DIODES
INCORPORATED

Lead-free Green

HIGH-PERFORMANCE GREEN MODE PWM CONTROLLER

Description

The AP3108LS is a Current Mode PWM controller specially designed for offline power supply that requires ultra-low standby power, high-power density and comprehensive protection. The AP3108LS coordinating with Diodes Incorporated's secondary side controller, such as the AP4320, can be applied in the situation that requires for constant CC and constant CV.

The maximum switching frequency of the AP3108LS is set at 65kHz. The switching frequency can be modulated through green mode, in which it will smoothly decrease along with the decreasing load. This will cause the minimum switching frequency to be clamped at about 22kHz to avoid audible noise.

The AP3108LS provides an inner high-voltage start-up function through HV pin which can save the use of the external start-up resistor, reducing the standby loss. The HV pin also realizes X-CAP discharge function. This is a useful function for power saving when an X-CAP is connected to a system, for it will discharge the X-CAP when the AC line voltage is off automatically without the need for extra discharge resistors.

The AP3108LS integrates a VCC LDO circuitry, allowing the LDO to regulate the wide range V_{CC_IN}, which is rectified from auxiliary winding to an acceptable value. This makes the AP3108LS a good choice in wide range output voltage application.
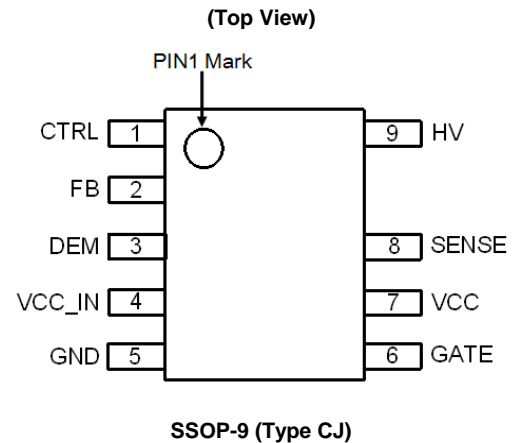
There are also versatile system protections provided by AP3108LS, such as secondary side OVP, secondary side UVP, constant output current limit, cycle-by-cycle current limit, brown-out protection, programmable external OTP, etc.

Features

- Current Mode Control
- High-Voltage Startup
- Embedded VCC LDO to Guarantee Wide Range Output Voltage
- Constant, Low Output Current in Output Short Situation
- Low VCC Charge Current Reduces Standby Power in Output Short Situation
- Non-Audible-Noise Green-Mode Control
- Internal Slope Compensation
- Soft Start During Startup Process
- Frequency Fold Back for High Average Efficiency
- Constant Over Current Protection (COCP)
- VCC Maintain Mode
- X-CAP Discharge Function
- Precise Secondary Side OVP and UVP
- Programmable External OTP
- Brown-Out Protection
- Overload Protection
- FOCP and SSCP Protection
- Useful Pin Fault Protection
- SSOP-9 (Type CJ) is Available
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**
- **For automotive applications requiring specific change control (i.e. parts qualified to AEC-Q100/101/200, PPAP capable, and manufactured in IATF 16949 certified facilities), please contact us or your local Diodes representative. https://www.diodes.com/quality/product-definitions/**

Pin Assignments

(Top View)

PIN1 Mark

CTRL	1	9 HV
FB	2	
DEM	3	8 SENSE
VCC_IN	4	7 VCC
GND	5	6 GATE

SSOP-9 (Type CJ)

Applications

- Switching AC-DC Adapter/Charger
- Open Frame Switching Power Supply

Notes: 1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
 2. See https://www.diodes.com/quality/lead-free/ for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
 3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.
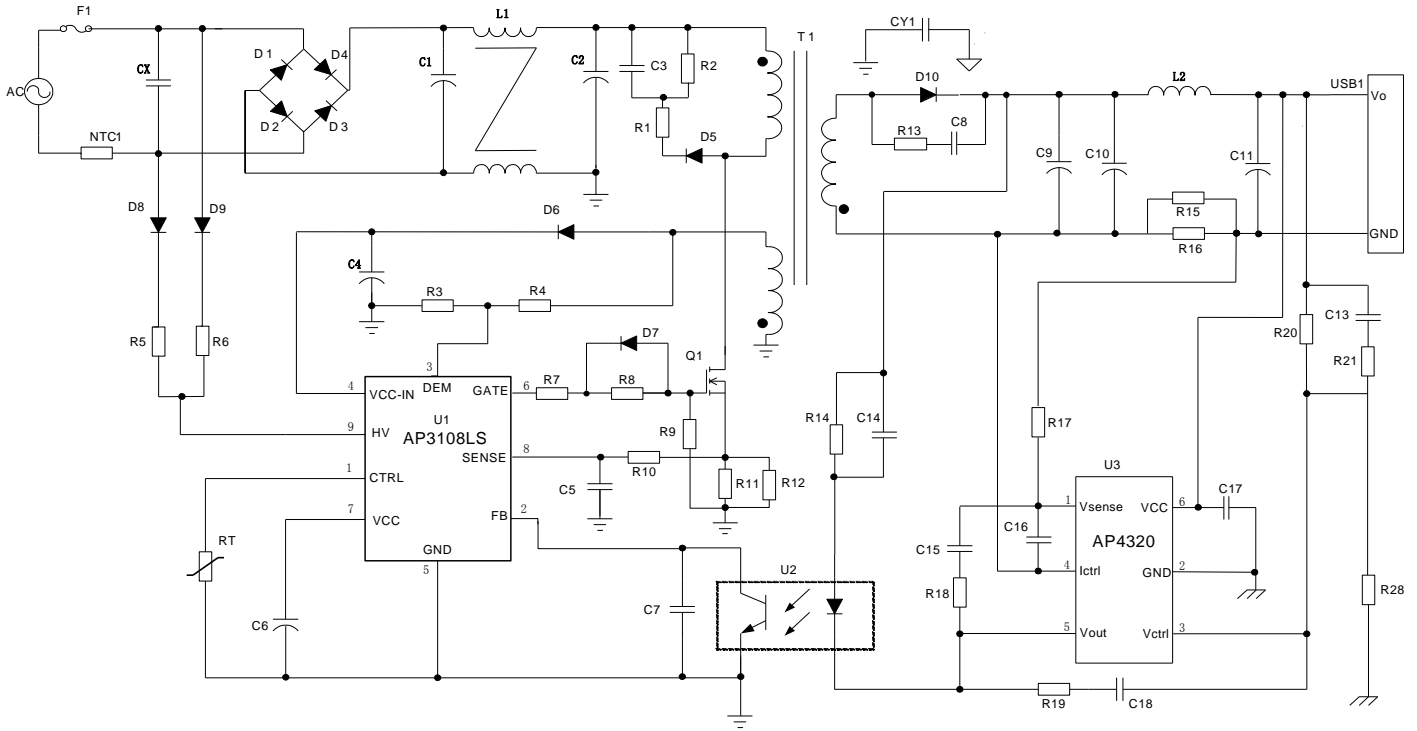
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Typical Applications Circuit

Pin Descriptions

Pin Number	Pin Name	Function
1	CTRL	Programmable external protection
2	FB	Feedback. Directly connected to the opto-coupler
3	DEM	Sample V_{OUT} to realize SOVP and SUVP protection
4	VCC_IN	Wide range input supply voltage to produce V_{CC}
5	GND	Signal ground
6	GATE	Gate driver output
7	VCC	Supply voltage of driver and control circuits
8	SENSE	Sense the primary current
9	HV	High voltage input. Sense line voltage and provide startup current to V_{CC}

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Functional Block Diagram

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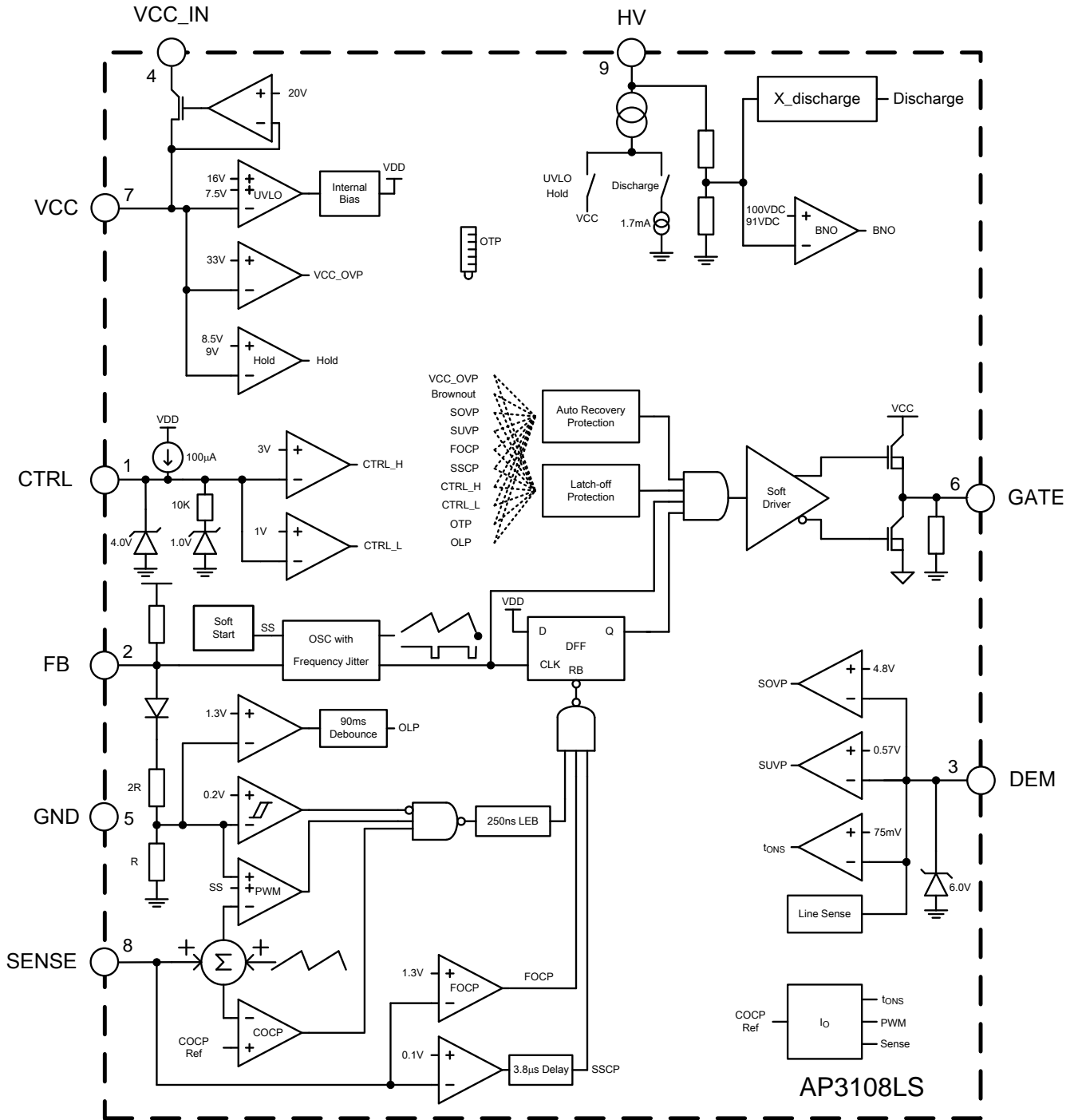
Absolute Maximum Ratings (Note 4)

Symbol	Parameter	Rating	Unit
V_{HV}	HV Pin Input Voltage	700	V
V_{CC_IN}	LDO Supply Voltage	120	V
V_{CC}	Power Supply Voltage	40	V
I_O	Gate Output Current	500	mA
V_{FB}, V_{SENSE}, V_{CTRL}, V_{DEM}	Input Voltage to FB, SENSE, CTRL, DEM	-0.3 to 7	V
θ_{JA}	Thermal Resistance (Junction to Ambient) (Note 5)	150	°C/W
P_D	Power Dissipation at $T_A < +25°C$	550	mW
T_J	Operating Junction Temperature	-40 to +150	°C
T_{STG}	Storage Temperature Range	+150	°C
ESD	Human Body Model (Except HV Pin and VCC_IN Pin (Note 6))	2,000	V
	Charged Device Model	500	V

Notes: 4. Stresses greater than those listed under "*Absolute Maximum Ratings*" can 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 under "*Recommended Operating Conditions*" is not implied. Exposure to "*Absolute Maximum Ratings*" for extended periods can affect device reliability.
5. Test condition: Device mounted on FR-4 substrate PC board, 2oz copper, with 1inch^2 cooling area.
6. HV devices are ESD sensitive (HBM: HV Pin is 1000V, VCC_IN Pin is 350V).

Recommended Operating Conditions

Symbol	Parameter	Min	Max	Unit
V_{CC_IN}	LDO Supply Input Voltage	10	50	V
V_{CC}	Power Supply Voltage	10	28	V
T_{OP}	Operating Temperature Range	-40	+85	°C

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Electrical Characteristics (@T_A = -40°C to +85°C, V_{CC} = 16V, unless otherwise specified.)

Symbol	Parameter	Condition	Min	Typ	Max	Unit
Power Supply Voltage (VCC Pin)						
I_{ST}	Startup Current	—	—	1.5	15	μA
I_{CC}	Operating Supply Current	V_{FB} = 0V, C_L = 1nF	0.35	0.55	0.75	mA
		V_{FB} = 3V, C_L = 0nF	1.2	1.7	2.2	
V_{ST}	Turn-On Threshold Voltage	—	15.3	15.8	16.3	V
V_M	VCC Maintain	—	8.1	8.5	8.9	V
$V_{CC-UVLO}$	VCC UVLO Voltage	—	7	7.5	8	V
V_{CC-OVP}	VCC OVP Threshold Voltage	—	32	33	34	V
HV Section (HV Pin)						
$I_{CHARGE-L}$	Charge Current	V_{CC} = 0V, V_{HV} = 100V	0.1	0.2	0.35	mA
$I_{CHARGE-H}$		V_{CC} = 6V, V_{HV} = 100V	1.5	1.8	2.2	mA
$I_{CHARGE-FAULT}$	Charge Current If Fault Occurs	V_{CC} = 6V, V_{HV} = 100V	50	95	145	μA
V_{BR-IN}	Brown In Voltage	—	95	100	105	V
V_{BR-OUT}	Brown Out Voltage	—	87	91	95	V
t_{BR-IN}	Delay of Brown In (Note 8)	—	—	100	—	μs
t_{BR-OUT}	Delay of Brown Out (Note 8)	—	—	50	—	ms
$I_{DISCH-X}$	X-CAP Discharge Current	—	1.3	1.7	2.1	mA
PWM Section/Oscillator Section						
D_{MAX}	Maximum Duty Cycle	—	70	75	80	%
f_S	Oscillation frequency	—	60	65	70	kHz
$f_{OSC-GREEN}$	Green Mode Frequency	—	18	—	30	kHz
$f_{OSC-JITTER}$	Frequency Dithering	—	±4	±6	±8	%
Current Sense Section (SENSE Pin)						
V_{REF}	Inner Reference For Primary Constant OCP Control	—	2.47	2.5	2.53	V
V_{CS-MAX}	Maximum SENSE Voltage	V_{FB} = 4.5V	0.93	0.95	0.97	V
$t_{DELAY-CS}$	Delay To Output (Note 7)	—	—	100	—	ns
$V_{TH-FOCP}$	FOCP Voltage	—	1.2	1.3	1.4	V
$V_{TH-SSCP}$	SSCP Voltage	—	80	100	120	mV
t_{LEB}	LEB Time Of SENSE	—	200	250	300	ns
Feedback Input Section (FB Pin)						
K_{FB-CS}	The Ratio of FB Input Voltage to Current Sense Voltage	—	2.5	3	3.5	V/V
R_{FB}	Input Impedance	—	15	20	25	kΩ
V_{FB-OCP}	Threshold For Overcurrent Protection (Note 8)	—	—	4.2	—	V

Notes: 7. Cycle-by-Cycle limit delay time contains OCP comparator delay time and driver delay time, Guaranteed by design.
8. Guaranteed by design.

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Electrical Characteristics (@T$_A$ = -40°C to +85°C, V$_{CC}$ = 16V, unless otherwise specified.) (continued)

Symbol	Parameter	Condition	Min	Typ	Max	Unit
t$_{DELAY-OCP}$	Delay of Overcurrent Protection (Note 8)	—	—	90	—	ms
I$_{FB-SOURCE}$	Source Current	V$_{FB}$ = 0V	0.15	0.25	0.35	mA
V$_{TH-GREEN}$	Green Mode Threshold (Note 8)	V$_{DEM}$ > 1.4V	—	2.3	—	V
		V$_{DEM}$ ≤ 1.4V	—	1.9	—	V
V$_{BURST}$	Input Voltage For Zero Duty	—	1	1.2	1.4	V
Output Section (GATE Pin)						
V$_{GATE-L}$	Output Low-Level Voltage	I$_O$ = 20mA, V$_{CC}$ = 12V	—	—	1	V
V$_{GATE-H}$	Output High-Level Voltage	I$_O$ = 20mA, V$_{CC}$ = 12V	8	—	—	V
V$_{GATE-CLP}$	Output Clamping Voltage	—	9	10.5	12.5	V
t$_{GATE-RISE}$	Rising Time (Note 8)	C$_L$ = 1nF, V$_{CC}$ = 13V	—	150	200	ns
t$_{GATE-FALL}$	Falling Time (Note 8)	C$_L$ = 1nF, V$_{CC}$ = 13V	—	50	100	ns
De-magnetization Section (DEM Pin)						
V$_{TH-DEM}$	De-Magnetization Voltage (Note 8)	—	—	75	—	mV
V$_{CLP-L}$	Clamping Voltage	I$_{DEM}$ = -200µA (Source Current)	—	-5	—	mV
V$_{CLP-H}$		I$_{DEM}$ = 1mA (Sink Current)	—	6	—	V
V$_{TH-SOVP}$	SOVP Threshold	—	4.7	4.8	4.9	V
V$_{TH-SUVP}$	SUVP Threshold	—	0.54	0.57	0.60	V
t$_{BLANK-SUVP}$	SUVP Blank Time After Startup	—	20	25	30	ms
t$_{SAMPLE}$	Sample Delay Time (Note 8)	—	—	2	—	µs
LDO Section (VCC_IN Pin/VCC Pin)						
V$_{CC}$	LDO Regulated Voltage (Power Supply Voltage)	VCC open, V$_{CC\_IN}$ = 10V	9	9.8	—	V
		VCC open, V$_{CC\_IN}$ = 40V	18	20	21	V
I$_{LDO}$	Operating Current	V$_{CC}$ = 12V, V$_{CC\_IN}$ = 40V	5	6	7	mA
Protection Section (CTRL Pin)						
I$_{CTRL-SOURCE}$	Source Current	—	-110	-100	-90	µA
V$_{TH-CTRL-L}$	Low Threshold	—	0.96	1	1.04	V
V$_{TH-CTRL-H}$	High Threshold	—	2.85	3	3.15	V
V$_{CTRL-CLP}$	Clamp Voltage (Note 9)	I$_{CTRL}$ = -2mA	4.1	4.4	4.7	V
t$_{DELAY-HICC}$	Delay of Hiccup Protection (Note 8)	SUVP, SOVP, VCC OVP, FOCP, SSCP, CTRL Pin Protection	—	7	—	Cycles
Internal OTP Section						
OTP	OTP Threshold	—	—	+150	—	°C
T$_{HYS}$	OTP Recovery Hysteresis	—	—	+25	—	°C

Notes: 8. Guaranteed by design.
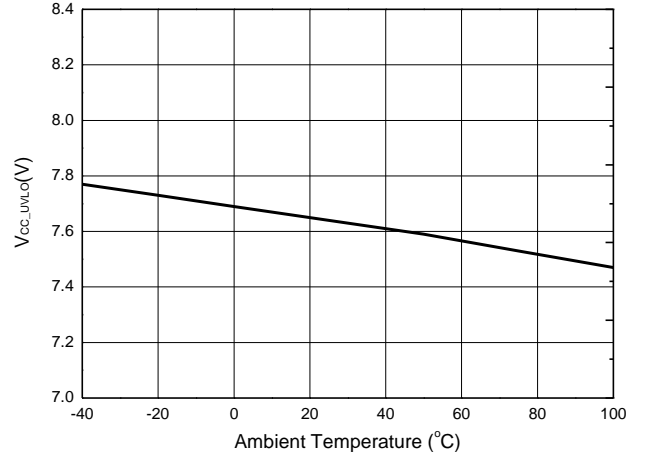9. The sourcing current of CTRL pin must be limited below 5mA. Otherwise it can cause permanent damage to the device.

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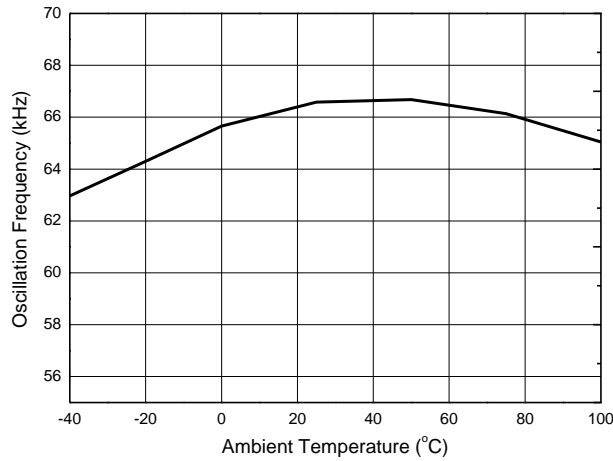## Performance Characteristics
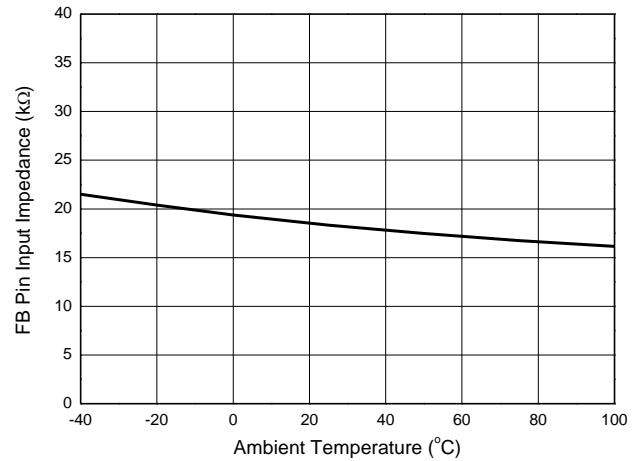
Startup Voltage vs. Ambient Temperature
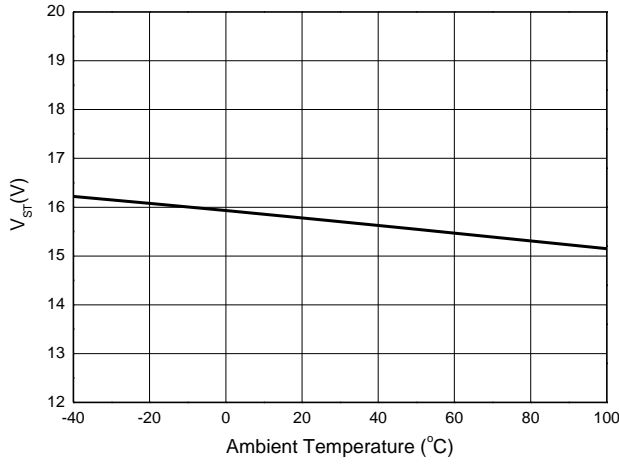
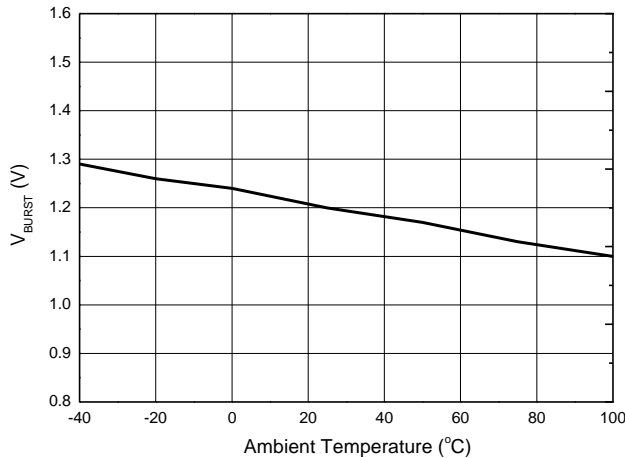### Shutdown Voltage vs. Ambient Temperature

Oscillation Frequency vs. Ambient Temperature

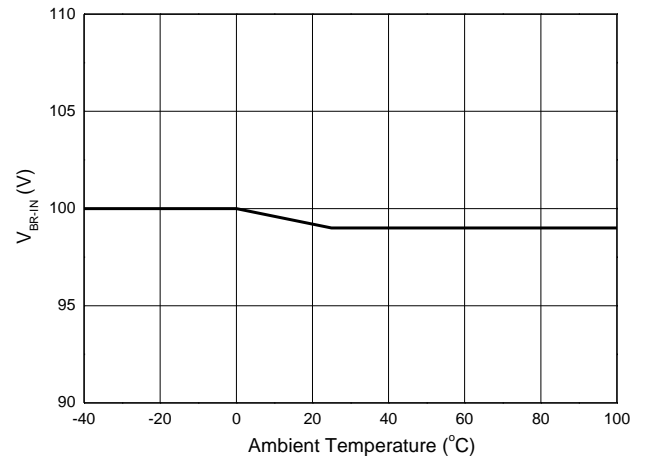### FB Pin Input Impedance vs. Ambient Temperature
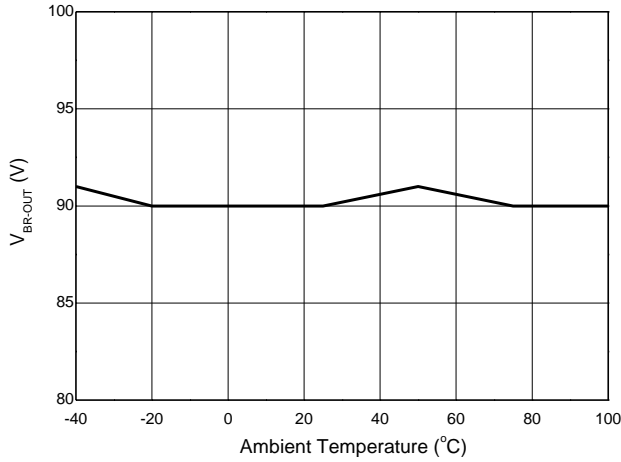

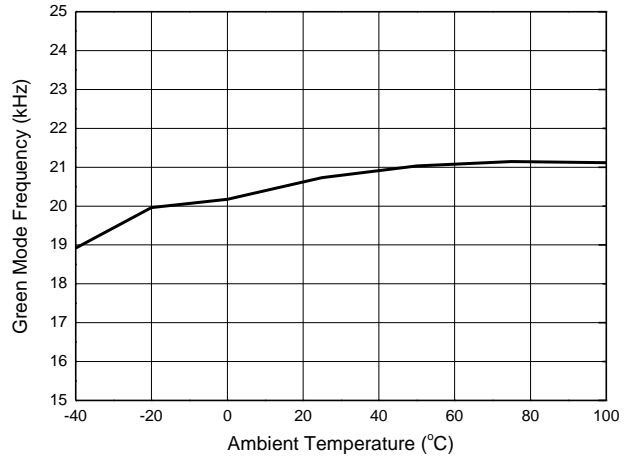### V$_{BURST}$ vs. Ambient Temperature

V$_{BR-IN}$ vs. Ambient Temperature

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Performance Characteristics (continued)

V_{BR-OUT} vs. Ambient Temperature

Green Mode Frequency vs. Ambient Temperature

Operation Description

PWM Operation Principle

Figure 1 describes how the AP3108LS and AP4320 work together to achieve constant voltage (CV), constant current (CC) and primary constant OCP (COCP) control. At secondary side, the sensed output voltage or output current signals are compared with the corresponding reference V_{REF_CV} and V_{REF_CC} in AP4320. The inner CV and CC amplifier combine with an external compensation network to generate an amplified error signal and transfer to the primary side FB pin through the opto-coupler. It's noted that only one amplifier works at one moment between CV and CC amplifier. The scaled FB voltage comparing with the SENSE voltage after slope compensation will turn off primary switch and determine the duty cycle.

Usually, secondary CC and CV provide a good enough static state performance for output voltage and current regulation under all load and line conditions. If any over current conditions occur, primary constant OCP control provides moderate over current limit, under output short condition, this method can restrain the device stress and output current value in a reasonable range. In primary constant OCP control, the product of V_{CSM} sampled from SENSE Pin and $\frac{t_{ONS}}{t}$ sampled from DEM Pin will compare with a primary OCP reference of V_{REF} and get a primary switch duty cycle, which will determine a real-time constant output current, detail information can be found in the following section.
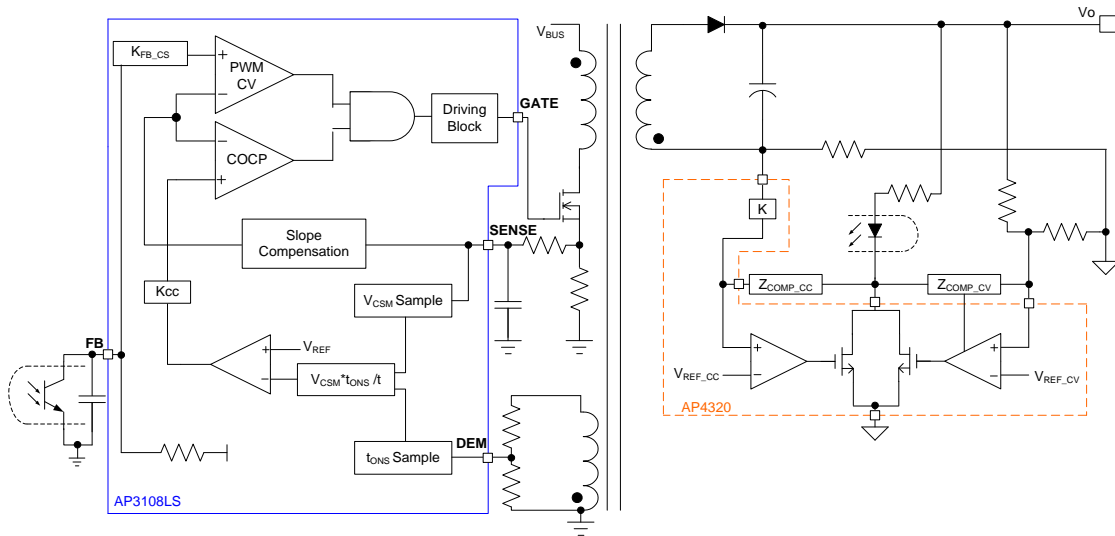

Figure 1

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Operation Description (continued)

Switching Frequency Control Strategy

The AP3108LS works in fixed frequency (65kHz) under heavy load, and decreases the switching frequency to improve the efficiency at light load and middle load through green mode. In green mode, the switching frequency is a function of V_{FB} and the relationship is shown as Figure 2. If the V_{FB} is lower than $V_{TH-GREEN}$-0.2V, the switching frequency is fixed at about 22kHz to avoid audible noise.

Burst mode is a traditional method used to reduce the standby power at no load and extremely light load. In burst mode, the controller will stop outputting switching pulses. As shown in Figure 3, when V_{FB} drops below V_{BURST} because of the light load, the system will enter burst mode and there is no more power transferred to the output, causing output voltage to decrease and V_{FB} to recover to V_{BURST} +110mV. Then, the system will recover and begin outputting switching pulses again, causing the output voltage to rise and V_{FB} to drop again, which will start a new cycle.
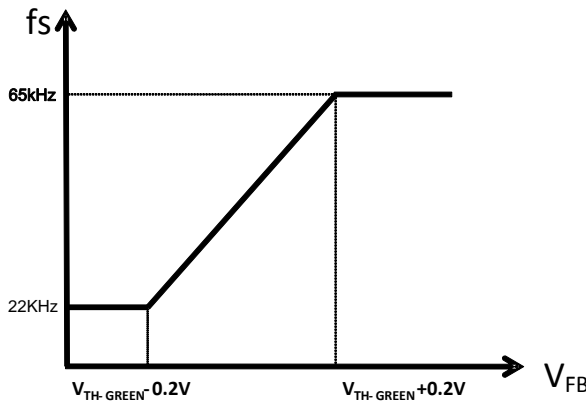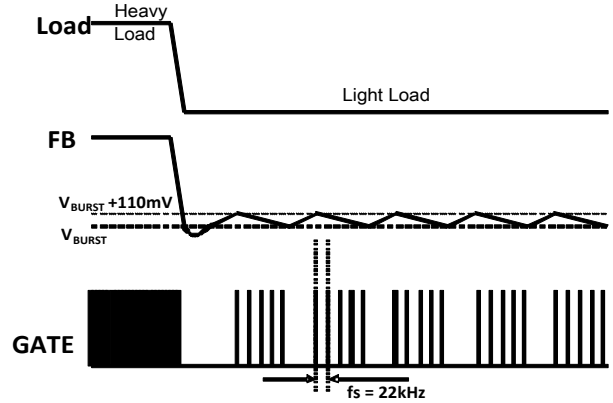

Figure 2

Figure 3

Maximum Output Current Limit (Primary Constant OCP Control)

The traditional primary cycle-by-cycle peak current limit method works well for overload protection situation, but the output short current (peak value) is still too high, which will result in a higher safety risk. In order to reduce output short current (peak value) and keep normal startup performance, the AP3108LS creates a new primary current control method to get a constant output current limit, the method is known as primary constant OCP control. The output current both for CCM and DCM can be both described as:

$$Io = \frac{V_{CSM}}{R_{CS}} * \frac{N_P}{N_S} * \frac{t_{ONS}}{t}$$

Where R_{CS} is the primary current sense resistor, V_{CSM} is the middle voltage of the current sense voltage across R_{CS}, N_P is the primary winding turns, N_S is the secondary winding turns, t_{ONS} is the conduction time of secondary rectifier, t is the switching period of the system. In primary constant OCP control mode, to get a constant output current, the product of V_{CSM} and $\frac{t_{ONS}}{t}$ is kept as a constant value equaling to V_{REF}, so the output current equation can be rearranged as:

$$Io = \frac{V_{REF}}{R_{CS}} * \frac{N_P}{N_S} * K_{CC}$$

Where K_{CC} is 1/8, an inner parameter used to balance the relationship between the current sense voltage and the primary constant OCP control signal. For a specific power design, output current can be set by adjusting the value of R_{CS}. The primary constant OCP control module only monitors the product of V_{CSM} and $\frac{t_{ONS}}{t}$. A peak current limitation of primary side is also set by V_{CS-MAX} to avoid transformer saturation under some transient conditions.

The AP3108LS samples the middle current of the primary side to calculate the output current. The detecting time takes the GATE signal as the reference shown as Figure 4, at the half-on time of the GATE, the AP3108LS will record the V_{CS} value as V_{CSM}. In the actual system, the primary current will be greatly impacted by the turn-off delay time which mainly contains MOSFET charging time, resulting in an error between the detected V_{CSM} and the actual V_{CSM}. The error varies depending on line voltage, generally increasing with the line voltage. To get a precise V_{CSM} and keep the output current constant when primary constant OCP module active, the AP3108LS adopts a line compensation technology and the control block is illustrated in Figure 5. The current flowing through R1 when the primary MOSFET is on reflects the line voltage. Scale down the current and multiply it with R_C and R_F, then a compensation signal is formed. The external resistor R1 can be used to adjust the compensation according to different delay time. The calculating formula is:

$$R1 = \frac{2 * L_P}{t_D} * \frac{N_A}{N_P} * \frac{(R_C + R_F)}{R_{CS}} * \frac{1}{m}$$

Where L_P is the inductance of the transformer, t_D is the turn-off delay time, N_A is the auxiliary winding turns, N_P is the primary winding turns, R_C is the inner compensation resistor which is 2.1kΩ, R_F is the filter resistor of SENSE pin, R_{CS} is the primary-current sense resistor, m is the inner proportional parameter which is 21.

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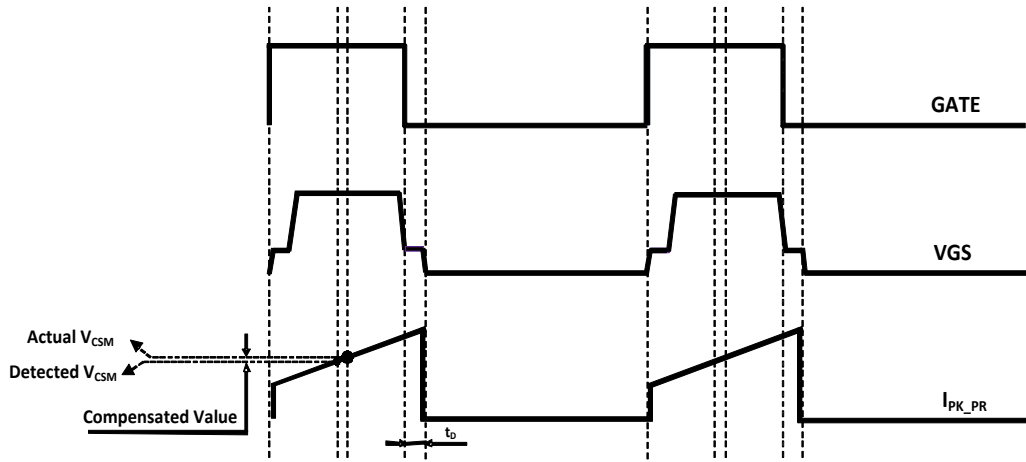
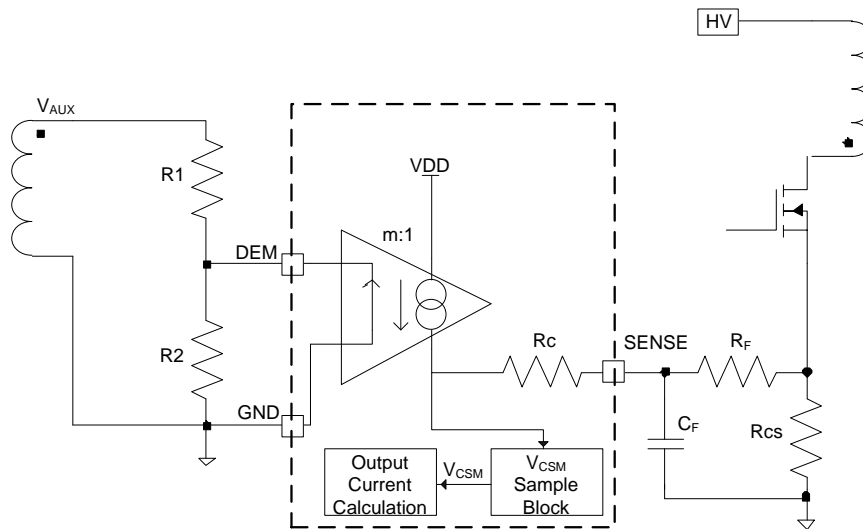## Operation Description (continued)

Figure 4

Figure 5

HV Start-Up Circuit

A built-in HV Start-Up circuit in AP3108LS can help to simplify the power system design for ultra low standby application. For AP3108LS, there are two HV Start-Up charging current: the $I_{CHARGE-L}$ when V_{CC} is lower than 6V and the $I_{CHARGE-H}$ when the V_{CC} voltage rises above 6V, which can prevent the IC from overheat when V_{CC} short-to-GND fault happens. The HV Start-Up circuit will stop working and has no additional power dissipation when V_{CC} voltage reaches the V_{ST}, at which the AP3108LS starts working and will supply energy to V_{CC} from auxiliary winding.

However, the charging process described above is only for the normal system startup condition. Once some system faults occur and the protection process is triggered, AP3108LS will shut down and V_{CC} voltage will begin to decrease. The HV Start-Up circuit starts working again when V_{CC} voltage decreases below $V_{CC-UVLO}$, and charges the V_{CC} capacitor with current of $I_{CHARGE-FAULT}$. This special design can reduce hugely the input power dissipation when system fault happens, especially for output short condition. The HV Start-Up circuit working process is illustrated in Figure 6.

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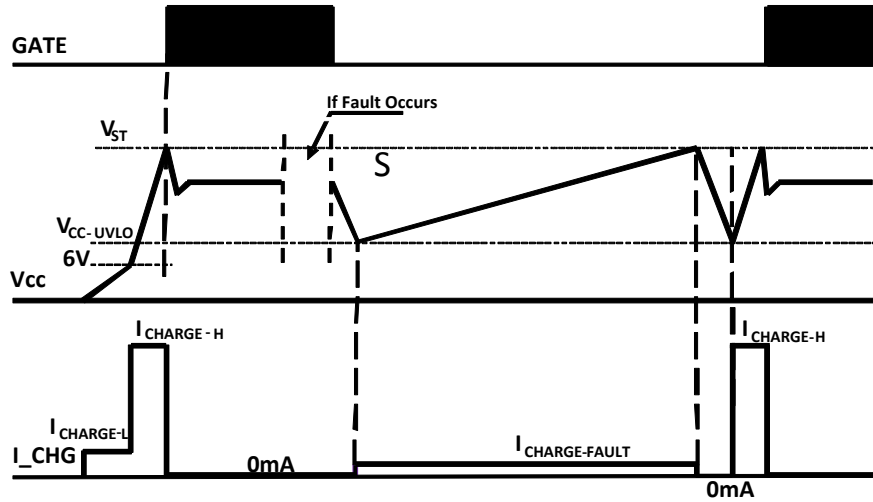
Operation Description (continued)

Figure 6

X-CAP Discharge Function

For the higher power application, to attenuate the differential mode noise, an X-CAP is usually used before the rectifier bridge, and there are paralleled resistors to discharge the X-CAP for safety consideration when the AC line is off. The paralleled resistors have large power dissipation and will increase the standby power. The AP3108LS integrates an X-CAP discharge function to replace discharge resistors and decreases the standby power.

This function contains two processes; the first process detects the condition of the AC line through HV pin, this detected voltage is named as V_b. When the system is plugged in, an inner timer of 40ms within the AP3108LS begins to work, meanwhile, a phase-drifted and filtered signal V_c is generated based on V_b, compare V_b with V_c as shown in Figure 7.

Whenever signal V_c crosses over with signal V_b, the inner 40ms timer will be reset which represents the AC line is on. If the system is disconnected from AC line, the cross-over signal of V_c and V_b will disappear and the 40ms timer will continue to count until it reaches 40ms, at this moment, the second process, discharge process, will come into effect and a 1.7mA discharge current will flow through HV pin to GND lasting for 40ms. After the AC line is off, the first process and the second process will act alternately until the HV Pin voltage is discharged below 10V even when the V_{CC} voltage is lower than $V_{CC-UVLO}$.
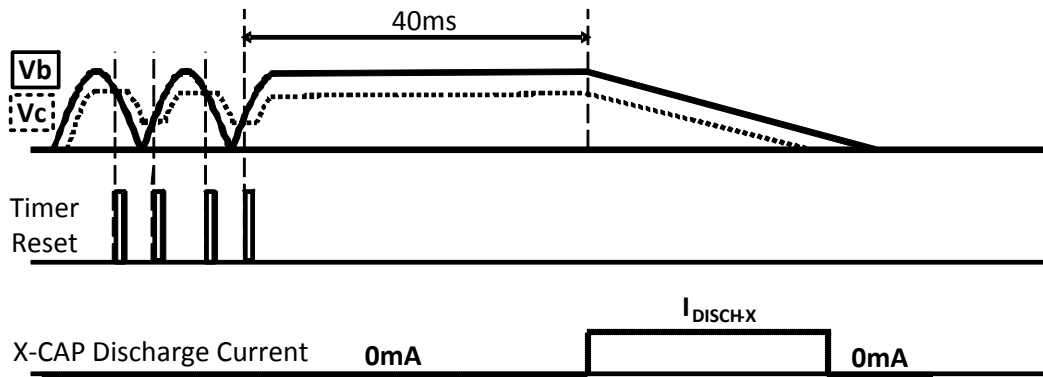

Figure 7

Built-In Slope Compensation

It is well known that a continuous current mode SMPS may become unstable when the duty cycle exceeds 50%. The built-in slope compensation in the AP3108LS can keep the system stable.

Built-In V_{CC} LDO

The AP3108LS integrates a V_{CC} LDO circuitry, the LDO regulates the wide range V_{CC_IN} which is rectified from auxiliary winding to an acceptable value. It makes the AP3108LS a good choice in wide range output voltage application.

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Operation Description (continued)

Brown In/Out Protection

To avoid potential high-current stress at low line voltage, the AP3108LS introduces a reliable brownout protection. The AC line voltage is detected through HV pin. A pair of high-voltage diodes are connected to the AC line which will rectify the AC input voltage to a double-frequency positive voltage referring to GND, a ~20kΩ resistor is recommended to be added to improve the surge immunity. When the voltage across HV pin is higher than V_{BR-IN} for about 100µs of t_{BR-IN} and V_{CC} reaches V_{ST}, the GATE pin will output drive signals and the system starts to work. If the HV pin voltage falls below V_{BR-OUT} and lasts for 50ms of t_{BR-OUT}, the GATE pin will turn off and the system will shut down until the line voltage rises over its brown-in voltage again.

SOVP/SUVP Protection

The AP3108LS provides output OVP and UVP protection function. The auxiliary winding voltage during secondary rectifier conducting period reflects the output voltage. A voltage divide network is connected to the auxiliary winding and DEM pin, the DEM pin will detect the equivalent output voltage with a delay of t_{SAMPLE} from the falling edge of GATE driver signal, as shown in Figure 8. The detected voltage will be compared to the SOVP and SUVP threshold voltage $V_{TH-SOVP}$ and $V_{TH-SUVP}$. If the SOVP or SUVP threshold is reached continuously by 7 switching cycles, the SOVP or SUVP protection will be triggered, the AP3108LS will shut down and the system will restart when the V_{CC} voltage falls below the UVLO voltage.

To prevent from false-trigger of SUVP during start up process, a blank time of $t_{BLANK-SUVP}$ is set during which the SUVP protection function is ignored.

Externally Triggered Protection

The AP3108LS reserves flexible protection mode for power design. The CTRL pin can achieve external programmable protection. A high threshold of $V_{TH-CTRL-H}$ is set for any over voltage protection, the CTRL pin voltage will be sampled with a delay of t_{SAMPLE} from the falling edge of GATE and compared to $V_{TH-CTRL-H}$, if the sampled voltage is higher than the threshold for 7 switching cycles, the CTRL-High protection will be triggered. A low threshold of $V_{TH-CTRL-L}$ is usually used for external over temperature protection. To realize the external OTP, a proper value NTC should be connected from the CTRL pin to the ground. An inner current of 100µA flows through the NTC from the CTRL pin. The voltage of the CTRL pin changes along with the resistance of NTC. The AP3108LS will detect the voltage of CTRL pin ahead of the falling edge of GATE with about 100ns. If the detected voltage is lower than the VTH-CTRL-L for 32ms duration at least, the CTRL-Low protection will be triggered. Whenever the protection is triggered, the system will stop the output drive signal and will restart after the V_{CC} voltage falling below the UVLO voltage. The CTRL-High and CTRL-Low protection sample time is illustrated as Figure 8.
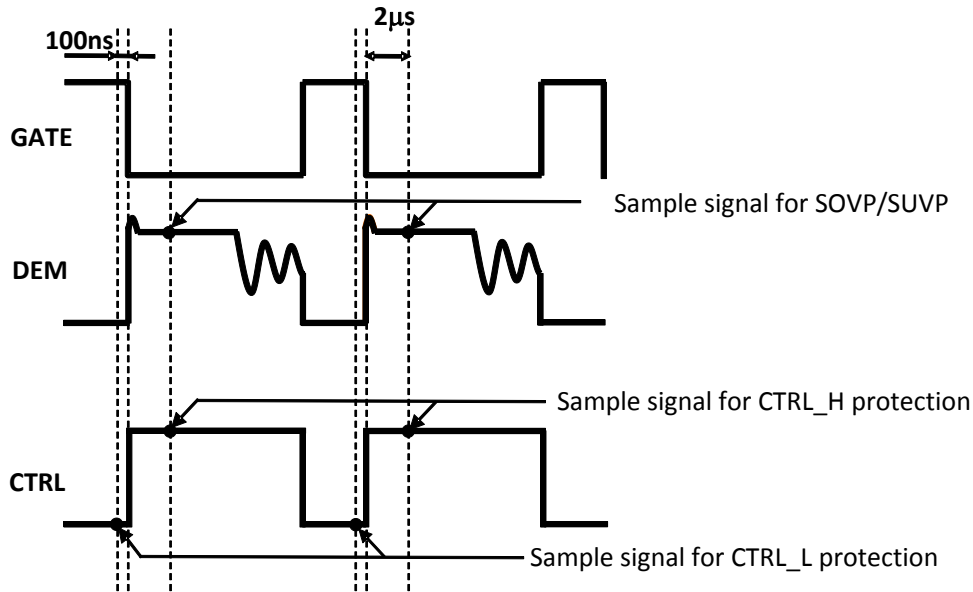

Figure 8

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Operation Description (continued)

System Protection
FOCP, SSCP, VCC OVP, OTP

The AP3108LS provides versatile protection to ensure the reliability of the power system. FOCP protection is an ultra-fast short-current protection which is helpful to avoid catastrophic damage of the system when the secondary rectifier is short. The primary peak current will be monitored by SENSE pin through a primary sense resistor, whenever the sampled voltage reaches the threshold of $V_{TH-FOCP}$ for 7 switching cycles continuously, the FOCP protection will be active to shut down the switching pulse. SSCP might be triggered at ultra-low line voltage condition or other failure condition that short the SENSE pin to ground. The SSCP module senses the voltage across the primary sense resistor with a delay of 4μs after the rising edge of primary GATE signal, this sensed signal is compared with $V_{TH-SSCP}$. If it is lower than $V_{TH-SSCP}$ for 7 switching cycles, the SSCP protection will be triggered and the drive signal will be disabled. All these protections described above will restart the system when the V_{CC} voltage falls below UVLO. Although the external OTP can be easily implemented through CTRL pin, the AP3108LS still reserves the inner OTP with a hysteresis for any necessary use.

V_{CC} Maintain Mode

During light-load or transient-load condition, V_{FB} will drop and be lower than 1.2V, thus the PWM drive signal will be stopped, and there is no more new energy transferring to the output. Therefore, the IC supply voltage may reduce to the UVLO threshold voltage and system may enter the unexpected restart mode. To avoid this, the AP3108LS holds a so-called V_{CC} maintain mode which can supply energy to V_{CC}.

When V_{CC} decreases to a setting threshold as V_M, the V_{CC} maintain mode will be awaked and a charging current of $I_{CHARGE-H}$ will flow to the VCC pin. With V_{CC} maintain mode, the V_{CC} is not easy to touch the shutdown threshold during the startup process and transient load condition. This will also simplify the system design. The minimum V_{CC} voltage is suggested to be designed a little higher than V_{CC} maintain threshold thus can achieve the best balance between the power loss and step load performance.

Leading-Edge Blanking Time

A narrow spike on the leading edge of the current waveform can usually be observed when the power MOSFET is turned on. A 250ns leading-edge blank is built-in to prevent the false-trigger caused by the turn-on spike. During this period, the current limit comparator and the PWM comparator are disabled and the gate driver cannot be switched off.

At the time of turning-off the MOSFET, a negative undershoot (maybe larger than -0.3V) can occur on the SENSE pin. So it is strongly recommended to add a small RC filter or at least connect a resistor "R" on this pin to protect the IC (Shown as Figure 9).
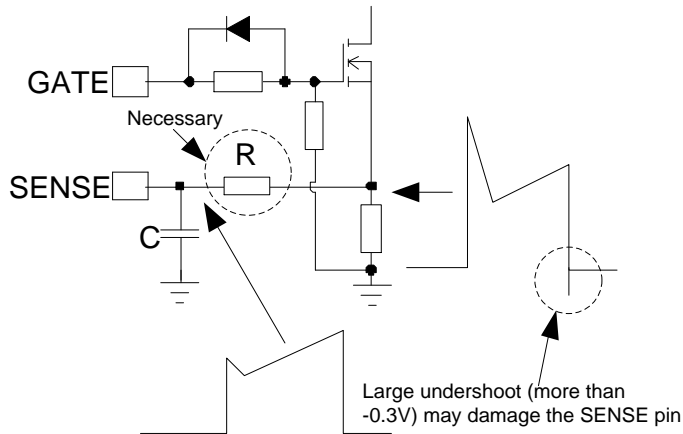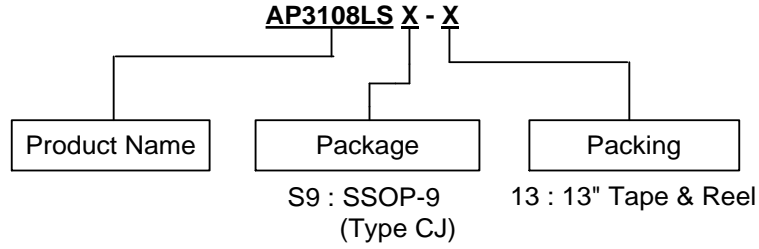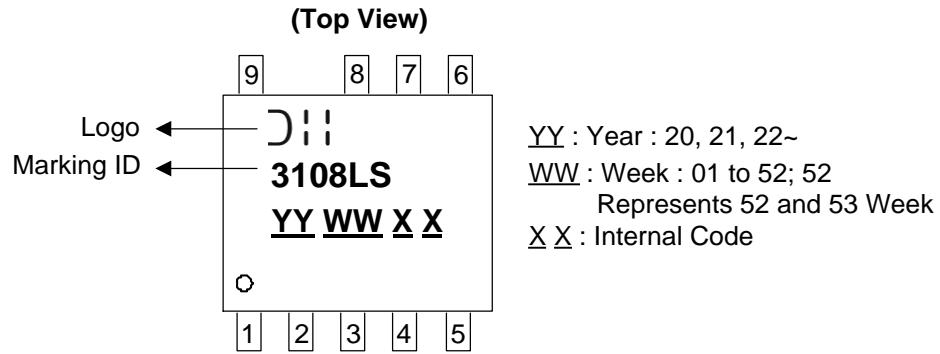

Figure 9

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Ordering Information

AP3108LS X - X

| Product Name | Package | Packing |

S9 : SSOP-9
(Type CJ)   13 : 13" Tape & Reel

Package	Temperature Range	Part Number	Marking ID	Packing
SSOP-9 (Type CJ)	-40°C to +85°C	AP3108LSS9-13	3108LS	4,000/Tape & Reel

Marking Information

(Top View)

Logo
Marking ID

3108LS
YY WW X X

YY : Year : 20, 21, 22~
WW : Week : 01 to 52; 52
Represents 52 and 53 Week
X X : Internal Code

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Package Outline Dimensions

Please see http://www.diodes.com/package-outlines.html for the latest version.

(1)   Package Type: SSOP-9 (Type CJ)
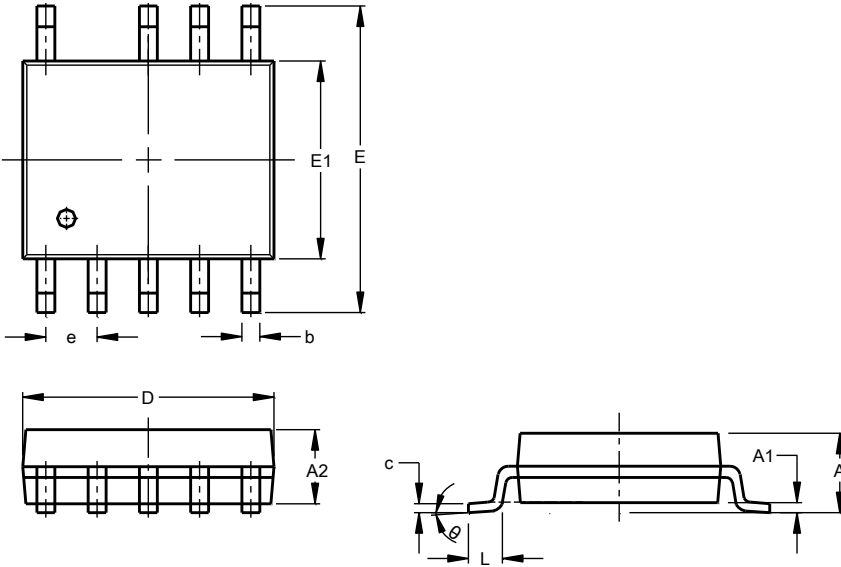
SSOP-9 (Type CJ)			
Dim	Min	Max	Typ
A	1.35	1.75	--
A1	0.10	0.25	--
A2	1.350	1.550	--
b	0.270	0.430	--
c	0.170	0.258	--
D	4.70	5.10	--
E	5.80	6.20	--
E1	3.80	4.00	--
e	--	--	1.00
L	0.40	1.27	--
θ	0°	8°	--
All Dimensions in mm			

Suggested Pad Layout

Please see http://www.diodes.com/package-outlines.html for the latest version.

(1)   Package Type: SSOP-9 (Type CJ)
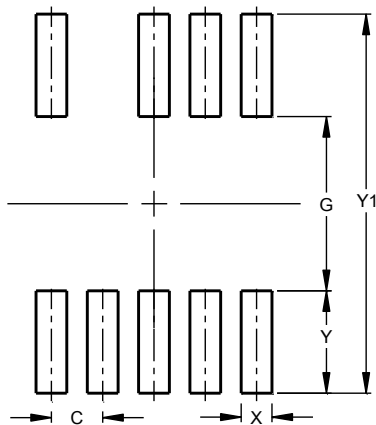
Dimensions	Value (in mm)
C	1.00
G	3.40
X	0.60
Y	2.00
Y1	7.40

Mechanical Data

- Moisture Sensitivity: MSL Level 1 per J-STD-020
- Terminals: Finish – Matte Tin Plated Leads, Solderable per JESD22-B102 ⓔ③
- Weight: 0.08 grams (Approximate)

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