Ordering number : EN*A2201

LV5011MD

Advance Information

ON Semiconductor®

http://onsemi.com

Bi-CMOS LSI

LED Driver IC

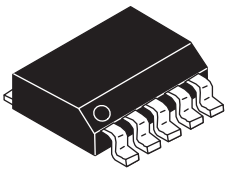
Overview

LV5011MD is a High Voltage LED driver with internal power FET.
LV5011MD is realized very simple LED circuits with a few external parts. It corresponds to various wide dimming controls including the TRIAC dimming control.

Note) This LV5011MD is designed or developed for general use or consumer appliance. Therefore, it is NOT permitted to use for automotive, communication, office equipment, and industrial equipment.

Function

- High Voltage LED Driver
- Built-in output power FET
- Built-in TRIAC stabilized function
- Various Dimming Control
  - TRIAC & Analog Input
- Selectable reference Voltage
  - Internal 0.605V & External Input Voltage
- Over Voltage Protection
- Short Protection Circuit



SOIC-10 NB

Specifications

Maximum Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	unit
Maximum Input voltage	V_{IN} max (Note1)		-0.3 to 42	V
REF_IN, CS, ACS pin			-0.3 to 7	V
Drain pin	V_{Drain} _abs		-0.3 to 600	V
OUT2 pin	V_{OUT2}_abs		-0.3 to 42	V
Allowable power dissipation	Pd max	With specified board *1	0.6	W
Junction temperature	Tj		150	°C
Operating Junction temperature	Topj (Note2)		-30 to +125	°C
Storage temperature	Tstg		-40 to +150	°C

*1: Specified board=35mm×16.5mm×1.2mm, glass epoxy board
Note1) Absolute maximum ratings represent the values which cannot be exceeded for any length of time.
Note2) Even when the device is used within the range of absolute maximum ratings, as a result of continuous usage under high temperature, high current, high voltage, or drastic temperature change, the reliability of the IC may be degraded. Please contact us for the further details.

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

This document contains information on a new product. Specifications and information herein are subject to change without notice.

Recommended Operating Conditions at Ta = 25°C

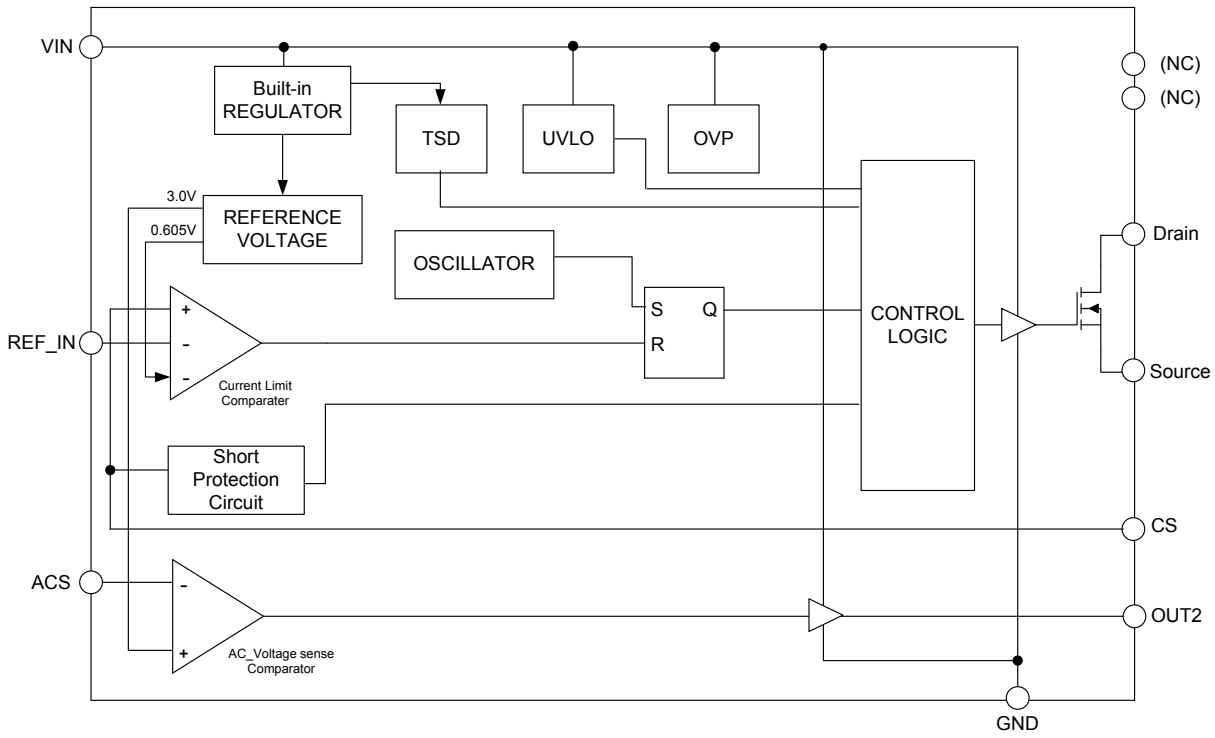
Parameter	Symbol	Conditions	Ratings	Unit
Input voltage	V_{IN}		8.5 to 24	V

Electrical Characteristics at Ta = 25°C, V_{IN} = 12V, unless otherwise specified.

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Reference Voltage block						
Built-in Reference Voltage	VREF		0.585	0.605	0.625	V
VREF V_{IN} line regulation	VREF_LN	V_{IN} = 8.5 to 24V		±0.5		%
Under Voltage Lockout						
Operation Start Input Voltage	UVLOON		8	9	10	V
Operation Stop Input Voltage	UVLOOFF		6.3	7.3	8.3	V
Hysteresis Voltage	UVLOH			1.7		V
Oscillation						
Frequency	FOSC		55	70	85	kHz
Maximum ON duty	MAXDuty			93		%
Comparator						
Input offset Voltage (Between CS and REF_IN)	V_{IO}_RI			1	10	mV
Input current	IIOCS			160		nA
	IIOREF			80		nA
CS pin max voltage	VOM				1	V
FET output stage						
Drain Leakage current	ILK	V_{Drain}=480V			100	uA
Power FET ON resistor	Ron	VIN=12V		9.5		Ω
Minimum On time	TMIN			200		ns
Thermal protection Circuit						
Thermal shutdown temperature	TSD	*Design guarantee		165		°C
Thermal shutdown hysteresis	ΔTSD	*Design guarantee		30		°C
TRIAC Stabilization Circuit						
Threshold of OUT2	VACS	OUT2=High [less than right record]	2.8	3.0	3.2	V
OUT2 sink current	I_O2I	VIN=12V, OUT2=6V		0.6		mA
OUT2 source current	I_O2O	VIN=12V, OUT2=6V		0.6		mA
V_{CC} current						
UVLO mode V_{IN} current	I_{CC}OFF	V_{IN}<UVLOOFF		120	160	μA
Normal mode V_{IN} current	I_{CC}ON	V_{IN}=12V		1.0		mA
V_{IN} Over Voltage Protection Circuit						
V_{IN} over voltage protection voltage	V_{IN}OVP		24	27	30	V
VIN Current at OVP	IINOVP	V_{IN}=30V	0.7	1.0	1.5	mA
CS terminal abnormal sensing circuit						
Abnormal sensing voltage	CSOCP			1.9		V

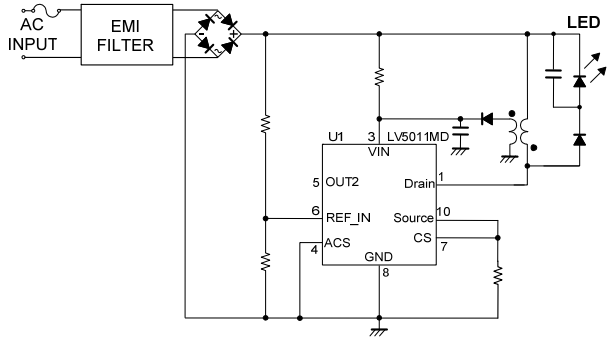
*: Design guarantee (value guaranteed by design and not tested before shipment)

Block Diagram

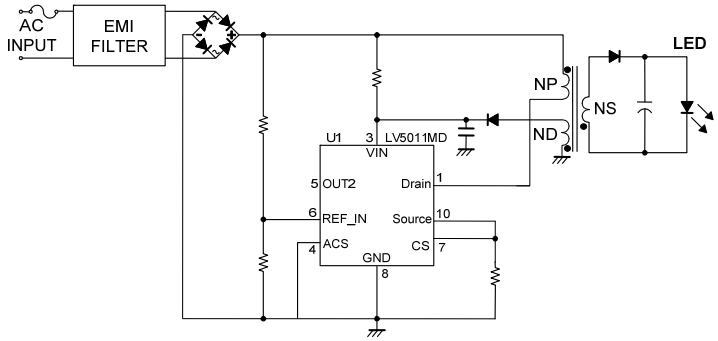


Sample Application Circuit

<Non-isolation>



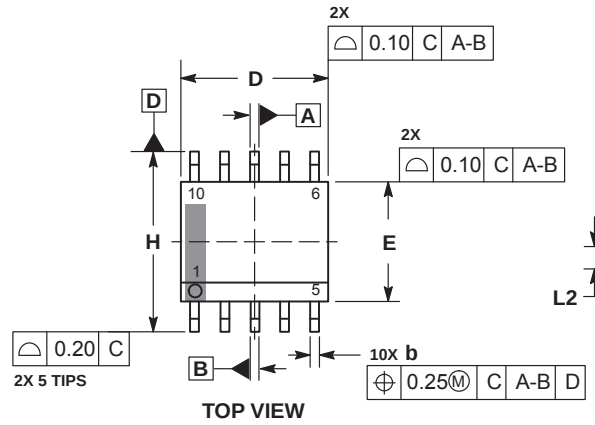
<Isolation>

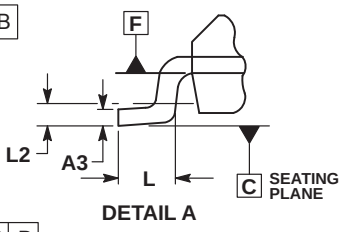


Package Dimensions

unit : mm

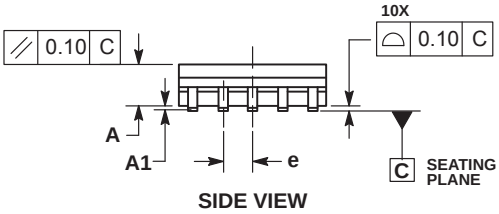
SOIC- 10 NB
CASE 751BQ- 01
ISSUE A

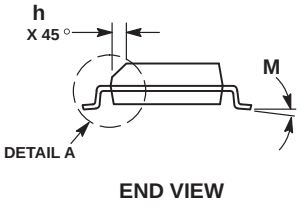




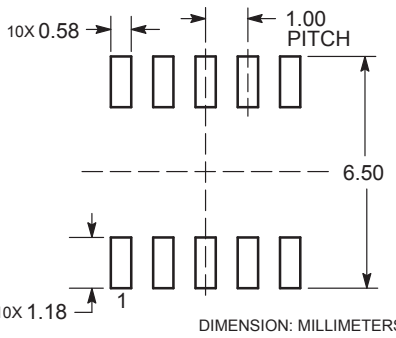
NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE PROTRUSION SHALL BE 0.10mm TOTAL IN EXCESS OF b AT MAXIMUM MATERIAL CONDITION.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS. MOLD FLASH, PROTRUSIONS, OR GATE BURRS SHALL NOT EXCEED 0.15mm PER SIDE. DIMENSIONS D AND E ARE DETERMINED AT DATUM F.
5. DIMENSIONS A AND B ARE TO BE DETERMINED AT DATUM F.
6. A1 IS DEFINED AS THE VERTICAL DISTANCE FROM THE SEATING PLANE TO THE LOWEST POINT ON THE PACKAGE BODY.

	MILLIMETERS	
DIM	MIN	MAX
A	1.25	1.75
A1	0.10	0.25
A3	0.17	0.25
b	0.31	0.51
D	4.80	5.00
E	3.80	4.00
e	1.00 BSC	
H	5.80	6.20
h	0.37 REF	
L	0.40	1.27
L2	0.25 BSC	
M	0°	8°



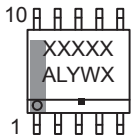


RECOMMENDED SOLDERING FOOTPRINT*



*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

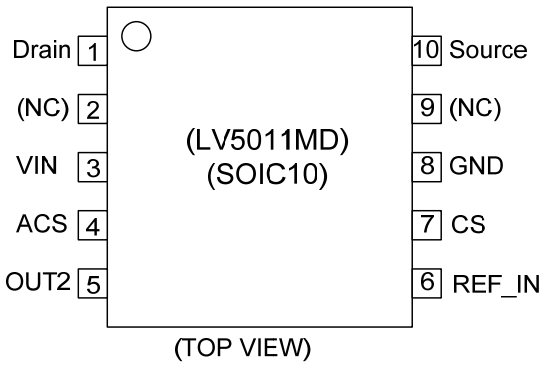
GENERIC MARKING DIAGRAM*

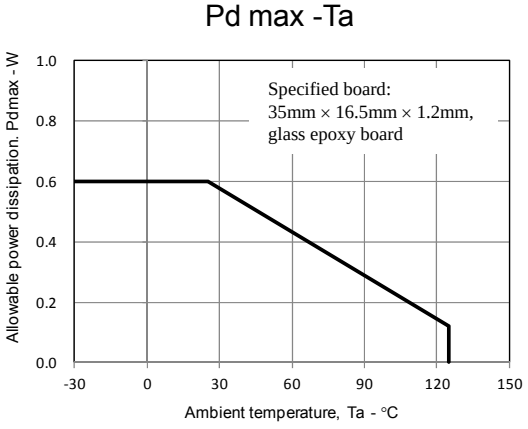


XXXXX = Specific Device Code
A = Assembly Location
L = Wafer Lot
Y = Year
W = Work Week
▪ = Pb−Free Package

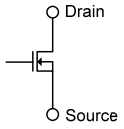
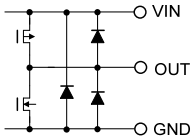
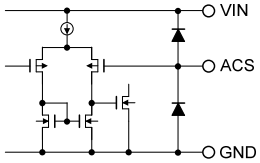
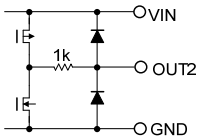
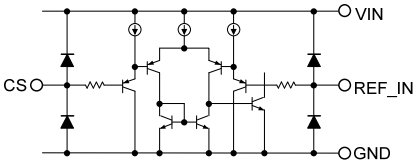
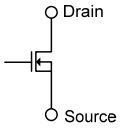
*This information is generic. Please refer to device data sheet for actual part marking. Pb−Free indicator, G, may or not be present.

Pin Assignment

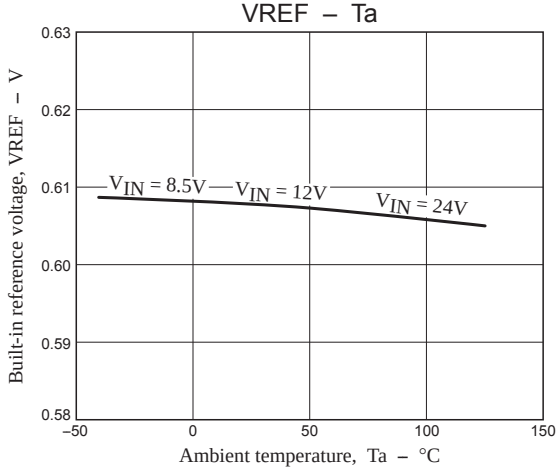




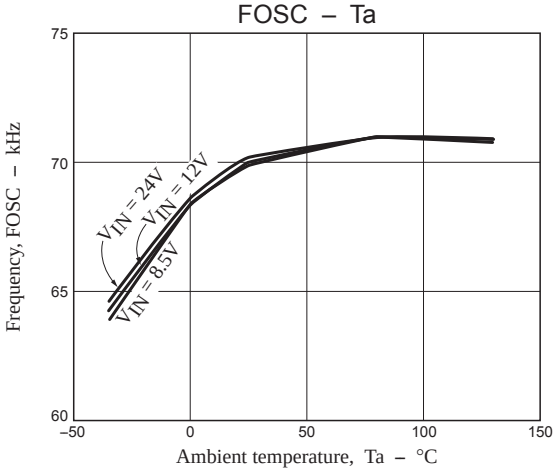
Pin Functions

pin No	Pin Name	Pin Function	Equivalent Circuit
1	Drain	Drain pin of built-in power FET	
2	(NC)	No connect pin	
3	VIN	Power supply pin. Under voltage lock out VIN<UVLOOFF(7.3V): Stop VIN>UVLOON(9V): Operation Over voltage protection VIN>VINOVP(27V): Switching Stop	
4	ACS	ACS pin senses AC Voltage. This pin is used to stabilize the TRIAC dimming application. ACS pin>3V : OUT2=Low ACS pin<3V : OUT2=High If this function isn't used, please connect GND.	
5	OUT2	This pin drive the FET which is stabilized the TRIAC dimming application. If ACS is less than 3V, OUT2 turn High voltage. If this function isn't used, please connect nothing.	
6	REF_IN	External LED current Limit Setting pin. If less than VREF (0.605V) voltage is input, Peak current value is used at the input voltage. If more than REF_IN voltage is input, it is done at VREF voltage.	
7	CS	LED current sensing in. If this terminal voltage exceeds VREF (Or REF_IN), external FET is OFF. And if the voltage of the terminal exceeds 1.9V, LV5011MD turns to latch-off mode.	
8	GND	GND pin	
9	(NC)	No connect pin	
10	Source	Source pin of built-in FET	

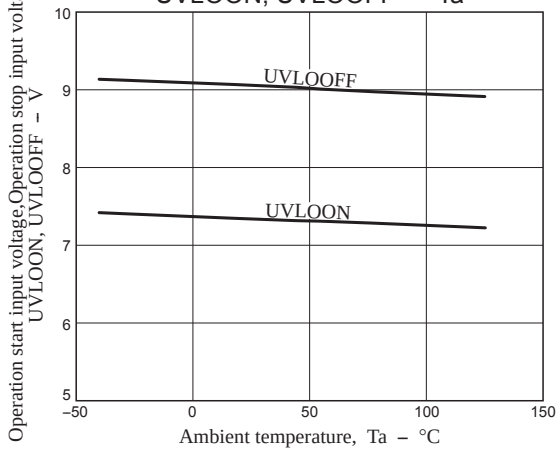
VREF – Ta



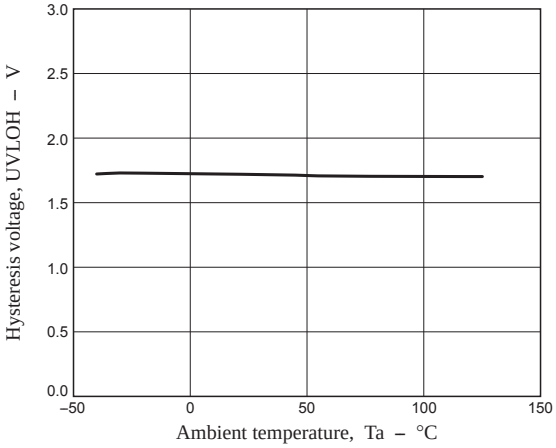
FOSC – Ta



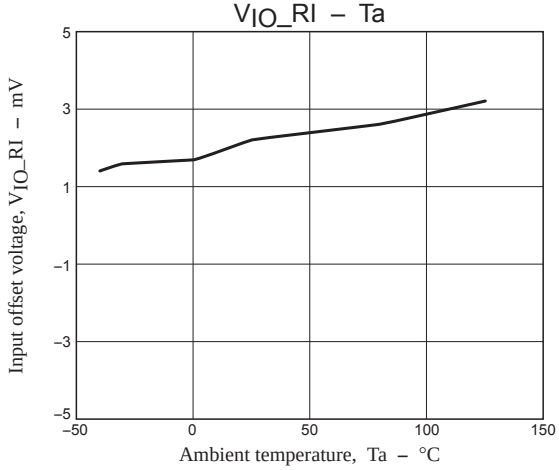
UVLOON, UVLOOFF – Ta



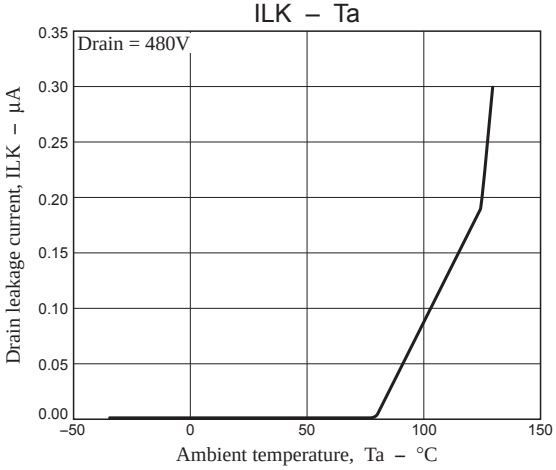
UVLOH – Ta



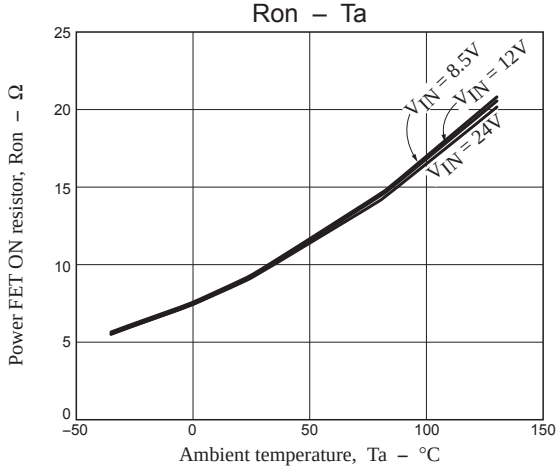
V_{IO_RI} – Ta



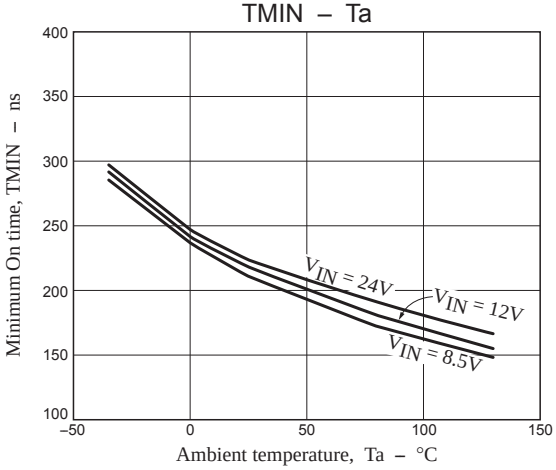
ILK – Ta



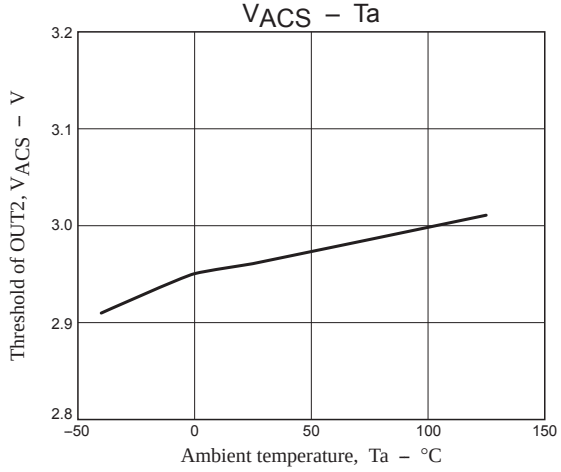
Ron – Ta



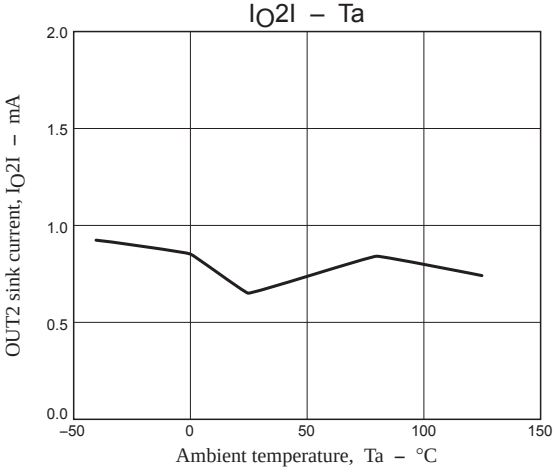
TMIN – Ta



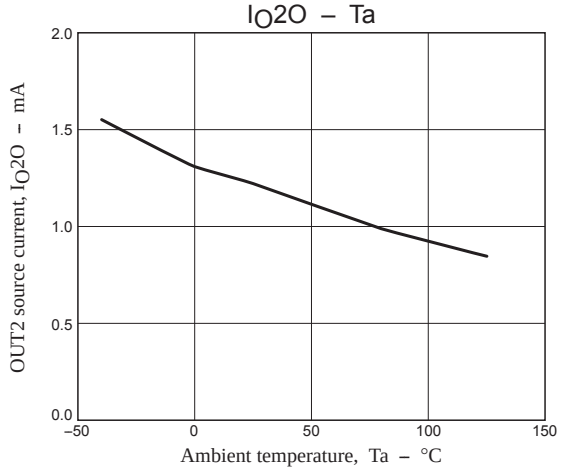
V_{ACS} – Ta



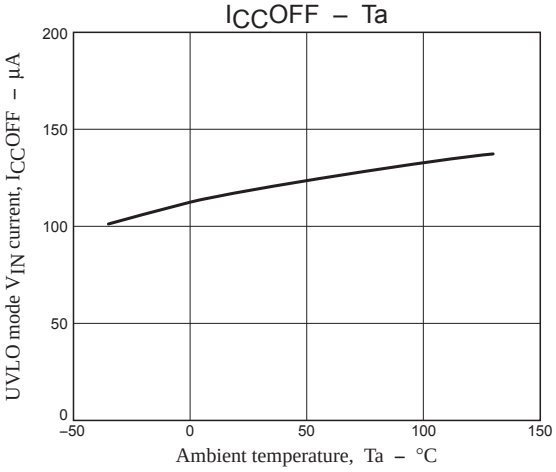
I_{O2I} – Ta



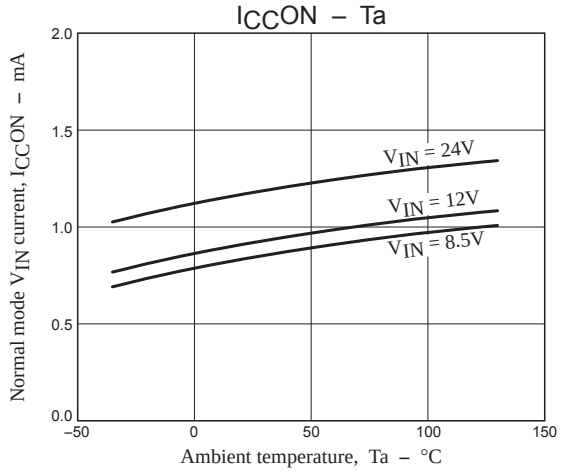
I_{O2O} – Ta



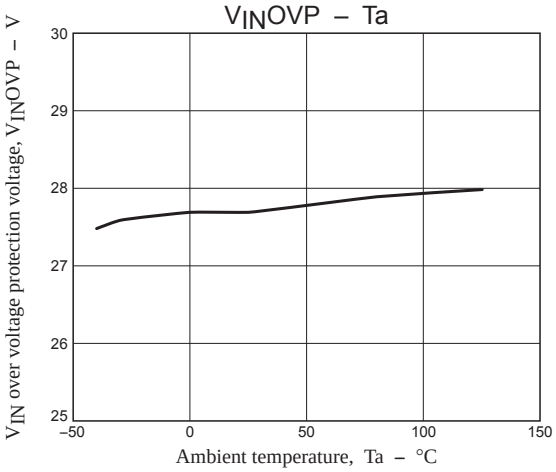
I_{CCOFF} – Ta



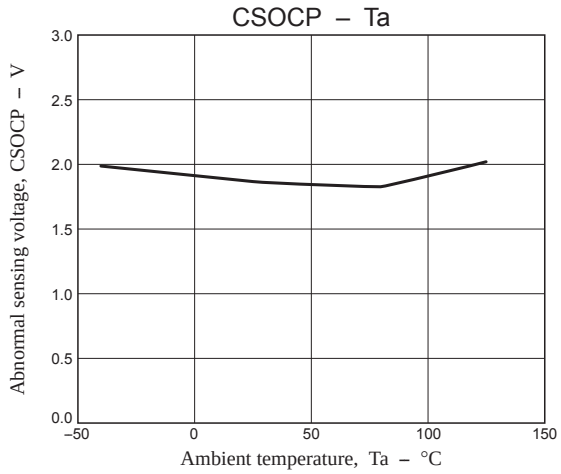
I_{CCON} – Ta



V_{INOVP} – Ta



CSOCP – Ta

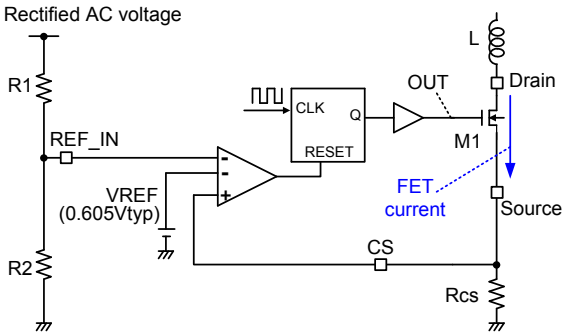


Functional description

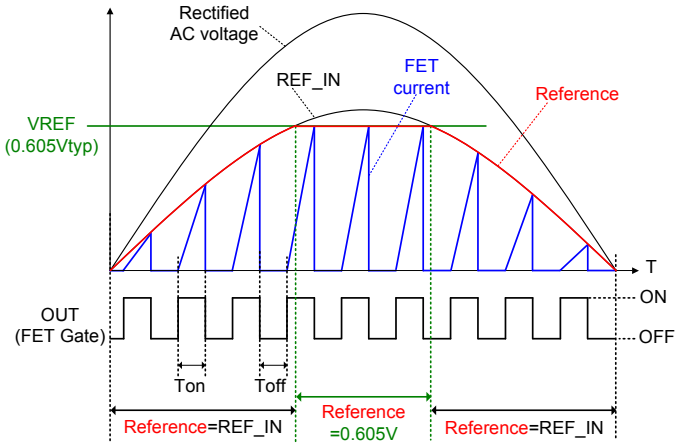
LV5011MD is an LED driver IC that operates directly from the rectified AC voltage. LV5011MD controls brightness of the LED by controlling a peak current of the internal MOSFET.

1. Peak current control

LV5011MD detects the current of internal MOSFET as shown in the following diagram. The current that flows into MOSFET is a triangular wave shown in the diagram. The current peak value is determined by the relationship between the reference level and CS voltage. This relationship makes Power Factor Correction (PFC). CS pin voltage is inputted to internal comparator. CS pin voltage is compared with the reference level, and the internal MOSFET is controlled. LV5011MD controls the peak value of MOSFET current.
Here, the reference level is lower value of either “REF_IN” or “VREF(0.605V)”.



R1,R2 : External resistor for REF_IN pin setting
Rcs : External resistor for current sense
M1 : Internal Power MOSFET



The peak value of MOSFET current (Ipk) is the following expression.

In the case of “REF_IN < VREF(0.605V)” $\rightarrow Ipk = \dfrac{REF\_IN}{Rcs}$

In the case of “REF_IN > VREF(0.605V)” $\rightarrow Ipk = \dfrac{0.605V}{Rcs}$

2. Bleeder current cuircuit for TRIAC dimming

LV5011MD contains the bleeder current circuit for TRIAC dimming. Please connect OUT2 to the external MOSFET gate and connect the resistor “Rd” to its drain.

2-1. Operating voltage setting

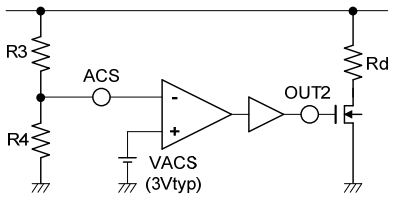
By the setting of ACS pin, OUT2 is controlled. Thereby the external MOSFET is operated. When ACS pin voltage is less than 3V(typical), OUT2 become “High” and the external MOSFET is turned on.
The Bleeder operation threshold of the rectified AC is determined below.

$$Vac\_bleeder = \frac{R3+R4}{R4} \times 3V$$

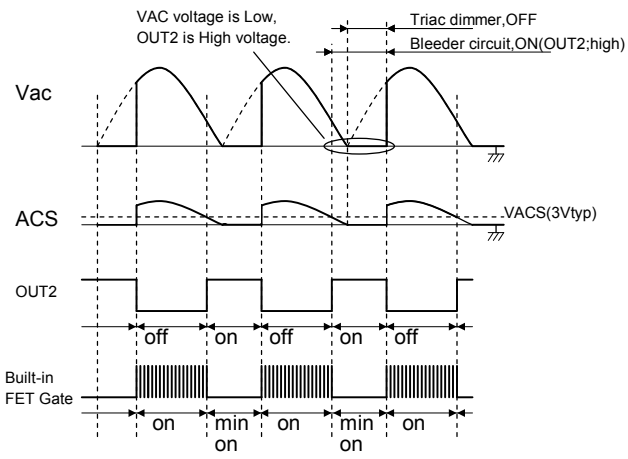
2-2. Bleeder current setting

Bleeder current is set by Rd. Please decide Rd value depending on Triac dimmer.

a block diagram in outline



a blockdiagram in outline

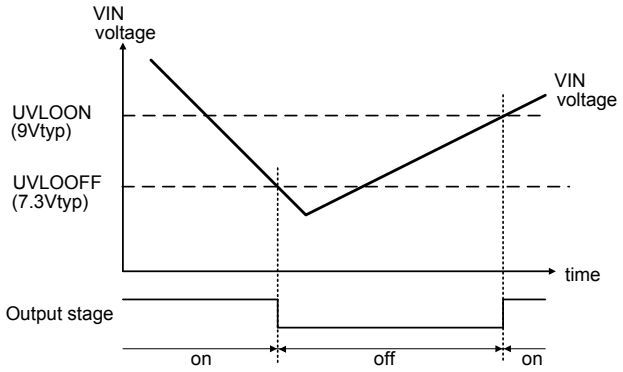


3. Protection Function

	Tilte	outline	monitor point
3.1	UVLO	Under Voltage Lock Out	VIN voltage
3.2	OCP	Over Current Protection	CS voltage
3.3	OVP	Over Voltage Protection	VIN voltage
3.4	OTP (TSD)	Over Temperature Protection (Thermal Shut Down)	PN Junction temperature

3.1 UVLO(Under Voltage Lock Out)

If VIN voltage is 7.3V or lower, then UVLO operates and the IC stops. When UVLO operates, the power supply current of the IC is about 120uA or lower. If VIN voltage is 9V or higher, then the IC starts switching operation.

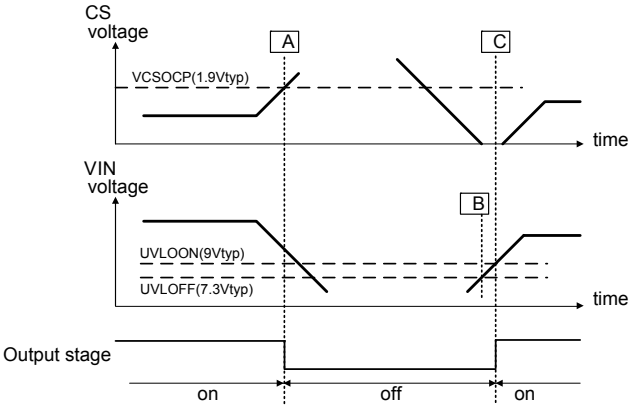


3.2 OCP(Over Current Protection)

The CS pin sense the current through the MOS FET switch and the primary side of the transformer. This provides an additional level of protection in the event of a fault. If the voltage of the CS pin exceeds VCSOCP(1.9Vtyp)(A), the internal comparator will detect the event and turn off the MOSFET. The peak switch current is calculated

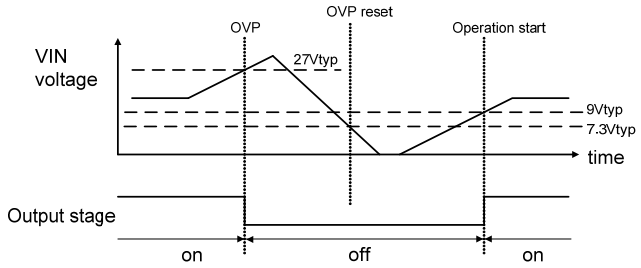
Io(peak) [A] = VCSOCP[V]/Rcs[ohm]

The VIN pin is pulled down to fixed level, keeping the controller lached off.The lach reset occurs when the user disconnects LED from VAC and lets the VIN falls below the VIN reset voltage,UVLOOFF(7.3Vtyp)(B). Then VIN rise UVLOON(9Vtyp)(C),restart the switching.



3.3 OVP(Over Voltage Protection)

If the voltage of VIN pin is higher than the internal reference voltage VINOVP(27Vtyp),switching operation is stopped. The stopping operation is kept until the voltage of VIN is lower than 7.3V. If the voltage of VIN pin is higher than 9V, the switching operation is restated.



3.4 OTP(Over Temperature Protection)

The over temperature protection works when the junction temperature of IC is 165deg (typ) (A), and the IC switching stops. The IC starts switching operation again when the junction temperature is 135°Ctyp (B) or lower.