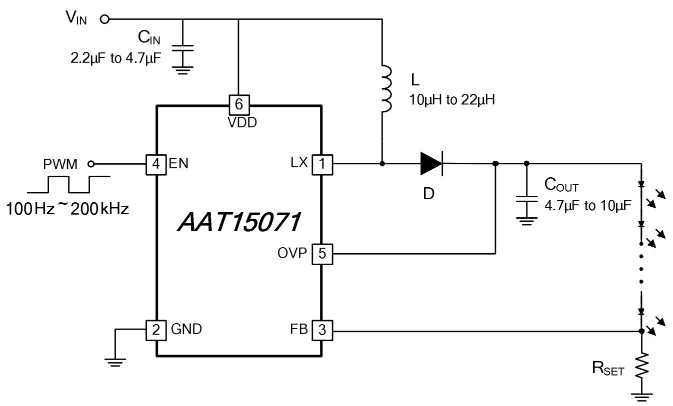
BOOST CONVERTER FOR WLED DRIVER

FEATURES

- **Boost PWM with Internal NMOS**
- **Wide PWM Dimming Range:100Hz to 200kHz**
- **2.7V to 5.5V Input Voltage Range**
- **Under-Voltage Lockout (UVLO) Protection**
- **Internal Over Voltage and Thermal Protection**
- **Internal Soft-Start**
- **Fixed Switching Frequency : 1.3MHz**
- **0.1µA Shutdown Current**
- **Small TSOT-23-6 and SOT-23-6 Package**

APPLICATIONS

- **Cell Phones**
- **DSC**
- **Small LCD Displays**



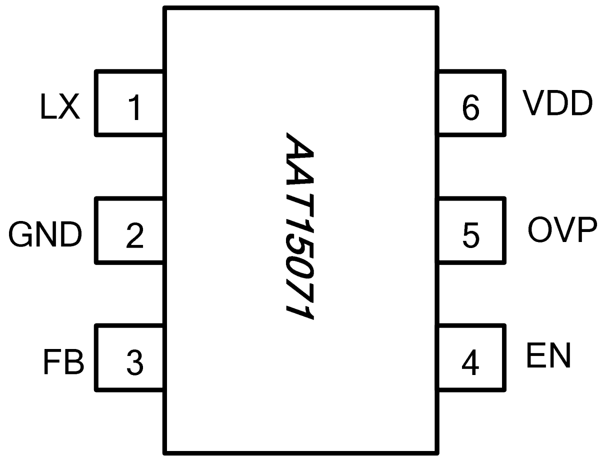
GENERAL DESCRIPTION

The AAT15071 is a boost DC-DC converter for white LEDs. Series connection of the LEDs allows consistent LED currents, which is essential for uniform brightness, and eliminates the need for ballast resistors. The 20V over voltage comparator can also be used to prevent output open-circuit, caused by bond wire breakages.

The AAT15071 switches at 1.3MHz. Optional external components may also be added if required. The optimized input/output capacitor and a low feedback voltage to minimize power loss in current-setting resistor make AAT15071 a power-smart solution.

The AAT15071 is available in a space-saving TSOT23-6 (TSOT26) and SOT23-6 (SOT26) package, which are ideal for portable applications.

PIN CONFIGURATION



TSOT23-6 / SOT23-6

ORDERING INFORMATION

DEVICE TYPE	PART NUMBER	PACKAGE	PACKING	TEMP. RANGE	MARKING	MARKING DESCRIPTION
AAT15071	AAT15071-S3-T	S3: SOT23-6 (SOT26)	T: Tape and Reel	–40°C to +85°C	B05AA	B05AA Product Code: AAT15071 Tracing Code: From AA, AB, AC;‥ BA, BB,…
AAT15071	AAT15071-S13-T	S13: TSOT23-6 (TSOT26)	T: Tape and Reel	–40°C to +85°C		

Note: All AAT products are lead free and halogen free.

ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	VALUE	UNIT
Supply Voltage	V_{DD}	6	V
LX Pin Voltage	V_{LX}	23	V
OVP Pin Voltage	V_{OVP}	23	V
Package Thermal Resistance-SOT26/TSOT26	θ_{JA}	275	°C /W
Power Dissipation, @ T_C = +25°C , T_J = +125°C	P_d	0.364	W
Operating Free-Air Temperature Range	T_C	–40 to +85	°C
Storage Temperature Range	$T_{STORAGE}$	–45 to +125	°C

Note: Stresses above those listed under ABSOLUTE MAXIMUM RATINGS may cause permanent damage to the devices. Exposure to ABSOLUTE MAXIMUM RATINGS conditions for extended periods may affect device reliability.

RECOMMENDED OPERATING CONDITIONS

PARAMETER	SYMBOL	MIN	MAX	UNIT
Supply Voltage	V_{DD}	2.7	5.5	V
Error Amplifier Input Voltage	V_I	0	1.6	V
Operating Free-Air Temperature	T_C	–40	+85	°C

ELECTRICAL CHARACTERISTICS

(V_{DD} = 2.7V to 5.5V, T_C = –20°C to +85°C , unless otherwise specified. Typical values are tested at +25°C ambient temperature, V_{DD} = 3.3V.)

Oscillator

PARAMETER	SYMBOL	TEST CONDITION	MIN	TYP	MAX	UNIT
Oscillation Frequency	f_{OSC}		1.1	1.3	1.5	MHz
Frequency Variation with Temperature	$f_{\Delta T}$	T_C = –20°C to +85°C	-	±5	-	%
Frequency Input Stability	$f_{\Delta V}$	V_{DD} = 2.7V to 5.5V	-	±5	-	%

Operation Voltage

PARAMETER	SYMBOL	TEST CONDITION	MIN	TYP	MAX	UNIT
Operation Voltage	V_{IN}		2.7	-	5.5	V
Over Voltage Threshold	V_{OVP}		18	20	22	V

Thermal Shutdown

PARAMETER	SYMBOL	TEST CONDITION	MIN	TYP	MAX	UNIT
Thermal Shutdown Threshold	T_{SD}		-	160	-	°C
Hysteresis			-	20	-	°C

Soft Start

PARAMETER	SYMBOL	TEST CONDITION	MIN	TYP	MAX	UNIT
Soft Start Time	t_{SS}		-	1	-	ms

Shutdown Control

PARAMETER	SYMBOL	TEST CONDITION	MIN	TYP	MAX	UNIT
Shutdown Enable Voltage	V_{SE}		-	-	0.4	V
Shutdown Release Voltage	V_{SR}		1.4	-	-	V
Input Bias Current	I_{BEN}		-	10	-	µA

Idle Period Adjustment Section

PARAMETER	SYMBOL	TEST CONDITION	MIN	TYP	MAX	UNIT
Maximum Duty Ratio	D_{MAX}	V_{FB} = 0V	93	95	97	%

ELECTRICAL CHARACTERISTICS

(V_{DD} = 2.7V to 5.5V, T_C = –20°C to +85°C , unless otherwise specified. Typical values are tested at +25°C ambient temperature, V_{DD} = 3.3V.)

Error Amplifier

PARAMETER	SYMBOL	TEST CONDITION	MIN	TYP	MAX	UNIT
Input Threshold Voltage	V_{TH}		190	200	210	mV
VTH Input Stability	$V_{TH\Delta V}$	V_{DD} = 2.7V to 5.5V	-	2	5	mV
VTH Variation with Temperature	$V_{TH\Delta T}$	T_C = –20°C to +85°C	-	1	-	%
Input Bias Current	I_B		-	0.1	1.0	μA
Open-Loop Voltage Gain	A_{VO}		70	84	-	dB

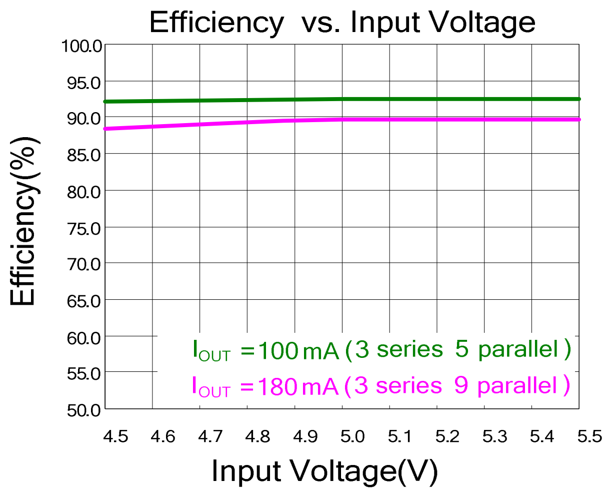
Operation Current

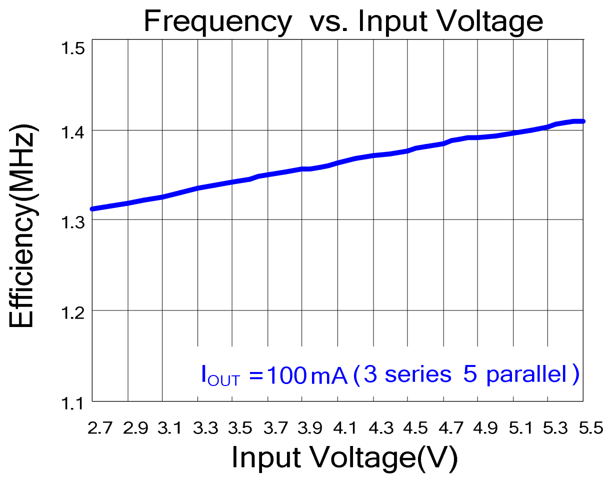
PARAMETER	SYMBOL	TEST CONDITION	MIN	TYP	MAX	UNIT
Supply Current	I_{SD}	V_{EN} = 0V	-	0.1	0.5	μA
	I_{DD-OFF}	Not Switching FB = 0.5V	-	600	700	μA
	I_{DD-ON}	Switching FB = 0V	-	1,000	1,100	μA

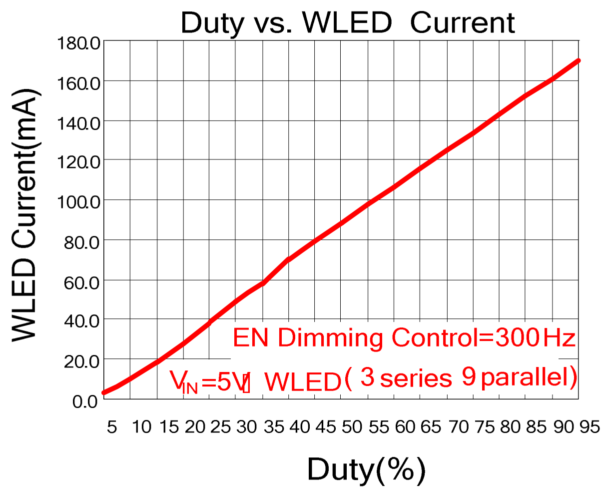
Output Section

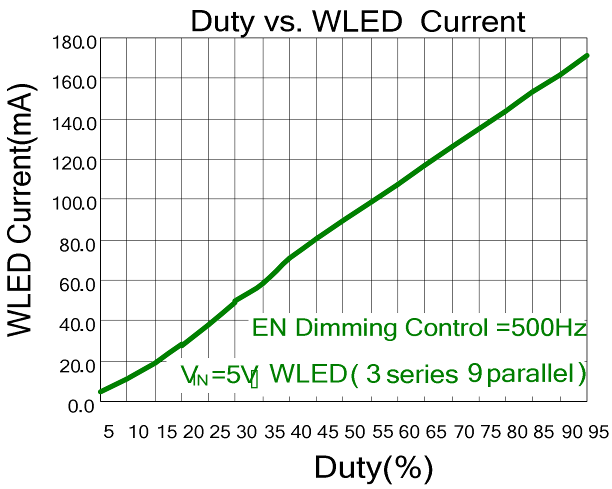
PARAMETER	SYMBOL	TEST CONDITION	MIN	TYP	MAX	UNIT
LX Switch-on Resistance	R_{SWON}		-	0.3	0.6	Ω
LX Switch Current Limit	I_{LXLV}		-	1.3	-	A
LX Leakage Current	$I_{LEAKAGE}$	V_{LX} = 6V	-	-	1.0	μA

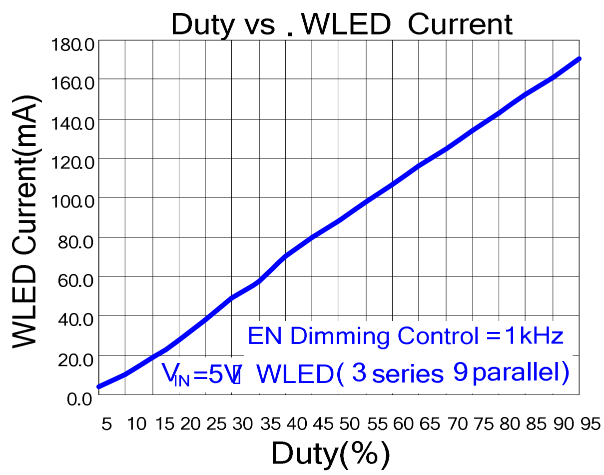
TYPICAL OPERATING CHARACTERISTICS



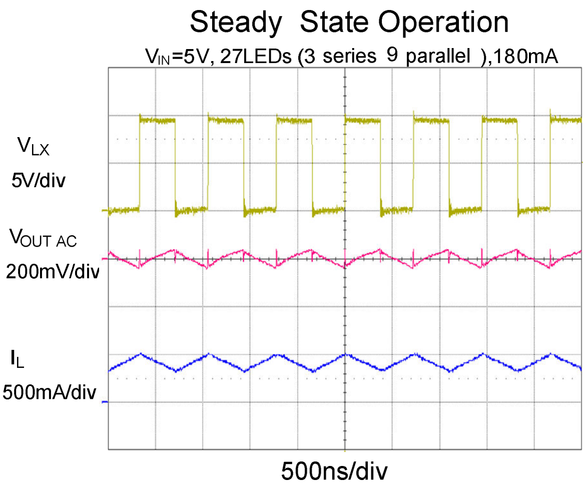


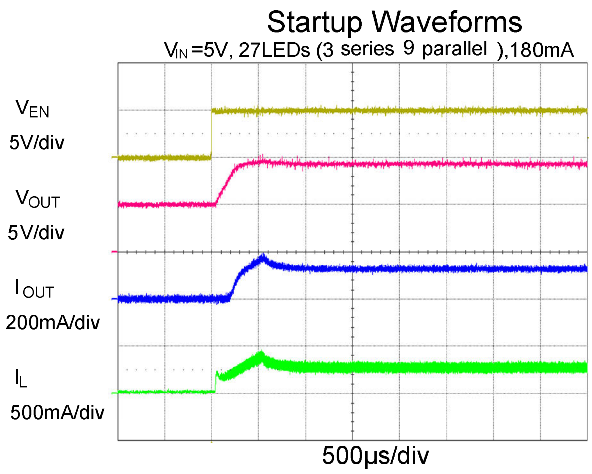


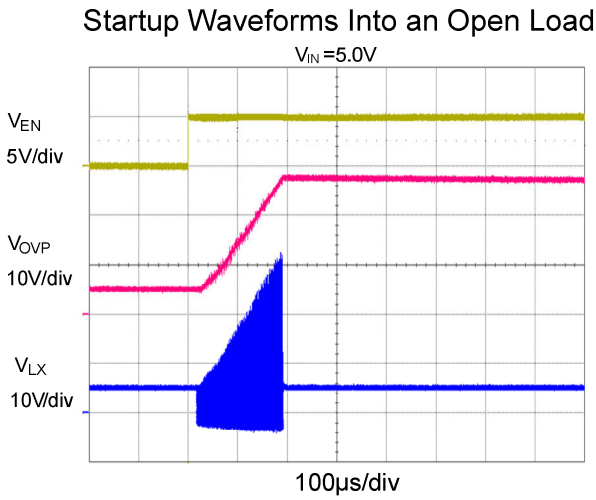




TYPICAL OPERATING CHARACTERISTICS



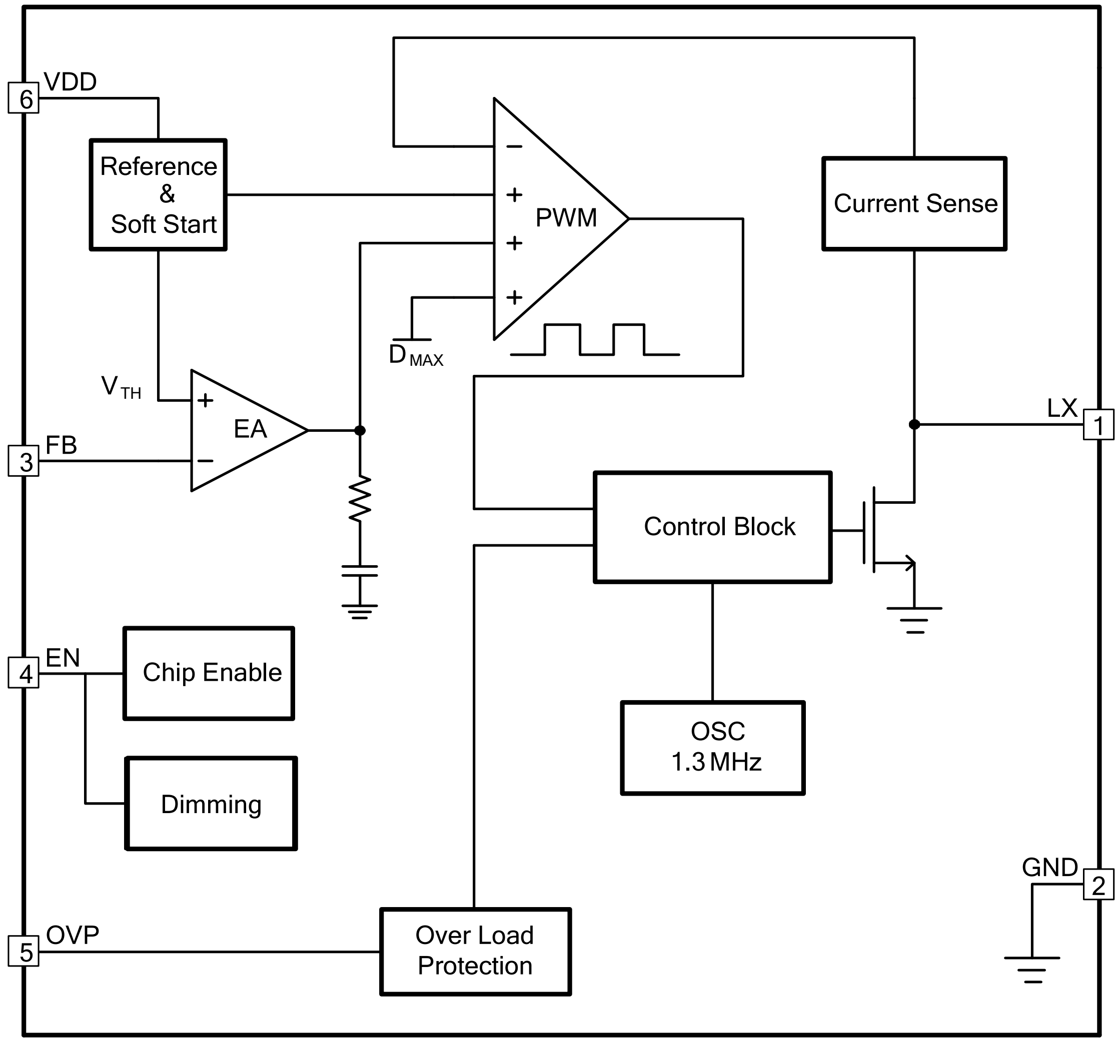




PIN DESCRIPTION

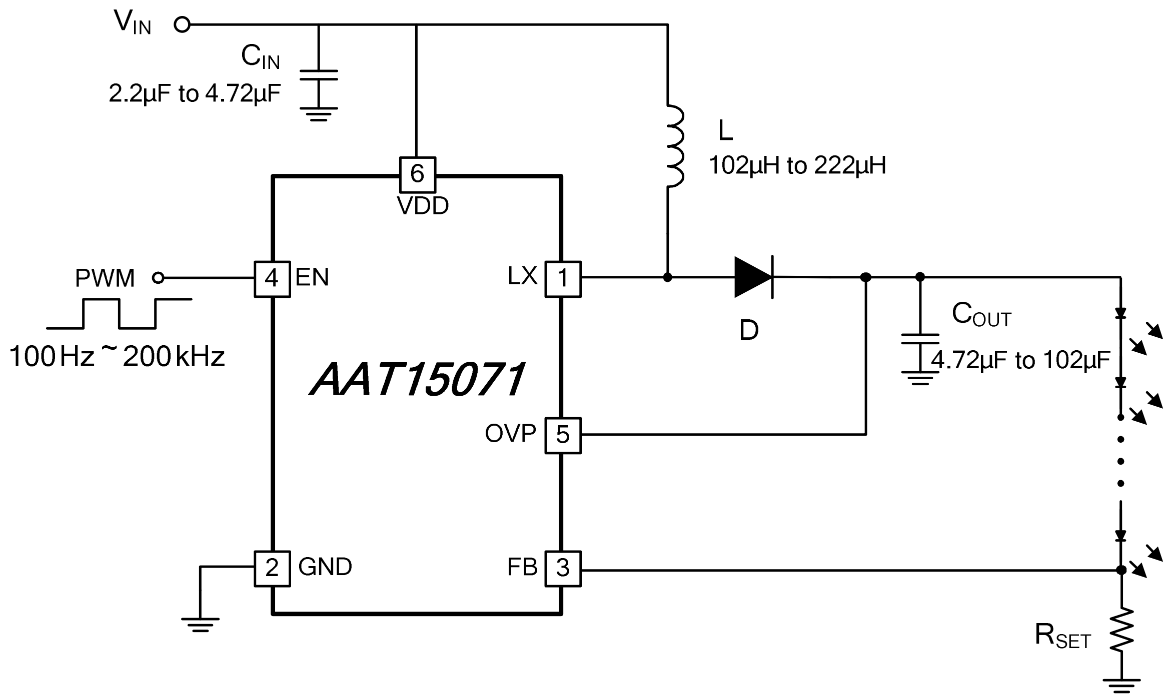
PIN NO	NAME	I/O	FUNCTION
1	LX	O	Power Transistor Open Drain Terminal
2	GND	P	Ground
3	FB	I	Feedback Pin. The regulation voltage is 200mV
4	EN	I	Chip Enable Input Pin
5	OVP	I	Output Over Voltage Protect Pin
6	VDD	P	Power Supply

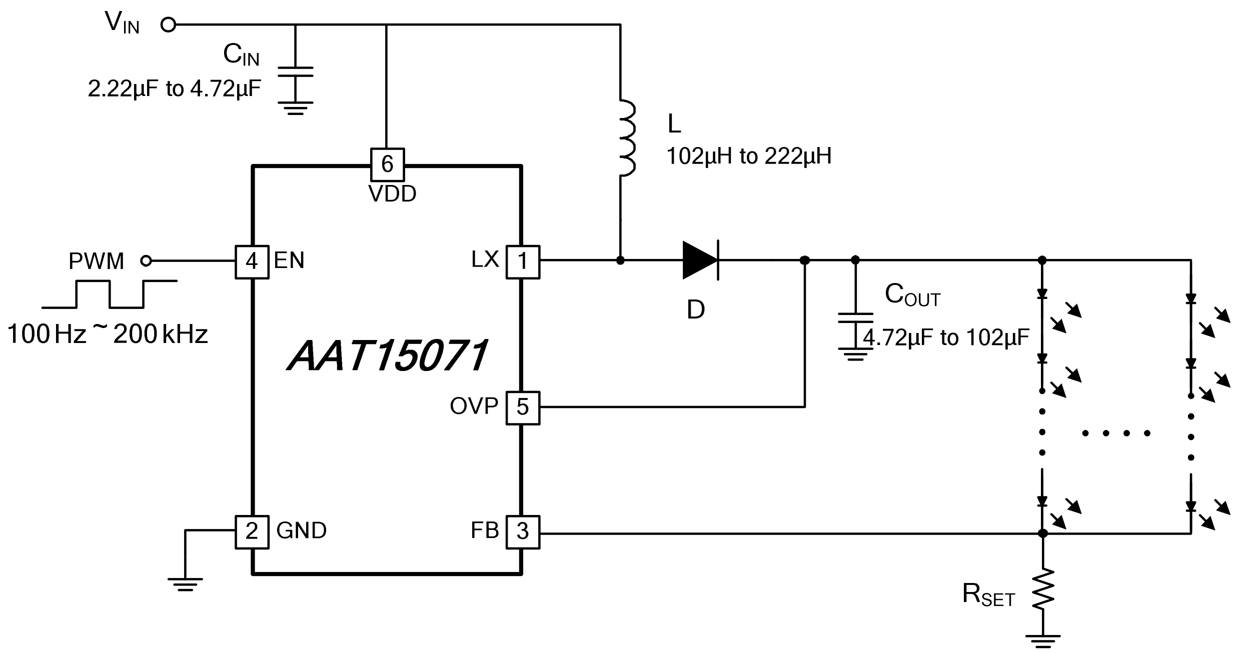
FUNCTION BLOCK DIAGRAM



TYPICAL APPLICATION CIRCUIT

PWM Dimming Control Frequency Range: 100Hz~200kHz





DETAILED DESCRIPTION

The AAT15071 is a boost DC-DC converter for white LEDs. The AAT15071 switches at 1.3MHz. Optional external components may also be added as required. The optimized input and output capacitor saves space at an economical cost. In addition, a low feedback voltage of 200mV minimizes power loss from the current setting resistor for better efficiency.

PWM Dimming Control

EN functions as a digital input to control LED brightness by using a PWM signal applied directly to CTL. Frequency ranges from 100Hz to 200kHz, while 0% duty cycle corresponds to zero current, and 100% duty cycle corresponds to full current.

Soft-Start

The AAT15071 channels feature a soft-start function that limits inrush current and limits the amount of overshoot on the output. This is accomplished by ramping the internal reference inputs to error amplifier from 0V to the 0.2V reference voltage over a period of 1ms when initial power is applied.

Over Voltage Protection

The OVP pin includes an output over voltage comparator that disables the power MOSFET whenever OVP exceeds 20V typically. The OVP comparator can also be used to prevent the output voltage in the event of an output open-circuit, due to bond wire breakages.

Thermal Shutdown

The AAT15071 has an internal thermal shutdown circuitry. It is provided to protect the IC in the event when temperature exceeds the maximum junction temperature. When the shutdown circuitry is activated, (typically at 160°C) output switch will be disabled. The temperature sensing circuit is designed with some hysteresis. The output switch will be enabled again when the chip temperature is below threshold.

Oscillator

The AAT15071 operating frequency is 1.3MHz. The fast 1.3MHz internal oscillator inductor and small input and output capacitors while minimizing input and output ripple.

DESIGN PROCEDURE

LEDs Current Setting

Figure 1 shows the typical application circuit of a LED driver. LED current is set by the feedback resistor (R_{SET} in Figure 1). The feedback voltage (V_{FB}) is 200mV. In order to get accurate LED current, 1% precision resistors are needed. The equation and select table of R_{SET} are shown below.

$$R_{SET} = \frac{V_{FB}}{I_{LED}}$$

Table 1. Select Table of R_{SET} Resistance Value Under the Different LED Current.

I_{LED} (mA)	R_{SET} (Ω)
5	40
10	20
15	13.3
20	10

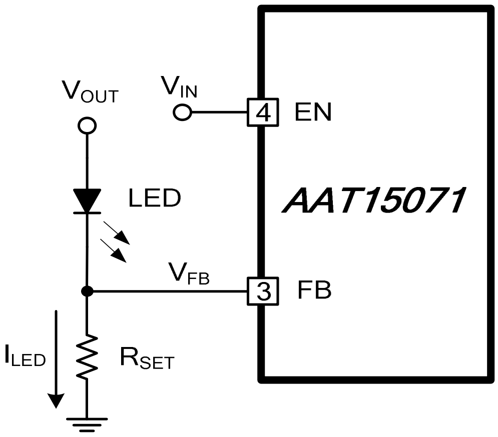


Figure 1. LED Driver Typical Circuit

LED Dimming Control

In general, there are three different types of LED dimming controls methods:

(1) Dimming control using PWM signal received by EN Pin is shown in Figure 2. The typical frequency of PWM signal ranges from 100Hz to 200kHz. The average LED current increases proportionally with the duty cycle of the PWM signal. By adjusting the duty cycle of PWM, the LED brightness can be controlled from 0% duty cycle (dark) to 100% duty cycle (full brightness).

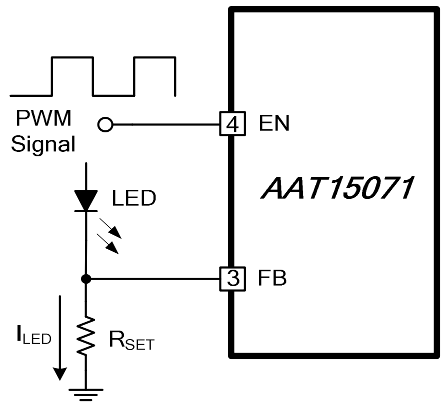


Figure 2. LED Dimming Control Using EN Pin

(2) LED dimming control using DC voltage signals received by FB Pin.

Dimming control using DC voltage is shown in Figure 3. The LED current is adjusted by DC voltage, R_3, R_4 and R_{SET}. The equation is as the following:

$$I_{LED} = \frac{V_{FB} - \frac{V_{DC} - V_{FB}}{R_3} * R_4}{R_{SET}}$$

When V_{DC} is between 0V and 2V, users can keep LED current at 0mA to 20mA by setting R_3, R_4 and R_{SET}.

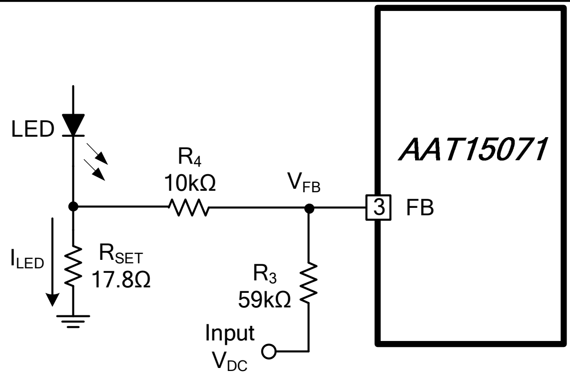


Figure 3. Dimming Control Using DC Voltage

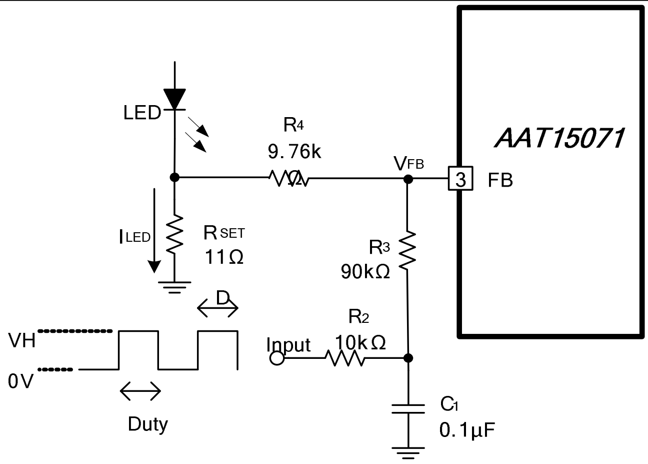


Figure 4. Dimming Control Using Filtered PWM Signal

(3) LED dimming control using filtered PWM signals received by FB pin is shown in Figure 4. Filtered PWM signal can replace the variable DC voltage source in dimming control. For the PWM signal ranging from 0V to 3.3V, users should select R_{SET}, R_2, R_3, R_4 and C_1 to supply 0mA to 20mA current to the dimming control of LED current.

$$I_{LED}(min) = \frac{V_{FB} - \frac{V_H - V_{FB}}{R_2 + R_3} * R_4}{R_{SET}}$$

$$I_{LED}(max) = \frac{V_{FB} - \frac{0V - V_{FB}}{R_2 + R_3} * R_4}{R_{SET}}$$

$$I_{LED} = \frac{V_{FB} - \frac{V_H * Duty - V_{FB}}{R_2 + R_3} * R_4}{R_{SET}}$$

LAYOUT CONSIDERATION

▲ Always try to use a low EMI inductor with a ferrite core.

▲ The input capacitor should be placed close to the VDD and GND pin.

▲ LED current sensor R_{SET} should be placed close to AAT15071 to ensure LED current accuracy.

▲ LX trace should be thick and short to eliminate losses and decrease EMI disturbance.

PCB Layout

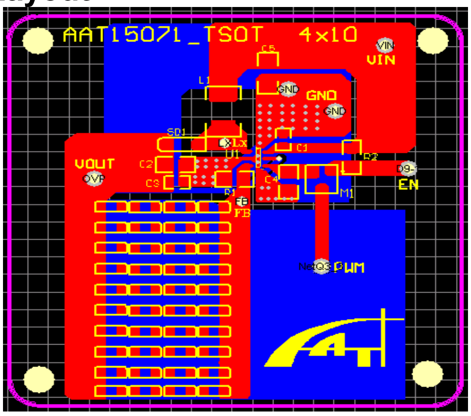


Figure 5. TOP Layer

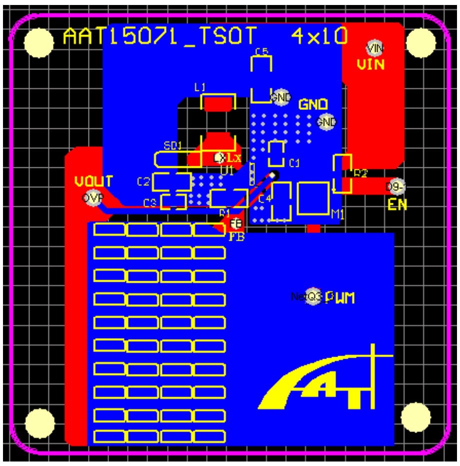
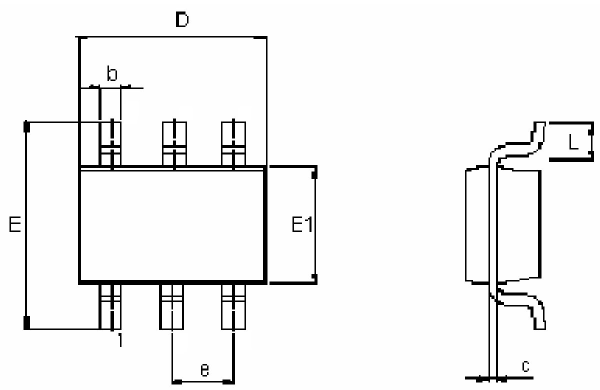
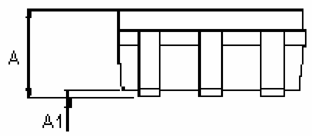


Figure 6. Bottom Layer

PACKAGE DIMENSION

SOT23-6 (SOT26)

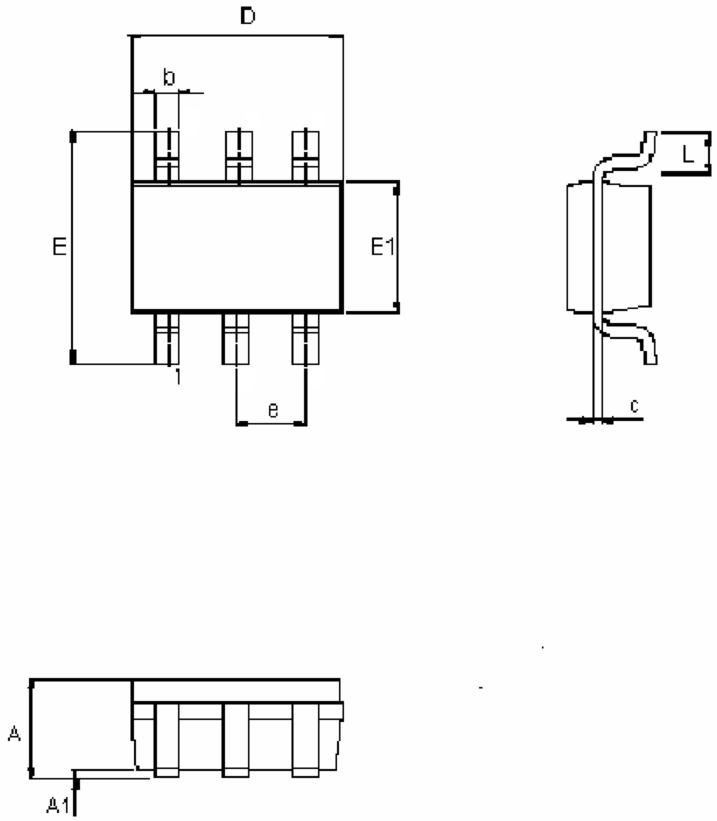




Symbol	Dimensions In Millimeters		
	MIN	TYP	MAX
A	0.9	1.2	1.3
A1	0.05	------	0.15
b	0.30	------	0.55
c	0.08	------	0.20
D	2.7	2.9	3.1
E	2.6	2.8	3.0
E1	1.4	1.6	1.8
e	0.85	0.95	1.05
L	0.35	0.45	0.55

PACKAGE DIMENSION

TSOT23-6 (TSOT26)



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e	0.85	0.95	1.05
L	0.35	0.45	0.55