

Description

The AP3108L 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 AP3108L coordinating with Diodes' 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 AP3108L 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 AP3108L 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 AP3108L 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 AP3108L a good choice in wide range output voltage application.

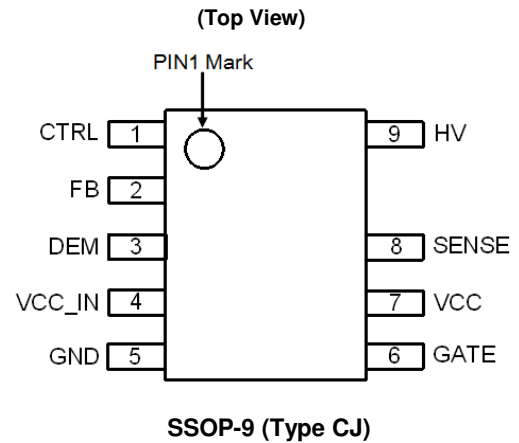
There are also versatile system protections provided by AP3108L, such as secondary side OVP, secondary side UVP, constant output current limit, cycle-by-cycle current limit, brown-out protection, programmable external OTP, etc.

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)**

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.

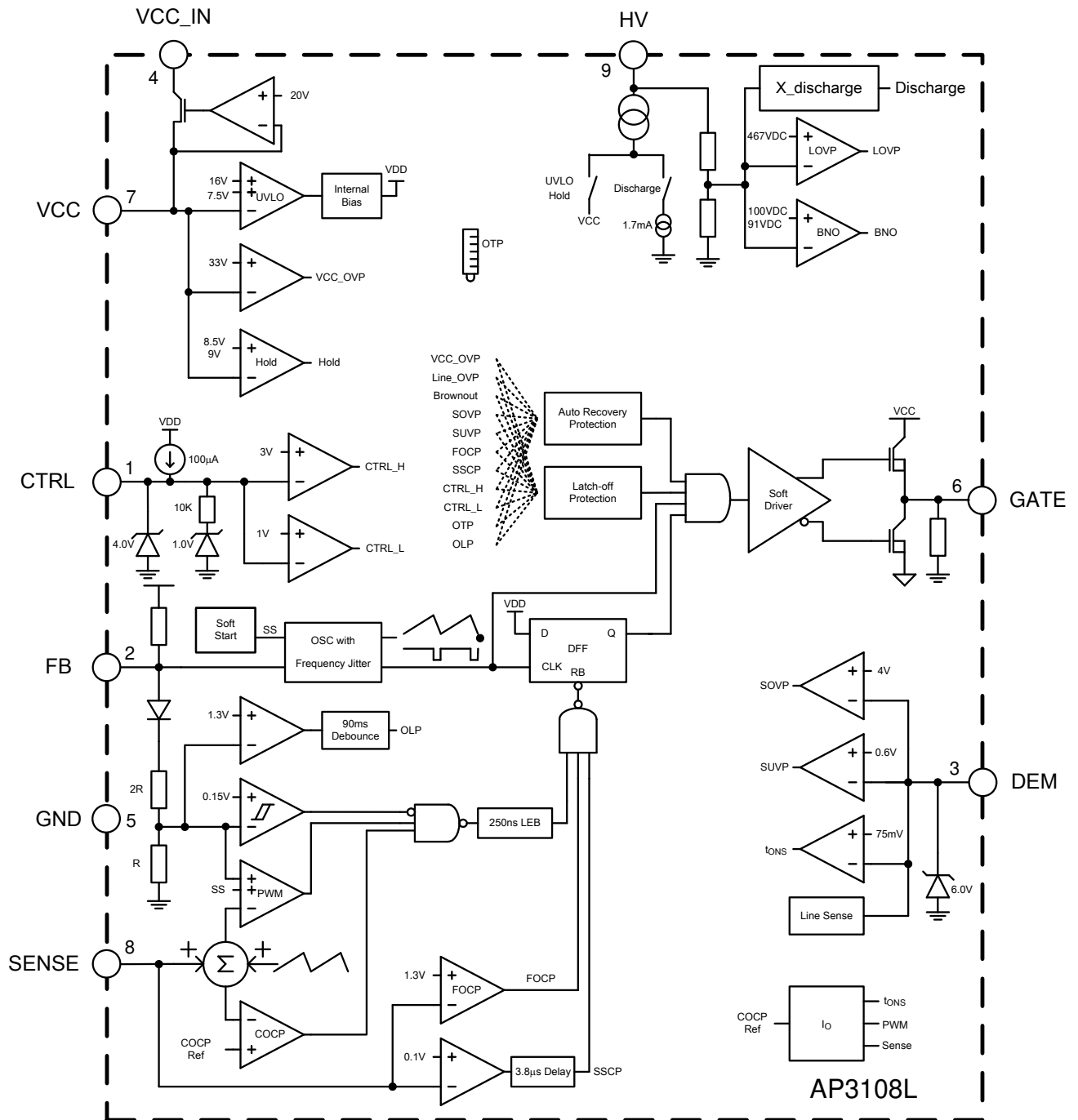
Pin Assignments



Applications

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

Functional Block Diagram



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) | 165 | °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 V _{CC_IN} Pin (Note 5)) | 2,000 | V |
| | Machine Model (Except HV Pin and V _{CC_IN} Pin (Note 5)) | 200 | V |

Note 4: Stresses greater than those listed under "Absolute Maximum Ratings" may 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 may affect device reliability.

Note 5: ESD sensitive pins with HV device.

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 |

Electrical Characteristics (@T_A = -40 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 | 75 | 100 | 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 |
| V _{LOVP} | Line OVP (Note 8) | – | – | 467 | – | V |
| 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 6) | – | – | 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 |

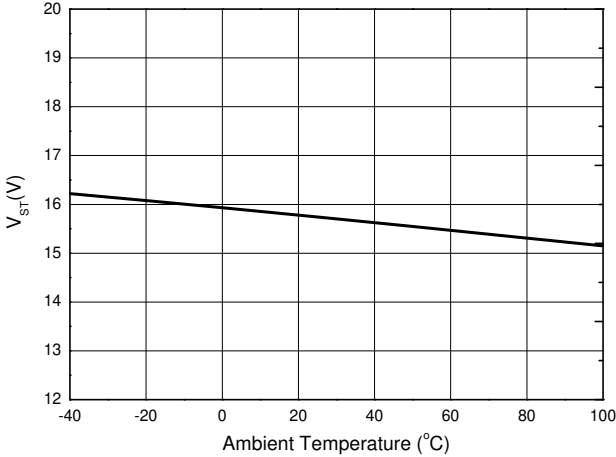
Electrical Characteristics (@T_A = -40 to +85°C, V_{CC} = 16V, unless otherwise specified.) (Cont.)

| 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) | – | – | 2.3 | – | 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 | V |
| t _{GATE-RISE} | Rising Time (Note 6) | C _L = 1nF, V _{CC} = 13V | – | 150 | 200 | ns |
| t _{GATE-FALL} | Falling Time (Note 6) | 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 | – | 3.9 | 4 | 4.1 | V |
| V _{TH-SUVP} | SUVP Threshold | – | 0.58 | 0.6 | 0.62 | 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) | V _{CC} open, V _{CC_IN} = 10V | 9 | 9.8 | – | V |
| | | V _{CC} open, V _{CC_IN} = 40V | 19 | 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 7) | I _{CTRL} = -2mA | 4.1 | 4.4 | 4.7 | V |
| t _{DELAY-HICC} | Delay of Hiccup Protection (Note 8) | SUVP, SOVP, Line OVP, VCC OVP,FOCP,SSCP, CTRL Pin Protection | – | 7 | – | Cycles |
| Internal OTP Section | | | | | | |
| OTP | OTP Threshold | – | – | +150 | – | °C |
| T _{HYS} | OTP Recovery Hysteresis | – | – | +25 | – | °C |

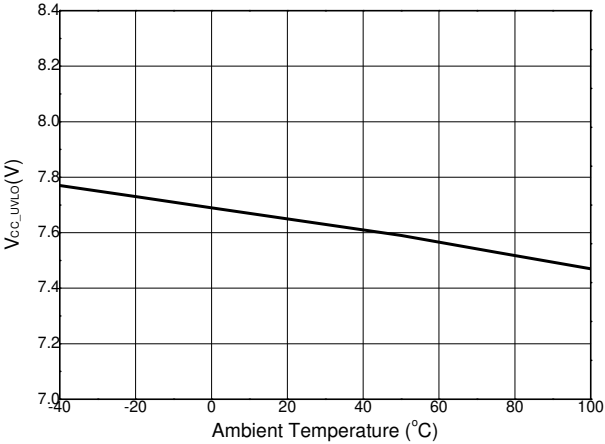
- Notes:
6. Cycle-by-Cycle limit delay time contains OCP comparator delay time and driver delay time, Guaranteed by design.
 7. The sourcing current of CTRL pin must be limited below 5mA. Otherwise it may cause permanent damage to the device.
 8. Guaranteed by design.

Performance Characteristics

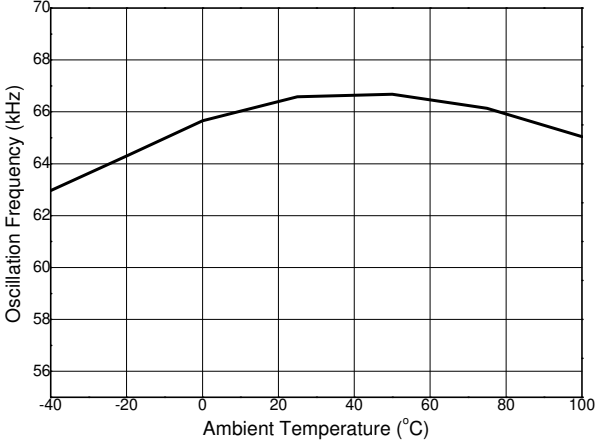
Startup Voltage vs. Ambient Temperature



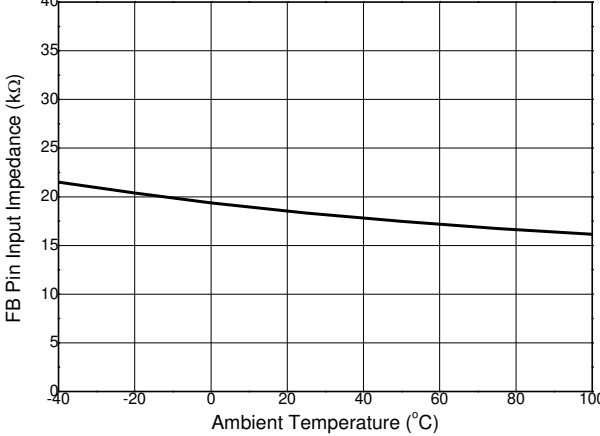
Shutdown Voltage vs. Ambient Temperature



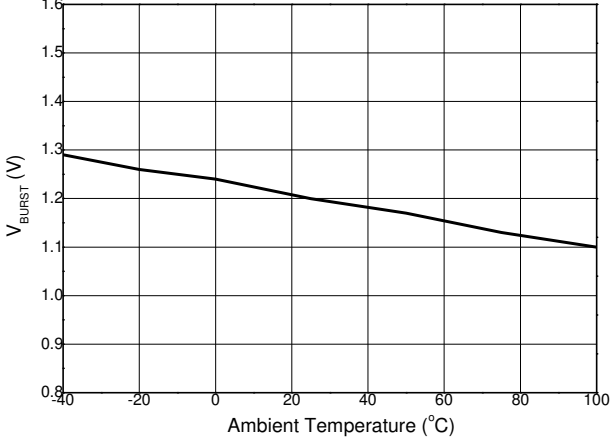
Oscillation frequency vs. Ambient Temperature



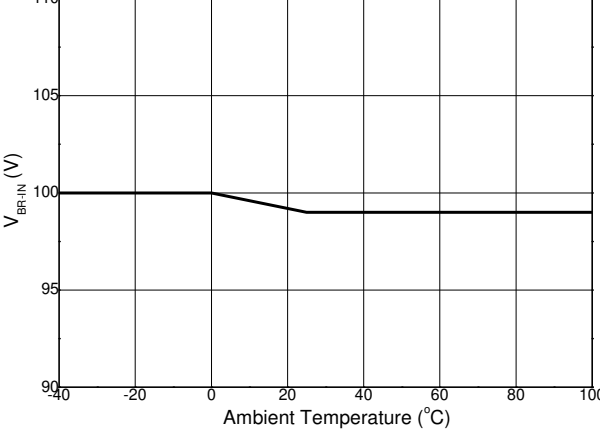
FB Pin Input Impedance vs. Ambient Temperature



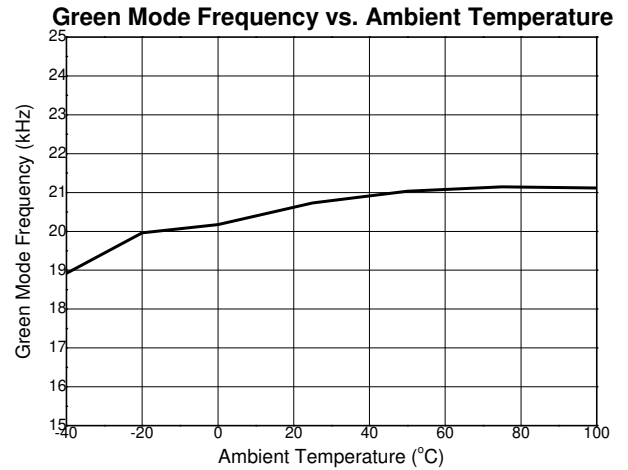
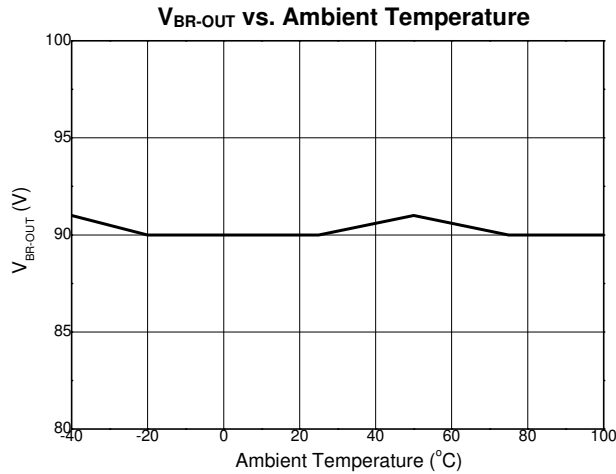
V_{BURST} vs. Ambient Temperature



V_{BR-IN} vs. Ambient Temperature



Performance Characteristics (Cont.)



Operation Description

PWM Operation Principle

Figure 1 describes how the AP3108L 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.

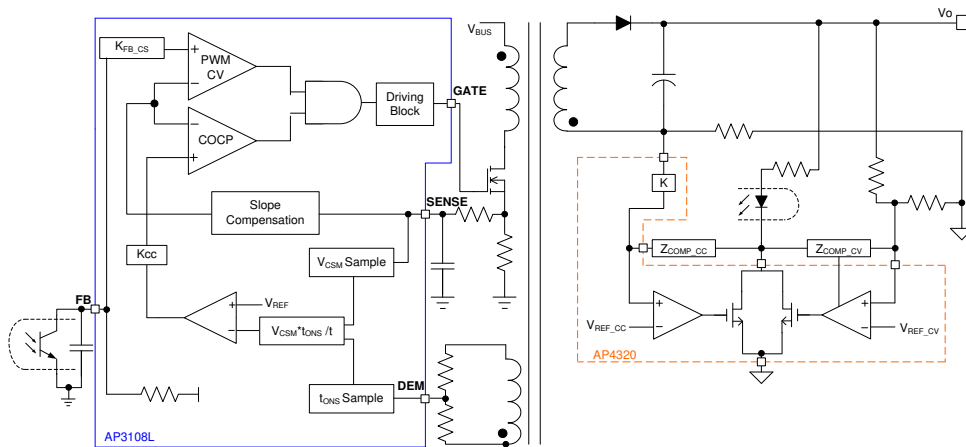


Figure 1

Operation Description (Cont.)

Switching Frequency Control Strategy

The AP3108L 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.

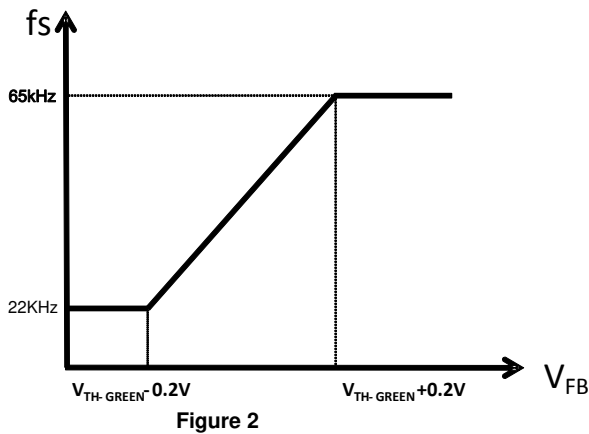


Figure 2

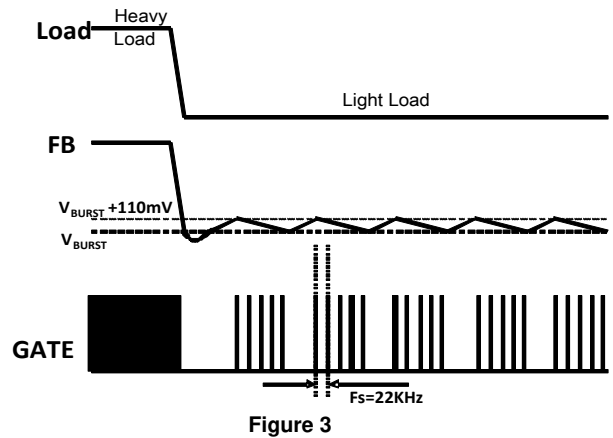


Figure 3

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 AP3108L 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:

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

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:

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

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 AP3108L 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 AP3108L 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 activates, the AP3108L adopts a line compensation technology and the control block is illustrated in Figure 5. The current flowing through R_1 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 R_1 can be used to adjust the compensation according to different delay time. The calculating formula is:

$$R_1 = \frac{2 * L_P}{t_D} * \frac{N_A}{N_P} * \frac{(R_C + R_F)}{R_{CS}} * \frac{1}{m}$$

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 2.1k Ω , 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.

Operation Description (Cont.)

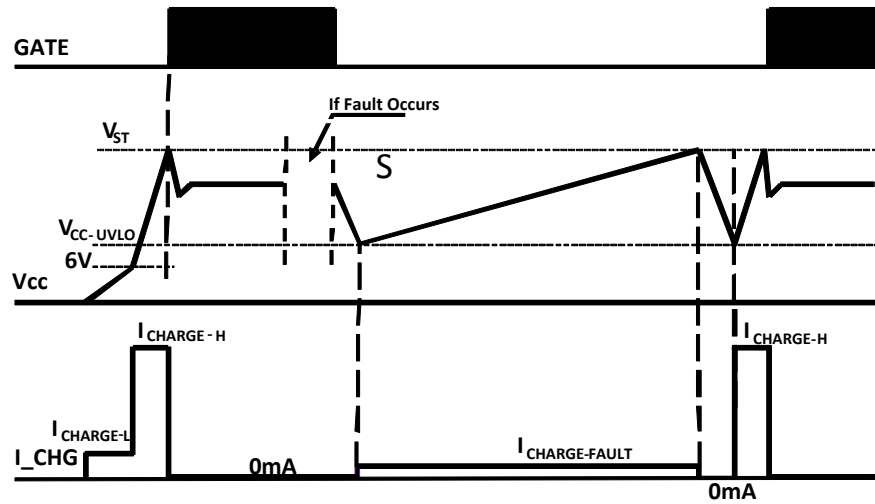


Figure 6

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 AP3108L 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 AP3108L 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}.

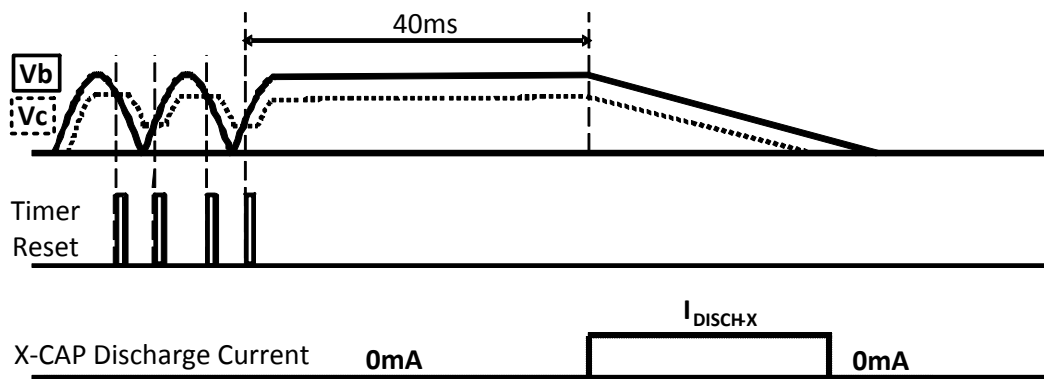


Figure 7

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 AP3108L can keep the system stable.

Built-In V_{CC} LDO

The AP3108L 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 AP3108L a good choice in wide range output voltage application.

Operation Description (Cont.)

Brown In/Out Protection

To avoid potential high-current stress at low line voltage, the AP3108L 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 AP3108L 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 AP3108L 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 AP3108L 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. During the primary switch turning-on period, 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 AP3108L 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 $V_{TH-CTRL-L}$ 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.

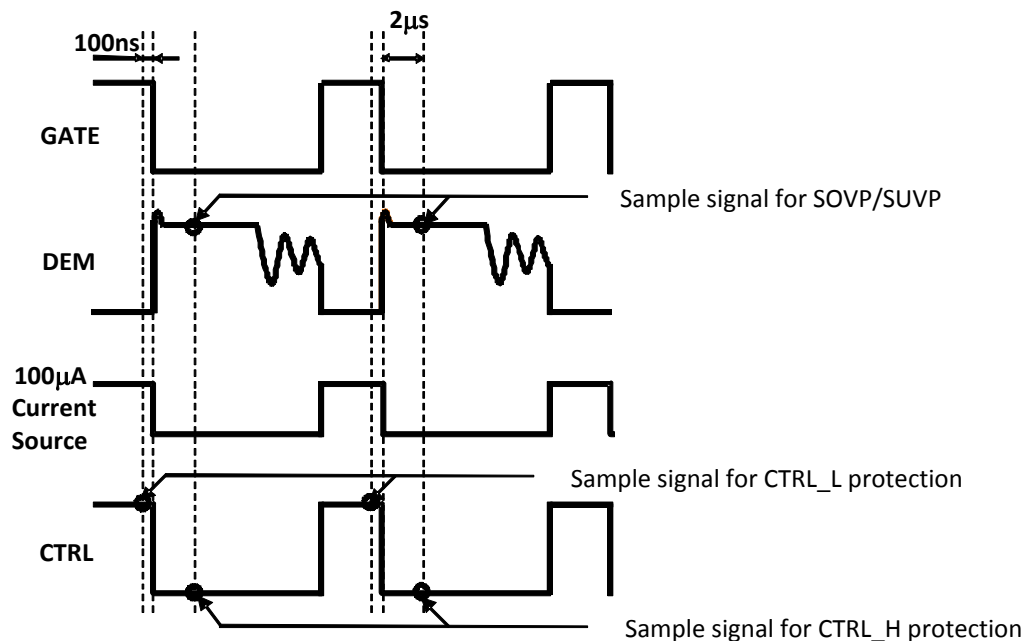


Figure 8

Operation Description (Cont.)

System Protection

LOVP, FOCV, SSCP, VCC OVP, OTP

The AP3108L provides versatile protection to ensure the reliability of the power system. LOVP achieves line voltage overvoltage protection, if the detected AC line voltage is higher than V_{LOVP} for 7 switching cycles, the LOVP protection will be triggered. FOCV 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 $V_{TH-FOCV}$ for 7 switching cycles continuously, the FOCV 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 $4\mu s$ 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 AP3108L still reserves the inner OTP with a hysteresis for any necessary use.

VCC 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 AP3108L 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 V_{CC} 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).

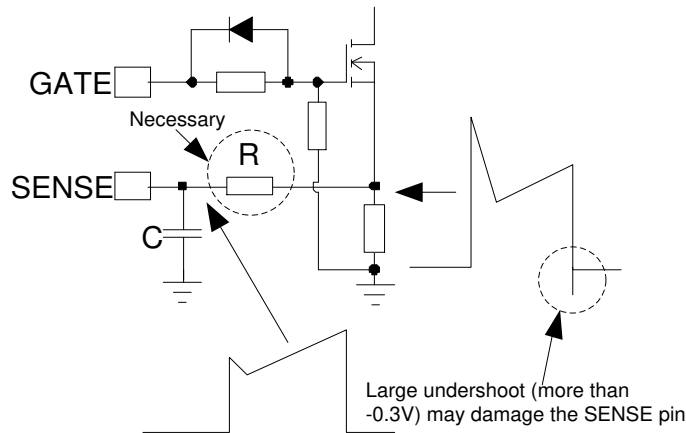
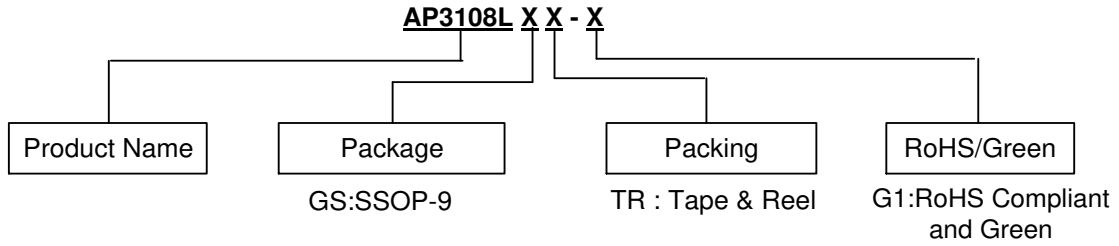


Figure 9

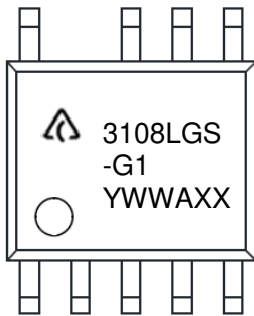
Ordering Information



| Package | Temperature Range | Part Number | Marking ID | Packing |
|------------------|-------------------|----------------|------------|-------------------|
| SSOP-9 (Type CJ) | -40°C to +85°C | AP3108LGSTR-G1 | 3108LGS-G1 | 4,000/Tape & Reel |

Marking Information

(Top View)

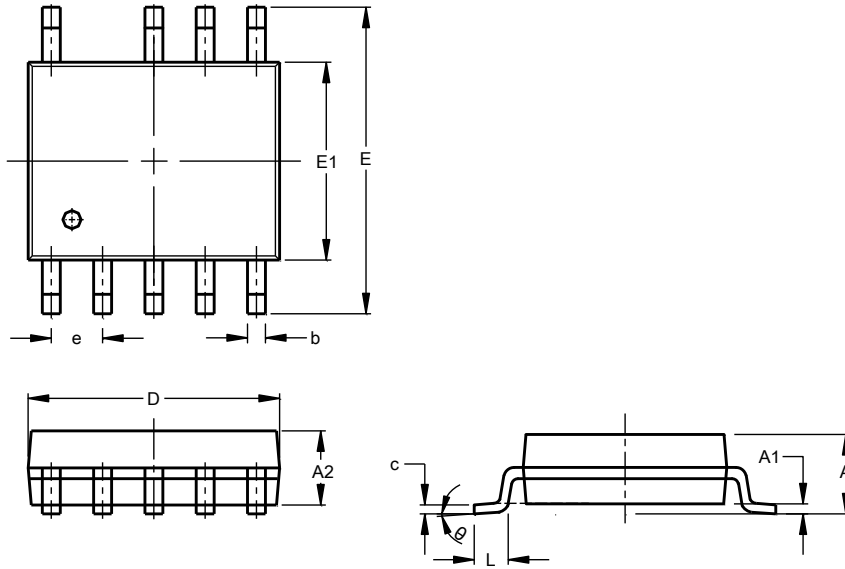


First and Second Lines: Logo and Marking ID
 Third Line: Date Code
 Y: Year
 WW: Work Week of Molding
 A: Assembly House Code
 XX: 7th and 8th Digits of Batch No.

Package Outline Dimensions (All dimensions in mm.)

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

(1) Package Type: SSOP-9 (Type CJ)

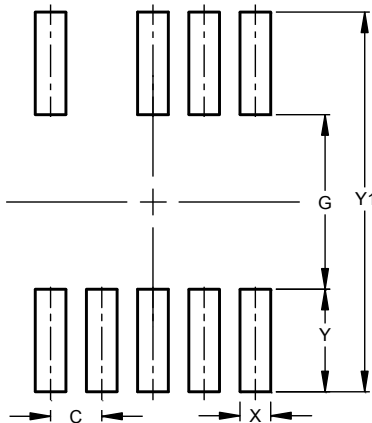


| SSOP-9 (Type CJ) | | | |
|----------------------|-------|-------|------|
| Dim | Min | Max | Typ |
| A | 1.35 | 1.75 | -- |
| A1 | 0.10 | 0.25 | -- |
| A2 | 1.350 | 1.550 | -- |
| b | 0.270 | 0.430 | -- |
| c | 0.170 | 0.258 | -- |
| D | 4.70 | 5.10 | -- |
| E | 5.80 | 6.20 | -- |
| E1 | 3.80 | 4.00 | -- |
| 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 |

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