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Lead-free Green

SYNCHRONOUS RECTIFIER CONTROLLER

Description

The ZXGD3101 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.

Application

- Flyback Converters in:
  - Adaptors
  - LCD Monitors
  - Server PSU's
  - Set Top Boxes
- LLC Converter in:
  - High Power Adaptors
  - LCD TV
  - Street Lighting

Refer to documents: AN54, AN69, DN90, DN91 and DN94 available from the website

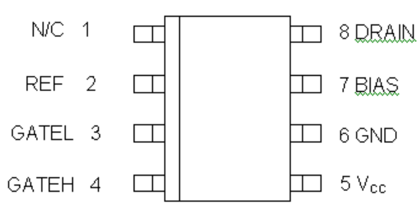
Features

- Turn-off propagation delay 15ns and turn-off time 20ns.
- Suitable for Discontinuous Mode (DCM), Critical Conduction Mode (CrCM) and Continuous Mode (CCM) operation
- Compliant with Energy Star V2.0 and European Code of Conduct V3
- Halogen Free part
- 5-15V Vcc range

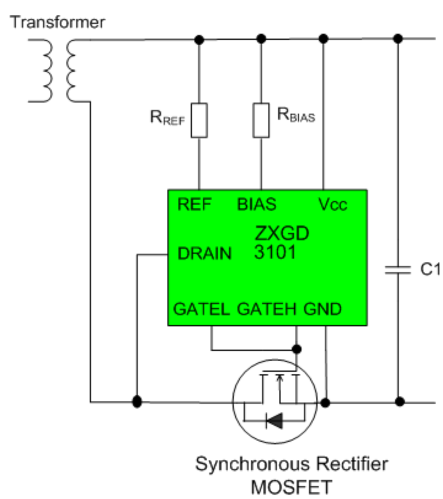
Mechanical Data

- Case: SO-8
- Marking Information: See Page 13

SO-8



Pin out details



Typical Configuration

Ordering Information

Product	Status	Package	Marking	Reel size (inches)	Tape width (mm)	Quantity per reel
ZXGD3101N8TC	Active	SO-8	ZXGD3101	13	12	2500

Maximum Ratings

Parameter	Symbol	Limit	Unit
Supply voltage (Note 1)	V_{CC}	15	V
Continuous Drain pin voltage (Note 1)	V_D	-3 to180	V
GATEH and GATEL output Voltage (Note 1)	V_G	-3 to V_{CC} + 3	V
Driver peak source current	I_{SOURCE}	4	A
Driver peak sink current	I_{SINK}	7	A
Reference current	I_{REF}	25	mA
Bias voltage	V_{BIAS}	V_{CC}	V
Bias current	I_{BIAS}	100	mA
Power dissipation at T_A =25°C	P_D	490	mW
Operating junction temperature	T_J	-40 to +150	°C
Storage temperature	T_{STG}	-50 to +150	°C

Thermal Characteristics

Parameter	Symbol	Value	Unit
Junction to ambient (Note 2)	$R_{\theta JA}$	255	°C/W
Junction to lead (Note 3)	$R_{\theta lA}$	120	°C/W

ESD Rating

Model	Rating	Unit
Human Body	4000	V
Machine	400	V

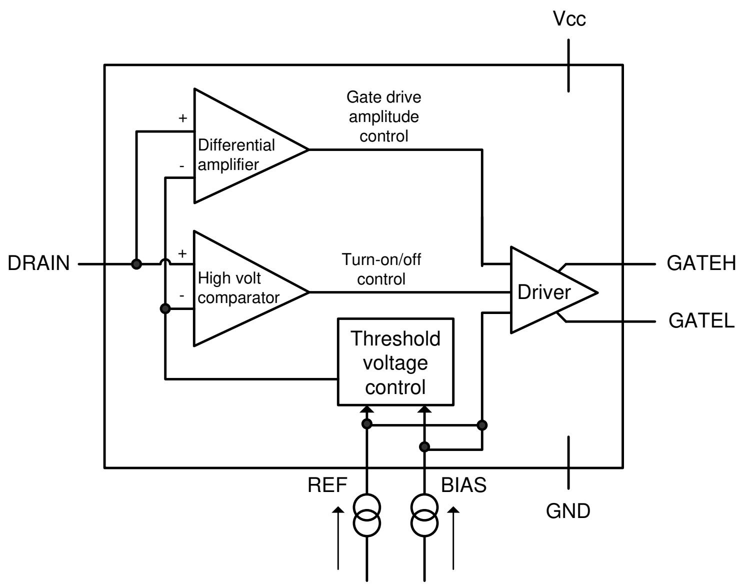
Notes: 1.All voltages are relative to GND pin
2. Mounted on minimum 1oz weight copper on FR4 PCB in still air conditions.
3. Output Drivers - Junction to solder point at end of the lead 5 and 6

Electrical Characteristics @T_A = 25°C, V_{CC}= 10V, R_{BIAS}=1.8kΩ, R_{REF}=3kΩ

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Input and supply characteristics						
Operating current	I_{OP}	V_{DRAIN} ≤ -200m V	-	3	-	mA
		V_{DRAIN} ≥ 0V	-	8	-	
Gate Driver						
Turn-off Threshold Voltage(Note 4)	V_T	V_G = 1V, (Note 5)	-45	-16	0	mV
GATE output voltage (Note 4)	$V_{G(off)}$	V_{DRAIN} ≥ 0V, (Note 5)	-	0.6	1	V
	V_G	V_{DRAIN} = -60mV, (Note 6)	5.0	7.5	-	
		V_{DRAIN} = -80mV, (Note 6)	7.0	8.5	-	
		V_{DRAIN} = -100mV, (Note 6)	8.4	9	-	
		V_{DRAIN} ≤ -140mV, (Note 6)	9.2	9.4	-	
		V_{DRAIN} ≤ -200mV, (Note 6)	9.3	9.5	-	
GATEH peak source current	I_{SOURCE}	V_{GH} = 1V		2.5	-	A
GATEL peak sink current	I_{SINK}	V_{GL} = 5V		2.5	-	A
Turn on Propagation delay	t_{d1}	C_L = 2.2nF, (Notes 6 and 7)		525		ns
Turn off Propagation delay	t_{d2}			15		ns
Gate rise time	t_r			305		ns
Gate fall time	t_f			20		ns

Notes: 4. GATEH connected to GATEL
5. R_H = 100kΩ, R_L = O/C
6. R_L = 100kΩ, R_H = O/C
7. Refer to Fig 6: test circuit and Fig 7: timing diagram on Page 12

Schematic Symbol and Pin Out Details



Pin No.	Symbol	Description and function
1	**NC**	**No connection** This pin can be connected to GND
2	**REF**	**Reference** This pin is connected to V_{CC} via resistor, R_{REF}. R_{REF} should be selected to source approximately 3mA into this pin. (Note 8)
3	**GATEL**	**Gate turn off** This pin sinks current, I_{SINK}, from the synchronous MOSFET Gate.
4	**GATEH**	**Gate turn on** This pin sources current, I_{SOURCE}, to the synchronous MOSFET Gate.
5	V_{CC}	**Power Supply** This is the supply pin. It is recommended to decouple this point to ground closely with a ceramic capacitor.
6	**GND**	**Ground** This is the ground reference point. Connect to the synchronous MOSFET Source terminal.
7	**BIAS**	**Bias** This pin is connected to V_{CC} via resistor, R_{BIAS}. R_{BIAS} should be selected to source 1.6 times I_{REF} into this pin. (Note 9)
8	**DRAIN**	**Drain connection** This pin connects directly to the synchronous MOSFET Drain terminal.

Notes: 8. REF pin should be assumed to be at GND +0.7V.
9. BIAS pin should be assumed to be at GND +0.3V.

Operation

Normal Operation

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

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 -0.6V on the Drain pin.

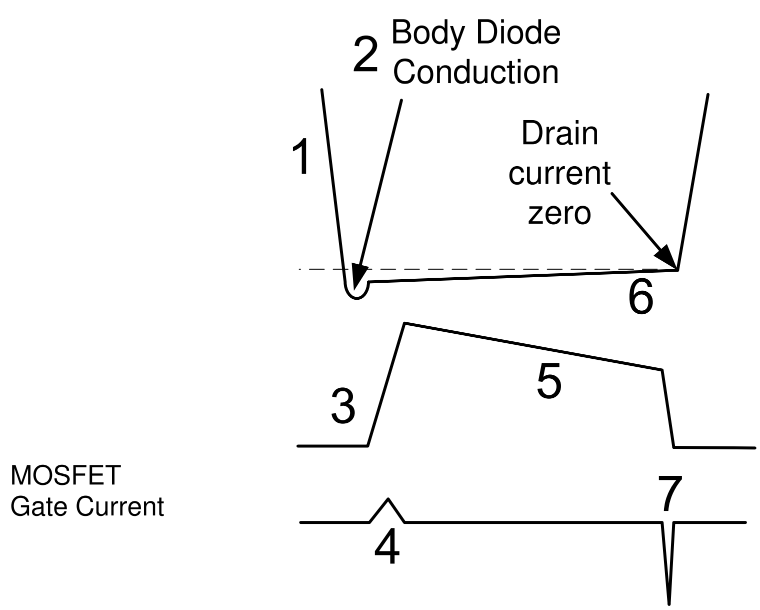
3. The detector outputs a positive voltage with respect to ground, this voltage is then fed to the MOSFET driver stage and current is sourced out of the GATEH pin.

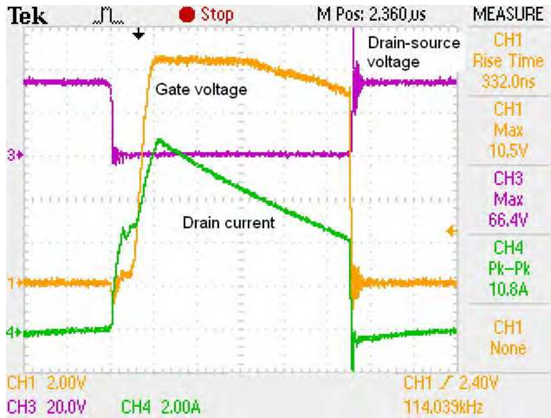
4. The current out of the GATEH pin is sourced into the synchronous MOSFET Gate to turn the device on.

5. The GATEH output voltage is now proportional to the Drain-Source voltage drop across the MOSFET due to the current flowing through the MOSFET.

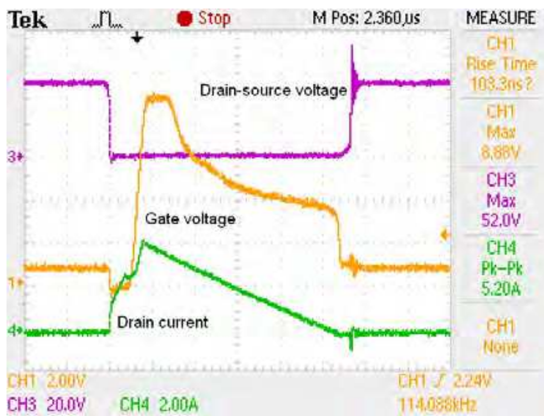
6. MOSFET conduction continues until the drain current reaches zero.

7. At zero current the detector output voltage is zero and the synchronous MOSFET Gate voltage is pulled low by the GATEL, turning the device off.

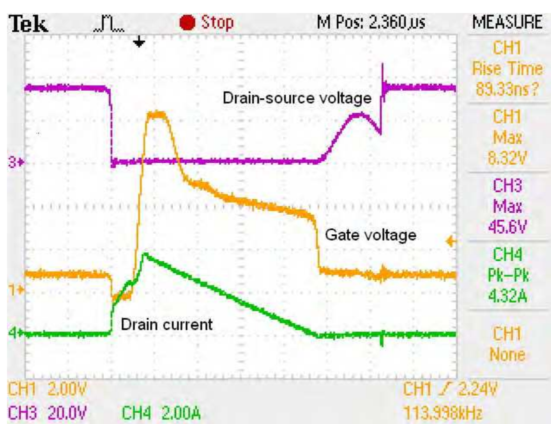




1a) Continuous Conduction Mode (CCM)



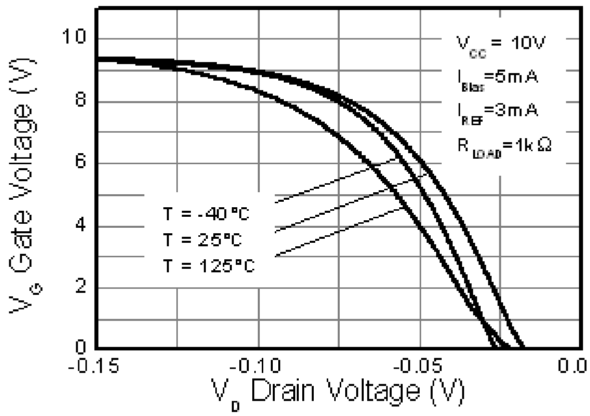
1b) Critical Conduction Mode (CrCM)



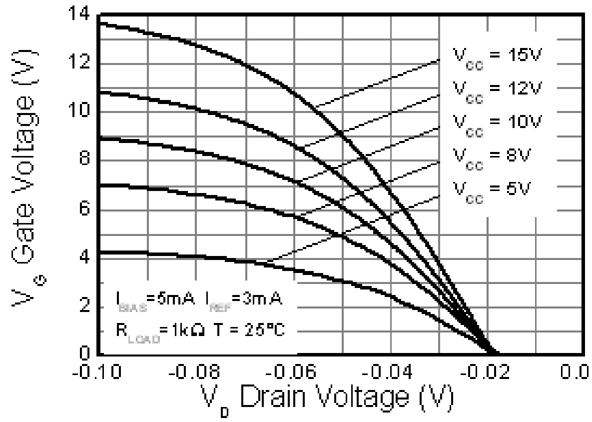
1c) Discontinuous Conduction Mode (DCM)

Figure 1: Typical waveforms

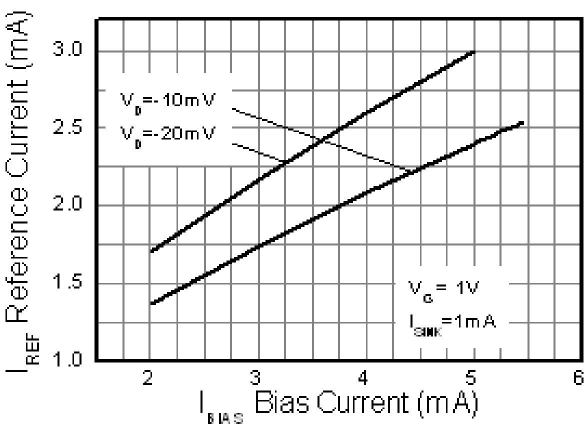
Typical Characteristics



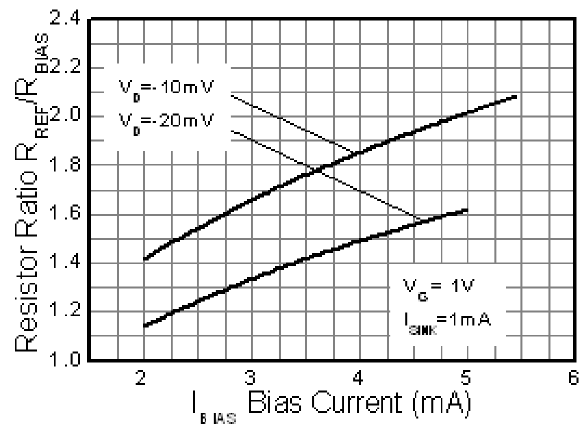
Transfer Characteristic



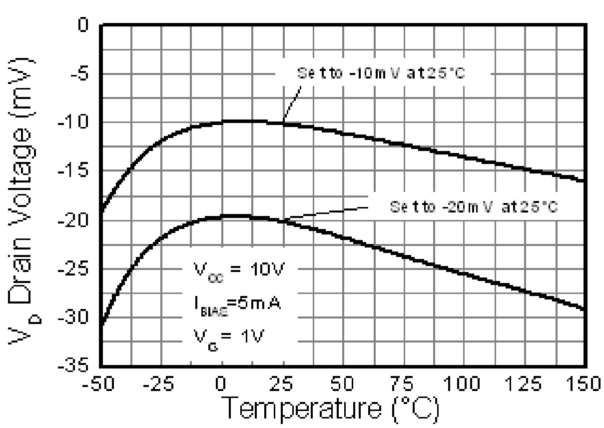
Transfer Characteristic



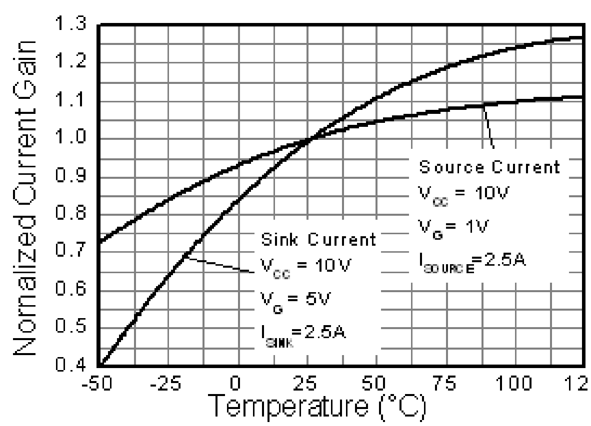
Bias Current vs Reference Current



Bias Resistor vs Reference Resistor

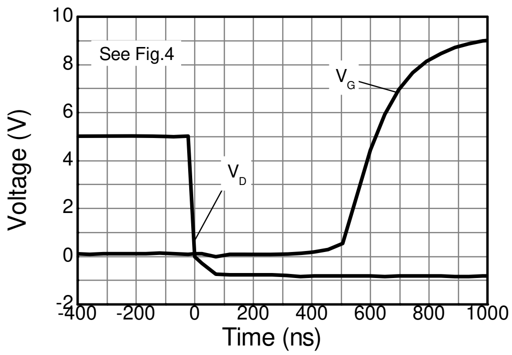


Drain Sense Voltage vs Temperature

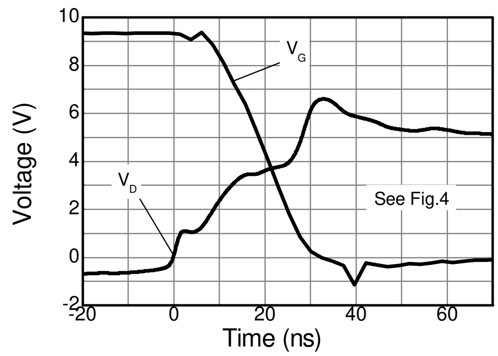


Output Current vs Temparature

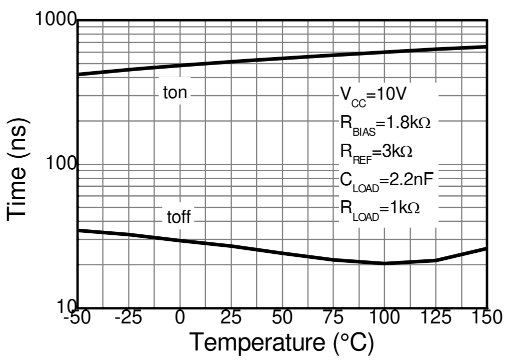
Typical Characteristics



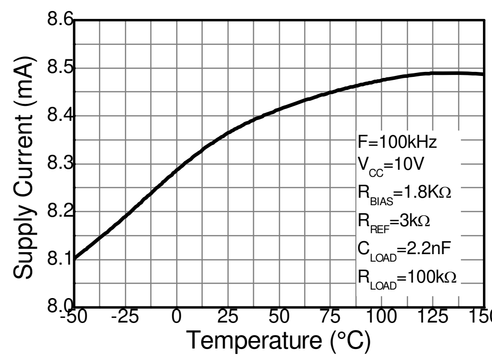
Switch On Speed



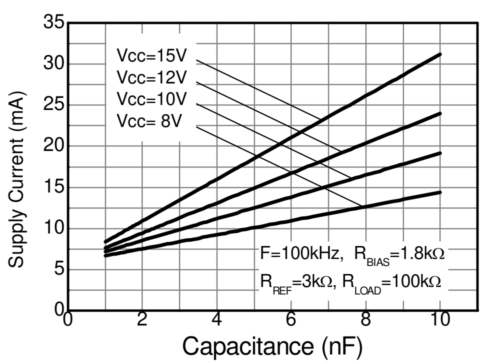
Switch Off Speed



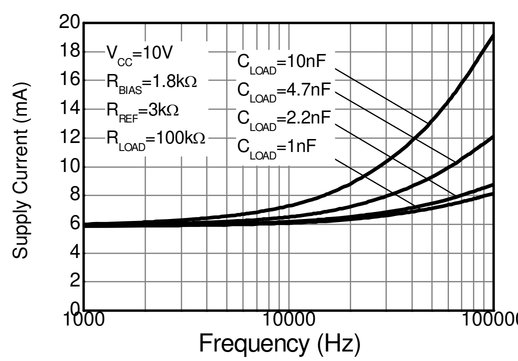
Switching vs Temperature



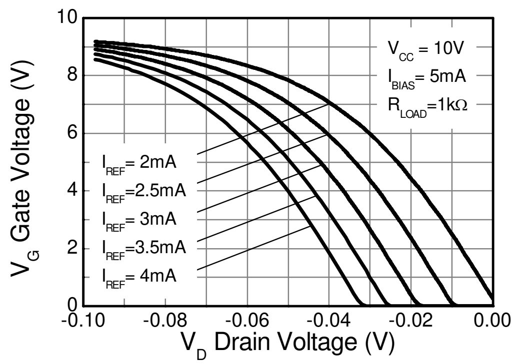
Supply Current vs Temperature



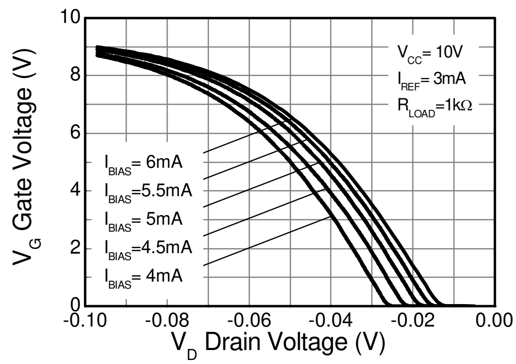
Supply Current vs Capacitive Load



Supply Current vs Frequency



Transfer Characteristic



Transfer Characteristic

Component Selection

It is advisable to decouple the ZXGD3101 closely to V_{CC} and ground due to the possibility of high peak gate currents with C1 in Figure 2.

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} to give a reference current, I_{REF}, of ~3mA. The value of R_{BIAS} must then be 0.6 times the value of R_{REF} giving a bias current, I_{BIAS}, of ~1.6 times I_{REF}. This provides a recommended typical offset voltage of ~20mV.

External gate resistors are optional. They can be inserted to control the rise times which may help with EMI issues, power supply consumption issues or dissipation within the part.

$R_{REF} = (V_{CC} - 0.7V) / 0.003$

$R_{BIAS} = (V_{CC} - 0.3V) / 0.005$

Layout considerations

The Gate pins should be as close to the MOSFET Gate as possible. Also the ground return loop should be as short as possible. The decoupling capacitor should be close to the V_{CC} and Ground pin, and should be a X7R type.

For more detailed information refer to application note AN54..

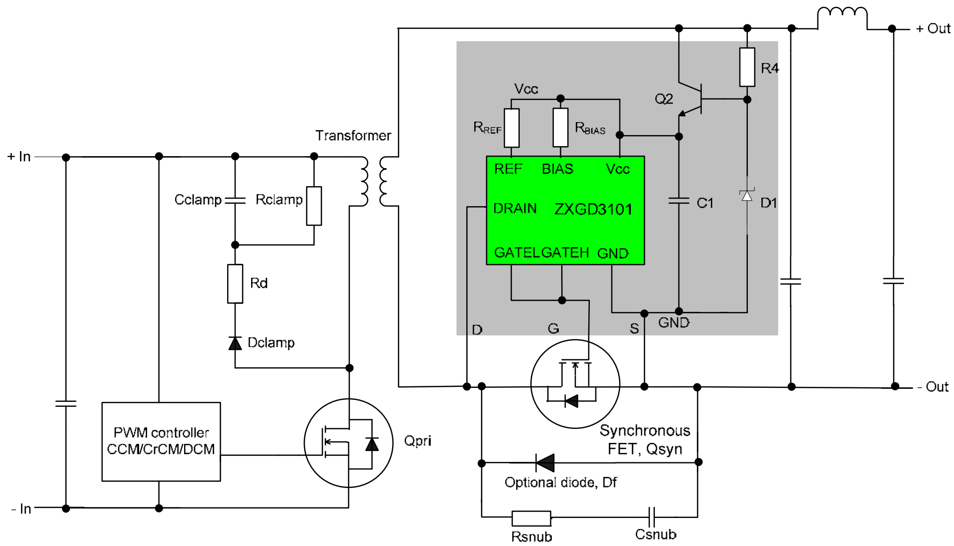


Figure 2 Example connection for low side synchronous rectification

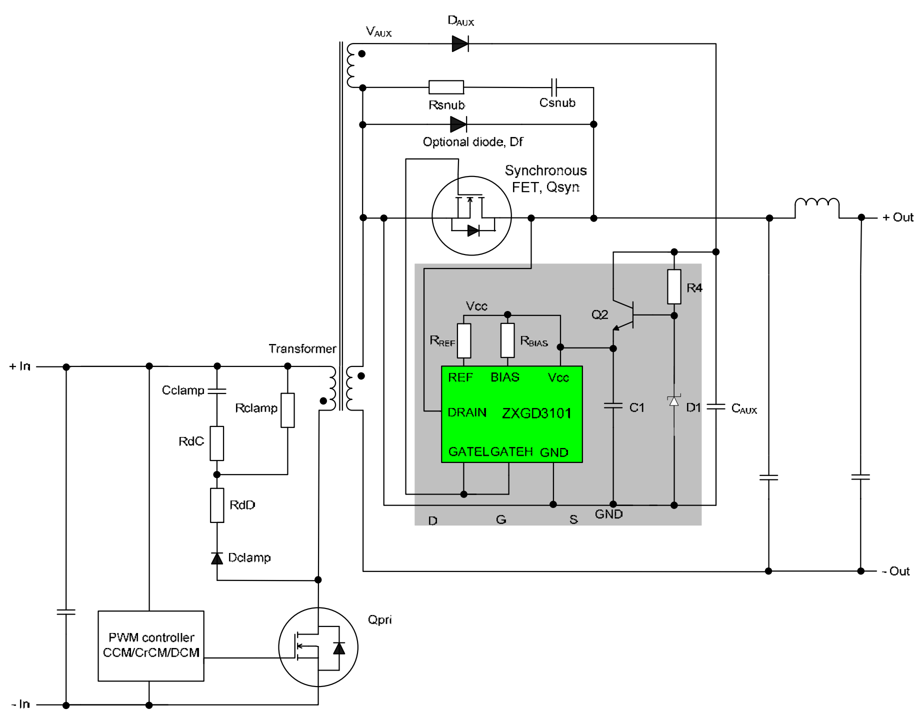


Figure 3: Example connection for high side synchronous rectification

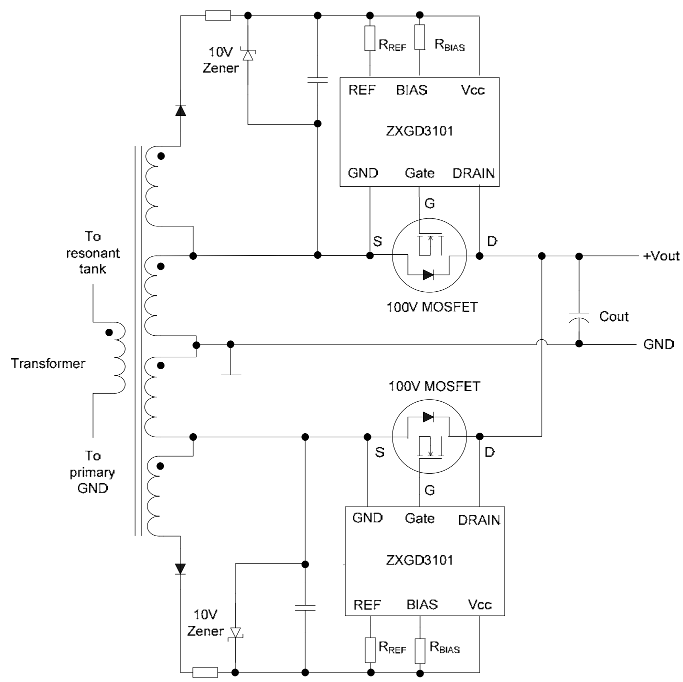


Figure 4: Example connections for LLC converter

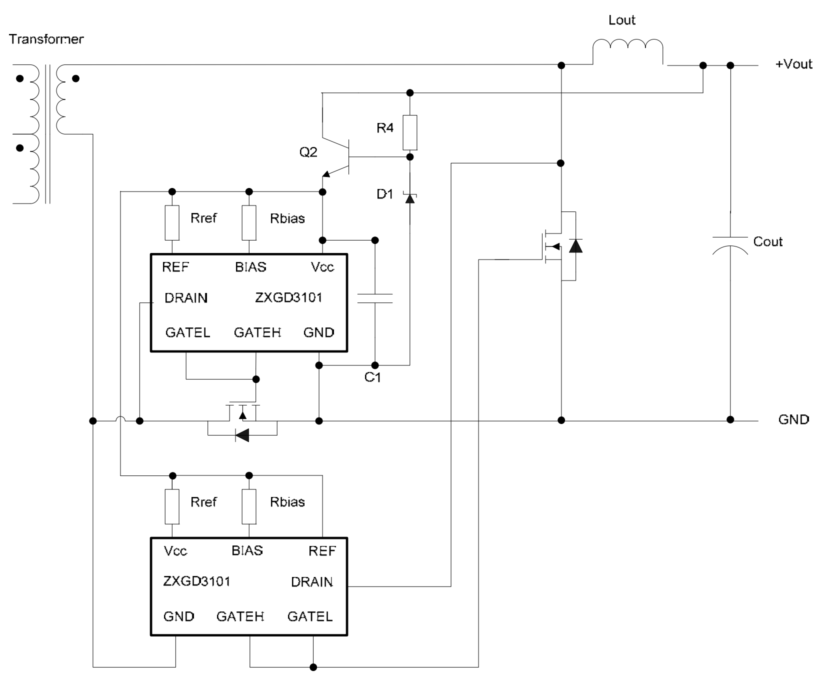


Figure 5: Example connections for Forward converter

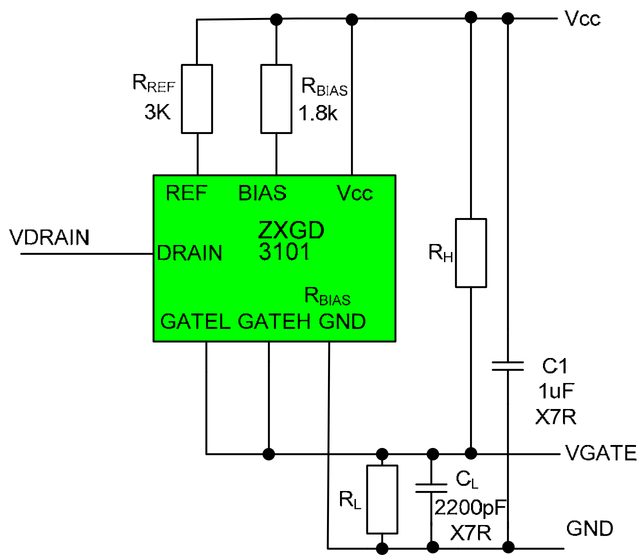


Figure 6: Test circuit

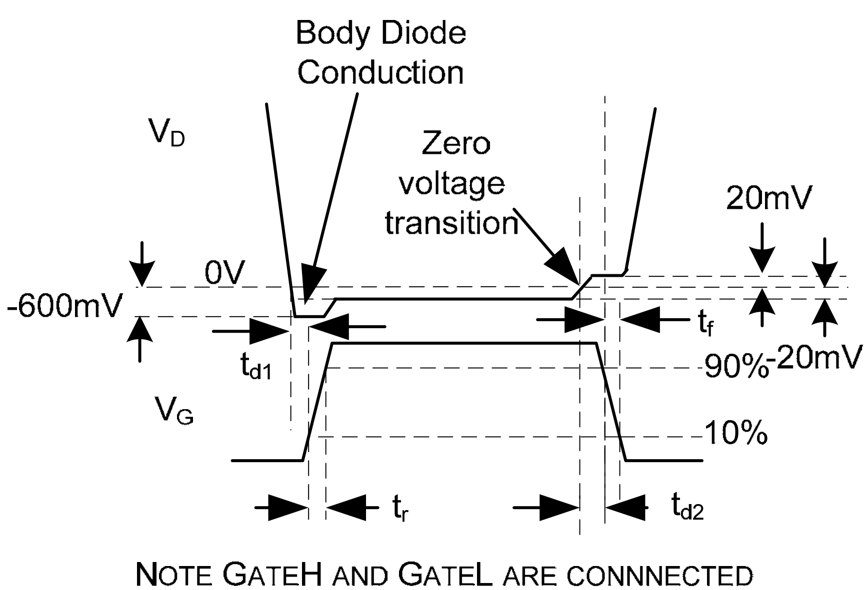
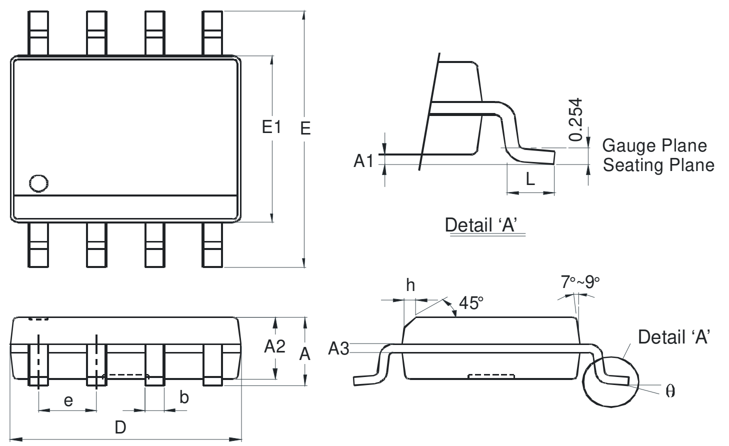


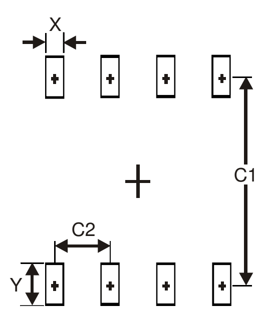
Figure 7: Timing Diagram

Package Outline and Dimensions



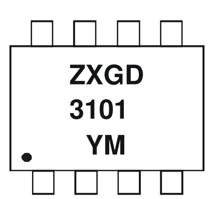
SO-8		
Dim	**Min**	**Max**
A	-	1.75
A1	0.10	0.20
A2	1.30	1.50
A3	0.15	0.25
b	0.3	0.5
D	4.85	4.95
E	5.90	6.10
E1	3.85	3.95
e	1.27 Typ	
h	-	0.35
L	0.62	0.82
θ	0°	8°
All Dimensions in mm		

Suggested Pad Layout



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

Marking Information



ZXGD3101 = Product Type Marking Code
YM = Date Code Marking
Y = Year (ex. W = 2009)
M = Month (ex. 9 = September)

Date Code Key

Year	2009	2010	2011	2012	2013	2014	2015
Code	W	X	Y	Z	A	B	C

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Code	1	2	3	4	5	6	7	8	9	O	N	D