

## 150KHz 60V 3A Buck DC to DC Converter

## XL2596HVT

### Features

- Operating Voltage: 4.5V~50V
- Adjustable, 3.3V, 5.0V and 12V Versions
- Output Adjustable from 1.23V to 48V
- Maximum Duty Cycle 100%
- Feedback Voltage Accuracy  $\pm 1.5\%$
- Minimum Drop Out 1.5V
- Fixed 150KHz Switching Frequency
- 3A Constant Output Current Capability
- Internal Optimize HV Power Transistor
- High efficiency up to 90%
- Excellent line and load regulation
- TTL shutdown capability
- Built in thermal shutdown function
- Built in current limit protection function
- Built in output short protection function
- Temperature Grade 1:  $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$   
Ambient Operating Temperature Range
- Device HBM ESD Classification Level Class3B
- Available in TO220-5L package

### General Description

The XL2596HVT is a 150 KHz fixed frequency buck DC/DC converter, capable of driving a 3A load with high voltage, high efficiency. The XL2596HVT supports wide input operating voltage range of 4.5V ~ 50V and a maximum duty cycle of 100% output. A built-in loop compensation module reduces components in the system, lowering power system cost and reducing printed circuit board space. The XL2596HVT is available in adjustable, fixed 3.3V, 5.0V and 12V versions. The XL2596HVT has built-in thermal shutdown, current limit protection and output short protection function and so on. When the output short protection function happens, the operation frequency will be reduced about from 150KHz to 30KHz.

### Applications

- Automotive Electronics
- Industrial Control
- Networking Equipment
- Internet of Things

### Typical application schematic

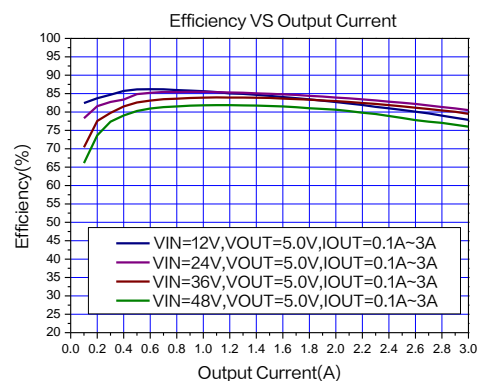
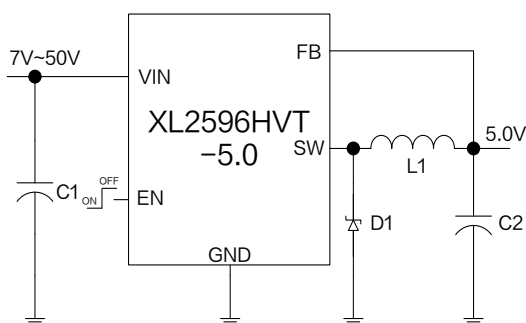


Figure1.XL2596HVT-5.0 Typical application schematic and efficiency curve

## Pin Configurations

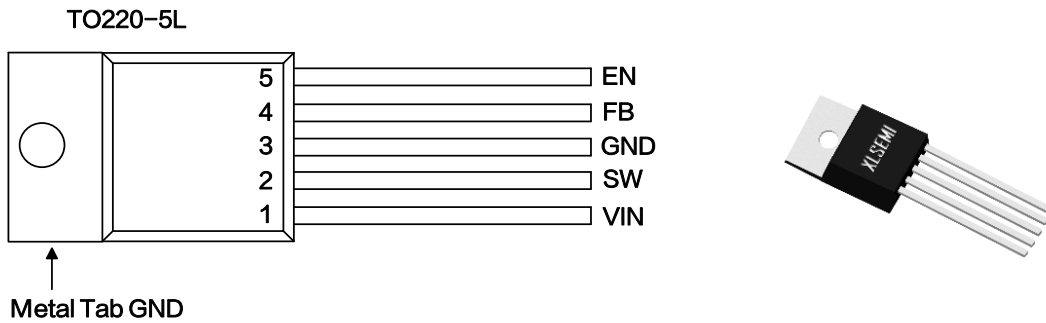


Figure2. Pin Configuration of XL2596HVT

Table 1. Pin Description

Pin Number	Pin Name	Description
1	VIN	Supply Voltage Input Pin. XL2596HVT DC operating voltage range from a 4.5V to 50V . Bypass VIN to GND with a suitably large capacitor to eliminate noise on the input.
2	SW	Power Switch Output Pin (SW). Output is the switch node that supplies power to the output.
3	GND	Ground Pin.
4	FB	Feedback Pin (FB). Through an external resistor divider network, detects the output voltage for adjustment, with an adjustable version reference voltage of 1.23V.
5	EN	Enable Pin. Drive EN pin low to turn on the device, drive it high to turn it off. Floating is default low.

## Ordering Information

Order Information	Marking ID	Package Type	Eco Plan	Packing Type Supplied As
XL2596HVT-ADJE1	XL2596HVT-ADJE1	TO220-5L	RoHS & HF	50 Units Per Tube/ 1000 Units Per Box
XL2596HVT-3.3E1	XL2596HVT-3.3E1	TO220-5L	RoHS & HF	50 Units Per Tube/ 1000 Units Per Box
XL2596HVT-5.0E1	XL2596HVT-5.0E1	TO220-5L	RoHS & HF	50 Units Per Tube/ 1000 Units Per Box
XL2596HVT-12E1	XL2596HVT-12E1	TO220-5L	RoHS & HF	50 Units Per Tube/ 1000 Units Per Box

### Function Block

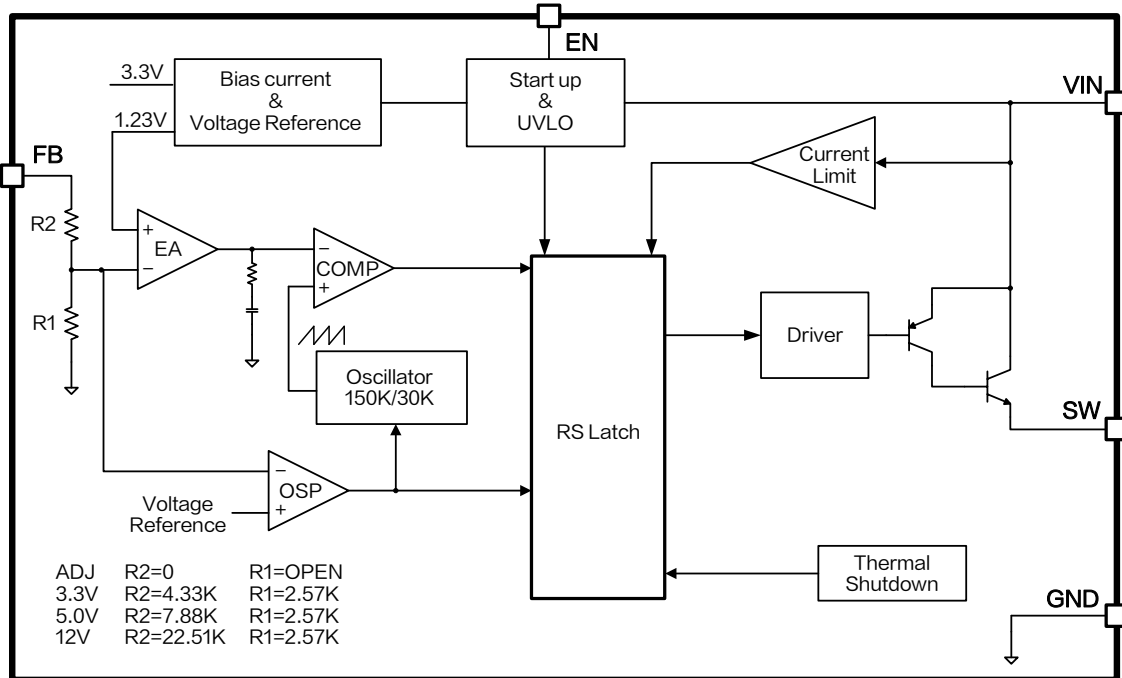


Figure3. Function Block Diagram of XL2596HVT

### Absolute Maximum Ratings ( Note1 )

Parameter	Symbol	Value	Unit
Input Voltage	$V_{IN}$	-0.3~60	V
Feedback Pin Voltage	$V_{FB}$	-0.3~20	V
EN Pin Voltage	$V_{EN}$	-0.3~7	V
Output Switch Pin Voltage	$V_{SW}$	-0.3~ $V_{IN}$	V
Power Dissipation	$P_D$	Internally limited	mW
Thermal Resistance (TO220-5L) (Junction to Ambient, No Heatsink, Free Air)	$R_{JA}$	30	°C /W
Operating Junction Temperature	$T_J$	-40~150	°C
Storage Temperature	$T_{STG}$	-65~150	°C
Lead Temperature (Soldering, 10 sec)	$T_{LEAD}$	260	°C
ESD (HBM)		> 8000	V

**Note1:** Stresses greater than those listed under Maximum Ratings may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operation is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

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### XL2596HVT –ADJ Electrical Characteristics

T<sub>A</sub> = 25°C; System parameters test circuit figure4 and figure6, unless otherwise specified.

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
V <sub>FB</sub>	Feedback Voltage	V <sub>IN</sub> = 12V, V <sub>OUT</sub> = 5.0V I <sub>OUT</sub> = 0.5A	1.212	1.23	1.248	V
η	Efficiency	V <sub>IN</sub> = 12V, V <sub>OUT</sub> = 5.0V I <sub>OUT</sub> = 2A	–	82.7	–	%
η	Efficiency	V <sub>IN</sub> = 24V, V <sub>OUT</sub> = 15V I <sub>OUT</sub> = 1A	–	92.8	–	%

### XL2596HVT –3.3 Electrical Characteristics

T<sub>A</sub> = 25°C; System parameters test circuit figure8, unless otherwise specified.

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
V <sub>OUT</sub>	Output Voltage	V <sub>IN</sub> = 12V I <sub>OUT</sub> = 0.5A	3.250	3.3	3.350	V
η	Efficiency	V <sub>IN</sub> = 12V, V <sub>OUT</sub> = 3.3V I <sub>OUT</sub> = 2A	–	78.4	–	%

### XL2596HVT –5.0 Electrical Characteristics

T<sub>A</sub> = 25°C; System parameters test circuit figure10, unless otherwise specified.

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
V <sub>OUT</sub>	Output Voltage	V <sub>IN</sub> = 12V I <sub>OUT</sub> = 0.5A	4.925	5.0	5.075	V
η	Efficiency	V <sub>IN</sub> = 12V, V <sub>OUT</sub> = 5.0V I <sub>OUT</sub> = 2A	–	82.7	–	%

### XL2596HVT –12 Electrical Characteristics

T<sub>A</sub> = 25°C; System parameters test circuit figure12, unless otherwise specified.

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
V <sub>OUT</sub>	Output Voltage	V <sub>IN</sub> = 24V I <sub>OUT</sub> = 0.25A	11.82	12	12.18	V
η	Efficiency	V <sub>IN</sub> = 24V, V <sub>OUT</sub> = 12V I <sub>OUT</sub> = 2A	–	90.5	–	%

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## Electrical Characteristics (DC Parameters)

$T_A = 25^\circ\text{C}$ ,  $V_{IN}=12\text{V}$ ,  $V_{EN}=0\text{V}$ , System parameters test circuit figure4, unless otherwise specified.

Parameters	Symbol	Test Condition	Min.	Typ.	Max.	Unit
Operating Voltage	$V_{IN}$		4.5		50	V
Shutdown Supply Current	$I_S$	$V_{EN}=2\text{V}$		46	100	$\mu\text{A}$
Quiescent Supply Current	$I_Q$	Note2		1.3	2.0	mA
Oscillator Frequency	$F_{OSC}$		135	150	165	KHz
Switch Current Limit	$I_L$	$V_{FB}=0\text{V}$		3.2		A
EN Pin Threshold Voltage	$V_{EN,H}$	High (Regulator OFF)	1.4			V
	$V_{EN,L}$	Low (Regulator ON)			0.8	V
EN Pin Current	$I_{EN}$	$V_{EN}=2.5\text{V}$		5		$\mu\text{A}$
Output Saturation Voltage	$V_{CE}$	$V_{FB}=0\text{V}$ $I_{OUT}=2\text{A}$		1.1	1.3	V
Max. Duty Cycle	$D_{MAX}$	$V_{FB}=0\text{V}$		100		%
Thermal Shutdown Temperature	$T_{SD}$			180		$^\circ\text{C}$
Thermal Shutdown Hysteresis	$T_D$			40		$^\circ\text{C}$

**Note 2:** In the adjustable, fixed 3.3V and 5.0V versions,  $V_{FB}=10\text{V}$ ; In the fixed 12V version,  $V_{FB}=15\text{V}$ .

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### Typical System Application Schematic for ADJ Version

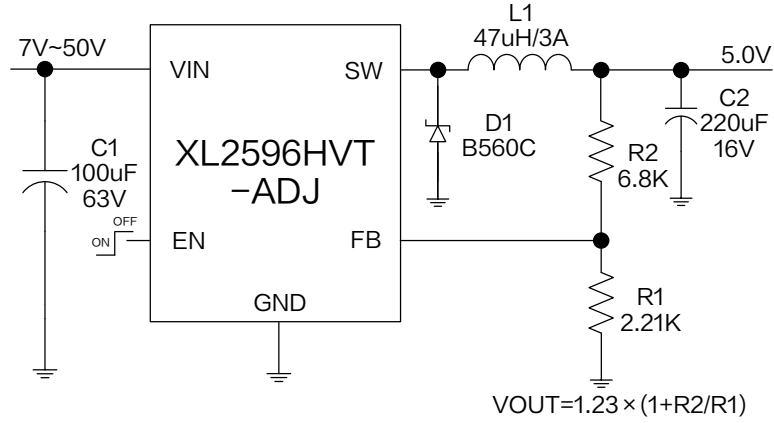


Figure4. XL2596HVT-ADJ System Parameters Test Circuit( $V_{OUT}=5.0V$ )

### Typical System Application Transfer Efficiency

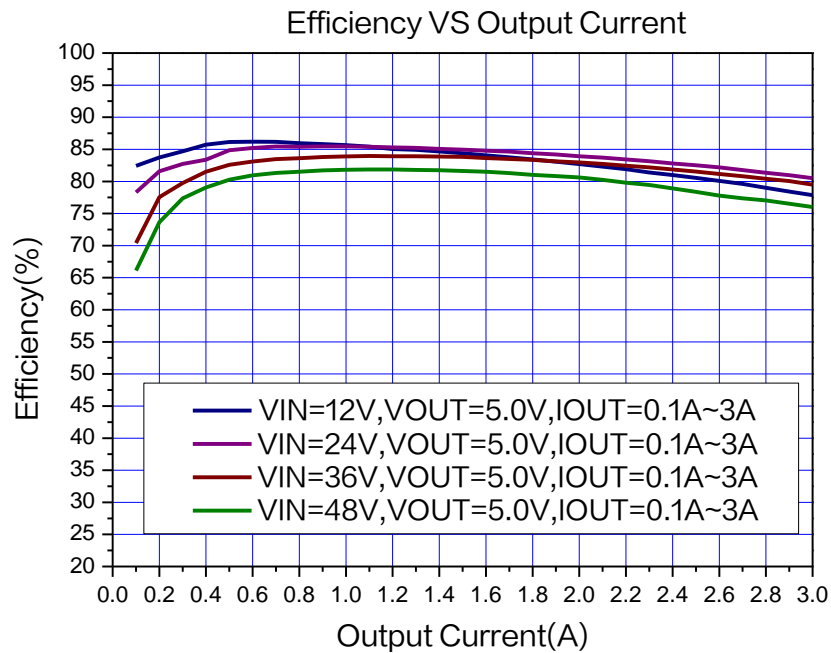


Figure5. XL2596HVT-ADJ System Efficiency Curve

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### Typical System Application Schematic for ADJ Version

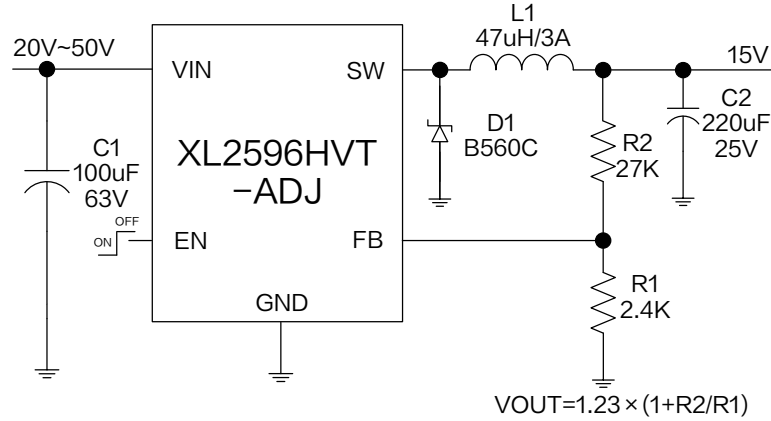


Figure6. XL2596HVT-ADJ System Parameters Test Circuit( $V_{OUT}=15V$ )

### Typical System Application Transfer Efficiency

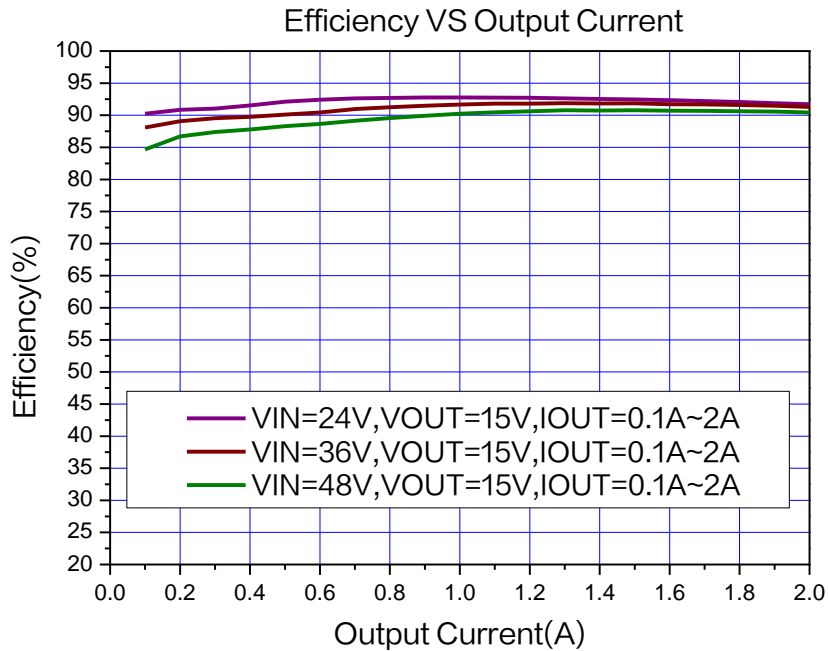


Figure7. XL2596HVT-ADJ System Efficiency Curve

### Typical System Application Schematic for 3.3V Version

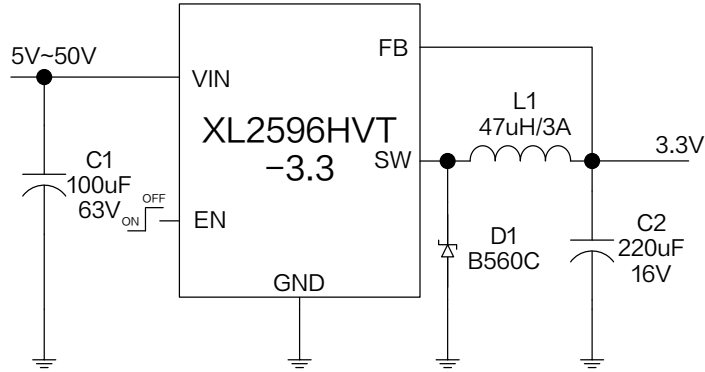


Figure8. XL2596HVT-3.3 System Parameters Test Circuit

### Typical System Application Transfer Efficiency

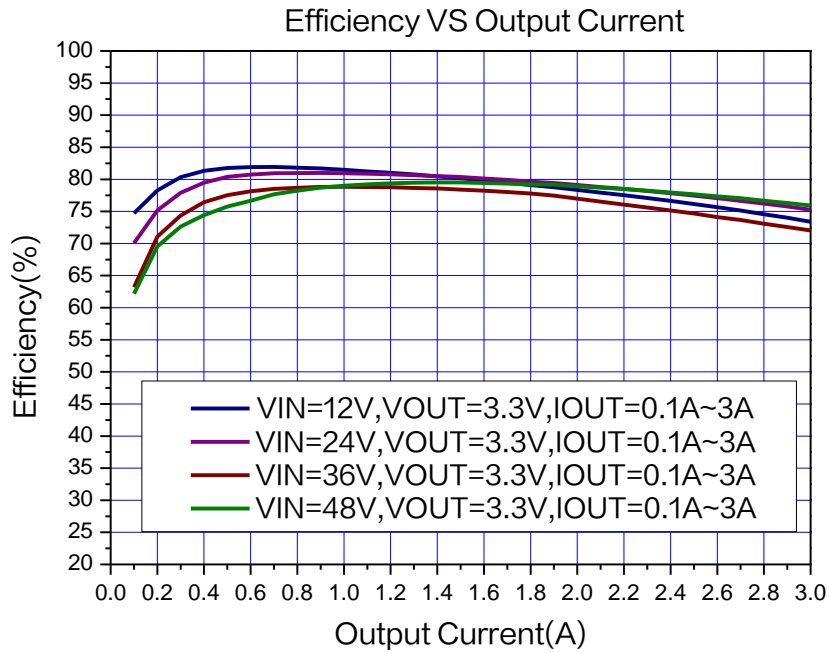


Figure9. XL2596HVT-3.3 System Efficiency Curve



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Typical System Application Schematic for 5.0V Version

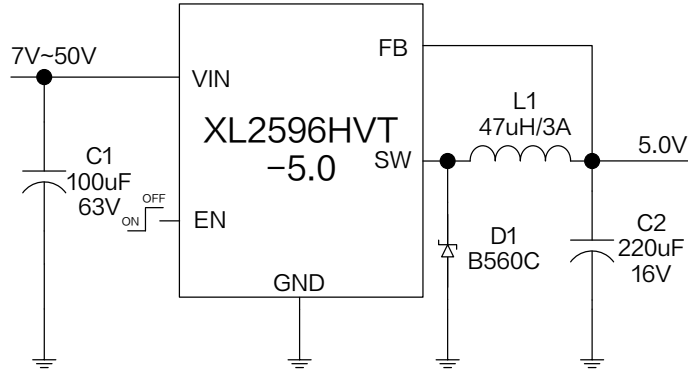


Figure10. XL2596HVT-5.0 System Parameters Test Circuit

Typical System Application Transfer Efficiency

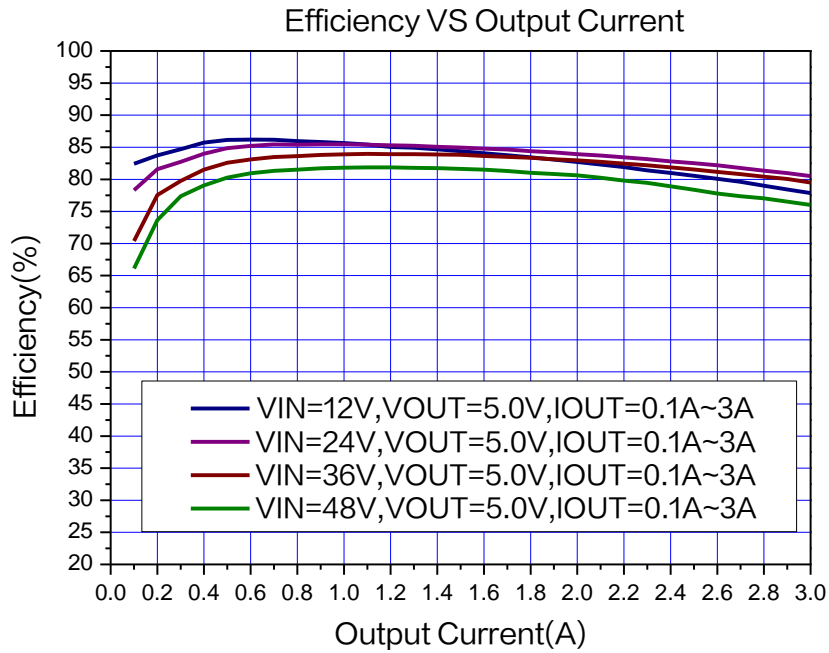


Figure11. XL2596HVT-5.0 System Efficiency Curve

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Typical System Application Schematic for 12V Version

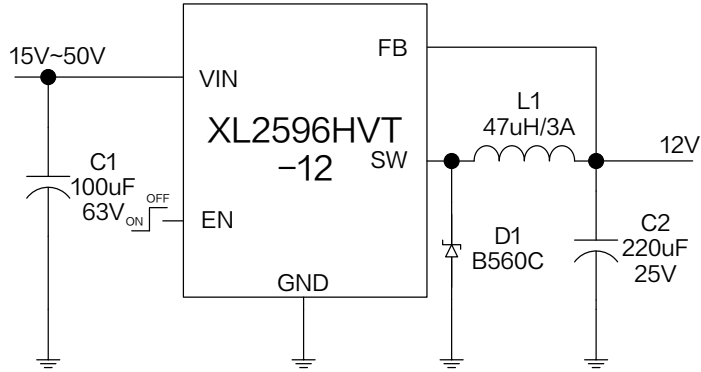


Figure12. XL2596HVT-12 System Parameters Test Circuit

Typical System Application Transfer Efficiency

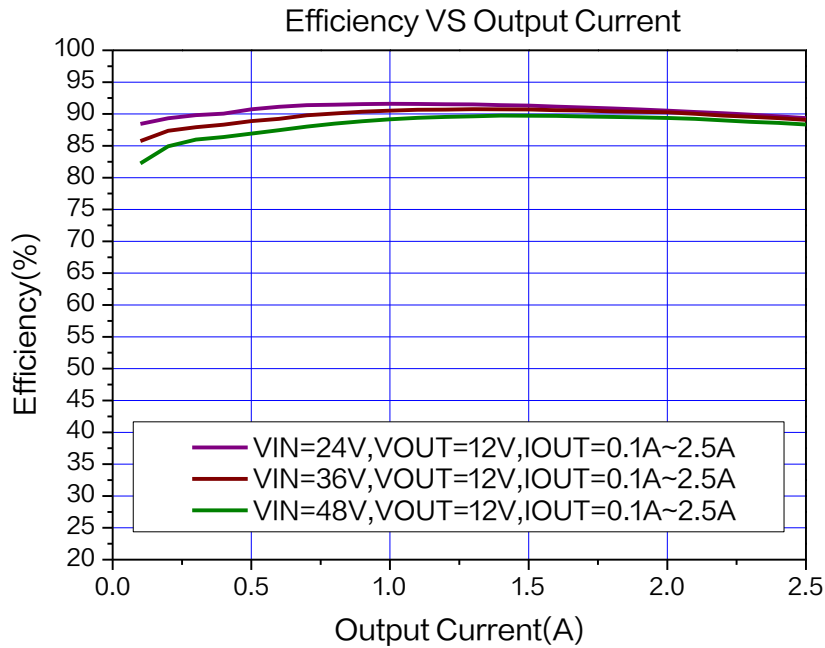


Figure13. XL2596HVT-12 System Efficiency Curve

### Typical Characteristics

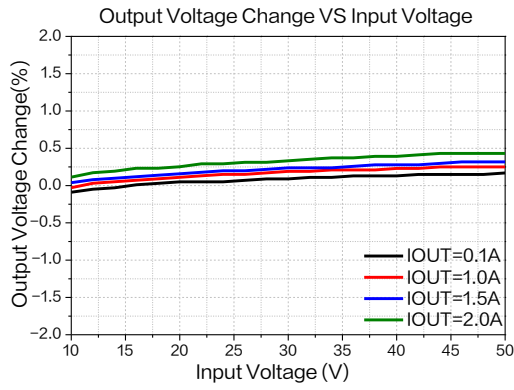


Figure14.Line Regulation

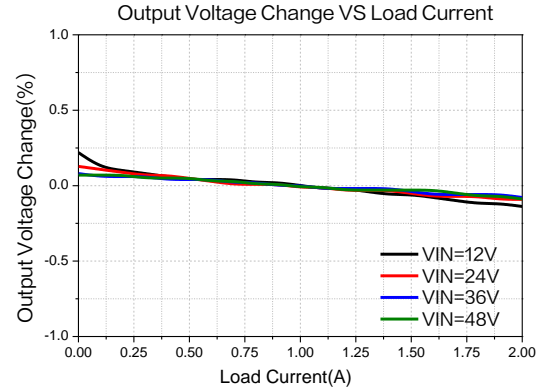


Figure15.Load Regulation

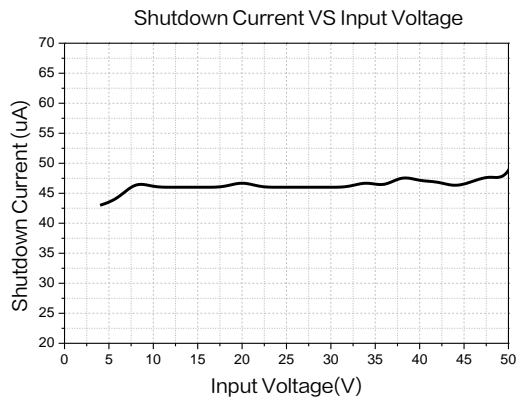


Figure16.Shutdown Current

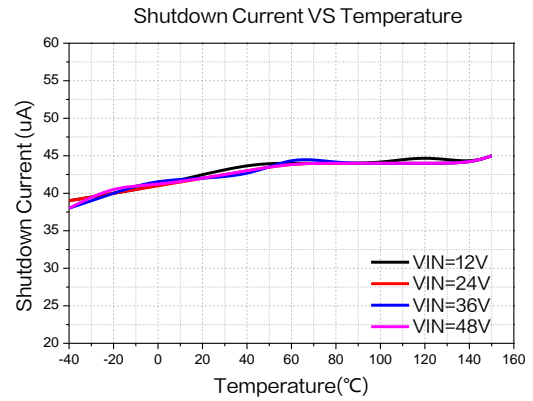


Figure17.Shutdown Current

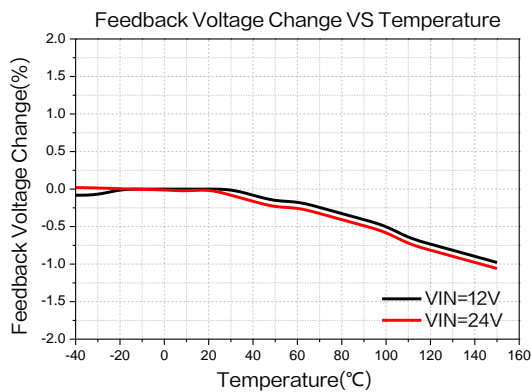


Figure18.Feedback Voltage Regulation

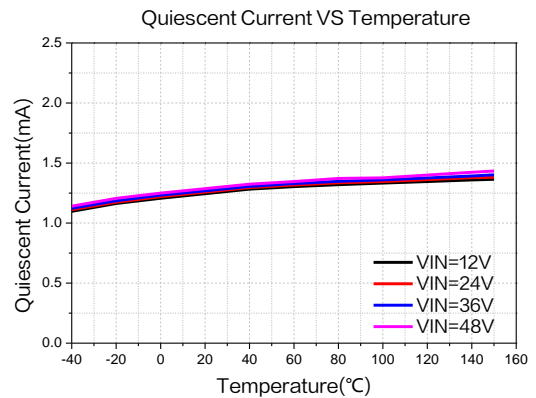


Figure19. Quiescent Current

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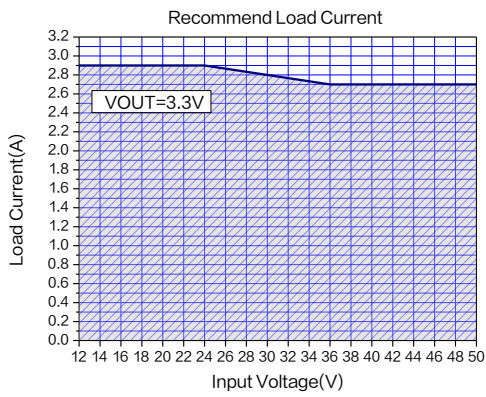


Figure 20. Max Output Current  
(V<sub>OUT</sub>=3.3V, T<sub>A</sub>=25°C)

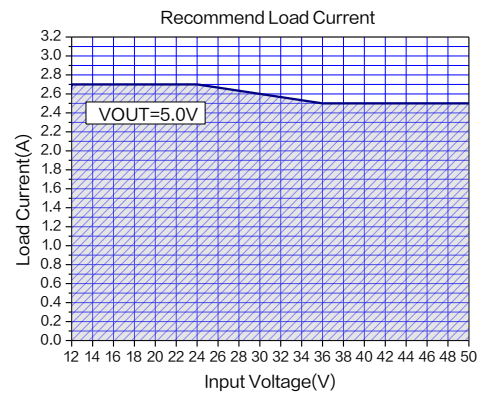


Figure 21. Max Output Current  
(V<sub>OUT</sub>=5.0V, T<sub>A</sub>=25°C)

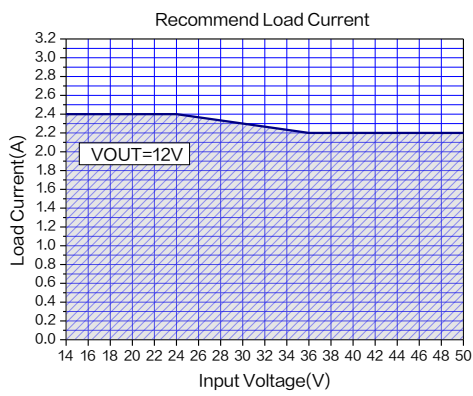


Figure 22. Max Output Current  
(V<sub>OUT</sub>=12V, T<sub>A</sub>=25°C)

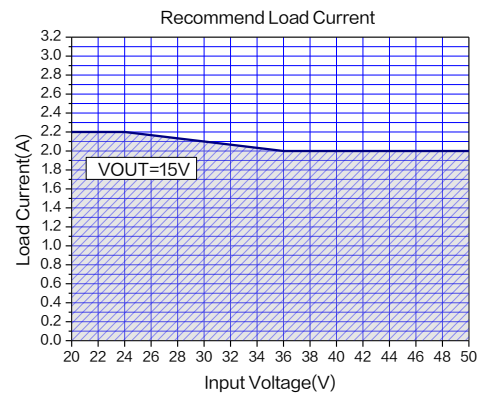


Figure 23. Max Output Current  
(V<sub>OUT</sub>=15V, T<sub>A</sub>=25°C)

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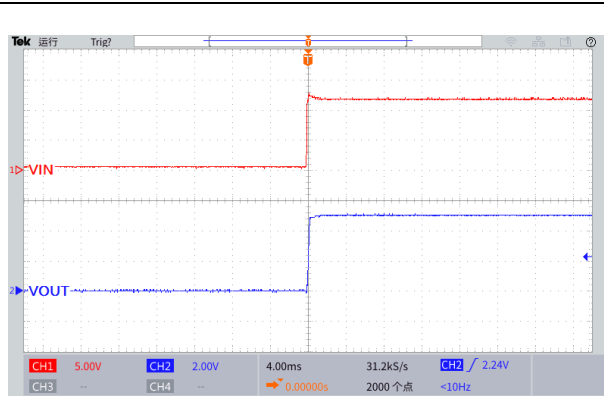


Figure24. Start-Up Characteristic  
( $V_{IN}=12V$ ,  $V_{OUT}=5.0V$ ,  $I_{OUT}=0.1A$ )

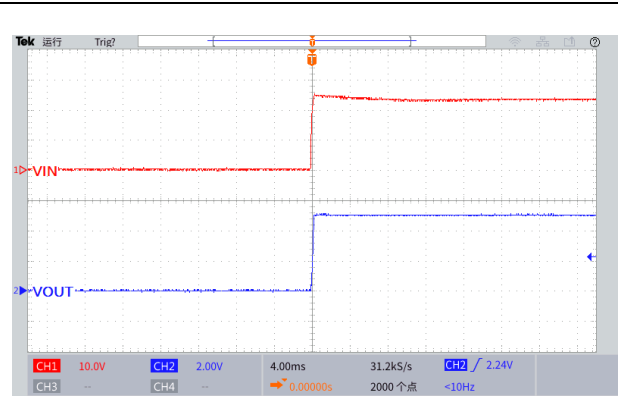


Figure25. Start-Up Characteristic  
( $V_{IN}=24V$ ,  $V_{OUT}=5.0V$ ,  $I_{OUT}=0.1A$ )

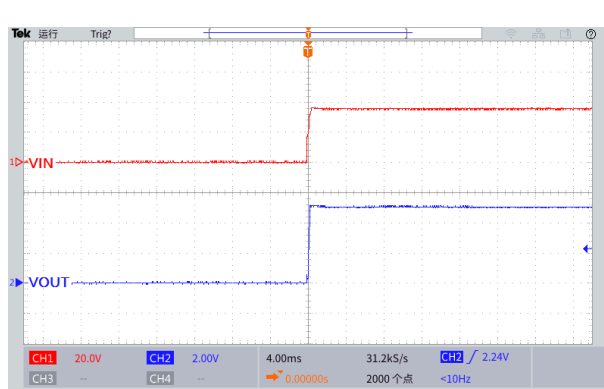


Figure26. Start-Up Characteristic  
( $V_{IN}=36V$ ,  $V_{OUT}=5.0V$ ,  $I_{OUT}=0.1A$ )

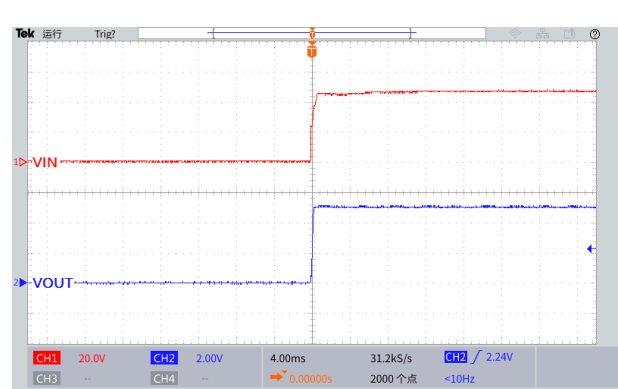


Figure27. Start-Up Characteristic  
( $V_{IN}=48V$ ,  $V_{OUT}=5.0V$ ,  $I_{OUT}=0.1A$ )

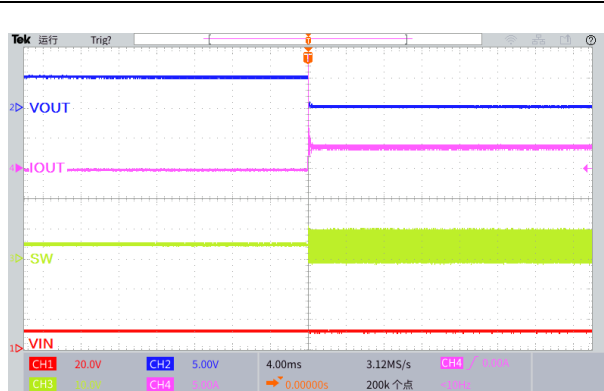


Figure28. Output Short Circuit Waveform  
( $V_{IN}=12V$ ,  $V_{OUT}=5.0V$ )

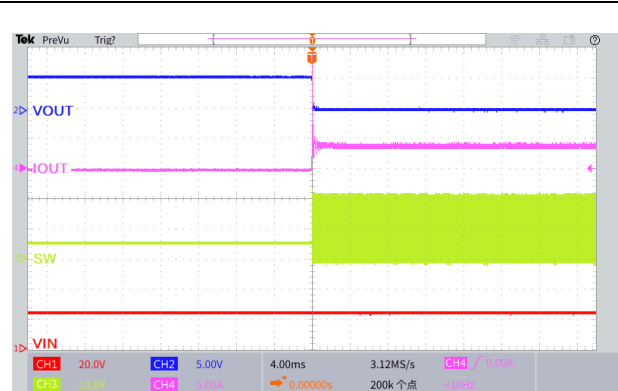


Figure29. Output Short Circuit Waveform  
( $V_{IN}=24V$ ,  $V_{OUT}=5.0V$ )

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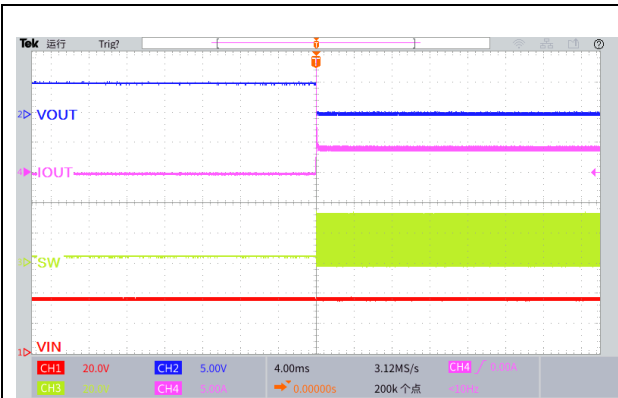


Figure30. Output Short Circuit Waveform  
( $V_{IN}=36V$ ,  $V_{OUT}=5.0V$ )

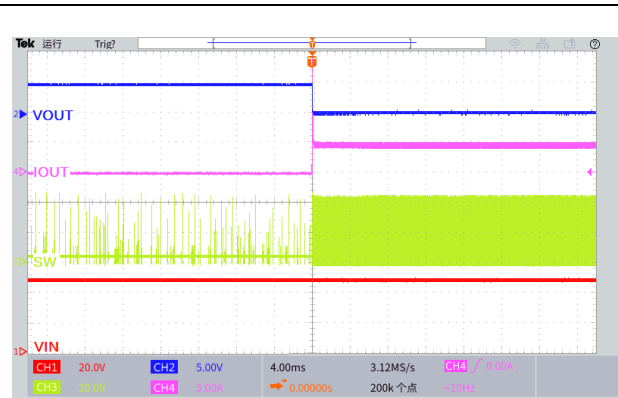


Figure31. Output Short Circuit Waveform  
( $V_{IN}=48V$ ,  $V_{OUT}=5.0V$ )

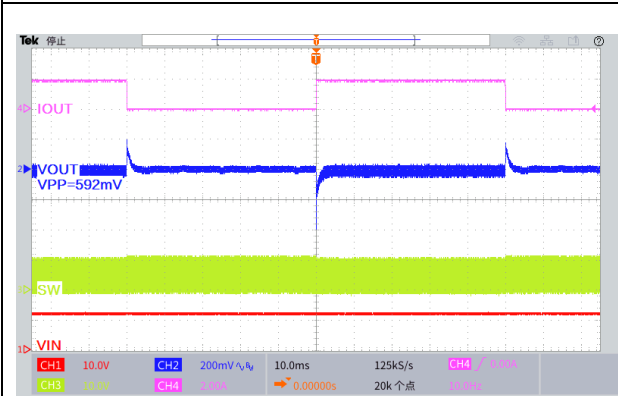


Figure32. Load Transient Response  
( $V_{IN}=12V$ ,  $V_{OUT}=5.0V$ ,  $I_{OUT}=0.1$  to 2A)

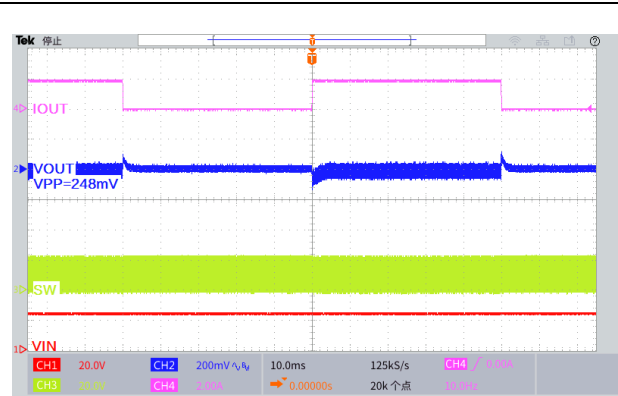


Figure33. Load Transient Response  
( $V_{IN}=24V$ ,  $V_{OUT}=5.0V$ ,  $I_{OUT}=0.1$  to 2A)

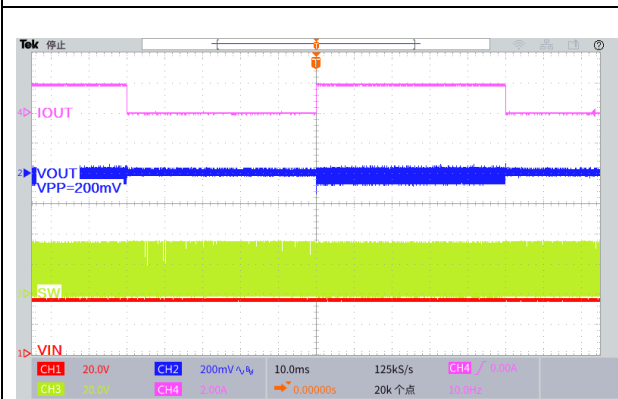


Figure34. Load Transient Response  
( $V_{IN}=36V$ ,  $V_{OUT}=5.0V$ ,  $I_{OUT}=0.1$  to 2A)

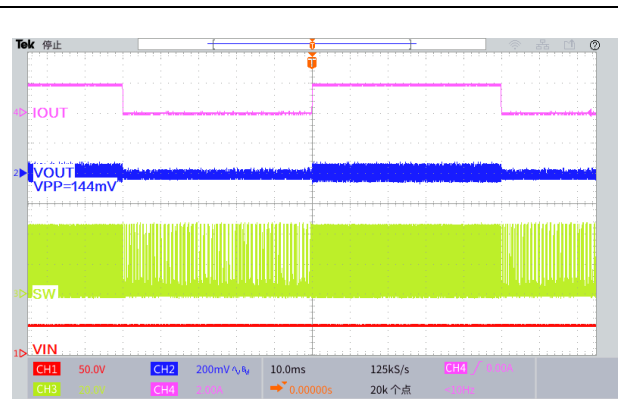


Figure35. Load Transient Response  
( $V_{IN}=48V$ ,  $V_{OUT}=5.0V$ ,  $I_{OUT}=0.1$  to 2A)

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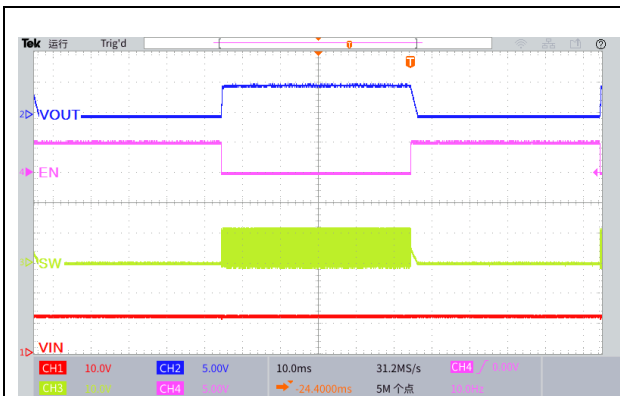


Figure36. Start or Shutdown Using EN Pin  
( $V_{IN}=12V$ ,  $V_{OUT}=5.0V$ ,  $I_{OUT}=0.5A$ )

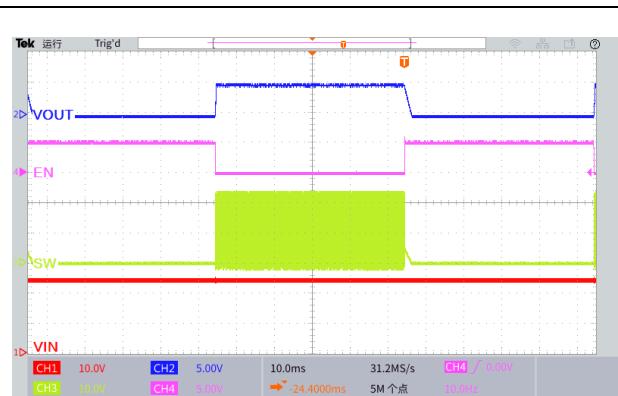


Figure37. Start or Shutdown Using EN Pin  
( $V_{IN}=24V$ ,  $V_{OUT}=5.0V$ ,  $I_{OUT}=0.5A$ )

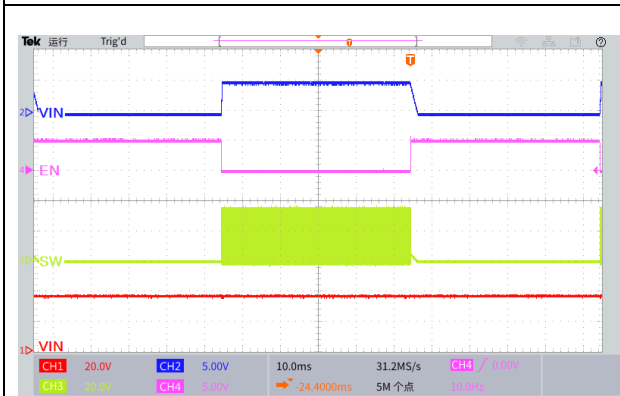


Figure38. Start or Shutdown Using EN Pin  
( $V_{IN}=36V$ ,  $V_{OUT}=5.0V$ ,  $I_{OUT}=0.5A$ )

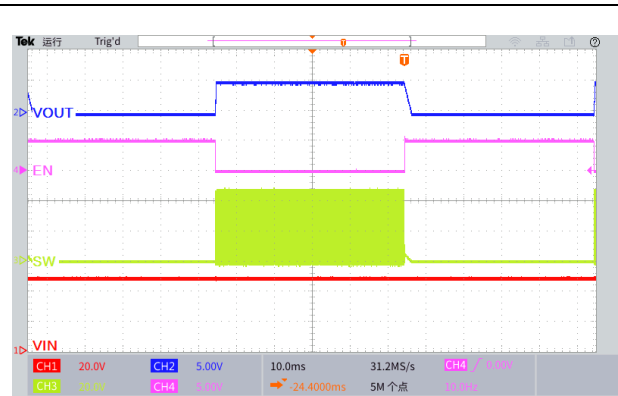


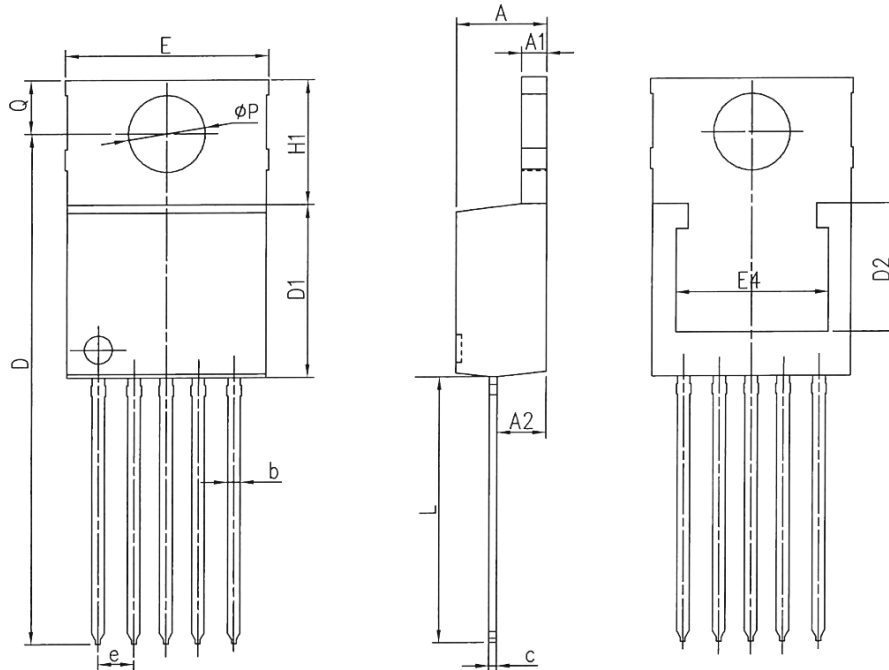
Figure39. Start or Shutdown Using EN Pin  
( $V_{IN}=48V$ ,  $V_{OUT}=5.0V$ ,  $I_{OUT}=0.5A$ )

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## Package Information

TO220-5L



Symbol	Dimensions In Millimeters			Dimensions In Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	4.37	4.57	4.77	0.172	0.180	0.188
A1	1.17	1.27	1.42	0.046	0.050	0.056
A2	2.47	2.67	2.87	0.097	0.105	0.113
b	0.76	0.89	1.02	0.030	0.035	0.040
c	0.33	0.38	0.64	0.013	0.015	0.025
D	25.65	26.00	26.35	1.009	1.023	1.037
D1	8.38	8.70	9.00	0.330	0.342	0.354
D2	5.50	5.84	6.14	0.216	0.230	0.242
E	9.86	10.26	10.39	0.388	0.404	0.409
E4	7.30	8.33	9.30	0.287	0.328	0.366
e	1.55	1.70	1.85	0.061	0.067	0.073
H1	6.10	6.35	6.60	0.240	0.250	0.260
L	13.34	13.74	14.10	0.525	0.541	0.555
ΦP	3.70	3.84	3.95	0.146	0.151	0.156
Q	2.54	2.75	3.05	0.100	0.108	0.120



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**150KHz 60V 3A Buck DC to DC Converter****XL2596HVT**

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