TNY263-268

TinySwitch-II® Family

Enhanced, Energy Efficient, Low Power Off-line Switcher

Product Highlights

TinySwitch-II Features Reduce System Cost

- Fully integrated auto-restart for short circuit and open loop fault protection – saves external component costs
- Built-in circuitry practically eliminates audible noise with ordinary dip-varnished transformer
- Programmable line under-voltage detect feature prevents power on/off glitches – saves external components
- Frequency jittering dramatically reduces EMI (~10 dB) – minimizes EMI filter component costs
- 132 kHz operation reduces transformer size – allows use of EF12.6 or EE13 cores for low cost and small size
- Very tight tolerances and negligible temperature variation on key parameters eases design and lowers cost
- Lowest component count switcher solution
- Expanded scalable device family for low system cost

Better Cost/Performance over RCC & Linears

- Lower system cost than RCC, discrete PWM and other integrated/hybrid solutions
- Cost effective replacement for bulky regulated linears
- Simple ON/OFF control – no loop compensation needed
- No bias winding – simpler, lower cost transformer
- Simple design practically eliminates rework in manufacturing

EcoSmart® – Extremely Energy Efficient

- No load consumption <50 mW with bias winding and <250 mW without bias winding at 265 VAC input
- Meets California Energy Commission (CEC), Energy Star, and EU requirements
- Ideal for cell-phone charger and PC standby applications

High Performance at Low Cost

- High voltage powered – ideal for charger applications
- High bandwidth provides fast turn on with no overshoot
- Current limit operation rejects line frequency ripple
- Built-in current limit and thermal protection improves safety

Description

TinySwitch-II integrates a 700 V power MOSFET, oscillator, high voltage switched current source, current limit and thermal shutdown circuitry onto a monolithic device. The start-up and operating power are derived directly from the voltage on the DRAIN pin, eliminating the need for a bias winding and associated circuitry. In addition, the

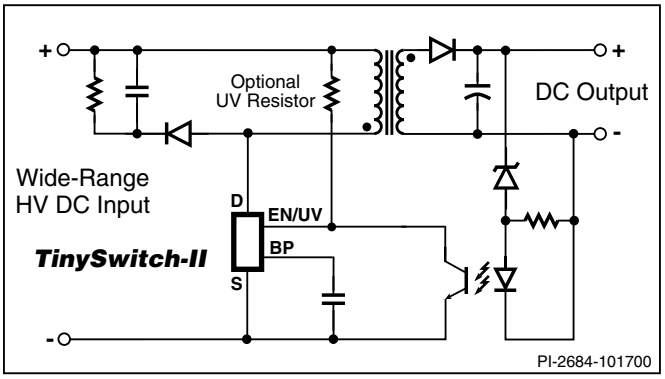


Figure 1. Typical Standby Application.

OUTPUT POWER TABLE				
PRODUCT[3]	230 VAC ±15%		85-265 VAC	
	Adapter[1]	Open Frame[2]	Adapter[1]	Open Frame[2]
TNY263 P or G	5 W	7.5 W	3.7 W	4.7 W
TNY264 P or G	5.5 W	9 W	4 W	6 W
TNY265 P or G	8.5 W	11 W	5.5 W	7.5 W
TNY266 P or G	10 W	15 W	6 W	9.5 W
TNY267 P or G	13 W	19 W	8 W	12 W
TNY268 P or G	16 W	23 W	10 W	15 W

Table 1. Notes: **1.** Minimum continuous power in a typical non-ventilated enclosed adapter measured at 50 °C ambient. **2.** Minimum practical continuous power in an open frame design with adequate heat sinking, measured at 50 °C ambient (See Key Applications Considerations). **3.** Packages: P: DIP-8B, G: SMD-8B. For lead-free package options, see Part Ordering Information.

TinySwitch-II devices incorporate auto-restart, line under-voltage sense, and frequency jittering. An innovative design minimizes audio frequency components in the simple ON/OFF control scheme to practically eliminate audible noise with standard taped/varnished transformer construction. The fully integrated auto-restart circuit safely limits output power during fault conditions such as output short circuit or open loop, reducing component count and secondary feedback circuitry cost. An optional line sense resistor externally programs a line under-voltage threshold, which eliminates power down glitches caused by the slow discharge of input storage capacitors present in applications such as standby supplies. The operating frequency of 132 kHz is jittered to significantly reduce both the quasi-peak and average EMI, minimizing filtering cost.

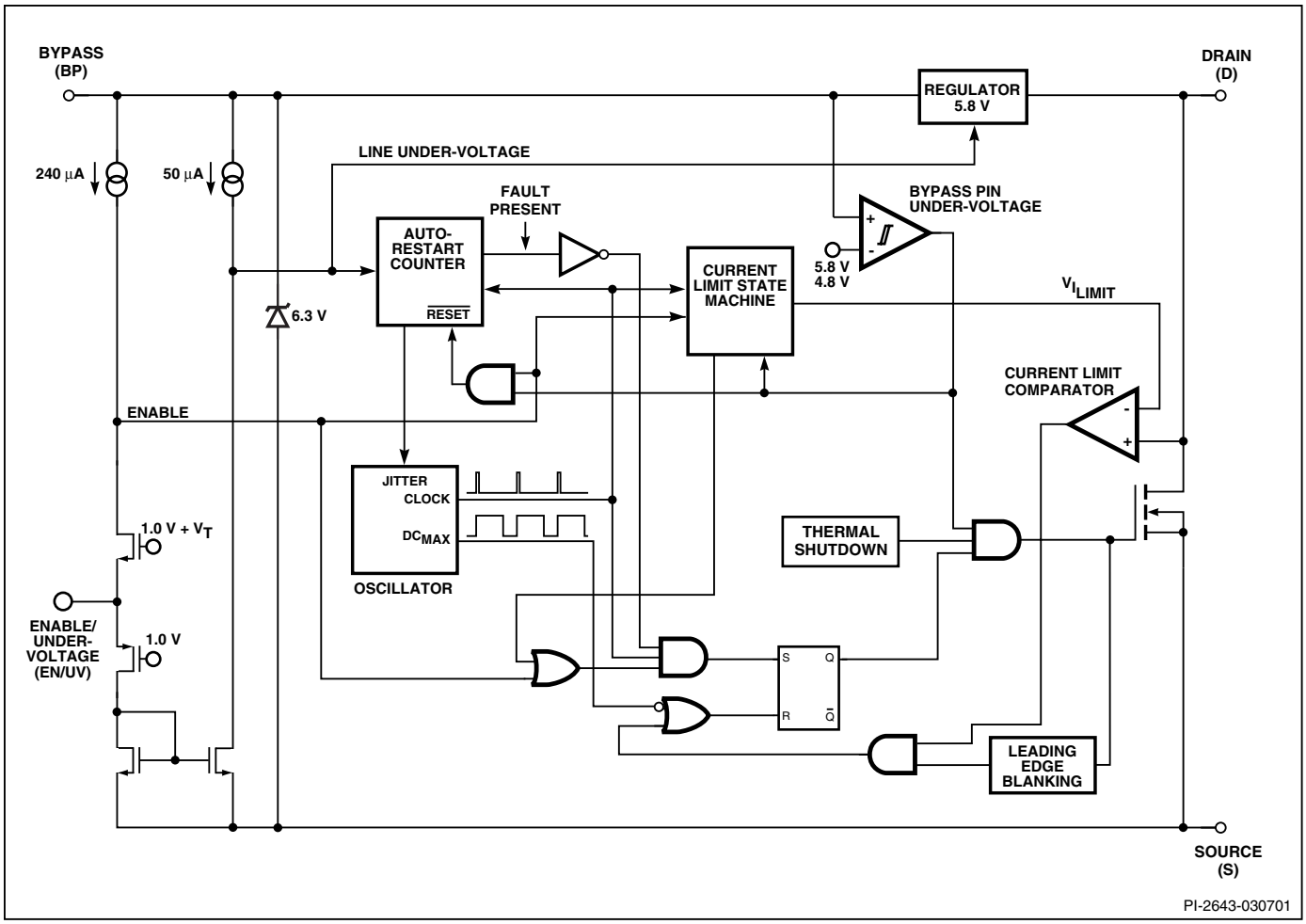


Figure 2. Functional Block Diagram.

Pin Functional Description

DRAIN (D) Pin:
Power MOSFET drain connection. Provides internal operating current for both start-up and steady-state operation.

BYPASS (BP) Pin:
Connection point for a 0.1 µF external bypass capacitor for the internally generated 5.8 V supply.

ENABLE/UNDER-VOLTAGE (EN/UV) Pin:
This pin has dual functions: enable input and line under-voltage sense. During normal operation, switching of the power MOSFET is controlled by this pin. MOSFET switching is terminated when a current greater than 240 µA is drawn from this pin. This pin also senses line under-voltage conditions through an external resistor connected to the DC line voltage. If there is no external resistor connected to this pin, *TinySwitch-II* detects its absence and disables the line under-voltage function.

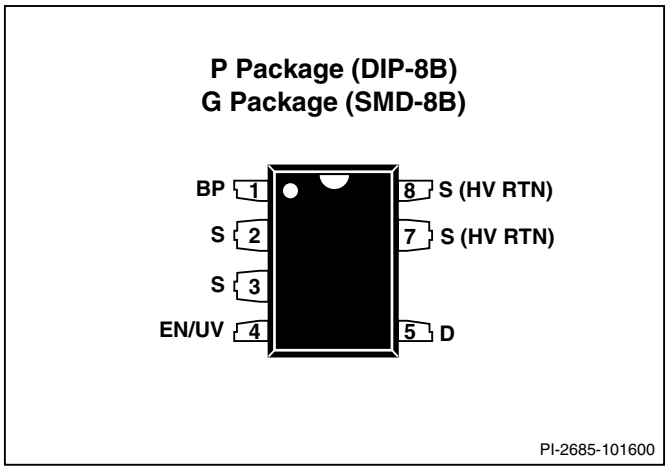


Figure 3. Pin Configuration.

SOURCE (S) Pin:
Control circuit common, internally connected to output MOSFET source.

SOURCE (HV RTN) Pin:
Output MOSFET source connection for high voltage return.

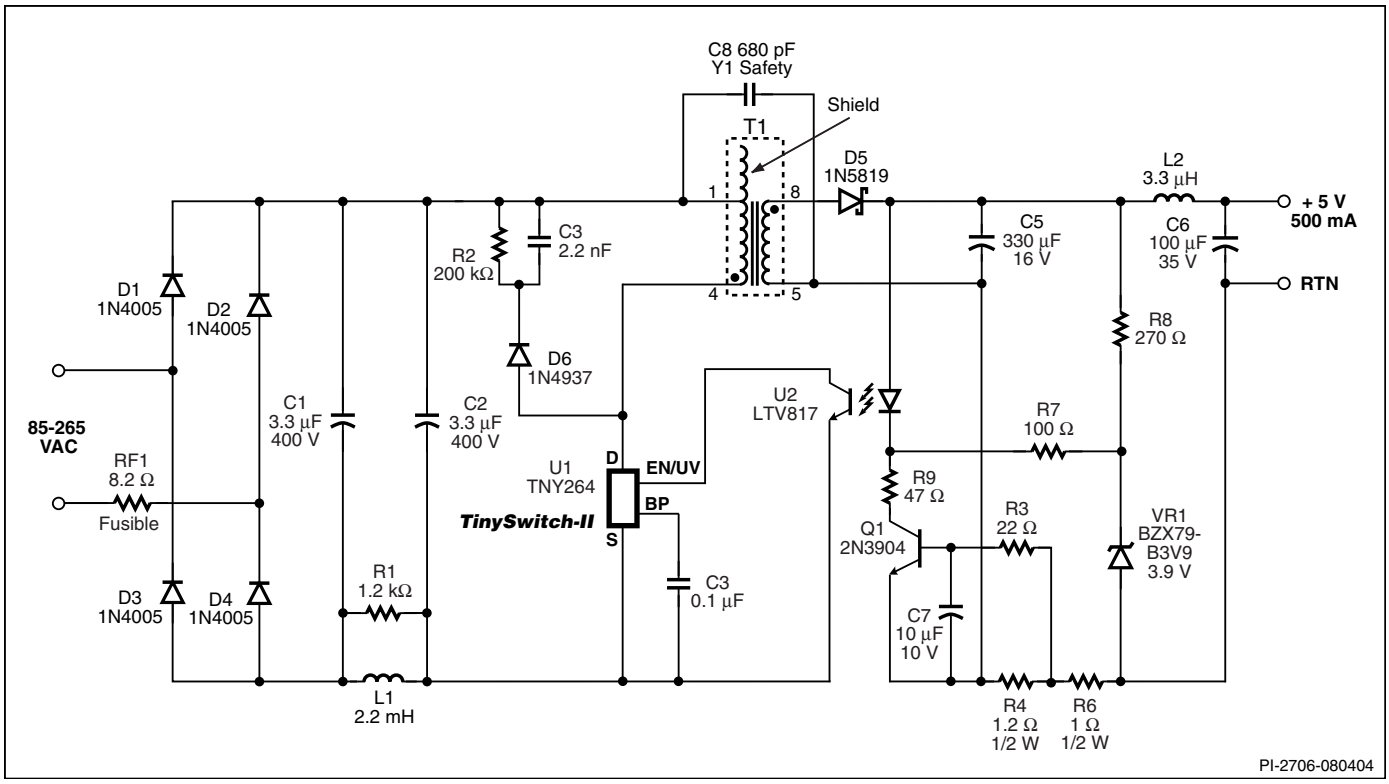


Figure 14. 2.5 W Constant Voltage, Constant Current Battery Charger with Universal Input (85-265 VAC).

The *TinySwitch-II* does not require a bias winding to provide power to the chip, because it draws the power directly from the DRAIN pin (see Functional Description above). This has two main benefits. First, for a nominal application, this eliminates the cost of a bias winding and associated components. Secondly, for battery charger applications, the current-voltage characteristic often allows the output voltage to fall close to zero volts while still delivering power. This type of application normally requires a forward-bias winding which has many more associated components. With *TinySwitch-II*, neither are necessary. For applications that require a very low no-load power consumption (50 mW), a resistor from a bias winding to the BYPASS pin can provide the power to the chip. The minimum recommended current supplied is 750 µA. The BYPASS pin in this case will be clamped at 6.3 V. This method will eliminate the power draw from the DRAIN pin, thereby reducing the no-load power consumption and improving full-load efficiency.

Current Limit Operation

Each switching cycle is terminated when the DRAIN current reaches the current limit of the *TinySwitch-II*. Current limit operation provides good line ripple rejection and relatively constant power delivery independent of input voltage.

BYPASS Pin Capacitor

The BYPASS pin uses a small 0.1 µF ceramic capacitor for decoupling the internal power supply of the *TinySwitch-II*.

Application Examples

The *TinySwitch-II* is ideal for low cost, high efficiency power supplies in a wide range of applications such as cellular phone chargers, PC standby, TV standby, AC adapters, motor control, appliance control and ISDN or a DSL network termination. The 132 kHz operation allows the use of a low cost EE13 or EF12.6 core transformer while still providing good efficiency. The frequency jitter in *TinySwitch-II* makes it possible to use a single inductor (or two small resistors for under 3 W applications if lower efficiency is acceptable) in conjunction with two input capacitors for input EMI filtering. The auto-restart function removes the need to oversize the output diode for short circuit conditions allowing the design to be optimized for low cost and maximum efficiency. In charger applications, it eliminates the need for a second optocoupler and Zener diode for open loop fault protection. Auto-restart also saves the cost of adding a fuse or increasing the power rating of the current sense resistors to survive reverse battery conditions. For applications requiring under-voltage lock out (UVLO), such as PC standby, the *TinySwitch-II* eliminates several components and saves cost. *TinySwitch-II* is well suited for applications that require constant voltage and constant current output. As *TinySwitch-II* is always powered from the input high voltage, it therefore does not rely on bias winding voltage. Consequently this greatly simplifies designing chargers that must work down to zero volts on the output.

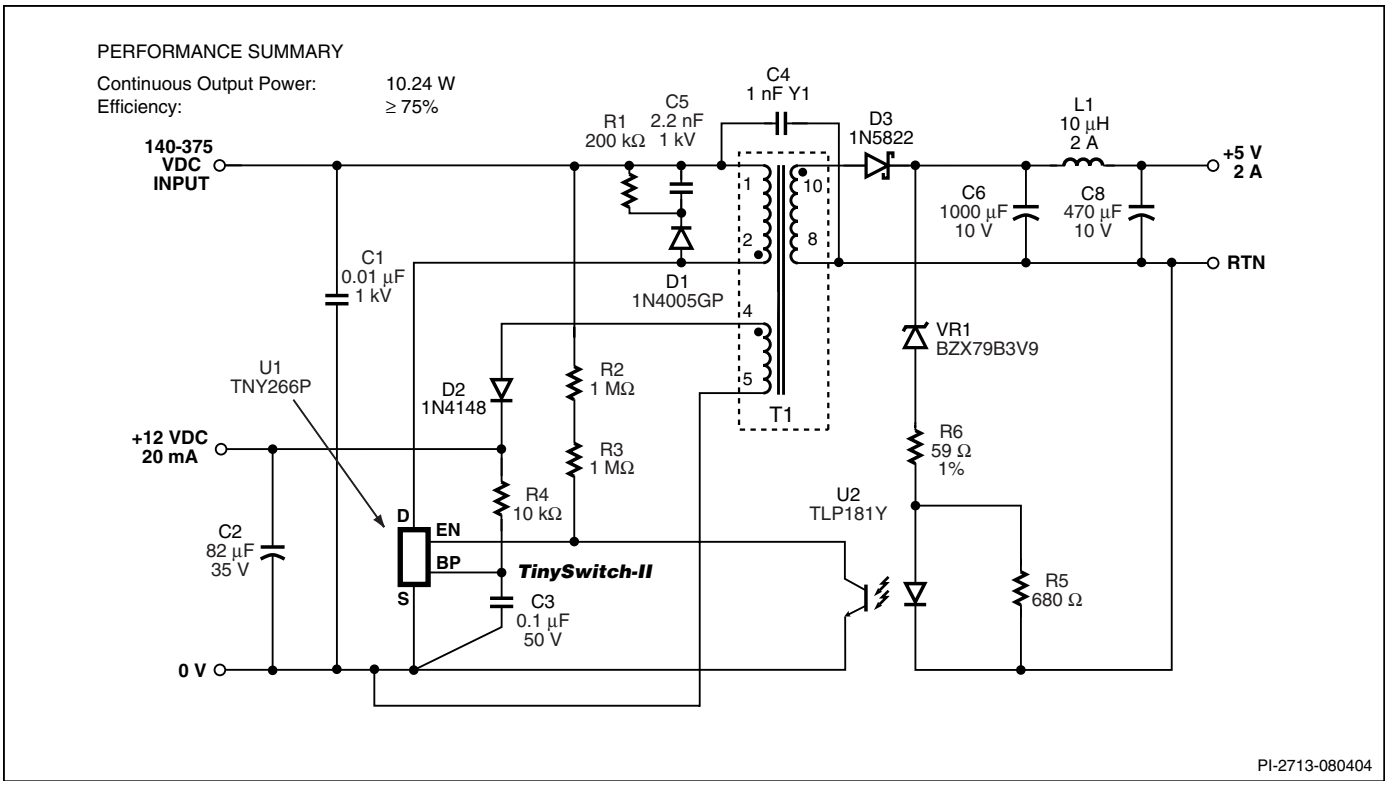


Figure 15. 10 W Standby Supply.

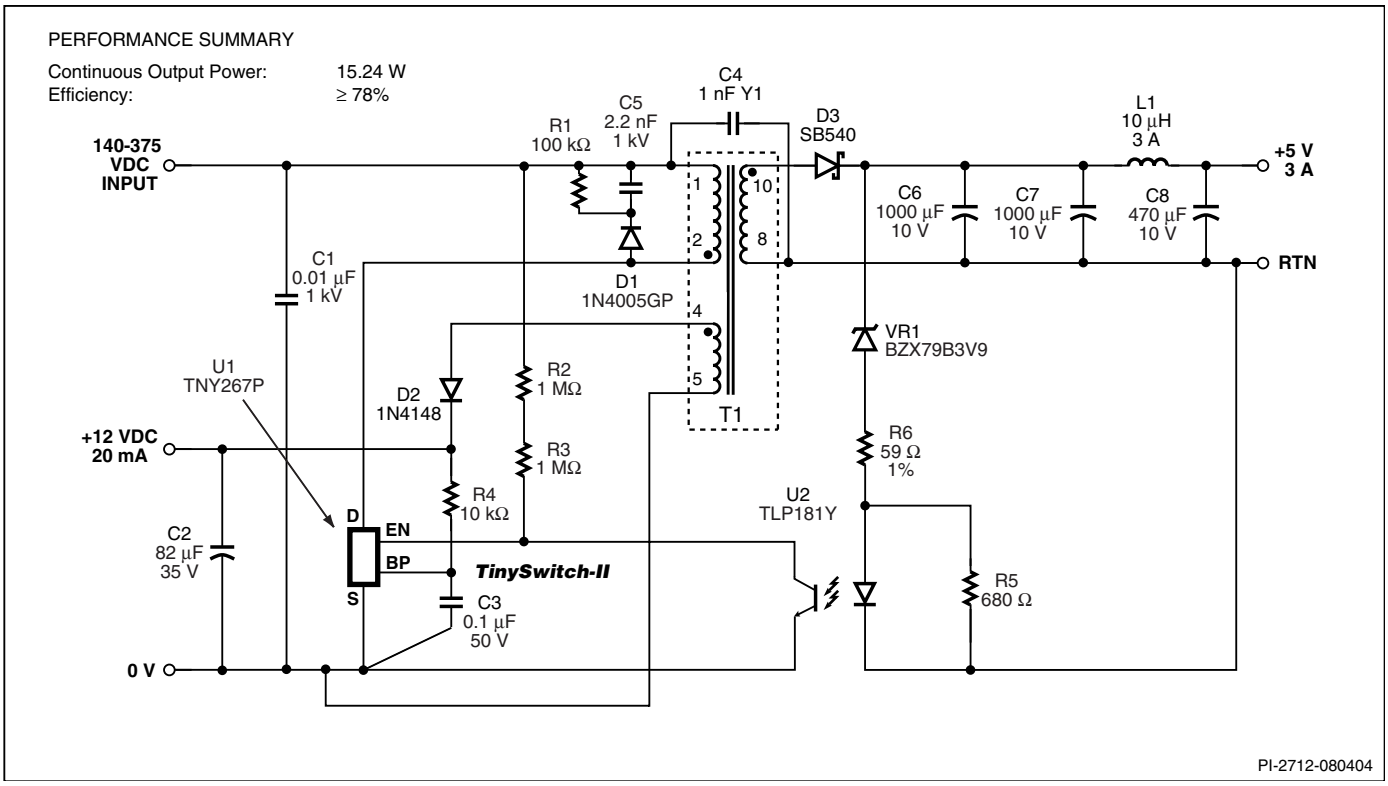


Figure 16. 15 W Standby Supply.

Key Application Considerations

TinySwitch-II vs. *TinySwitch*

Table 2 compares the features and performance differences between the TNY254 device of the *TinySwitch* family with the *TinySwitch-II* family of devices. Many of the new features eliminate the need for or reduce the cost of circuit components. Other features simplify the design and enhance performance.

Design

Output Power

Table 1 (front page) shows the practical continuous output power levels that can be obtained under the following conditions:

1. The minimum DC input voltage is 90 V or higher for 85 VAC input, or 240 V or higher for 230 VAC input or 115 VAC input with a voltage doubler. This corresponds to a filter capacitor of 3 µF/W for universal input and 1 µF/W for 230 VAC or 115 VAC with doubler input.

Function	*TinySwitch* TNY254	*TinySwitch-II* TNY263-268	*TinySwitch-II* Advantages
Switching Frequency and Tolerance Temperature Variation (0-100 °C)**	44 kHz ±10% (at 25 °C) +8%	132 kHz ±6% (at 25 °C) +2%	• Smaller transformer for low cost • Ease of design • Manufacturability • Optimum design for lower cost
Active Frequency Jitter	N/A*	±4 kHz	• Lower EMI minimizing filter component costs
Transformer Audible Noise Reduction	N/A*	Yes–built into controller	• Practically eliminates audible noise with ordinary dip varnished transformer – no special construction or gluing required
Line UV Detect	N/A*	Single resistor programmable	• Prevents power on/off glitches
Current Limit Tolerance Temperature Variation (0-100 °C)**	±11% (at 25 °C) -8%	±7% (at 25 °C) 0%	• Increases power capability and simplifies design for high volume manufacturing
Auto-Restart	N/A*	6% effective on-time	• Limits output short-circuit current to less than full load current - No output diode size penalty • Protects load in open loop fault conditions - No additional components required
BYPASS Pin Zener Clamp	N/A*	Internally clamped to 6.3 V	• Allows *TinySwitch-II* to be powered from a low voltage bias winding to improve efficiency and to reduce on-chip power dissipation
DRAIN Creepage at Package	0.037 in. / 0.94 mm	0.137 in. / 3.48 mm	• Greater immunity to arcing as a result of dust, debris or other contaminants build-up

**Not available. ** See typical performance curves.*

Table 2. Comparison Between TinySwitch and TinySwitch-II.

2. A secondary output of 5 V with a Schottky rectifier diode.

3. Assumed efficiency of 77% (TNY267 & TNY268), 75% (TNY265 & TNY266) and 73% (TNY263 & TNY264).

4. The parts are board mounted with SOURCE pins soldered to sufficient area of copper to keep the die temperature at or below 100 °C.

In addition to the thermal environment (sealed enclosure, ventilated, open frame, etc.), the maximum power capability of *TinySwitch-II* in a given application depends on transformer core size and design (continuous or discontinuous), efficiency, minimum specified input voltage, input storage capacitance, output voltage, output diode forward drop, etc., and can be different from the values shown in Table 1.

Audible Noise
The *TinySwitch-II* practically eliminates any transformer audio noise using simple ordinary varnished transformer construction. No gluing of the cores is needed. The audio noise reduction is accomplished by the *TinySwitch-II* controller reducing the current limit in discrete steps as the load is reduced. This minimizes the flux density in the transformer when switching at audio frequencies.

Worst Case EMI & Efficiency Measurement
Since identical *TinySwitch-II* supplies may operate at several different frequencies under the same load and line conditions, care must be taken to ensure that measurements are made under worst case conditions. When measuring efficiency or EMI verify that the *TinySwitch-II* is operating at maximum frequency and that measurements are made at both low and high line input voltages to ensure the worst case result is obtained.

Layout

Single Point Grounding
Use a single point ground connection at the SOURCE pin for the BYPASS pin capacitor and the Input Filter Capacitor (see Figure 17).

Primary Loop Area
The area of the primary loop that connects the input filter capacitor, transformer primary and *TinySwitch-II* together should be kept as small as possible.

Primary Clamp Circuit
A clamp is used to limit peak voltage on the DRAIN pin at turn-off. This can be achieved by using an RCD clamp (as shown in Figure 14). A Zener and diode clamp (200 V) across the primary or a single 550 V Zener clamp from DRAIN to SOURCE can also be used. In all cases care should be taken to minimize the circuit path from the clamp components to the transformer and *TinySwitch-II*.

Thermal Considerations
Copper underneath the *TinySwitch-II* acts not only as a single point ground, but also as a heatsink. The hatched areas shown in Figure 17 should be maximized for good heat sinking of *TinySwitch-II* and the same applies to the output diode.

EN/UV pin
If a line under-voltage detect resistor is used then the resistor should be mounted as close as possible to the EN/UV pin to minimize noise pick up.

The voltage rating of a resistor should be considered for the under-voltage detect (Figure 15: R2, R3) resistors. For 1/4 W resistors, the voltage rating is typically 200 V continuous, whereas for 1/2 W resistors the rating is typically 400 V continuous.

Y-Capacitor
The placement of the Y-capacitor should be directly from the primary bulk capacitor positive rail to the common/return terminal on the secondary side. Such placement will maximize the EMI benefit of the Y-capacitor and avoid problems in common-mode surge testing.

Optocoupler
It is important to maintain the minimum circuit path from the optocoupler transistor to the *TinySwitch-II* EN/UV and SOURCE pins to minimize noise coupling.

The EN/UV pin connection to the optocoupler should be kept to an absolute minimum (less than 12.7 mm or 0.5 in.), and this connection should be kept away from the DRAIN pin (minimum of 5.1 mm or 0.2 in.).

Output Diode
For best performance, the area of the loop connecting the secondary winding, the output diode and the output filter capacitor, should be minimized. See Figure 17 for optimized layout. In addition, sufficient copper area should be provided at the anode and cathode terminals of the diode for adequate heatsinking.

Input and Output Filter Capacitors
There are constrictions in the traces connected to the input and output filter capacitors. These constrictions are present for two reasons. The first is to force all the high frequency currents to flow through the capacitor (if the trace were wide then it could flow around the capacitor). Secondly, the constrictions minimize the heat transferred from the *TinySwitch-II* to the input filter capacitor and from the secondary diode to the output filter capacitor. The common/return (the negative output terminal in Figure 17) terminal of the output filter capacitor should be connected with a short, low impedance path to the secondary winding. In addition, the common/return output connection should be taken directly from the secondary winding pin and not from the Y-capacitor connection point.

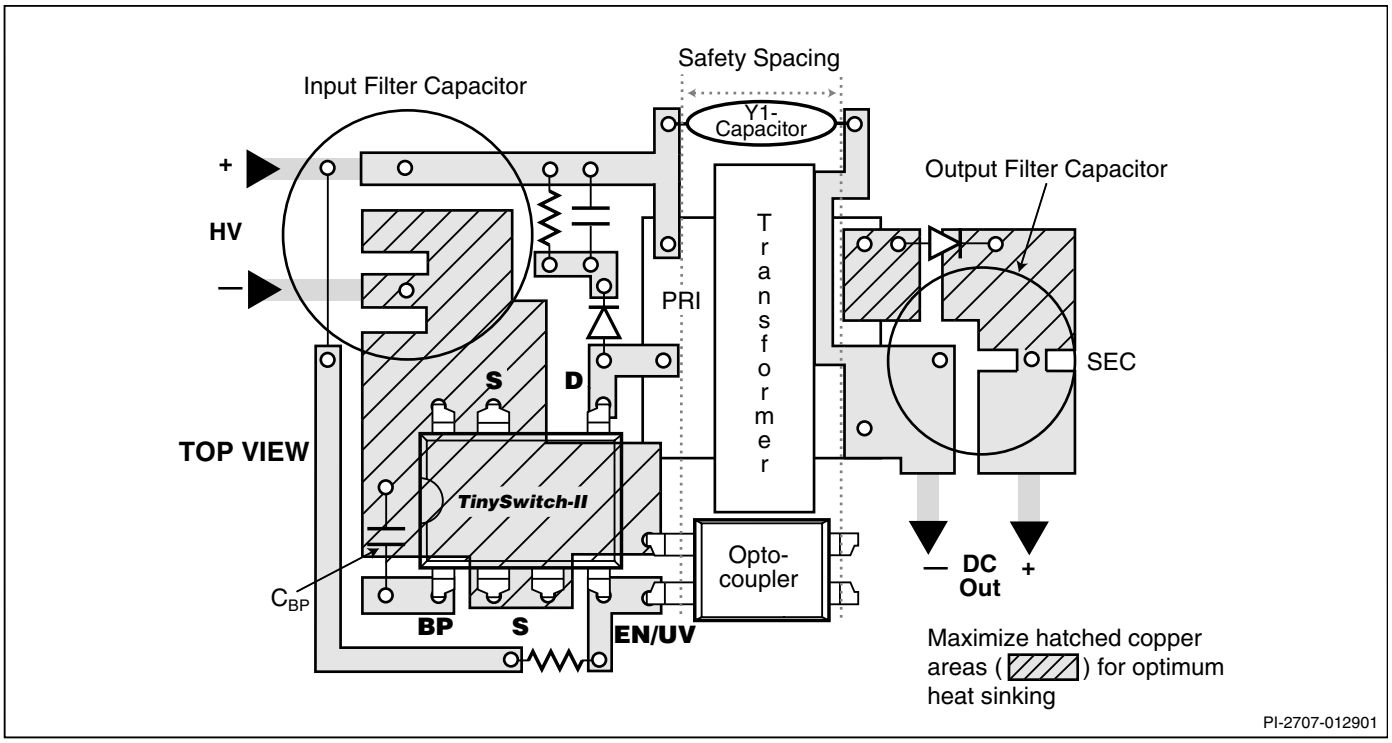


Figure 17. Recommended Circuit Board Layout for TinySwitch-II with Under-Voltage Lock Out Resistor.

PC Board Cleaning

Power Integrations does not recommend the use of "no clean" flux.

For the most up-to-date information visit the PI website at: *www.powerint.com.*

ABSOLUTE MAXIMUM RATINGS[1,4]

DRAIN Voltage ..... -0.3 V to 700 V
DRAIN Peak Current: TNY263.....400 mA
TNY264.....400 mA
TNY265.....440 mA
TNY266.....560 mA
TNY267.....720 mA
TNY268.....880 mA
EN/UV Voltage ..... -0.3 V to 9 V
EN/UV Current ..... 100 mA
BYPASS Voltage .....-0.3 V to 9 V
Storage Temperature .....-65 °C to 150 °C
Operating Junction Temperature[2] .....-40 °C to 150 °C
Lead Temperature[3] ..... 260 °C

Notes:
1. All voltages referenced to SOURCE, T_A = 25 °C.
2. Normally limited by internal circuitry.
3. 1/16 in. from case for 5 seconds.
4. Maximum ratings specified may be applied one at a time, without causing permanent damage to the product. Exposure to Absolute Maximum Rating conditions for extended periods of time may affect product reliability.

THERMAL IMPEDANCE

Thermal Impedance: P or G Package:
(θ_{JA}) ..... 70 °C/W[2]; 60 °C/W[3]
(θ_{JC})[1] ..... 11 °C/W

Notes:
1. Measured on the SOURCE pin close to plastic interface.
2. Soldered to 0.36 sq. in. (232 mm^2), 2 oz. (610 g/m^2) copper clad.
3. Soldered to 1 sq. in. (645 mm^2), 2 oz. (610 g/m^2) copper clad.

Parameter	Symbol	Conditions SOURCE = 0 V; T_J = -40 to 125 °C See Figure 18 (Unless Otherwise Specified)		Min	Typ	Max	Units
CONTROL FUNCTIONS							
Output Frequency	f_{OSC}	T_J = 25 °C See Figure 4	Average	124	132	140	kHz
			Peak-Peak Jitter		8		
Maximum Duty Cycle	DC_{MAX}	S1 Open		62	65	68	%
EN/UV Pin Turnoff Threshold Current	I_{DIS}	T_J = -40 °C to 125 °C		-300	-240	-170	µA
EN/UV Pin Voltage	V_{EN}	$I_{EN/UV}$ = -125 µA		0.4	1.0	1.5	V
		$I_{EN/UV}$ = 25 µA		1.3	2.3	2.7	
DRAIN Supply Current	I_{S1}	$V_{EN/UV}$ = 0 V			430	500	µA
	I_{S2}	EN/UV Open (MOSFET Switching) See Note A, B	TNY263		200	250	µA
			TNY264		225	270	
			TNY265		245	295	
			TNY266		265	320	
			TNY267		315	380	
			TNY268		380	460	
BYPASS Pin Charge Current	I_{CH1}	V_{BP} = 0 V, T_J = 25 °C See Note C, D	TNY263-264	-5.5	-3.3	-1.8	mA
			TNY265-268	-7.5	-4.6	-2.5	
	I_{CH2}	V_{BP} = 4 V, T_J = 25 °C See Note C, D	TNY263-264	-3.8	-2.0	-1.0	
			TNY265-268	-4.5	-3.0	-1.5	

Parameter	Symbol	Conditions SOURCE = 0 V; T_J = -40 to 125 °C See Figure 18 (Unless Otherwise Specified)		Min	Typ	Max	Units
CONTROL FUNCTIONS (cont.)							
BYPASS Pin Voltage	V_{BP}	See Note C		5.6	5.85	6.15	V
BYPASS Pin Voltage Hysteresis	V_{BPH}			0.80	0.95	1.20	V
EN/UV Pin Line Under-Voltage Threshold	I_{LUV}	T_J = 25 °C		44	49	54	µA
CIRCUIT PROTECTION							
Current Limit	I_{LIMIT}	TNY263 T_J = 25 °C	di/dt = 42 mA/µs See Note E	195	210	225	mA
		TNY264 T_J = 25 °C	di/dt = 50 mA/µs See Note E	233	250	267	
		TNY265 T_J = 25 °C	di/dt = 55 mA/µs See Note E	255	275	295	
		TNY266 T_J = 25 °C	di/dt = 70 mA/µs See Note E	325	350	375	
		TNY267 T_J = 25 °C	di/dt = 90 mA/µs See Note E	419	450	481	
		TNY268 T_J = 25 °C	di/dt = 110 mA/µs See Note E	512	550	588	
Initial Current Limit	I_{INIT}	See Figure 21 T_J = 25 °C		0.65 x $I_{LIMIT(MIN)}$			mA
Leading Edge Blanking Time	t_{LEB}	T_J = 25 °C See Note F		170	215		ns
Current Limit Delay	t_{ILD}	T_J = 25 °C See Note F, G			150		ns
Thermal Shutdown Temperature				125	135	150	°C
Thermal Shutdown Hysteresis					70		°C

Parameter	Symbol	Conditions SOURCE = 0 V; T_J = -40 to 125 °C See Figure 18 (Unless Otherwise Specified)		Min	Typ	Max	Units
OUTPUT							
ON-State Resistance	$R_{DS(ON)}$	TNY263 I_D = 21 mA	T_J = 25 °C		33	38	Ω
			T_J = 100 °C		50	57	
		TNY264 I_D = 25 mA	T_J = 25 °C		28	32	
			T_J = 100 °C		42	48	
		TNY265 I_D = 28 mA	T_J = 25 °C		19	22	
			T_J = 100 °C		29	33	
		TNY266 I_D = 35 mA	T_J = 25 °C		14	16	
			T_J = 100 °C		21	24	
		TNY267 I_D = 45 mA	T_J = 25 °C		7.8	9.0	
			T_J = 100 °C		11.7	13.5	
		TNY268 I_D = 55 mA	T_J = 25 °C		5.2	6.0	
			T_J = 100 °C		7.8	9.0	
OFF-State Drain Leakage Current	I_{DSS}	V_{BP} = 6.2 V, $V_{EN/UV}$ = 0 V, V_{DS} = 560 V, T_J = 125 °C	TNY263-266			50	µA
			TNY267-268			100	
Breakdown Voltage	BV_{DSS}	V_{BP} = 6.2 V, $V_{EN/UV}$ = 0 V, See Note H, T_J = 25 °C		700			V
Rise Time	t_R	Measured in a Typical Flyback Converter Application			50		ns
Fall Time	t_F				50		ns
Drain Supply Voltage				50			V
Output EN/UV Delay	$t_{EN/UV}$	See Figure 20				10	µs
Output Disable Setup Time	t_{DST}				0.5		µs
Auto-Restart ON-Time	t_{AR}	T_J = 25 °C See Note I			50		ms
Auto-Restart Duty Cycle	DC_{AR}				5.6		%

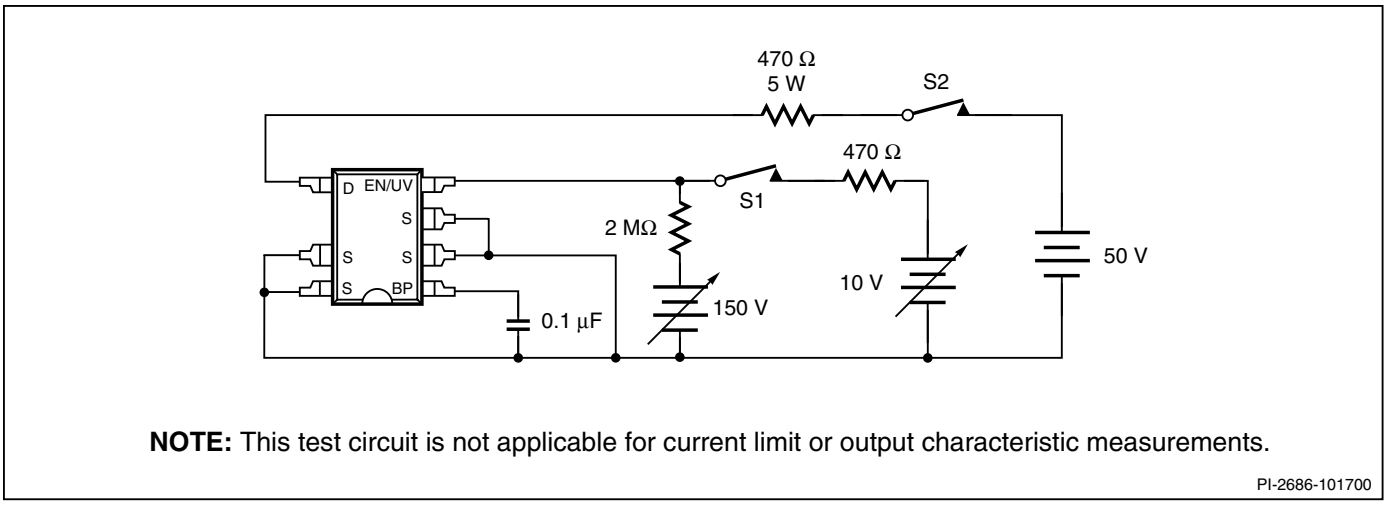


Figure 18. TinySwitch-II General Test Circuit.

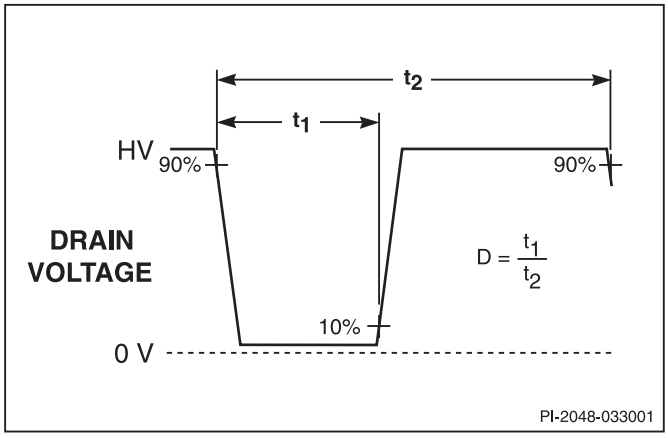


Figure 19. TinySwitch-II Duty Cycle Measurement.

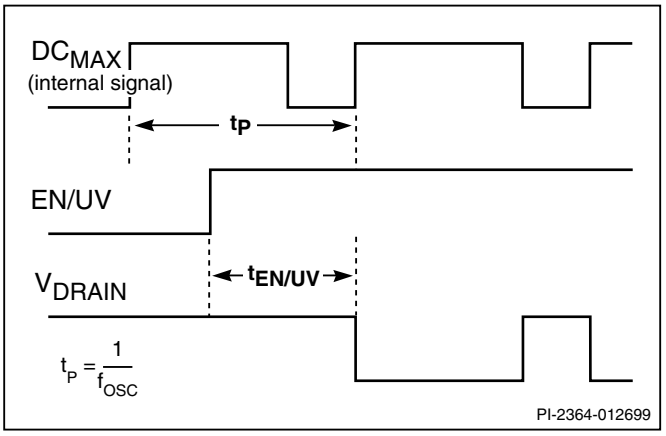


Figure 20. TinySwitch-II Output Enable Timing.

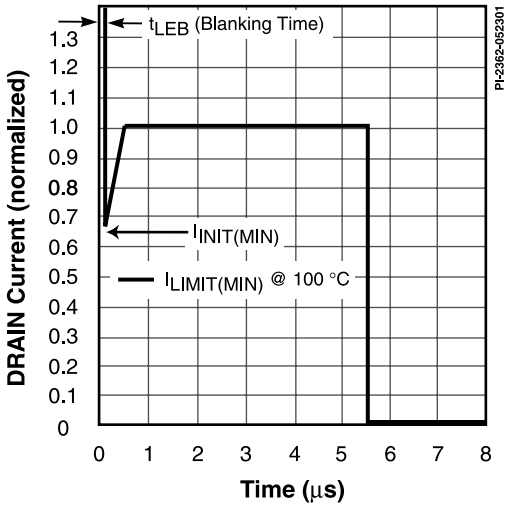
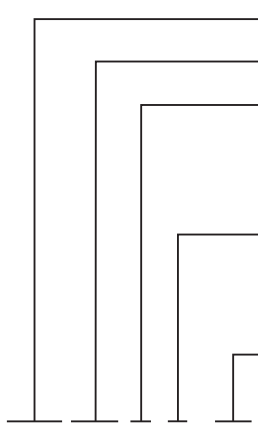


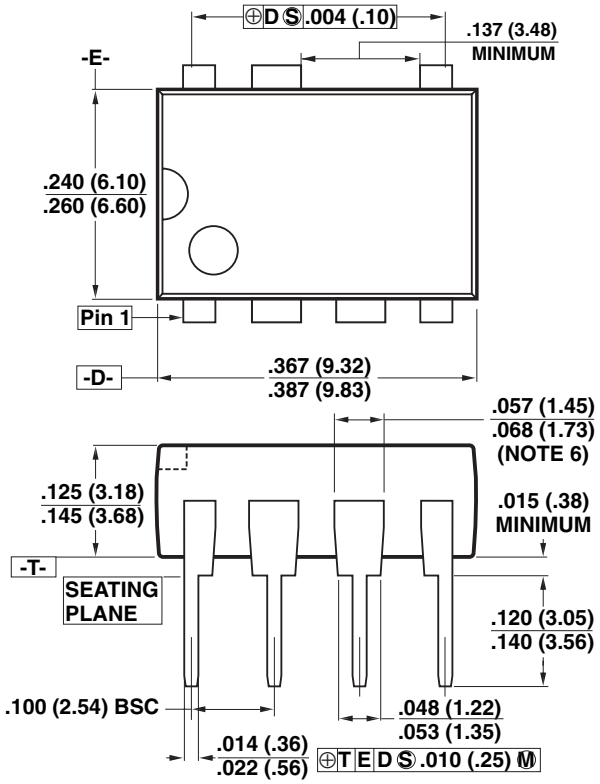
Figure 21. Current Limit Envelope.

PART ORDERING INFORMATION



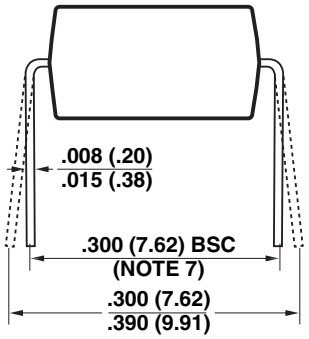
***TinySwitch* Product Family**	
Series Number	
Package Identifier	
G	Plastic Surface Mount SMD-8B
P	Plastic DIP-8B
Lead Finish	
Blank	Standard (Sn Pb)
N	Pure Matte Tin (Pb-Free)
Tape & Reel and Other Options	
Blank	Standard Configurations
TL	Tape & Reel, 1 k pcs minimum, G Package only

DIP-8B



Notes:

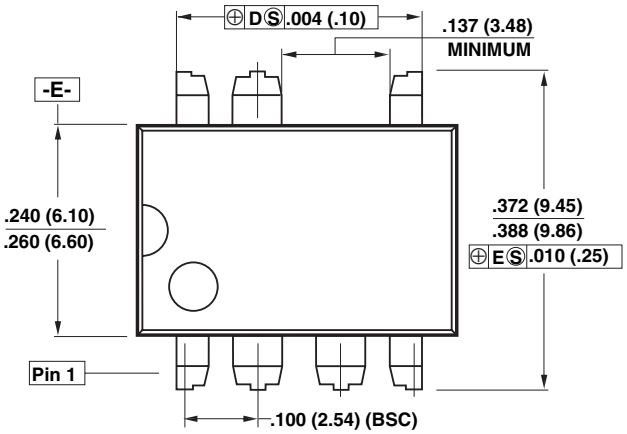
1. **Package dimensions conform to JEDEC specification MS-001-AB (Issue B 7/85) for standard dual-in-line (DIP) package with .300 inch row spacing.**
2. **Controlling dimensions are inches. Millimeter sizes are shown in parentheses.**
3. **Dimensions shown do not include mold flash or other protrusions. Mold flash or protrusions shall not exceed .006 (.15) on any side.**
4. **Pin locations start with Pin 1, and continue counter-clockwise to Pin 8 when viewed from the top. The notch and/or dimple are aids in locating Pin 1. Pin 6 is omitted.**
5. **Minimum metal to metal spacing at the package body for the omitted lead location is .137 inch (3.48 mm).**
6. **Lead width measured at package body.**
7. **Lead spacing measured with the leads constrained to be perpendicular to plane T.**

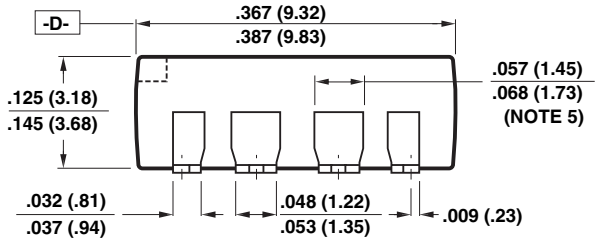


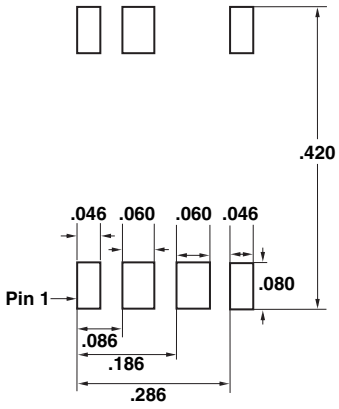
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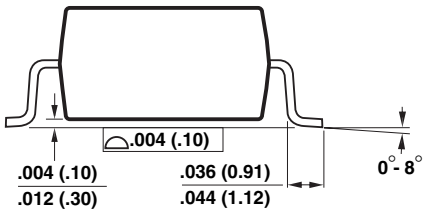
SMD-8B







Solder Pad Dimensions



Notes:

1. Controlling dimensions are inches. Millimeter sizes are shown in parentheses.
2. Dimensions shown do not include mold flash or other protrusions. Mold flash or protrusions shall not exceed .006 (.15) on any side.
3. Pin locations start with Pin 1, and continue counter-clock-wise to Pin 8 when viewed from the top. Pin 6 is omitted.
4. Minimum metal to metal spacing at the package body for the omitted lead location is .137 inch (3.48 mm).
5. Lead width measured at package body.
6. D and E are referenced datums on the package body.

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