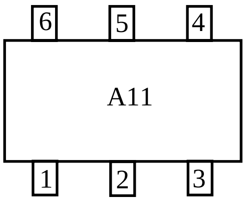
General Description

The ADT7110 is a fixed frequency step-down converter designed to drive Infrared LEDs in the CCD camera module application.
And internal current limit circuit protect external devices.



Package outline of the ADT7110

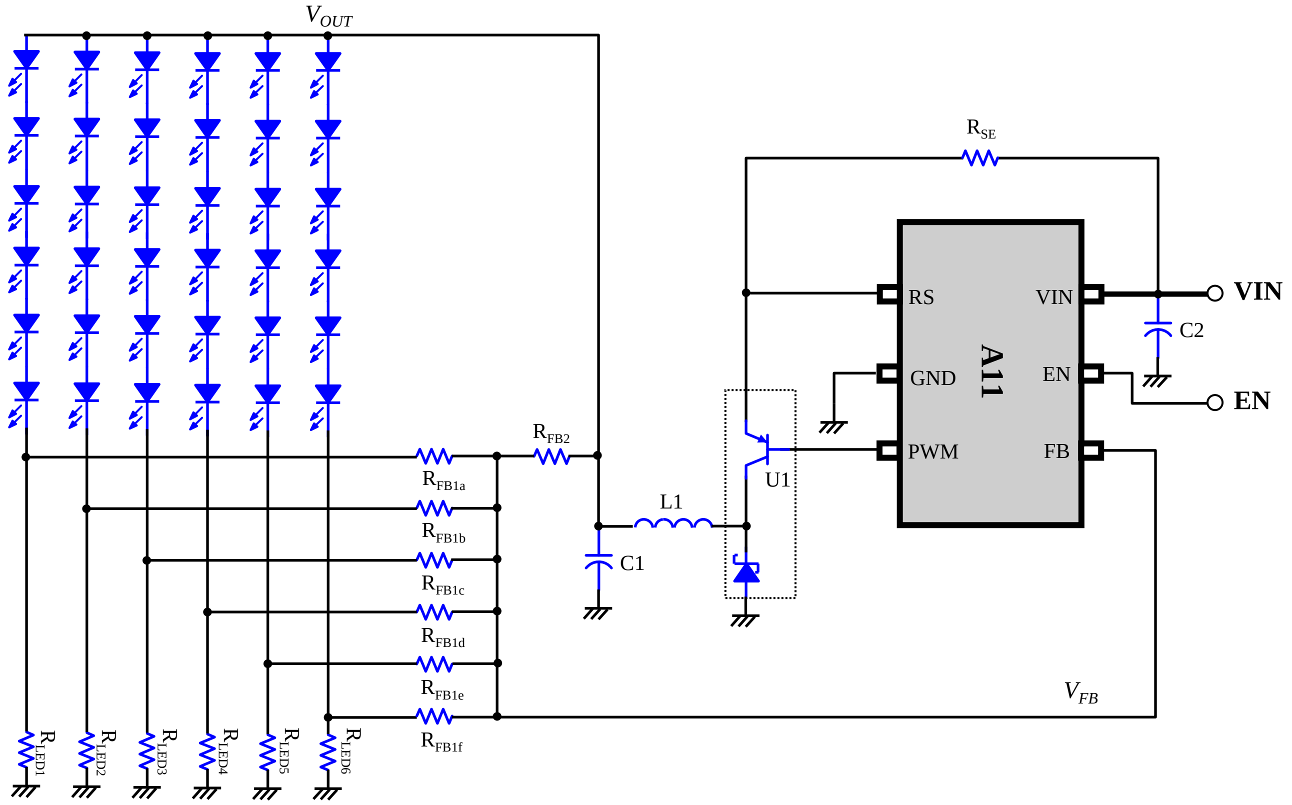
Features

- Input voltage range : 10.5V to 15V
- Current mode PWM controller with integrated compensation components
- 350mA output load current available
- Built-in chip enable/disable function
- Built-in current limit protection
- 500kHz fixed frequency internal oscillator
- Small outline SOT-26 package (2.9mm x 1.6mm body)

Applications

- Infrared LED driver for CCD camera

Typical Application Circuit



** This specifications are subject to be changed without notice*

Part List

Component	Description	Type	Value
U1*1	Composite type with a PNP transistor and schottky barrier diode	IC	FP103
L1	Output filter inductor	Chip inductor	47uH/590mA
C1	Output filter capacitor	Tantalum capacitor	47uF/16V
C2	Bypass capacitor	Tantalum capacitor	10uF/25V
R_{SE}	Current sense resistor	Chip resistor	0.1Ω
R_{LED1} ~ R_{LED6} *2	LED current ballast resistor	Chip resistor , 1%	4.0Ω
R_{FB1a} ~ R_{FB1f}	Buck converter feedback loop component	Chip resistor	120㏀ (table 3)
R_{FB2} *3	Buck converter feedback loop component	Chip resistor , 1%	68㏀ (table 2)

*1 : For cost down , it is possible to use discrete component with a PNP transistor and a schottky barrier diode.
In this case, you make use the discrete components with proper electrical specification.
Table A shows the required key electrical limits. It is recommended to use PNP and schottky barrier diode having equivalent specification in the Table A.

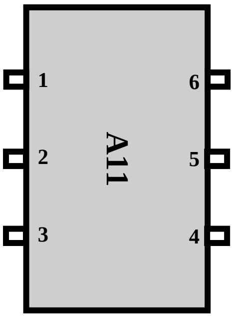
*2, *3 : To setting appropriate LED current, Refer to 'Application Hints'.

Table A : Selection guide for the discrete components

Component	Parameter	Ratings	Unit	Remarks
PNP	Collector to Emitter Voltage	-23	V	Recommend '2SB1706' by ROHM or Equivalent IC
	Collector Current	-2	A	
Schottky Barrier Diode	Repetitive Peak Reverse Voltage	30	V	Recommend 'RSX101M-30' by ROHM or Equivalent
	Average Rectified Current	700	mA	

** This specifications are subject to be changed without notice*

Pin Configuration

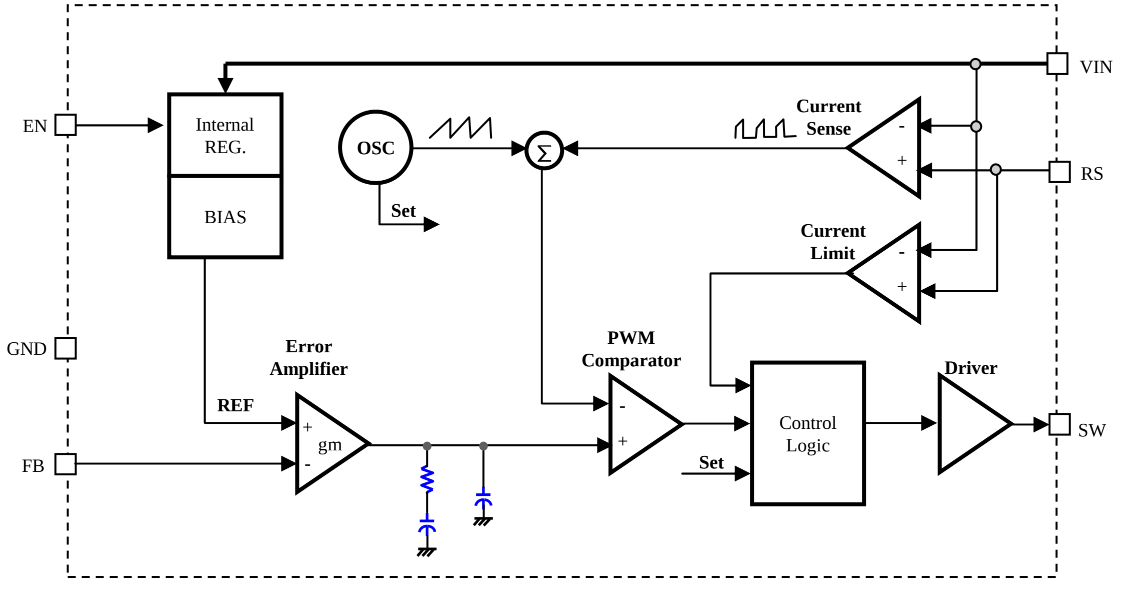


Pin Description

Pin No.	Name	I/O	Type	Description
1	RS	I	A	Current sense and provide voltage feed-forward.
2	GND	-	G	Ground
3	PWM	O	D	Switching output.
4	FB	I	A	Feedback voltage input
5	EN	I	D	Device enable pin
6	VIN	-	P	Power supply input

I : Input pin O : Output pin IO : Input/Output pin
P : Power pin G : Ground pin
A : Analog pin D : Digital pin

Functional Block Diagram



** This specifications are subject to be changed without notice*

Absolute Maximum Ratings

Parameter	Symbol	Min.	Typ.	Max.	Unit
Power supply voltage	V_{IN}	-	-	23	㎽
Power dissipation (Ta=70℃) (Note1)	P_{Dmax}	-	-	265	㎽
Storage temperature	T_{STG}	-65	-	+150	℃
Junction temperature	T_{Jmax}	-	-	+150	℃
Thermal resistance	Θ_{JA}	-	301.2	-	℃/W

Note1. derate 301℃/W above +70℃.
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and 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 affect device reliability.

Operating Ratings

Parameter	Symbol	Min.	Typ.	Max.	Unit
Power supply voltage*2	V_{IN}	10.5	12.0	15.0	V
Operating temperature	T_{OPR}	-20	-	+85	℃
Junction temperature	T_J	-	-	+125	℃
Max. power dissipation (Ta=70℃)*1	P_D	-	-	180	㎽

*1 This spec. indicates that junction temperature of the device is under 125℃. In specific applications , this is recommended under this power dissipation specification.
*2 Minimum V_{IN} operating range is dependant to the V_{OUT} voltage. (VIN min. ≒ V_{OUT} + 0.5V)
Maximum V_{IN} operating range can be extended. In this case, maximum drive current is limited.
For using V_{IN} over 15V, refer to the Table B.

Table B : Maximum drive current as maximum V_{IN} operating voltage.

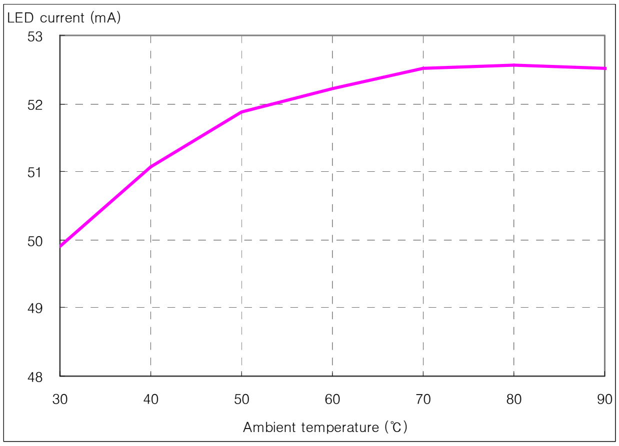
V_{IN} (V)	16	17	18	19	20	21	22
Drive current (㎃)	330	310	290	270	250	230	210

Electrical Characteristics (Ta=25℃, V_{IN}=12V, unless otherwise noted)

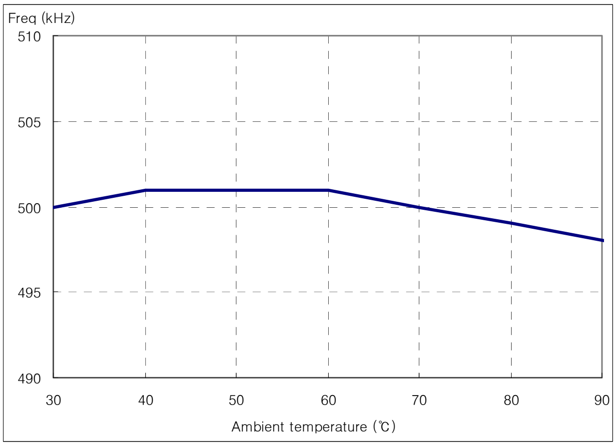
Parameter	Condition	MIN	TYP	MAX	Unit	Note
Supply current, operating	V(EN) = 3.3V , I_O=300㎃	-	6	9	㎃	
Supply current, disable	V(EN) = 0V	-	90	200	㎂	
V(EN), input voltage high	-	2.4	-	-	V	
V(EN), input voltage low	-	-	-	1.2	V	
PWM controller						
Output drive current	VIN ≤ 15V	-	300	350	㎃	
Current limit	-	550	-	-	㎃	
Efficiency	I_O=300㎃	-	85	-	%	
Oscillator frequency	I_O=300㎃	350	500	625	㎑	
Feedback voltage (V_{FB})	I_O=300㎃	2.16	2.21	2.26	V	

Typical Performance Characteristics

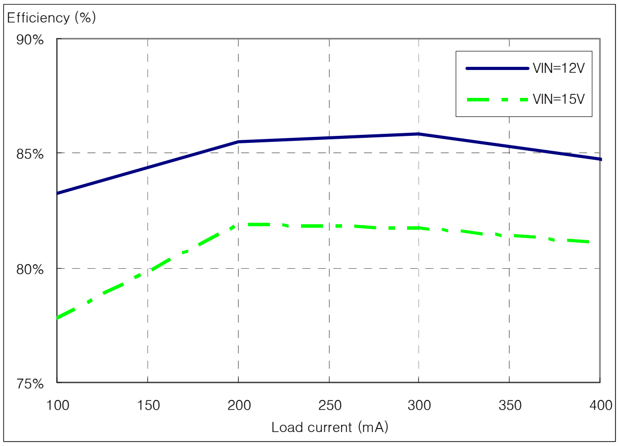
LED current vs. Ta



Switching frequency vs. Ta



Efficiency vs. Load current



** This specifications are subject to be changed without notice*

Application Hints

▶ LED Current control

The LED current is determined by current ballast resistor (R_{LED1}~R_{LED6}) and feedback resistor (R_{FB2}). The current setting procedure is described as below.

i) Choose the R_{LED1} ~ R_{LED6}

The voltage on current ballast resistor (R_{LED}) is about 200mV normally. So the LED current is 200mV/R_{LED}.

In order to set LED current accurately, the precision resistors are preferred (1% recommended).

The R_{LED} value as LED current is shown as below table.

< table 1 > R_{LED} vs. LED current

R_{LED} (Ω)	LED current (mA)
5.76	35
4.42	45
4.02	50
2.67	75
2.49	80

ii) Choose the R_{FB2}

Secondly you choose appropriate R_{FB2} value for setting V_{LED}. R_{FB2} is determined by forward voltage of the 6 series LEDs because the forward voltages of LED are different each other according to the LED manufacturers. (1.2 ~ 1.5volts for V_F setting current flow away). The table and formula of the R_{FB2} are shown as below.

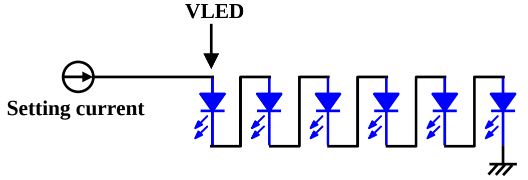
< table 2 > R_{FB2} vs. VLED

R_{FB2} (kΩ)	VLED (V)
61.9	8.4
64.9	8.6
66.5	8.8
68.1	9.0
69.8	9.2
71.5	9.4
73.2	9.6
75.0	9.8

$$R_{FB2} \approx \frac{VLED - V_{FB}}{100uA}$$

Where the VLED is the sum of the forward voltage in 6 series LEDs at setting current and V_{FB} is the feedback voltage. (typically 2.21V)

Fig. 1 shows the method of measuring VLED.



<Fig. 1 VLED test>

iii) Choose the R_{FB1} (= R_{FB1a} ~ R_{FB1f})

R_{FB1} is used to biasing of LED. And these resistor value should be changed by the number of the LED branch. Therefore you should choose appropriate R_{FB1} value according to the LED branch count. The R_{FB1} selection formula is shown as below.

$$R_{FB1} \approx 20\,k\Omega \times number\ \ of\ \ LED\ \ branches$$

Typical ap each LED branch has 6 series LEDs. In this circuit, proper R_{FB1} value is 120㏀ and R_{FB1a} ~ R_{FB1f} value are used 120㏀ equally.

The R_{FB1} value by the number of LED branch is shown below.

< table 3 > R_{FB1} by the LED branches

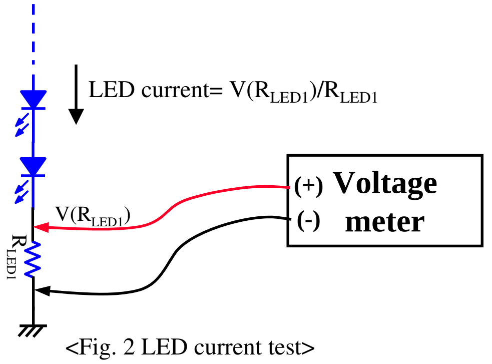
Number of LED branch	R_{FB1} (kΩ)
6	120
5	100
4	80
3	60
2	40
1	20

▶ LED current check

The accurate method of measuring LED current is to measure the voltage on current ballast resistor (R_{LED}). And then the LED current is simply obtained by dividing this voltage by R_{LED}.

To measure voltage on R_{LED} accurately, (-) probe of the voltage meter is connected to (-) terminal of the ballast resistor and measure the voltage of (+) terminal on ballast resistor.

Fig. 2 shows the method of measuring voltage on ballast resistor.



<Fig. 2 LED current test>

It is possible to calculate the LED current by measuring of ICC current. As the ADT7110 is basically buck converter, its ICC current is the function of VIN, VOUT, LED branch current and quiescent current. Therefore it is not easy to calculate accurate LED current by measurement of ICC current.

The relation LED branch current to the ICC current is shown b

$$I_{LED.1branch} \approx ICC \times efficiency \times \frac{V_{IN}}{V_{OUT}} \times \frac{1}{N} \quad , \quad where$$

N : the number of LED branch

$efficiency$: efficiency of the ADT7110 at applied condition

Application Hints (continued)

Example : typical application circuit
N = 6 (6 LED branches)
V_{IN} = 12V , V_{OUT} = 9V
ICC = 280mA (measured) , and efficiency is 80%.
So, calculated 1 branch LED current is 49.77mA.

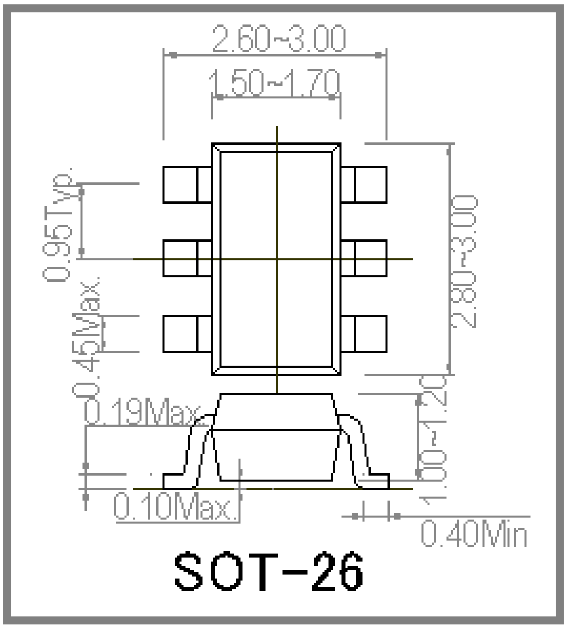
▶ Dimming control

The LED brightness control can be obtained by forcing a pulse wave to the EN input terminal. Typically, a 100Hz to 1kHz pulse signal is used. LED brightness is proportional to the duty of pulse wave. And in this case , LED branch current is RMS value of the PWM modulated current.

When the pulse-width is below 50% duty, the driving current of ADT7110 can be increased up to current limit condition.(~550mA) But you keep carefully to select the inductor (L1) over 700mA rated current.

Note that the inductor (L1) is 590mA rated in typical application circuit.

Package ; SOT-26, 2.9mm x 1.6mm body (units : mm)



** This specifications are subject to be changed without notice*