

High Performance Dual-Mode Flyback PWM Controller with Peak-Load**General Description**

IN2091 is a Flyback AC-DC PWM controller which uses Peak-Current Mode and proprietary Dual-Mode technology (CCM / Quasi-Resonant DCM). The PWM Frequency Variation and Jittering are included for EMI optimization and efficiency improvement.

IN2091 provides complete fault protections including AC & VDD over voltage protection, output over voltage/load and short circuit protection, open loop protection, secondary rectifier short protection, short winding protection, and cycle by cycle current limit... etc.

To increase light-load efficiency, the burst mode is automatically activated to reduce power loss. Under very light-load condition, the VDD holdup mode will be triggered to avoid VDD drop to turn-off threshold by forcing PWM switching.

In peak-load mode, the maximum frequency will be doubled, and the internal current sense limitation will be increased automatically for peak power requirement. In the meantime, the protection timer will be started to prevent damage of the unexpected load condition.

IN2091 is available in standard SOT-23-6 and SOP-8 packages.

Applications

- Switching Power Supply with Peak Power
- Printer Power
- Storage Power

Features

- 2x Maximum Frequency in Peak-Load
- Increase V_{CS_MAX} in Peak-Load
- 10 Seconds Peak-Load Protection Timer
- Peak Current mode PWM controller
- CCM/QR-DCM Dual Mode Operation
- Burst Mode & VDD Holdup Mode at Light-Load
- Frequency Variation by the different AC_{IN} & I_{OUT}
- Frequency Jittering for EMI Reduction
- Low Supply Current
- No-load power consumption under 75mW
- Internal Soft-Start
- Fault Protection

Output

- Over/Under Voltage Protection
- Over Load Protection
- Open Loop Protection
- Short Circuit Protection

Input

- Brown-In/Out
- VDD Under Voltage Lockout
- VDD Over Voltage Protection
- Mains Over Voltage Protection

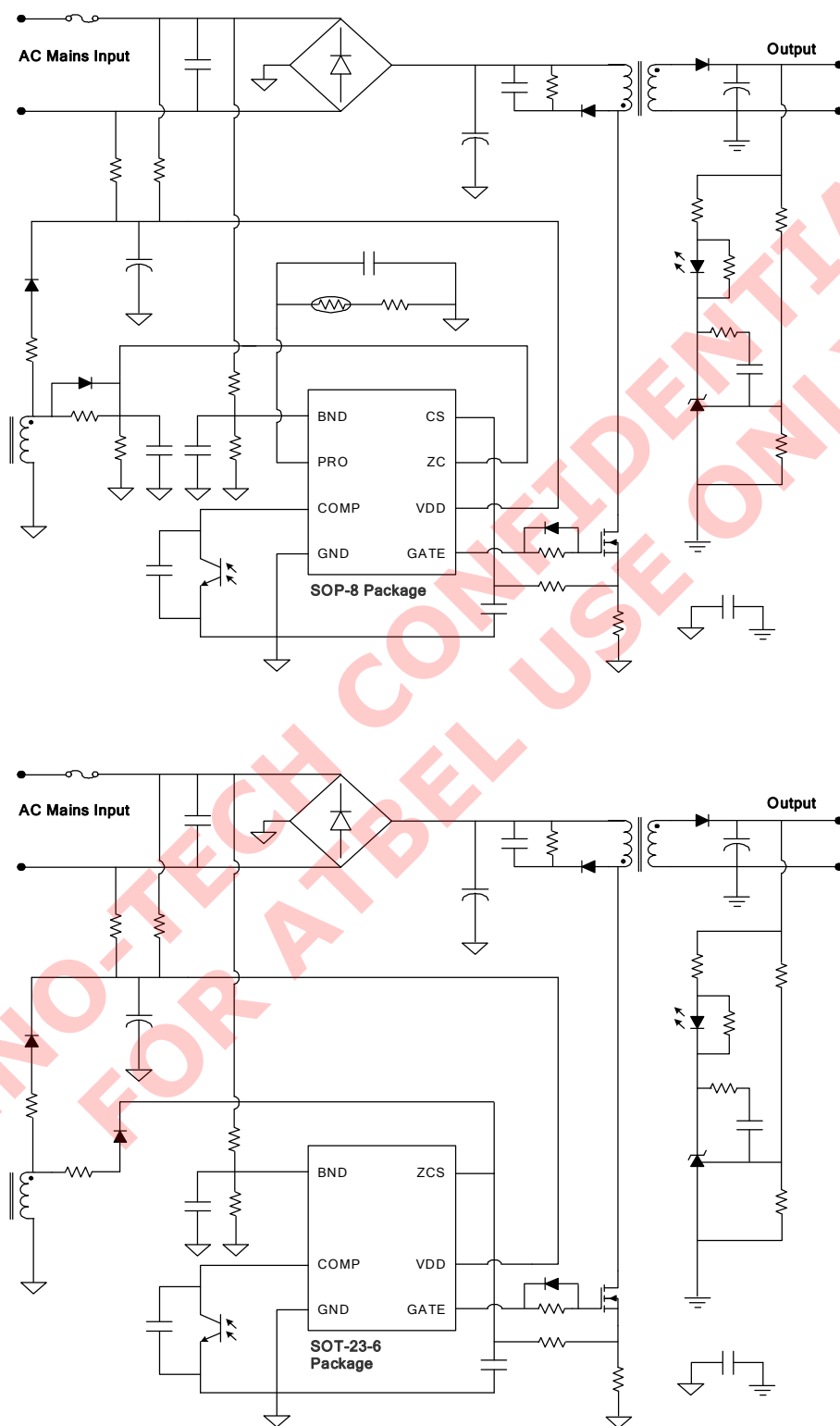
Primary Current

- Cycle by Cycle Current Limit
- Over Current Protection

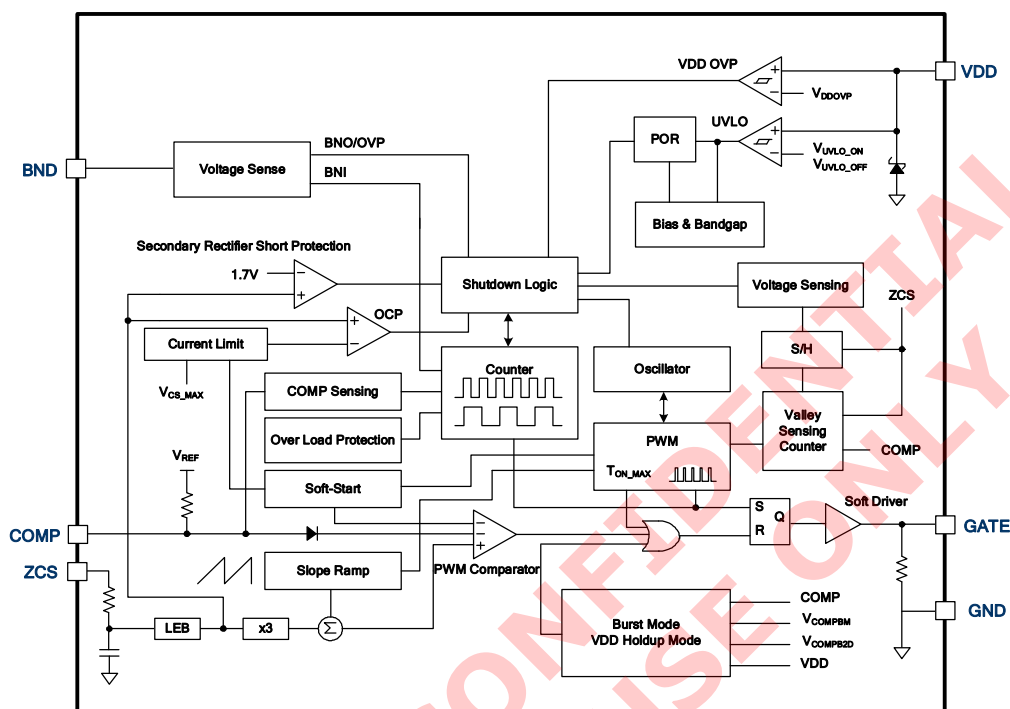
Others

- Short Winding Protection
- Secondary Rectifier Short Protection
- Over Temperature Protection
- Internal Slope Compensation
- No Audible Noise over Full Operating Range
- SOT-23-6 & SOP-8 Packages
- Meet RoHS Standard

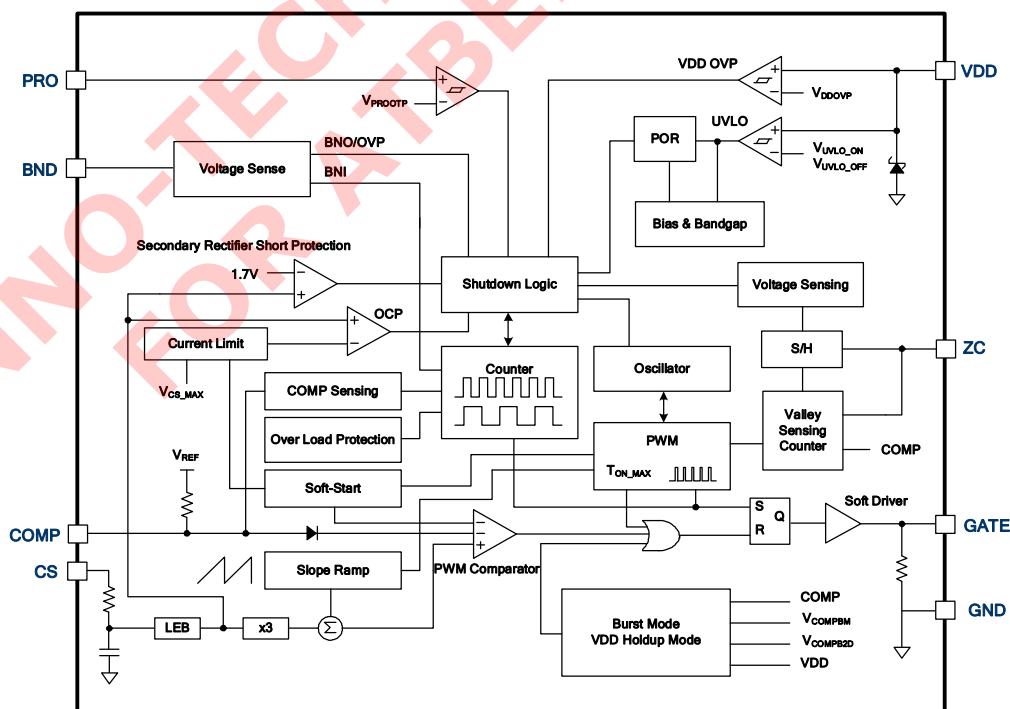
Typical Application



Functional Block Diagram

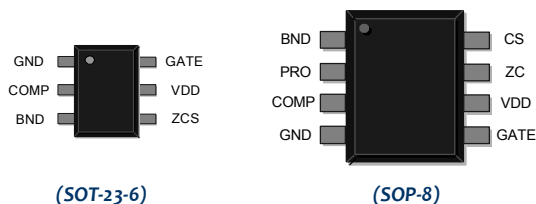


SOT-23-6 Package



SOP-8 Package

Pin Configurations



Pin Name		Pin Type	Description
SOT-23-6	SOP-8		
BND	BND	<i>AI</i>	Brown-in/out (BNI/BNO) Detection. Connect this pin to AC line input or bulk capacitor with a resistive divider to achieve the BNI/BNO protection.
-	PRO	<i>AI</i>	This pin is designed for external OVP or OTP applications. Leave PRO unconnected if the function is not used.
COMP	COMP	<i>AI</i>	Feedback Voltage Input. Connect an Opto-Coupler to close the control loop and achieve output voltage regulation. The Open Loop Protection and Over Load Protection are also achieved by monitoring this pin.
GND	GND	-	Ground. Connect this pin to the circuit ground.
GATE	GATE	<i>O</i>	Gate drive output for external power MOSFET.
VDD	VDD	-	Power Input of the Controller.
ZCS	ZC	<i>AI</i>	Zero Crossing Detection. When GATE outputs LOW, this pin detects the PWM and makes the controller can be switched at valley to reduce the power loss in DCM. It also monitors the output voltage.
	CS	<i>AI</i>	Current Sense Input. When GATE outputs HIGH, the current sense resistor between this pin and GND is used for cycle-by-cycle peak current control and limit.

Absolute Maximum Ratings

Parameter	Rating
Supply Input Voltage, VDD	-0.3V ~ 30V
VDD Operating Current, IDD	8mA
GATE Voltage, V _{GATE}	-0.3V ~ 30V
COMP, ZC, CS, ZCS, BND, PRO Voltage	-0.3V ~ 5.5V
Storage Temperature Range	-65°C ~ 150°C
Junction Temperature	-40°C ~ 150°C
Lead Soldering Temperature (10 sec)	260°C
ESD rating per JEDEC JESD22-A114	HBM 4KV
	MM 200V
Latch-up test per JEDEC 78	±200mA

Notes:

- (1). These are stress ratings only and functional operation is not implied. Exposure to absolute maximum ratings for prolonged time periods may affect device reliability.
- (2). All voltages are with respect to ground.
- (3). Devices are ESD sensitive. Handling precaution is recommended.

Recommended Operating Conditions

Parameter	Rating
Supply Input Voltage Range	12V ~ 25V
Junction Temperature Range	-40°C ~ 125°C

Notes:

- (1). These are conditions under which the device functions but the specifications might not be guaranteed.
- (2). For guaranteed specifications and test conditions, please see the [Electrical Specifications](#).

Package Information

Parameter	Package	Symbol	Rating
Thermal Resistance of Junction to Case	SOT-23-6	θ_{JC}	110 °C/W
	SOP-8		40 °C/W
Thermal Resistance of Junction to Ambient	SOT-23-6	θ_{JA}	250 °C/W
	SOP-8		105 °C/W

Electrical Specifications

VDD=16V, T_A=25°C, unless otherwise noted.

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Supply Section						
VDD Over Voltage Protection	V _{DDOVP}		22.3	23.5	24.7	V
Delay Time of V _{DDOVP}	T _{VDDOVP}			320		us
VDD Zener Clamp	V _Z	I _{DD} =5mA	27.6			V
VDD UVLO ON Threshold Voltage	V _{UVLO_ON}		16	16.5	17	V
VDD UVLO OFF Threshold Voltage	V _{UVLO_OFF}		6.7	7	7.4	V
VDD Holdup Mode Entry Point	V _{DD_ET}		7.3	7.7	8.1	V
VDD Holdup Mode Ending Point	V _{DD_ED}		7.6	8	8.4	V
Start-Up Current	I _{DD_ST}	VDD < V _{TH_ON} - 0.1V		1	2	μA
Supply Current in Normal Operation	I _{DD_OP}	V _{COMP} =1.5V GATE pin open		1	2	mA
Internal Reference Voltage	V _{REF}		4.3	4.4	4.5	V
PWM Section						
Minimum Operation PWM Frequency	F _{SW_MIN}		20.5	21.5	22.5	KHz
Maximum Operation PWM Frequency	F _{SW_MAX}	V _{AC} =90V	80	85	90	KHz
		V _{AC} =115V	60	65	70	
		V _{AC} =230V	70	75	80	

Maximum Operation PWM Frequency in Peak-Load	F _{SW_PKL}	V _{AC} =90V		170		KHz
		V _{AC} =115V		130		
		V _{AC} =230V		150		
Maximum Duty Cycle	DC _{MAX}	CCM	70	75	80	%
Maximum Gate ON-Time	T _{ON_MAX}	DCM	13.5	15	16.5	us
Frequency Jittering Range	Δf _{JT}			12.5		%
Frequency Variation Versus VDD Deviation	f _{DV}	VDD=9V to 23V		0.5	1	%
Current Sensing / CS						
Peak Current Limitation in Normal Operation	V _{CS_MAX}	V _{AC} =90V	0.64	0.67	0.7	V
		V _{AC} =115V	0.61	0.64	0.67	
		V _{AC} =230V	0.56	0.59	0.62	
Peak Current Limitation in Peak-Load	V _{CS_PKL}	V _{AC} =90V		0.98		V
		V _{AC} =115V		0.95		
		V _{AC} =230V		0.69		
Leading Edge Blanking	T _{LEB_CS}			850		ns
Internal Propagation Delay Time	T _{PD}			150		ns
Minimum Gate On Time	T _{ON_MIN}			250		ns
Threshold for Short Winding Protection	V _{CSSW}		1.66	1.75	1.84	V
Blanking Time for Short Winding Protection	T _{LEB_SW}			600		ns
Zero Crossing / ZC						
Zero Crossing Threshold Voltage	V _{ZCCT}			150		mV
Threshold for Output Over Voltage Protection	V _{ZCOVP}		1.03	1.08	1.13	V
Blanking Time for Output Over Voltage Protection	T _{LEB_ZCOVP}			2.2		us
Threshold for Output Under Voltage Protection	V _{ZCUVP}		0.52	0.55	0.58	V
Delay Time for Output Under Voltage Protection	T _{D_ZCUVP}			16		ms
Feedback Voltage Input / COMP						
Open Loop Voltage	V _{COMP_OP}	COMP pin open	4.1	4.2	4.3	V

Short Circuit Current of COMP	I_{ZERO}	$V_{COMP}=0V$		0.1	0.2	mA
Reduce Frequency Entry Voltage	V_{COMPET}	$V_{AC}=90V, F=F_{SW_MAX}$		1.75		V
		$V_{AC}=115V, F=F_{SW_MAX}$		2.08		
		$V_{AC}=230V, F=F_{SW_MAX}$		2		
Reduce Frequency Ending Voltage	V_{COMPED}	$V_{AC}=90V, F=F_{SW_MIN}$		1.47		V
		$V_{AC}=115V, F=F_{SW_MIN}$		1.14		
		$V_{AC}=230V, F=F_{SW_MIN}$		1.54		
Exit Burst Mode COMP Voltage	$V_{COMPB2D}$	$V_{AC}=90V \text{ \& } 115V$		1.12		V
		$V_{AC}=230V$		1.47		
Burst Mode COMP Voltage	V_{COMPBM}			1.05		V
Entry Peak-Load COMP Voltage	V_{PKLET}	$V_{AC}=90V$		2.59		V
		$V_{AC}=115V$		2.45		
		$V_{AC}=230V$		2.31		
Exit Peak-Load COMP Voltage	V_{PKLED}	$V_{AC}=90V$		2.34		V
		$V_{AC}=115V$		2.2		
		$V_{AC}=230V$		2.06		
Peak-Load Maximum Frequency Entry Voltage at COMP Pin	V_{PKLFM}	$V_{AC}=90V$		3.22		V
		$V_{AC}=115V$		2.98		
		$V_{AC}=230V$		2.77		
Peak-Load Protection Timer	T_{PT_PKL}			10		S
Over Load Protection Threshold Voltage at COMP Pin	V_{PKL_OL}			3.82		V
Delay Time of Over Load Protection	T_{PKLOL}			8		ms
Soft Start						
Soft-Start Time	T_{SS}			3		ms
Brown-IN & Brown-OUT / BND						
Brown-In Threshold Voltage	V_{BNI_TH}		0.9	0.95	1	V
Brown-Out Threshold Voltage	V_{BNO_TH}		0.73	0.77	0.81	V

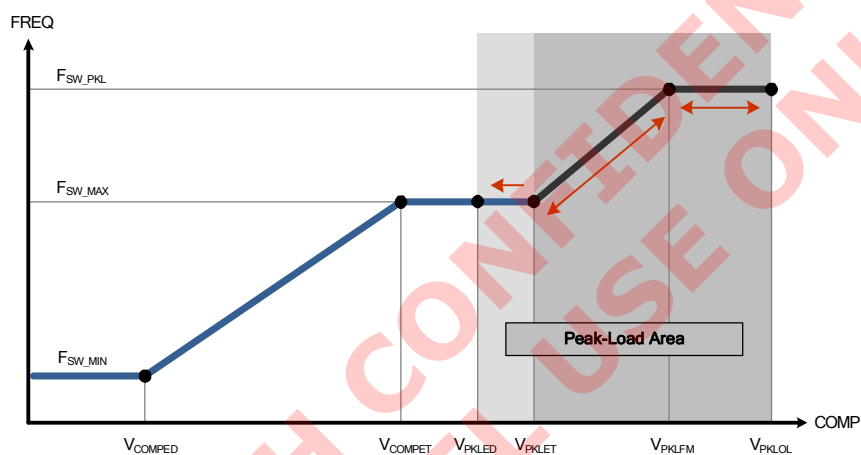
De-bounce Time of V_{BNO_TH}	T_{D_BNO}			66		ms
Mains Over Voltage Protection Threshold at BND Pin	$V_{BND OVP}$		3.15	3.32	3.49	V
De-bounce Time of $V_{BND OVP}$	$T_{D_BND OVP}$			66		ms
PRO						
Protection Threshold Voltage	V_{PRO_TH}		0.99	1.04	1.09	V
Gate Driver Output/ GATE						
Output Voltage at Logic Low	V_{GATE_LOW}	$I_{OUT}=20mA$		0.3	0.32	V
Output Voltage at Logic High	V_{GATE_HIGH}	$I_{OUT}=-20mA$	15.2	16		V
Rise Time	T_R	$C_{OUT}=1nF$		560		ns
Fall Time	T_F	$C_{OUT}=1nF$		40		ns
Over Temperature Protection						
On-Chip Over Temperature Protection	T_{OTP}			140		°C

Note: The specifications of leading edge blanking time and de-bounce time is guaranteed by design.

Peak-Load Operation

In the peak-load mode, the maximum frequency (F_{SW_MAX}) will ramp up to F_{SW_PKL} that makes possible the minimization of the cost by downsizing the flyback transformer, translating to the maximization of the performance-to-cost ratio. The limitation of internal CS voltage (V_{CS_MAX}) will also be lifted up to V_{CS_PKL} to allow for a higher peak-to-nominal current ratio, and the timer for the peak-load protection will get started to avoid unexpected damage by abnormal peak load.

The figure below details the peak-load operation. When the load goes up to the point where the COMP voltage is higher than the peak-load entry threshold (V_{PKLET}), the controller will get into the peak-load mode.

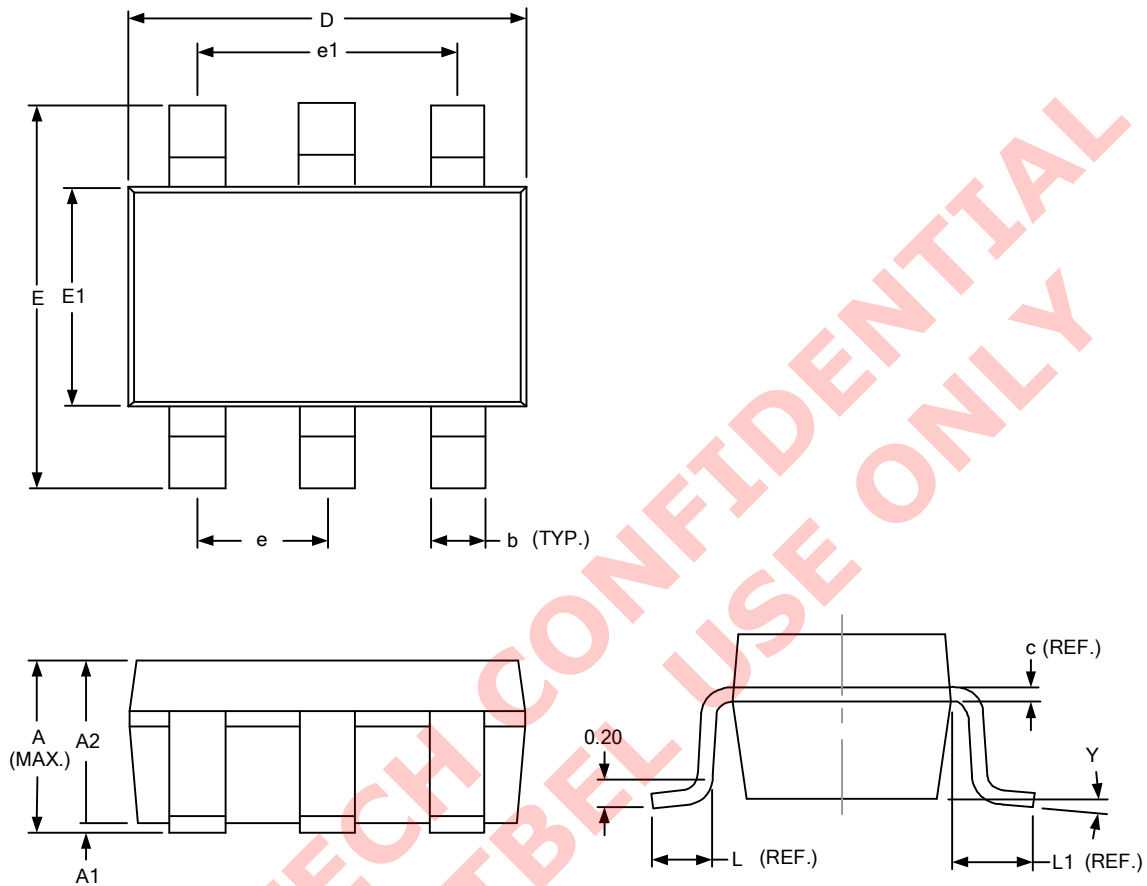


In the peak-load mode, the switching frequency will ramp up to F_{SW_PKL} as a linear function of the COMP voltage, and the protection timer will get started. When time is up, the controller will immediately shut off the flyback converter if the COMP voltage still stays between V_{PKLED} and V_{PKLOL} . Once the COMP voltage falls below V_{PKLED} as a sign of the removal of the peak load, the controller will drop out of the peak-load mode; meanwhile, the maximum frequency and the CS voltage limitation will go back to normal, as well as the protection timer will get reset.

Should an abnormal peak load causing the COMP voltage to exceed V_{PKLOL} , take place by accident, the flyback converter will be shut off immediately to avoid unexpected damage.

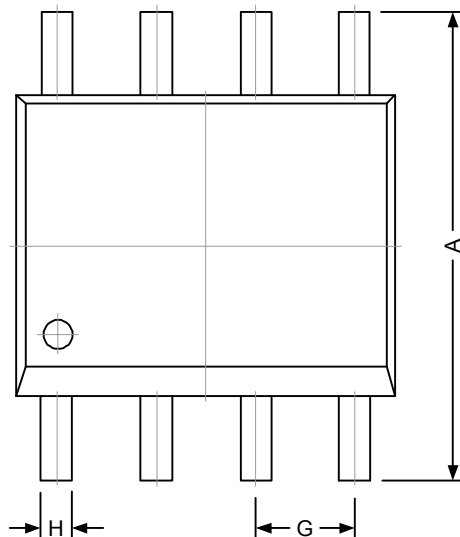
Package Outline

SOT-23-6



DIMENSIONS					
REF.	Millimeter		REF.	Millimeter	
	Min.	Max.		Min.	Max.
A	1.45 MAX.		L	0.37 REF.	
A1	0	0.10	L1	0.60 REF.	
A2	1.10	1.30	Y	0°	10°
c	0.12 REF.		b	0.30	0.50
D	2.70	3.10	e	0.95 REF.	
E	2.60	3.00	e1	1.90 REF.	
E1	1.40	1.80			

SOP-8



REF.	DIMENSIONS	
	Millimeter	
	Min.	Max.
A	5.80	6.20
B	4.80	5.00
C	3.80	4.00
D	0°	8°
E	0.40	0.90
F	0.19	0.25
M	0.10	0.25
H	0.35	0.49
L	1.35	1.75
J	0.375 REF.	
K	45°	
G	1.27 TYP.	

