INN2904K*
InnoSwitch-EP Family

Off-Line CV/CC Flyback Switcher IC with Integrated 900 V MOSFET, Sync-Rect Feedback with Advanced Protection

Product Highlights

Highly Integrated, Compact Footprint
- Incorporates flyback controller 900 V MOSFET, secondary-side sensing and synchronous rectification driver
- FluxLink™ integrated, HIPOT-isolated, feedback link
- Exceptional CV accuracy, independent of transformer design or external components
- Excellent multi-output cross regulation with weighted SSR feedback and synch FETs

EcoSmart™ – Energy Efficient
- <10 mW no-load at 230 VAC when supplied by transformer bias winding
- Easily meets all global energy efficiency regulations

Advanced Protection / Safety Features
- Primary sensed output OVP
- Secondary sensed output overshoot clamp
- Secondary sensed output OCP to zero output voltage
- Hysteretic thermal shutdown
- Input voltage monitor with accurate brown-in/brown-out and overvoltage protection

Full Safety and Regulatory Compliance
- 100% production HIPOT compliance testing equivalent to 4.8 kV AC for 1 second
- Reinforced insulation
- Isolation voltage 4,000 VAC
- UL1577 and TUV (EN60950) safety approved
- EN61000-4-8 (100 A/m) and EN61000-4-9 (1000 A/m) compliant

Green Package
- Halogen free and RoHS compliant

Applications
- Appliance, industrial, utility meter, smart grid, solar inverters and smart lighting

Description

The InnoSwitch™-EP family of ICs dramatically simplify the development and manufacturing of low-voltage, high current power supplies, particularly those in compact enclosures or with high efficiency requirements. The InnoSwitch-EP architecture is revolutionary in that the devices incorporate both primary and secondary controllers, with sense elements and a safety-rated feedback mechanism into a single IC.

Close component proximity and innovative use of the integrated communication link permit accurate control of a secondary-side synchronous rectification MOSFET and optimization of primary-side switching to maintain high efficiency across the entire load range. Additionally, the minimal DC bias requirements of the link, enable the system to achieve less than 10 mW no-load to maximize efficiency in standby.

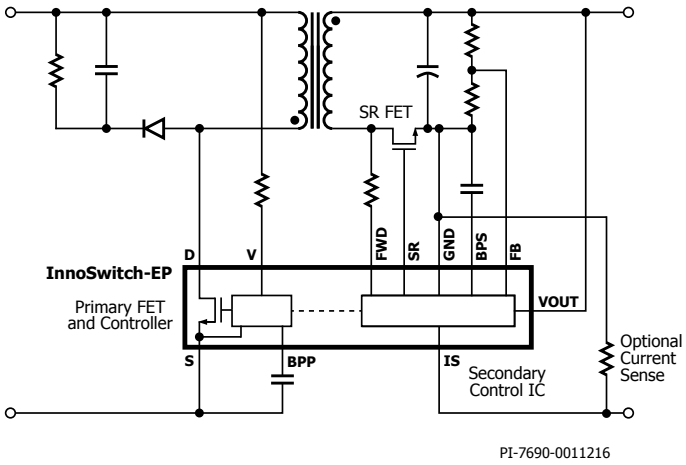


Figure 1. Typical Application/Performance.

Figure 2. High Creepage, Safety-Compliant eSOP-R16B Package.

Output Power Table

Product[3]	Peak or Open Frame[1,2]	
	900 V MOSFET	
	230 VAC ±15%	85-484 VAC
INN2904K	29 W	20 W

Table 1. Output Power Table.

Notes:
1. Minimum continuous power in a typical non-ventilated enclosed typical size adapter measured at 40 °C ambient. Max output power is dependent on the design. With condition that package temperature must be < = 125 °C.
2. Minimum peak power capability.
3. Package: eSOP-R16B.

Special Note: This is a custom version of INN2904K. See Part Ordering Information page for details. This part must be ordered as INN2904K0044.

The data sheet for the standard version of INN2904K can be found on the web site.

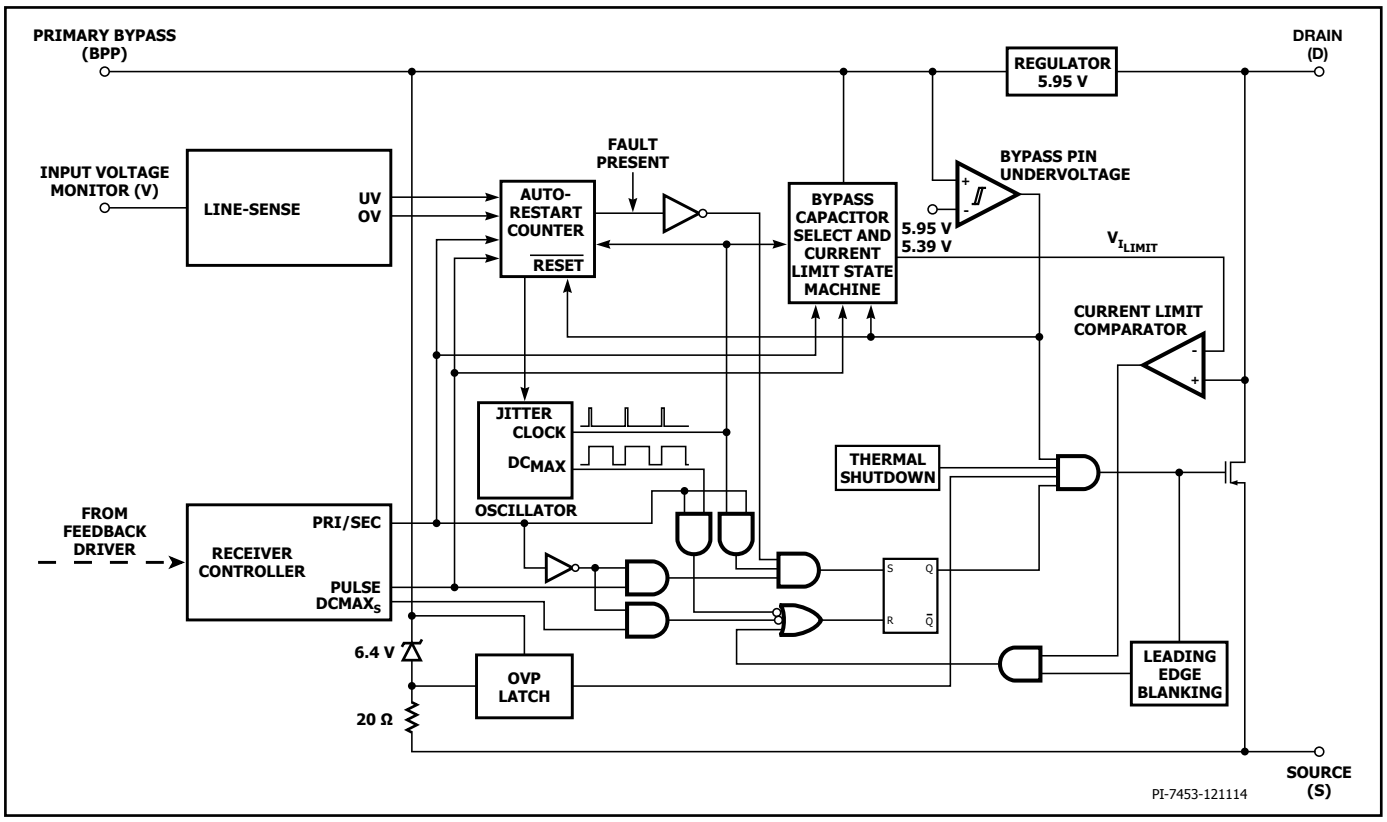


Figure 3. Primary-Side Controller Block Diagram.

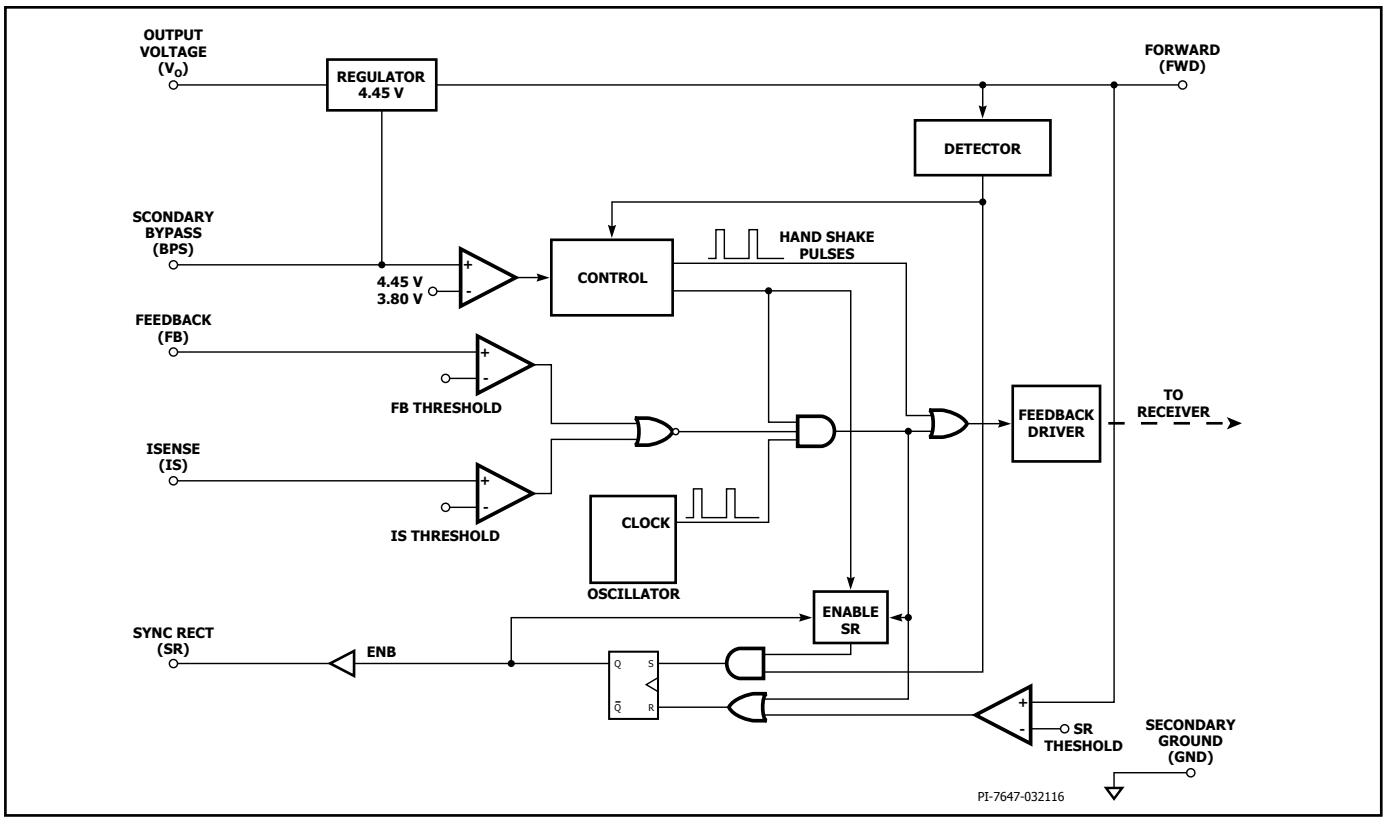


Figure 4. Secondary-Side Controller Block Diagram.

Pin Functional Description

DRAIN (D) Pin (Pin 1)
This pin is the power MOSFET drain connection.

SOURCE (S) Pin (Pin 3-6)
This pin is the power MOSFET source connection. It is also the ground reference for the PRIMARY BYPASS pin.

PRIMARY BYPASS (BPP) Pin (Pin 7)
It is the connection point for an external bypass capacitor for the primary-side controller IC supply.

INPUT VOLTAGE MONITOR (V) Pin (Pin 8)
AA 8 MΩ resistor is tied between the pin and the input bulk capacitor to provide input under and overvoltage protection. This pin should be tied to the PRIMARY BYPASS pin if line UV/OV functionality is not required.

NO CONNECTION (NC) Pin (Pin 9)
This pin should be left open.

FORWARD (FWD) Pin (Pin 10)
The connection point to the switching node of the transformer output winding for sensing and other functions.

OUTPUT VOLTAGE (VOUT) Pin (Pin 11)
This pin is connected directly to the output voltage of the power supply to provide bias to the secondary IC.

SYNCHRONOUS RECTIFIER DRIVE (SR) Pin (Pin 12)
Connection to external SR FET gate terminal.

SECONDARY BYPASS (BPS) Pin (Pin 13)
It is the connection point for an external bypass capacitor for the secondary-side controller supply.

FEEDBACK (FB) Pin (Pin 14)
This pin connects to an external resistor divider to set the power supply CV voltage regulation threshold.

SECONDARY GROUND (GND) (Pin 15)
Ground connection for the secondary IC.

ISENSE (IS) Pin (Pin 16)
Connection to the power supply output terminals. An external current sense resistor is connected between this pin and the SECONDARY GROUND pin.

If secondary current sense is not required, the ISENSE pin should be connected to the SECONDARY GROUND pin.

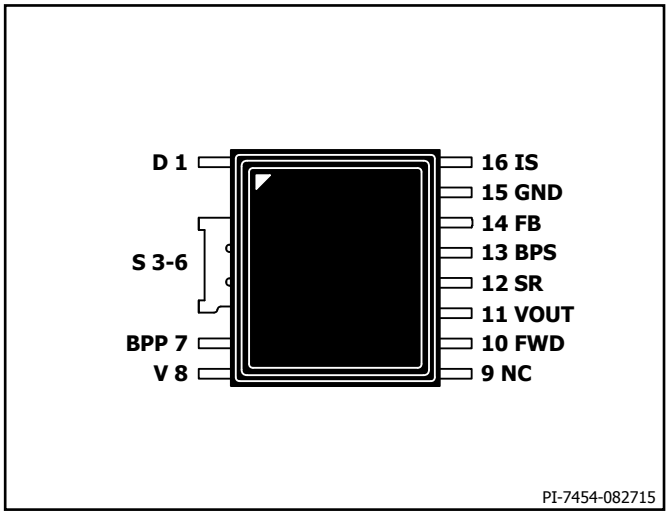


Figure 5. Pin Configuration.

Absolute Maximum Ratings[1,2]

DRAIN Pin Voltage ..... -0.3 V to 900 V
DRAIN Pin Peak Current[3] ..... 1800 (2550) mA
PRIMARY BYPASS/SECONDARY BYPASS Pin Voltage ..... -0.3 V to 9 V
PRIMARY BYPASS/SECONDARY BYPASS Pin Current ..... 100 mA
FORWARD Pin Voltage ..... -1.5 V to 150[7] V
FEEDBACK/CURRENT SENSE Pin Voltage ..... -0.3 to 9 V
SR/V Pin Voltage ..... -0.3 to 9 V[6]
OUTPUT VOLTAGE Pin Voltage ..... -0.3 to 15[8] V
Storage Temperature ..... -65 to 150 °C
Operating Junction Temperature[4] ..... -40 to 150 °C
Ambient Temperature ..... -40 to 105 °C
Lead Temperature[5] ..... 260 °C

Notes:
1. All voltages referenced to Source and Secondary Ground, T_A = 25 °C.
2. Maximum ratings specified may be applied one at a time without causing permanent damage to the product. Exposure to Absolute Maximum Ratings conditions for extended periods of time may affect product reliability.
3. Higher peak Drain current is allowed while the Drain voltage is simultaneously less than 400 V.
4. Normally limited by internal circuitry.
5. 1/16” from case for 5 seconds.
6. -1.8 V for a duration of ≤500 nsec. See Figure 32.
7. The maximum current out of the FORWARD pin when the FORWARD pin is below Ground is -40 mA.
8. Maximum current into VOUT pin at 15 V should not exceed 10 mA.

Thermal Resistance

Thermal Resistance: eSOP-R16B Package:
(θ_{JA}) ..... 65 °C/W[2], 69 °C/W[1]
(θ_{JC}) ..... 12 °C/W[3]

Notes:
1. Solder to 0.36 sq. in (232 mm²), 2 oz. (610 g/m²) copper clad.
2. Solder to 1 sq. in (645 mm²), 2 oz. (610 g/m²) copper clad.
3. The case temperature is measured at the plastic surface at the top of the package.

Parameter	Conditions	Rating	Units
Ratings for UL1577 (Adapter power rating is derated power capability)			
Primary-Side Current Rating	Current from pin (3-6) to pin 1	1.5	A
Primary-Side Power Rating	T_{AMB} = 25 °C (Device mounted in socket resulting in T_{CASE} = 120 °C)	1.35	W
Secondary-Side Power Rating	T_{AMB} = 25 °C (Device mounted in socket)	0.125	W

Parameter	Symbol	Conditions SOURCE = 0 V T_{JI} = -40 °C to +125 °C (Unless Otherwise Specified)		Min	Typ	Max	Units
Control Functions							
Output Frequency Applies to Both Primary and Secondary Controllers	f_{OSC}	T_J = 25 °C	Average	93	100	107	kHz
			Peak-to-Peak Jitter	4	6	8	
Maximum Duty Cycle	DC_{MAX}	T_J = 0 °C to 125 °C		60	68	78	%
PRIMARY BYPASS Pin Supply Current	I_{S1}	T_J = 25 °C, V_{BPP} + 0.1 V (MOSFET not Switching) See Note B		235	260	290	µA
	I_{S2}	T_J = 25 °C, V_{BPP} + 0.1 V (MOSFET Switching at f_{OSC}) See Note A, C		600	740	880	
PRIMARY BYPASS Pin Charge Current	I_{CH1}	T_J = 25 °C, V_{BP} = 0 V See Notes D, E		-7.55	-6.4	-5.25	mA
	I_{CH2}	T_J = 25 °C, V_{BP} = 4 V See Notes D, E		-5.45	-4.3	-3.15	
PRIMARY BYPASS Pin Voltage	V_{BPP}	See Note D		5.70	5.95	6.15	V
PRIMARY BYPASS Pin Voltage Hysteresis	$V_{BPP(H)}$			0.40	0.56	0.70	V
PRIMARY BYPASS Shunt Voltage	V_{SHUNT}	I_{BPP} = 2 mA		6.15	6.45	6.75	V
Line Fault Protection							
UV/OV Pin Brown-In Threshold	I_{UV+}	T_J = 25 °C		10.7	11.9	13.1	µA
UV/OV Pin Brown-Out Threshold	I_{UV-}	T_J = 25 °C		8.9	0.86 × I_{UV+}	11.5	
Brown-Out Delay Time	t_{UV-}			30	34	38	ms
UV/OV Pin Line Over-voltage Threshold	I_{OV+}	T_J = 25 °C		74.5	77.5	80.1	µA
UV/OV Pin Line Ovevolt-age Recovery Threshold	I_{OV-}			69	0.95 × I_{OV+}	81	
UV/OV Pin Overvoltage Deglitch Filter	t_{OV+}	See Note A			5		µs
VOLTAGE MONITOR Pin Threshold Voltage	V_V	I_V = 30 µA		3.1	3.7	4.3	V

Parameter	Symbol	Conditions SOURCE = 0 V T_{JI} = -40 °C to +125 °C (Unless Otherwise Specified)	Min	Typ	Max	Units
Circuit Protection (cont.)						
Standard Current Limit (BPP) Capacitor = 0.1 µF	I_{LIMIT} See Note E	di/dt = 160 mA/µs T_J = 25 °C	940	1000	1060	mA
Reduced Current Limit (BPP) Capacitor = 10 µF	$I_{LIMIT-1}$ See Note E	di/dt = 160 mA/µs T_J = 25 °C	773	850	927	mA
Increased Current Limit (BPP) Capacitor = 1 µF	$I_{LIMIT+1}$ See Note E	di/dt = 160 mA/µs T_J = 25 °C	1045	1150	1254	mA
Power Coefficient	I^2f	Standard Current Limit, $I^2f = I_{LIMIT(TYP)}^2 \times f_{OSC(TYP)}$ See Note A	0.87 × I^2f	I^2f	1.15 × I^2f	A^2Hz
		Reduced Current Limit, $I^2f = I_{(LIMIT-1(TYP)}^2 \times f_{OSC(TYP)}$ See Note A	0.84 × I^2f	I^2f	1.18 × I^2f	
		Increased Current Limit, $I^2f = I_{(LIMIT+1(TYP)}^2 \times f_{OSC(TYP)}$ See Note A	0.84 × I^2f	I^2f	1.18 × I^2f	
Initial Current Limit	I_{INIT}	T_J = 25 °C See Note A	0.75 × $I_{LIMIT(TYP)}$			mA
Leading Edge Blanking Time	t_{LEB}	T_J = 25 °C See Note A	170	250		ns
Current Limit Delay	t_{ILD}	T_J = 25 °C See Note A, F		170		ns
Thermal Shutdown	T_{SD}	See Note A	135	142	150	°C
Thermal Shutdown Hysteresis	$T_{SD(H)}$	See Note A		75		°C

Parameter	Symbol	Conditions SOURCE = 0 V T_{JI} = -40 °C to +125 °C (Unless Otherwise Specified)		Min	Typ	Max	Units
Circuit Protection (cont.)							
PRIMARY BYPASS Pin Shutdown Threshold Current	I_{SD}			5.6	7.6	9.6	mA
Primary Bypass Power-Up Reset Threshold Voltage	$V_{BPP(RESET)}$	T_J = 25 °C		2.8	3.0	3.3	V
Auto-Restart On-Time at f_{osc}	t_{AR}	T_J = 25 °C See Note G		64	77	90	ms
Auto-Restart Trigger-Skip Time	$t_{AR(SK)}$	T_J = 25 °C See Note A, G			1		s
Auto-Restart Off-Time at f_{osc}	$t_{AR(OFF)}$	T_J = 25 °C See Note G		1	1.5	2	s
Short Auto-Restart Off-Time at f_{osc}	$t_{AR(OFF)SH}$	T_J = 25 °C See Note A, G			0.5		s
Output							
ON-State Resistance	$R_{DS(ON)}$	I_D = 1150 mA	T_J = 25 °C		3.35	3.95	Ω
			T_J = 100 °C See Note A		5.55	6.35	
OFF-State Drain Leakage Current	I_{DSS1}	V_{BPP} = 6.2 V, V_{DS} = 80% BV_{DSS} V, T_J = 125 °C See Note H				200	µA
OFF-State Drain Leakage Current	I_{DSS2}	V_{BPP} = 6.2 V, V_{DS} = 325 V, T_J = 25 °C See Note A, H			15	50	µA
Breakdown Voltage	BV_{DSS}	V_{BPP} = 6.2 V T_J = 25 °C See Note I		900			V
Drain Supply Voltage				50			V
Secondary							
FEEDBACK Pin Voltage	V_{FB}	T_J = 25 °C		1.250	1.265	1.280	V
FEEDBACK Pin Auto-Restart Threshold	$V_{FB(AR)}$			V_{OUT}-2.3 V	V_{OUT}-2 V	V_{OUT}-1.6 V	
SECONDARY BYPASS Pin Current at No-Load	I_{SNL}	T_J = 25 °C		265	300	335	µA

Parameter	Symbol	Conditions SOURCE = 0 V T_{JI} = -40 °C to +125 °C (Unless Otherwise Specified)		Min	Typ	Max	Units
Secondary (cont.)							
SECONDARY BYPASS Pin Voltage	V_{BPS}			4.25	4.45	4.65	V
SECONDARY BYPASS Pin Undervoltage Threshold	$V_{BPS(UVLO)}$			3.45	3.8	4.15	V
SECONDARY BYPASS Pin Undervoltage Hysteresis	$V_{BPS(HYS)}$			0.10	0.65	1.2	V
Output (IS Pin) Current Limit Voltage Threshold	IS_{VTH}	T_J = 25 °C		34.1	35	35.9	mV
FEEDBACK Pin Auto-Restart Timer	$t_{FB(AR)}$			50	62	75	ms
FEEDBACK Pin Short-Circuit	$V_{FB(OFF)}$			80	100	120	mV
Synchronous Rectifier[1]							
SYNCHRONOUS RECTIFIER Pin Threshold	V_{SRTH}	T_J = 25 °C		-19	-24	-29	mV
SYNCHRONOUS RECTIFIER Pin Pull-Up Current	I_{SRPU}	T_J = 25 °C C_{LOAD} = 2 nF, f_S = 100 kHz		135	162	185	mA
SYNCHRONOUS RECTIFIER Pin Pull-Down Current	I_{SRPD}	T_J = 25 °C C_{LOAD} = 2 nF, f_S = 100 kHz		210	250	330	mA
SYNCHRONOUS RECTIFIER Pin Drive Voltage	V_{SR}	See Note A		4.2	4.4	4.6	V
Rise Time	t_R	T_J = 25 °C C_{LOAD} = 2 nF See Note A	0-100%		71		ns
			10-90%		40		
Fall Time	t_F	T_J = 25 °C C_{LOAD} = 2 nF See Note A	0-100%		32		ns
			10-90%		15		
Output Pull-Up Resistance	R_{PU}	T_J = 25 °C, V_{SPS} = 4.4 V I_{SR} = 10 mA, See Note A			11.5		Ω
Output Pull-Down Resistance	R_{PD}	T_J = 25 °C, V_{SPS} = 4.4 V I_{SR} = 10 mA, See Note A			3.5		Ω

NOTES:

A. This parameter is derived from characterization.

B. I_{S1} is an estimate of device current consumption at no-load, since the operating frequency is so low under these conditions. Total device consumption at no-load is sum of I_{S1} and I_{DSS2} (this does not include secondary losses)

C. Since the output MOSFET is switching, it is difficult to isolate the switching current from the supply current at the Drain. An alternative is to measure the PRIMARY BYPASS pin current at 6.2 V.

D. The PRIMARY BYPASS pin is not intended for sourcing supply current to external circuitry.

E. To ensure correct current limit it is recommended that nominal 0.1 µF/1 µF/10 µF capacitors are used. In addition, the BPP capacitor value tolerance should be equal or better than indicated below across the ambient temperature range of the target application. The minimum and maximum capacitor values are guaranteed by characterization.

Nominal PRIMARY BYPASS Pin Capacitor Value	**Tolerance Relative to Nominal Capacitor Value**	
	Minimum	Maximum
0.1 µF	-60%	+100%
1 µF	-50%	+100%
10 µF	-50%	N/A

F. This parameter is derived from the change in current limit measured at 1X and 4X of the di/dt shown in the I_{LIMIT} specification.

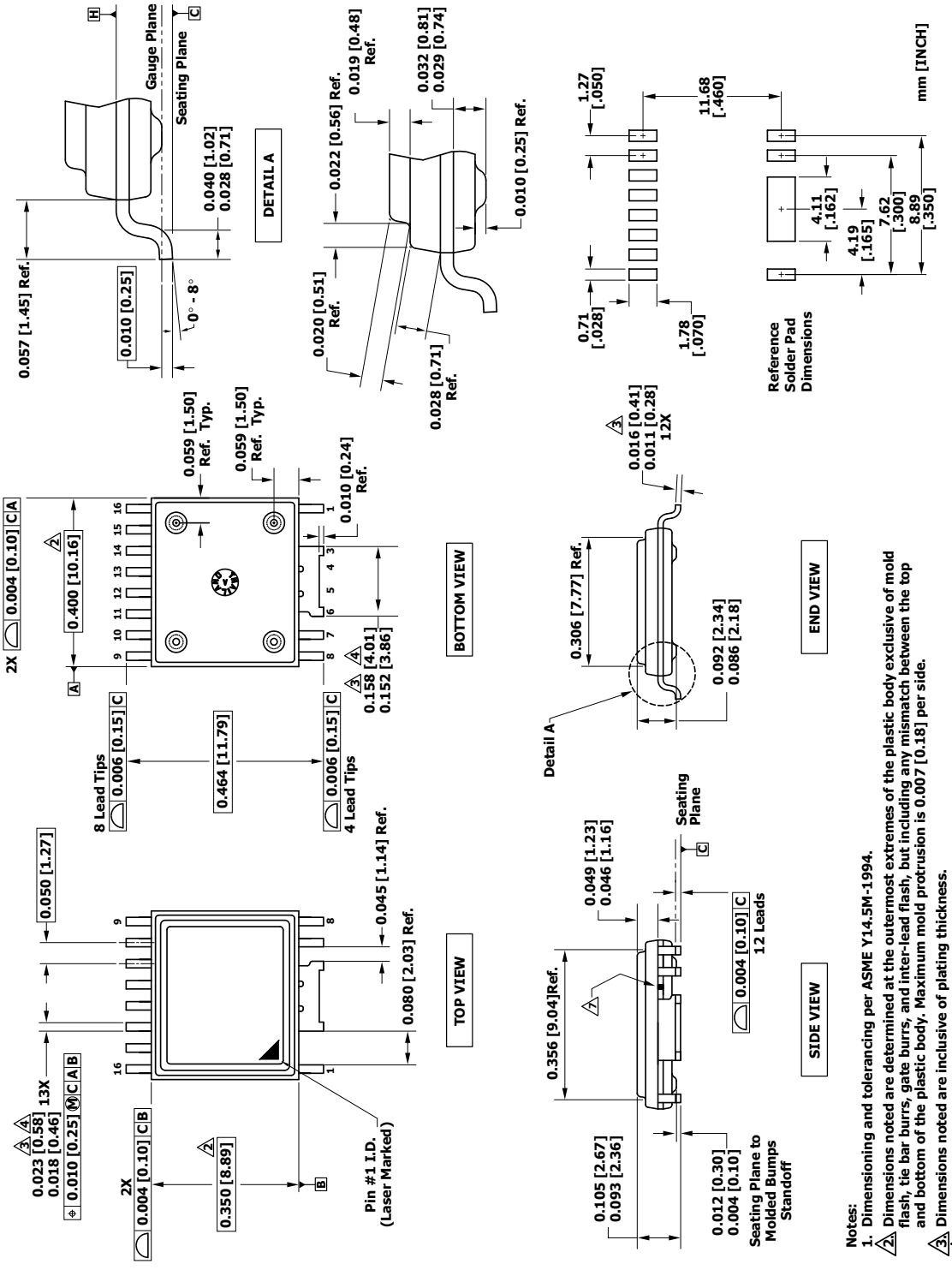
G. Auto-restart on-time has same temperature characteristics as the oscillator (inversely proportional to frequency).

H. I_{DSS1} is the worst-case OFF-state leakage specification at 80% of BV_{DSS} and the maximum operating junction temperature. I_{DSS2} is a typical specification under worst-case application conditions (rectified 230 VAC) for no-load consumption calculations.

I. Breakdown voltage may be checked against minimum BV_{DSS} specification by ramping Drain voltage up to but not exceeding minimum BV_{DSS}.

J. For reference only. This is the total range of current limit threshold which corrects for variations in the current sense bond wire. Both of which are trimmed to set the normalized output constant current.

eSOP-R16B

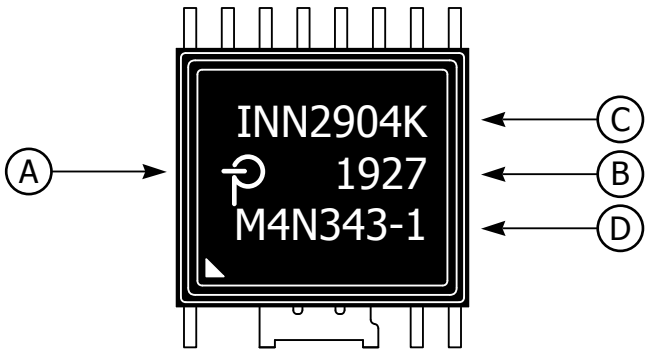


Notes:
1. Dimensioning and tolerancing per ASME Y14.5M-1994.
2. Dimensions noted are determined at the outermost extremes of the plastic body exclusive of mold flash, tie bar burrs, gate burrs, and inter-lead flash, but including any mismatch between the top and bottom of the plastic body. Maximum mold protrusion is 0.007 [0.18] per side.
3. Dimensions noted are inclusive of plating thickness.
4. Does not include inter-lead flash or protrusions.
5. Controlling dimensions in inches [mm].
6. Datums A and B to be determined in Datum H.
7. Exposed metal at the plastic package body outline/surface between leads 6 and 7, connected internally to wide lead 3/4/5/6.

PI-6995-010615
POD-eSOP-R16B Rev B

PACKAGE MARKING

eSOP-R16B



A. Power Integrations Registered Trademark
B. Assembly Date Code (last two digits of year followed by 2-digit work week)
C. Product Identification (Part #/Package Type)
D. Lot Identification Code

PI-7801b-111915

Part Ordering Table

Product	Cable Compensation
INN2904K0044	0%

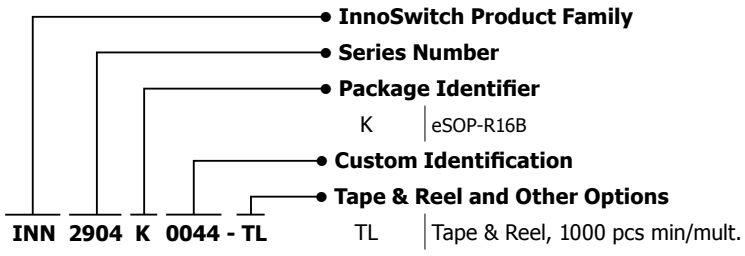
MSL Table

Part Number	MSL Rating
INN2904K0044	3

ESD and Latch-Up Table

Test	Conditions	Results
Latch-up at 125 °C	JESD78D	> ±100 mA or > 1.5 V (max) on all pins
Human Body Model ESD	ANSI/ESDA/JEDEC JS-001-2014	> ±2000 V on all pins
Machine Model ESD	JESD22-A115C	> ±200 V on all pins

Part Ordering Information



Notes

Revision	Notes	Date
A	Initial release.	07/19
B	Added Min & Max values for f_{OSE}, DC_{MAX}, I_{S2}, I_{CH1}, I_{CH2}, I_{UV+}, I_{UV-}, I_{OV+}, I_{OV-}, $t_{AR(OFF)}$, and IS_{VTH}.	09/19

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2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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