

## Description

The ZXGD3103 is intended to drive MOSFETS configured as ideal diode replacements. The device is comprised of a differential amplifier detector stage and high current driver. The detector monitors the reverse voltage of the MOSFET such that if body diode conduction occurs a positive voltage is applied to the MOSFET's Gate pin.

Once the positive voltage is applied to the Gate the MOSFET switches on allowing reverse current flow. The detectors' output voltage is then proportional to the MOSFET Drain-Source reverse voltage drop and this is applied to the Gate via the driver. This action provides a rapid turn off as current decays.

## Applications

Flyback Converters in:

- Low Voltage AC/DC Adaptors
- LED TV, Monitors, Set Top Boxes

Resonant Converters in:

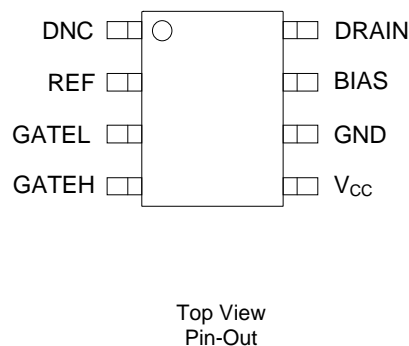
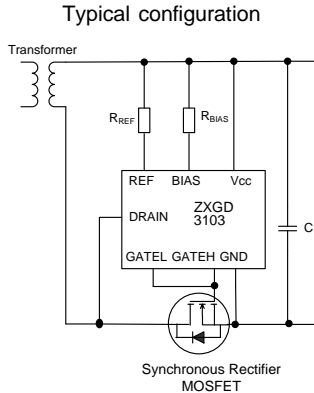
- Higher Power PSU - Telecoms and Server PSU
- Computing Power Supplies – ATX and Server PSU
- Street Lighting

## Features

- 5 to 15V  $V_{CC}$  Range
- Operation Up to 250kHz
- 180V Drain Voltage Rating
- Proportional Gate Drive to Minimize Body Diode Conduction
- Turn-off Propagation Delay 15ns and Turn-off Time 20ns
- Detector Threshold Voltage ~10mV
- Standby Current 5mA
- Suitable for Discontinuous Mode (DCM), Critical Conduction Mode (CrCM) and Continuous Mode (CCM) Operation
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**

## Mechanical Data

- Case: SO-8
- Case material: Molded Plastic. "Green" Molding Compound  
UL Flammability Rating 94V-0
- Moisture Sensitivity: Level 1 per J-STD-020
- Terminals: Finish - Matte Tin Plated Leads, Solderable per MIL-STD-202, Method 208
- Weight: 0.074 grams (Approximate)



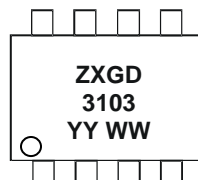
Pin Name	Pin Function
GND	Ground
$V_{CC}$	Power Supply
GATEL	Gate Turn off
GATEH	Gate Turn on
BIAS	Bias connection
DRAIN	Drain Sense
REF	Reference
DNC	Do not connect

## Ordering Information (Note 4)

Product	Marking	Reel Size (inches)	Tape Width (mm)	Quantity per Reel
ZXGD3103N8TC	ZXGD3103	13	12	2,500

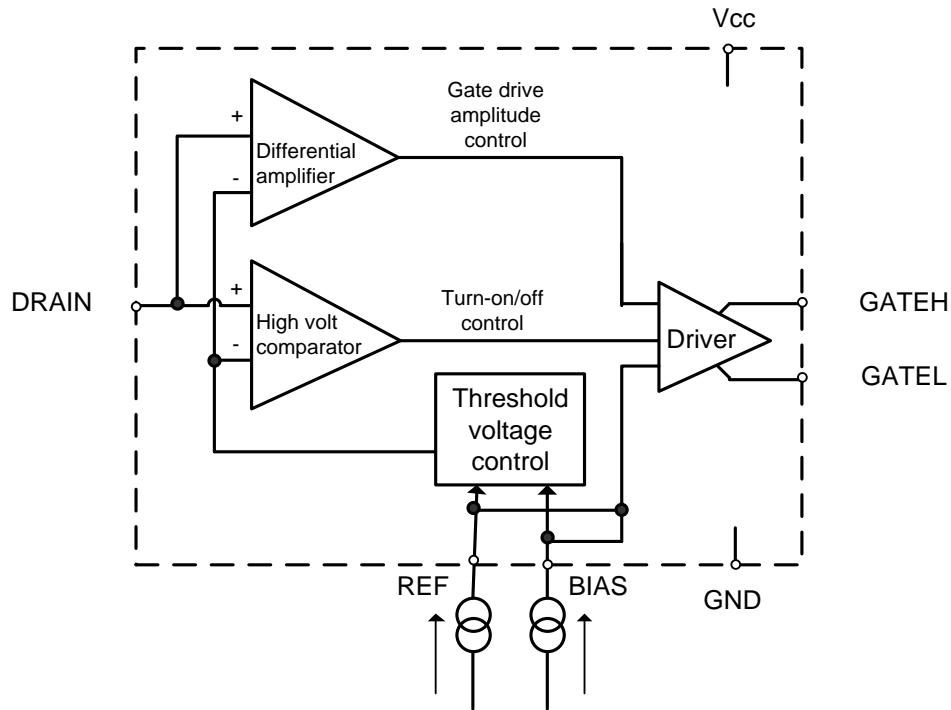
- Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS) & 2011/65/EU (RoHS 2) compliant.
  2. See [http://www.diodes.com/quality/lead\\_free.html](http://www.diodes.com/quality/lead_free.html) for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "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.
  4. For packaging details, go to our website at <http://www.diodes.com/products/packages.html>.

## Marking Information



- ZXGD = Product Type Marking Code, Line 1
- 3103 = Product Type Marking Code, Line 2
- YY = Year (ex: 16 = 2016)
- WW = Week (01 to 53)

## Functional Block Diagram



## Pin Functions

Pin Number	Pin Name	Pin Function and Description
1	DNC	<b>Do not connect</b> Leave pin floating
2	REF	<b>Reference</b> This pin is connected to $V_{CC}$ via resistor, $R_{REF}$
3	GATEL	<b>Gate turn off</b> This pin sinks current, $I_{SINK}$ , from the synchronous MOSFET Gate
4	GATEH	<b>Gate turn on</b> This pin sources current, $I_{SOURCE}$ , to the synchronous MOSFET Gate
5	Vcc	<b>Power Supply</b> This is the supply pin. It is recommended to decouple this point to ground closely with a ceramic capacitor.
6	GND	<b>Ground</b> This is the Ground reference point. Connect to the synchronous MOSFET Source terminal.
7	BIAS	<b>Bias</b> This pin is connected to $V_{CC}$ via resistor $R_{BIAS}$
8	DRAIN	<b>Drain Connection</b> Connect this pin to the synchronous MOSFET drain terminal.

**Absolute Maximum Ratings** (Voltage relative to GND, @  $T_A = +25^\circ\text{C}$ , unless otherwise specified.)

Characteristic	Symbol	Value	Unit
Supply Voltage	$V_{CC}$	15	V
Continuous Drain Pin Voltage	$V_D$	-3 to 180	V
GATEH and GATEL Output Voltage	$V_G$	-3 to $V_{CC} + 3$	V
Gate Driver Peak Source Current	$I_{SOURCE}$	2.5	A
Gate Driver Peak Sink Current	$I_{SINK}$	6	A
Reference Current	$I_{REF}$	25	mA
Bias Voltage	$V_{BIAS}$	$V_{CC}$	V
Bias Current	$I_{BIAS}$	100	mA

**Thermal Characteristics** (@  $T_A = +25^\circ\text{C}$ , unless otherwise specified.)

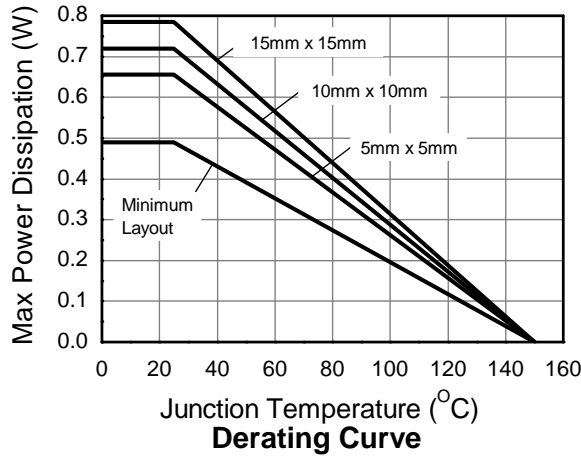
Characteristic	Symbol	Value	Unit	
Power Dissipation Linear Derating Factor	$P_D$	(Note 5)	490	mW mW/ $^\circ\text{C}$
		(Note 6)	3.92	
		(Note 7)	655	
		(Note 8)	5.24	
		(Note 5)	720	
		(Note 6)	5.76	
		(Note 7)	785	
		(Note 8)	6.28	
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	(Note 5)	255	$^\circ\text{C/W}$
		(Note 6)	191	
		(Note 7)	173	
		(Note 8)	159	
Thermal Resistance, Junction to Lead	$R_{\theta JL}$	135	$^\circ\text{C/W}$	
Operating Temperature Range	$T_J$	-40 to +150	$^\circ\text{C}$	
Storage Temperature Range	$T_{STG}$	-55 to +150	$^\circ\text{C}$	

**ESD Ratings** (Note 10)

Characteristic	Symbol	Value	Unit	JEDEC Class
Electrostatic Discharge - Human Body Model	ESD HBM	2,000	V	2
Electrostatic Discharge - Machine Model	ESD MM	300	V	B

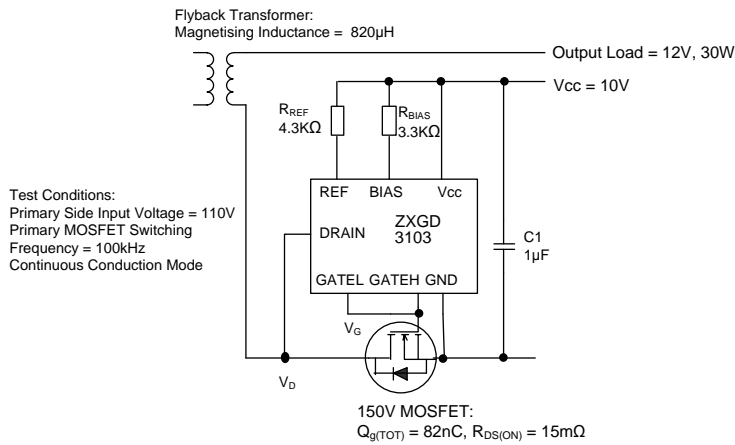
- Notes:
5. For a device surface mounted on minimum recommended pad layout FR-4 PCB with high coverage of single sided 1oz copper, in still air conditions; the device is measured when operating in a steady-state condition.
  6. Same as Note 5, except pin 5 ( $V_{CC}$ ) and pins 6 (PGND) are both connected to separate 5mm x 5mm 1oz copper heat-sinks.
  7. Same as Note 6, except both heat-sinks are 10mm x 10mm.
  8. Same as Note 6, except both heat-sinks are 15mm x 15mm.
  9. Thermal resistance from junction to solder-point at the end of each lead on pin 6 (GND) and pin 5 ( $V_{CC}$ ).
  10. Refer to JEDEC specification JESD22-A114 and JESD22-A11.

**Thermal Derating Curve**

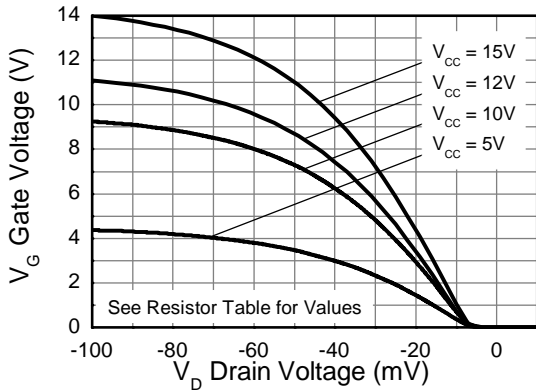


**Electrical Characteristics** (@  $V_{CC} = 10V$ ,  $T_A = +25^\circ C$ ,  $R_{BIAS} = 3.3k\Omega$ ,  $R_{REF} = 4.3k\Omega$ , unless otherwise specified.)

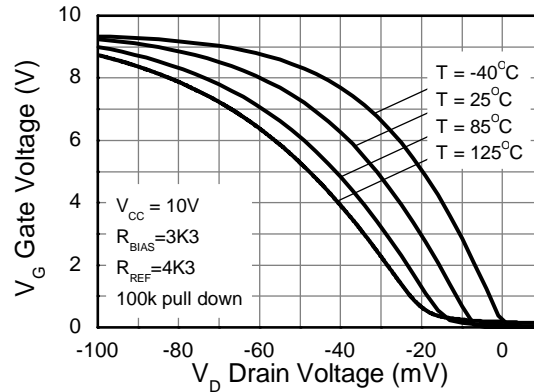
Characteristic	Symbol	Min	Typ	Max	Unit	Test Condition
<b>Input Supply</b>						
Operating Current	$I_{OP}$	—	2.16	—	mA	$V_D \leq -200mV$
		—	5.16	—	mA	$V_D \geq 0mV$
<b>Gate Driver</b>						
Turn-off Threshold Voltage	$V_T$	-16	-10	0	mV	$V_G = 1V$ , $R_H = 100k\Omega$ , $R_L = o/c$
Gate Output Voltage	$V_{G(OFF)}$	—	0.73	1	V	$V_D \geq 0mV$ , $R_H = 100k\Omega$ , $R_L = o/c$
	$V_G$	6	7.2	—		$V_D = -50mV$ , $R_H = o/c$ , $R_L = 100k\Omega$
	$V_G$	8.8	9.2	—		$V_D = -100mV$ , $R_H = o/c$ , $R_L = 100k\Omega$
	$V_G$	9.2	9.4	—		$V_D \leq -150mV$ , $R_H = o/c$ , $R_L = 100k\Omega$
	$V_G$	9.3	9.5	—		$V_D \leq -200mV$ , $R_H = o/c$ , $R_L = 100k\Omega$
<b>Switching Performance</b>						
Turn-On Propagation Delay	$t_{D1}$	—	150	—	ns	Refer to application test circuit below
Gate Rise Time	$t_R$	—	450	—		
Turn-Off Propagation Delay	$t_{D2}$	—	15	—		
Gate Fall Time, Continuous Conduction Mode	$t_F$	—	21	—		
Gate Fall Time, Discontinuous Conduction Mode	$t_F$	—	17	—		



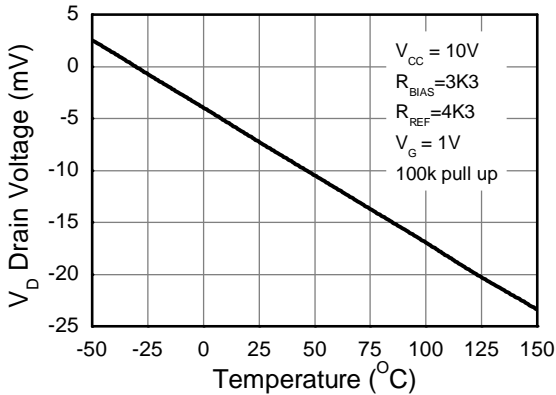
**Typical Electrical Characteristics** (@  $T_A = +25^\circ\text{C}$ , unless otherwise specified.)



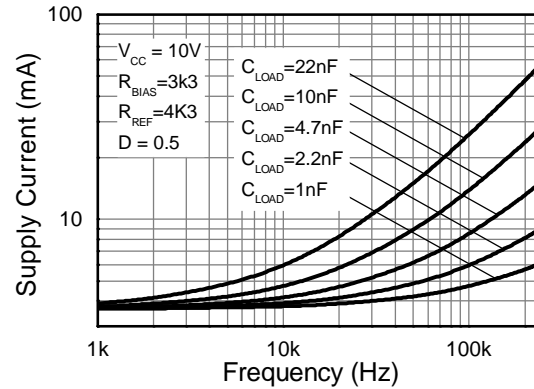
**Transfer Characteristic**



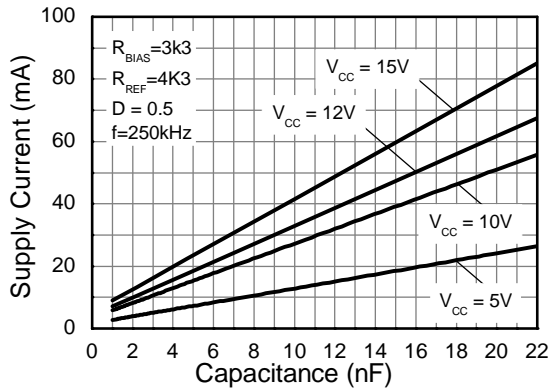
**Transfer Characteristic**



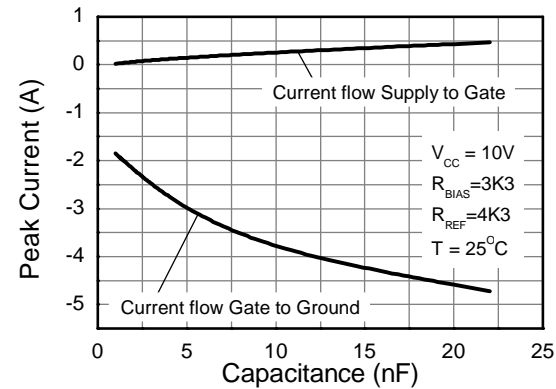
**Drain Sense Voltage vs Temperature**



**Supply Current vs Frequency**

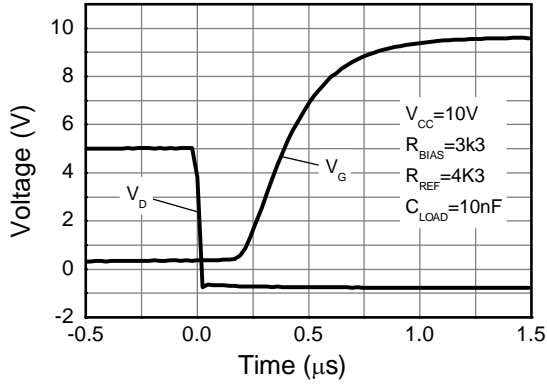


**Supply Current vs Capacitive Load**

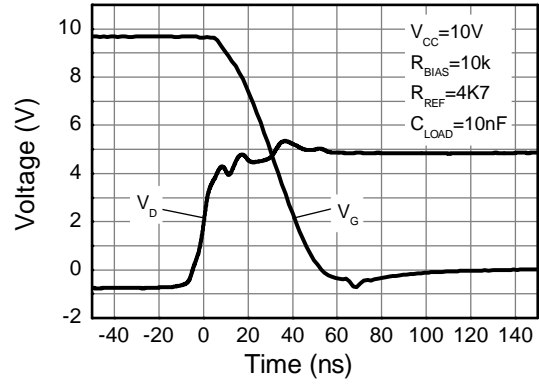


**Gate Current vs Capacitive Load**

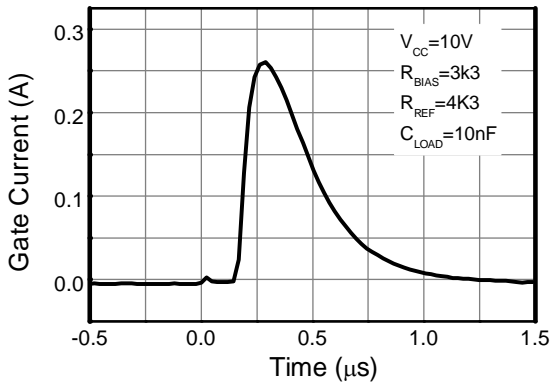
**Typical Electrical Characteristics** (@  $T_A = +25^\circ\text{C}$ , unless otherwise specified.) (Cont.)



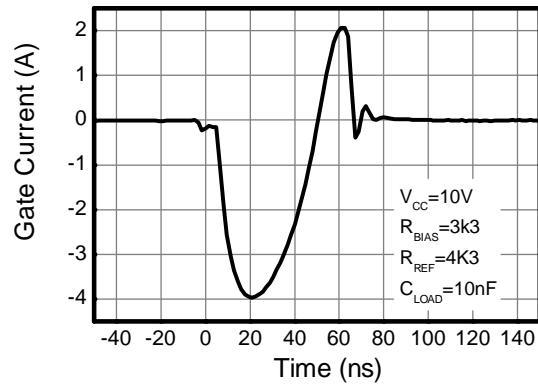
**Switch On Speed**



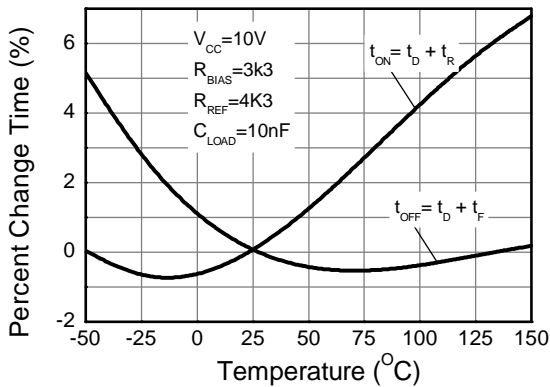
**Switch Off Speed**



**Gate Drive On Current**



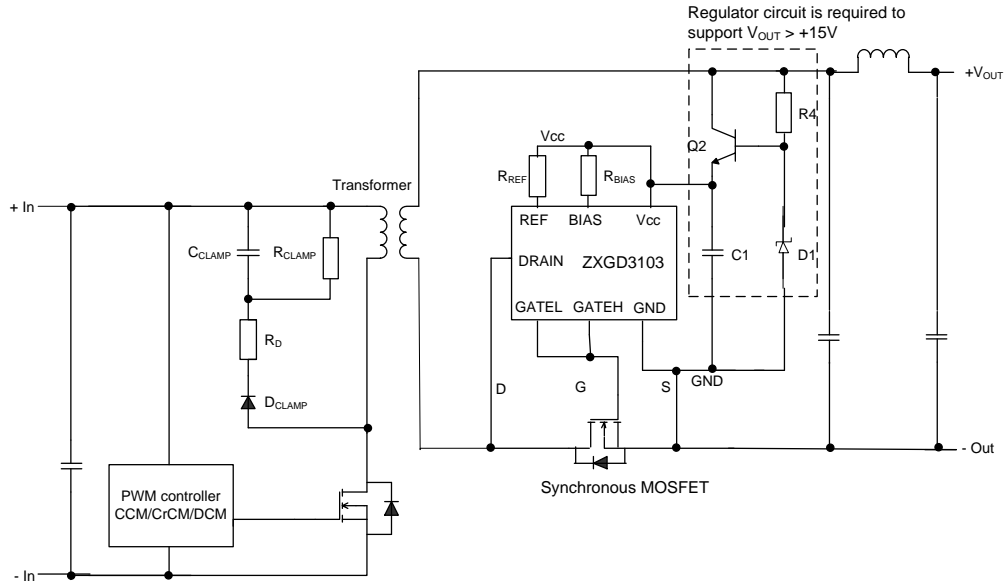
**Gate Drive Off Current**



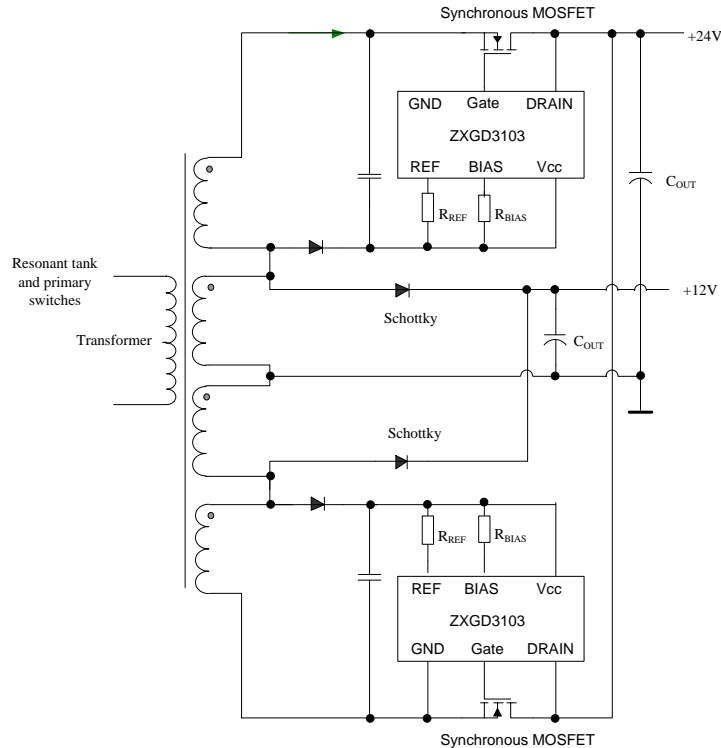
**Switching vs Temperature**

**Typical Application Circuits**

The purpose of the ZXGD3103 is to drive a MOSFET as a low- $V_F$  Schottky diode replacement in offline power converters. When combined with a low  $R_{DS(ON)}$  MOSFET, it can yield significant power efficiency improvement, whilst maintaining design simplicity and incurring minimal component count. Figure 1 and 2 show typical configuration of ZXGD3103 for synchronous rectification in a Flyback and a multiple output resonant converter.



**Figure 1. Example Connections in Flyback Supply**



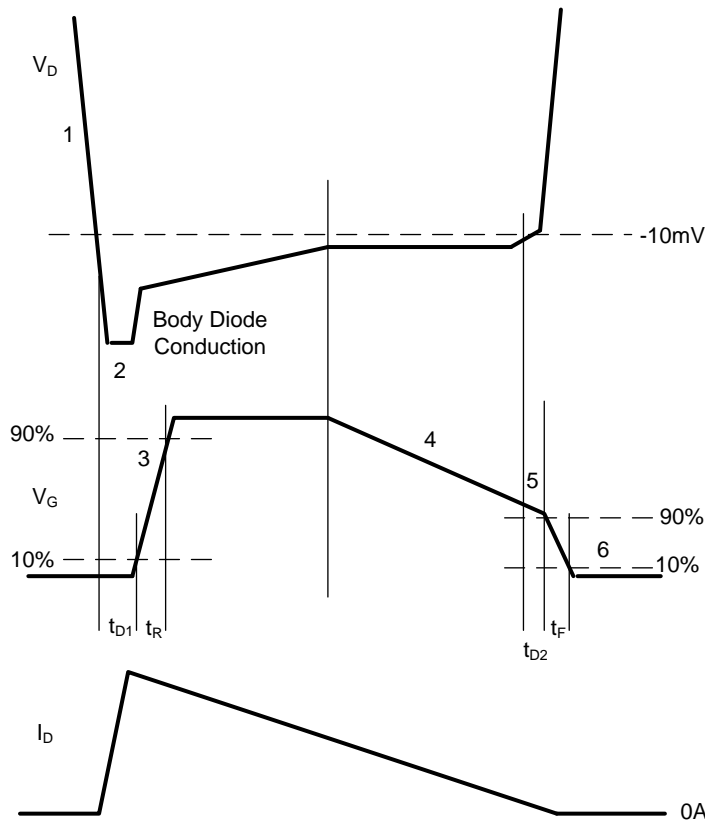
**Figure 2. Example Connections in LLC Supply**

## Operation in Typical Application

The operation of the device is described step-by-step with reference to the timing diagram in Figure 3.

1. The detector monitors the MOSFET Drain-Source voltage.
2. When, due to transformer action, the MOSFET body diode is forced to conduct there is approximately -0.8V on the Drain pin.
3. The detector outputs a positive voltage with respect to ground, this voltage is then fed to the MOSFET driver stage and current is sourced out of the GATE pin.
4. The controller goes into proportional gate drive control — the GATE output voltage is proportional to the on-resistance-induced Drain-Source voltage drop across the MOSFET. Proportional gate drive ensures that MOSFET conducts for majority of the conduction cycle and minimizes body diode conduction time.
5. As the Drain current decays linearly toward zero, proportional gate drive control reduces the Gate voltage so the MOSFET can be turned off rapidly at zero current crossing. The GATE voltage is removed when the Drain-Source voltage crosses the detection threshold voltage to minimize reverse current flow.
6. At zero Drain current, the controller GATE output voltage is pulled low to  $V_{G(OFF)}$  to ensure that the MOSFET is off.

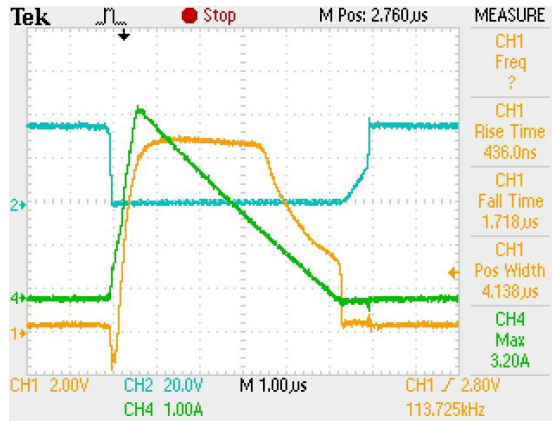
Figure 3 shows typical operating waveforms for ZXGD3103 driving a MOSFET with  $Q_{g(TOT)} = 82nC$  in a Flyback converter operating in critical conduction mode.



**Figure 3. Timing Diagram for a Critical Conduction Mode Flyback Converter**

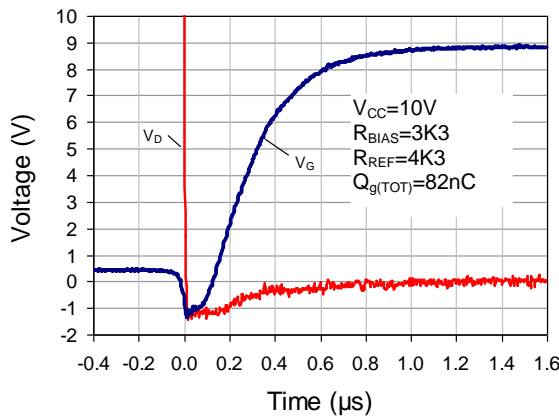


**Typical Waveforms**



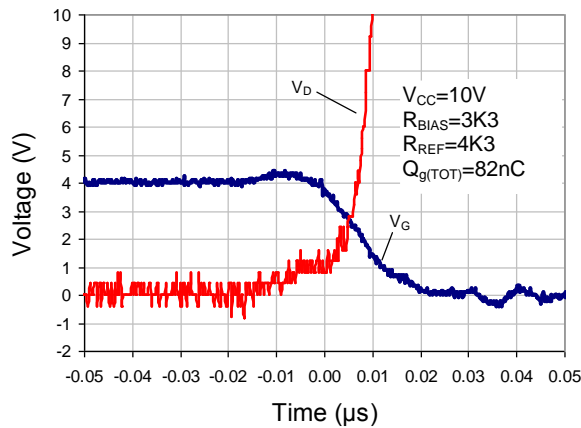
**Fig 4a: Critical Conduction Mode**

**Switch On Speed**



**Fig 4b: Typical Switch ON Speed when Driving a  $Q_{g(TOT)} = 82\text{nC}$  MOSFET**

**Switch On Speed**



**Fig 4c: Typical Switch OFF Speed when Driving a  $Q_{g(TOT)} = 82\text{nC}$  MOSFET**

## Design Considerations

It is advisable to decouple the ZXGD3103 closely to  $V_{CC}$  and ground due to the possibility of high peak gate currents with a 1 $\mu$ F X7R type ceramic capacitor as shown in Figure 2. The Gate pins should be as close to the MOSFET's gate as possible. Also the ground return loop should be as short as possible.

To minimize parasitic inductance-induced premature turn-off issue of the synchronous controller always keep the PCB track length between ZXGD3101's Drain input and MOSFET's Drain to less than 10mm. Low internal inductance MOSFET packages such as SO-8 and PolarPak are also recommended for high switching frequency power conversion to minimize body diode conduction.

R4, Q2, D1 and C1 in Figure 1 are only required as a series drop-down regulator to maintain a stable  $V_{CC}$  around 10V from a power supply output voltage greater than 15V.

External gate resistors are optional. They can be inserted to control the rise and fall time which may help with EMI issues.

The proper selection of external resistors  $R_{REF}$  and  $R_{BIAS}$  is important to the optimum device operation. Select a value for resistor  $R_{REF}$  and  $R_{BIAS}$  from Table 1 based on the desired  $V_{CC}$  value. This provides the typical ZXGD3103's detection threshold voltage of 10mV.

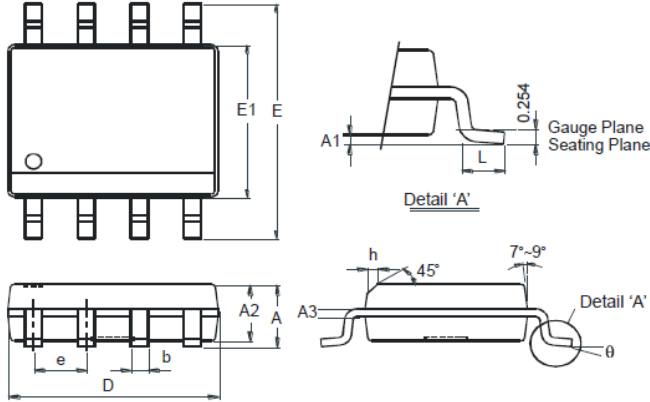
**Table 1. Recommended Resistor Values for Various Supply Voltages**

$V_{CC}$	$R_{BIAS}$	$R_{REF}$
5V	1K6	2K0
10V	3K3	4K3
12V	3K9	5K1
15V	5K1	6K8

**Package Outline Dimensions**

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

**SO-8**

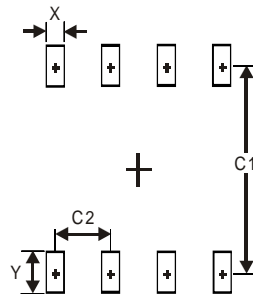


SO-8		
Dim	Min	Max
A	-	1.75
A1	0.10	0.20
A2	1.30	1.50
A3	0.15	0.25
b	0.3	0.5
D	4.85	4.95
E	5.90	6.10
E1	3.85	3.95
e	1.27 Typ	
h	-	0.35
L	0.62	0.82
θ	0°	8°
All Dimensions in mm		

**Suggested Pad Layout**

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

**SO-8**



Dimensions	Value (in mm)
X	0.60
Y	1.55
C1	5.4
C2	1.27

Note: For high voltage applications, the appropriate industry sector guidelines should be considered with regards to creepage and clearance distances between device Terminals and PCB tracking.

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