

WD35-S28T

2+2 Channel AC Direct LED Driver IC with TRIAC Dimming

Rev1.4 – 10 Mar 2023

1. General Description

The WD35-S28T is an AC Direct LED Driving IC with internal 2step and external 2step, respectively. It can drive several series LEDs from the rectified AC voltage. It will give much convenience to the design because it requires a small number of external components. The WD35-S28T has higher LED current driving capability and its current can be adjustable with external resistors. The WD35-S28T will help that engineers produce excellent products in LED lightings in terms of energy efficiency, design efficiency, cost efficiency, and so on.

2. Features

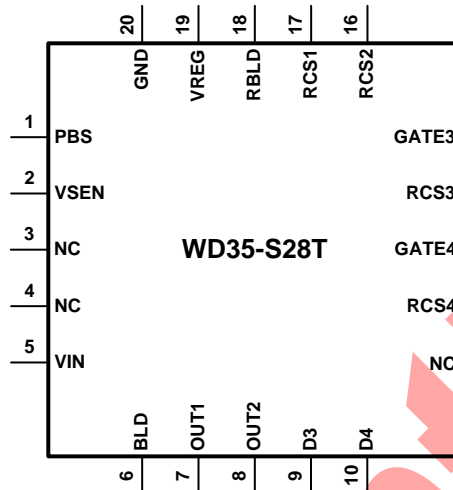
- LEDs direct driver from AC line
- Wide input range : 90VAC~305VAC
- Constant current driving with internal 2 channels and external 2 channels
- Adjustable driving current for each step
- Compatible with TRIAC dimming
- Including bleeder current to supply holding current of TRIAC dimmer
- Including the gate driver for external MOSFET supplying the latching current of TRIAC dimmer
- Excellent TRIAC dimmer compatibility due to the holding and latching currents
- Excellent power factor > 0.9
- Lower total harmonic distortion < 15%
- Over temperature protection
- EMI safe operation
- Thermally enhanced QFN 20pin

3. Applications

- AC direct LED light Applications
- Down Light
- High Bay
- Street Light

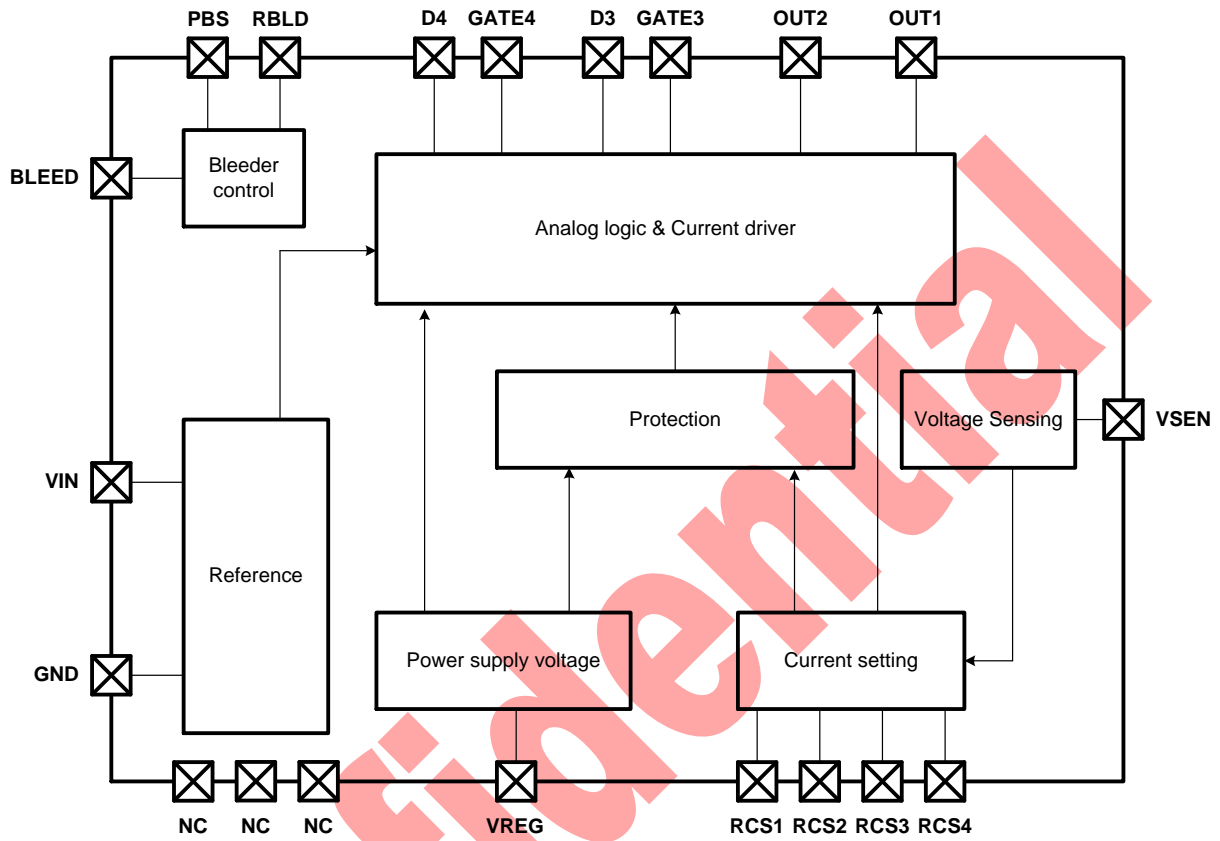
6. Pin Information

Top View



Pin	Symbol	I/O	Description
1	PBS	O	Gate Driver Output of external MOSFET
2	VSEN	I	AC Supply Voltage Sense Input
3	NC	-	No Connection
4	NC	-	No Connection
5	VIN	P	AC Supply Input
6	BLD	O	Intern Bleeder Output
7	OUT1	O	Internal LED Driver Output 1
8	OUT2	O	Internal LED Driver Output 2
9	D3	I	Connect to Ext MOSFET Drain of Output3
10	D4	I	Connect to Ext MOSFET Drain of Output4
11	NC	-	No Connection
12	RCS4	I/O	LED Current Setting for Output 4
13	GATE4	O	Gate Signal Output for External FET 4
14	RCS3	I/O	LED Current Setting for Output 3
15	GATE3	O	Gate Signal Output for External FET 3
16	RCS2	I/O	LED Current Setting for Output 2
17	RCS1	I/O	LED Current Setting for Output 1
18	RBLD	I/O	Internal Bleeder Current Setting
19	VREG	O	Internal Reference Voltage
20	GND	P	Ground

7. Block Diagram



8. Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
VIN, BLEED, OUT1, OUT2, D3, D4	V _{HV1}	-0.3 ~ +700	V
GATE3, GATE4	V _{LV1}	-0.3 ~ +16	V
VREG	V _{LV1}	-0.3 ~ +9	V
Other Pins	V _{LV2}	-0.3 ~ +7.5	V
Maximum Junction Temperature	T _{JMAX}	+160	°C
Storage Temperature	T _{STG}	-65 ~ +150	°C

9. Package Thermal Characteristics

Parameter	Symbol	Value	Unit
Junction to ambient thermal resistance	θ_{JA}	33.8	°C/W
Junction to case thermal resistance	θ_{JC}	7.5	°C/W

*Test conditions

- θ_{JA} : The package thermal impedance is calculated in accordance with JESD 51-7
- θ_{JC} : The package thermal impedance is calculated in accordance with JESD 51-14

10. Recommended Operating Conditions

Parameter	Symbol	Min	Typ.	Max	Unit
Supply Voltage	V _{IN}	90		305	VAC
Ambient Temperature	T _A	-25		85	°C

11. Electrical Characteristics

$T_A = 80^\circ\text{C}$, $V_{AC} = 100/120/220\text{V}$, unless otherwise specified

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
General						
Bias Current	I_{BIAS}		0.7	1.4	2.1	mA
Power Factor	PF		0.9			-
Total Harmonic Distortion	I_{THD}				15	%
VREG Voltage	V_{REG}	No load	6.8	7.8	8.8	V
GATE3, GATE4 Output	V_{GATE}				15	V
Thermal Shutdown	T_{SHDN}			160		$^\circ\text{C}$
Driver Stage Current						
Max. Driver Current ^(Note 1)	I_{OUT1}				180	mA
	I_{OUT2}				210	mA

Note 1)

- The maximum drive current means the guaranteed operating current.
- The maximum drive current is not the DC current. It is the maximum peak current of the four stage for guaranteeing normal operation in AC direct drive method.
- The operating drive current must be determined within the maximum drive current with margin.

12. Functional Description

Driver Current and Power Setting

The WD35-S28T is (2+2) Ch LED lighting driver IC that controls constant LED current regulation in order to control brightness at the LED lighting system by internal 2 channels consist of high voltage FETs and external 2 channels consist of drivers for external High Voltage MOSFET. The constant LED current regulation value can be controlled by 4 external resistors. The LED current can be set by using RCS1, RCS2, RCS3, RCS4 pin and the equations are as below.

$$\text{Channel 1 Current} = \frac{1.85V}{R_{CS1}}$$

$$\text{Channel 2 Current} = \frac{1.90V}{R_{CS2}}$$

$$\text{Channel 3 Current} = \frac{2.00V}{R_{CS3}}$$

$$\text{Channel 4 Current} = \frac{2.00V}{R_{CS4}}$$

RCSx Open

When RCSn Pin is opened, the outputs from step 1 to step [n] of WD35-S28T become deactivated.

For examples,

If RCS2 is opened, both output1 and output2 become deactivated, but both output3 and output4 operate normally.

If RCS3 is opened, all three output1, output2 and output3 become deactivated, but output4 operates normally.

Over Temperature Protection

The junction temperature of WD35-S28T should not exceed its maximum limit. The WD35-S28T makes all LEDs off when its junction temperature becomes higher than 160°C. The WD35-S28T will restart the normal operation when the junction temperature becomes lower than the temperature hysteresis of over temperature protection.

TRIAC Dimming Function

The WD35-S28T can be used with TRIAC dimmer. To use TRIAC dimmer properly, a resistor network must be added on VSEN, VIN and GND pins. Please refer to the typical application circuit.

As the voltage of VSEN pin decreases, all the output current of each steps decreases, but the bleeder current increases. This operation improves the compatibility of the TRIAC dimmer from various manufacturers and the dimming characteristic.

12. Functional Description (Continued)

LED Current in TRIAC Dimming

As the TRIAC dimming angle varies from its full angle of 180° to low angle for dimming control, the existing time of AC input voltage is decreased and hence the average LED current is accordingly decreased. The brightness of LED is, therefore, controlled by this turn-on angle variation of TRIAC dimmer. As the TRIAC dimming angle varies from its full angle to low angle, the brightness of LED must satisfy the NEMA regulation. Usually, the LED brightness decreasing amount only according to the decrease of TRIAC dimming angle is not sufficient to satisfy the NEMA limit.

The WD35-S28T has a function to scale down the LED current starting from TRIAC dimming angle of about 130° by using the voltage of VSEN which is decreasing according to TRIAC dimming angle with some proper gain.

In these ways, the WD35-S28T can satisfy the NEMA regulation in TRIAC dimming control.

Bleeder Current

The current flowing through the TRIAC dimmer must be larger than its minimum holding current limit to maintain its turn-on state at every turn-on time duration after it is turned-on. As the TRIAC dimming angle is decreasing, the WD35-S28T scales down the magnitude of each step currents to satisfy the NEMA regulation and this operation can make the current of TRIAC dimmer smaller than its holding current limit. So, the WD35-S28T provides a function of the bleeder current varying according to the TRIAC dimming angle.

The bleeder current is maintained its minimum level from full angle of 180° to about 140°. From that angle to about 90°, the bleeder current is increased linearly up and reached its maximum level. From about 90° to the minimum TRIAC dimming angle, the bleeder current is maintained its maximum level. The maximum current of the bleeder current is given by the following equation and can be determined by the external resistor RBLD. For higher compatibility of TRIAC dimmer, it is recommended to set the bleeder current larger than 30mA.

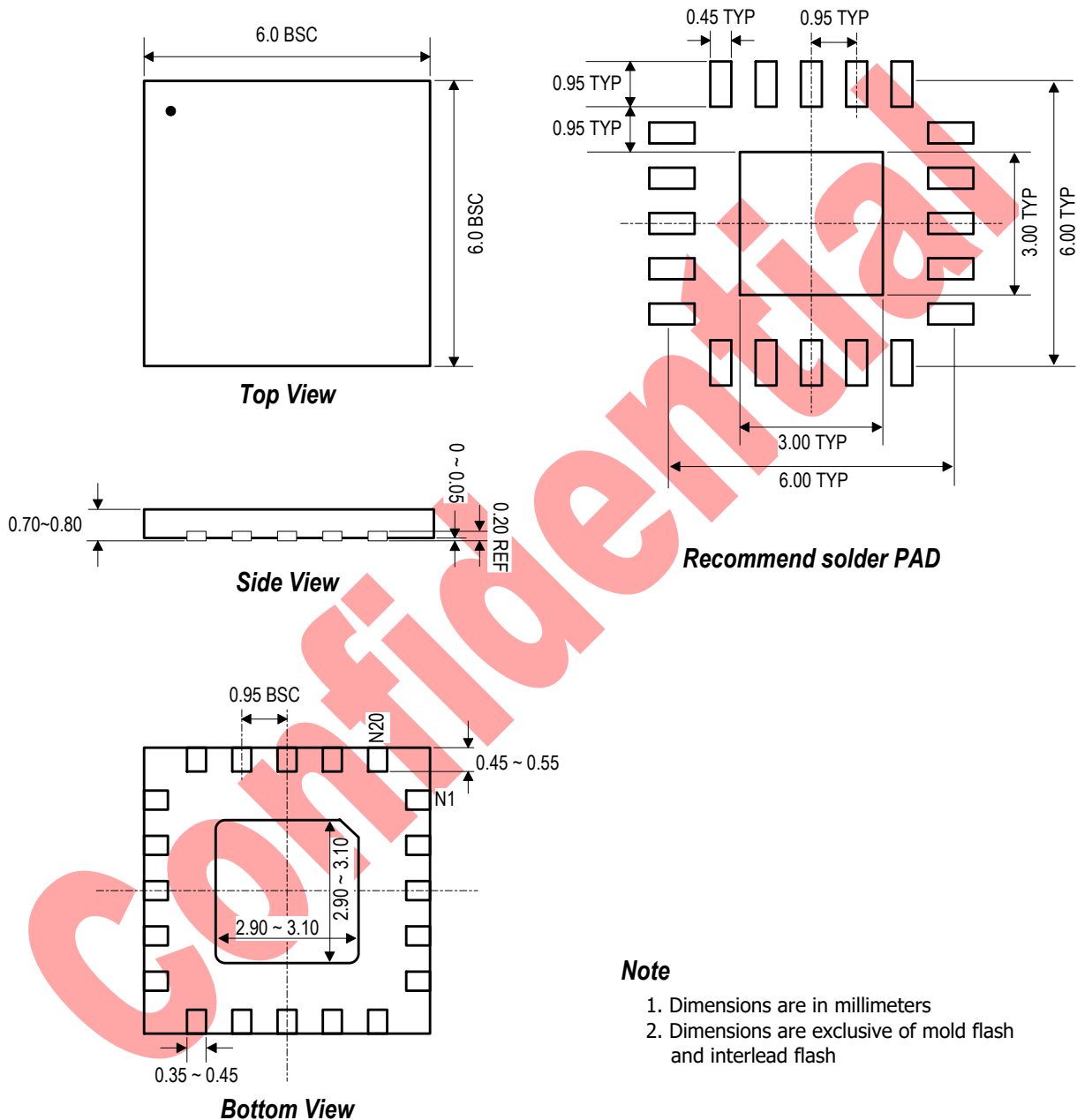
$$\text{Bleeder Current} = \frac{1.80V}{R_{BLD}}$$

PBS Output

The TRIAC dimmer can be turned on when the current of the TRIAC dimmer is larger than its latching current limit at the moment of turn-on. The WD35-S28T provides the PBS gate driver output for an external MOSFET to supply the latching current. The PBS signal is initiated at the rising moment of VIN input voltage and maintain its high state during about 150µsec after that time. The PBS signal with external MOSFET can substitute to the well-known passive bleeder circuitry simply. Please refer to the typical application circuit.

13. Package Outline Dimensions

QFN 12Pin



Note

1. Dimensions are in millimeters
2. Dimensions are exclusive of mold flash and interlead flash

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