General Description

The PIS2300 is a versatile controller designed for use in boost power converter and topologies that needs an external low-side N-MOSFET acting as primary switch. Besides cycle-by-cycle current limiting, current mode control scheme also makes it wide bandwidth and good transient response. The current limit can be programmed simply with an external resistor.

The switching frequency can be set in any value between 100kHz and 1MHz with a resistor or any external clock source. The PIS2300 can be operated at high switching frequency to save the solution board size. While entering shutdown mode, the PIS2300 only sinks 10μA and it allows power supply sequencing. It has built-in protection circuits such as thermal shutdown, short circuit protection, and overvoltage protection. Internal soft-start circuitry reduces the inrush current at start-up.

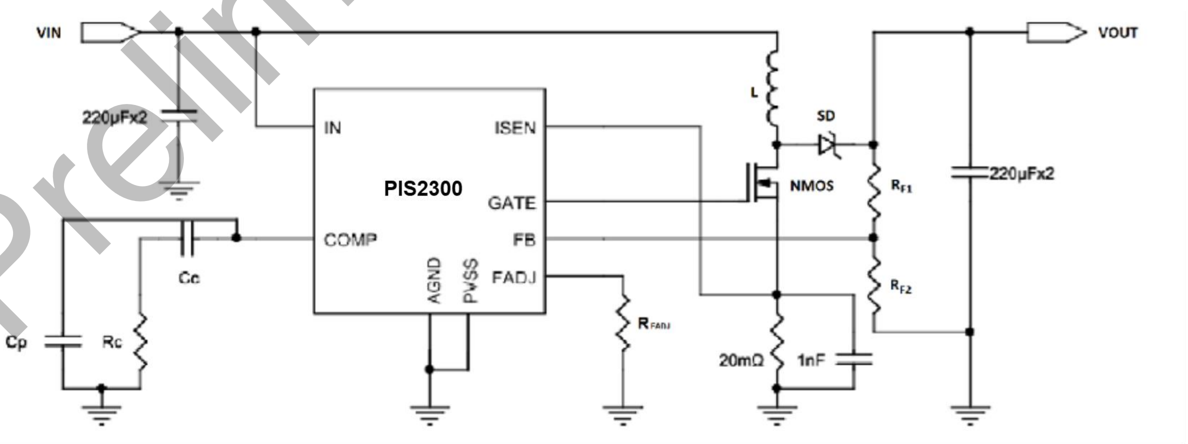
Features

- *Wide Input Voltage from 2.97V to 40V*
- *Reference Voltage with ±2.0% Accuracy*
- *Adjustable 100kHz~1MHz Clock Frequency*
- *V_{FB} = 1.26V*
- *10μA Shutdown Current*
- *1A Peak Current Limit Using Internal Driver*
- *Current Mode Operation*
- *Internal 12/4 Ω MOSFET*
- *External RC Compensation*
- *Internal Soft-Start*
- *High Efficiency at Light Loads*
- *Current Limit and Over Temperature Protection*

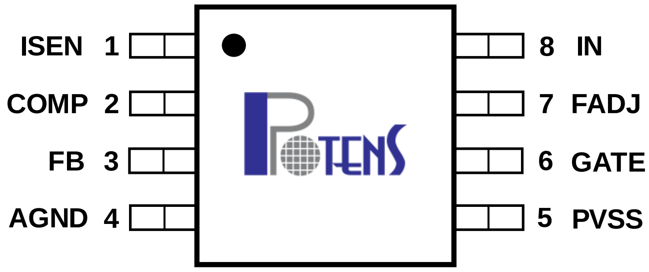
Applications

- *Portable Speakers*
- *Offline Power Supply*
- *Battery Powered Device*
- *Set-Top Box*
- *Photovoltaic Inverters*

Typical Applications



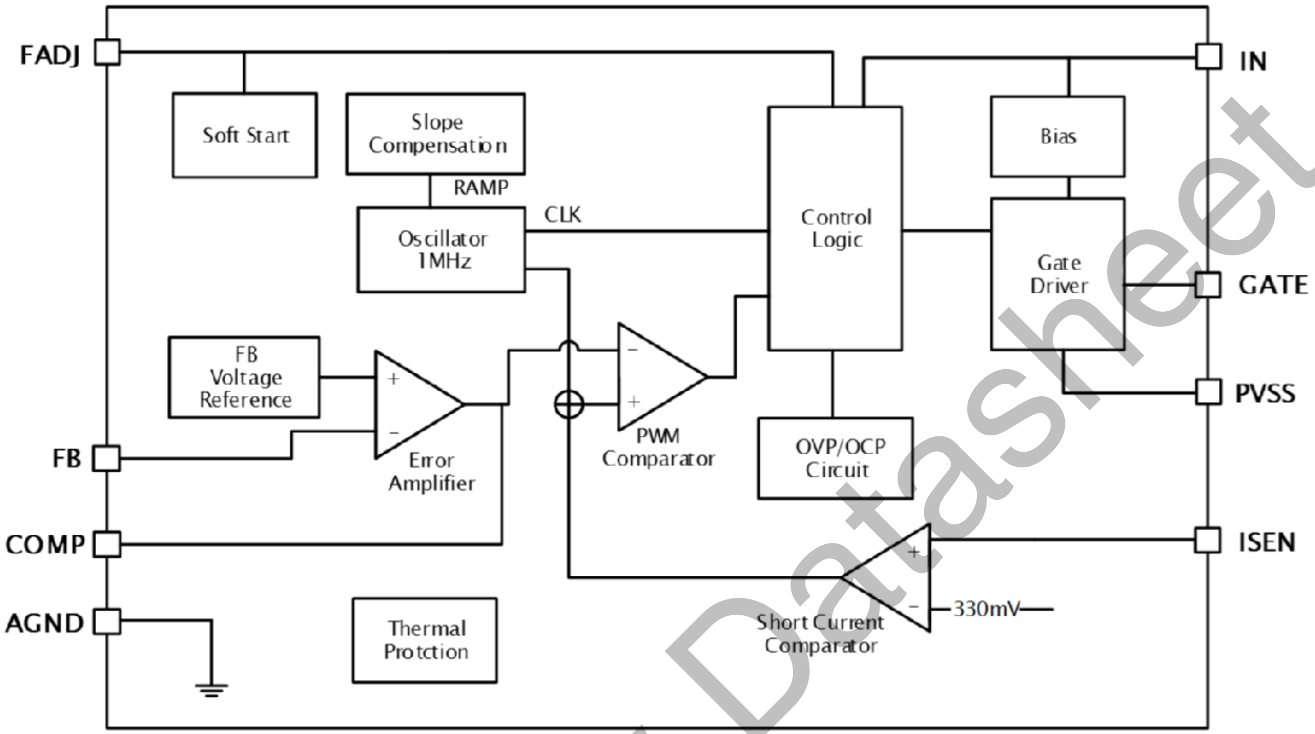
MSOP8 Pin Configuration



Top View

Pin No.	Symbol	I/O/P	Function
1	ISEN	P	Current Sense. Use an external resistor in series with ground to measure the voltage drop.
2	COMP	I	Compensation. Use a RC/C network to do proper loop compensation.
3	FB	I	Output Feedback. Connect the external resistor divider network from output to this pin to sense output voltage. The FB pin voltage is regulated to internal 1.26V reference voltage.
4	AGND	P	Analog Ground. Connect to exposed pad.
5	PVSS	I	Power Ground. Connect to exposed pad.
6	GATE	O	Gate Drive. Connect this terminal to the gate pin of the external MOSFET.
7	FADJ	O	Frequency Adjust/Synchronization/Shutdown. A resistor connected from this pin to ground simply sets the oscillator frequency. An external clock signal at this pin will synchronize the controller to the clock. Pull on this pin for ≥ 30 μs will turn the device off and the device will then very few current about 5μA from the supply.
8	IN	I	Power Supply Input.

Functional Block Diagram



Absolute Maximum Ratings (T_a=25 ℃, unless otherwise noted)

Symbol	Parameter	Min	Max	Units
V_{IN}	Supply voltage range	-0.3	42	V
V_{LV} (COMP/FB/FADJ/GATE)	Low voltage range	-0.3	6	V
V_{ISEN}	Current sense pin range	-0.4	0.6	V
T_J	Operating junction temperature range	-40	150	°C
T_{STG}	Storage temperature range	-65	150	°C
Electrostatic discharge	Human body model	---	2	kV
Electrostatic discharge	Machine model	---	200	V
$\theta_{JC(top)}$	Thermal resistance (Junction to Case (top))	---	47	°C/W
θ_{JA}	Thermal resistance (Junction to Air)	---	146	°C/W
θ_{JB}	Thermal resistance (Junction to Board)	---	84	°C/W
ψ_{JT}	Junction-to-top characterization parameter	---	4	°C/W
ψ_{JB}	Junction-to-board characterization parameter	---	80	°C/W

* Stress beyond those listed at “absolute maximum rating” table may cause permanent damage to the device. These are stress rating ONLY. For functional operation are strongly recommend follow up “recommended operation conditions” table.

Recommend Operating Condition

Symbol	Parameter	Min	Max	Units
V_{IN}	Supply voltage range	2.97	40	V
f_{OSC}	Switching Frequency range	0.1	1	MHz
T_J	Operating junction temperature range	-40	125	°C

Electrical Characteristic

(V_{IN}=12V, R_{FADJ}=40kΩ, T_a=25 ℃, unless otherwise noted)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_{FB}	Feedback voltage	V_{COMP}=1.4V, 3V<V_{IN}<40V	1.2416	1.26	1.2843	V
I_Q	Quiescent current in shutdown mode	V_{FADJ}=3V, V_{IN}=12V	---	10	---	μA
		V_{FADJ}=3V, V_{IN}=12V -40℃<T_J<125℃	---	---	15	
		V_{FADJ}=3V, V_{IN}=5V	---	5	---	
		V_{FADJ}=3V, V_{IN}=5V, -40℃<T_J<125℃	---	---	10	
V_{UVLO}	Under voltage lockout		---	2.5	---	V
$V_{UV(HYS)}$	Input Under voltage Lock-out Hysteresis		---	160	---	mV
$R_{DS(ON)}$	High-side switch $R_{DS(ON)}$	V_{IN}=5V, I_{GATE}=0.2A	---	12	---	Ω
	Low-side switch $R_{DS(ON)}$	V_{IN}=5V, I_{GATE}=0.2A	---	4	---	
A_{VOL}	Error amplifier voltage gain	V_{COMP}=1.4V, I_{EAO}=100μA	---	60	---	V/V
g_M	Error amplifier trans-conductance	V_{COMP}=1.4V	---	430	---	μ℧
V_{GATE}	Maximum GATE driving swing	V_{IN} < 5.8V	---	V_{IN}	---	V
		V_{IN} ≥ 5.8V	---	5.7	---	
f_{OSC}	Oscillation frequency	R_{FADJ}=40kΩ	---	0.44	---	MHz
		R_{FADJ}=40kΩ ,-40℃<T_J<125℃	0.34	---	0.48	
D_{MAX}	Maximum duty cycle	R_{FADJ}=40kΩ	---	85	---	%
ΔV_{LINE}	Voltage line regulation	3V<V_{EN}<40V	---	0.05	---	%/V
ΔV_{LOAD}	Voltage load regulation	I_{EAO} Source/Sink	---	±0.5	---	%/A
$t_{MIN(ON)}$	Minimum on-time		---	410	---	ns
I_{SUPPLY}	Supply Current	R_{FADJ}=40kΩ	---	2.7	---	mA
		R_{FADJ}=40kΩ ,-40℃<T_J<125℃	---	---	4.5	
V_{SENSE}	Current sense threshold voltage	V_{IN}=5V	120	160	180	mV
		V_{IN}=5V , -40℃<T_J<125℃	120	---	200	
V_{SC}	Overload current limit sense voltage	V_{IN}=5V	---	290	---	mV
		V_{IN}=5V , -40℃<T_J<125℃	240	---	415	
V_{SL}	Internal compensation ramp	V_{IN}=5V	---	90	---	mV
		V_{IN}=5V , -40℃<T_J<125℃	52	---	132	
V_{OVP}	Output overvoltage protection	V_{COMP}=1.4V	---	85	---	mV
$V_{OVP(HYS)}$	Output overvoltage protection hysteresis	V_{COMP}=1.4V	---	70	---	mV

Electrical Characteristic – cont.

(V_{IN}=12V, R_{FADJ}=40kΩ, T_a=25 ℃, unless otherwise noted)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
I_{EAO}	Error amplifier output current (Source/Sink)	Source, V_{COMP} = 1.4V, V_{FB} = 0V	---	127	---	μA
		Source, V_{COMP} = 1.4V, V_{FB} = 0V , -40℃<T_J<125℃	65	---	180	
		Sink, V_{COMP} = 1.4V, V_{FB} = 1.4V	---	180	---	
		Sink, V_{COMP} = 1.4V, V_{FB} = 1.4V , -40℃<T_J<125℃	100	---	230	
V_{EAO}	Error amplifier output voltage	V_{FB}=0V, COMP pin floating	---	2.38	---	V
		V_{FB}=0V, COMP pin floating -40℃<T_J<125℃	2	---	2.6	
		V_{FB} = 1.4V	---	0.67	---	
		V_{FB} = 1.4V, -40℃<T_J<125℃	0.2	---	1	
V_{SD}	Shutdown signal threshold on FADJ pin*	Output = High Level	---	1.29		V
		Output = High Level , -40℃<T_J<125℃	---	---	1.4	
		Output = Low Level	---	0.63	---	
		Output = Low Level , -40℃<T_J<125℃	---	---	0.4	
t_{SS}	Soft start delay	V_{FB} = 1.2V, COMP pin floating	---	9	---	ms
t_R	GATE pin rising time	Cgs = 3000pF, V_{GATE} = 0V to 3V	---	75	---	ns
t_F	GATE pin falling time	Cgs = 3000pF, V_{GATE} = 3V to 0V	---	20	---	ns
I_{SD}	Shutdown pin current FADJ pin	V_{SD}=0V	---	20	---	μA
T_{SD}	Thermal shutdown		---	170	---	℃
$T_{SD(HYS)}$	Thermal shutdown hysteresis		---	10	---	℃

* The FADJ pin should be pulled to VIN through a resistor to turn the regulator off. The voltage on the FADJ pin must be above the maximum limit for Output = High Level to keep the regulator off and must be below the limit for Output = Low Level to keep the regulator on.

Functional Descriptions

The PIS2300 employs the current-mode, adjustable frequency pulse-width modulation (PWM) architecture. It operates at adjustable switching frequency under medium to high load current conditions.

Overvoltage Protection

The PIS2300 uses FB pin to detect overvoltage occurrence. The overvoltage protection should be triggered at the voltage rises to V_{FB} +V_{OVP} . When OVP occurs only the MOSFET will be turned off, the output voltage will drop. PIS2300 will switch when the voltage on FB pin is less then V_{FB} +(V_{OVP} -$V_{OVP(HYS)}$) for limit on $V_{OVP(HYS)}$.

Frequency Adjust

The switching frequency can be adjusted from 100kHz to 1MHz by a external resistor in series with FADJ terminal and ground. The following equation is used to calculate resistor value.

a. When Fs < 300KHz the calculate as below,

$$R_{FADJ} \cong \frac{17.5 \times 10^3}{f_s} + 8.2$$

b. When Fs > 300KHz the calculate as below,

$$R_{FADJ} \cong \frac{21 \times 10^3}{f_s} - 7.3$$

Where f_S is in kHz and R_{FA} is in kΩ.

Clock Synchronization

PIS2300 is able to be synchronized to an external clock by connecting to the FADJ terminal with R_{FADJ} in series with ground as shown in figure 2.

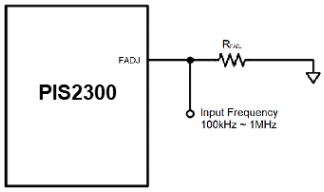


Figure 2. Clock Synchronization

Shutdown

The FADJ pin can be used as a shutdown pin. If the high signal pulls up this pin, PIS2300 will stop the switching and then enter the shutdown state. In this state, PIS2300 consumes only 5μA typically.

The use of shutdown control in frequency adjustment mode is quite simple. Connects a resistor between the FADJ pin and ground will force the PIS2300 runs at specified frequency and pulls this pin high will shutdown the IC. In both frequency and synchronization mode, pulls FADJ pin high lasting then 30μs will also force the PIS2300 enter the shutdown state.

Slope Compensation

PIS2300 employs current mode control scheme. It has many advantages such as cycle-by-cycle current limit for the switch and easier to parallel power stages because automatic current sharing. The compensation ramp is already added in PIS2300 and the slope of the default compensation ramp could satisfy most applications.

Short Circuit Protection

The ISEN pin is used to sense the over-current occurrence. If the difference between ISEN pin and ground is greater than 330mV, the current limit will be activated. The comparator will decrease the switching frequency by the factor of 8 and maintains this condition until the over-current (short) event is removed.

Application Information

Programming the Output Voltage and Output Current

The output voltage can be programmed using a resistor divider between the output and the feedback pins, as shown in Figure 3. The resistors are selected such that the voltage at the feedback pin is 1.26V. R_{F1} and R_{F2} can be selected using the equation,

$$V_{OUT} = V_{FB} \times (1 + \frac{R_{F1}}{R_{F2}})$$

A 100pF capacitor may be connected between the feedback and ground pins to reduce noise.

The maximum amount of current that can be delivered at the output can be controlled by the sense resistor, R_{SEN} . Current limit occurs when the voltage that is generated across the sense resistor equals the current sense threshold voltage, V_{SENSE} . Limits for V_{SENSE} have been specified in the Electrical Characteristics section. This can be expressed as:

$$I_{SW(pexk)} \times R_{SEN} = V_{SENSE} - D \times V_{SL}$$

The peak current through the switch is equal to the peak inductor current.

$$I_{SW(pexk)} = I_L(\max) + \Delta i_L$$

Therefore for a boost converter,

$$I_{SW(pexk)} = \frac{I_{OUT(\max)}}{(1-D)} + \frac{(D \times V_{IN})}{(2 \times f_s \times L)}$$

Combining the two equations yields an expression for R_{SEN} ,

$$R_{SEN} = \frac{V_{SENSE} - (D \times V_{SL})}{\left[\frac{I_{OUT(\max)}}{(1-D)} + \frac{(D \times V_{IN})}{(2 \times f_S \times L)}\right]}$$

Evaluate R_{SEN} at the maximum and minimum V_{IN} values and choose the smallest R_{SEN} calculated.

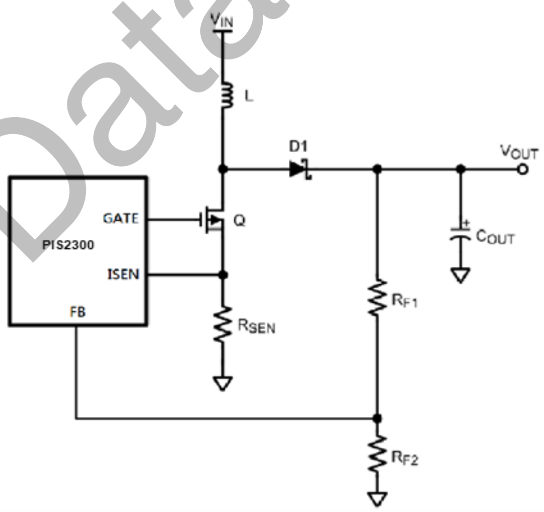


Figure 3. Adjusting the Output Voltage

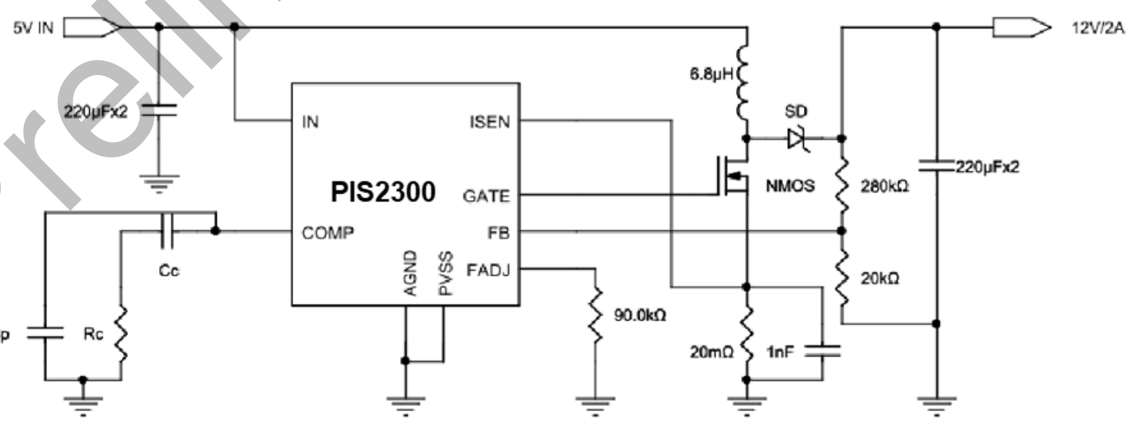
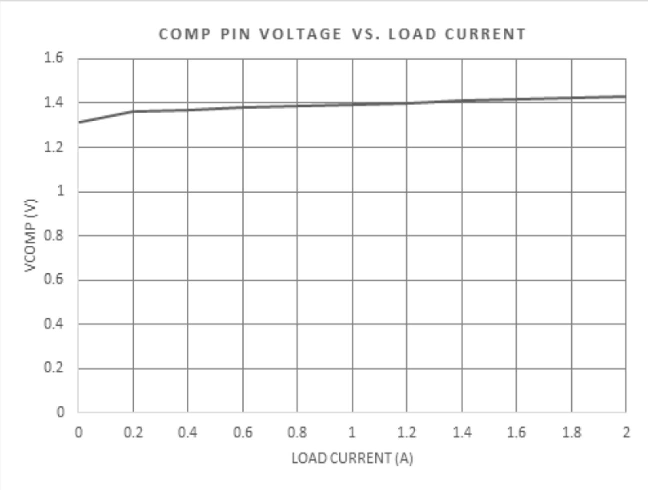
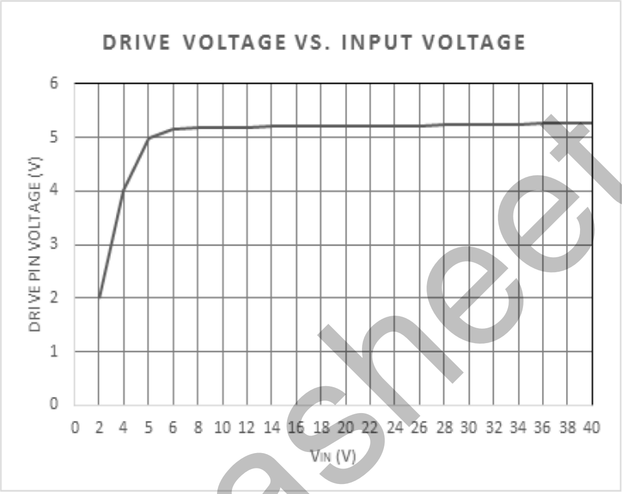
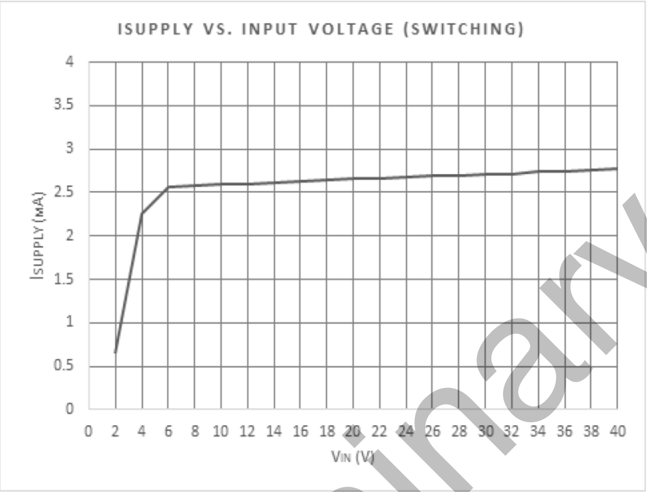


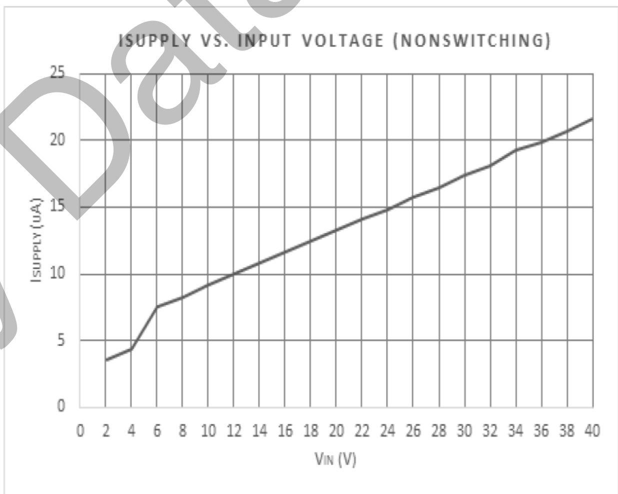
Figure 4. PIS2300 Typical Boost Application

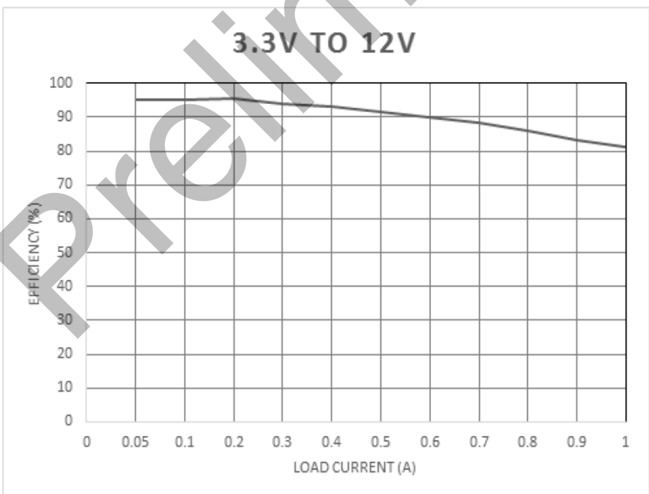
Typical Characteristic

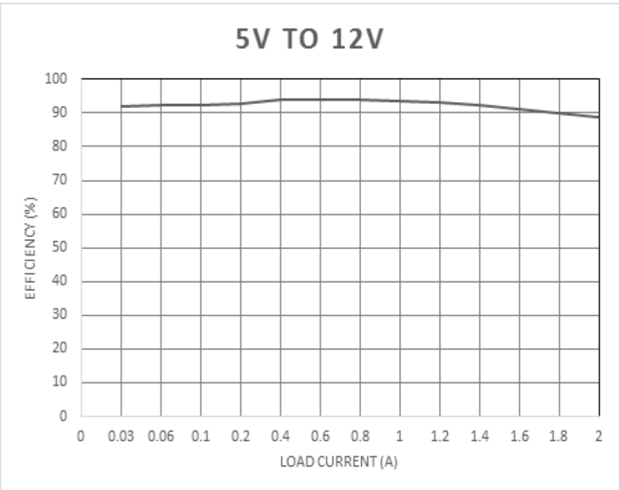




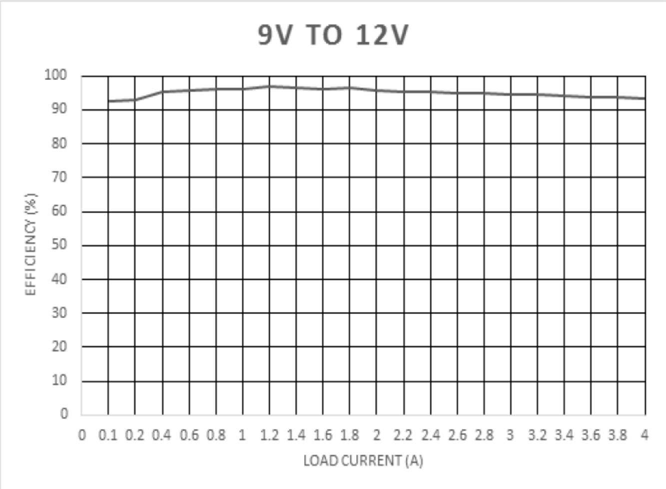


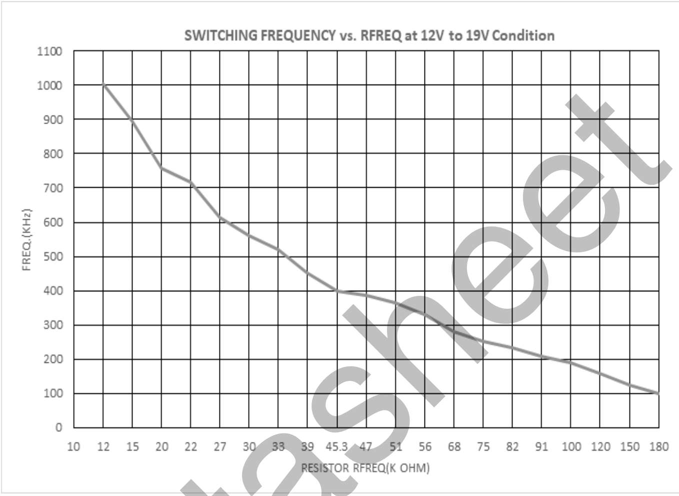




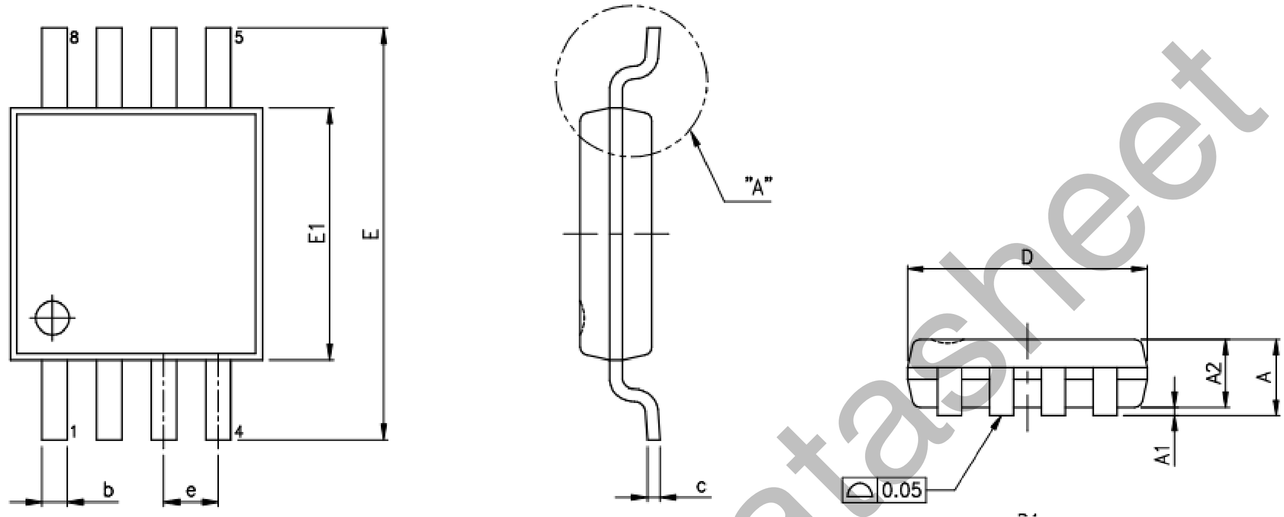


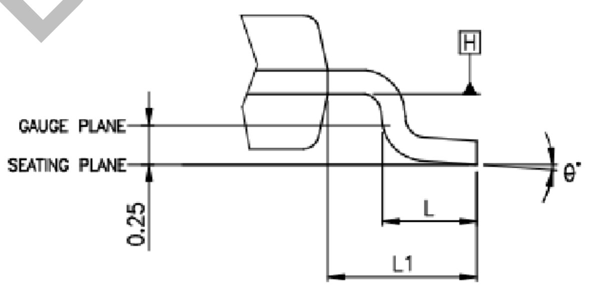
Typical Characteristic (cont.)



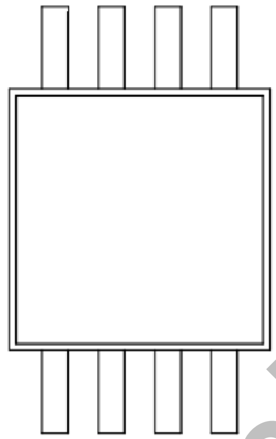


MSOP8 PACKAGE INFORMATION





DETAIL A



THERMALLY ENHANCED VARIATIONS ONLY

SYMBOLS	MIN.	NOM.	MAX.
A	–	–	1.10
A1	0.00	–	0.15
A2	0.75	0.85	0.95
6 b	0.22	–	0.38
6 c	0.08	–	0.23
D	3.00 BSC		
E	4.90 BSC		
E1	3.00 BSC		
6 e	0.65 BSC		
L	0.40	0.60	0.80
L1	0.95 REF		
θ°	0	–	8

UNIT : MM

NOTES:
1.JEDEC OUTLINE :
STANDARD : MO–187 AA.
THERMALLY ENHANCED : MO–187 AA–T.
2.DIMENSION D DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH, PROTRUSIONS OR GATE BURRS SHALL NOT EXCEED 0.15 mm PER END.
DIMENSION E1 DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.15 mm PER SIDE.
3.DIMENSION 'b' DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 MM TOTAL IN EXCESS OF THE 'b' DIMENSION AT MAXIMUM MATERIAL CONDITION. THE DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OF THE FOOT. MINIMUM SPACE BETWEEN PROTRUSION AND AN ADJACENT LEAD SHALL NOT BE LESS THAN 0.07 mm.
4.D AND E1 DIMENSIONS ARE DETERMINED AT DATUM H .