General Description

The LTP850x is a monolithic oscillator/power-driver, specifically designed for small form factor, isolated power supplies in isolated interface applications. The device drives a low-profile, center-tapped transformer primary from a 3.3 V or 5 V DC power supply. The secondary can be wound to provide any isolated voltage based on transformer turns ratio.

The LTP850x consists of an oscillator followed by a gate drive circuit that provides the complementary output signals to drive the ground referenced N-channel power switches. The internal logic ensures break-before-make action between the two switches.

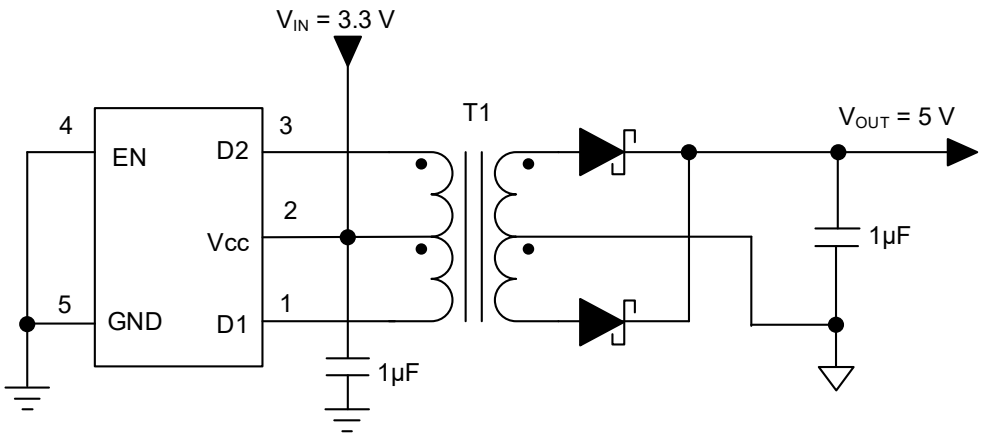
The LTP850x is available in a small SOT23-5 package, and is specified for operation at temperatures from –40°C to 125°C.

Features

- Push-pull driver for small transformers
- Single 3.3 V or 5 V supply
- High primary-side current drive:
  –5 V Supply: 350 mA (Max)
  –3.3 V Supply: 150 mA (Max)
- Low ripple on rectified output permits small output capacitors
- Small Package: SOT23-5

Applications

- Isolated interface power supply for CAN, RS-485, RS-422, RS-232, SPI, I2C, Low-Power LAN
- Industrial automation
- Process control
- Medical equipment

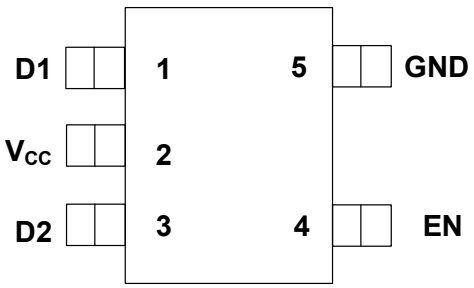


Simplified Schematic

Ordering Information

Model	Ordering Number	Operating Frequency	Package	Packing Option
LTP850x	LTP8501XT5/R6	160kHz	SOT23-5	Tape and Reel, 3000
	LTP8502XT5/R6	360kHz	SOT23-5	Tape and Reel, 3000

Pin Configurations (Top View)



Pin Function

Pin no.	Symbol	Function
1	D1	Open Drain output 1. Connect this pin to one end of the transformer primary side.
2	Vcc	Supply voltage input. Connect this pin to the center-tap of the transformer primary side. Buffer this voltage with a 1 µF to 10 µF ceramic capacitor.
3	D2	Open Drain output 2. Connect this pin to the other end of the transformer primary side.
4	EN	Regulator Enable. Drive EN low to turn on the regulator; drive EN high to turn off the regulator
5	GND	Device ground. Connect this pin to board ground.

Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
Supply voltage	V_{CC}	-0.3 to 6	V
Output switch voltage	V_{D1}, V_{D2}	14	V
Peak output switch current	I_{D1P}, I_{D2P}	500	mA
Continuous power dissipation	P_{TOT}	250	mW
Junction temperature	T_J	150	°C
Storage Temperature	T_{STG}	-65 to 150	°C
Human Body Model	HBM	±2000	V
ESD Charged device model	CDM	±1.5k	V

NOTE:

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Recommended Operating Conditions

Parameter	Symbol			Min.	Max.	Unit
Input supply voltage range	V_{CC}			3	5.5	V
Output switch voltage	V_{D1}, V_{D2}	V_{CC}= 5 V ± 10%	When connected to Transformer with primary winding Center-tapped	0	11	V
		V_{CC}= 3.3 V ± 10%		0	7.2	
D1 and D2 output switch current – Primary-side	I_{D1}, I_{D2}	V_{CC}= 5 V ± 10%, V_{D1}, V_{D2} Swing ≥ 3.8 V,			350	mA
		V_{CC}= 3.3 V ± 10%, V_{D1}, V_{D2} Swing ≥ 2.5 V			150	
Ambient temperature	T_A			-40	125	°C

Thermal Information

Parameter	Symbol	Value	Unit
Junction-to-ambient thermal resistance	θ_{JA}	208.3	°C/W
Junction-to-case (top) thermal resistance	θ_{JCtop}	87.1	
Junction-to-board thermal resistance	θ_{JB}	40.4	
Junction-to-top characterization parameter	ψ_{JT}	5.2	
Junction-to-board characterization parameter	ψ_{JB}	39.7	
Junction-to-case (bottom) thermal resistance	θ_{JCbot}	N/A	

Electrical Characteristics

(T_J = 25°C, unless otherwise noted)

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Switch-on resistance	R_{ON}	V_{CC}= 3.3 V ± 10%		1	3	Ω
		V_{CC}= 5 V ± 10%		0.7	2	
Average supply current(1)	I_{CC}	V_{CC}= 3.3 V ± 10%, See Figure 13		150	400	µA
		V_{CC}= 5 V ± 10%, See Figure 13		250	700	
Startup frequency	f_{ST}	V_{CC}= 2.4 V ± 10%,		350		kHz
D1, D2 Switching frequency	f_{SW}	V_{CC}= 3.3 V ± 10%, See Figure 14		380		kHz
		V_{CC}= 5 V ± 10%, See Figure 14		400		
Enable Under Voltage Lockout	$EN_{UVLO(rise)}$			2.9		V
	$EN_{UVLO(fall)}$			0.8		

Switching Characteristics

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
D1, D2 output rise time	t_{r-D}	V_{CC}= 3.3 V ± 10%,		70		ns
		V_{CC}= 5 V ± 10%		80		
D1, D2 output fall time	t_{f-D}	V_{CC}= 3.3 V ± 10%,		100		ns
		V_{CC}= 5 V ± 10%		60		
Break-before-make time	t_{BBM}	V_{CC}= 3.3 V ± 10%,		150		ns
		V_{CC}= 5 V ± 10%		70		

Typical Performance Characteristics

(T_J = 25°C, unless otherwise noted)

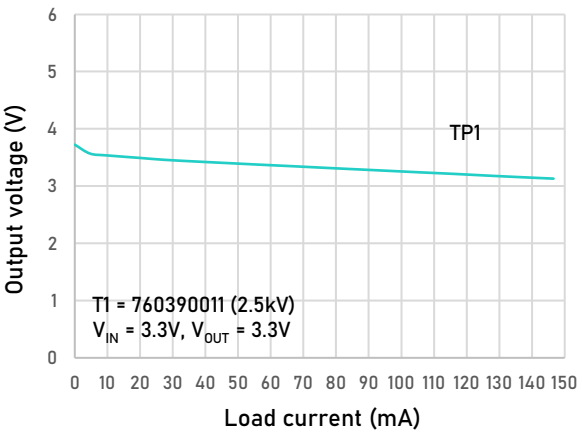


Figure 1. Output voltage vs Load current

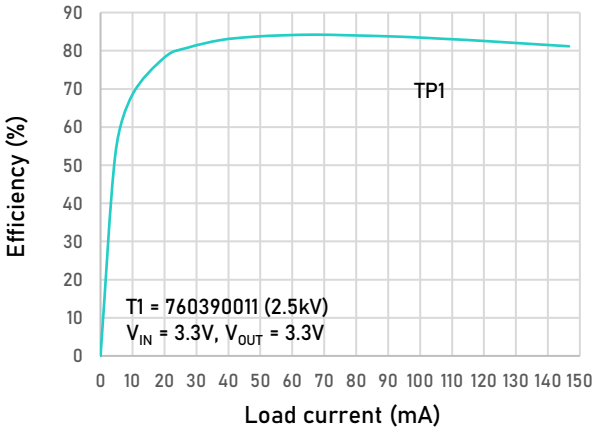


Figure 2. Efficiency vs Load current

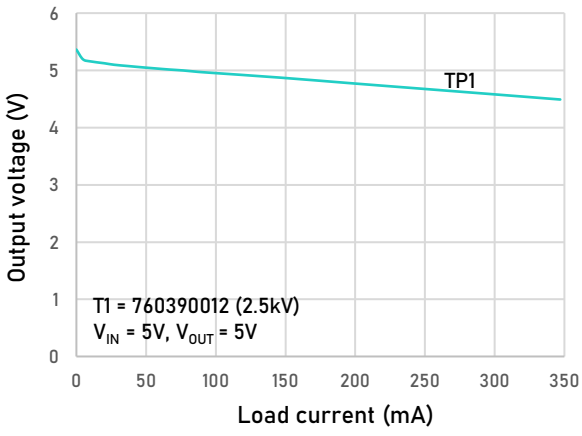


Figure 3. Output voltage vs Load current

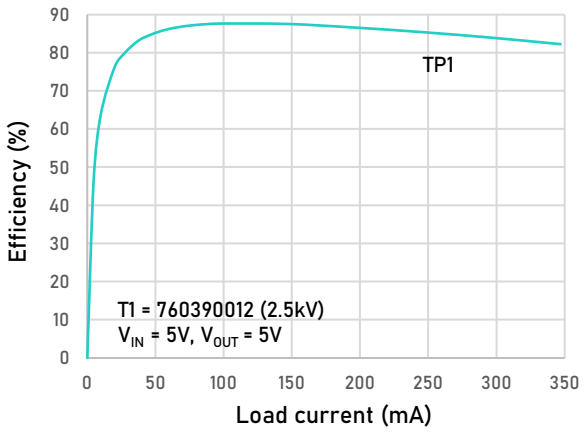


Figure 4. Efficiency vs Load current

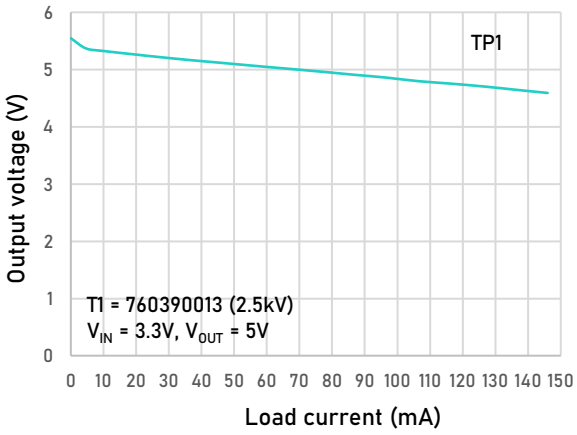


Figure 5. Output voltage vs Load current

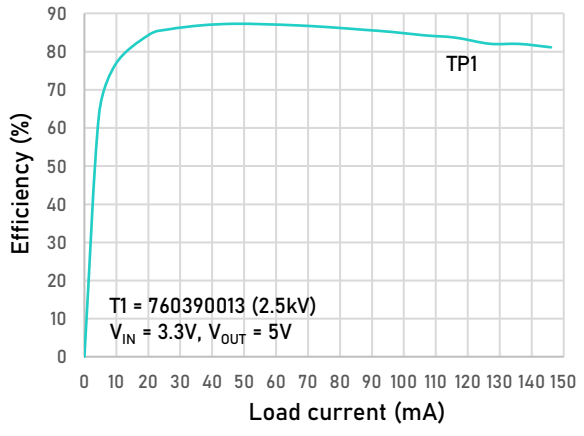


Figure 6. Efficiency vs Load current

Typical Performance Characteristics

(T_J = 25°C, unless otherwise noted)

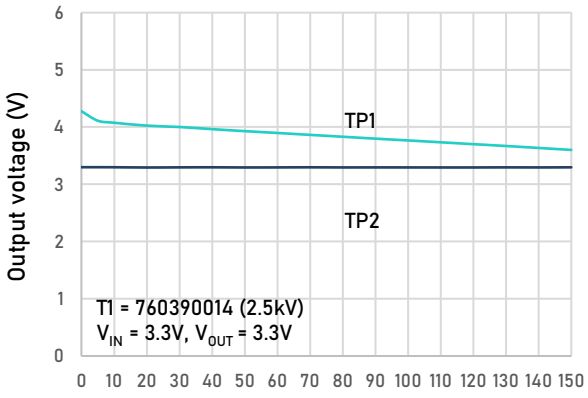


Figure 7. Output voltage vs Load current

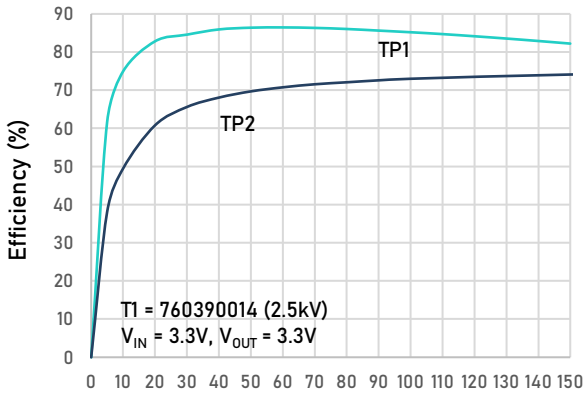


Figure 8. Efficiency vs Load current

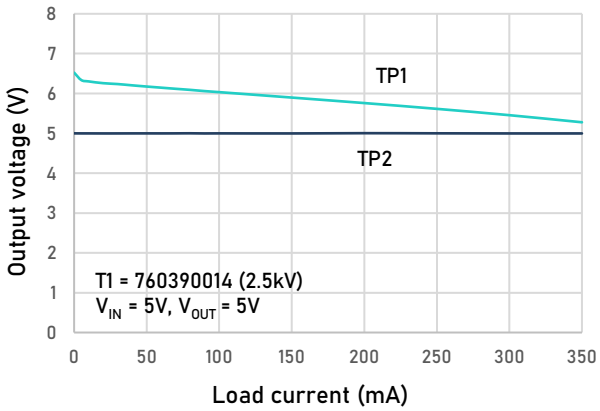


Figure 9. Output voltage vs Load current

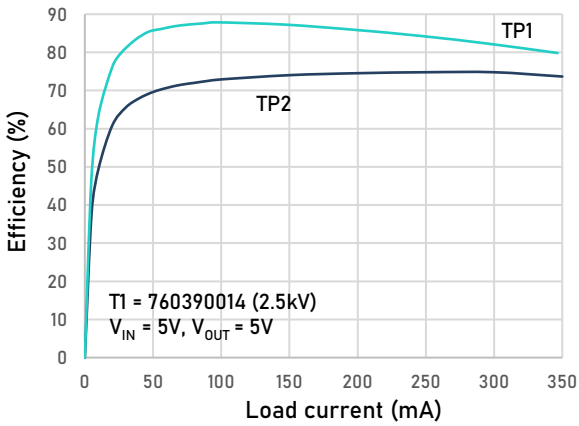


Figure 10. Efficiency vs Load current

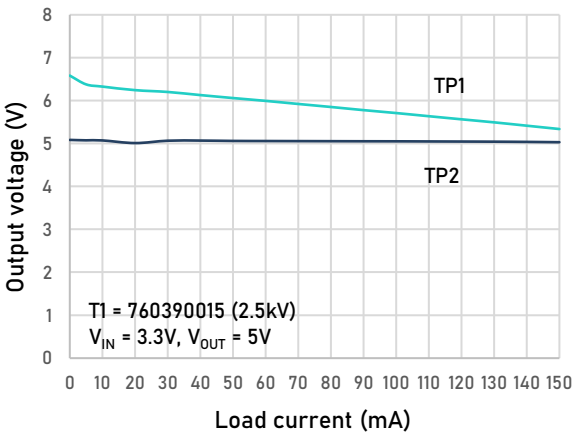


Figure 11. Output voltage vs Load current

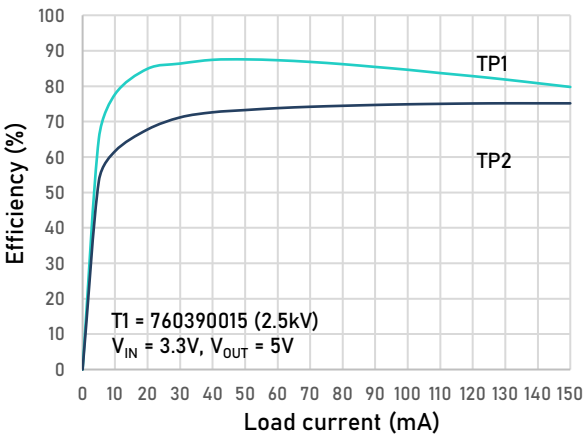


Figure 12. Efficiency vs Load current

Typical Performance Characteristics

(T_J = 25°C, unless otherwise noted)

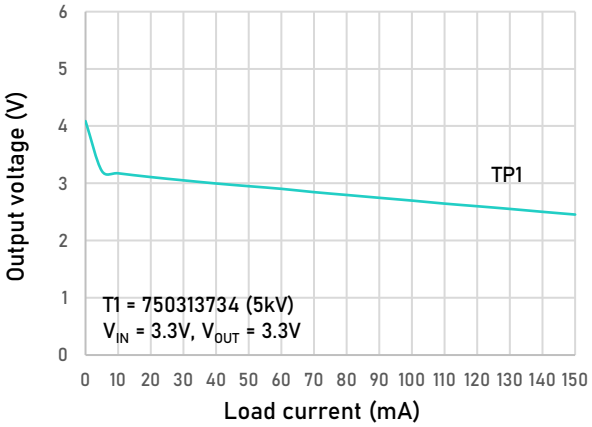


Figure 13. Output voltage vs Load current

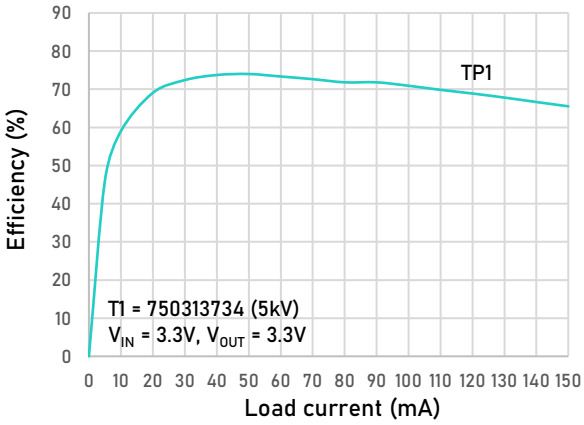


Figure 14. Efficiency vs Load current

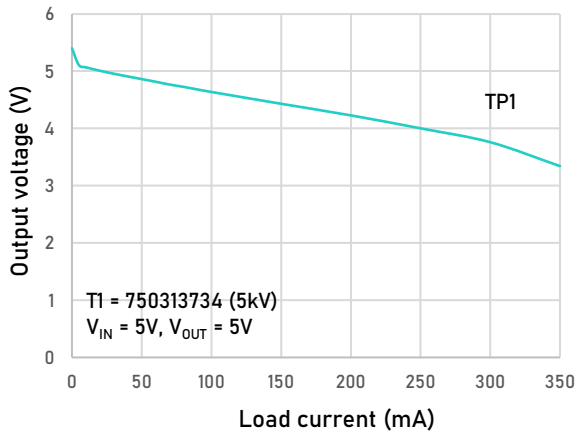


Figure 15. Output voltage vs Load current

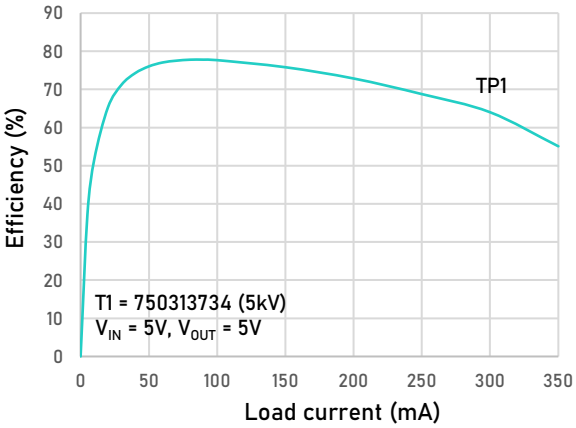


Figure 16. Efficiency vs Load current

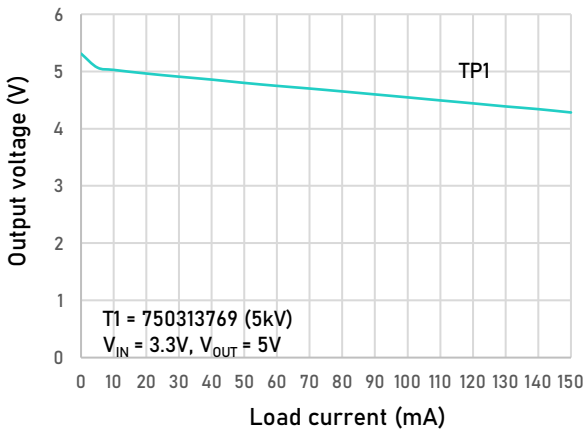


Figure 17. Output voltage vs Load current

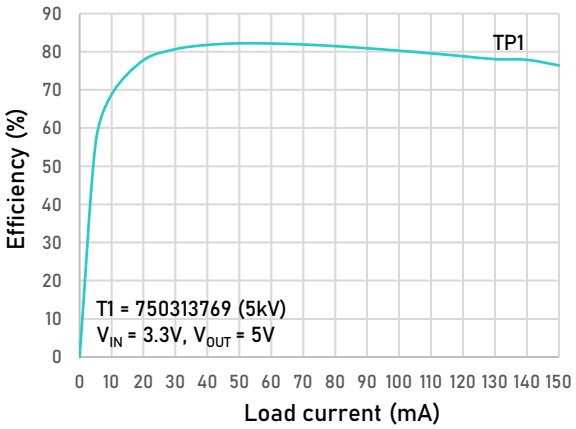


Figure 18. Efficiency vs Load current

Typical Performance Characteristics

(T_J = 25°C, unless otherwise noted)

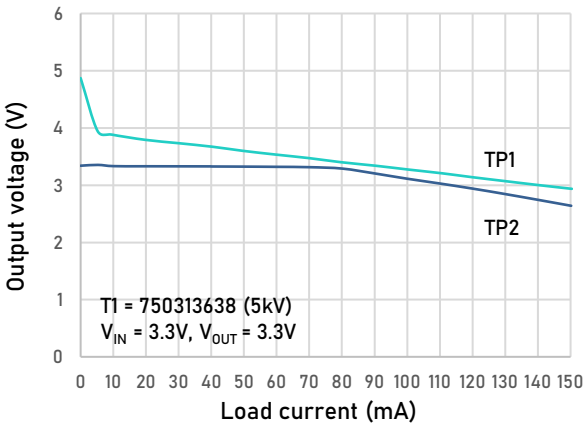


Figure 19. Output voltage vs Load current

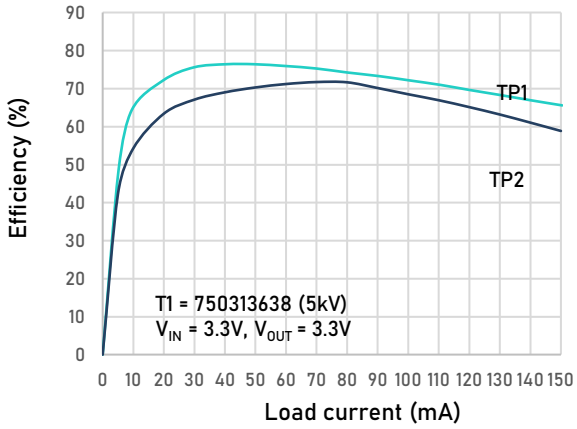


Figure 20. Efficiency vs Load current

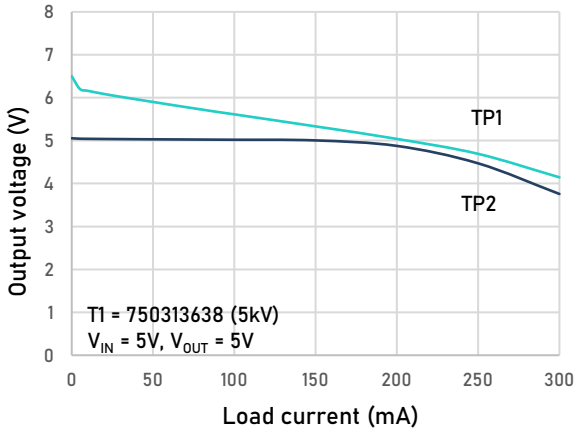


Figure 21. Output voltage vs Load current

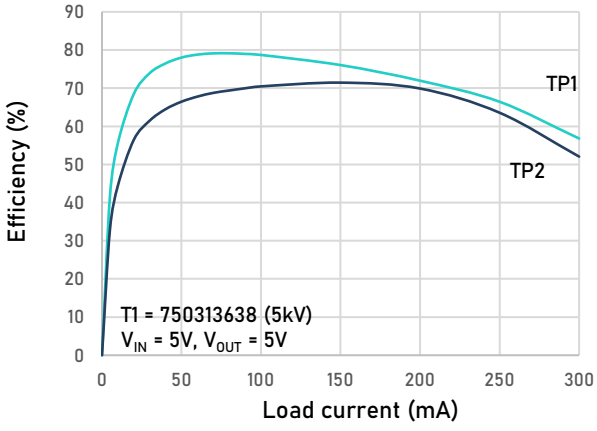


Figure 22. Efficiency vs Load current

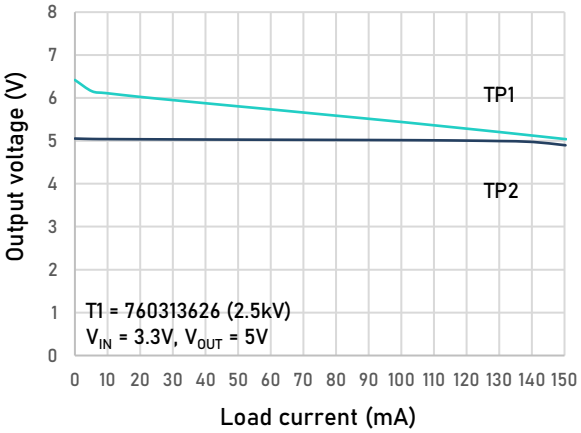


Figure 23. Output voltage vs Load current

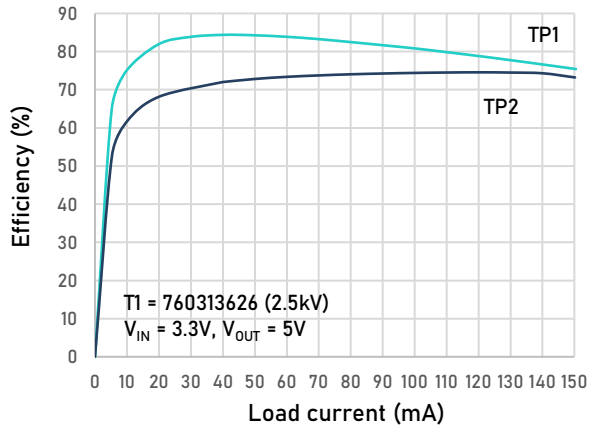


Figure 24. Efficiency vs Load current

Typical Performance Characteristics

(T_J = 25°C, unless otherwise noted)

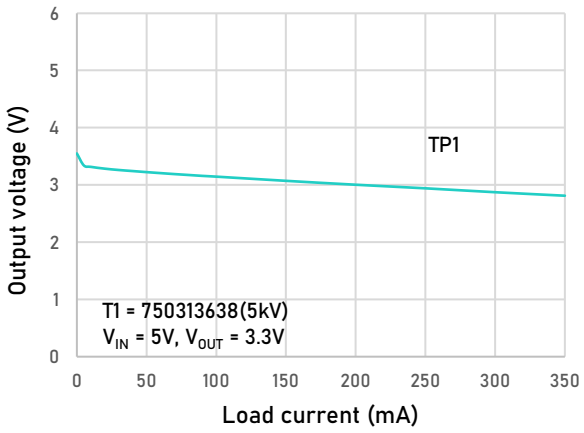


Figure 25. Output voltage vs Load current

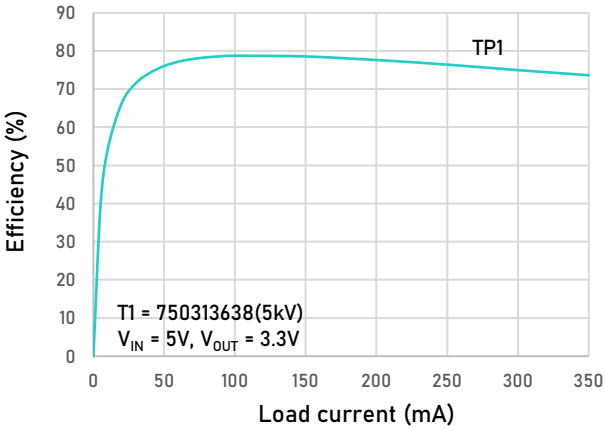


Figure 26. Efficiency vs Load current

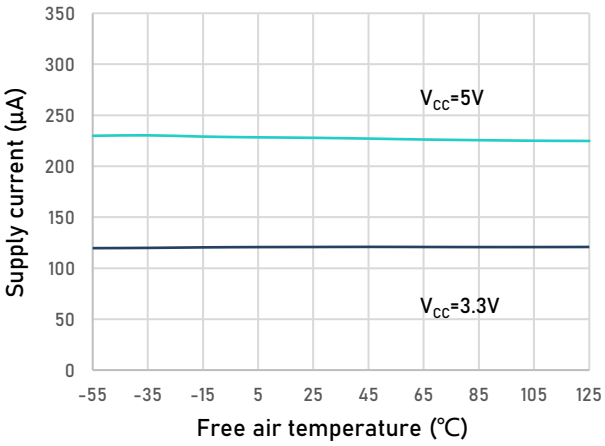


Figure 27. Supply current vs Free air temperature

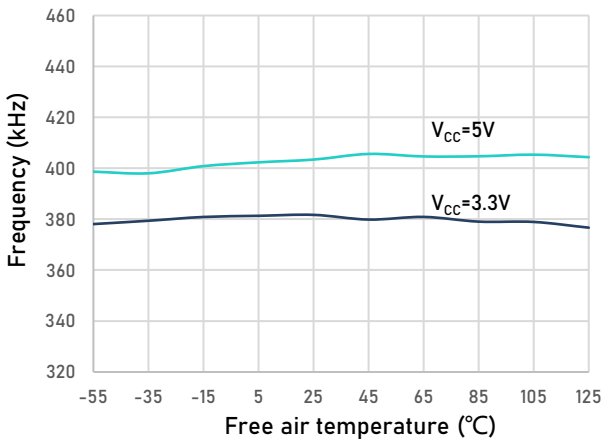


Figure 28. Frequency vs Free air temperature

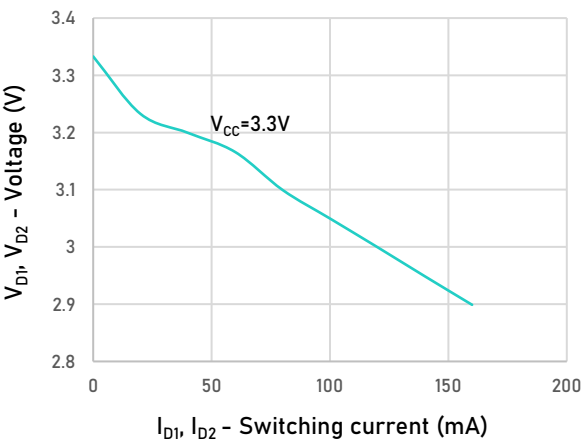


Figure 29. Diode voltage vs Switching current

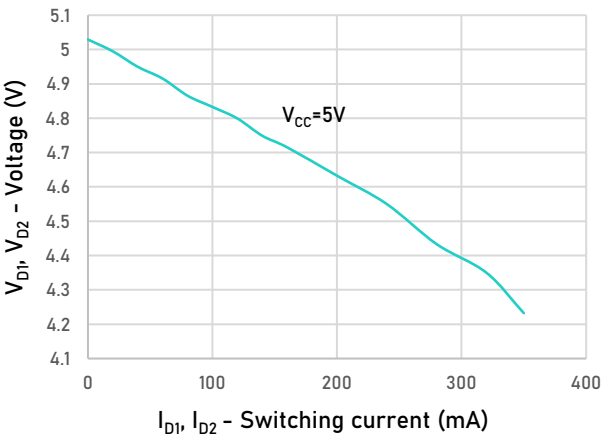
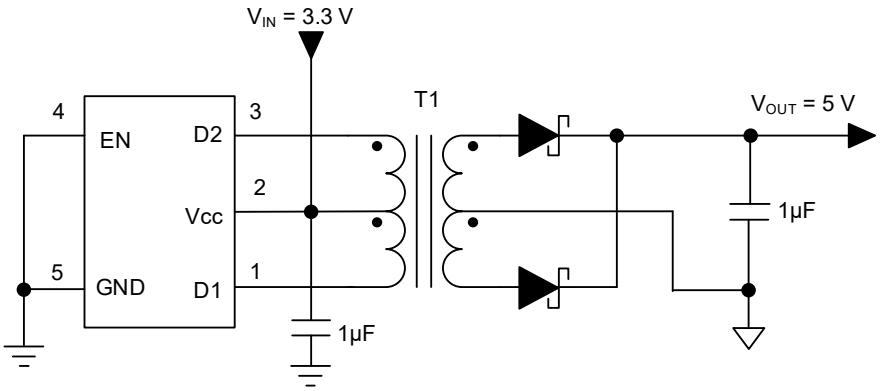
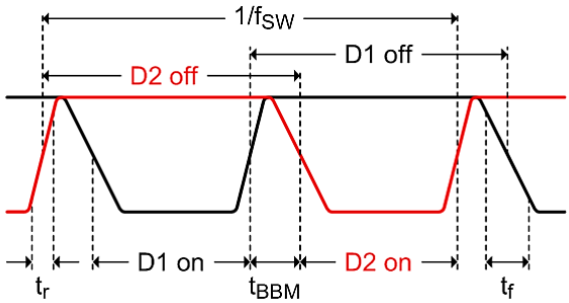


Figure 30. Diode voltage vs Switching current

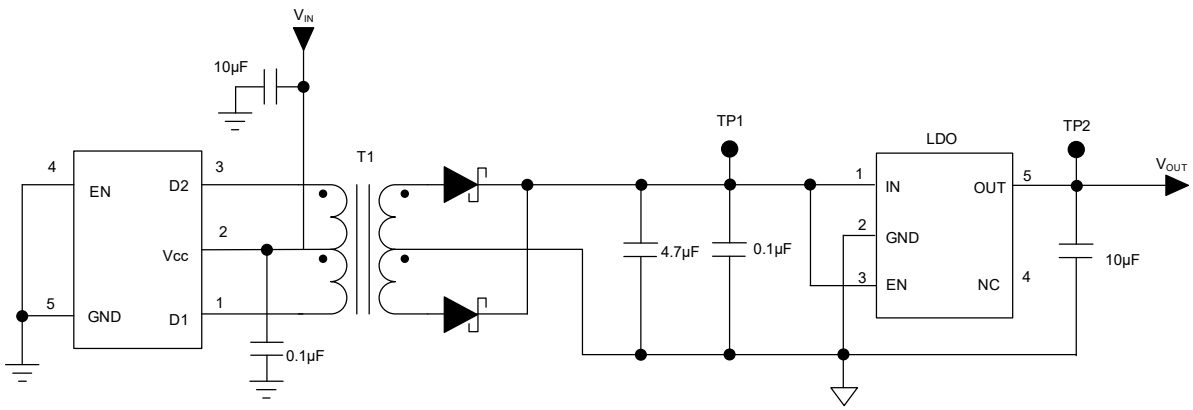
Parameter Measurement Information



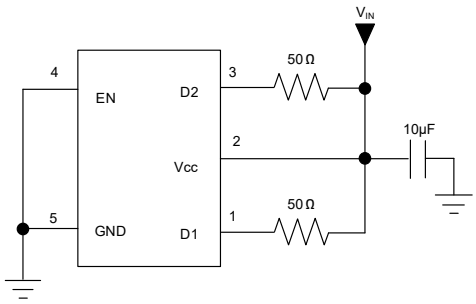
Measurement Circuit for Unregulated Output (TP1)



Timing Diagram



Measurement Circuit for regulated Output (TP1 and TP2)



Test Circuit For R_{ON}, F_{SW}, F_{St}, T_{r-D}, T_{f-D}, T_{BBM}

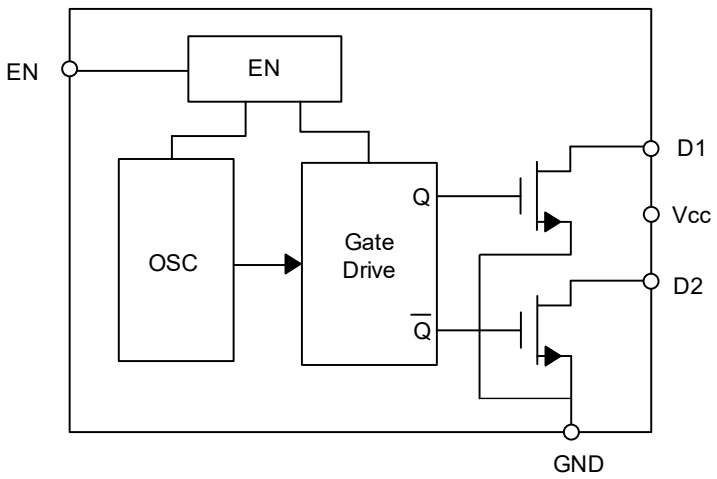
Detailed Description

Overview

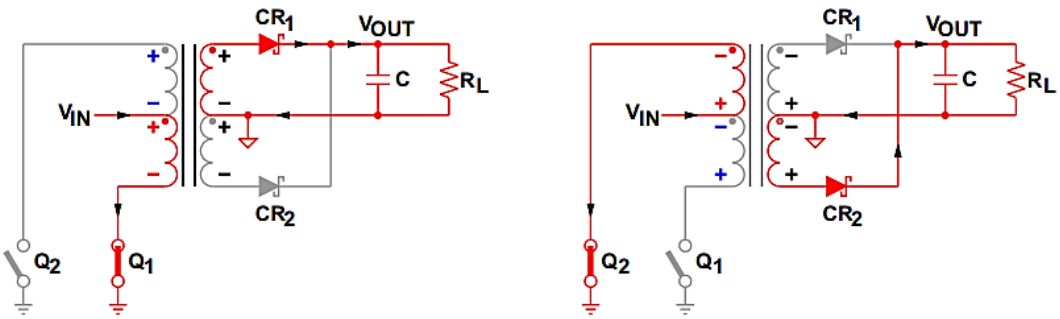
The LTP850x is a transformer driver designed for low-cost, small form-factor, isolated DC-DC converters utilizing the push-pull topology. The device includes an oscillator that feeds a gate-drive circuit. The gate-drive, comprising a frequency divider and a break-before-make (BBM) logic, provides two complementary output signals which alternately turn the two output transistors on and off.

The output frequency of the oscillator is divided down by an asynchronous divider that provides two complementary output signals with a 50% duty cycle. A subsequent break-before-make logic inserts a dead-time between the high-pulses of the two signals. The resulting output signals, present the gate-drive signals for the output transistors. As shown in the functional block diagram, before either one of the gates can assume logic high, there must be a short time period during which both signals are low and both transistors are high-impedance. This short period, known as break-before-make time, is required to avoid shorting out both ends of the primary.

Functional Block Diagram



Feature Description



Switching Cycles of a Push-Pull Converter

Detailed Description

Feature Description

Push-pull converters require transformers with center-taps to transfer power from the primary to the secondary.

When Q1conducts, V_{IN} drives a current through the lower half of the primary to ground, thus creating a negative voltage potential at the lower primary end with regards to the V_{IN} potential at the center-tap.

At the same time the voltage across the upper half of the primary is such that the upper primary end is positive with regards to the center-tap in order to maintain the previously established current flow through Q_2, which now has turned high-impedance. The two voltage sources, each of which equaling V_{IN}, appear in series and cause a voltage potential at the open end of the primary of $2\times V_{IN}$ with regards to ground.

Per dot convention the same voltage polarities that occur at the primary also occur at the secondary. The positive potential of the upper secondary end therefore forward biases diode CR_1. The secondary current starting from the upper secondary end flows through CR_1, charges capacitor C, and returns through the load impedance R_L back to the center-tap.

When Q_2 conducts, Q_1 goes high-impedance and the voltage polarities at the primary and secondary reverse. Now the lower end of the primary presents the open end with a $2\times V_{IN}$ potential against ground. In this case CR_2 is forward biased while CR_1 is reverse biased and current flows from the lower secondary end through CR_2, charging the capacitor and returning through the load to the center-tap.

Device Functional Modes

The functional modes of the LTP850x are divided into start-up, operating, and off-mode.

Start-Up Mode

When the supply voltage at Vcc ramps up to 2.4 V typical, the internal oscillator starts operating at a start frequency of 350 kHz. The output stage begins switching but the amplitude of the drain signals at D1 and D2 has not reached its full maximum yet.

Operating Mode

When the device supply has reached its nominal value ±10% the oscillator is fully operating. However variations over supply voltage and operating temperature can vary the switching frequencies at D1 and D2 between 360 kHz and 400kHz for V_{CC}= 3.3 V , and between 380 kHz and 420 kHz for V_{CC}= 5 V.

Off-Mode

The LTP850x is deactivated by reducing V_{CC} to 0 V. In this state both drain outputs, D1 and D2, are high-impedance.

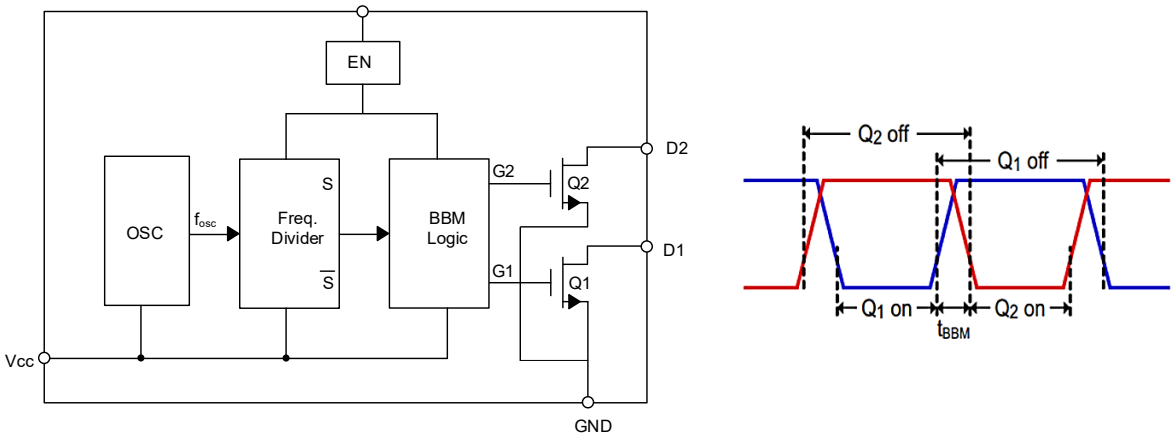
EN

Drive EN low to turn on the regulator; drive EN high to turn off the regulator

Application and Implementation

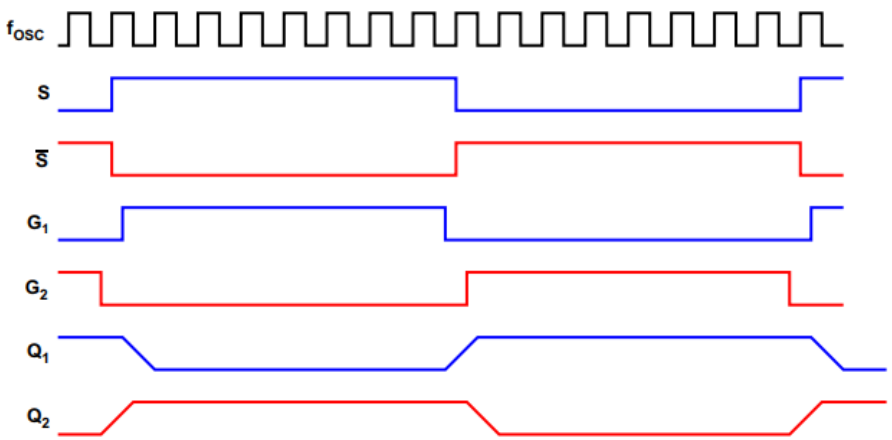
Application Information

The LTP850x is a transformer driver designed for low-cost, small form-factor, isolated DC-DC converters utilizing the push-pull topology. The device includes an oscillator that feeds a gate-drive circuit. The gate-drive comprising a frequency divider and a break-before-make (BBM) logic, provides two complementary output signals which alternately turn the two output transistors on and off.



LTP850x Block Diagram And Output Timing With Break-Before-Make Action

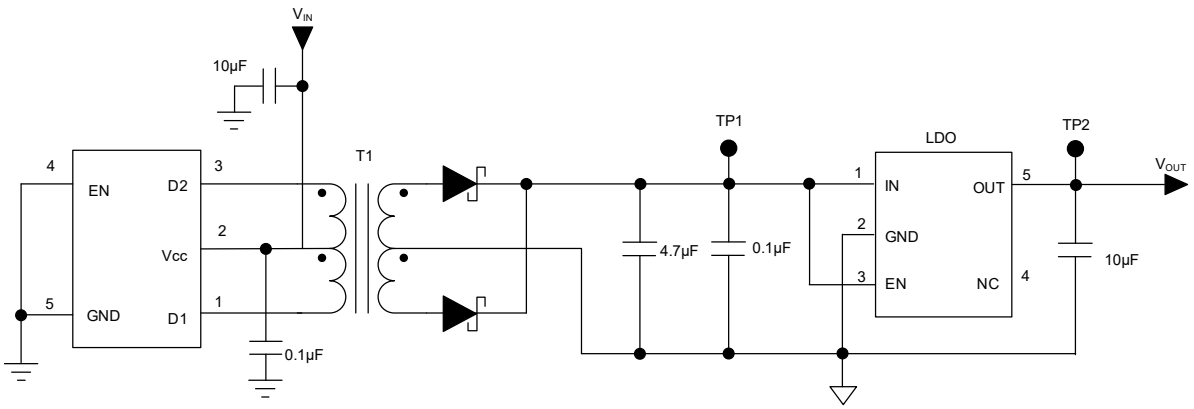
The output frequency of the oscillator is divided down by an asynchronous divider that provides two complementary output signals, S and $\overline{S}$, with a 50% duty cycle. A subsequent break-before-make logic inserts a dead-time between the high-pulses of the two signals. The resulting output signals, G1 and G2, present the gate-drive signals for the output transistors Q1 and Q2. As shown in the below picture, before either one of the gates can assume logic high, there must be a short time period during which both signals are low and both transistors are high-impedance. This short period, known as break-before-make time, is required to avoid shorting out both ends of the primary.



Detailed Output Signal Waveforms

Application and Implementation

Typical Application



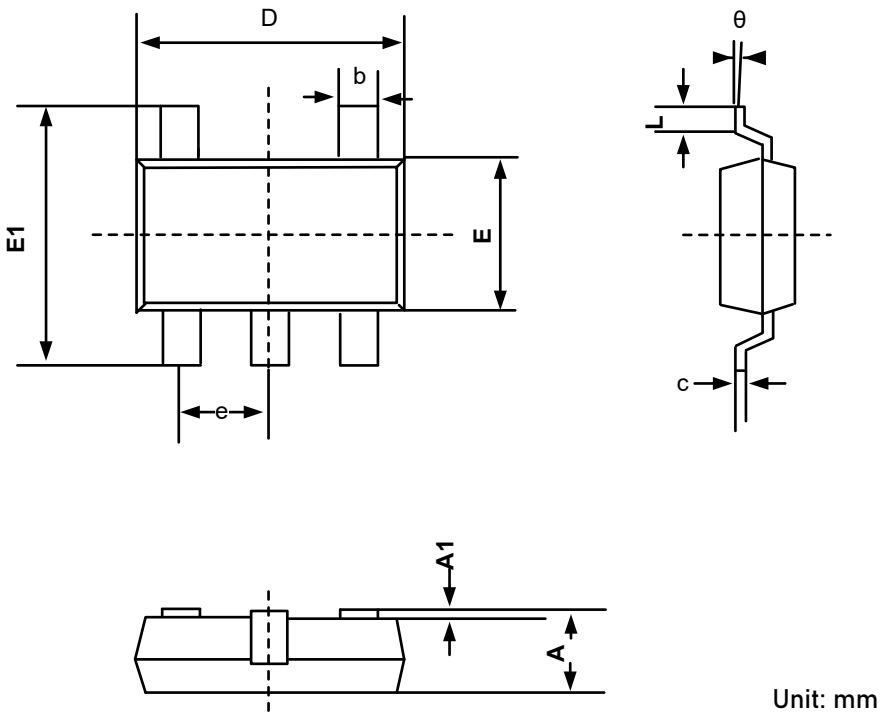
Typical Application Schematic

Table 1. Recommended Isolation Transformers Optimized for LTP850x

Turn Ratio	V x T (Vµs)	Isolation (V_{RMS})	Dimensions(mm)	Application	LDO	Figures	Order No.
1:1.1 ±2%	7	2500	6.73 x 10.05 x 4.19	3.3 V →3.3 V	No	Figure 1、2	760390011
1:1.1 ±2%	11			5 V →5 V		Figure 3、4	760390012
1:1.7 ±2%				3.3 V →5 V		Figure 5、6	760390013
1:1.3 ±2%				3.3 V →3.3 V 5 V →5 V	Yes	Figure 7~10	760390014
1:2.1 ±2%				5 V →5 V		Figure 11、12	760390015
1:1.1 ±2%	11	5000	9.14 x 12.7 x 7.37	3.3 V →3.3 V	No	Figure 13、14	750313734
1:1.1 ±2%				5 V →5 V		Figure 15、16	750313734
1:1.7 ±2%				3.3 V →5 V		Figure 17、18	750313769
1:1.3 ±2%				3.3 V →3.3 V 5 V →5 V	Yes	Figure 19~22	750313638
1:2.1 ±2%				3.3 V →5 V		Figure 23、24	750313626
1:3.1 ±2%				5 V →3.3 V		Figure 25、26	750313638

Package Dimension

SOT23-5



Unit: mm

Symbol	Dimensions In Millimeters		
	MIN	NOM	MAX
A	1.06	1.15	1.24
A1	0.01	0.05	0.09
b	0.30	0.35	0.45
c		0.127REF	
D	2.87	2.92	2.97
E	2.72	2.80	2.88
E1	1.55	1.60	1.65
e		0.95BSC	
L	0.55	0.60	0.65
θ	0		8°