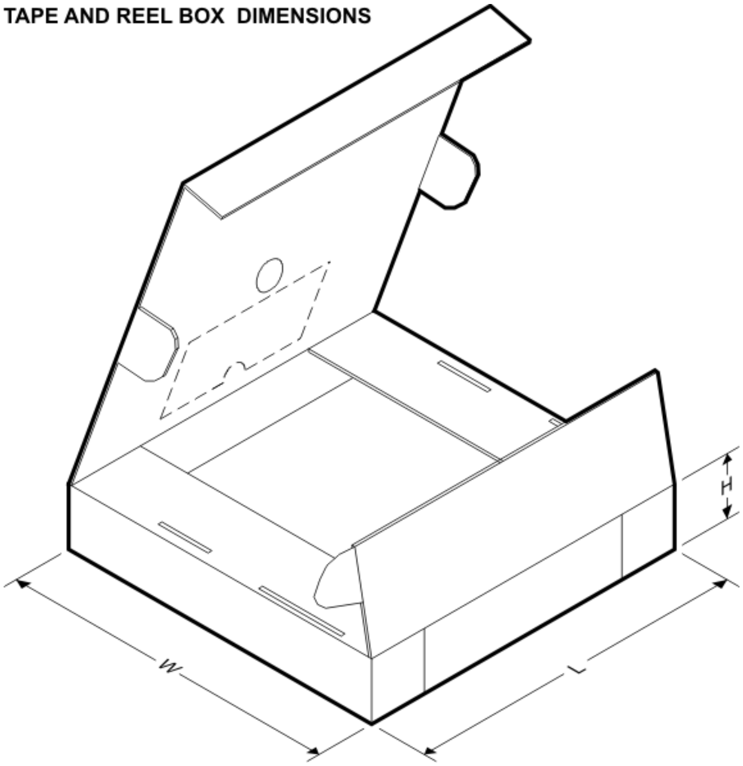
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
LM2587SX-12	DDPAK/ TO-263	KTT	5	500	330.0	24.4	10.75	14.85	5.0	16.0	24.0	Q2
LM2587SX-12/NOPB	DDPAK/ TO-263	KTT	5	500	330.0	24.4	10.75	14.85	5.0	16.0	24.0	Q2
LM2587SX-3.3	DDPAK/ TO-263	KTT	5	500	330.0	24.4	10.75	14.85	5.0	16.0	24.0	Q2
LM2587SX-5.0	DDPAK/ TO-263	KTT	5	500	330.0	24.4	10.75	14.85	5.0	16.0	24.0	Q2
LM2587SX-5.0/NOPB	DDPAK/ TO-263	KTT	5	500	330.0	24.4	10.75	14.85	5.0	16.0	24.0	Q2
LM2587SX-ADJ	DDPAK/ TO-263	KTT	5	500	330.0	24.4	10.75	14.85	5.0	16.0	24.0	Q2
LM2587SX-ADJ/NOPB	DDPAK/ TO-263	KTT	5	500	330.0	24.4	10.75	14.85	5.0	16.0	24.0	Q2

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM2587SX-12	DDPAK/TO-263	KTT	5	500	358.0	343.0	63.0
LM2587SX-12/NOPB	DDPAK/TO-263	KTT	5	500	358.0	343.0	63.0
LM2587SX-3.3	DDPAK/TO-263	KTT	5	500	358.0	343.0	63.0
LM2587SX-5.0	DDPAK/TO-263	KTT	5	500	358.0	343.0	63.0
LM2587SX-5.0/NOPB	DDPAK/TO-263	KTT	5	500	358.0	343.0	63.0
LM2587SX-ADJ	DDPAK/TO-263	KTT	5	500	358.0	343.0	63.0
LM2587SX-ADJ/NOPB	DDPAK/TO-263	KTT	5	500	358.0	343.0	63.0

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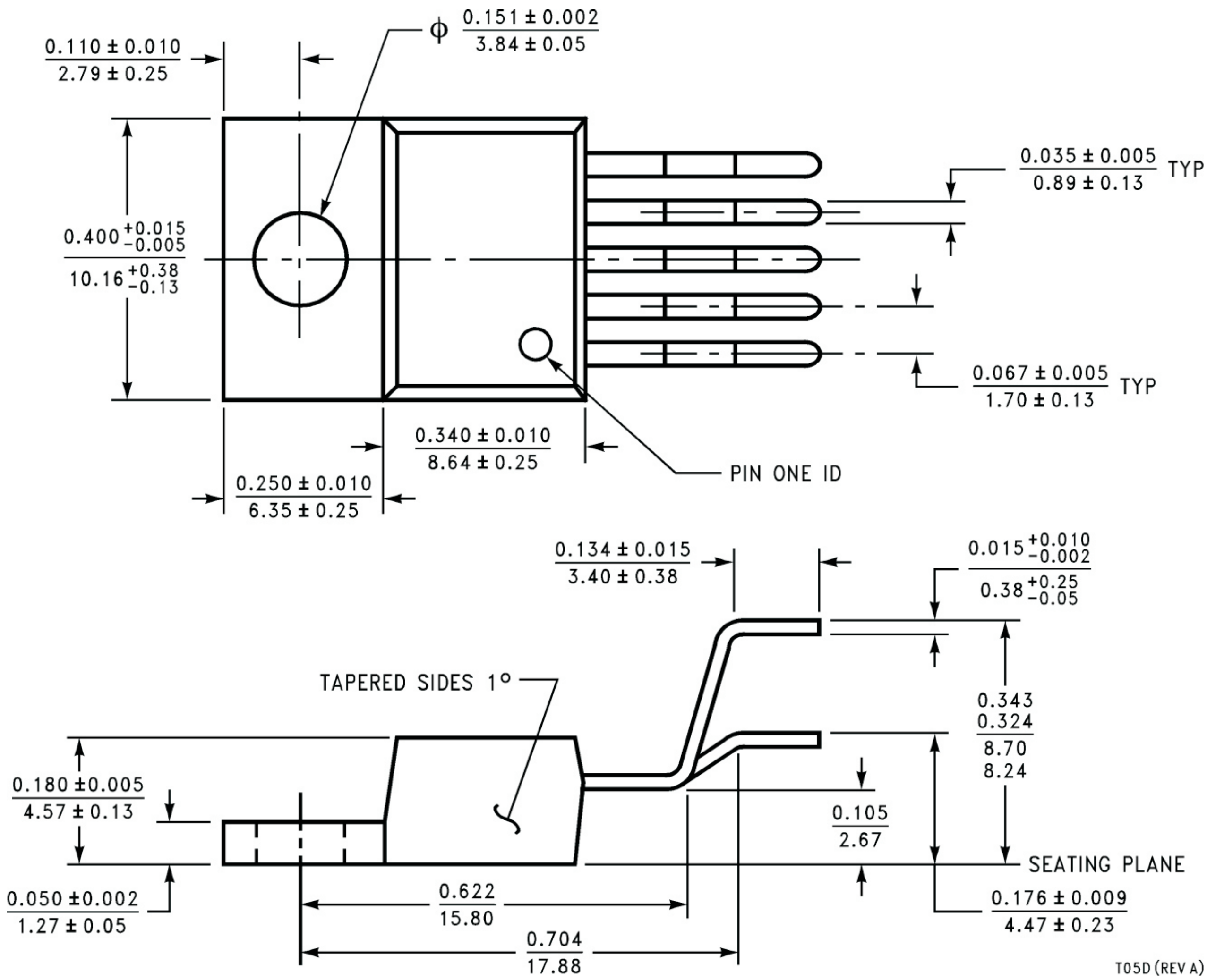
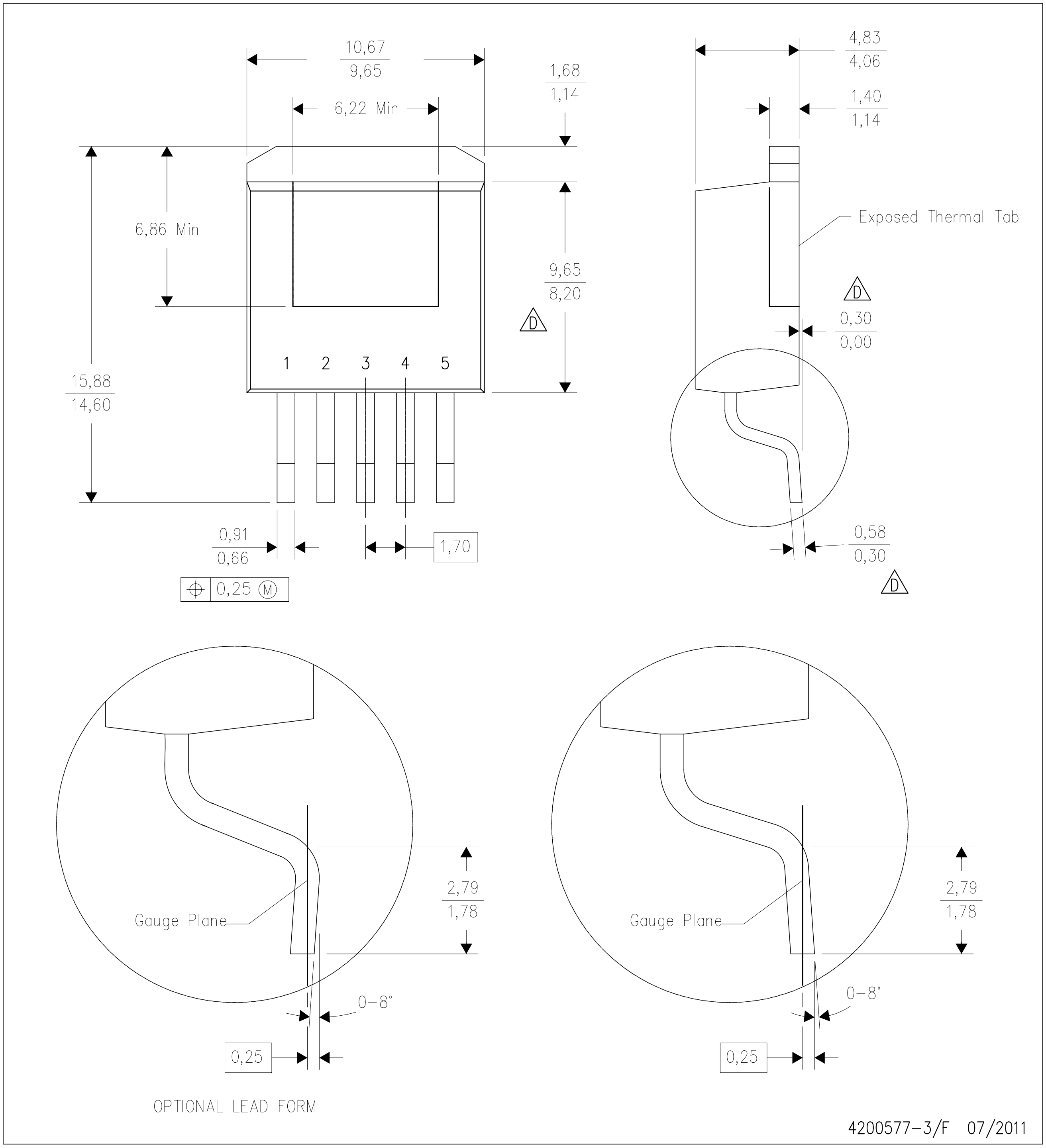


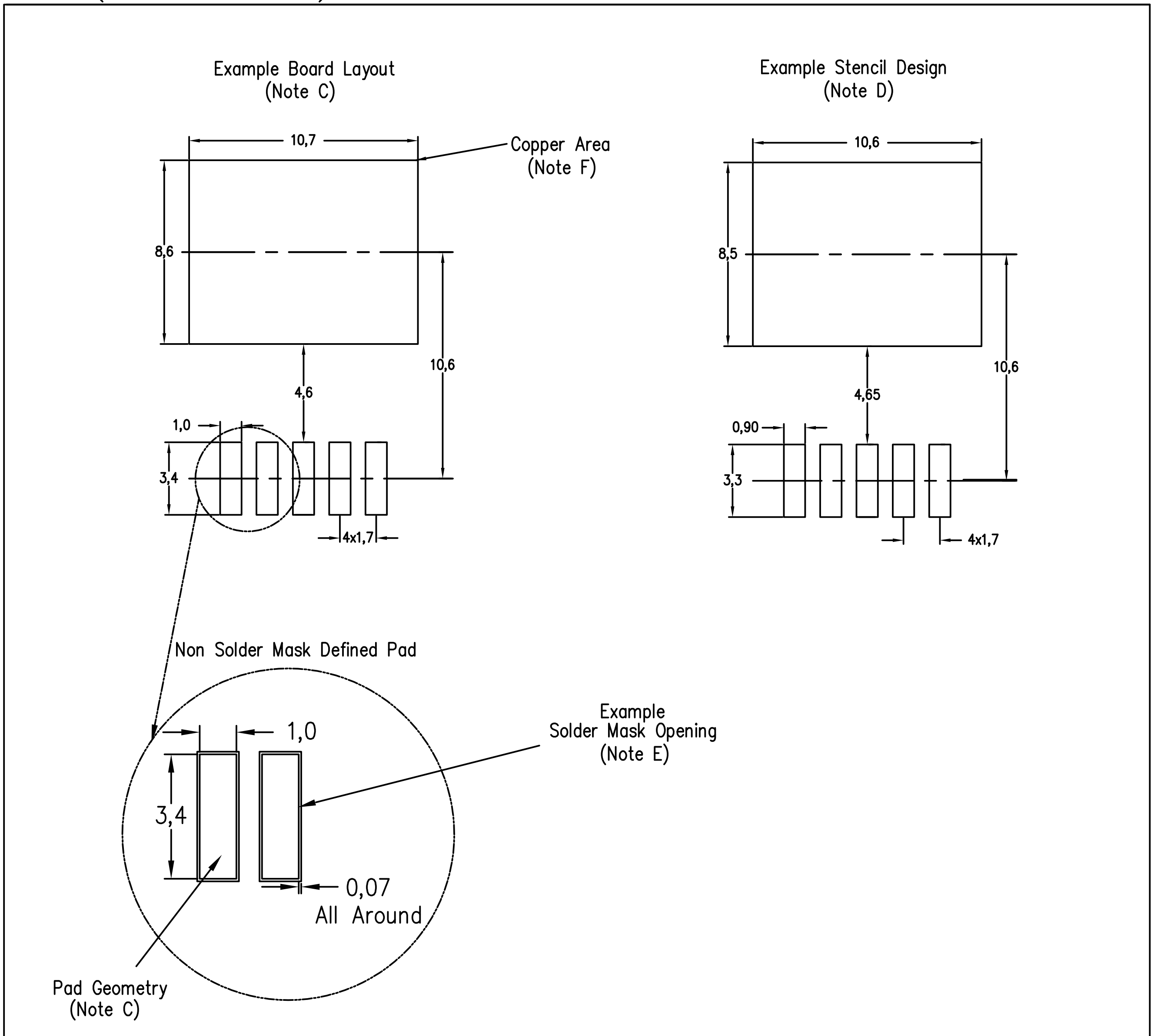
0.110 ± 0.010
2.79 ± 0.25
φ 0.151 ± 0.002
3.84 ± 0.05
0.035 ± 0.005
0.89 ± 0.13 TYP
0.400 +0.015 −0.005
10.16 +0.38 −0.13
0.067 ± 0.005
1.70 ± 0.13 TYP
0.340 ± 0.010
8.64 ± 0.25
PIN ONE ID
0.250 ± 0.010
6.35 ± 0.25
0.134 ± 0.015
3.40 ± 0.38
0.015 +0.010 −0.002
0.38 +0.25 −0.05
TAPERED SIDES 1°
0.343
0.324
8.70
8.24
0.180 ±0.005
4.57 ± 0.13
0.105
2.67
SEATING PLANE
0.050 ±0.002
1.27 ± 0.05
0.622
15.80
0.176 ± 0.009
4.47 ± 0.23
0.704
17.88
T05D (REV A)

KTT (R–PSFM–G5) PLASTIC FLANGE–MOUNT PACKAGE



NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion. Mold flash or protrusion not to exceed 0.005 (0,13) per side.
D. Falls within JEDEC TO–263 variation BA, except minimum lead thickness, maximum seating height, and minimum body length.

KTT (R–PSFM–G5) PLASTIC FLANGE–MOUNT PACKAGE



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NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Publication IPC–SM–782 is recommended for alternate designs.
D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC–7525.
E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.
F. This package is designed to be soldered to a thermal pad on the board. Refer to the Product Datasheet for specific thermal information, via requirements, and recommended thermal pad size. For thermal pad sizes larger than shown a solder mask defined pad is recommended in order to maintain the solderable pad geometry while increasing copper area.

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