TOSHIBA BiCD Integrated Circuit Silicon Monolithic

TB62D901FNG

The LED driver for lighting

1. Feature

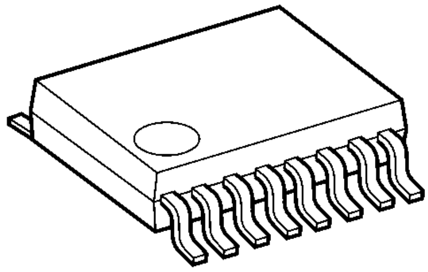
This product is constant current controller IC which built in the step-down type AC-DC converter.

The switching frequency of step-down control is automatically adjusted according to LED applied voltage or V_f value of connected LED. By this, it is possible to suppress the influence on the LED current value by LED applied voltage or V_f value of connected LED.

The linear dimming system which adjusts an LED current value by an analog voltage input and the PWM dimming system are supported.

In addition, the protection function to thermal shutdown, over-current, over-voltage, Under-voltage lockout, open / short of the ISEN terminal is built in.

TB62D901FNG



SSOP16-P-225-0.65B

Weight: TBD g (Typ.)

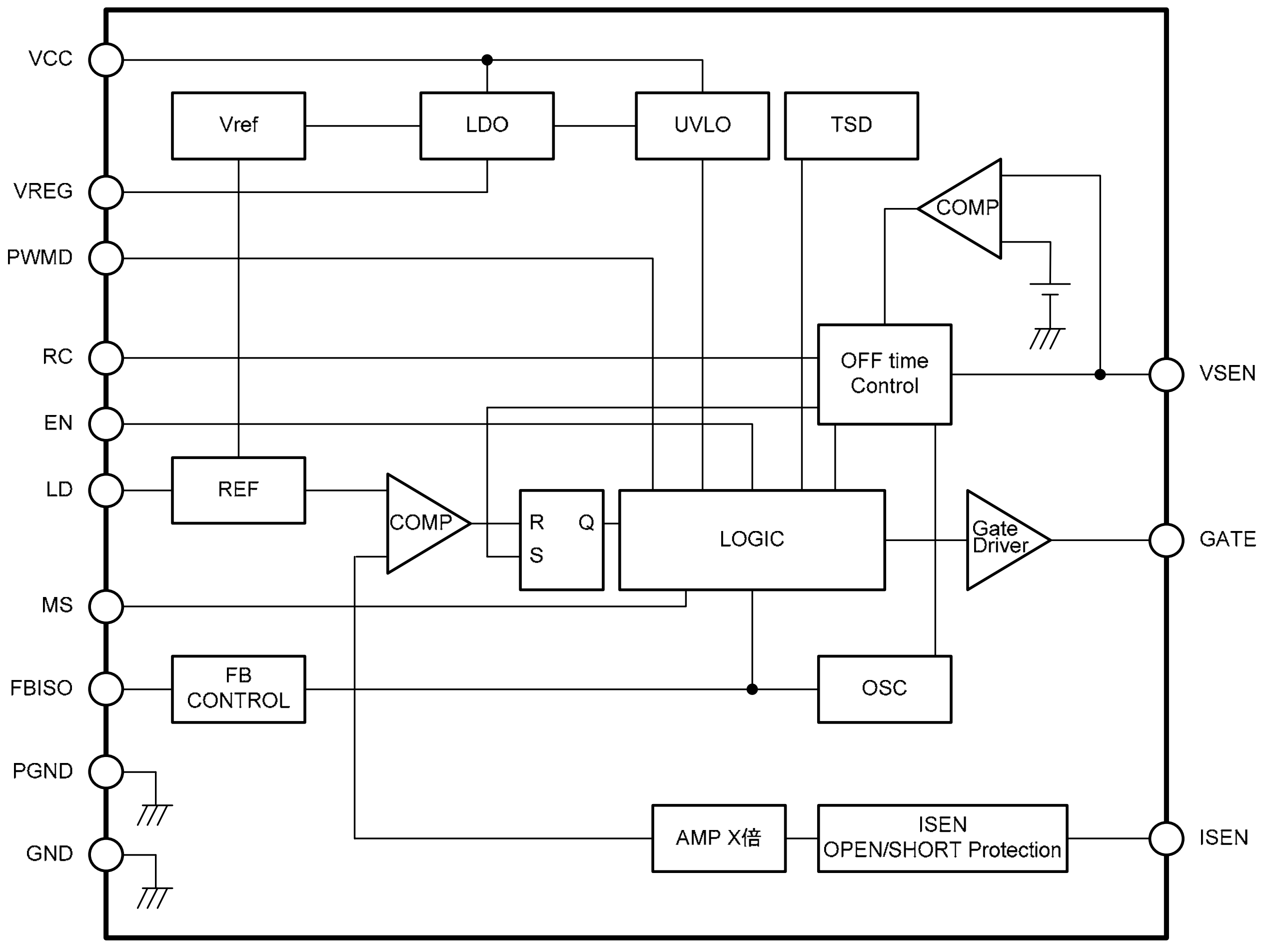
2. Use

LED lighting

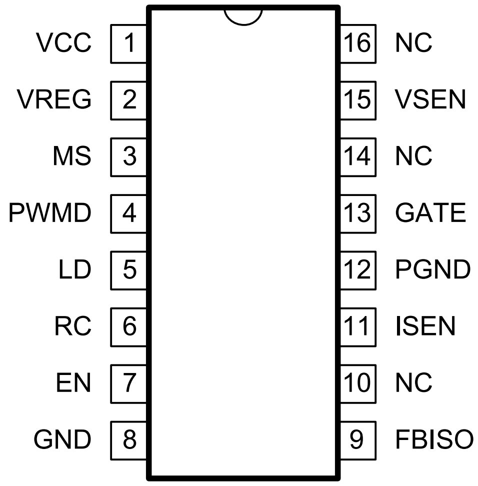
3. Characteristics

- Worldwide input is supported : Application voltage range $80V_{AC}$ ~ $270V_{AC}$
- Constant-current-control system : Constant LED current is realized by adjusting switching frequency automatically according to “LED applied voltage” or “V_f value of connected LED”.
- Dimming function : Linear dimming (Adjustment of LED current peak and ripple value)
  PWM dimming
- Switching frequency : Variable type 500kHz (MAX)
- Operation mode : It supports continuous current mode and critical mode
  As for critical mode, efficiency improvement and noise reduction are possible
- efficiency : 90% or more (with recommendation parts)
- Protection function : Thermal shutdown (TSD)
  Over-current protection (OCP)
  Over-voltage protection (OVP)
  Under-voltage lockout (UVLO)
  ISEN terminal open protection (IOP)
  ISEN terminal short protection (ISP)
- IC standby function : By an input to the EN, a change to the standby mode is possible
  It is 0.8mA (MAX) of supply current at the time of standby mode.
- The operating temperature range : T_{opr} = –40 °C ~ 105 °C
- Package : SSOP16-P-225-0.65B

4. Block Diagram



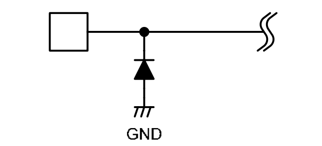
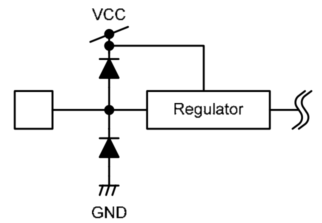
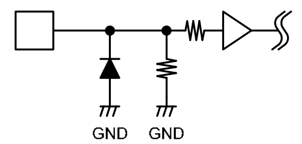
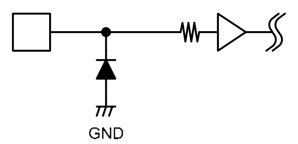
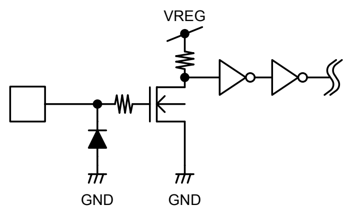
5. Pin Assignment (top view)

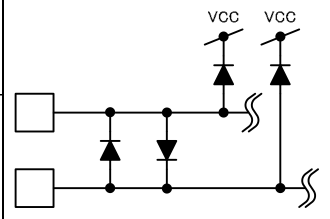
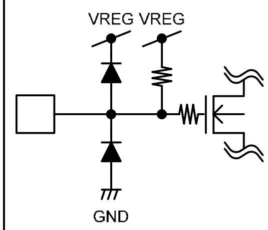
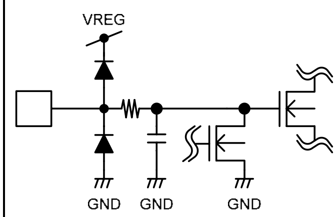
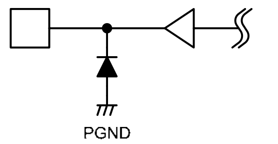
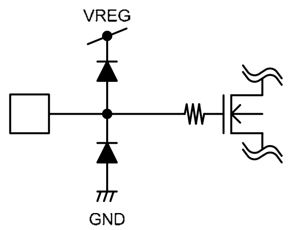


6. Pin Functions

Pin No	Pin Name	I/O	Function
1	VCC	P	Power supply input terminal.
2	VREG	O	Output terminal of the internal regulator.
3	MS	I	Input terminal for operation mode setting. It becomes continuous mode at the time of GND Short, and becomes critical mode at the time of VREG terminal Short.
4	PWMD	I	PWM signal input terminal for the PWM dimming. It becomes LED lighting at the time of “H" level voltage input, and becomes LED lighting out at the time of "L" level voltage input.
5	LD	I	Analog voltage input terminal for the linear dimming. The input voltage to this terminal can adjust the peak value of LED current.
6	RC	I	Analog voltage input terminal for the linear dimming. The input voltage to this terminal can adjust the ripple value of LED current.
7	EN	I	IC enable signal input terminal. It becomes operation mode at the time of “H" level voltage input, and becomes standby mode at the time of "L" level voltage input. In standby mode, circuits other than the regulator circuit, the standard voltage circuit, and the protection circuit stop.
8	GND	P	Grand terminal.
9	FBISO	I	Feedback voltage input terminal at the time of isolated type application. In the non-isolated type application, please make Short connection at the VREG terminal.
10	NC	-	Non-contact terminal.
11	ISEN	I	Detection terminal of LED current. The peak value of LED current is decided by the resistance that was connected between this terminal and GND.
12	PGND	P	Power grand terminal.
13	GATE	O	Output terminal for control of power MOSFET. The gate of the power MOSFET for step-down control is driven.
14	NC	-	Non-contact terminal.
15	VSEN	I	Feedback voltage input terminal. The switching frequency of step-down control is decided according to the input voltage to this terminal.
16	NC	-	Non-contact terminal.

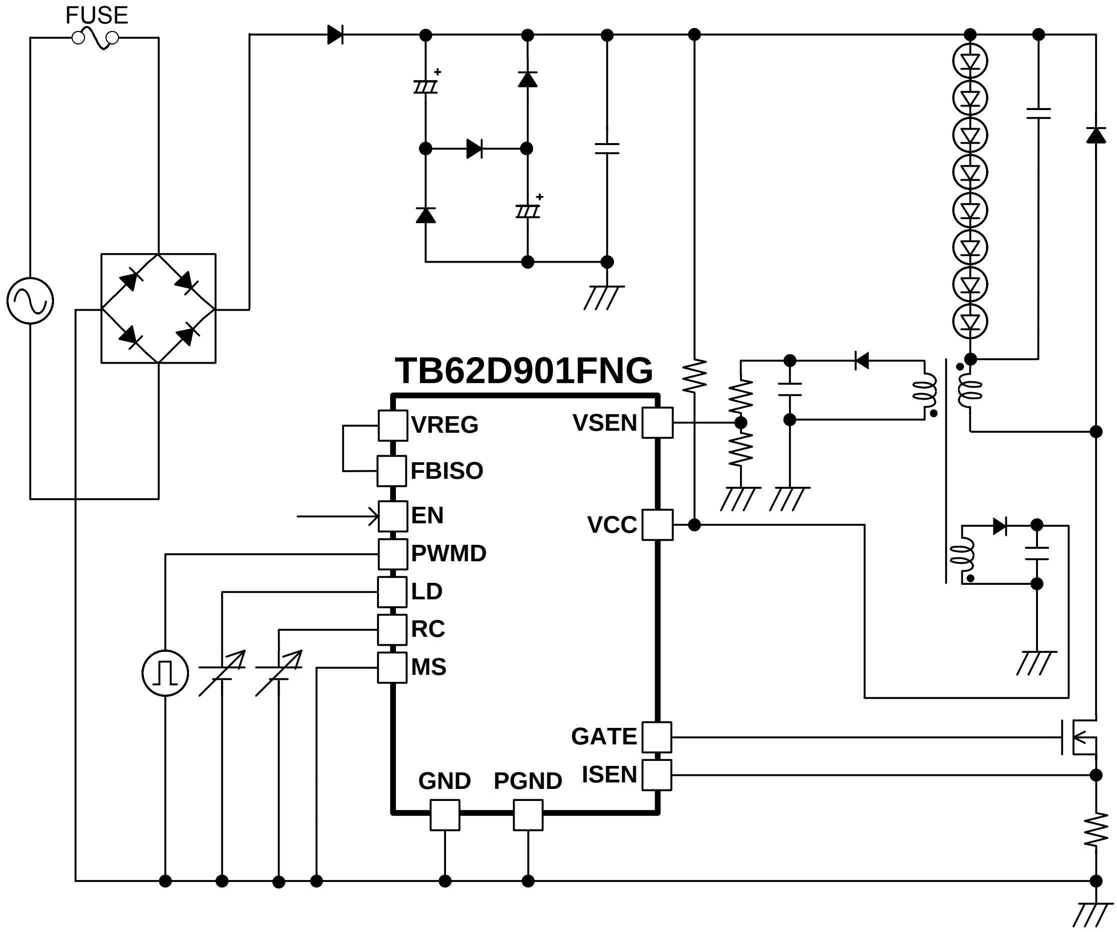
7. I/O Equivalent Circuits

Pin No	Pin Name	Equivalent circuit
1	VCC	
2	VREG	
3	MS	
5	LD	
6	RC	
4	PWMD	
7	EN	

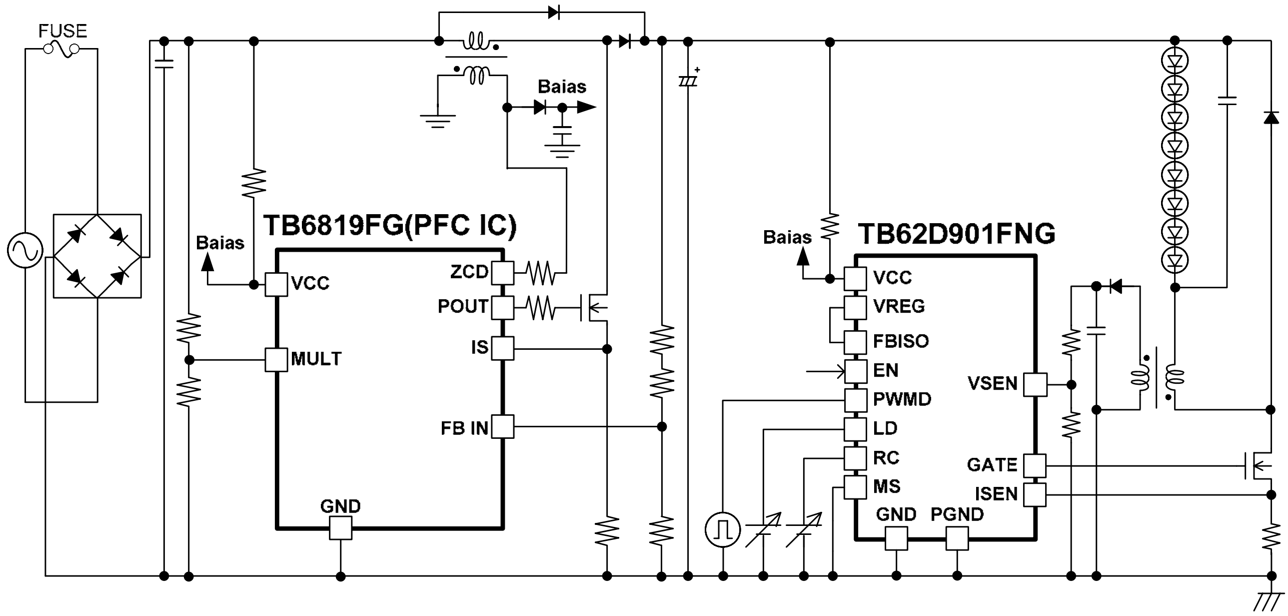
Pin No	Pin Name	Equivalent circuit
8	GND	
12	PGND	
9	FBISO	
11	ISEN	
13	GATE	
15	VSEN	

8. Application figure

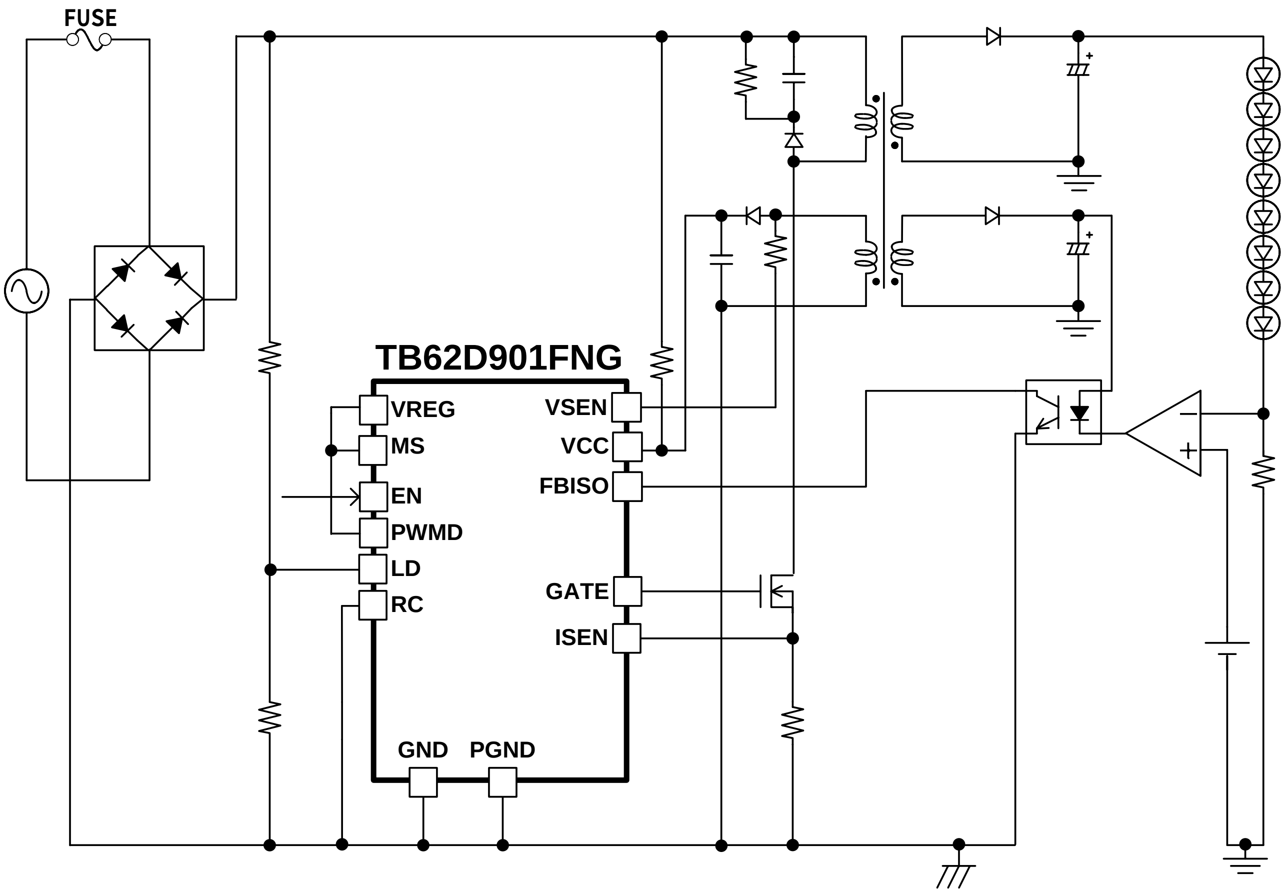
Non-isolated application figure 1



Non-isolated application figure 2



Isolated application figure



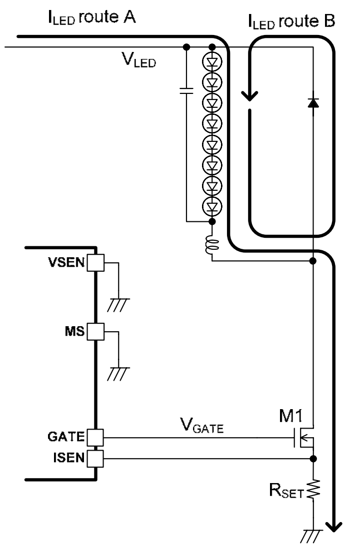
9. Application Information

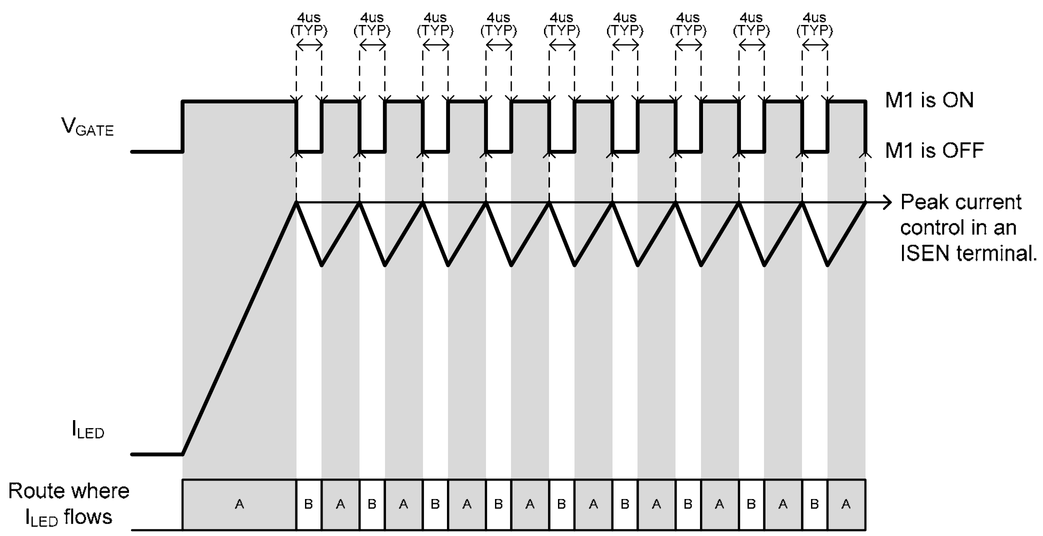
9.1 Non-isolated application

It can choose from the following three kinds of modes of operation mode. Operation mode is decided according to processing of MS terminal and a VSEN terminal. Control of power MOS (M1) is different in each operation mode.

Operation mode		Terminal processing		Control of Power MOS (M1)	
		MS terminal	VSEN terminal	On-timing	Off-timing
1	OFF time fixed mode	Short to GND	Short to GND	It fixes after 4μs(TYP).	It is decided by the peak current detection in the SEN terminal.
2	OFF time automatic adjustment mode	Short to GND	The secondary side of the transformer is connected.	It is decided by a VSEN terminal applied voltage.	It is decided by the peak current detection in the SEN terminal.
3	Critical mode	Short to VREG terminal	The secondary side of the transformer is connected.	It is decided by a VSEN terminal applied voltage.	It is decided by the peak current detection in the SEN terminal.

9.1.1 About OFF time fixed mode (It is realizable with few parts.)

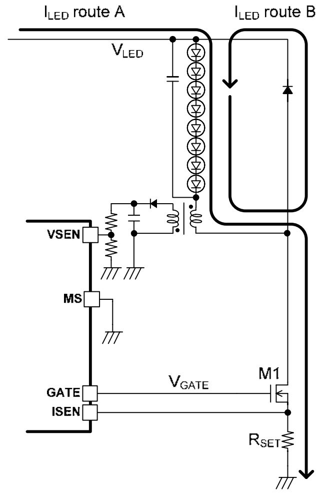


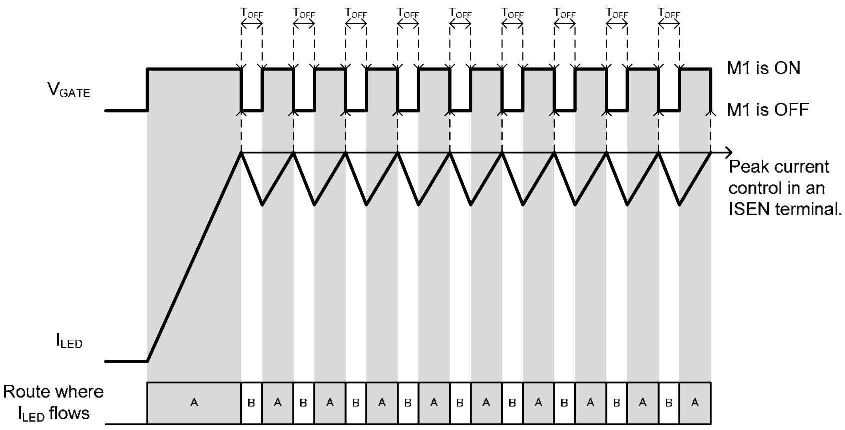


When I_{LED} route A detected with the ISEN terminal rises to the set peak current value, M1 is turned off. And when 4μs (TYP) has passed since M1 turned off, M1 is turned on again. The peak current value can be set up with LD terminal input voltage. (Please refer to page 12 for details.)

By this control, it is possible to suppress the influence on the LED current value by V_f value of connected LED.

9.1.2 OFF time automatic adjustment mode (LED current with the small dependence to LED applied voltage or V_f value of connected LED is obtained.)

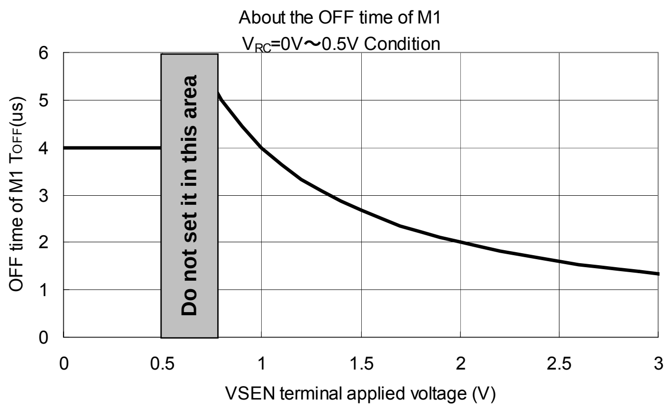




When I_{LED} route A detected with the ISEN terminal rises to the set peak current value, M1 is turned off. And when T_{OFF} has passed since M1 turned off, M1 is turned on again. The peak current value can be set up with LD terminal input voltage. (Please refer to page 12 for details.) T_{OFF} is decided according to the voltage generated on secondary side voltage of a transformer. Secondary side voltage is stabilized in (total V_f of LED) + (V_f of diode).

Please input the voltage to the VSEN terminal through voltage divider circuit. Please set the resistance of the voltage divider circuit so that a VSEN terminal applied voltage becomes 1V. In this case, the OFF time of M1 is set to 4μs (TYP).

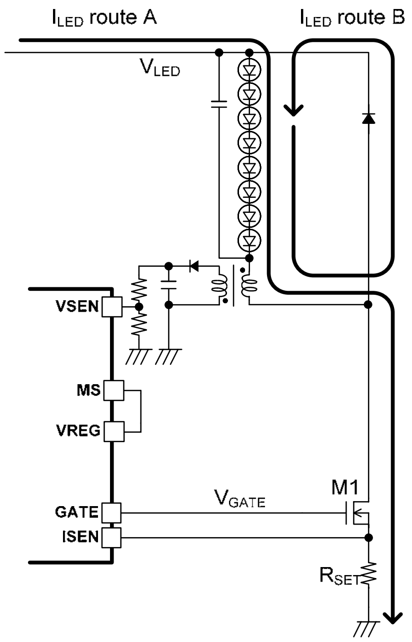
The applied voltage of the VSEN terminal changes when Vf of LED and the diode is changed by the temperature property. This voltage change is detected and the OFF time of M1 is adjusted automatically.

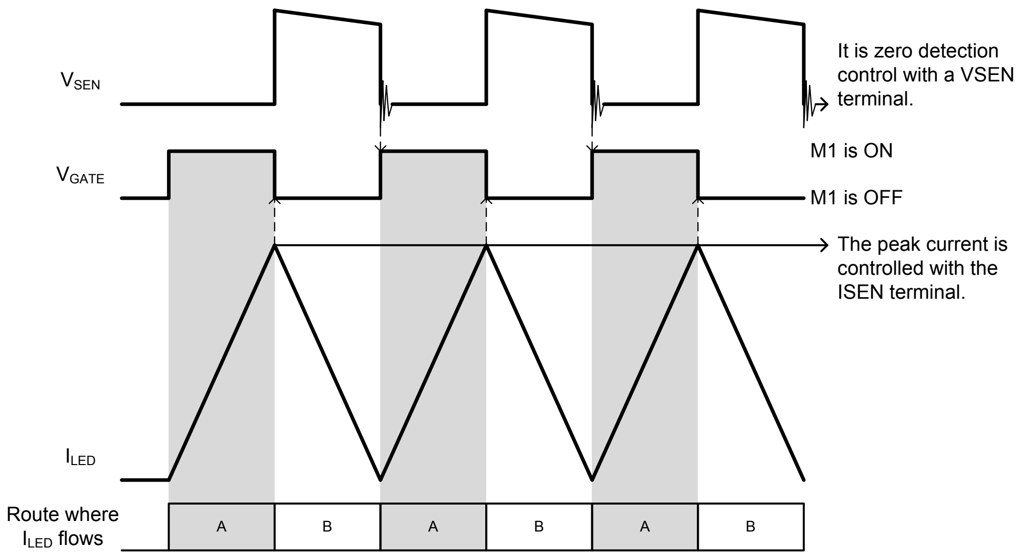


Please use the input voltage to a VSEN terminal in 0V~0.5V or 0.75V~3.0V.

By this control, it is possible to suppress the influence on the LED current value by LED applied voltage or V_f value of connected LED.

9.1.3 About critical mode





When I_{LED} route A detected with the ISEN terminal rises to the set peak current value, M1 is turned off. I_{LED} route B = 0mA is detected by zero detection on the secondary side of the transformer, and M1 is turned on again. The peak current value can be set up with LD terminal input voltage. (Please refer to page 12 for details.)

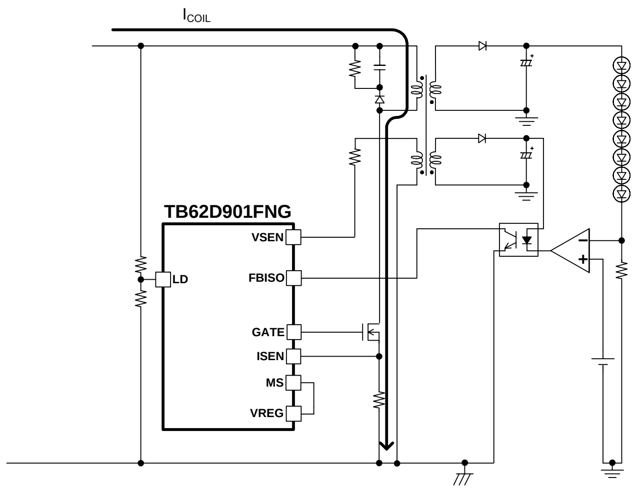
By this control, it is possible to suppress the influence on the LED current value by LED applied voltage or V_f value of connected LED. In addition, because this mode is slow the switching frequency of M1, the improvement of efficiency and the decrease of the noise are possible.

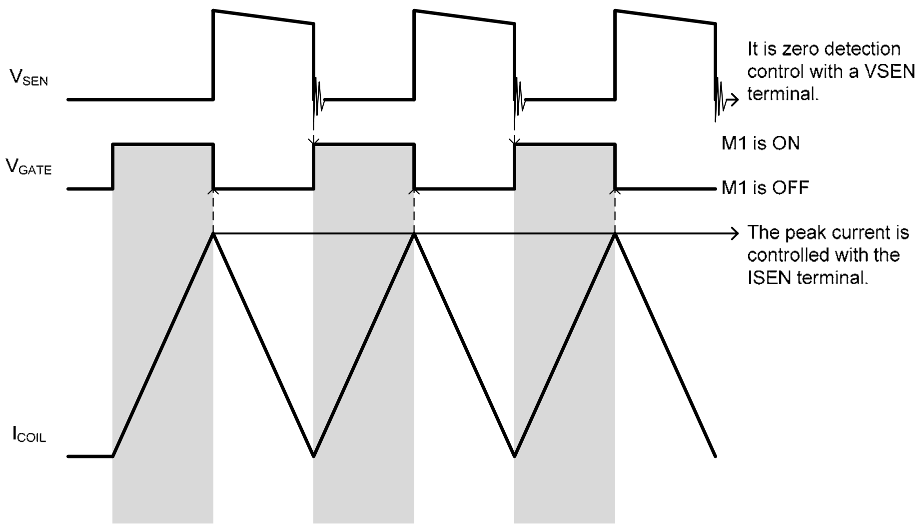
9.2 Isolated application

Operation mode		Terminal processing		Control of Power MOS (M1)	
		MS terminal	VSEN terminal	On-timing	Off-timing
1	Isolated system mode	Short to VREG terminal	The secondary side of the transformer is connected.	It is decided by a VSEN terminal applied voltage.	It is decided by the peak current detection in the SEN terminal.

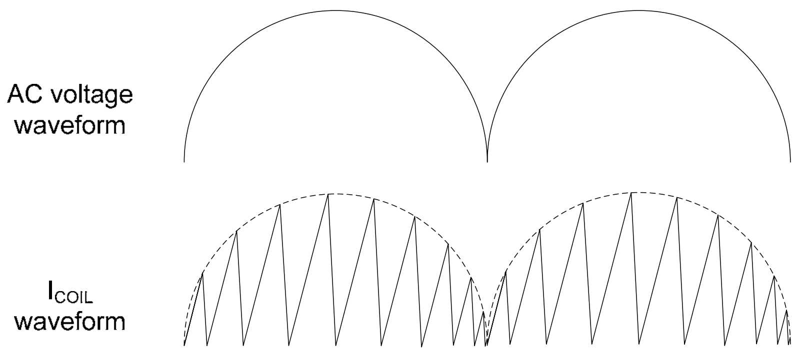
When I_{COIL} detected with the ISEN terminal rises to the set peak current value, M1 is turned off. The peak current value can be set up with LD terminal input voltage. (Please refer to page 12 for details.)

I_{COIL} = 0mA is detected by zero detection on the secondary side of the transformer, and M1 is turned on again. The peak current is decided according to the feedback from a photo-coupler.





When AC voltage waveform is input to a LD terminal, I_{COIL} waveform is made a waveform similar to AC voltage waveform. The power factor can be improved by this.



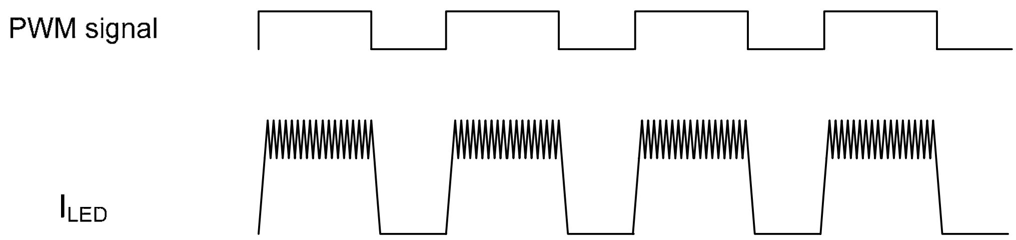
10. The dimming function

This IC has three kinds of dimming function built-in.

10.1 PWM diming

The LED current is turned on and off according to the PWM signal input to the PWMD terminal. As a result, dimming is done. PWM frequency recommends 0.1kHz to 30kHz.

When not using this function, please make the PWMD terminal a VREG terminal short circuit. Please connect the PWMD terminal with the VREG terminal.



10.2 Linear dimming by peak value control of LED current

The peak value of LED current is controlled according to the analog voltage input to the LD terminal. The peak value of LED current is controlled by V_{PEAK}/R_{SEN}.

V_{PEAK} is decided by input to LD terminal as follows.

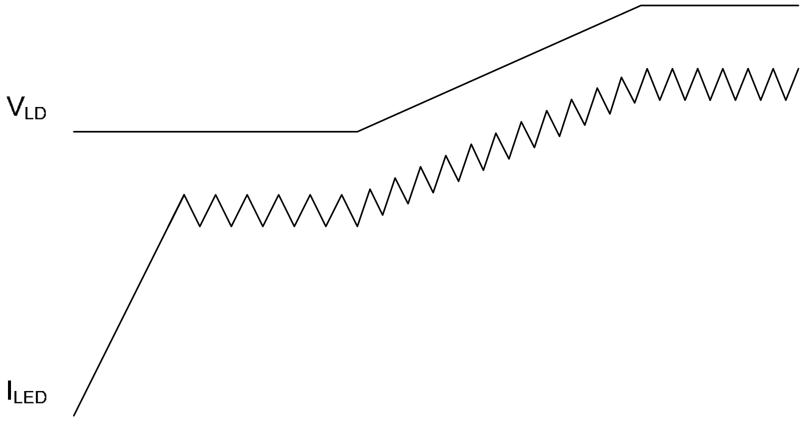
About the setting of V_{PEAK}

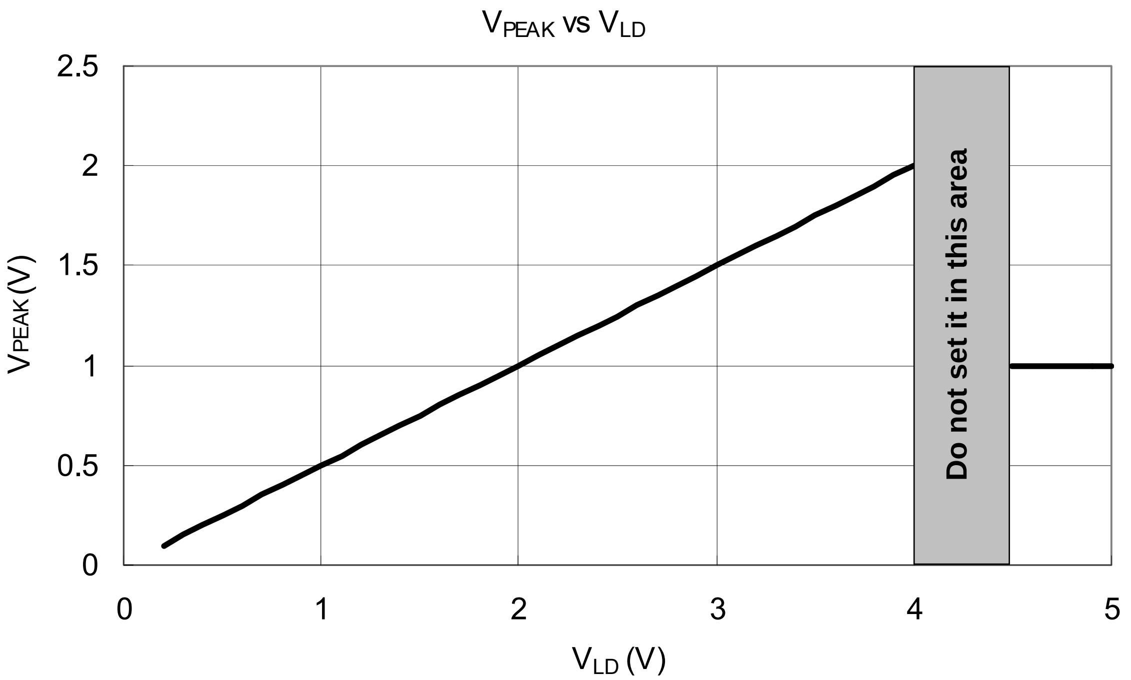
The input to LD terminal	V_{PEAK}
LD terminal is connected with the terminal V_{REG}. (When linear dimming by a LD terminal isn't used)	1.0V(TYP)
The analog voltage is input to LD terminal.	$V_{LD}/2$(TYP) Please use the input voltage to a LD terminal in 0.2V~4.0V.

Please set up the input to LD terminal by the following methods.

- ·It sets up by VREG terminal output voltage divided by resistance.
- ·It sets up by the PWM signal from the microcomputer integrated by LPF.
- ·It sets up by the analog voltage from a microcomputer.

The wave form chart of operation at the time of the peak value adjustment by LD terminal





Please use the input voltage to a LD terminal in 0.2V~4.0V or 4.5V~V_{REG}.

10.3 Linear dimming by ripple value control of LED current

The OFF time of M1 is controlled according to the analog voltage input to the RC terminal.
The ripple value of LED current is adjusted by changing the OFF time of M1.

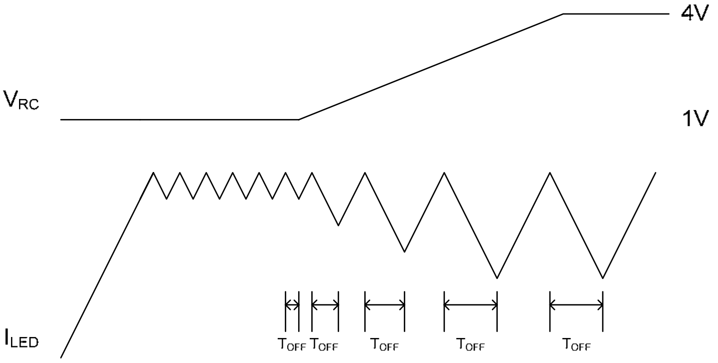
About the setting of the OFF time of M1

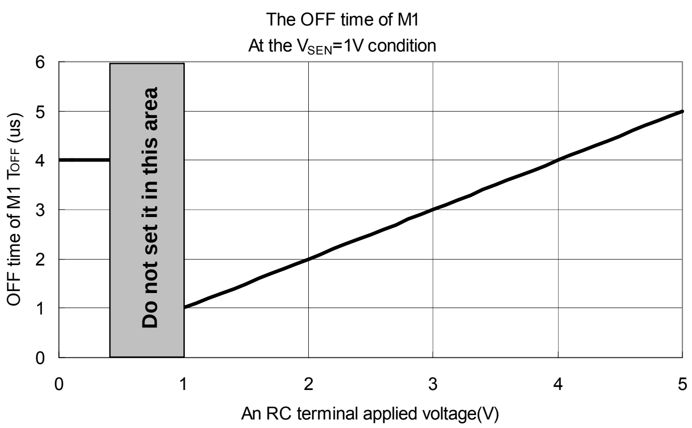
The input to RC terminal	The OFF time of M1 (At the V_{SEN}=1V condition)
RC terminal is connected with the GND. (When linear dimming by a RC terminal isn't used)	T_{OFF} is 4μs (TYP)
The analog voltage is input to RC terminal.	Please refer to the graph about M1 OFF time. Please use the input voltage to a RC terminal in 1.0V~V_{REG}.

Please set up the input to RC terminal by the following methods.

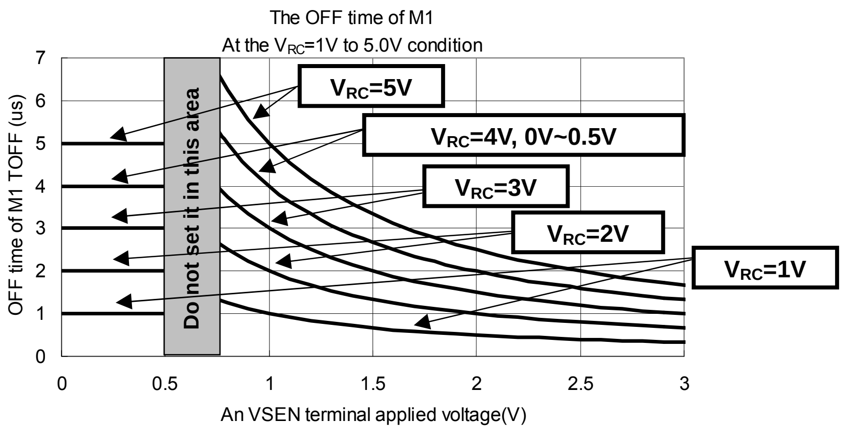
- ·It sets up by VREG terminal output voltage divided by resistance.
- ·It sets up by the PWM signal from the microcomputer integrated by LPF.
- ·It sets up by the analog voltage from a microcomputer.

The wave form chart of operation at the time of the ripple value adjustment by RC terminal





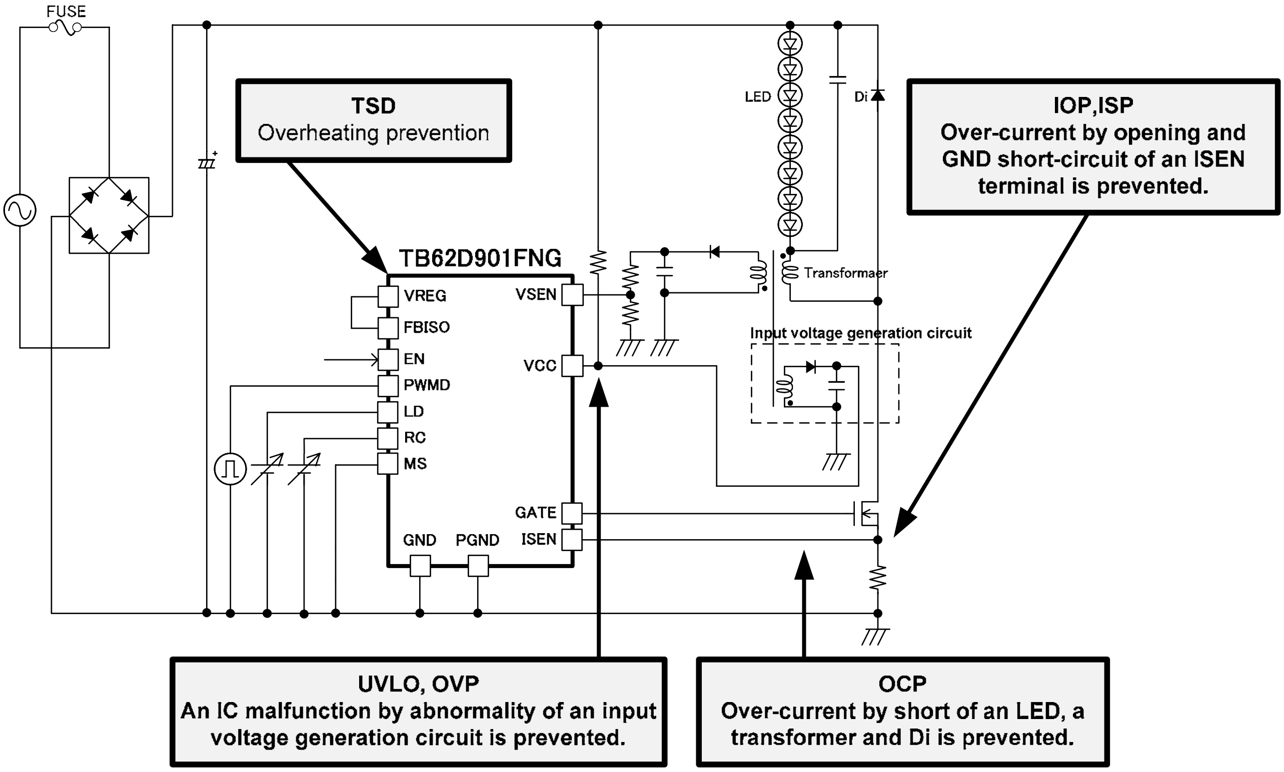
Please use the input voltage to a RC terminal in 0V~0.5V or 1.0V~V_{REG}.



Please use the input voltage to a VSEN terminal in 0V~0.5V or 0.75V~3.0V.

11. Protection function

Protection function	Effect	Detection point	detection level	Operation at the time of detection	Release condition
Thermal shutdown (TSD)	Overheating prevention	Internal temperature of IC	145°C(TYP)	GATE terminal output voltage is set to 0V, and switching control of Power MOS is stopped in the state of OFF.	Temperature falls by 20°C(TYP) or more from a detection level
Over-current protection (OCP)	Over current prevention by circuit short-circuit	ISEN terminal voltage	2V(TYP) or V_{LD}		Power supply reboot or EN reboot
Under-voltage lockout (UVLO)	Malfunction prevention by IC supply voltage abnormality	VCC terminal voltage	10V(TYP)		Voltage rises by 1V(TYP) or more from a detection level
Over-voltage protection (OVP)	Malfunction prevention by IC supply voltage abnormality	VCC terminal voltage	35V(TYP)		Power supply reboot or EN reboot
ISEN terminal open protection (IOP)	Over-current prevention by detection terminal opening	ISEN terminal voltage	0V(TYP)		Power supply reboot or EN reboot
ISEN terminal short protection (ISP)	Over-current prevention by detection terminal Short	ISEN terminal voltage	0V(TYP)		Power supply reboot or EN reboot



When abnormal voltage occurred by an input voltage generation circuit, the switching control of power MOS is stopped, and the input voltage generation is stopped. The OVP function prevents applying voltage more than absolute maximum ratings to VCC.

11.1 Thermal shutdown function (TSD)

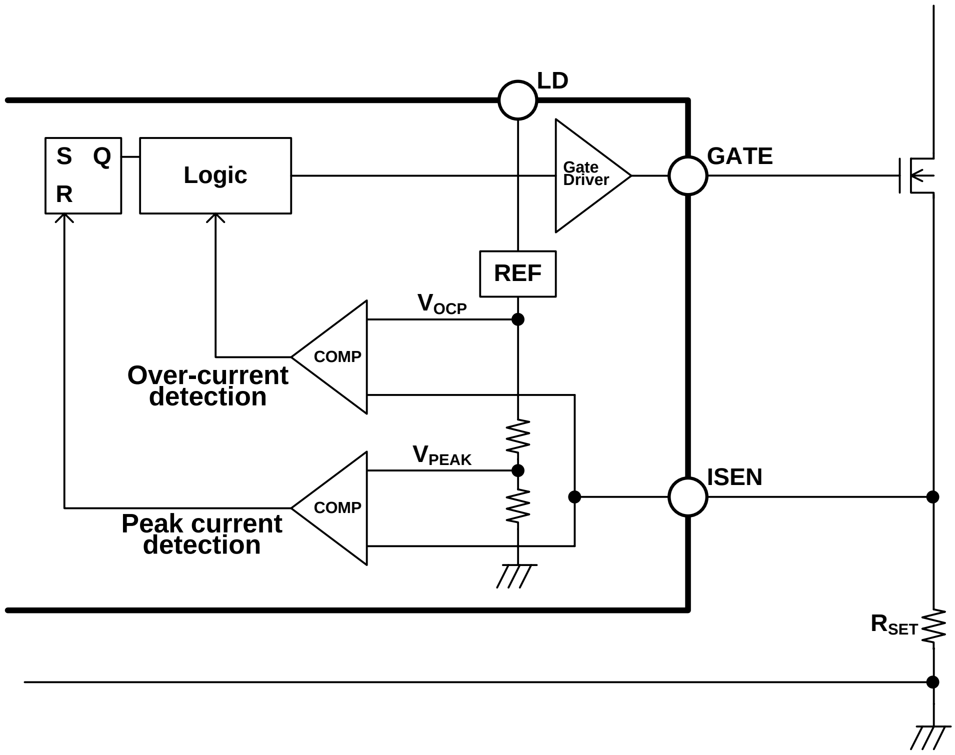
This function prevents overheating of IC. When the inside temperature of the IC became more than 145°C (TYP), TSD operates.

When TSD operates, the GATE terminal output voltage becomes 0V. And switching control of power MOS is stopped in the off state. If the internal temperature of IC falls by more than 20°C (TYP) from TSD operation temperature, it will return to operation mode.

11.2 Over-current protection function (OCP)

Usually, LED current is controlled so that ISEN terminal voltage becomes below V_{PEAK}. When it was control impossibility by short-circuit of LED / transformer / Di, this function prevents an LED current being increased suddenly. When ISEN terminal voltage becomes more than V_{OCP}, OCP operates.

When OCP operates, the GATE terminal output voltage becomes 0V. And switching control of power MOS is stopped in the off state. By Power supply reboot (V_{CC}=0V→more than 11V) or EN reboot (EN=H→L→H), it returns to operation mode.



About a setup of V_{OCP} and V_{PEAK}

Input to the LD terminal	V_{OCP}	V_{PEAK}
LD terminal is connected with the terminal V_{REG}. (When linear dimming by a LD terminal isn't used)	2.0V (TYP)	1.0V (TYP)
The analog voltage is input to LD terminal.	V_{LD} (TYP)	$V_{LD}/2$ (TYP)

11.3 Under-voltage lockout function (UVLO)

This function prevents a malfunction at the time of IC supply voltage abnormality by trouble of an input voltage generation circuit. When VCC terminal input voltage becomes below 9V (TYP), UVLO operates.

When UVLO operates, the GATE terminal output voltage becomes 0V. And switching control of power MOS is stopped in the off state. If the VCC terminal input voltage rises by more than 1V (TYP) from UVLO operation voltage, it will return to operation mode.

11.4 Over-voltage protection function (OVP)

This function prevents a malfunction at the time of IC supply voltage abnormality by trouble of an input voltage generation circuit. When VCC terminal input voltage becomes more than 35V (TYP), OVP operates.

When OVP operates, the GATE terminal output voltage becomes 0V. And switching control of power MOS is stopped in the off state. By Power supply reboot (V_{CC}=0V→more than 11V) or EN reboot (EN=H→L→H), it returns to operation mode.

11.5 ISEN terminal open protection function (IOP)

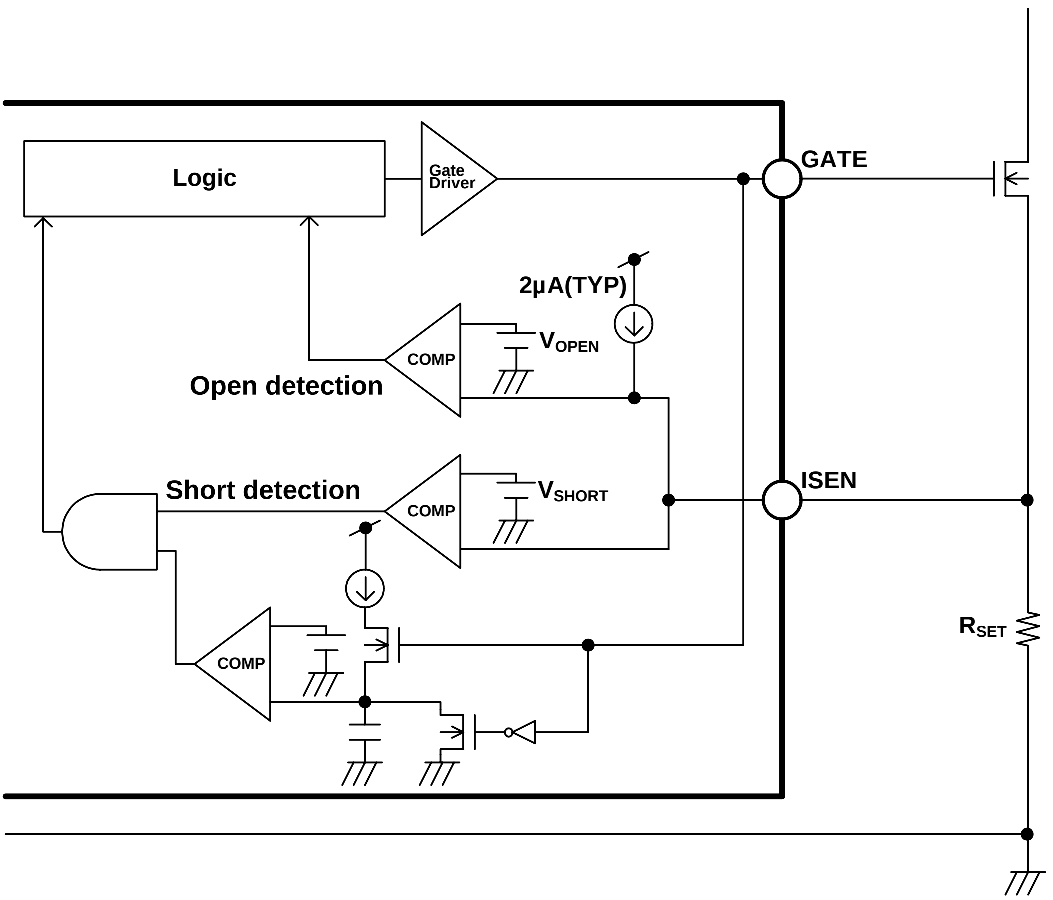
When an ISEN terminal is open, peak current control of LED current becomes impossible. This function prevents an over-current flowing to an LED by control impossibility.

When IOP operates, the GATE terminal output voltage becomes 0V. And switching control of power MOS is stopped in the off state. By Power supply reboot (V_{CC}=0V→more than 11V) or EN reboot (EN=H→L→H), it returns to operation mode.

11.6 ISEN terminal short protection function (ISP)

When an ISEN terminal is short to GND, peak current control of LED current becomes impossible. This function prevents an over-current flowing to an LED by control impossibility.

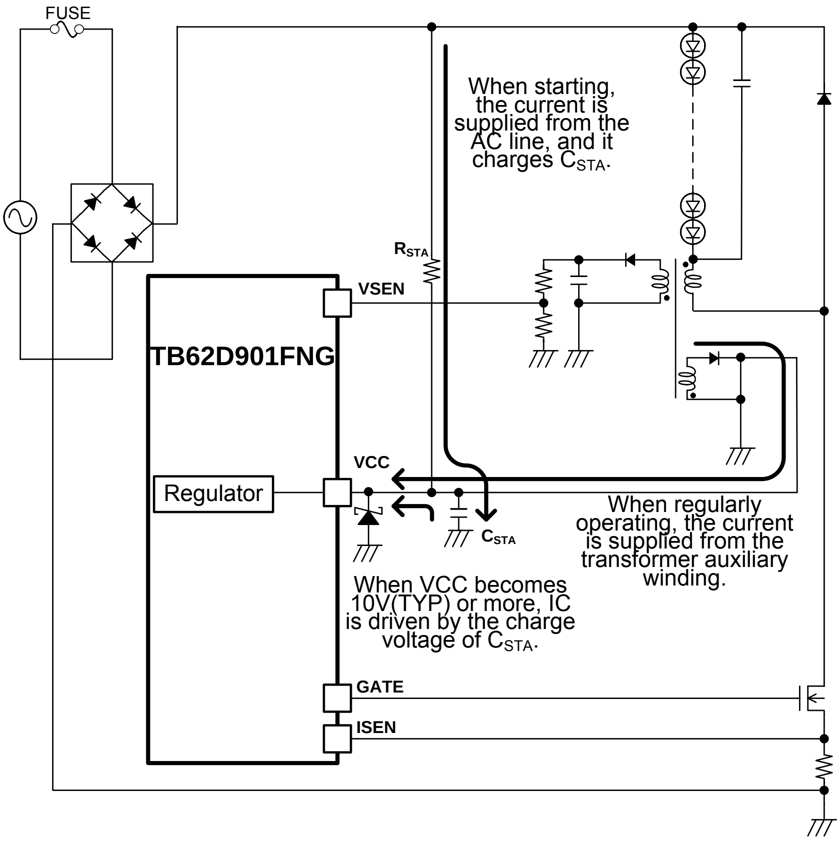
When ISP operates, the GATE terminal output voltage becomes 0V. And switching control of power MOS is stopped in the off state. By Power supply reboot (V_{CC}=0V→more than 11V) or EN reboot (EN=H→L→H), it returns to operation mode.



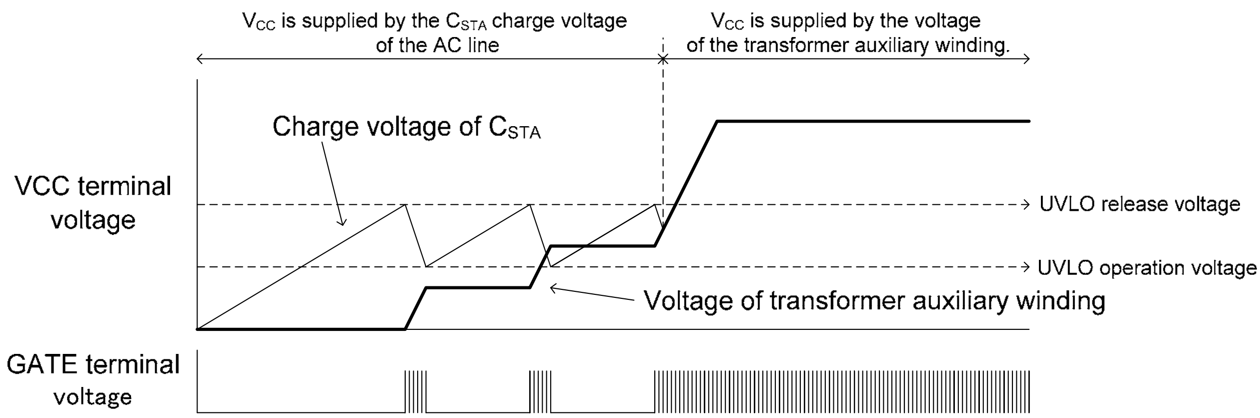
12. About IC power supply

When regularly operating, the current is supplied from the transformer auxiliary winding. When starting, the current is supplied from the AC line, and it charges C_{STA}. When VCC terminal voltage becomes more than 10V (TYP), UVLO is released, and IC starts and begins switching control of power MOS. When the voltage occurred to auxiliary winding of a transformer by switching of power MOS, V_{CC} supply from auxiliary winding starts.

The diagram of IC power supply

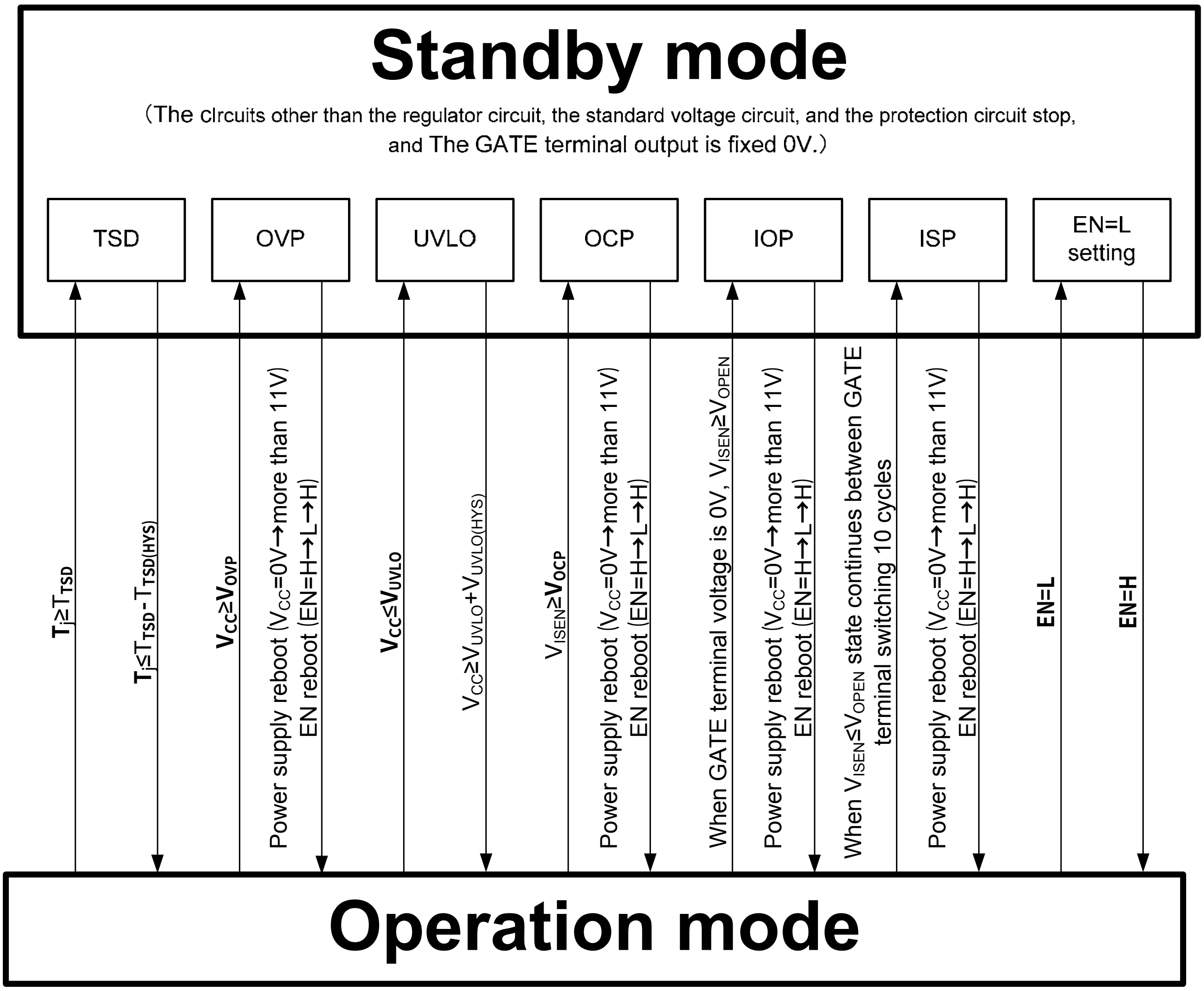


The timing chart of IC power supply



13. State transition diagram

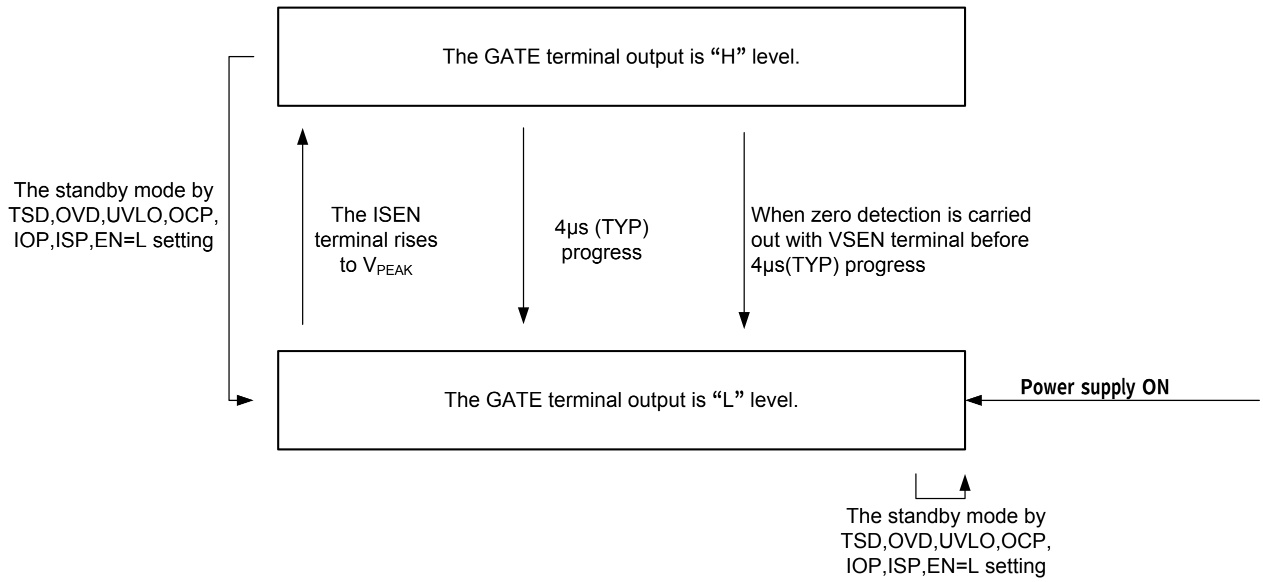
13.1 protection function



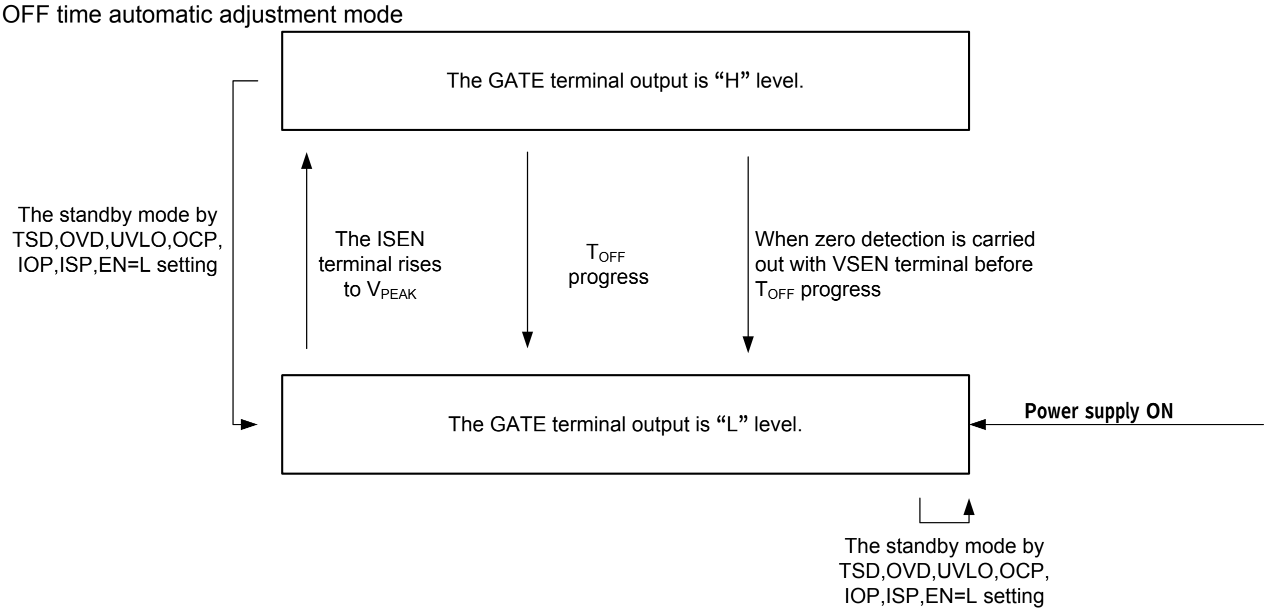
It becomes a standby mode when entering the state that corresponds to either the detection conditions of each protection function or EN=L condition. When corresponding to two or more conditions, unless the condition resolutive of each item is filled, it does not change to normal operation mode.

13.2 GATE control

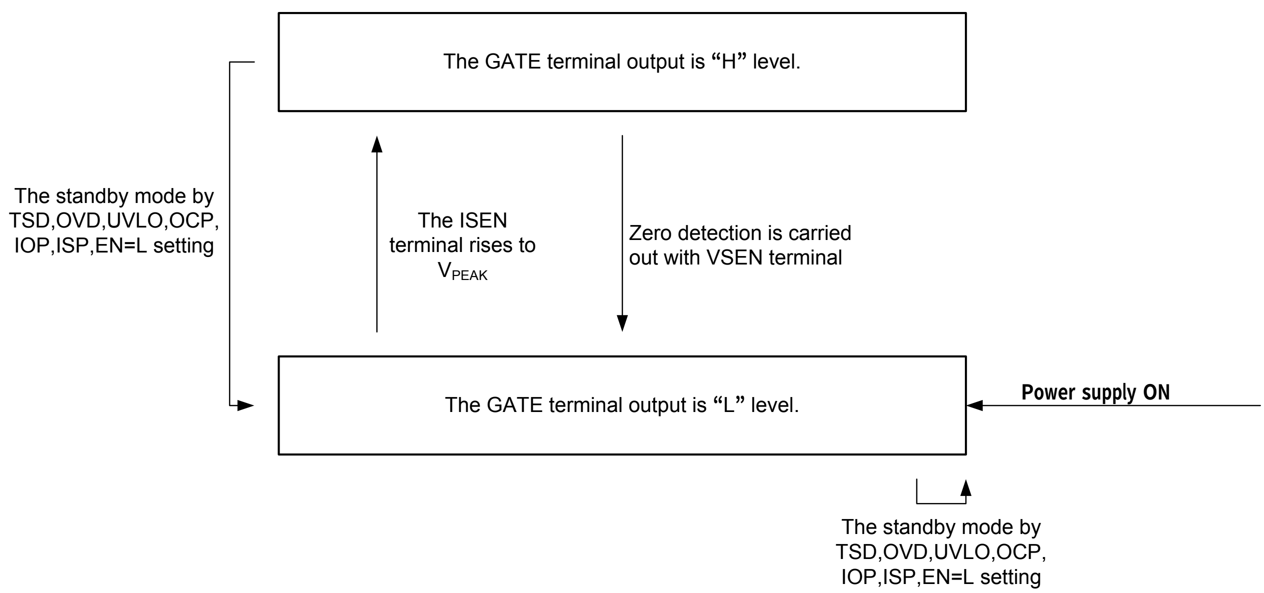
1. OFF time fixed mode



2. OFF time automatic adjustment mode



3. Critical mode and an isolated system mode



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

Characteristics	Symbol	Rating Note1	Unit
Supply voltage	V_{CC}	–0.3~40	V
Input terminal voltage (PWMD, LD, RC, EN, MS)	V_{IN}	–0.3~6.0	V
VREG terminal voltage	V_{REG}	–0.3~6.0	V
Feedback terminal voltage (ISEN, VSEN, FBISO)	V_{FB}	–0.3~6.0	V
GATE terminal voltage	V_{GATE}	–0.3~V_{CC}	V
Operating temperature	T_{opr}	–40~105	°C
Storage temperature	T_{stg}	–55~150	°C
Thermal resistance	$R_{th(j-a)}$	87.3 Note3	°C/ W
Power dissipation	P_D	1.43 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).

15. Operating Condition (Unless otherwise noted, T_a = -40 to 105 °C)

Characteristics	Symbol	Test Conditions	Min	Typ.	Max	Unit
Supply voltage	V_{CC}		11.0	—	30	V
Switching frequency	f_{SW}		—	—	500	kHz
LD terminal input voltage	V_{LD1}	At the time of LED peak current adjustment function use	0.2	—	4.0	V
	V_{LD2}	At the time of LED peak current adjustment function unused	4.5	—	V_{REG}	
RC terminal input voltage	V_{RD1}	At the time of LED ripple current adjustment function use	1	—	V_{REG}-0.5	V
	V_{RD2}	At the time of LED ripple current adjustment function unused	0	—	0.5	
VSEN terminal input voltage	V_{VSEN1}	When using it in OFF time automatic adjustment mode	0.75	—	3	V
	V_{VSEN2}	When using it by OFF time fixed mode	0	—	0.5	

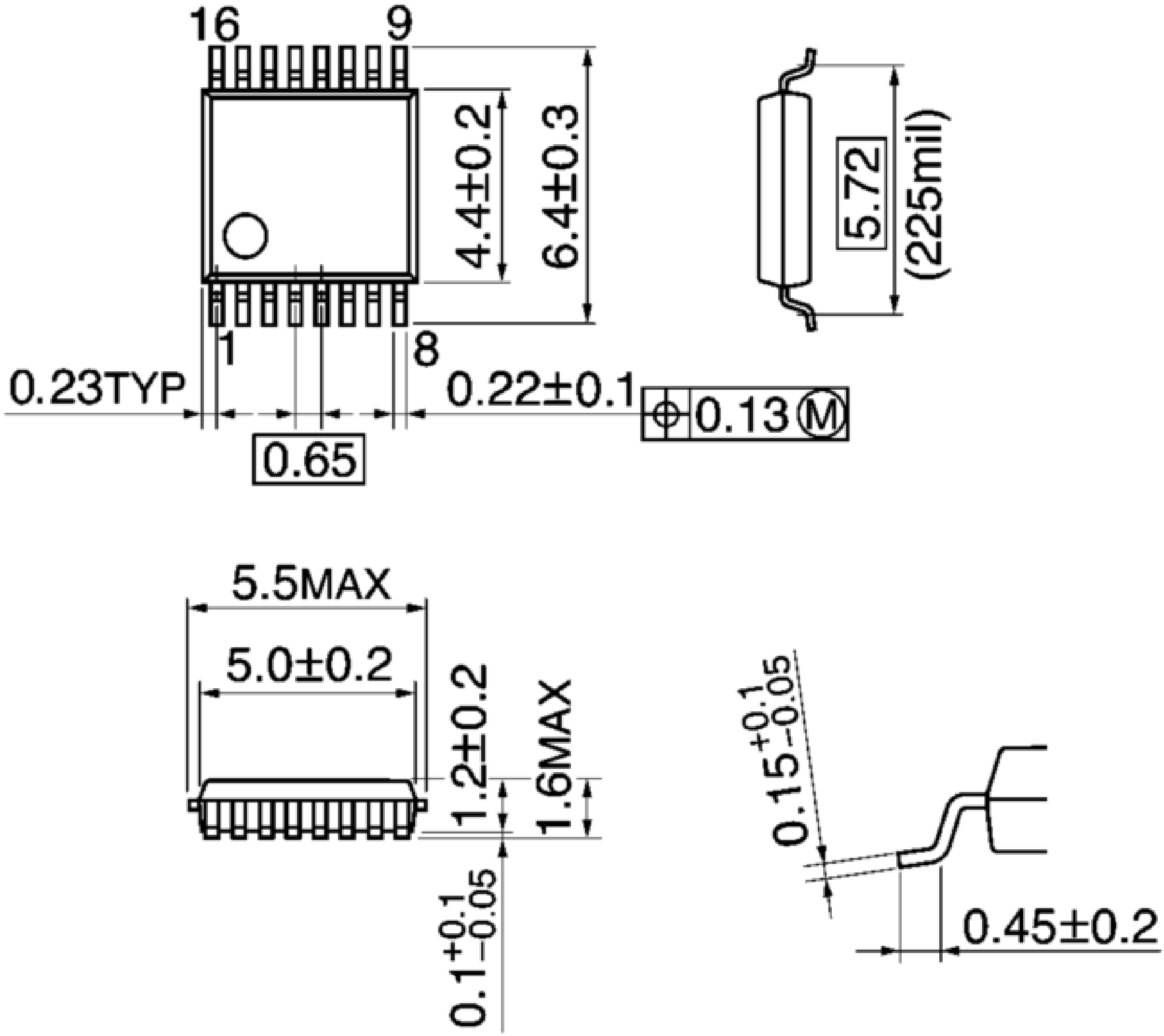
GATE terminal output voltage is the same level as VCC. Please set up VCC in consideration of the Absolute Maximum Ratings of the external power MOSFET

16. Electrical Characteristics (Unless otherwise noted, T_a = -40 to 105 °C, V_{CC}=12V)

Characteristics	Symbol	Test Circuit	Test Conditions	Min	Typ.	Max	Unit
<V_{CC} Supply>							
Operating supply current	$I_{CC(ON)}$		EN=H, PWMD=H, MS=L V_{VSEN}=1.0V, V_{LD}=V_{REG}, V_{RC}=0V V_{FBISO}=V_{REG}	—	2.0	2.5	mA
Standby supply current	$I_{CC(OFF)}$		EN=L	—	0.5	0.8	
<Regulator part>							
VREG output voltage	V_{REG}		I_{REG}=0mA	4.5	5	5.5	V
VREG maximum output current	I_{REG}			—	—	2	mA
<UVLO part>							
UVLO release voltage	V_{UVLO}		V_{CC} rising	9.5	10	10.5	V
UVLO hysteresis voltage	$V_{UVLO(HYS)}$		V_{CC} falling	0.9	1	1.1	V
<GATE Driver part>							
GATE terminal sauce resistance	R_{GATEH}		I_{GATE}=-100mA	—	5	10	Ω
GATE terminal sink resistance	R_{GATEL}		I_{GATE}=100mA	—	2.5	5	Ω
GATE terminal rise time	t_{rGATE}		C_L=1nF	—	15	—	ns
GATE terminal fall time	t_{fGATE}		C_L=1nF	—	15	—	ns
MOS OFF time	t_{OFF}		V_{VSEN}=1.0V, V_{RC}=0V	TBD	4	TBD	µs
<Protection circuit part>							
OVP operation voltage	V_{OVP}		VCC terminal	32	35	38	V
OCP operation voltage	V_{OCP1}		ISEN terminal, V_{LD}=V_{REG}	1.9	2.0	2.1	V
	V_{OCP2}		ISEN terminal, V_{LD}=0.2V~4.0V	V_{LD} -0.03	V_{LD}	V_{LD} +0.03	
IOP operation voltage	V_{OPEN}		ISEN terminal	3.5	4.0	4.5	V
IOP detection current	I_{OPEN}			1	2	3	µA
ISP operation voltage	V_{SHORT}		ISEN terminal	0.1	0.15	0.2	V
TSD operation temperature	T_{TSD}		Temperature rising	130	145	160	°C
TSD hysteresis temperature	$T_{TSD(HYS)}$		Temperature falling	10	20	30	°C
<Input terminal part>							
Input terminal high level input voltage (PWMD, EN, MS)	V_{INH}			1.5	—	V_{REG}	V
Input terminal Low level input voltage (PWMD, EN, MS)	V_{INL}			0	—	0.4	V
Input terminal input current	I_{INH}		Measurement terminal is PWMD,EN,LD,RC V_{IN}=V_{REG}	—	—	1	µA
	I_{INL}		Measurement terminal is PWMD,EN,MS,LD,RC V_{IN}=0V	-1	—	—	µA
MS terminal pull down resistance	R_{UP}			80	100	120	kΩ
<Detection terminal part>							
FBISO terminal pull-up resistance	R_{DOWN}			80	100	120	kΩ
ISEN terminal peak voltage	V_{PEAK1}		V_{LD}=VREG	0.95	1.0	1.05	V
	V_{PEAK2}		V_{LD}=0.2V~4.0V	V_{LD}/2 -0.1	V_{LD}/2	V_{LD}/2 +0.1	
Detection blanking time	t_{BLK}			250	350	450	ns

17. Package dimension

Unit : mm



Weight: TBD 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 protection 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 protection functions. If the power supply is unstable, the protection 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.

Points to remember on handling of ICs

(1) Heat Radiation Design
In using an IC with large current flow such as power amp, regulator or driver, please design the device so that heat is appropriately radiated, not to exceed the specified junction temperature (T_J) at any time and condition. These ICs generate heat even during normal use. An inadequate IC heat radiation design can lead to decrease in IC life, deterioration of IC characteristics or IC breakdown. In addition, please design the device taking into considerate the effect of IC heat radiation with peripheral components.

(2) Back-EMF
When a motor rotates in the reverse direction, stops or slows down abruptly, a current flow back to the motor's power supply due to the effect of back-EMF. If the current sink capability of the power supply is small, the device's motor power supply and output pins might be exposed to conditions beyond maximum ratings. To avoid this problem, take the effect of back-EMF into consideration in system design.

(3) Thermal Shutdown Circuit
Thermal shutdown circuits do not necessarily protect ICs under all circumstances. If the thermal shutdown circuits operate against the over temperature, clear the heat generation status immediately.
Depending on the method of use and usage conditions, such as exceeding absolute maximum ratings can cause the thermal shutdown circuit to not operate properly or IC breakdown before operation.

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