

**SECONDARY SIDE SYNCHRONOUS RECTIFICATION SWITCHER**

NEW PRODUCT

**Description**

The APR34709 is a secondary side Combo IC, which combines an N-Channel MOSFET and a driver circuit designed for Synchronous Rectification (SR), supports DCM and Quasi-Resonant Flyback Topologies.

The N-Channel MOSFET is optimized for low gate charge, low  $R_{DS(ON)}$ , fast switching speed and body diode reverse recovery performance.

The synchronous rectification can effectively reduce the secondary side rectifier power dissipation and provide high performance solution. By sensing MOSFET drain-to-source voltage, the APR34709 can output ideal drive signal with less external components.

It can provide high performance solution for 3.3V to 15V output voltage application.

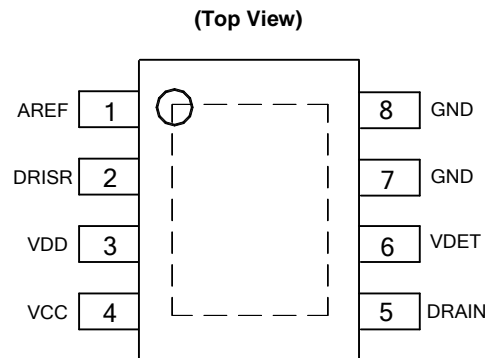
The APR34709 is available in SO-8EP package.

**Features**

- Synchronous Rectification for DCM Operation Flyback
- Eliminate Resonant Ring Interference
- Fast Detector of Supply Voltages
- Fewest External Components
- **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**



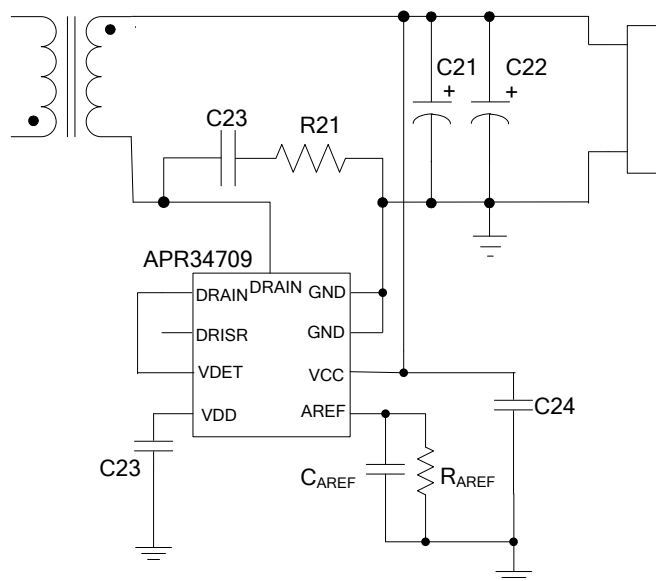
Note: The DRAIN pin of internal MOSFET is exposed PAD, which is at the bottom of IC (the dashed box). The secondary current should flow from GND (pins 7 and 8) to this exposed PAD.

SO-8EP

**Applications**

- Adapters/Chargers for Cell/Cordless Phones, ADSL Modems, MP3 and Other Portable Apparatus
- Standby and Auxiliary Power Supplies

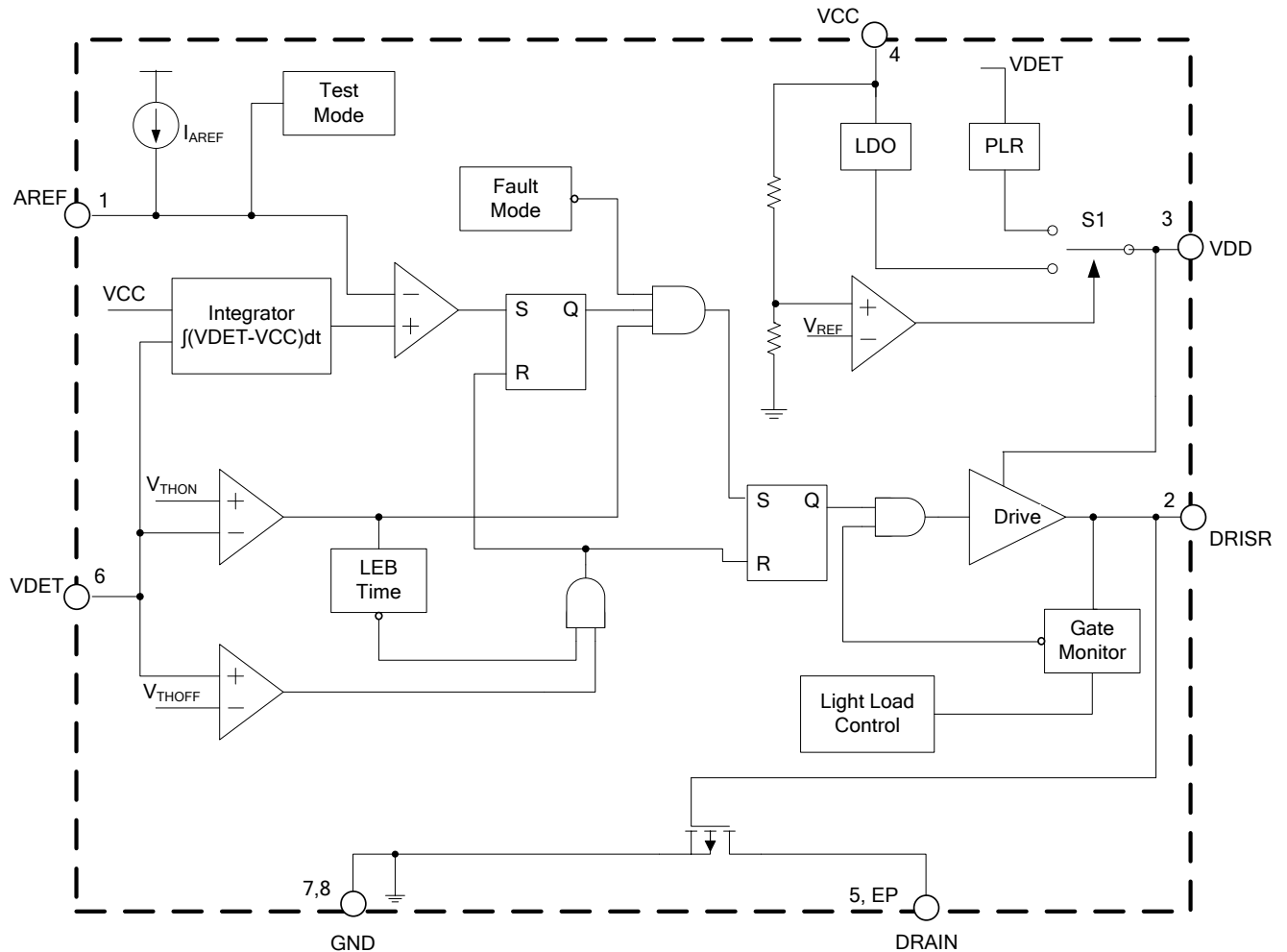
**Typical Applications Circuit**



**Pin Descriptions**

Pin Number	Pin Name	Function
1	AREF	Program a voltage reference with a resistor from AREF to GND, to enable synchronous rectification MOSFET drive signal.
2	DRISR	Synchronous rectification MOSFET drive.
3	VDD	Internal power supply. It provides bias voltage for the internal logic circuit and the MOSFET driver. Connect this pin to a capacitor.
4	VCC	Power supply, connected with system output. Input of internal LDO and system output voltage sensing circuit.
5	DRAIN	Drain pin of internal MOSFET. The drain voltage signal can obtain from this pin.
6	VDET	Synchronous rectification sense input and dynamic function output, connected to DRAIN through a resistor.
7, 8	GND	Source pin of internal MOSFET, connected to Ground.
Exposed PAD	DRAIN	Drain pin of internal MOSFET. The secondary current should flow from GND (pins 7 and 8) to this DRAIN pad.

**Functional Block Diagram**



**Absolute Maximum Ratings** (Note 4)

Symbol	Parameter	Value	Unit
V <sub>CC</sub>	Supply Voltage	-0.3 to 28	V
V <sub>DET</sub> , V <sub>DRAIN</sub>	Voltage at VDET, DRAIN Pins ( Note 5)	-2 to 60	V
V <sub>AREF</sub> , V <sub>DRISR</sub>	Voltage at AREF, DRISR Pins	-0.3 to 7	V
I <sub>D</sub>	Continuous Drain Current	20	A
I <sub>DM</sub>	Pulsed Drain Current	80	A
P <sub>D</sub>	Power Dissipation at T <sub>A</sub> = +25°C	2.2	W
θ <sub>JA</sub>	Thermal Resistance (Junction to Ambient) (Note 6)	54	°C/W
θ <sub>JC</sub>	Thermal Resistance (Junction to Case) (Note 6)	11	°C/W
T <sub>J</sub>	Operating Junction Temperature	+150	°C
T <sub>STG</sub>	Storage Temperature	-65 to +150	°C
T <sub>LEAD</sub>	Lead Temperature (Soldering, 10s)	+300	°C

- Notes:
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.
  5. VDET pin ESD sensitive.
  6. Test condition: Device mounted on FR-4 substrate PC board, 2oz copper, with 1inch<sup>2</sup> cooling area.

**Recommended Operating Conditions**

Symbol	Parameter	Min	Max	Unit
V <sub>CC</sub>	Supply Voltage	3.3	16	V
T <sub>A</sub>	Ambient Temperature	-40	+85	°C

**Electrical Characteristics** (@ $T_A = +25^\circ\text{C}$ ,  $V_{CC} = 5\text{V}$ , unless otherwise specified.)

Symbol	Parameter	Condition	Min	Typ	Max	Unit
<b>Supply Voltage ( VCC Pin )</b>						
$I_{STARTUP}$	Startup Current	$V_{CC} = V_{STARTUP} - 0.1\text{V}$	—	150	—	$\mu\text{A}$
$I_{OP}$	Operating Current	VDET Pin Floating $V_{CC} = 5\text{V}$	—	150	—	$\mu\text{A}$
$V_{STARTUP}$	Startup Voltage	—	—	2.4	—	V
$V_{UVLO}$	UVLO Voltage	—	—	2.2	—	V
$V_{DD\_ENABLE}$	VDD Enable Falling Threshold at VCC Pin	—	—	4.6	—	V
$V_{DD\_DISABLE}$	VDD Disable Rising Threshold at VCC Pin	—	—	4.75	—	V
$V_{DD\_HYS}$	VDD Disable Hysteresis at VIN Pin	—	—	150	—	mV
<b>VDD Pin</b>						
$V_{DD\_MAX}$	Internal Power Supply	—	—	5.5	—	V
<b>Gate Driver</b>						
$V_{THON}$	Gate Turn On Threshold	—	0	—	1	V
$V_{THOFF}$	Gate Turn Off Threshold	—	—	—	0	mV
$t_{DON}$	Turn On Delay Time	From $V_{THON}$ to $V_{DRISR} = 1\text{V}$	—	70	180	ns
$t_{DOFF}$	Turn Off Propagation Delay Time	From $V_{THOFF}$ to $V_{DRISR} = 4\text{V}$	—	100	150	ns
$t_{RG}$	Turn On Rising Time	From 1V to 4V, $V_{CC} = 5\text{V}$ , $C_L = 4.7\text{nF}$	—	50	100	ns
$t_{FG}$	Turn Off Falling Time	From 4V to 1V, $V_{CC} = 5\text{V}$ , $C_L = 4.7\text{nF}$	—	20	100	ns
$t_{ON\_MIN}$	Minimum On Time	—	1.2	1.6	2	$\mu\text{s}$
$t_{OFF\_MIN}$	Minimum Off Time	—	—	2	—	$\mu\text{s}$
$V_{DRISR}$	SR Drive Voltage	$V_{CC} < 4.6\text{V}$	—	—	$V_{DD} - 0.1$	V
		$4.75\text{V} < V_{CC} < 5.5\text{V}$	—	—	$V_{CC} - 0.1$	
		$V_{CC} > 5.5\text{V}$	—	—	$V_{DD\_MAX} - 0.1$	
$K_{QS}$	(Note 7)	—	—	0.42	—	$\text{mA} \cdot \mu\text{s}$
$V_{S\_MIN}$	Synchronous Rectification (SR) Minimum Operating Voltage (Note 8)	—	—	—	4.5	V
<b>Green Mode (Note 9)</b>						
$t_{LL}$	Minimum Off Time to Enter Green Mode	—	—	600	—	$\mu\text{s}$

Notes: 7. This item is used to specify the value of  $R_{AREF}$ .  
8. This item specifies the minimum SR operating voltage of  $V_{IN\_DC}$ ,  $V_{IN\_DC} \geq N_{PS} \cdot V_{S\_MIN}$ .  
9. The parameter is guaranteed by design and characterization.

## Electrical Characteristics (@T<sub>A</sub> = +25°C, unless otherwise specified.) (continued)

### MOSFET Static Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V <sub>DSS(BR)</sub>	Drain to Source Breakdown Voltage	V <sub>GS</sub> = 0V, I <sub>D</sub> = 0.25mA	60	—	—	V
V <sub>GS(TH)</sub>	Gate Threshold Voltage	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 0.25mA	0.7	1.3	2	V
I <sub>DSS</sub>	Zero Gate Voltage Drain Current	V <sub>DS</sub> = 60V, V <sub>GS</sub> = 0V	—	—	1	μA
I <sub>GSS</sub>	Gate to Source Leakage Current	V <sub>GS</sub> = 4.5V, V <sub>DS</sub> = 0V	—	—	±50	μA
R <sub>DS(ON)</sub>	Drain to Source On-state Resistance	V <sub>GS</sub> = 4.5V, I <sub>D</sub> = 3A	—	8	—	mΩ

### MOSFET Dynamic Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
C <sub>iss</sub>	Input Capacitance	V <sub>GS</sub> = 0V, V <sub>DS</sub> = 25V, f = 1MHz	—	1872	—	pF
C <sub>oss</sub>	Output Capacitance		—	506	—	
C <sub>rss</sub>	Reverse Transfer Capacitance		—	43	—	
Q <sub>gs</sub>	Gate to Source Charge	V <sub>GS</sub> = 0V to 10V, V <sub>DD</sub> = 25V, I <sub>D</sub> = 15A	—	3.1	—	nC
Q <sub>gd</sub>	Gate to Drain Charge (Miller Charge)		—	4.8	—	
Q <sub>g</sub>	Total Gate Charge	V <sub>GS</sub> = 4.5V	—	15	—	
R <sub>g</sub>	Gate Resistance	—	—	1.8	—	Ω

## Synchronous Rectification Principle Description

### SR MOSFET Turn on

The APR34709 determines the synchronous rectification MOSFET turning on time by monitoring the MOSFET drain-to-source voltage. When the drain voltage is lower than the turn-on threshold voltage  $V_{THON}$ , the IC outputs a positive drive voltage after a turn-on delay time ( $t_{DON}$ ). The MOSFET will turn on and the current will transfer from the body diode into the MOSFET's channel. Since of parasitic parameter, the voltage on MOSFET drain pin has moderate voltage ringing at this moment, which maybe impact on the  $V_{DET}$  voltage and resulting in the turning-off fault. To avoid fault situation happening, a Minimum On-Time ( $t_{ONMIN}$ ) blanking period is used to maintain the power MOSFET on for a minimum amount of time.

In Figure 1, the turn on blanking time  $t_{ONMIN}$  is to prevent the MOSFET drain-to-source voltage ringing affect.

### Turn off Operation

The DCM operation of the SR is described with timing diagram shown in Figure 1.

In the process of drain current decreasing linearly toward zero, the drain-source voltage rises synchronically. When it rises over the turn off threshold voltage  $V_{THOFF}$ , the APR34709 pulls the drive signal down after a turn-off delay ( $t_{DOFF}$ ).

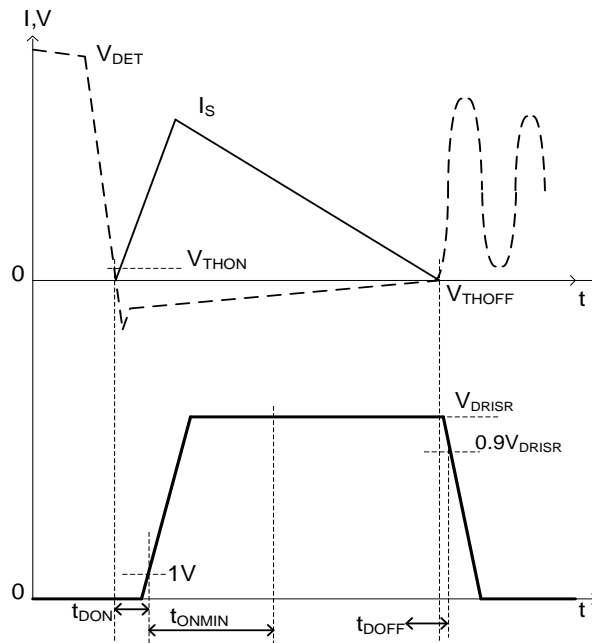


Figure 1. Typical Waveforms of APR34709 in DCM

**Synchronous Rectification Principle Description** (continued)

**Minimum On/Off Time**

When the controlled MOSFET gate is turned on, some ringing noise is generated. The minimum on-time timer blanks the  $V_{THOFF}$  comparator, keeping the controlled MOSFET on for at least the minimum on time. During the minimum on time, the turn off threshold is totally blanked.

After the SR driver turns off, the SR control block initiates a minimum off time timer during which the SR will remain off to avoid the ringing from turning on the synchronous MOSFET.

**The Value and Meaning of AREF Resistor**

As to DCM operation Flyback converter, after the secondary rectifier stops conducting, the primary MOSFET Drain-to-source ringing waveform is resulted from the resonant of primary inductance and the equivalent output capacitance. This ringing waveform probably leads to Synchronous Rectifier error conduction. To avoid this fault happening, the APR34709 has a special function design by means of volt-second product detecting. Regarding of the sensed voltage of VDET pin, the volt-second product of voltage above  $V_{CC}$  at primary switch on time is much higher than that of each cycle ringing voltage above  $V_{CC}$ . Therefore, before every time Synchronous Rectifier turns on, the APR34709 judges if the detected volt-second product of VDET voltage above  $V_{CC}$  is higher than a threshold and then turn on synchronous Rectifier. The purpose of AREF resistor is to determine the volt-second product threshold. The APR34709 has a parameter,  $K_{qs}$ , which converts  $R_{AREF}$  value to volt-second product.

$$\text{Area2} = R_{AREF} * K_{qs}$$

In general, the Area1 and Area3 values depend on the system design and are always fixed if the system design is frozen. As to Diodes Incorporated's PSR design, the Area1 value changes with primary peak current value and Area3 value generally keeps constant at all of conditions. So the AREF resistor design should consider the worst case, the minimum primary peak current condition. Since of system design parameter distribution, Area1 and Area3 have moderate tolerance. So Area2 should be designed in the middle of Area1 and Area3 to ensure enough design margins.

$$\text{Area3} < R_{AREF} * K_{qs} < \text{Area1}$$

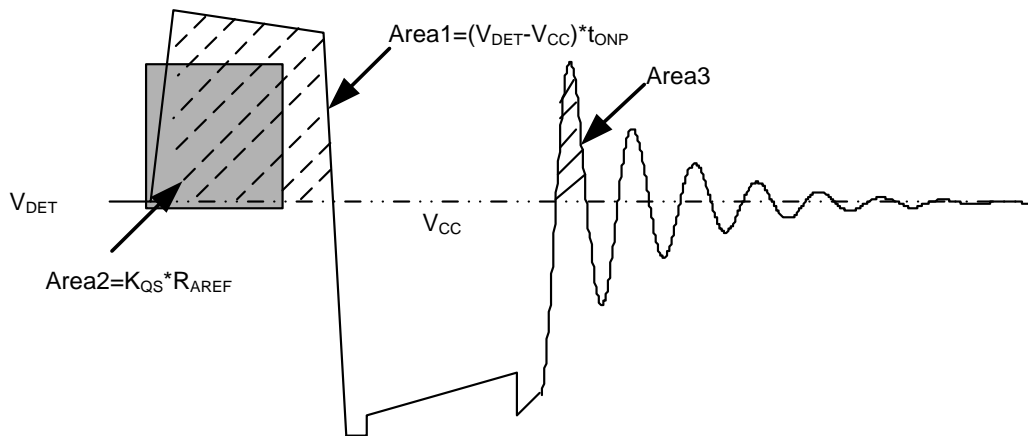


Figure 2. AREF Function

**SR Minimum Operating Voltage**

The APR34709 sets a minimum SR operating voltage by comparing the difference between  $V_{DET}$  and output voltage ( $V_{CC}$ ). The value of  $V_{DET} - V_{CC}$  must be higher than its internal reference, then the APR34709 will begin to integrate the area of  $(V_{DET} - V_{CC}) * t_{ONP}$ . If not, the area integrating will not begin and the SR driver will be disabled.

**Synchronous Rectification Principle Description** (continued)

**Recommended Application Circuit Parameters**

The C<sub>CAREF</sub> is suggested to parallel with the AREF resistor to keep the volt-second product threshold stable. And the recommended value of C<sub>CAREF</sub> is 20nF.

The recommended value of C<sub>24</sub> is 100nF. The value of VDD capacitor C<sub>23</sub> is 4.7μF.

**Green Mode at Light Load**

When the system is running with light load, rectifier conduction loss no longer dominates the secondary-side power loss, in which condition it is preferred the SR MOSFET keeps off to save the driver loss.

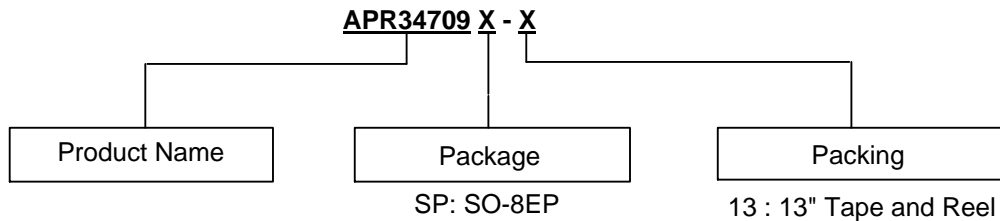
The APR34709 can sense the non-switching duration cycle by cycle, when the non-switching duration keeps longer than the internal light load timing t<sub>LL</sub>, the IC will shut down the gate driver and keep it off for the next two cycles.

**VDD**

The VDD is the output of Pulse Linear Regulator and the internal linear regulator. It provides bias voltage for the controller. A capacitor (C<sub>23</sub>, typical 4.7μF) should be connected between the VDD pin and GND pin.

A Pulse Linear Regulator is integrated in the controller to provided voltage to the VDD pin of the APR34709. So that the APR34709 can operate at Constant Current (CC) Mode, in which the system output voltage may drop to as low as 2V. The bias voltage is disabled when system output voltage is higher than 4.75V, in that case the system output provides voltage to VDD pin of the APR34709 through its internal LDO.

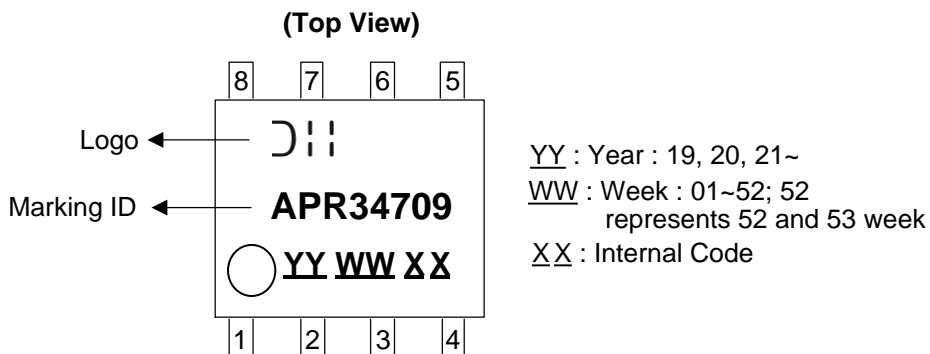
**Ordering Information**



Package	Temperature Range	Part Number	Marking ID	13" Tape and Reel	
				Quantity	Part Number Suffix
SO-8EP	-40 to +85°C	APR34709SP-13	APR34709	4000/Tape and Reel	-13

**Marking Information**

**SOP-8EP**

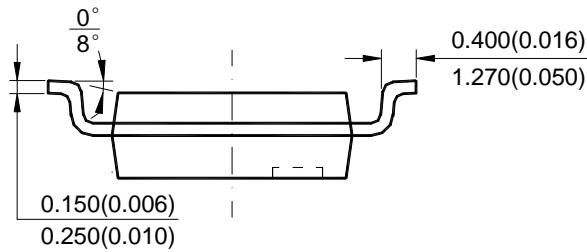
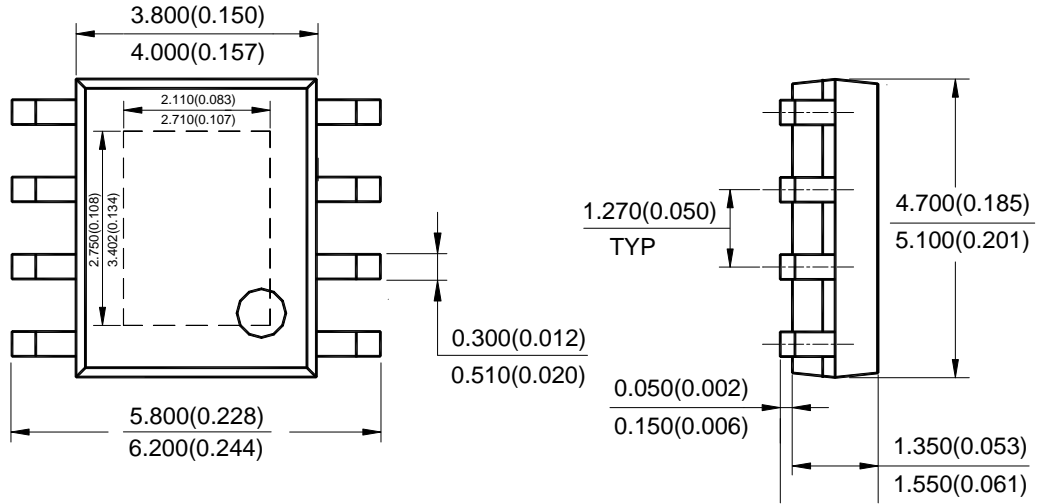




**Package Outline Dimensions** (All dimensions in mm(inch).)

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

(1) Package Type: SO-8EP



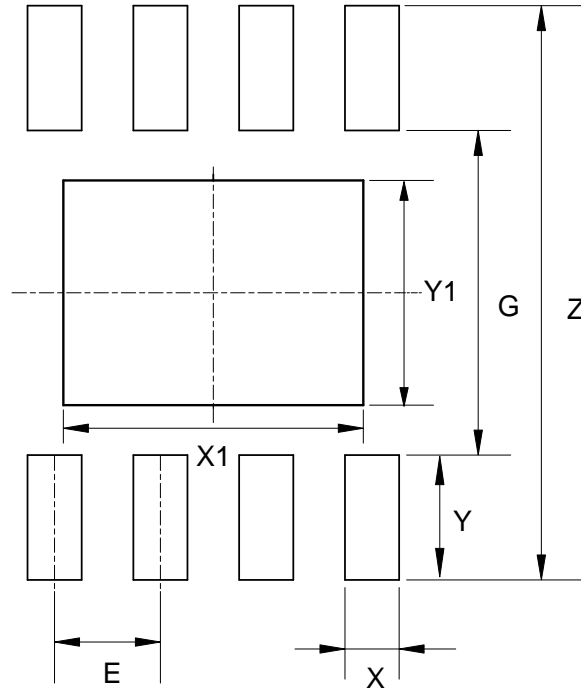
Note: Eject hole, oriented hole and mold mark is optional.

NEW PRODUCT

**Suggested Pad Layout**

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

(1) Package Type: SO-8EP



Dimensions	Z (mm)/(inch)	G (mm)/(inch)	X (mm)/(inch)	Y (mm)/(inch)	X1 (mm)/(inch)	Y1 (mm)/(inch)	E (mm)/(inch)
Value	6.900/0.272	3.900/0.154	0.650/0.026	1.500/0.059	3.600/0.142	2.700/0.106	1.270/0.050

NEW PRODUCT

**IMPORTANT NOTICE**

DIODES INCORPORATED MAKES NO WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, WITH REGARDS TO THIS DOCUMENT, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION).

Diodes Incorporated and its subsidiaries reserve the right to make modifications, enhancements, improvements, corrections or other changes without further notice to this document and any product described herein. Diodes Incorporated does not assume any liability arising out of the application or use of this document or any product described herein; neither does Diodes Incorporated convey any license under its patent or trademark rights, nor the rights of others. Any Customer or user of this document or products described herein in such applications shall assume all risks of such use and will agree to hold Diodes Incorporated and all the companies whose products are represented on Diodes Incorporated website, harmless against all damages.

Diodes Incorporated does not warrant or accept any liability whatsoever in respect of any products purchased through unauthorized sales channel. Should Customers purchase or use Diodes Incorporated products for any unintended or unauthorized application, Customers shall indemnify and hold Diodes Incorporated and its representatives harmless against all claims, damages, expenses, and attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized application.

Products described herein may be covered by one or more United States, international or foreign patents pending. Product names and markings noted herein may also be covered by one or more United States, international or foreign trademarks.

This document is written in English but may be translated into multiple languages for reference. Only the English version of this document is the final and determinative format released by Diodes Incorporated.

**LIFE SUPPORT**

Diodes Incorporated products are specifically not authorized for use as critical components in life support devices or systems without the express written approval of the Chief Executive Officer of Diodes Incorporated. As used herein:

A. Life support devices or systems are devices or systems which:

1. are intended to implant into the body, or
2. support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labeling can be reasonably expected to result in significant injury to the user.

B. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or to affect its safety or effectiveness.

Customers represent that they have all necessary expertise in the safety and regulatory ramifications of their life support devices or systems, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of Diodes Incorporated products in such safety-critical, life support devices or systems, notwithstanding any devices- or systems-related information or support that may be provided by Diodes Incorporated. Further, Customers must fully indemnify Diodes Incorporated and its representatives against any damages arising out of the use of Diodes Incorporated products in such safety-critical, life support devices or systems.

Copyright © 2019, Diodes Incorporated

[www.diodes.com](http://www.diodes.com)

## Данный компонент на территории Российской Федерации

### Вы можете приобрести в компании MosChip.

Для оперативного оформления запроса Вам необходимо перейти по данной ссылке:

<http://moschip.ru/get-element>

Вы можете разместить у нас заказ для любого Вашего проекта, будь то серийное производство или разработка единичного прибора.

В нашем ассортименте представлены ведущие мировые производители активных и пассивных электронных компонентов.

Нашей специализацией является поставка электронной компонентной базы двойного назначения, продукции таких производителей как XILINX, Intel (ex.ALTERA), Vicor, Microchip, Texas Instruments, Analog Devices, Mini-Circuits, Amphenol, Glenair.

Сотрудничество с глобальными дистрибьюторами электронных компонентов, предоставляет возможность заказывать и получать с международных складов практически любой перечень компонентов в оптимальные для Вас сроки.

На всех этапах разработки и производства наши партнеры могут получить квалифицированную поддержку опытных инженеров.

Система менеджмента качества компании отвечает требованиям в соответствии с ГОСТ Р ИСО 9001, ГОСТ РВ 0015-002 и ЭС РД 009

### Офис по работе с юридическими лицами:

105318, г.Москва, ул.Щербаковская д.3, офис 1107, 1118, ДЦ «Щербаковский»

Телефон: +7 495 668-12-70 (многоканальный)

Факс: +7 495 668-12-70 (доб.304)

E-mail: [info@moschip.ru](mailto:info@moschip.ru)

Skype отдела продаж:

moschip.ru

moschip.ru\_4

moschip.ru\_6

moschip.ru\_9