

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.

**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)

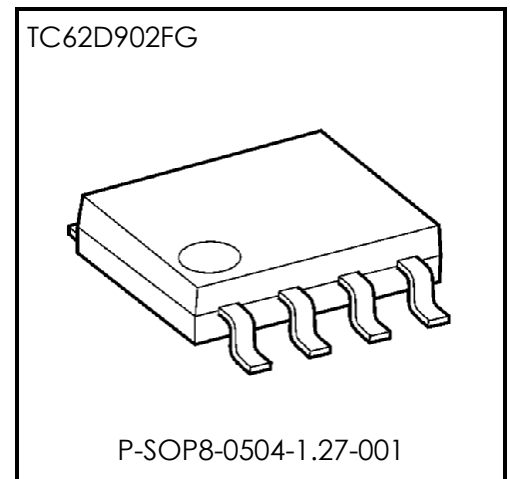
Over temperature detection (OTD)

Output open circuit detection (OOD)

Output short circuit detection (OSD)

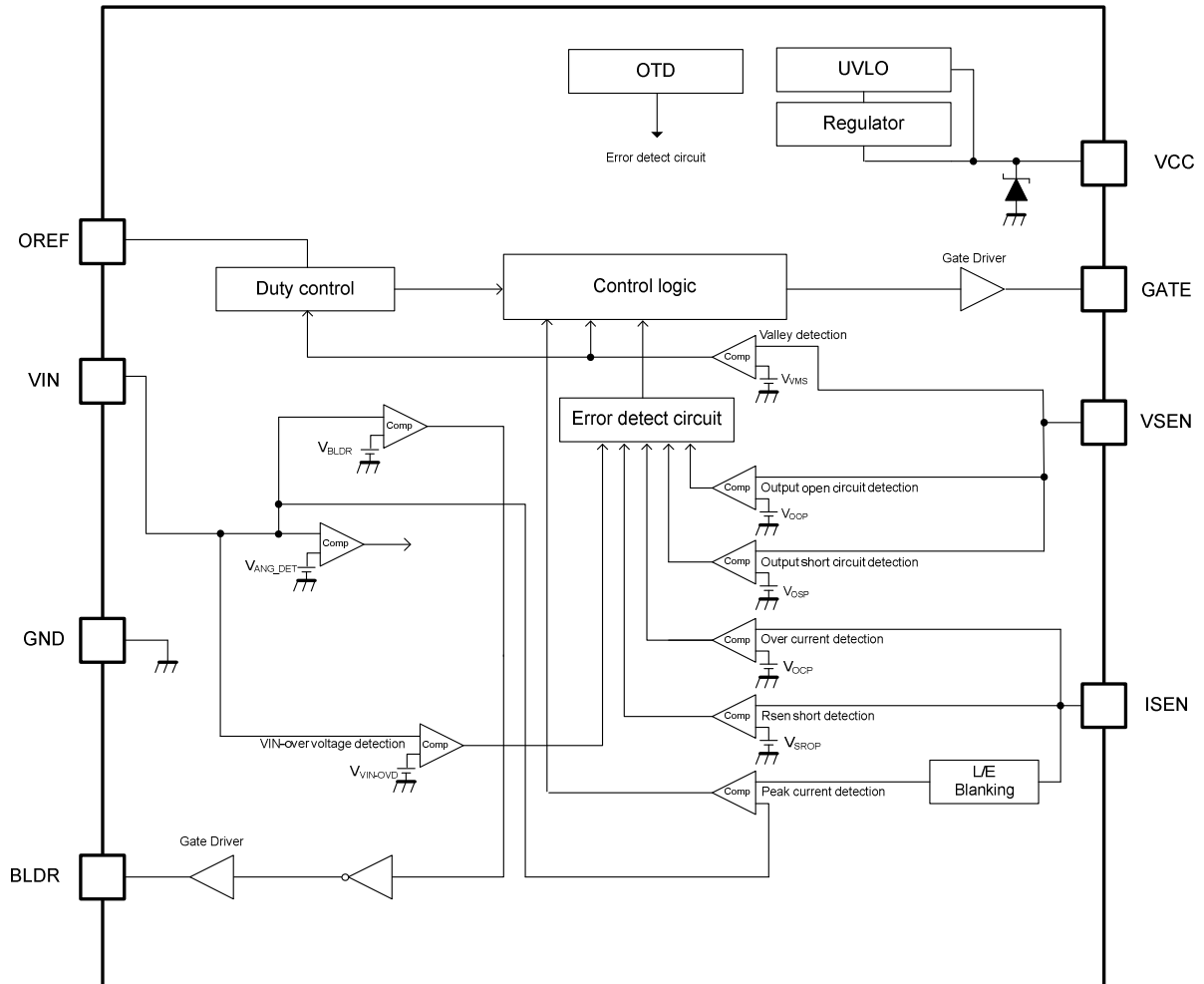
Over current detection (OCD)

- Package : P-SOP8-0504-1.27-001

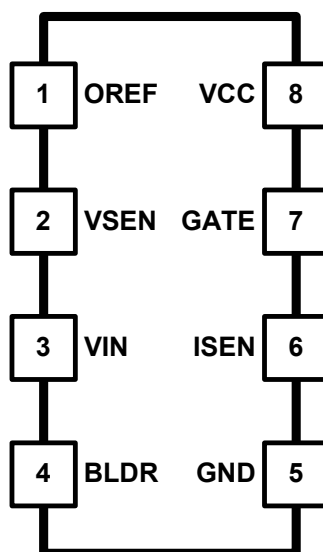


Weight: 0.07g (Typ.)

**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 ( $T_a = 25^\circ\text{C}$ )

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	$^\circ\text{C}$
Storage temperature	$T_{stg}$	-55~150	$^\circ\text{C}$
Thermal resistance	$R_{th(j-a)}$	90 Note3	$^\circ\text{C}/\text{W}$
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/ $R_{th(j-a)}$ .**

$T_a$  : the ambient air temperature of IC.

$T_{opr}$  : the ambient air temperature of IC under operation.

$T_j$  : It is the junction temperature of IC under operation.

$T_j$  maximum is restricted by the TSD (thermal shutdown) circuit.

$T_j$  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.

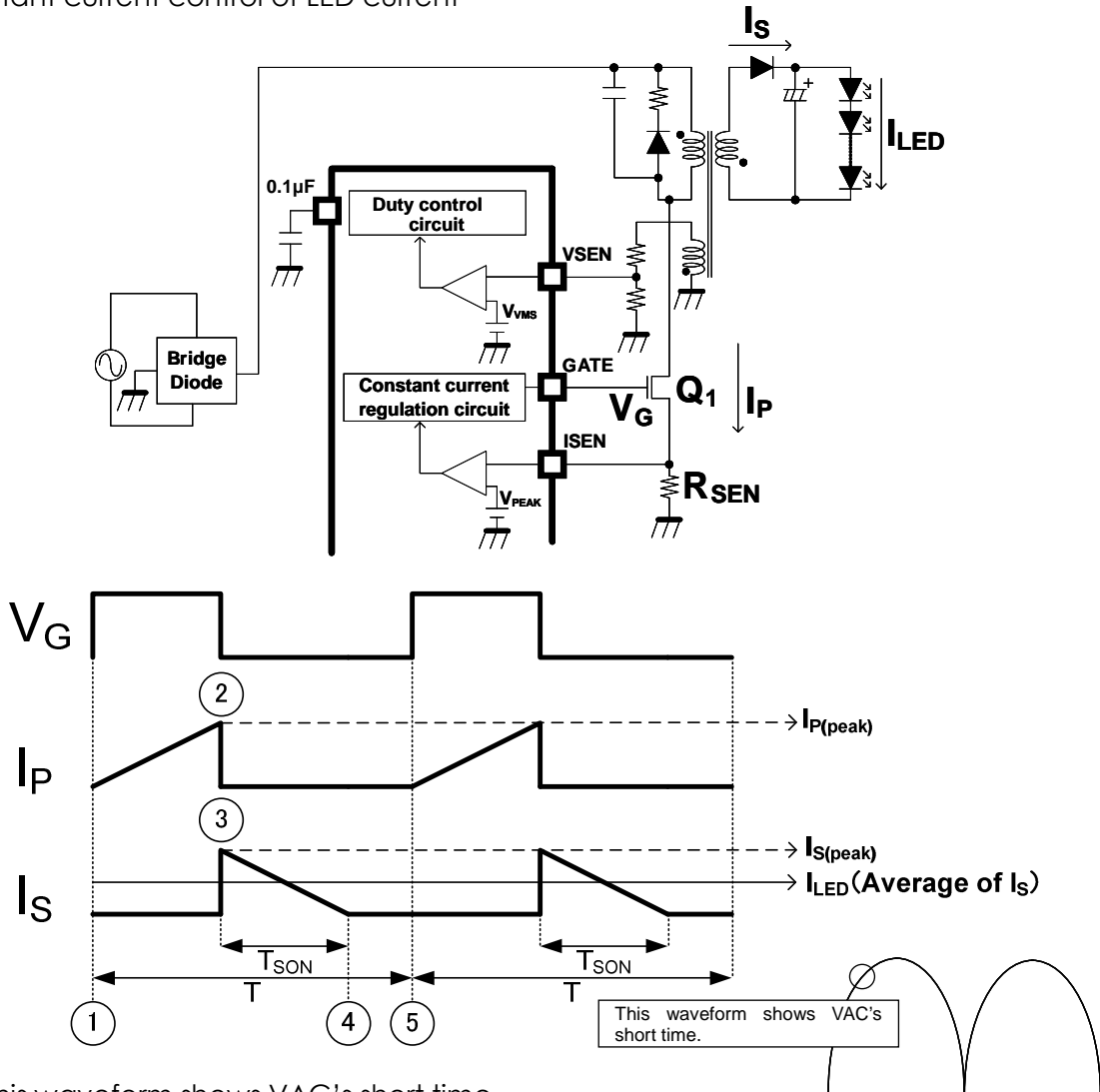
**All voltage ratings including supply voltages must always be followed. The section on the protection features on the latter page should also be referred to.**

8. Electrical Characteristics (Unless otherwise noted,  $T_a = -40\sim 85\text{ }^\circ\text{C}$ ,  $V_{CC}=15\text{V}$ )

Characteristics	Symbol	Test Circuit	Test Conditions	Min	Typ.	Max	Unit
<b>&lt;VCC part&gt;</b>							
Maximum operating voltage	$V_{CC(MAX)}$					<b>25</b>	V
Start-up current	$I_{INST}$		$V_{IN} = 10\text{V}$ , $C_{VCC} = 10\text{ }\mu\text{F}$		10	15	$\mu\text{A}$
Operating supply current	$I_{CC}$		BLDR=OFF,GATE=OFF		1.7	2.5	mA
Zener diode clamp voltage	$V_Z$		$T_A = 25^\circ\text{C}$ , $I_Z = 5\text{mA}$	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
<b>&lt;VIN part&gt;</b>							
Input voltage range	$V_{IN}$			0		1.8	V
VIN-OVD threshold voltage	$V_{VIN-OVD}$			1.85	2.10	2.35	V
Conduction angle detection voltage	$V_{ANG\_DET}$			0.10	0.14	0.18	V
<b>&lt;BLDR part&gt;</b>							
BLDR terminal off voltage	$V_{BLDR}$			0.22	0.28	0.34	V
BLDR terminal source resistance	$R_{BLDRH}$		$I_{GATE} = -5\text{mA}$	—	300	—	$\Omega$
BLDR terminal sink resistance	$R_{BLDRL}$		$I_{GATE} = +5\text{mA}$	—	300	—	$\Omega$
Output voltage	$V_{BLDR}$				$V_{CC}$		
<b>&lt;VSEN part&gt;</b>							
Input leakage current	$I_{IN(VSEN)}$		$V_{SENSE} = 2\text{V}$			1	$\mu\text{A}$
Valley detection voltage	$V_{VMS}$			0.10	0.14	0.18	V
OPP threshold voltage	$V_{OOP}$		$T_A = 25^\circ\text{C}$	1.85	2.10	2.35	V
OSP threshold voltage	$V_{OSP}$			0.10	0.14	0.18	V
<b>&lt;GATE part&gt;</b>							
GATE terminal source resistance	$R_{GATEH}$		$I_{GATE} = -10\text{mA}$	—	30	—	$\Omega$
GATE terminal sink resistance	$R_{GATEL}$		$I_{GATE} = +10\text{mA}$	—	50	—	$\Omega$
GATE terminal rise time	$t_{RIGATE}$		$C_L = 330\text{pF}$ , 10%to90%, $T_A = 25^\circ\text{C}$	—	50	—	ns
GATE terminal fall time	$t_{FIGATE}$		$C_L = 330\text{pF}$ , 90%to10%, $T_A = 25^\circ\text{C}$	—	30	—	ns
Maximum operating frequency	$f_{SW(MAX)}$			200	—	—	kHz
Output voltage	$V_{BLDR}$			—	$V_{CC}$	—	
<b>&lt;ISEN part&gt;</b>							
OC 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	$t_{BLANK}$		$T_a = 25^\circ\text{C}$	0.2	0.3	0.4	$\mu\text{s}$
<b>&lt;OTP part&gt;</b>							
OTP operation temperature	$T_{OTP}$		Temperature rising	—	140	—	$^\circ\text{C}$
OTP hysteresis temperature	$T_{OTP(HYS)}$		Temperature falling	—	20	—	$^\circ\text{C}$

9. Application Information

9-1 Constant current control of LED current



Note: This waveform shows VAC's short time.

- 1: Q<sub>1</sub> is turned on, and I<sub>P</sub> flows to the primary-side of transformer.
- 2: I<sub>P</sub> is detected by I<sub>SEN</sub> terminal when I<sub>P</sub> reaches I<sub>P(peak)</sub>, and Q<sub>1</sub> is turned off.  
\*I<sub>P(peak)</sub> = V<sub>PEAK</sub>/R<sub>SEN</sub>
- 3: I<sub>S(peak)</sub> is generated on the secondary-side of transformer.  
\*I<sub>S(peak)</sub> = I<sub>P(peak)</sub> × N<sub>tr</sub> = V<sub>PEAK</sub>/R<sub>SEN</sub> × N<sub>tr</sub>  
\*N<sub>tr</sub>: Ratio of transformer winding on the primary-side and the secondary-side.
- 4: This current I<sub>S</sub> decreases as the energy charged in the transformer decreases. And, it becomes 0mA.  
When I<sub>S</sub> becomes 0mA, it is detected by V<sub>SEN</sub> terminal. As a result, T<sub>SON</sub> can be detected.
- 5: The frequency control circuit controls T so that T<sub>SON</sub>/T may become constant.

The LED current can be calculated by the following expressions.  
IC keeps the LED current constant by controlling V<sub>PEAK</sub> and T<sub>SON</sub>/T.

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

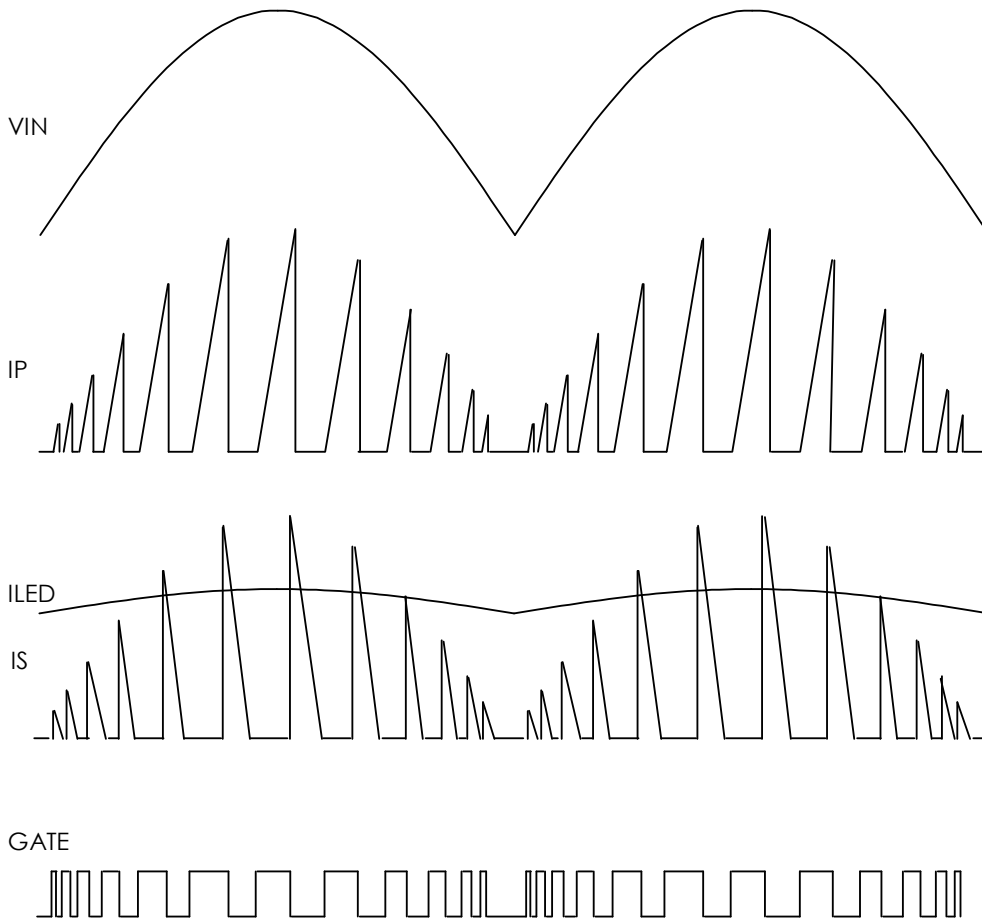
$$= I_{P(peak)} \times N_{tr} \times 1/2 \times T_{SON}/T \times 2/\pi$$

$$= V_{PEAK}/R_{SEN} \times N_{tr} \times 1/2 \times T_{SON}/T \times 2/\pi$$

Application Condition : T<sub>son</sub>/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

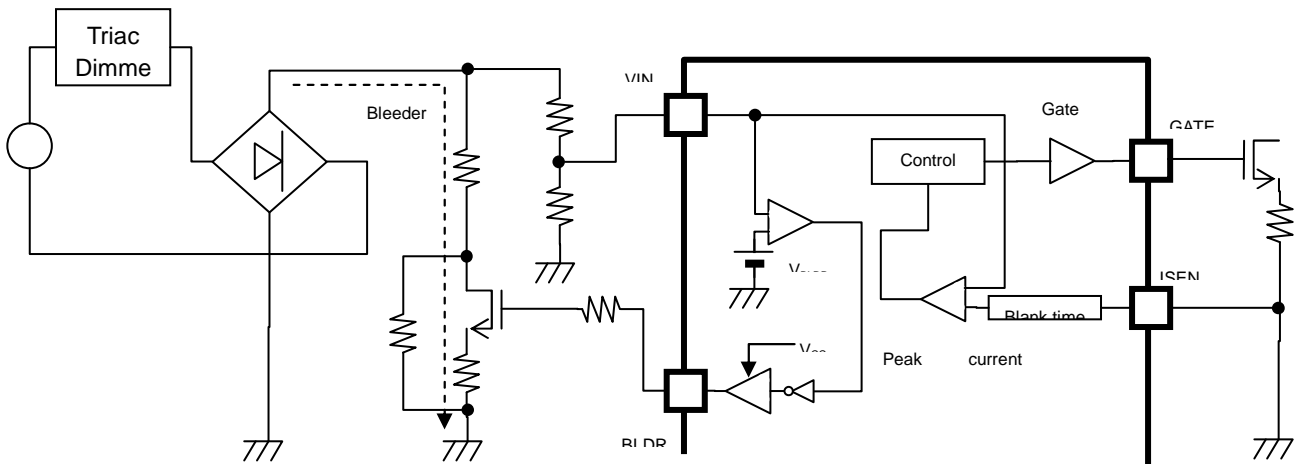


The output capacitance is necessary for LED to become smooth.  
The On time of GATE waveform changes by the PFC with the upper figure.

Note)

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

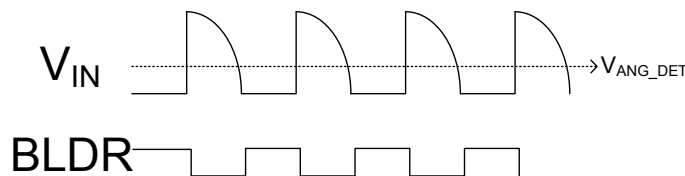
9-3 TRIAC Dimming function



Conduction angle of modulation AC signal of the triac dimmer input to the VIN terminal is detected in threshold  $V_{ANG-DET}$ . 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
$V_{Ang-DET} \leq 0.14V$ (TYP)	0~1.8V



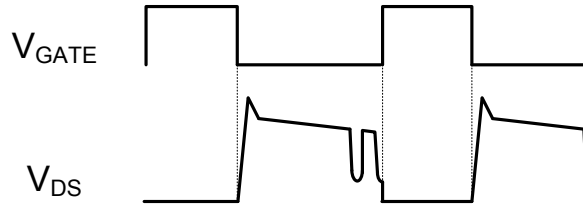
The bleeder current supply terminal changes depending on the input voltage to VIN terminal.

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.

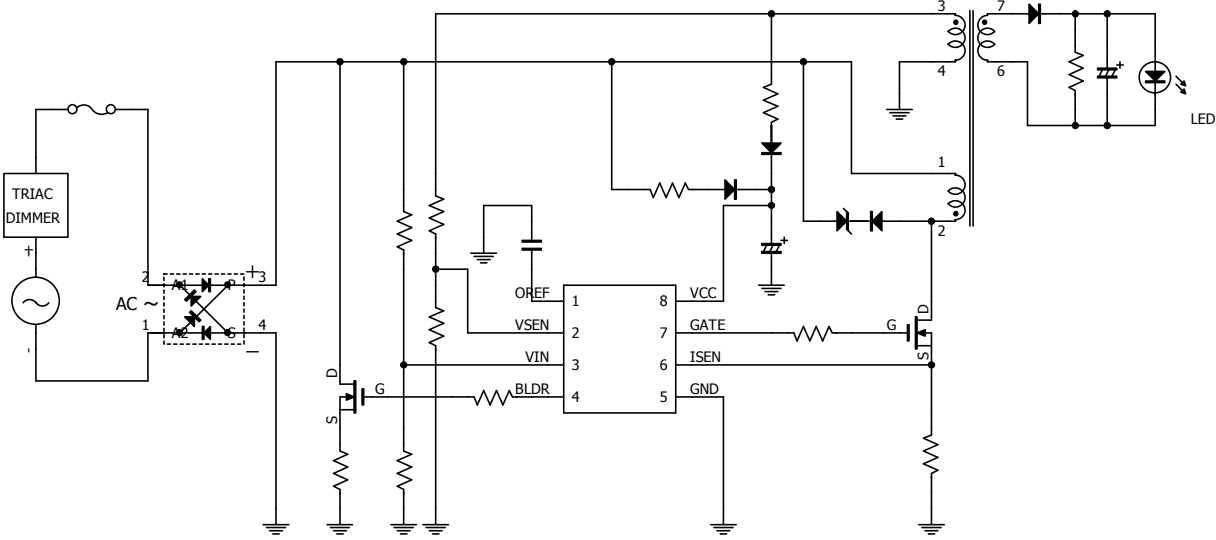


**10. Detection function**

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)		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)	GATE terminal output voltage is set to 0V, and switching control of Power MOS is stopped.	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	Repetition of Starting and Stop.	The function of UVLO
Output short circuit Detection (OSD)	Malfunction prevention by IC by Short-circuit of LED	VSEN terminal voltage	0.14V(TYP)		
Over current Detection (OCD)	Over current prevention by circuit short-circuit	ISEN terminal voltage	2.10V(TYP)		
ISEN line open detection (IOD)	Open line of ISEN to Rsense	ISEN terminal voltage	2.10V(TYP)	GATE terminal output voltage is set to 0V, and switching control of Power MOS is stopped.	

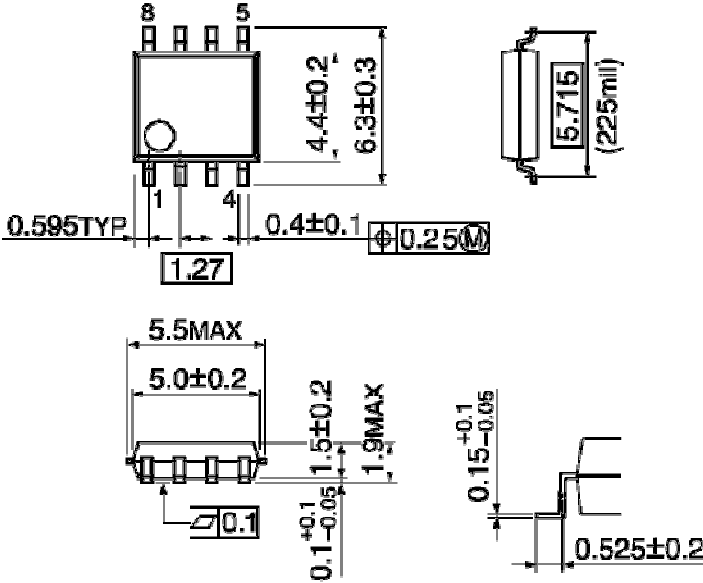


11. Application figure



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.

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**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.

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