杰力科技股份有限公司
Excelliance MOS Corporation

EM8801A

Constant Off Time, Current-Mode Controller for LED Applications

General Description

EM8801A is a constant off time current mode controller. This device can operated with a fixed off time of the power switch. The TOFF pin is provided to set the off time. In addition, the PWMD pin enables the user to use a PWM signal to modulate the switching pattern and adjust the average luminosity. The LD/SS pin enables the user to set peak current by adjust the voltage of this pin.

This part includes internal soft start, maximum on time protection, over current protection and thermal shutdown function. This part is available in SOP-8 package.

Ordering Information

Part Number	Package	Remark
EM8801AG	SOP-8	

Features

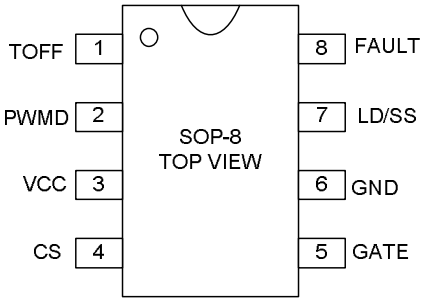
- Constant Off Time Current-Mode Control
- Adjustable Off Time
- Internal Leading Edge Blanking
- Internal Start Up Delay
- Maximum On Time Protection
- Over Current Protection
- Built-in Thermal Shutdown
- PFM mode operation to reduce EMI
- Internal / External Soft Start Function

Applications

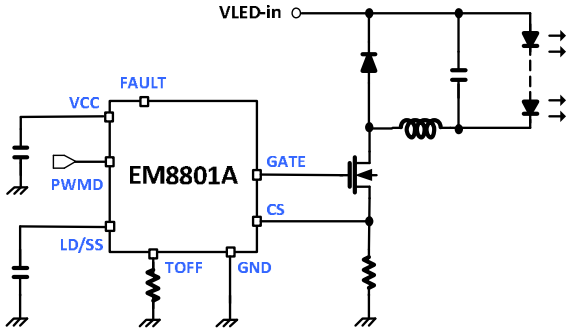
GP GREEN PRODUCT

- LED Backlight or lighting
- RGB Backlight or lighting
- Organic Light-Emitting Diode Backlight or lighting
- AC-DC or DC-DC LED Driver applications.

Pin Configuration



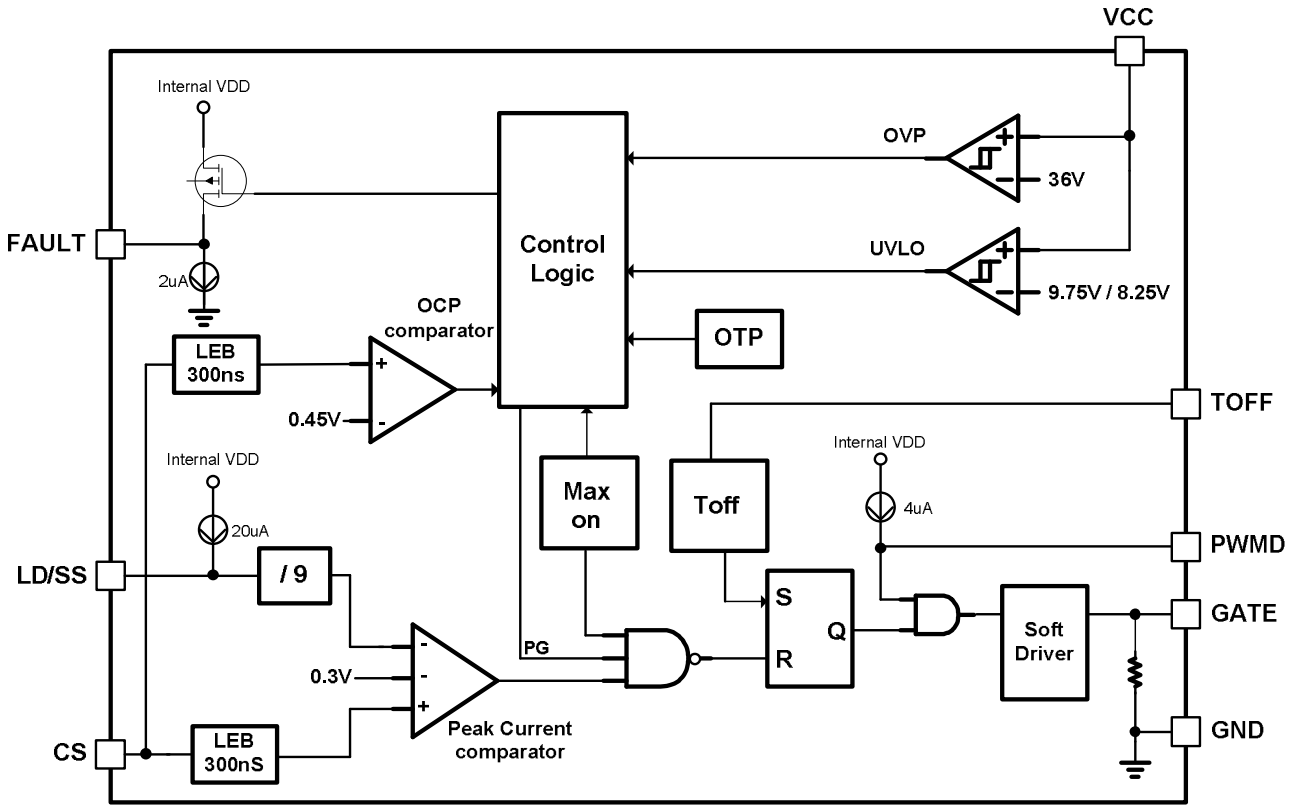
Typical Application Circuit



Pin Assignment

Pin Name	Pin No.	Pin Function
TOFF	1	**OFF Time Setting.** A resistor to ground to set off time. Pulling this pin to ground will disable the device.
PWMD	2	**PWM Dimming.** This pin is used for PWM dimming. When the voltage applied to this pin is low, switching is inhibited. When the voltage applied to this pin is high, switching restarts.
VCC	3	**Supply Voltage.** This pin provides the bias supply for the EM8801A. The supply voltage is internally regulated to 5VDD for internal control circuit. Connect a well-decoupled supply voltage to this pin. Ensure that a decoupling capacitor is placed near the IC.
CS	4	**Current Sense Input.** This pin senses the peak current.
GATE	5	**Driver OUTPUT.** The output of the driver is connected to the gate of the external MOSFET.
GND	6	**Signal and Power Ground for the IC.** All voltages levels are measured with respect to this pin. Tie this pin to the ground island/plane through the lowest impedance connection available.
LD/SS	7	**Linear Dimming and Soft Start.** A capacitor connected to the pin sets the soft start period. The voltage of this pin adjusts the peak current.
FAULT	8	**Fault.** This pin is asserted high when a fault condition is detected.

Function Block Diagram



Absolute Maximum Ratings (Note 1)

- Supply voltage, VCC---------- -0.3V to 40V
- GATE---------- -0.3V to 40V
- Other pins---------- 0.3V to 6V
- Power Dissipation, PD @ TA = 25°C, SOP-8 ---------- 0.909W
- Package Thermal Resistance, ΘJA, SOP-8 (Note 2)---------- 110°C/W
- Junction Temperature---------- 150°C
- Lead Temperature (Soldering, 10 sec.)---------- 260°C
- Storage Temperature Range---------- -65°C to 150°C
- ESD susceptibility (Note3)
  HBM (Human Body Mode)---------- 2kV
  MM (Machine Mode)---------- 200V

Recommended Operating Conditions (Note4)

- Supply Input Voltage, VCC ---------- 9.75V to 34V
- VCC capacitor ---------- 1uF to 10uF
- Junction Temperature ---------- -40°C to 125°C
- Ambient Temperature ---------- -40°C to 85°C

Electrical Characteristics

V_{CC}=12V, RTOFF=40kohm, T_A=25℃, unless otherwise specified

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
VCC Section						
VCC On Threshold Voltage	V_{TH-ON}		9.0	9.75	10.5	V
VCC Off Hysteresis Voltage	V_{TH-HY}			1.5		V
Current Consumption in Latch Mode	$I_{CC-LATCH}$			0.6	1.2	mA
Current Consumption in Start-up	I_{CC-OP1}	VCC=V_{TH-ON}-0.2V		0.05	0.08	mA
Current Consumption in Device Disable	I_{CC-OP2}	VCC=12V, V_{PWMD}=0V		0.6	1.2	mA
Current Consumption in Device Switching	I_{CC-OP3}	C_{GATE}=1nF F_{SW}=60KHz		1.5	2.35	mA
VCC OVP Protect voltage	I_{OVP}		34	36	38	V
Gate Section						
Rising Time	T_R	C_L = 1nF		80	140	ns
Falling Time	T_F	C_L = 1nF		30	60	ns
Gate Maximum Voltage	V_{GATE}			15		V
Current-Sense Section						
Maximum Internal Current Set-point	V_{CSLim}		0.285	0.3	0.315	V
Leading Edge Blanking Time	T_{LEB}			300		ns

Propagation Delay Time	T_{PD}	V_{CS}=V_{CSLim} to Vgate=1V, Cgate=1nF		100		ns
Internal Soft-Start Period	T_{SS}			0.6		ms
TOFF section						
Off Time	T_{OFF}	R_TOFF=30K ohm		6		us
		R_TOFF=10K ohm	1.8	2	2.2	us
Minimum Off Time	$T_{OFF-min}$	R_TOFF=1K ohm		0.435		us
Maximum Off Time	$T_{OFF-max}$	R_TOFF=60K ohm		12		us
TOFF Short Protection Trigger Level	$V_{TOFF-SHORT}$		0.3	0.4	0.5	V
Off Time Variation vs. VCC		VCC=9.5V to 16V			2	%
Off Time Variation vs. Temperature		-20°C to 105°C			5	%
PWMD Section						
PWMD ON Voltage Threshold	$V_{PWMD-ON}$	V_{PWMD} increasing			2.2	V
PWMD OFF Voltage Threshold	$V_{PWMD-OFF}$	V_{PWMD} decreasing	0.8			V
PWMD Pin Open Voltage	$V_{PWMD-OPEN}$			5		V
PWMD Pin Internal Pull High Current	I_{PWMD}		2	4	6	uA
Dimming Wake-up Time	T_{WAKE}	V_{PWMD}= $V_{PWMD-ON}$ to V_{GATE}=6V			1	us
LD/SS Section						
LD/SS Pin Open Voltage	$V_{LD-OPEN}$			5		V
LD/SS Pin Internal Pull High Current	I_{LD}		18	20	22	uA
LD/SS Pin Voltage to Peak Current Ratio			8.55	9	9.45	V/V
FAULT Section						
FAULT Internal Pull Low Current	I_{FA}			6	10	uA
FAULT Pull high Voltage	V_{FA_HIGH}			5		V
FAULT Pull high Capability	I_{FA_HIGH}		1	2		mA
Protection Section						
Maximum On Time	T_{ON-MAX}			50		us
Over Current Trigger Level	V_{OCP1}		0.42	0.45	0.48	V
Suspend mode Vcs over voltage protection	V_{OCP2}		0.42	0.45	0.48	V
OCP Leading Edge Blanking Time	$T_{LEB-OCP}$			300		ns
Start-up Delay	$T_{START-DELAY}$		80	130	160	ms
Thermal Shutdown	T_{SD}		135	155		°C
Thermal Shutdown Hysteresis	T_{SD-HYS}			40		°C

Note 1. Stresses listed as the above "Absolute Maximum Ratings" may cause permanent damage to the device. These are for stress ratings. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may remain possibility to affect device reliability.

Note 2. θ_{JA} SOP-8 packages is 52°C /W on JEDEC 51-7 (4 layers,2S2P) thermal test board with 50mm^2 copper area.

Note 3. Devices are ESD sensitive. Handling precaution is recommended.

Note 4. The device is not guaranteed to function outside its operating conditions.

Typical Operating Characteristics

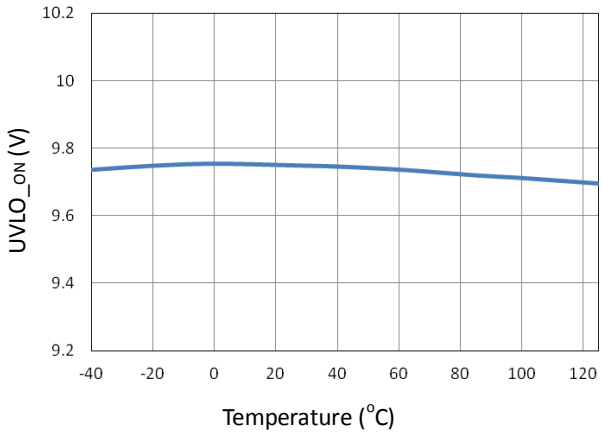


Fig1. UVLO_ON vs. Temperature

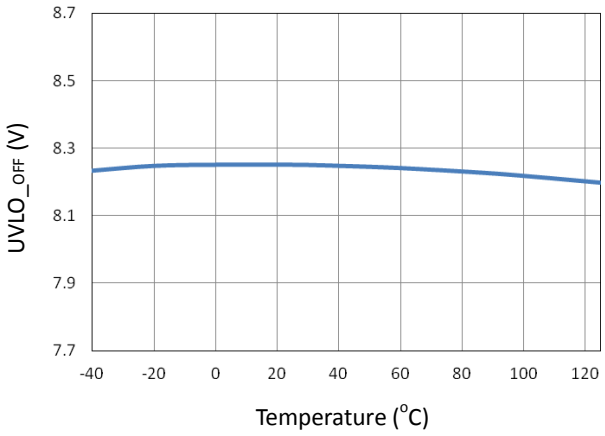


Fig2. UVLO_OFF vs. Temperature

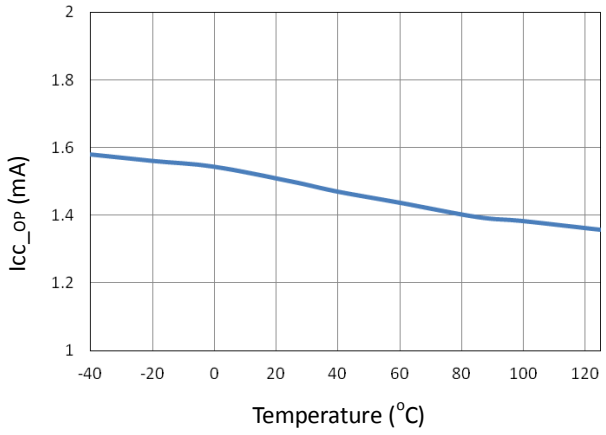


Fig3. Operation Supply Current (Icc_OP) vs. Temperature

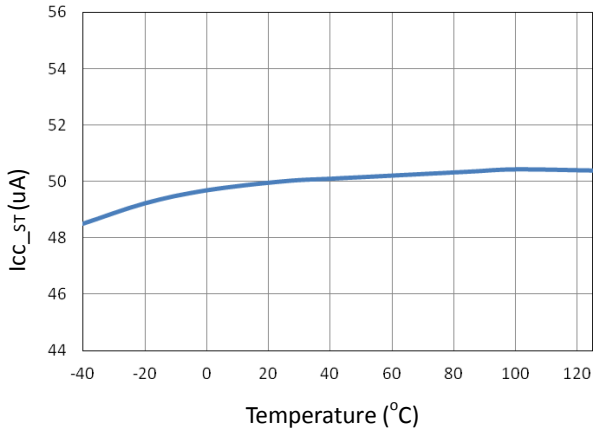


Fig4. Start Current (Icc_ST) vs. Temperature

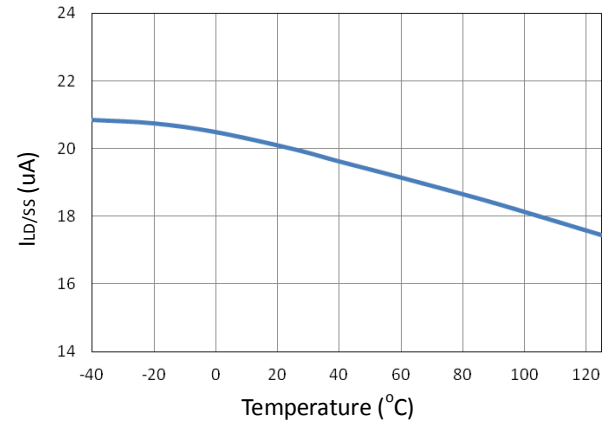


Fig5. LD/SS Pull High Current (ILD/SS) vs. Temperature

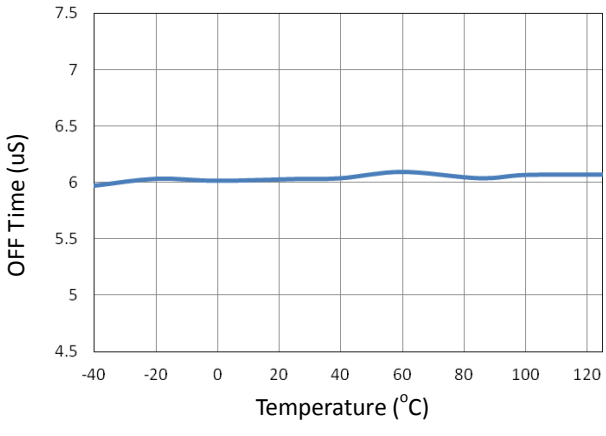


Fig6. OFF Time (R_TOFF=30KΩ) vs. Temperature

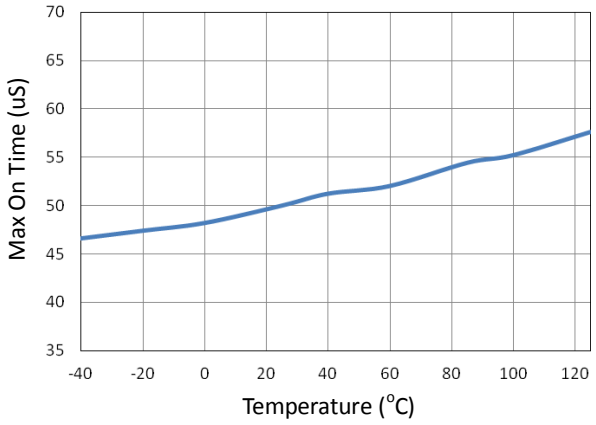


Fig7. Max On Time vs. Temperature

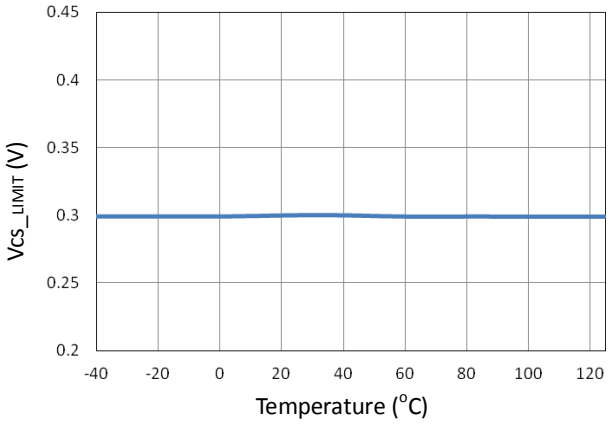


Fig8. Vcs_LIMIT vs. Temperature

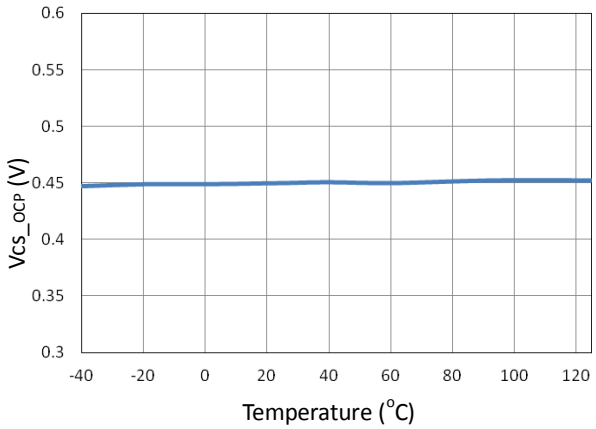


Fig9. Vcs_OCP vs. Temperature

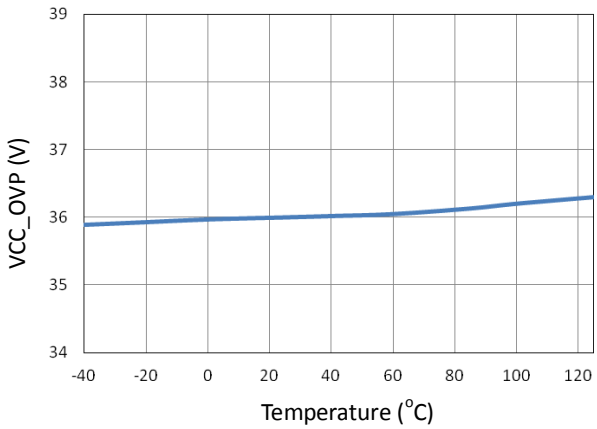
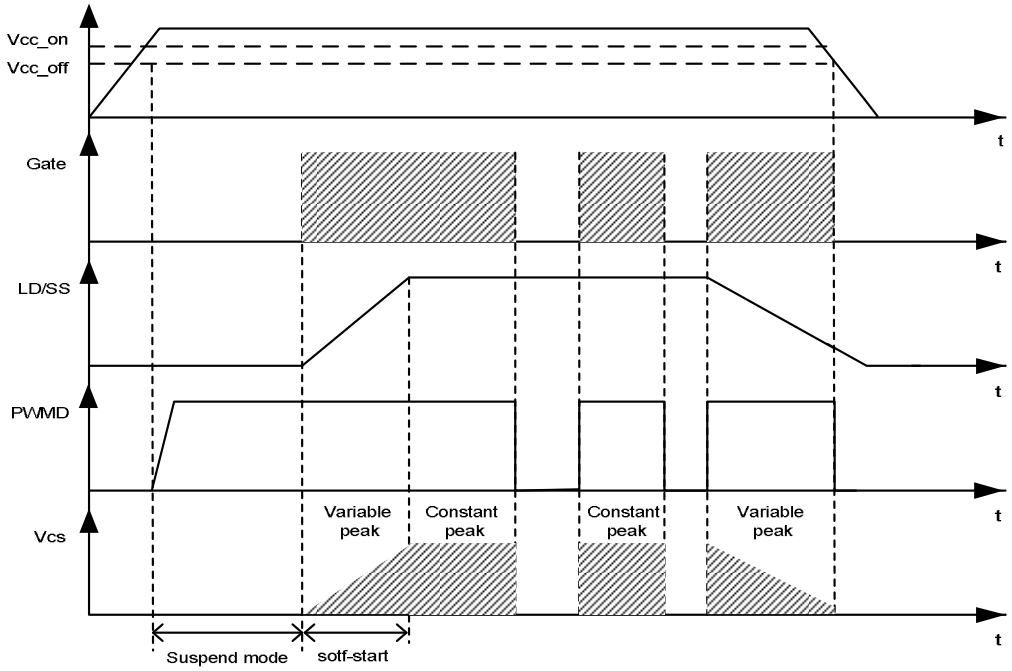
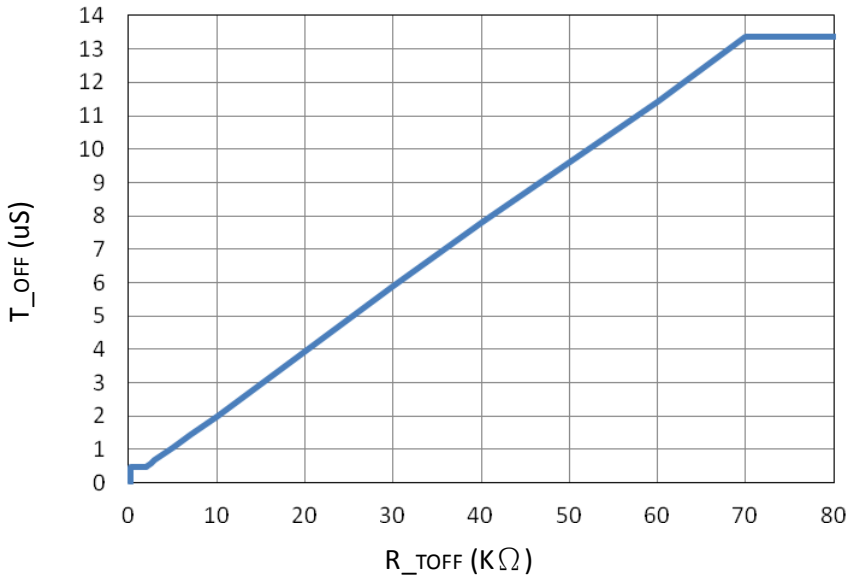


Fig10. VCC_OVP vs. Temperature

Typical start-up sequence and possible type of steady-state operation.



Toff(us) time vs Rtoff(kohm) Adjustment Resistor



Functional Description

EM8801A is a constant off time current mode controller. The PWMD pin enables the user to use a PWM signal to modulate the switching pattern and adjust the average luminosity. The LD/SS pin enables the user to set peak current by adjust the voltage of this pin. A capacitor connected to the LD/SS pin sets the soft start period.

Supply Voltage

The V_{CC} pin provides the bias supply of EM8801A control circuit, as well as MOSFET's gate. A minimum 0.1uF ceramic capacitor is recommended to bypass the supply voltage.

Power ON Reset

To let EM8801A start to operation, V_{CC} voltage must be higher than its POR voltage. Typical POR voltage is 9.75V.

Start Up Delay

When VCC reaches POR threshold, start-up-delay timer begins to count. When start-up-delay is finished, the current source of LD/SS pin is enabled and the soft-start sequence begins.

Soft Start

A capacitor connected to the LD/SS pin sets the soft start period.

Gate Output / Soft Driver

The output stage has a fast totem-pole gate driver. The output driver is clamped by an internal 15V Zener diode to protect the external power MOSFET gate from over voltage. A soft driving is implemented to minimize EMI by reducing the switching noise.

Dimming

The device is able to perform both linear and PWM dimming. Two separate inputs are provided (LD/SS pin for linear dimming, PWMD pin for PWM dimming). The two functions can be used simultaneously and independently to one another.

Linear dimming can be performed by applying a dc voltage between 0.45V and 2.7V. This voltage is internally processed, generating the reference level VCS_LD. The relationship between VLD and VCS_LD is:

VCS_LD=VLD/9, When VLD>0.45V

VCS_LD=0.05V, When VLD$\leqq$0.45V

PWM dimming can be achieved by driving the PWMD pin with a low frequency square wave signal. When the PWMD signal is lower than 0.8V, switching is inhibited. When the PWMD signal is higher than 2V, the switching is enabled.

Constant Off-Time Generator

The off-time generator begins at the end of each on time. Once the off time generator has elapsed, it begins the next GATE pulse. The off-time is programmed by connecting a resistor from the TOFF pin to ground.

Protections and Fault Flag

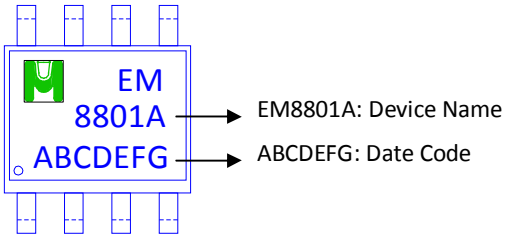
In case the LED string fails short, the inductor current will rise cycle by cycle without control. To prevent the current from exceeding levels that might lead to catastrophic failure of the power MOSFET, EM8801A detects if VCS exceeds 0.45V. If this occurs for eight consecutive switching cycles, a latched shutdown function is tripped: the device is stopped in an idle state and it is necessary to recycle its supply voltage to make it restart.

In case the LED string fails open, the current will drop to zero and the inductor current will never reach the programmed level. To detect this situation, an internal timer checks the ON time of the power MOSFET and, if it exceeds 50us for eight consecutive switching cycles, a latched shutdown function is tripped: the device is stopped in an idle state and it is necessary to recycle its supply voltage to make it restart.

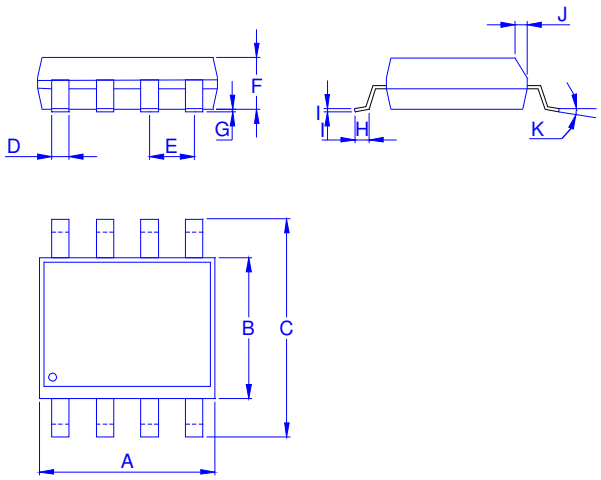
In either case, the activation of the protection functions is signaled by FAULT pin asserted high, becoming a 5V voltage source able to provide up to 2mA source current.

Ordering & Marking Information

Device Name: EM8801AG for SOP-8



Outline Drawing



Dimension in mm

Dimension	A	B	C	D	E	F	G	H	I	J	K
Min.	4.70	3.70	5.80	0.33		1.20	0.08	0.40	0.19	0.25	0°
Typ.					1.27						
Max.	5.10	4.10	6.20	0.51		1.62	0.28	0.83	0.26	0.50	8°