



# MT7893

## TRIAC Dimmable Constant Current LED Driver

### DESCRIPTION

MT7893 is a high precision LED constant current controller. It operates in critical conduction mode (CRM) with zero current switched-on and peak current switched-off. It's mainly targeted for BUCK, Fly-back LED power systems. MT7893 supports high power factor application. The Power Factor (PF) can reach 0.8 or higher.

CRM ensures that the MT7893 turns on the internal power MOSFET when the inductor current reaches zero, reducing the power MOSFET switching loss. With critical conduction mode, and line compensation, MT7893 outputs high accuracy LED current, and further achieves excellent line regulation and load regulation.

MT7893 embedded with 300V power MOSFET, it can achieve simplified peripheral circuits and low BOM cost.

MT7893 provides various protection features to improve the system reliability, including over current protection (OCP), short circuit protection (SCP), adjustable over voltage protection (OVP) and over temperature LED current foldback, etc. With a wide dimmer compatibility, the dimming curve meets the NEMA SSL6 standard.

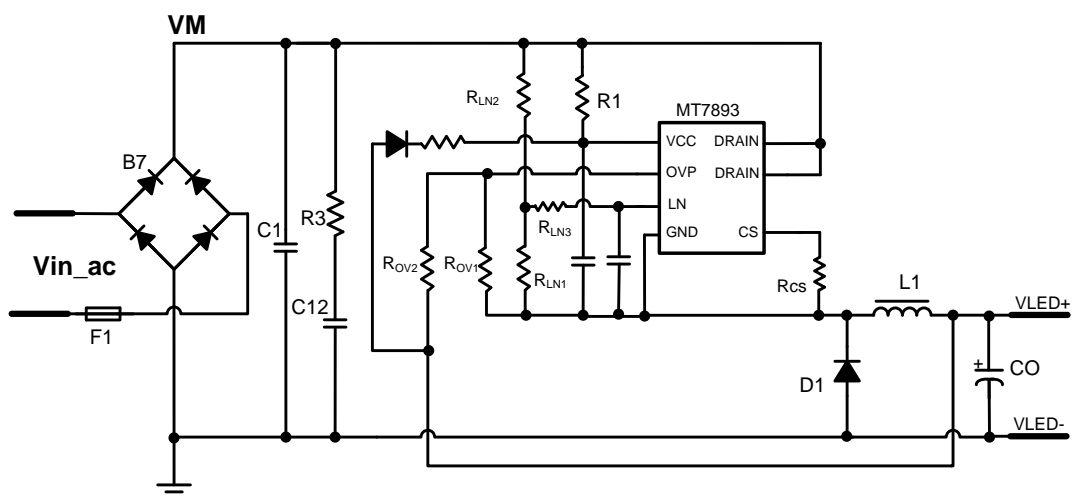
### FEATURES

- Supports high PF application (PF>0.8)
- Wide range of dimmer compatibility
- Deep dimming level (<1%)
- Internal 300V power MOSFET
- Highly accurate constant LED current
- Cycle-by-cycle current limiting
- LED short circuit protection
- Adjustable LED over voltage protection
- Under-voltage lockout (UVLO) protection
- Over temperature LED current foldback
- Available in SOP7 package

### APPLICATIONS

- LED bulb, panel light
- Filament bulb
- General purpose constant current source

### Typical Application Circuit





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### ABSOLUTE MAXIMUM RATINGS

VCC maximum sink current	5mA
OVP (over voltage protection pin voltage)	-0.3 ~ 6V
LN (line compensation pin voltage)	-0.3 ~ 6V
DRAIN (internal HV power MOSFET drain voltage)	-0.3V ~ 300V
CS (current sense pin input voltage)	-0.3V ~ 6V
P <sub>DMAX</sub> (maximum power consumption)	0.8W
Storage Temperature	-55°C ~ 150°C
Junction Temperature (T <sub>j</sub> )	150°C

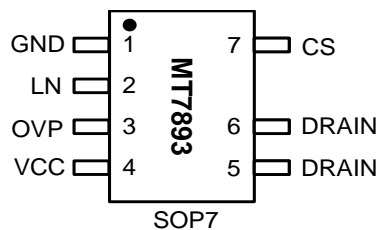
### RECOMMENDEDE OPERATING CONDITIONS

Operating Temperature range	-40°C ~ 105°C
Output Power	<12W @ V <sub>OUT</sub> =36V

### Thermal resistance

Junction to ambient (R <sub>θJA</sub> )	128°C/W
Junction to Case (R <sub>θJC</sub> )	90°C/W

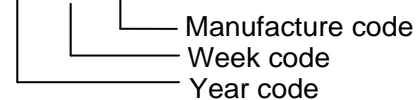
### PIN CONFIGURATIONS



### Chip Mark

MT7893

YY WW xx



### PIN DESCRIPTION

Name	Pin No.	Description
GND	1	Chip ground
LN	2	Line compensation pin. Tie to GND to disable line compensation function
OVP	3	Adjustable over voltage protection pin
VCC	4	Power supply, internal clamped at 19V
DRAIN	5/6	Drain of internal high-voltage power MOSFET
CS	7	Current sense pin, connect a sense resistor to ground

**MT7893****TRIAC Dimmable Constant Current LED Driver****ELECTRICAL CHARACTERISTICS**(Test condition: V<sub>CC</sub>=12V, T<sub>A</sub>=25°C unless otherwise stated.)

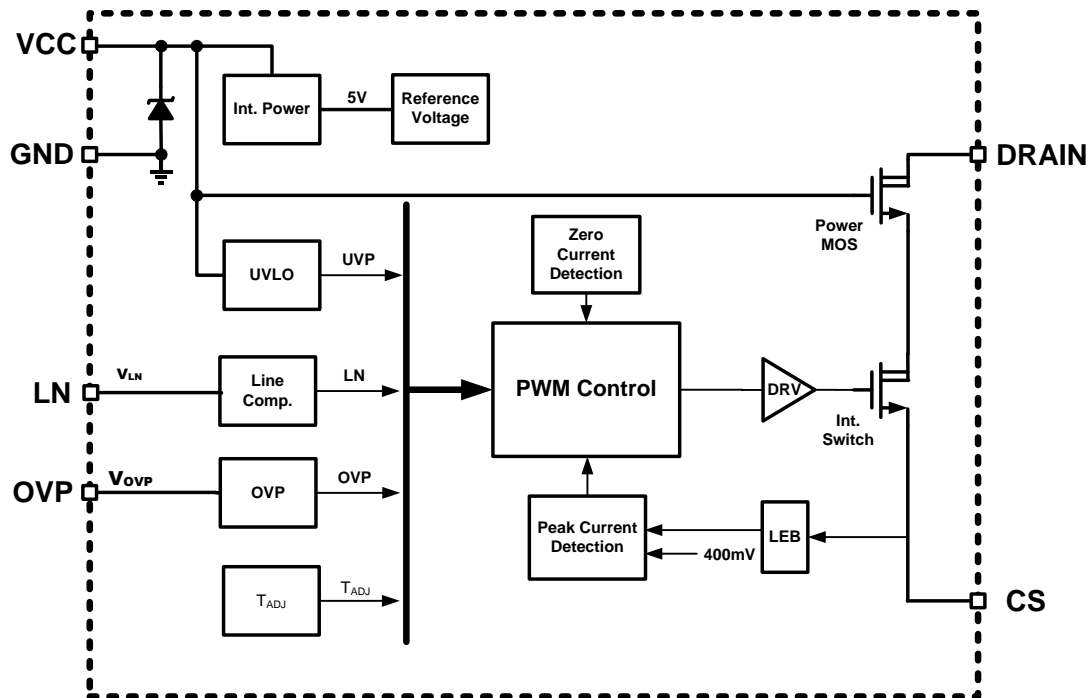
Symbol	Parameter		Min	Typ	Max	Unit
<b>Start-up and supply voltage (VCC Pin)</b>						
I <sub>START</sub>	Start up current	V <sub>CC</sub> < V <sub>CC_UV</sub>		160	200	μA
V <sub>CC_UV</sub>	Lower threshold voltage of V <sub>CC</sub> (UVLO)	V <sub>CC</sub> Pin ramp down		7		V
V <sub>START</sub>	Start-up voltage	V <sub>CC</sub> Pin ramp up		14		V
V <sub>CC-CLAMP</sub>	V <sub>CC</sub> Clamping voltage	I <sub>DD</sub> <5mA		19		V
I <sub>op</sub>	Operating current			0.3		mA
<b>Current sense (CS Pin)</b>						
V <sub>CS-TH</sub>	Threshold voltage for peak current limit		390	400	410	mV
LEB	Leading edge blanking time for current sense			500		ns
V <sub>LN</sub>	Threshold voltage for line compensation			2.7		V
<b>Over voltage protection</b>						
V <sub>TH_OVP</sub>	Threshold voltage for OVP			1		V
<b>Thermal Protection</b>						
T <sub>ADJ</sub>	Temperature threshold for LED current foldback			150		°C
<b>Driver Circuit</b>						
T <sub>OFF_MIN</sub>	Minimum OFF time			2		us
T <sub>OFF_MAX</sub>	Maximum OFF time			200		us
T <sub>ON_MAX</sub>	Maximum ON time			10		us
<b>POWER MOSFET (DRAIN)</b>						
R <sub>DS(on)</sub>	Static drain-source on-resistance	V <sub>GS</sub> =10V/I <sub>DS</sub> =1.5A		3		Ω
BV <sub>DSS</sub>	Drain-source breakdown voltage	V <sub>GS</sub> =0V/I <sub>DS</sub> =250uA	300			V



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### BLOCK DIAGRAM



### APPLICATION INFORMATION

MT7893 is a constant current driver with build-in 300V power MOSFET and is suitable for TRIAC dimmable LED system. The critical conduction mode and line compensation ensures that MT7893 outputs high accuracy LED current, and further achieves excellent line regulation and load regulation. With very few peripheral components, the system cost and size are greatly reduced.

#### Start up

VCC is charged by the startup resistor (or other startup circuit) once the system is powered on. As the VCC reaches 14V, the control logic starts to work, and internal switch starts toggling. When the VCC rises up to 19V, it will be clamped. MT7893 shuts down as VCC falls below 7V.

#### CRM and Output Current Setup

The peak current of the internal power MOSFET is cycle-by-cycle detected by monitoring the

voltage on the CS pin. When the voltage reaches 400mV (internal reference voltage without line compensation function), the internal power MOSFET is turned off, when the inductor current drops to zero, it will be turned on again.

The peak inductor current without line compensation function is given by:

$$I_{LPK} = \frac{400}{R_{CS}} (mA) \quad (1)$$

Where,  $R_{CS}$  is the current sense resistor in ohm. The CS comparator also includes a 500ns leading edge blanking time to block the transient noise as the power switch just turned on.

The current at LED can be calculated as:

$$I_{LED} = k \times \frac{I_{LPK}}{2} = k \times \frac{400mV}{2 \times R_{CS}} (mA) \quad (2)$$

Where,  $I_{LPK}$  is the peak current of the inductor;  $k$  is the compensation factor, and is less than 1. Shown in the equation (2), the output current is



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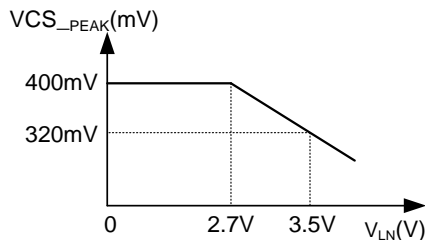
## TRIAC Dimmable Constant Current LED Driver

determined by the  $R_{CS}$  and the 400mV reference voltage, insensitive to the inductance. Please utilize the design tool that Maxic provided to calculate the initial value of  $R_{CS}$ .

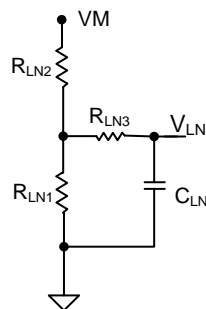
### Line Compensation

MT7893 integrates the line compensation function. Once the voltage on LN pin ( $V_{LN}$ ) exceeds 2.7V, the threshold for peak current limit decreases, thus, the input voltage compensation is achieved.

The relationship between  $V_{CS\_PEAK}$  and  $V_{LN}$  as shown below:



Where,  $V_{LN}$  is proportional to the average value of the rectified input voltage, which is obtained by sampling and filtering the input voltage as shown below:



Where,  $R_{LN1}$  is about 10kohm;  $R_{LN3}$  is about 200kohm;  $C_{LN}$  is about 1uF.

The passive filter  $R_{LN3}$  and  $C_{LN}$  converts the input line voltage VM to the DC-like line compensation voltage  $V_{LN}$ . Adjusting the ratio of  $R_{LN2}$  and  $R_{LN1}$  achieves optimized line compensation effect.

If the line compensation function is not needed, tie LN pin to ground.

Maxic provides design tool of MT7893 to help customer to design appropriate  $R_{LN1}$  and  $R_{LN2}$  ratio.

### Switching Frequency

MT7893 operates in critical conduction mode. When the inductor current is zero, the system turns on the internal power MOSFET, the inductor current rises up from the ground. The on time of the power MOSFET is calculated by the equation:

$$T_{ON} = \frac{L \times I_{LPK}}{V_{IN} - V_{LED}} \quad (3)$$

Where, L is the inductance of the inductor;  $I_{LPK}$  is the peak current through the inductor;  $V_{IN}$  is the DC voltage of the rectified input voltage.

The internal power MOSFET is turned off, while the voltage on the CS pin increases to 400mV. The inductor current will discharge the LED through the free-wheeling diode. The internal power MOSFET won't be turned on until the current in the inductor drops to zero. The off time of the power MOSFET is calculated by the equation:

$$T_{OFF} = \frac{L \times I_{LPK}}{V_{LED}} \quad (4)$$

Operating frequency of the system is:

$$F = \frac{1}{T_{ON} + T_{OFF}} = \frac{V_{LED} \times (1 - \frac{V_{LED}}{V_{IN}})}{L \times I_{LPK}} \quad (5)$$

From the equation, it's showing that MT7893 operating frequency is determined by the input voltage  $V_{IN}$ , the LED forward voltage drop  $V_{LED}$  and the inductance L. The higher input voltage  $V_{IN}$  makes the operating frequency to be higher. For both EMI and efficiency consideration, it's recommended to set the operating frequency between 30kHz ~ 120kHz. The appropriate inductance should be determined at minimum input voltage condition to meet the requirement. MT7893 sets the minimum off time  $T_{OFF\_MIN}=2\mu s$ . Shown in  $T_{OFF}$  equation, if the inductance is too



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small, the  $T_{OFF}$  may be shorter than  $T_{OFF\_MIN}$ , the system will operate in discontinuous conduction mode. The actual LED current will be smaller than the target value.

MT7893 determines the line valley automatically. The valley detection circuit is integrated in the MT7893. It senses when the input voltage reaches its lowest level (valley) automatically. MT7893 sets the maximum off time  $T_{OFF\_MAX}=2.5\mu s$  when the valley is detected in order to limit the operating efficiency. In application, the inductance should not be too big, it may cause the real current may not exactly match the design value by longer demagnetization time during valley.

Maxic provides design tool of this chip, it helps customer to come out proper solution and to choose the right inductance.

#### Over-current Protection

MT7893 immediately turns off the internal power MOSFET once the voltage on CS pin exceeds 400mV. This cycle-by-cycle current limitation scheme prevents the relevant components, such as power MOSFET, transformer, etc. suffers from damage.

#### LED Over voltage protection

The LED over voltage condition can be detected by OVP pin. The OVP threshold voltage is 1V. MT7893 shuts down and the VCC restarts as  $V_{OVP}$  exceeds 1V. MT7893 will resume when the over voltage condition has been removed.

The  $V_{OVP}$  is programmed by adjusting the pull up resistor  $R_{OVP2}$  and the pull down resistor  $R_{OVP1}$ :

$$V_{OVP} = 1V \times \left( 1 + \frac{R_{OVP2}}{R_{OVP1}} \right) \quad (6)$$

Where,  $R_{OVP1}$  is about 4.7k.

#### PCB Layout Consideration

- 1) The VCC de-couple capacitor (typically 1uF ~ 4.7uF ceramic capacitor) should be kept as close to the VCC pin as possible (no more than 5mm). This can greatly improve the system noise immunity.
- 2) The pin5, pin6 are the drain of the power MOSFET. They are the major noise disturbance source. Should put GND plane under the chip to shield the drain terminal with other pins. Recommended to put copper plane at DRAIN pins for better thermal dissipation.
- 3) The OVP (pin3) connection wire should be as short as possible. The connection wire and the related resistor terminals must be placed far away from the high voltage components (>3mm), such as the MOSFET drain (pin5, pin6), VCC pad, etc.
- 4) The RC filter of LN pin (pin2) should be kept as close to the LN pin as possible, and the divider terminals must be placed far away from the high voltage components and other noise sources.
- 5) The area of main current loop should be as small as possible to reduce EMI radiation, such as the related pathways area of the inductor current.

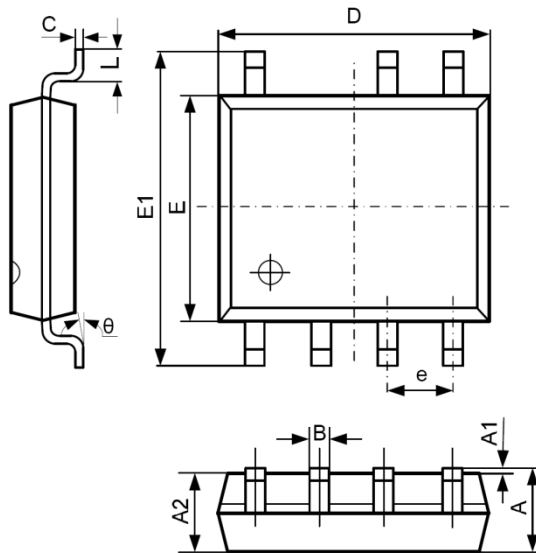


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**PACKAGE INFORMATION**

**SOP-7 PACKAGE OUTLINE AND DIMENSIONS**



SYMBOL	DIMENSION IN MILLIMETERS		DIMENSION IN INCHES	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
B	0.330	0.510	0.013	0.020
C	0.190	0.250	0.007	0.010
D	4.700	5.100	0.185	0.201
E	3.800	4.000	0.150	0.157
E1	5.800	6.300	0.228	0.248
e	1.270 TYP		0.050 TYP	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

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