



XTP8231

17V 3A, Sync Step-Down Converter

XTX Technology Inc.

Tel: (+86 755) 28229862

Fax: (+86 755) 28229847

Web Site: <http://www.xtxtech.com/>

Technical Contact: fae@xtxtech.com

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GENERAL DESCRIPTION

The XTP8231 is a high efficiency, Constant on-Time (COT) control mode synchronous step-down DC-DC converter capable of delivering up to 3A current.

Operating with an input range of 4.5V-17V, the XTP8231 delivers 3A of continuous output current with two integrated N-Channel MOSFETs. Low output voltage ripple and small external inductor and capacitor size is achieved with 600kHz switching frequency.

Constant-on-time (COT) control operation provides very fast transient response, Pulse frequency modulation (PFM) mode maximizes the light load efficiency.

The XTP8231 is available in 6-pin SOT23-6/TSOT23-6/SOT563/DFN1.2*1-6L/DFN6L-2*2 package, which provides a compact solution with minimal external components.

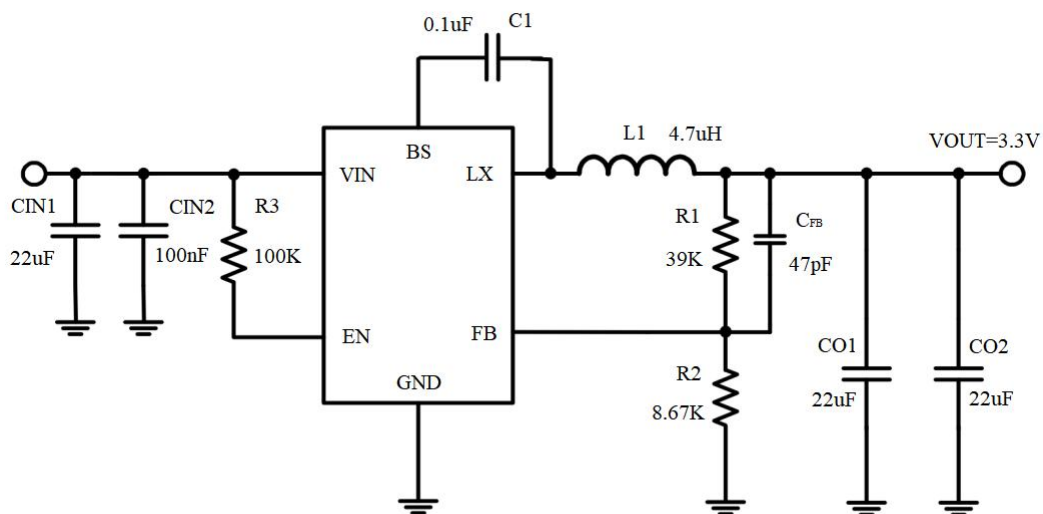
FEATURES

- 4.5V to 17V operating input range 3A output current
- Up to 93% efficiency
- High efficiency (>81%) at light load
- 600kHz Switching frequency
- Input under voltage lockout
- Pulse frequency modulation (PFM) for high light-load efficiency
- Over current protection
- Thermal protection
- SOT23-6/TSOT23-6/SOT563/DFN1.2*1-6L/DFN6L-2*2 package

APPLICATIONS

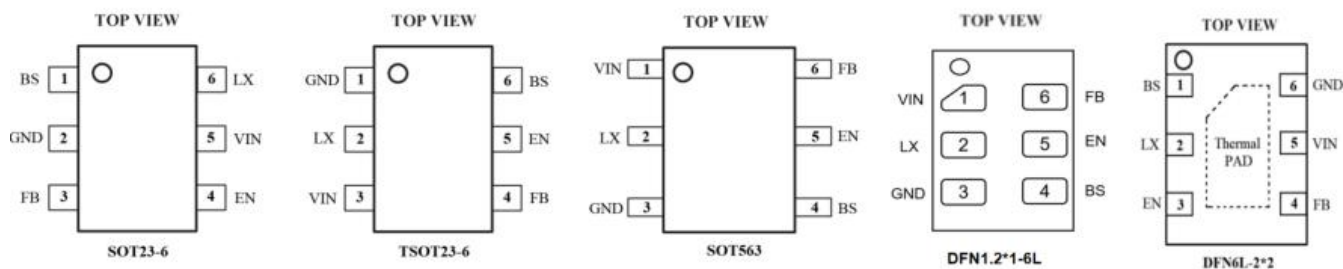
- Digital Set-Top Boxes
- Flat-Panel Television and Monitors
- Smart Door Lock
- General Purposes

TYPICAL APPLICATION



Typical Application Circuits ($V_{FB}=0.6V$)

PIN CONFIGURATIONS



Pin Functions

NO.				NAME	DESCRIPTION
SOT23-6	TSOT23-6	SOT563 DFN1.2*1-6L	DFN6L-2*2		
1	6	4	1	BS	Bootstrap. A capacitor connected between LX and BS pins is required to form a floating supply across the high-side switch driver.
2	1	3	6	GND	Ground
3	4	6	4	FB	Output Voltage feedback input. Connect FB to the center point of the external resistor divider.
4	5	5	3	EN	Drive this pin to a logic-high to enable the IC. Drive to a logic-low to disable the IC and enter micro-power shutdown mode. Don't floating.
5	3	1	5	VIN	Supply voltage
6	2	2	2	LX	Switching
-	-	-	-	Thermal PAD	Ground

PACKAGE/ORDERING INFORMATION

Part Number	Package	Quantity/Reel	Operating Temperature Range
XTP8231CS3CT	SOT23-6	3000	-40°C~85°C
XTP8231CT8CT	TSOT23-6	3000	-40°C~85°C
XTP8231CS5CT	SOT563	3000	-40°C~85°C
XTP8231CN2CT	DFN1.2*1-6L	3000	-40°C~85°C
XTP8231CD2CT	DFN6L-2*2	3000	-40°C~85°C

ABSOLUTE MAXIMUM RATINGS

Parameter		Min	Max	Unit
Power Supply	V_{DD}	-0.3	20	V
Output Current (Peak)	I_{PEAK}	-	3.6	A
Input Logic Voltage	V_{EN}	-0.3	20	V
FB Voltage	V_{FB}	-0.3	6	V
ESD (HBM)	ESD	2000	-	V
Storage Temperature	T_{stg}	-65	150	°C
Junction Temperature	T_j	-	150	°C
Lead Temperature (Soldering 10s)		-	260	°C

RECOMMENDED OPERATING CONDITIONS

(Unless otherwise noted, $T_a=25^{\circ}\text{C}$)

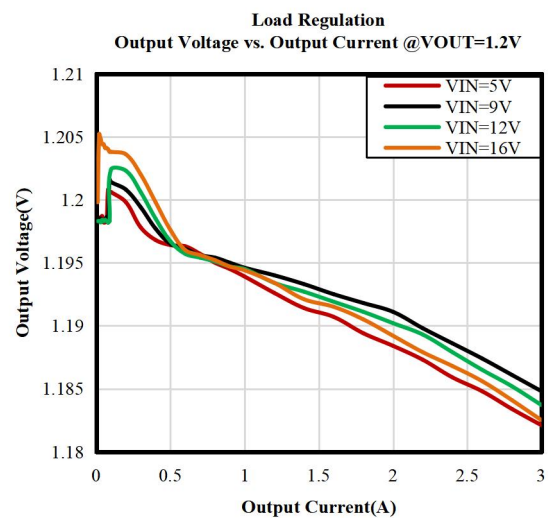
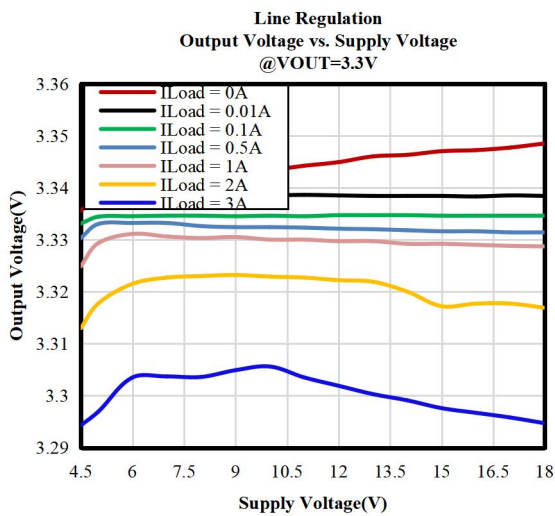
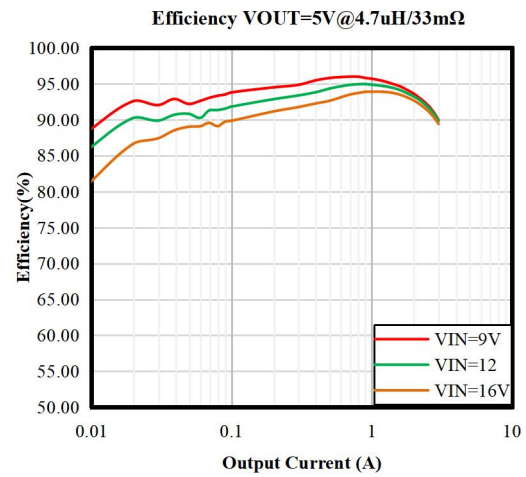
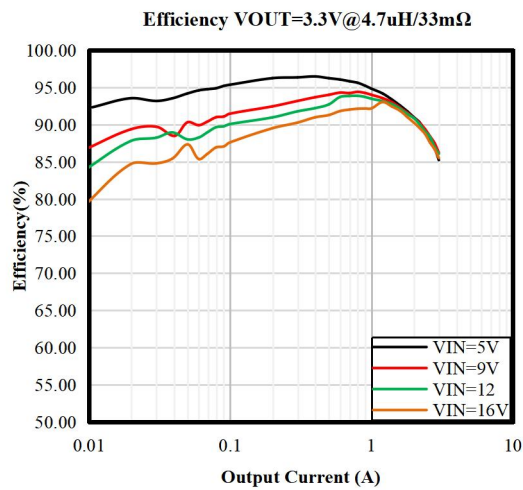
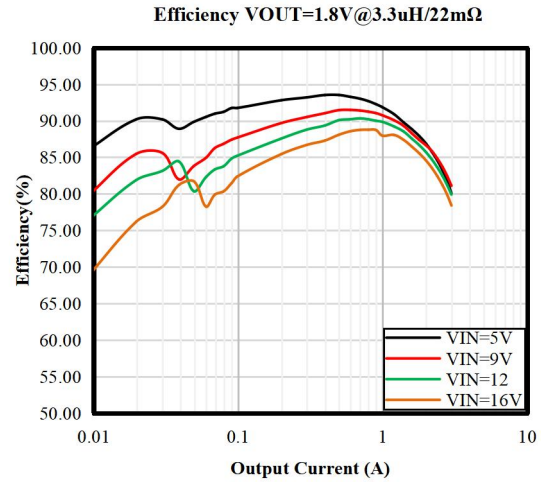
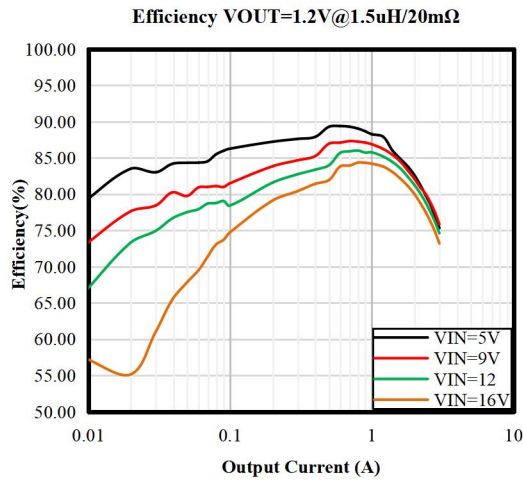
Parameter		Min	Max	Unit
Power Supply	V_{DD}	4.5	17	V
Output Current (continuously)	I_{OUT}	0	3	A
Operating Junction Temperature	T_J	-40	125	°C

ELECTRICAL CHARACTERISTICS

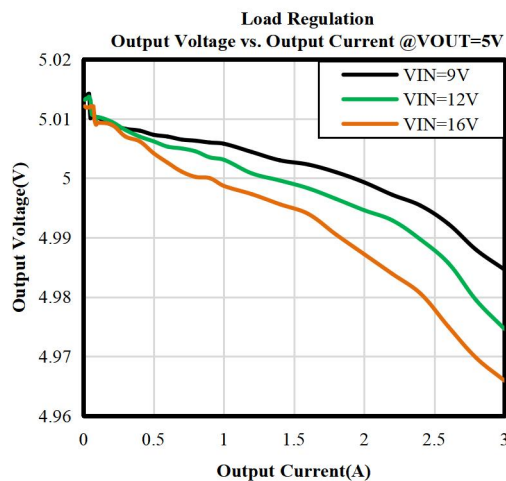
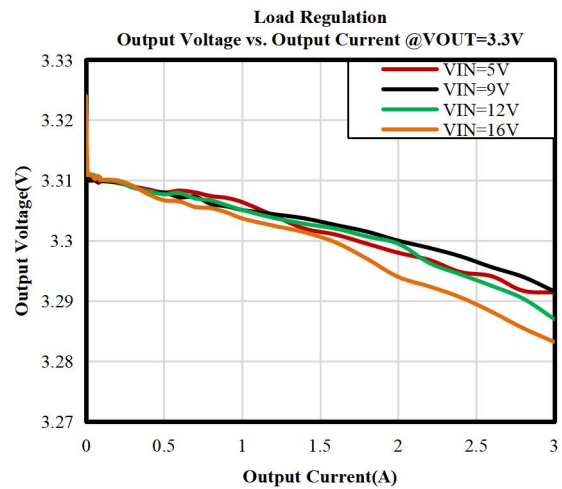
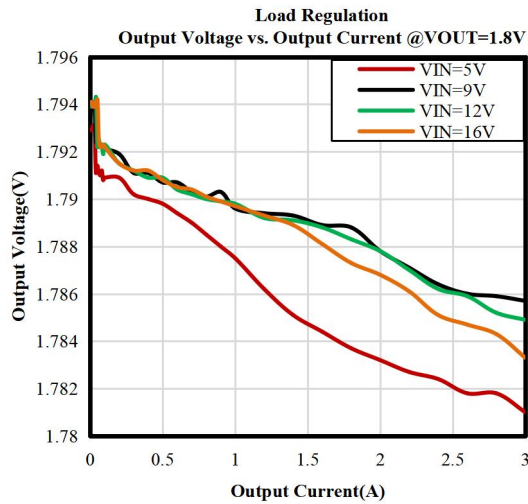
Unless otherwise noted, $V_{DD}=12V$, $V_{OUT}=3.3V$, $T_a=25^{\circ}C$

Parameter	Conditions	Min	Typ	Max	Unit
Input Voltage Range		4.5	-	17	V
OVP Threshold		17.3	-	18.6	V
VIN Under-Voltage Lockout Threshold Rising		4.0	4.2	4.5	V
VIN Under-Voltage Lockout Threshold Hysteresis		-	0.4	-	V
Quiescent Current	$EN = 5V$, $V_{FB} = 0.6V$	-	260	-	μA
Shutdown Current	$V_{EN} = 0V$	-	3.5	7	μA
Regulated Feedback Voltage	$T_J = 25^{\circ}C$, $4.5V < V_{IN} < 17V$	0.591	0.6	0.609	V
High-Side Switch Resistance	$R_{DS(ON)}$	-	91	-	$m\Omega$
Low-Side Switch Resistance	$R_{DS(ON)}$	-	58	-	$m\Omega$
High-Side Switch Leakage Current	$V_{EN}=0V$, $V_{LX}=0V$	-	-	5	μA
Switch Valley Current Limit	Minimum Duty Cycle	3.1	3.65	4.3	A
Oscillation Frequency		-	600	-	KHz
Maximum Duty Cycle		-	88	-	%
Minimum On-Time	$V_{IN}=12V$, $V_{OUT}=3.3V$, $I_{OUT}=1.5A$	-	56	-	ns
Short Circuit Hiccup On Time		-	1.05	-	ms
Soft Start Time		0.9	1.05	1.25	ms
EN High-Level Input Voltage		1.4	-	-	V
EN Low-Level Input Voltage		-	-	0.8	V
Thermal Shutdown Threshold	Shutdown temperature	-	170	-	$^{\circ}C$
Thermal Shutdown Hysteresis	Hysteresis	-	45	-	$^{\circ}C$

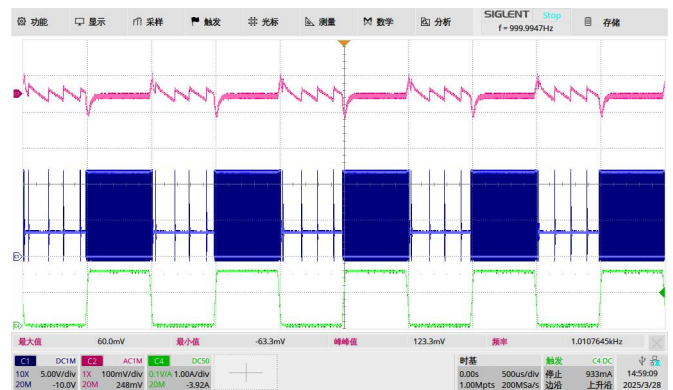
TYPICAL PERFORMANCE CHARACTERISTICS



TYPICAL PERFORMANCE CHARACTERISTICS



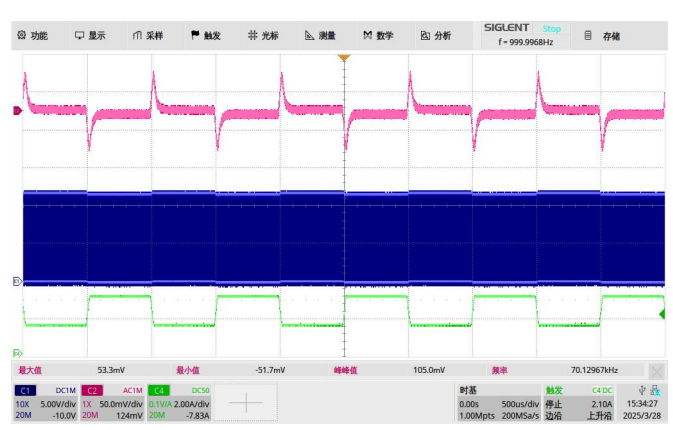
Load Transient VIN=12V, VOUT=3.3V, IO=0A to 1.5A



Load Transient VIN=12V, VOUT=3.3V, IO=0A to 3A



Load Transient VIN=12V, VOUT=3.3V, IO=1.5A to 3A



TYPICAL PERFORMANCE CHARACTERISTICS

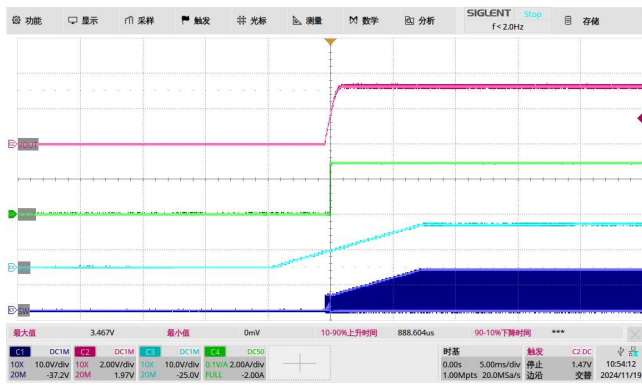
Output Short Entry $V_{IN}=12V$, $V_{OUT}=3.3V$, No Load



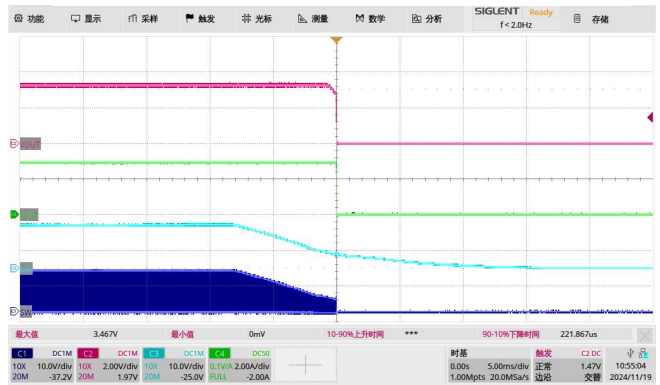
Output Short Recovery $V_{IN}=12V$, $V_{OUT}=3.3V$, No Load



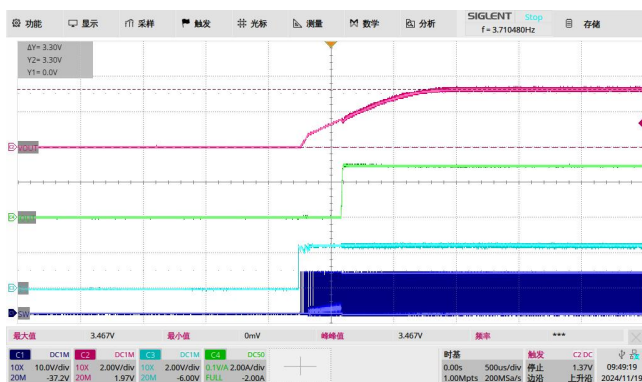
Input Power On $V_{IN}=12V$, $V_{OUT}=3.3V$, Full Load



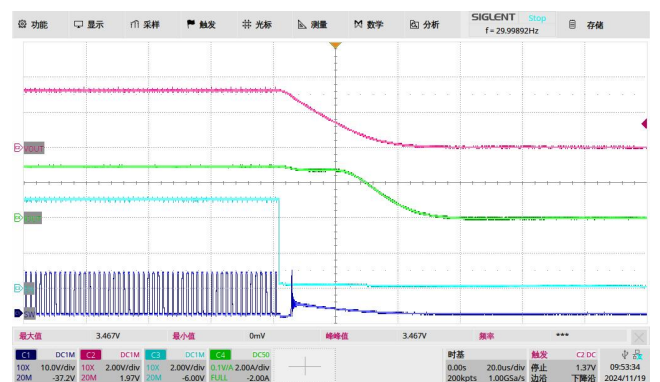
Input Power Down $V_{IN}=12V$, $V_{OUT}=3.3V$, Full Load



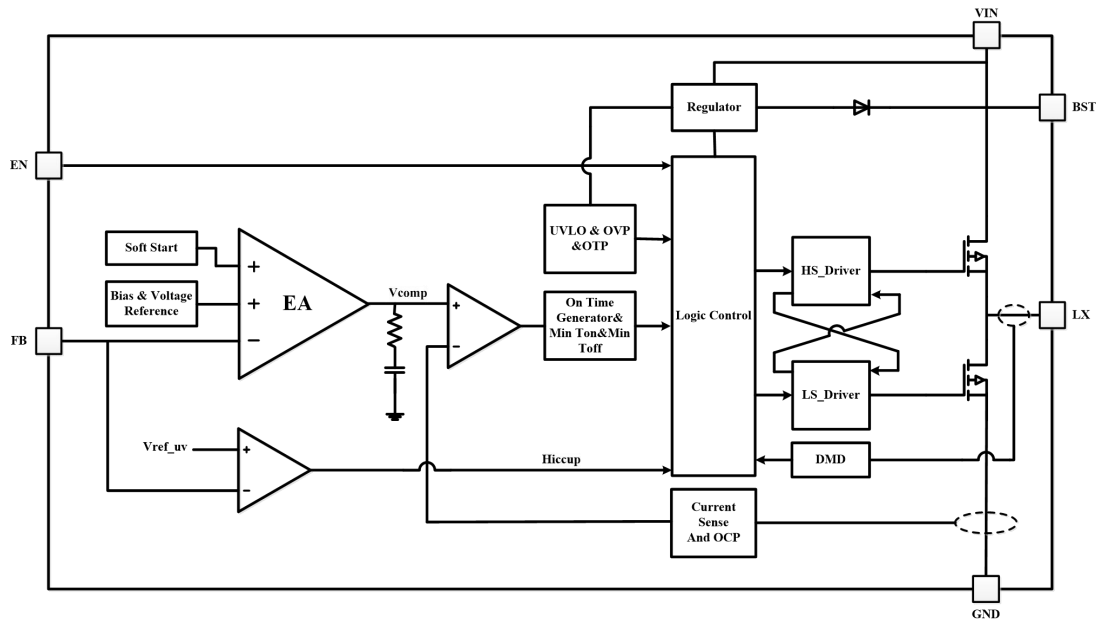
EN Enable $V_{IN}=12V$, $V_{OUT}=3.3V$, Full Load



EN Disable $V_{IN}=12V$, $V_{OUT}=3.3V$, Full Load



BLOCK DIAGRAM



FUNCTIONAL DESCRIPTION

Internal Regulator

The XTP8231 is a fully integrated, synchronous, rectified, step-down, device employs current control mode. Constant-on-time (COT) control is employed to provide fast transient response and ease loop stabilization. and operates at 600kHz operating frequency to ensure a compact, high efficiency design with excellent AC and DC performance.

Error Amplifier

XTP8231 adopts operational trans-conductance amplifier (OTA) as error amplifier. The error amplifier compares the FB pin voltage with the internal FB reference (V_{REF}) and outputs a current proportional to the difference between the two. This output current is then used to charge or discharge the internal compensation network to form the V_{COMP} voltage, which is used to compare with the low side power MOSFET current sensing signal and trigger on time pulse. The optimized internal compensation network minimizes the external component counts and simplifies the control loop design.

Enable

EN is a digital control pin that turns the XTP8231 on and off. Drive EN High to turn on the regulator, drive it Low to turn it off, three events can shut down the chip: EN low, VIN low and thermal shutdown.

Internal Soft-Start

The soft-start is implemented to prevent the converter output voltage from overshooting during startup. When the chip starts, the internal circuitry generates a soft-start voltage (SS) ramping up from 0V to V_{REF} . When it is lower than the internal FB reference (V_{REF}), SS overrides REF so the error amplifier uses SS as the reference. When SS is higher than V_{REF} , V_{REF} regains control. The SS time is internally fixed to 1.05ms typically.

Startup Shutdown

If both VIN and EN exceed their respective thresholds, the chip starts up. The reference block starts first, generating a stable reference voltage and current, and then the internal regulator is enabled. The regulator provides a stable supply for the remaining circuits. Three events can shut down the chip: EN low, VIN low, and thermal shutdown. The shutdown procedure starts by blocking the signaling path initially to avoid any fault triggering. The internal supply rail is then pulled down.

Over-Current-Protection and Short Circuits Protection

The XTP8231 has a cycle-by-cycle over current limit for when the inductor current peak value is over the set current limit threshold. If the output is short to GND and the output voltage drop until feedback voltage V_{FB} is below the output under-voltage(UV) threshold which is typically 75% of V_{REF} , XTP8231 enters into hiccup mode to periodically disable and restart switching operation. The hiccup mode helps to reduce power dissipation and thermal rise during output short condition. The period of XTP8231 hiccup mode is typically 7ms.

Over Temperature Protection

Thermal protection disables the output when the junction temperature rises to approximately 170°C, allowing the device to cool down. When the junction temperature cools to approximately 125°C, the output circuitry is again enabled. Depending on power dissipation, thermal resistance, and ambient temperature, the thermal protection circuit may cycle on and off. This cycling limits regulator dissipation, protecting the device from damage as a result of overheating.

APPLICATION INFORMATION

External Output Voltage Setting

In external Output Voltage Setting Version selected, the XTP8231 regulator is programmed using an external resistor divider. The output voltage is calculated using below equation.:

$$V_{OUT} = V_{REF} \times \left(1 + \frac{R1}{R2} \right)$$

Where: $V_{REF} = 0.6V$ typically

See Typical Application on page 1, table 1 lists the recommended resistor values for common output voltages.

Table 1: Selection for Common Output Voltages ($V_{FB}=0.6V$)

$V_{OUT}(V)$	$R1(K\Omega)$	$R2(K\Omega)$	$C_{FB}(pF)$	$L(uH)$
5	39	5.315	47	4.7
3.3	39	8.67	47	4.7
2.5	39	12.3	47	3.3
1.8	39	19.5	47	2.2
1.5	39	26	47	2.2
1.2	39	39	47	1.5
1	39	58.5	47	1

Selecting the Inductor

A 1.0μH to 4.7μH inductor with a DC current rating of at least 25% percent higher than the maximum load current is recommended for most applications. For highest efficiency, the inductor DC resistance should be as small as possible. For most designs, the inductance value can be derived from the following equation.

$$L = \frac{V_{OUT} \times (V_{IN} - V_{OUT})}{V_{IN} \times \Delta I_L \times F_{OSC}}$$

Where ΔI_L is the inductor ripple current. Choose inductor ripple current to be approximately 30% if the maximum load current 3A. The maximum inductor peak current is:

$$I_{L(MAX)} = I_{LOAD} + \frac{\Delta I_L}{2}$$

Under light load conditions below 100mA, larger inductance is recommended for improved efficiency

Selecting the Output Capacitor

The output capacitor (C_{O1} and C_{O2}) is required to maintain the DC output voltage. Ceramic, tantalum, or low ESR electrolytic capacitors are recommended. Low ESR capacitors are preferred to keep the output voltage ripple low. The output voltage ripple can be estimated by:

$$\Delta V_{OUT} = \frac{V_{OUT}}{f_s \times L} \times \left[1 - \frac{V_{OUT}}{V_{IN}} \right] \times \left[R_{ESR} + \frac{1}{8 \times f_s \times C_2} \right]$$

Where L is the inductor value and R_{ESR} is the equivalent series resistance (ESR) value of the output capacitor. In the case of ceramic capacitors, the impedance at the switching frequency is dominated by the capacitance. The output voltage ripple is mainly caused by the capacitance. For simplification, the output voltage ripple can be estimated by:

$$\Delta V_{OUT} = \frac{V_{OUT}}{8 \times f_s^2 \times L \times C_2} \times \left[1 - \frac{V_{OUT}}{V_{IN}} \right]$$

In the case of tantalum or electrolytic capacitors, the ESR dominates the impedance at the switching frequency. For simplification, the output ripple can be approximated to:

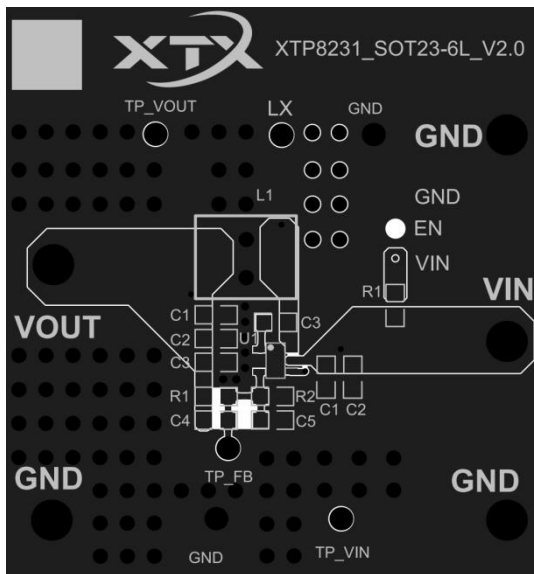
$$\Delta V_{OUT} = \frac{V_{OUT}}{f_s \times L} \times \left[1 - \frac{V_{OUT}}{V_{IN}} \right] \times R_{ESR}$$

The characteristics of the output capacitor also affect the stability of the regulation system. The XTP8231 can be optimized for a wide range of capacitance and ESR values.

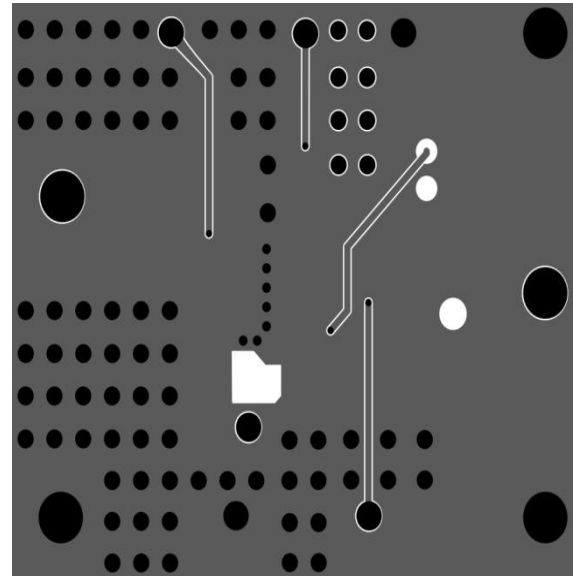
PCB LAYOUT GUIDE

PCB layout is very important to achieve stable operation. It is highly recommended to duplicate EVB layout for optimum performance. If change is necessary, please follow these guidelines.

- 1) Keep the path of switching current short and minimize the loop area formed by Input capacitor, VIN pin and GND.
- 2) Bypass ceramic capacitors are suggested to be put close to the VIN Pin.
- 3) Ensure all feedback connections are short and direct. Place the feedback resistors as close to the chip as possible.
- 4) VOUT, LX away from sensitive analog areas such as FB.
- 5) Connect VIN, LX, and especially GND respectively to a large copper area to cool the chip to improve thermal performance and long-term reliability.



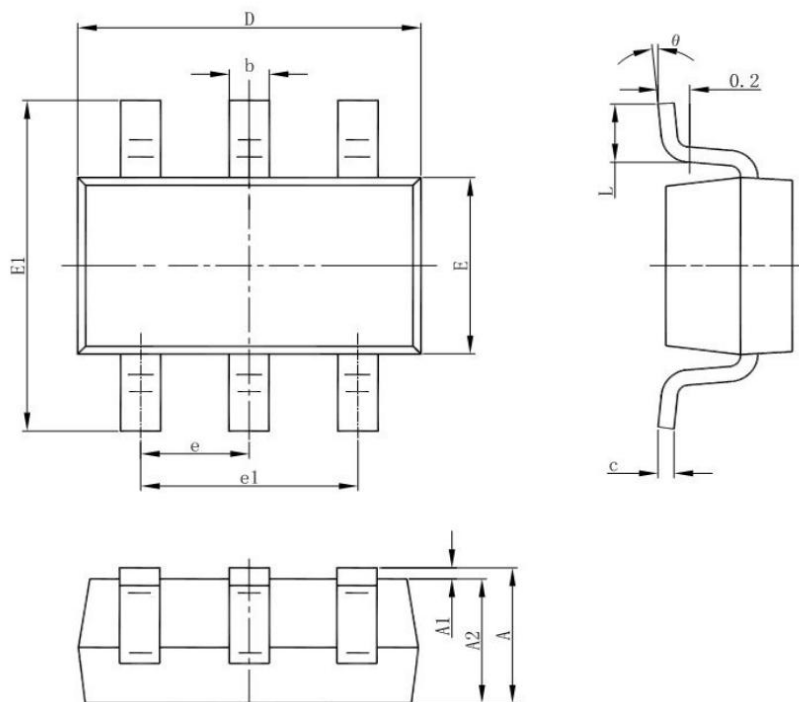
Top Layer



Bottom Layer

PACKAGE INFORMATION

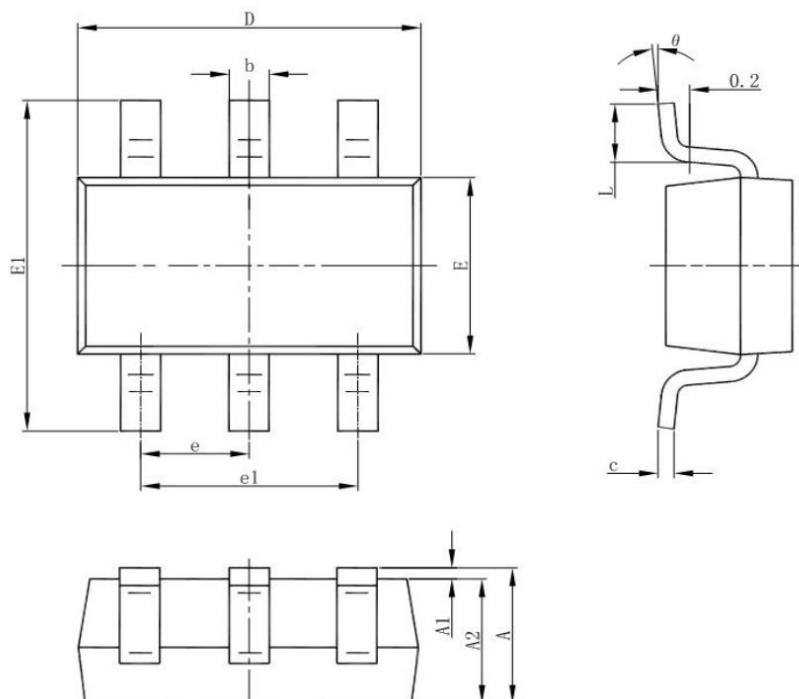
SOT23-6



Symbol	Dimensions In Millimeters	
	Min	Max
A	1.05	1.25
A1	0.00	0.10
A2	1.05	1.15
b	0.30	0.50
c	0.10	0.20
D	2.82	3.02
E	1.50	1.70
E1	2.65	2.95
e	0.95BSC	
e1	1.80	2.00
L	0.30	0.60
θ	0	8°

PACKAGE INFORMATION

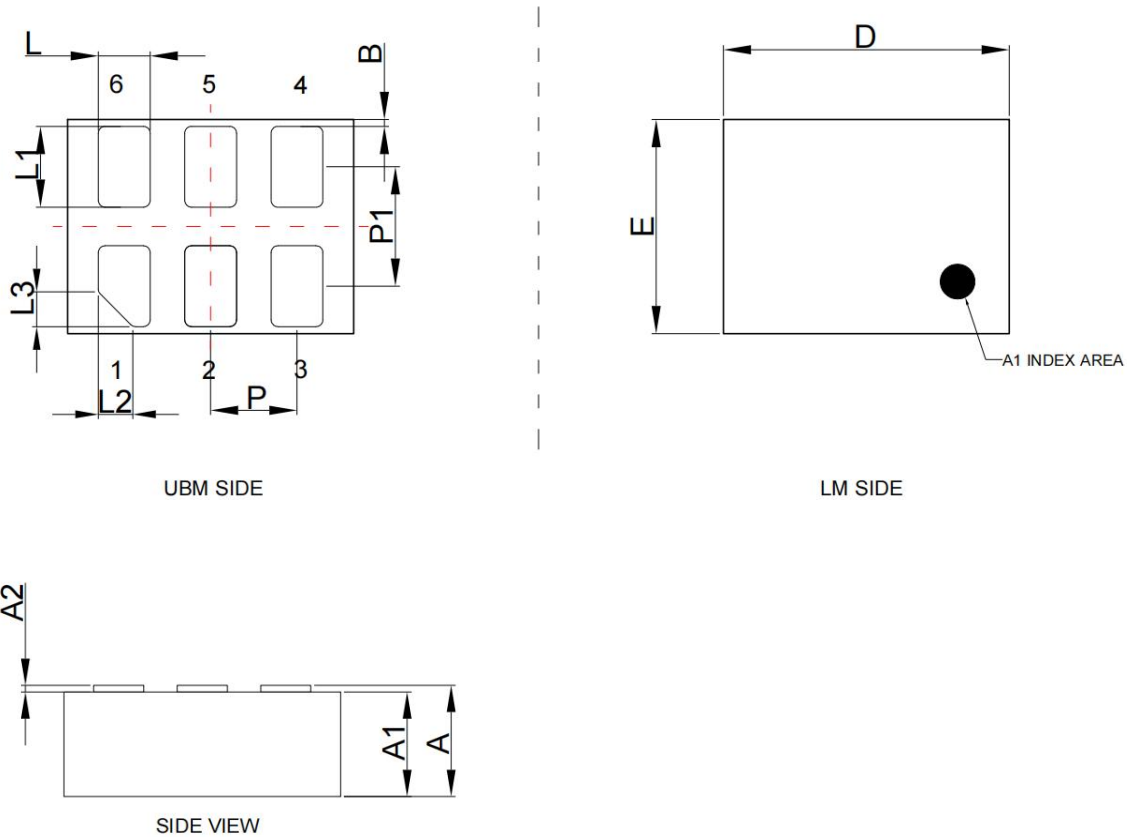
TSOT23-6



Symbol	Dimensions In Millimeters	
	Min	Max
A	1.05	1.25
A1	0.00	0.10
A2	1.05	1.15
b	0.30	0.50
c	0.10	0.20
D	2.82	3.02
E	1.50	1.70
E1	2.65	2.95
e	0.95BSC	
e1	1.80	2.00
L	0.30	0.60
θ	0	8°

PACKAGE INFORMATION

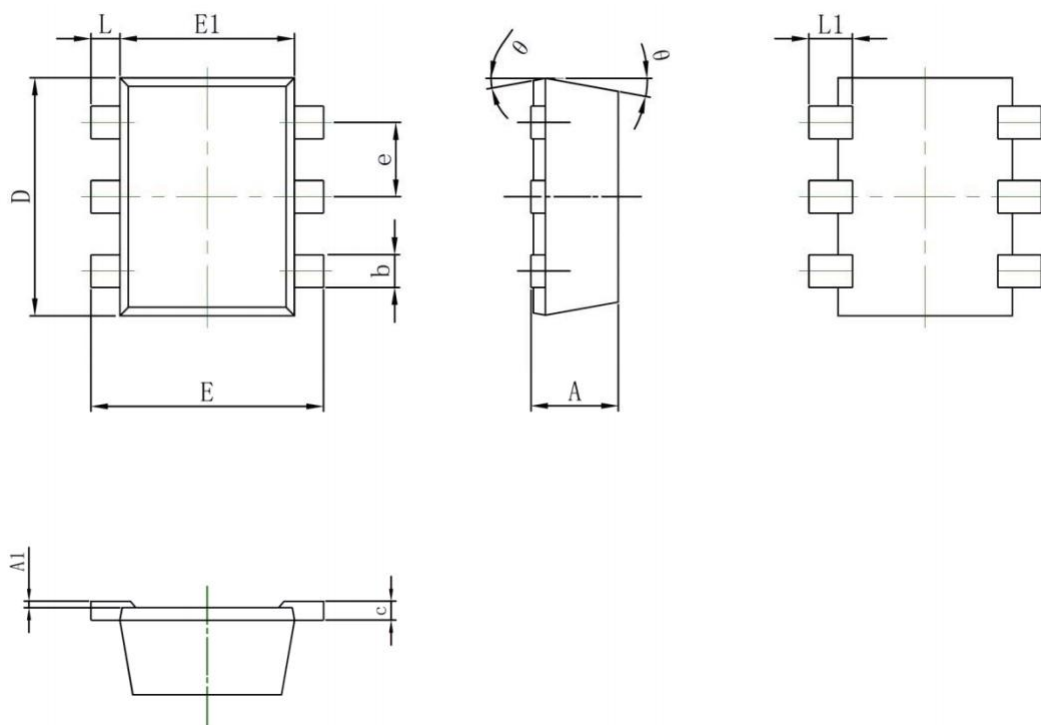
DFN1.2*1-6L



Symbol	ITEM		Dimensions In Millimeters		
			Min	Nom	Max
A	PACKAGE HEIGHT		0.450	0.55	0.550
A1	PANEL BODY THICKNESS		0.437	0.470	0.503
A2	UBM THICKNESS	CU	0.015	0.020	0.025
		SN	0.007-0.020		
D	PACKAGE SIZE X		1.217	1.242	1.267
E	PACKAGE SIZE Y		0.902	0.927	0.952
L	UBM SIZE		0.215	0.225	0.235
L1			0.340	0.350	0.360
L2	---		0.150		
L3	---		0.150		
P	MIN UBM PITCH X		0.375		
P1	MIN UBM PITCH Y		0.517		
L	EDGE DISTANCE		0.030		
---	UBM COUNT		6		

PACKAGE INFORMATION

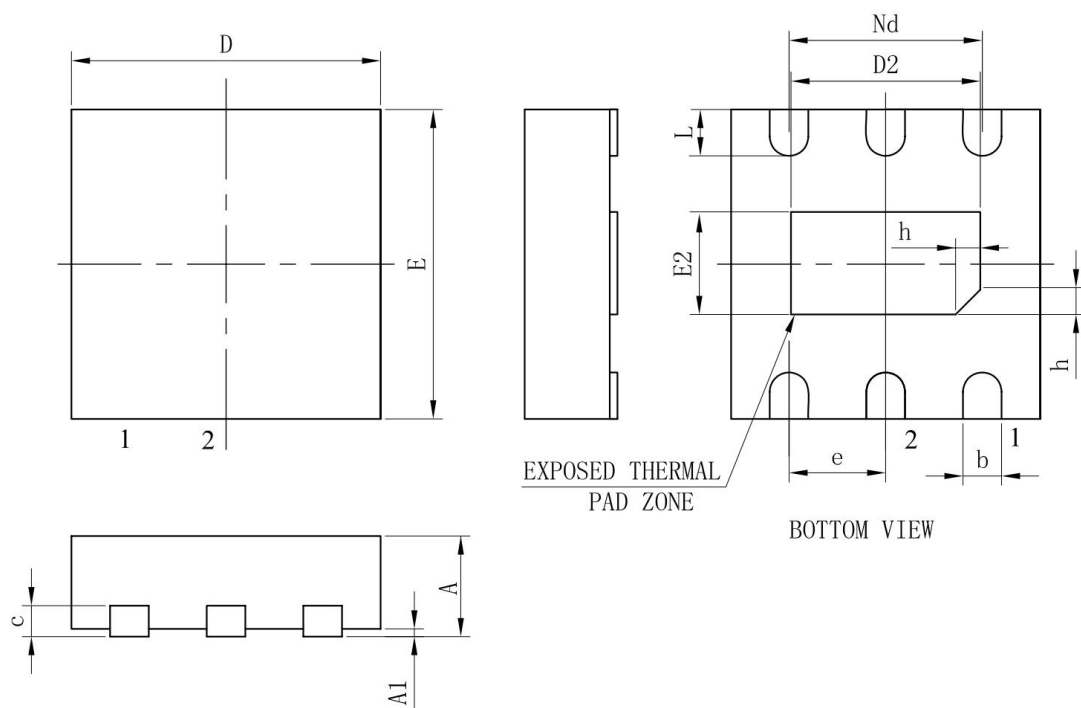
SOT563



Symbol	Dimensions In Millimeters	
	Min	Max
A	0.525	0.600
A1	0.00	0.05
e	0.45	0.55
c	0.09	0.18
D	1.50	1.70
b	0.17	0.27
E1	1.10	1.30
E	1.50	1.70
L	0.10	0.30
L1	0.20	0.40
θ	0	9°

PACKAGE INFORMATION

DFN6L-2*2



Symbol	Dimensions In Millimeters		
	Min	Nom	Max
A	0.70	0.75	0.80
A1	-	0.02	0.05
b	0.25	0.30	0.35
c	0.18	0.20	0.25
D	1.95	2.00	2.05
D2	1.00	1.23	1.45
E	1.95	2.00	2.05
E2	0.50	0.68	0.85
e	0.65BSC		
Nd	1.30BSC		
L	0.25	0.30	0.40
h	0.10	0.15	0.20

REVISION HISTORY

Number	Description
Rev 1.0	XTP8231 datasheet release
Rev 1.1	Update ELECTRICAL CHARACTERISTICS
Rev 1.2	Add the DFN1.2*1-6L package
Rev 1.3	Feedback Reference Voltage Accuracy: $\pm 1\%$
Rev 1.4	Feedback Reference Voltage Accuracy: $\pm 1.5\%$