TOSHIBA CDMOS Integrated Circuit Silicon Monolithic

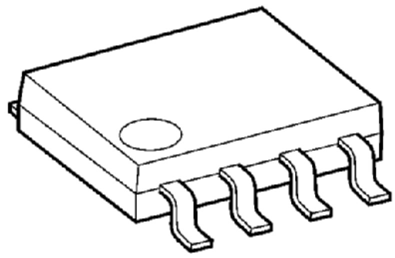
TC62D902FG

Offline Isolated flyback LED Controller with PFC

1. Feature

This product is isolated fly back LED controller IC with the power factor correction function.
A LED current that flows to the secondary-side of transformer is controlled by feedback primary-side of transformer. Therefore, the Photo coupler is not used.
External parts can be decreased compared with a past isolated fly back system.
Moreover, PFC function of one converter type is built into, and the power factor improvement is possible by few parts.

TC62D902FG



P-SOP8-0504-1.27-001

Weight: 0.07g (Typ.)

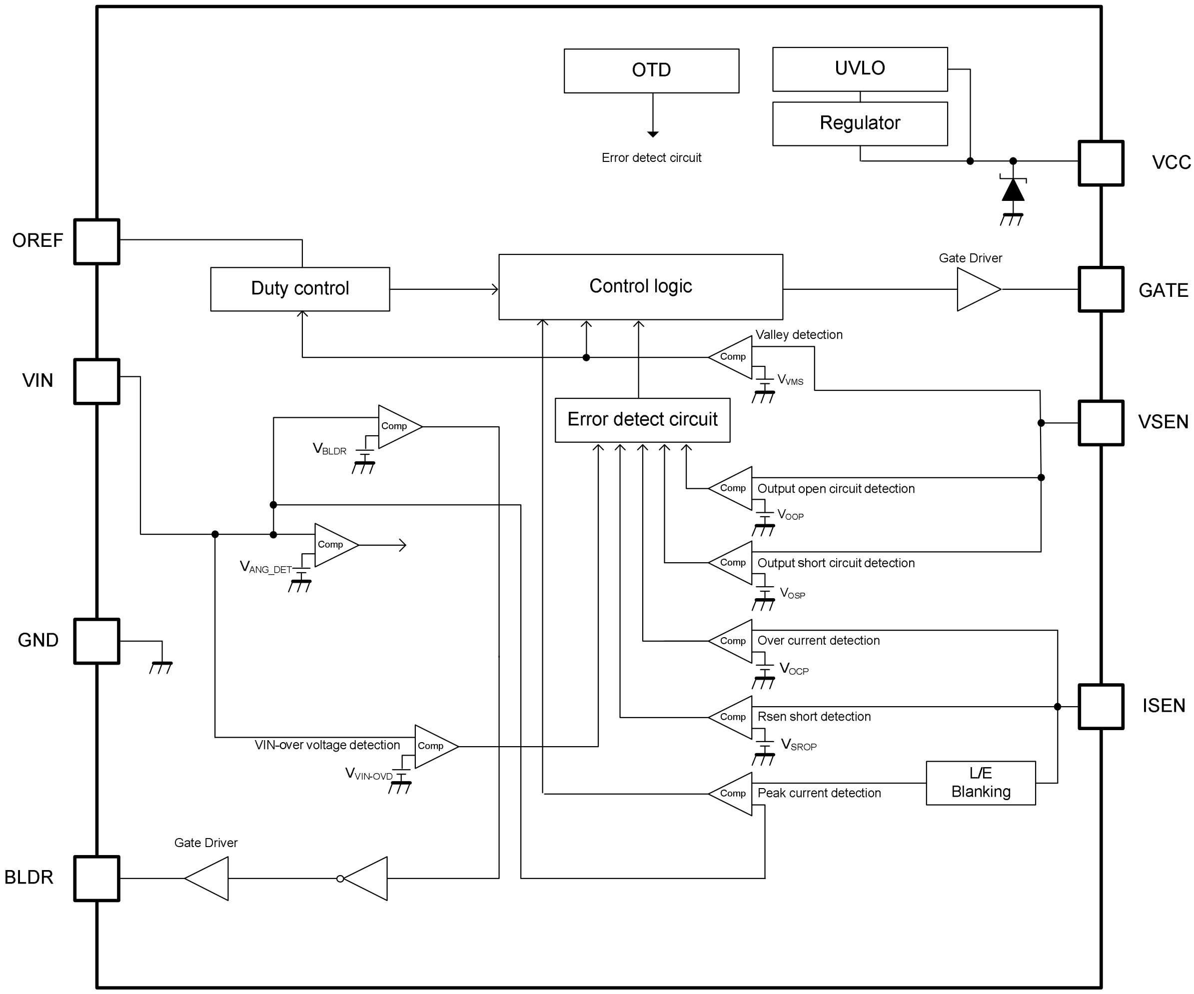
2. Use of recommend

LED lighting

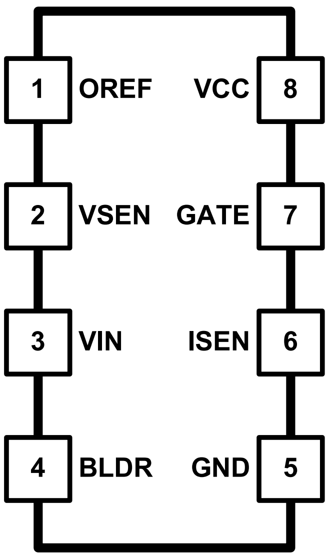
3. Characteristics

- Isolated PFC LED driver with minimum number of external parts
- TRIAC Dimmable
- 1 converter type PFC (PFC >0.9)
- Opto-isolator not need (Few parts and High Reliability)
- Valley switch operation (Efficiency improvement &EMI reduction)
- Detection function
  - Under voltage lockout (UVLO)
  - VIN over voltage detection (VIN-OVD)
  - Sense resistor short detection (SRSD)
  - Sense line open detection (IOD)
  - Over temperature detection (OTD)
  - Output open circuit detection (OOD)
  - Output short circuit detection (OSD)
  - Over current detection (OCD)
- Package : P-SOP8-0504-1.27-001

4. Block Diagram



5. Pin Assignment (top view)



6. Pin Functions

Pin No	Pin Name	I/O	Function
1	OREF	I	Capacitor connection terminal for internal oscillator
2	VSEN	I	Auxiliary voltage sense terminal. The LED current is controlled based on the detection result with this terminal.
3	VIN	I	PFC and TRIAC dimming operates based on the detection result with this terminal.
4	BLDR	O	Output terminal for control of external bleeder MOSFET.
5	GND	P	Grand terminal.
6	ISEN	I	Primary current sense terminal. The LED current is controlled based on the detection result with this terminal.
7	GATE	O	Output terminal for control of external power MOSFET.
8	VCC	PI	Power supply input terminal.

I: input terminal, O: output terminal, P: power supply and ground

7. Absolute Maximum Ratings (T_a = 25°C)

Characteristics	Symbol	Rating Note1	Unit
Supply voltage	V_{CC}	–0.3~ 40	V
OREF terminal voltage	V_{OREF}	–0.3~ 6.0	V
VSEN terminal voltage	V_{VSEN}	–0.7~ 6.0	V
VIN terminal voltage	V_{VIN}	–0.3~ 6.0	V
BLDR terminal voltage	V_{BLDR}	–0.3~ V_{CC}	V
ISEN terminal voltage	V_{ISEN}	–0.3~ 6.0	V
GATE terminal voltage	V_{GATE}	–0.3~V_{CC}	V
Operating temperature	T_{opr}	–40~85	°C
Storage temperature	T_{stg}	–55~150	°C
Thermal resistance	$R_{th(j-a)}$	90 Note3	°C/ W
Power dissipation	P_D	1.38 Note3,4	W

Note1: Voltage is ground referenced.
Note2: PCB condition is 76.2×114.3×1.6mm (JEDEC 4 layer substrate)
Note3: When ambient temperature is 25°C or more. Every time ambient temperature exceeded 1°C, please decrease 1/Rth(j-a).

Ta : the ambient air temperature of IC.
Topr : the ambient air temperature of IC under operation.
Tj : It is the junction temperature of IC under operation.
Tj maximum is restricted by the TSD (thermal shutdown) circuit.
Tj maximum recommends carrying out a thermal design within the limit of a 120 degreeC

Cautions on absolute maximum ratings

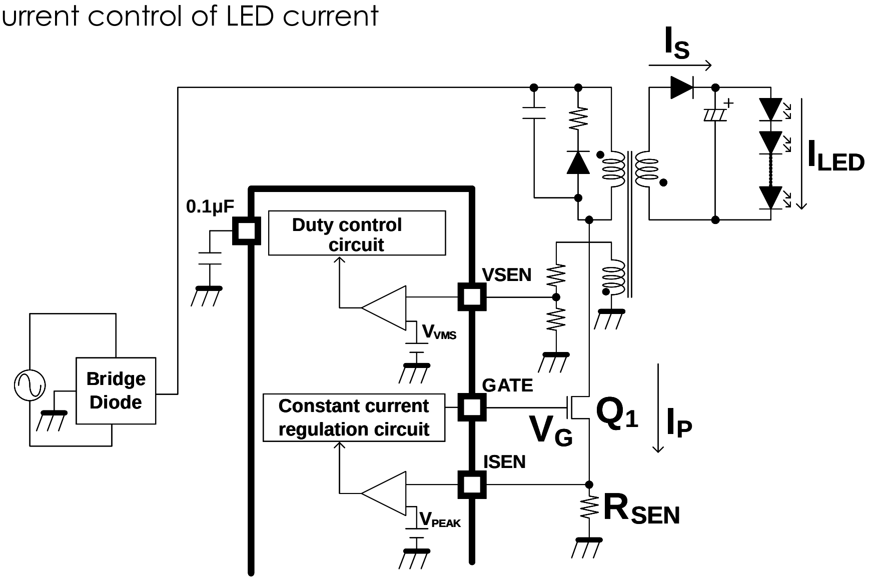
The absolute maximum ratings of a semiconductor device are a set of ratings that must not be exceeded, even for a moment.
Do not exceed any of these ratings.
Exceeding the rating(s) may cause the device breakdown, damage or deterioration, and may result injury by explosion or combustion.
The value of even one parameter of the absolute maximum ratings should not be exceeded under any circumstances. This device does not have over-voltage protection. Therefore, the device is damaged if a voltage exceeding its rated maximum is applied.
All voltage ratings including supply voltages must always be followed. The section on the protection features on the latter page should also be referred to.

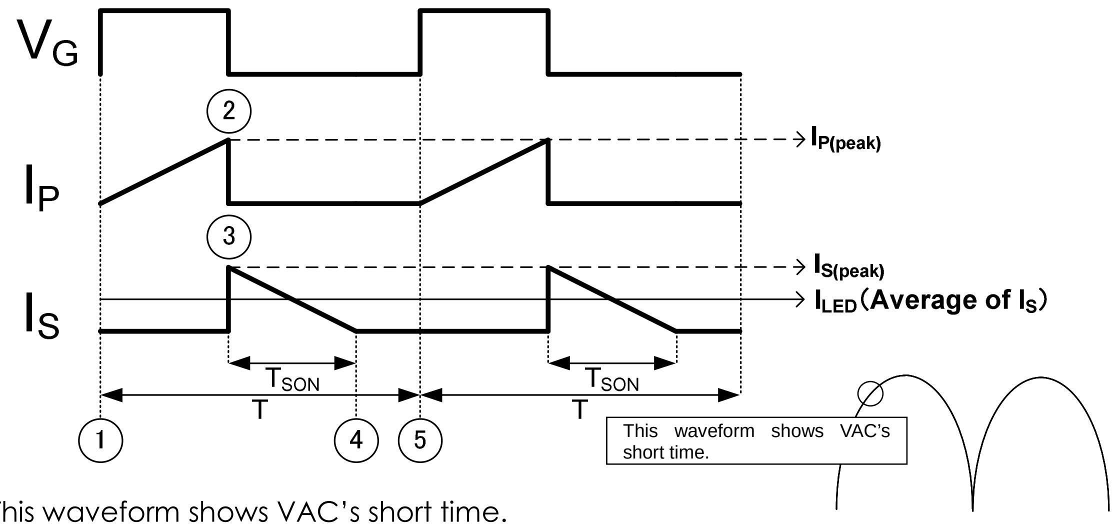
8. Electrical Characteristics (Unless otherwise noted, T_a = -40~85 °C, V_{CC}=15V)

Characteristics	Symbol	Test Circuit	Test Conditions	Min	Typ.	Max	Unit
<VCC part>							
Maximum operating voltage	$V_{CC(MAX)}$					**25**	V
Start-up current	I_{INST}		VIN = 10 V, CVCC = 10 µF		10	15	µA
Operating supply current	I_{CC}		BLDR=OFF,GATE=OFF		1.7	2.5	mA
Zener diode clamp voltage	V_Z		T_A = 25°C, I_Z = 5 mA	29			V
UVLO release threshold voltage	$V_{UVLO(REL)}$		V_{CC} rising	11	12	13	V
UVLO operation threshold voltage	$V_{UVLO(OPE)}$		V_{CC} falling	6.5	7.5	8.5	V
<VIN part>							
Input voltage range	V_{IN}			0		1.8	V
VIN-OVD threshold voltage	$V_{VIN\text{-}OVD}$			1.85	2.10	2.35	V
Conduction angle detection voltage	V_{ANG_DET}			0.10	0.14	0.18	V
<BLDR part>							
BLDR terminal off voltage	V_{BLDR}			0.22	0.28	0.34	V
BLDR terminal source resistance	R_{BLDRH}		I_{GATE}=-5mA	—	300	—	Ω
BLDR terminal sink resistance	R_{BLDRL}		I_{GATE}=+5mA	—	300	—	Ω
Output Voltage	V_{BLDR}				Vcc		
<VSEN part>							
Input leakage current	$I_{IN(Vsen)}$		V_{SENSE} = 2 V			1	µA
Valley detection voltage	V_{VMS}			0.10	0.14	0.18	V
OOP threshold voltage	V_{OOP}		T_A = 25°C	1.85	2.10	2.35	V
OSP threshold voltage	V_{OSP}			0.10	0.14	0.18	V
<GATE part>							
GATE terminal sauce resistance	R_{GATEH}		I_{GATE}=-10mA	—	30	—	Ω
GATE terminal sink resistance	R_{GATEL}		I_{GATE}=+10mA	—	50	—	Ω
GATE terminal rise time	t_{rGATE}		C_L=330pF, 10%to90%,T_A = 25°C	—	50	—	ns
GATE terminal fall time	t_{fGATE}		C_L=330pF, 90%to10%,T_A = 25°C	—	30	—	ns
Maximum operating frequency	$f_{SW(MAX)}$			200	—	—	kHz
Output Voltage	V_{BLDR}			—	Vcc	—	
<ISEN part>							
OCP threshold voltage	V_{OCP}			1.85	2.10	2.35	V
IOP threshold voltage	V_{OCP}			1.85	2.10	2.35	V
SROP threshold voltage	V_{SROP}			0.10	0.14	0.18	V
Blanking time	t_{BLANK}		Ta=25°C	0.2	0.3	0.4	µs
<OTP part>							
OTP operation temperature	T_{OTP}		Temperature rising	—	140	—	°C
OTP hysteresis temperature	$T_{OTP(HYS)}$		Temperature falling	—	20	—	°C

9. Application Information

9-1Constant current control of LED current





Note: This waveform shows VAC's short time.

1: Q_1 is turned on, and I_P flows to the primary-side of transformer.
2: I_P is detected by ISEN terminal when I_P reaches $I_{P(peak)}$, and Q_1 is turned off.
  *$I_{P(peak)}= V_{PEAK}/R_{SEN}$
3: $I_{S(peak)}$ is generated on the secondary-side of transformer.
  *$I_{S(peak)}= I_{P(peak)}\times Ntr= V_{PEAK}/R_{SEN}\times Ntr$
  *Ntr: Ratio of transformer winding on the primary-side and the secondary-side.
4: This current I_S decreases as the energy charged in the transformer decreases. And, it becomes 0mA.
  When I_S becomes 0mA, it is detected by VSEN terminal. As a result, T_{SON} can be detected.
5: The frequency control circuit controls T so that T_{SON}/T may become constant.

The LED current can be calculated by the following expressions.
IC keeps the LED current constant by controlling V_{PEAK} and T_{SON}/T.

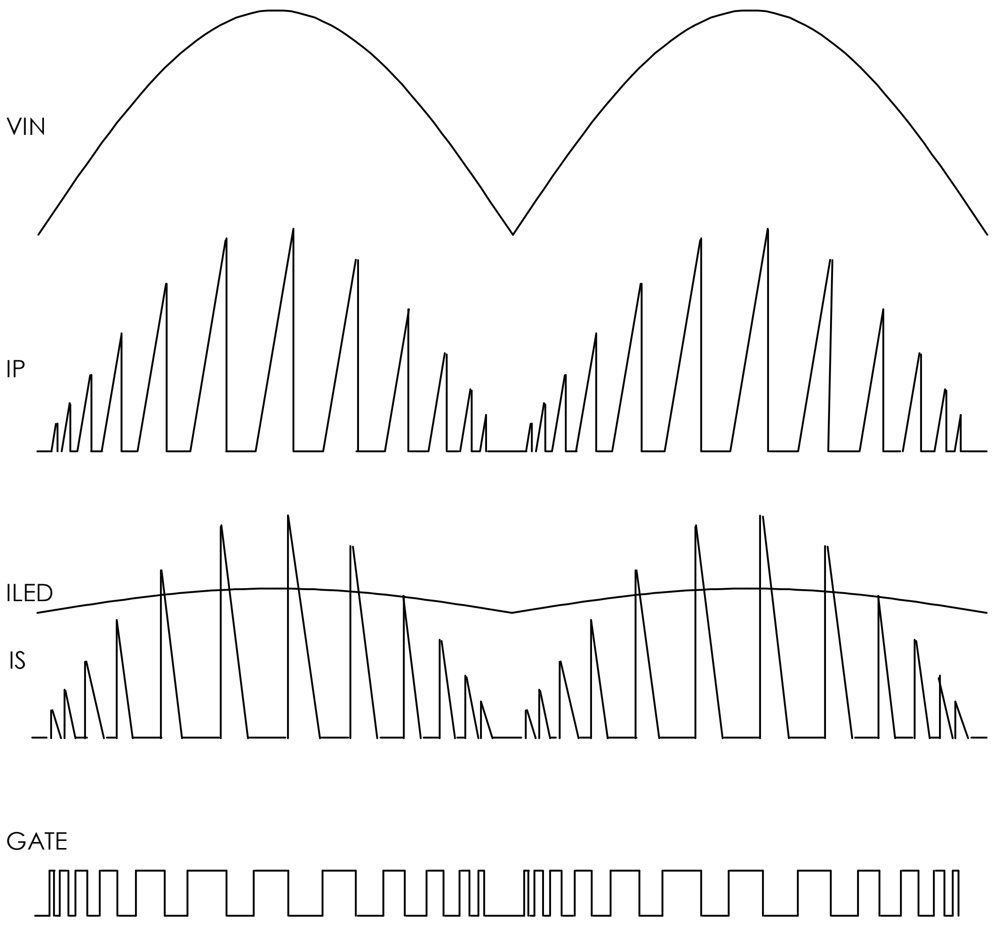
$$I_{LED}(\text{Average of } I_S)=I_{S(peak)}\times 1/2\times T_{SON}/T\times 2/\pi$$

$$= I_{P(peak)}\times Ntr\times 1/2\times T_{SON}/T\times 2/\pi$$
$$= V_{PEAK}/R_{SEN}\times Ntr\times 1/2\times T_{SON}/T\times 2/\pi$$

Application Condition : Tson/T = 4/7 (typ.), 1/T = 100kHz (30kHz ~ 200kHz)

9-2 One converter PFC

This IC adjusts V_{PEAK} according to AC shape of wave form detected with the V_{IN} terminal.
As a result, I_P near the sine wave is achieved and power factor will near 0.9

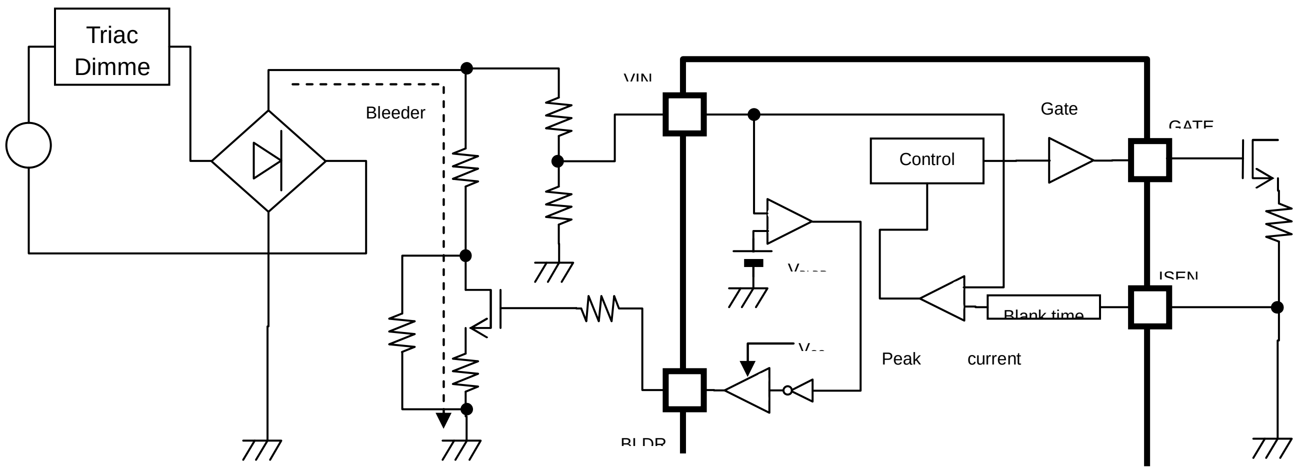


The output capacitance is necessary for LED to become smooth.
The On time of GATE waveform changes by the PFC with the upper figure.

Note)

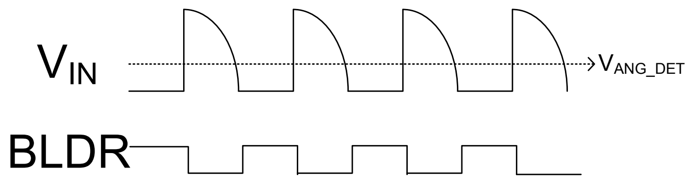
There are image, and anytime's different from the actual wave form.

9-3 TRIAC Dimming function



Conduction angle of modulation AC signal of the triac dimmer input to the VIN terminal is detected in threshold $V_{ANG\text{-}DET}$. The LED current is changed by adjusting V_{PEAK} by the detection result.
Triac dimming range is 5% to 100%. The input voltage of VIN terminal and BLDR terminal is 0V to 1.8V.

Threshold voltage of Triac conduction angle	Range of VIN
VAng-DET≦0.14V (TYP)	0~1.8V



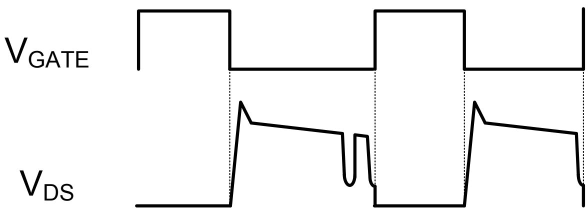
The bleeder current supply terminal changes depending on the input voltage to VIN terminal.

VIN terminal input voltage condition	The breeder current supply terminal
Less than 0.28V	BLDR ON
Over than 0.28V	BLDR Off

9-4 Valley switch operation

The EMI noise and the switching loss are decreased by doing the switching when V_{DS} of MOS is the lowest. This IC detects the minimum of V_{DS} by VSEN terminal.

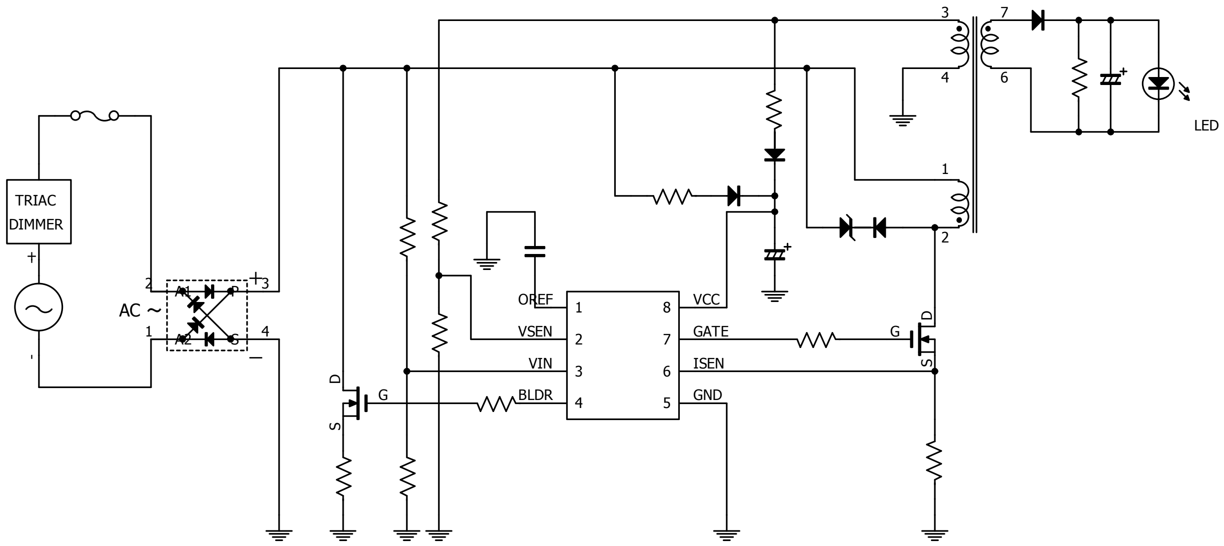
When it doesn't meet the condition of turning on by T_{SON}/T control, the valley might be skipped.



10. Detection function

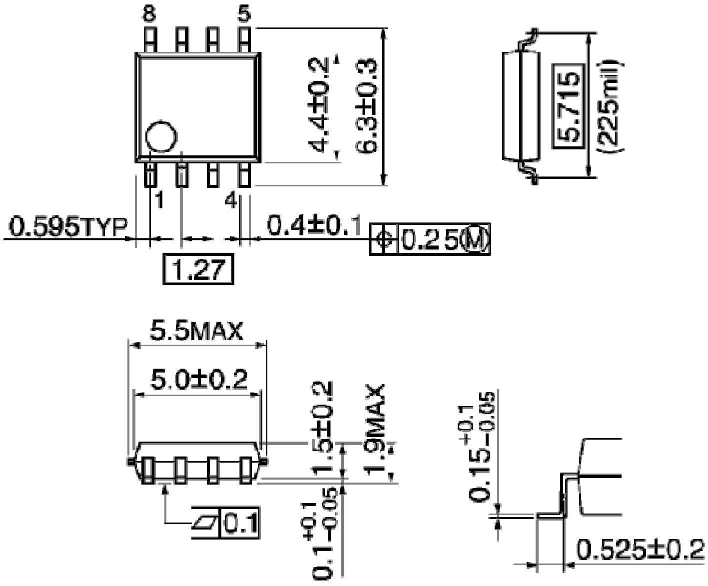
Detection function	Effect	Detection point	detection level	Operation at the time of detection	Release condition
Over temperature detection (OTD)	Over heating prevention	Internal temperature of IC	140°C(TYP)	GATE terminal output voltage is set to 0V, and switching control of Power MOS is stopped.	Temperature falls by 20°C(TYP) or more from a detection level
Under voltage lockout (UVLO)	Malfunction prevention by IC Supply voltage abnormality	VCC terminal voltage	7.5V(TYP)		Voltage rises by 4.5V(TYP) or more From a detection level
VIN over voltage detection (VIN-OVD)	Malfunction prevention by IC Supply voltage abnormality	VIN terminal voltage	2.10V(TYP) for 15 continuous half AC cycles		Voltage falls by blow detection level
Output open circuit detection (OOD)	Over-voltage prevention by LED open-circuit of LED	VSEN terminal voltage	2.10V(TYP) for 2 continuous switching cycles		The function of UVLO
Output short circuit Detection (OSD)	Malfunction prevention by IC by Short-circuit of LED	VSEN terminal voltage	0.14V(TYP)	Repetition of Starting and Stop.	
Over current Detection (OCD)	Over current prevention by circuit short-circuit	ISEN terminal voltage	2.10V(TYP)	GATE terminal output voltage is set to 0V, and switching control of Power MOS is stopped.	
ISEN line open detection (IOD)	Open line of ISEN to Rsense	ISEN terminal voltage	2.10V(TYP)		

11. Application figure



10. Package dimension

Unit : mm



Weight: 0.07 g (Typ.)

Notes on Contents

1. Block Diagrams
Some of the functional blocks, circuits, or constants in the block diagram may be omitted or simplified for explanatory purposes.

2. Equivalent Circuits
The equivalent circuit diagrams may be simplified or some parts of them may be omitted for explanatory purposes.

3. Timing Charts
Timing charts may be simplified for explanatory purposes.

4. Application Circuits
The application circuits shown in this document are provided for reference purposes only. Thorough evaluation is required, especially at the mass production design stage.
Toshiba does not grant any license to any industrial property rights by providing these examples of application circuits.

5. Test Circuits
Components in the test circuits are used only to obtain and confirm the device characteristics. These components and circuits are not guaranteed to prevent malfunction or failure from occurring in the application equipment.

IC Usage Considerations

Notes on handling of ICs

[1] The absolute maximum ratings of a semiconductor device are a set of ratings that must not be exceeded, even for a moment. Do not exceed any of these ratings.
Exceeding the rating(s) may cause the device breakdown, damage or deterioration, and may result injury by explosion or combustion.

[2] Use an appropriate power supply fuse to ensure that a large current does not continuously flow in case of over current and/or IC failure. The IC will fully break down when used under conditions that exceed its absolute maximum ratings, when the wiring is routed improperly or when an abnormal pulse noise occurs from the wiring or load, causing a large current to continuously flow and the breakdown can lead smoke or ignition. To minimize the effects of the flow of a large current in case of breakdown, appropriate settings, such as fuse capacity, fusing time and insertion circuit location, are required.

[3] If your design includes an inductive load such as a motor coil, incorporate a detection circuit into the design to prevent device malfunction or breakdown caused by the current resulting from the inrush current at power ON or the negative current resulting from the back electromotive force at power OFF. IC breakdown may cause injury, smoke or ignition.
Use a stable power supply with ICs with built-in detection functions. If the power supply is unstable, the detection function may not operate, causing IC breakdown. IC breakdown may cause injury, smoke or ignition.

[4] Do not insert devices in the wrong orientation or incorrectly.
Make sure that the positive and negative terminals of power supplies are connected properly.
Otherwise, the current or power consumption may exceed the absolute maximum rating, and exceeding the rating(s) may cause the device breakdown, damage or deterioration, and may result injury by explosion or combustion.
In addition, do not use any device that is applied the current with inserting in the wrong orientation or incorrectly even just one time.

[5] Carefully select external components (such as inputs and negative feedback capacitors) and load components (such as speakers), for example, power amp and regulator.
If there is a large amount of leakage current such as input or negative feedback condenser, the IC output DC voltage will increase. If this output voltage is connected to a speaker with low input withstand voltage, overcurrent or IC failure can cause smoke or ignition. (The over current can cause smoke or ignition from the IC itself.) In particular, please pay attention when using a Bridge Tied Load (BTL) connection type IC that inputs output DC voltage to a speaker directly.

RESTRICTIONS ON PRODUCT USE

- Toshiba Corporation, and its subsidiaries and affiliates (collectively "TOSHIBA"), reserve the right to make changes to the information in this document, and related hardware, software and systems (collectively "Product") without notice.
- This document and any information herein may not be reproduced without prior written permission from TOSHIBA. Even with TOSHIBA's written permission, reproduction is permissible only if reproduction is without alteration/omission.
- Though TOSHIBA works continually to improve Product's quality and reliability, Product can malfunction or fail. Customers are responsible for complying with safety standards and for providing adequate designs and safeguards for their hardware, software and systems which minimize risk and avoid situations in which a malfunction or failure of Product could cause loss of human life, bodily injury or damage to property, including data loss or corruption. Before customers use the Product, create designs including the Product, or incorporate the Product into their own applications, customers must also refer to and comply with (a) the latest versions of all relevant TOSHIBA information, including without limitation, this document, the specifications, the data sheets and application notes for Product and the precautions and conditions set forth in the "TOSHIBA Semiconductor Reliability Handbook" and (b) the instructions for the application with which the Product will be used with or for. Customers are solely responsible for all aspects of their own product design or applications, including but not limited to (a) determining the appropriateness of the use of this Product in such design or applications; (b) evaluating and determining the applicability of any information contained in this document, or in charts, diagrams, programs, algorithms, sample application circuits, or any other referenced documents; and (c) validating all operating parameters for such designs and applications. **TOSHIBA ASSUMES NO LIABILITY FOR CUSTOMERS' PRODUCT DESIGN OR APPLICATIONS.**
- **PRODUCT IS NEITHER INTENDED NOR WARRANTED FOR USE IN EQUIPMENTS OR SYSTEMS THAT REQUIRE EXTRAORDINARILY HIGH LEVELS OF QUALITY AND/OR RELIABILITY, AND/OR A MALFUNCTION OR FAILURE OF WHICH MAY CAUSE LOSS OF HUMAN LIFE, BODILY INJURY, SERIOUS PROPERTY DAMAGE AND/OR SERIOUS PUBLIC IMPACT ("UNINTENDED USE").** Except for specific applications as expressly stated in this document, Unintended Use includes, without limitation, equipment used in nuclear facilities, equipment used in the aerospace industry, medical equipment, equipment used for automobiles, trains, ships and other transportation, traffic signaling equipment, equipment used to control combustions or explosions, safety devices, elevators and escalators, devices related to electric power, and equipment used in finance-related fields. **IF YOU USE PRODUCT FOR UNINTENDED USE, TOSHIBA ASSUMES NO LIABILITY FOR PRODUCT.** For details, please contact your TOSHIBA sales representative.
- Do not disassemble, analyze, reverse-engineer, alter, modify, translate or copy Product, whether in whole or in part.
- Product shall not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable laws or regulations.
- The information contained herein is presented only as guidance for Product use. No responsibility is assumed by TOSHIBA for any infringement of patents or any other intellectual property rights of third parties that may result from the use of Product. No license to any intellectual property right is granted by this document, whether express or implied, by estoppel or otherwise.
- **ABSENT A WRITTEN SIGNED AGREEMENT, EXCEPT AS PROVIDED IN THE RELEVANT TERMS AND CONDITIONS OF SALE FOR PRODUCT, AND TO THE MAXIMUM EXTENT ALLOWABLE BY LAW, TOSHIBA (1) ASSUMES NO LIABILITY WHATSOEVER, INCLUDING WITHOUT LIMITATION, INDIRECT, CONSEQUENTIAL, SPECIAL, OR INCIDENTAL DAMAGES OR LOSS, INCLUDING WITHOUT LIMITATION, LOSS OF PROFITS, LOSS OF OPPORTUNITIES, BUSINESS INTERRUPTION AND LOSS OF DATA, AND (2) DISCLAIMS ANY AND ALL EXPRESS OR IMPLIED WARRANTIES AND CONDITIONS RELATED TO SALE, USE OF PRODUCT, OR INFORMATION, INCLUDING WARRANTIES OR CONDITIONS OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, ACCURACY OF INFORMATION, OR NONINFRINGEMENT.**
- Do not use or otherwise make available Product or related software or technology for any military purposes, including without limitation, for the design, development, use, stockpiling or manufacturing of nuclear, chemical, or biological weapons or missile technology products (mass destruction weapons). Product and related software and technology may be controlled under the applicable export laws and regulations including, without limitation, the Japanese Foreign Exchange and Foreign Trade Law and the U.S. Export Administration Regulations. Export and re-export of Product or related software or technology are strictly prohibited except in compliance with all applicable export laws and regulations.
- Please contact your TOSHIBA sales representative for details as to environmental matters such as the RoHS compatibility of Product. Please use Product in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. **TOSHIBA ASSUMES NO LIABILITY FOR DAMAGES OR LOSSES OCCURRING AS A RESULT OF NONCOMPLIANCE WITH APPLICABLE LAWS AND REGULATIONS.**