AA1700

PRELIMINARY Constant Current White LED driver

■OVERVIEW

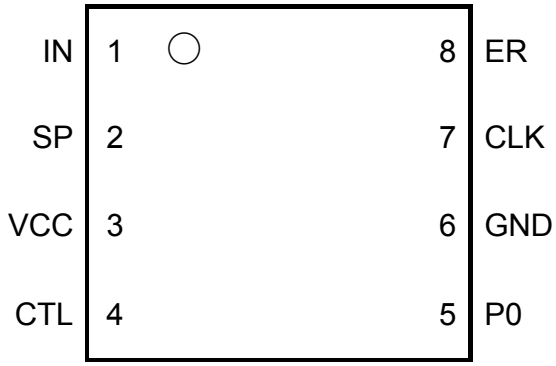
The AA1700 is a high frequency boost DC/DC converter with constant current output that drives white LEDs or similar. The LED current is set with the external resistor. Soft start circuitry prevents excessive current drawn from the supply during power on. Any number of LEDs can be connected in series as long as the summed forward voltages do not lead to exceed the specified operating output voltage range. This IC works with a wide operating supply range (1.8V to 15V) and low current consumption, is optimal for use in high-efficiency white LED driver.

■FEATURES

- Drives Up to 8 LEDs in Series.
- Second or more string of LEDs can be added.
- Low current consumption: Typically 5.5 mA in operation, 1 μA or less in stand-by.
- PWM mode operation of the boost circuit (frequency range: 10 kHz to 1 MHz).
- Incorporates a soft start circuit and adjustable soft start time.
- Timer latch LED short-circuit protection circuit (SP).
- On/off control function.
- Available in an 8-pin TSSOP or SOP package.

■PIN Configuration

(TOP VIEW)



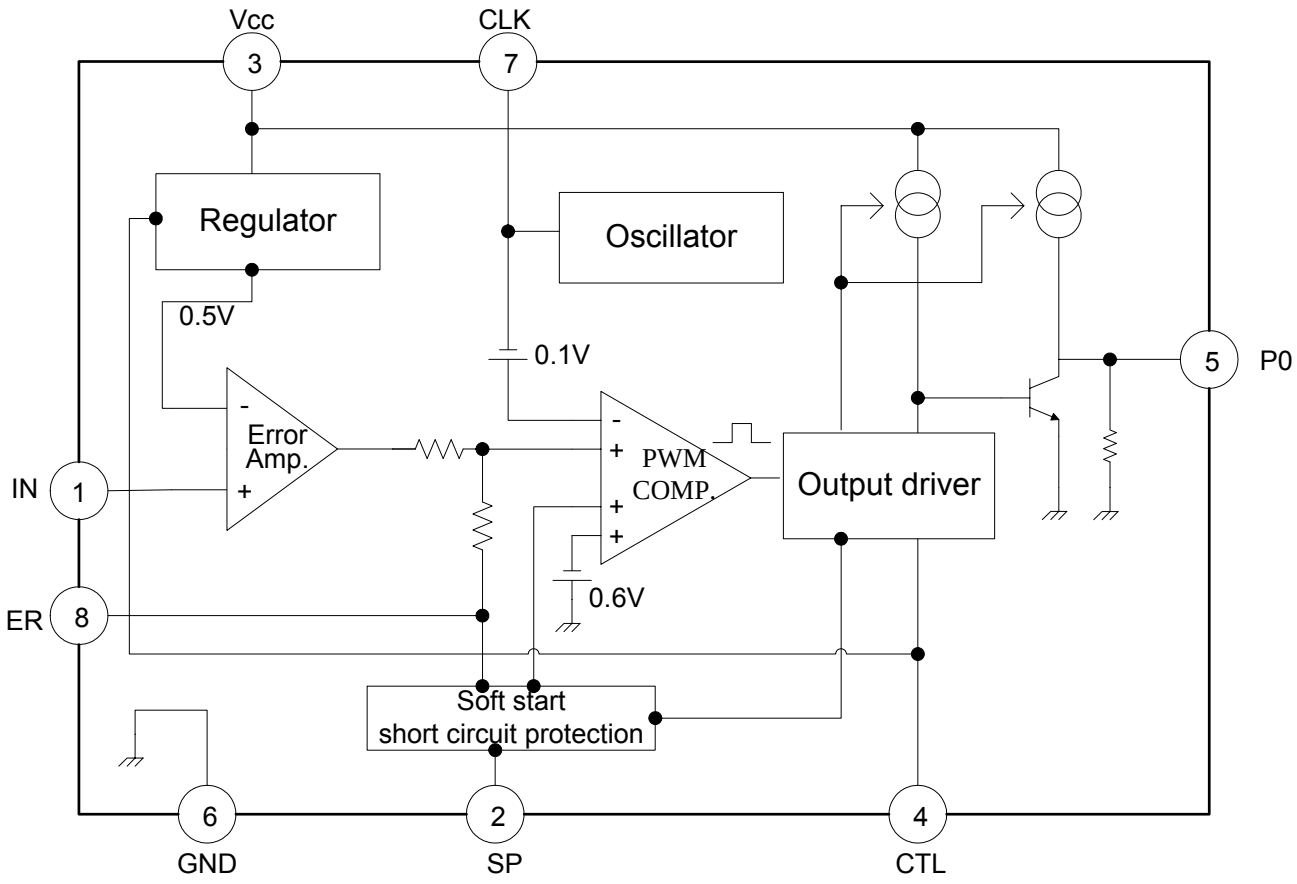
■APPLICATIONS

- LCD Bias Supplies
- White LED Backlighting
- Handheld Devices
- Digital Cameras
- Portable Applications

■PIN DESCRIPTIONS

Pin No.	Symbol	I/O	Description
1	IN	I	Output voltage feedback pin
2	SP	—	Soft start and short circuit protection setting
3	V_{CC}	—	Power supply pin
4	CTL	I	ON/OFF control pin
5	P0	O	Output driver pin
6	GND	—	Ground pin
7	CLK	—	Internal PWM frequency setting pin
8	ER	O	Error amplifier output pin

■BLOCK DIAGRAM



■ABSOLUTE MAXIMUM RATINGS

(Ta = +25°C)

Parameter	Symbol	Condition	Rating		Unit
			Min	Max	
Power supply voltage	V_{CC}	—	—	16	V
Output source current	I_{O+}		—	–50	mA
Output sink current	I_{O-}		—	50	mA
Allowable dissipation	P_D	Ta ≤ +25° C	—	430*	mW
Operating temperature	T_{op}	—	–30	+85	° C
Storage temperature	T_{stg}		–55	+125	° C

WARNING: Semiconductor devices can be permanently damaged by application of stress (voltage, current, temperature, etc.) in excess of absolute maximum ratings. Do not exceed these ratings.

■RECOMMENDED OPERATING RANGE

(Ta = +25° C)

Parameter	Symbol	Value			Unit
		Min	Typ	Max	
Power supply voltage	V_{CC}	1.8	—	15	V
Error amplifier input voltage	V_I	–0.2	—	1.0	V
CTL pin input voltage	V_{CTL}	–0.2	—	V_{CC}	V
Output source current	I_{O+}	–40	—	—	mA
Output sink current	I_{O-}	—	—	40	mA
SP pin capacitance	C_{PE}	—	0.1	—	μ F
Phase compensation capacitance	C_P	—	0.1	—	μ F
Output current setting resistance	R_B	150	390	5000	Ω
Timing resistance	R_T	1.0	3.0	10.0	kΩ
Timing capacitance	C_T	100	270	10000	pF
Oscillation frequency	f_{CLK}	10	500	1000	kHz
Operating temperature	T_{OP}	–30	+25	+85	° C

■ELECTRICAL CHARACTERISTICS

(V_{CC} = +2 V, Ta = +25° C)

Parameter		Symbol	Condition	Value			Unit
				Min	Typ	Max	
Circuit to prevent malfunction at low input voltage (U.V.L.O.)	Reset voltage	V_R	—	—	—	0.9	V
	Threshold voltage	V_{TH}		1.1	1.3	1.5	V
Soft start	Charging current	I_{CS}	V_{SP} = 0 V	–1.5	–1.0	–0.7	μ A
	Voltage at soft start completion	V_{tS}	—	0.7	0.8	0.9	V
Short circuit detection (S.C.P.)	Charging current	I_{CPC}	V_{SP} = 0 V	–1.5	–1.0	–0.7	μ A
	Threshold voltage	V_{tPC}	—	0.7	0.8	0.9	V
Sawtooth wave oscillator (CLK)	Oscillation frequency	f_{CLK}	R_T = 3.0 kΩ , C_T = 270 pF	400	500	600	kHz
	Frequency input stability	f_{dV}	V_{CC} = 2 V to 15 V	—	2	10	%
	Frequency variation with temperature	f_{dT}	Ta = –30°C to +85°C	—	5	—	%
Error amplifier	Input threshold voltage	V_T	V_{ER} = 450 mV	480	500	520	mV
	V_T input stability	V_{TdV}	V_{CC} = 2 V to 15 V	—	5	20	mV
	V_T variation with temperature	V_{TdT}	Ta = –30°C to +85°C	—	1	—	%
	Input bias current	I_B	V_{IN} = 0 V	–1.0	–0.2	1.0	μ A
	Voltage gain	A_V	—	70	100	145	V/V
	Frequency bandwidth	BW	A_V = 0 dB	—	6	—	MHz
	Maximum output voltage range	V_{OM+}	—	0.78	0.87	—	V
		V_{OM-}		—	0.05	0.2	V
	Output source current	I_{OM+}	V_{ER} = 0.45 V	—	–40	–24	μ A
	Output sink current	I_{OM-}		24	40	—	μ A
Idle period adjustment section	Maximum duty cycle	t_{DUTY}	R_T = 3.0 kΩ , C_T = 270 pF V_{ER} = 0.8 V	65	75	85	%

(Continued)

Parameter		Symbol	Condition	Value			Unit
				Min	Typ	Max	
Output section	Output voltage	V_{OH1}	R_B = 390 Ω , I_O = –15 mA	1.0	1.2	—	V
		V_{OH2}	R_B = 750 Ω , V_{CC} = 1.8 V I_O = –10 mA	0.8	1.0	—	V
		V_{OL1}	R_B = 390 Ω , I_O = 15 mA	—	0.1	0.2	V
		V_{OL2}	R_B = 750 Ω , V_{CC} = 1.8 V I_O = 10 mA	—	0.1	0.2	V
	Output source current	I_{O+}	R_B = 390 Ω , V_O = 0.9 V	—	–30	–20	mA
	Output sink current	I_{O-}	R_B = 390 Ω , V_O = 0.3 V	30	60	—	mA
	Pull down resistance	R_O	—	20	30	40	kΩ
Output current setting section/ Control section	Pin voltage	V_{CTL}	R_B = 390 Ω	0.2	0.3	0.4	V
	Input off condition	I_{OFF}	—	–20	—	0	μ A
	Input on condition	I_{ON}		—	—	–45	μ A
	Pin current range	I_{CTL}		–1.8	—	–0.1	mA
Entire device	Stand-by current	I_{CCS}	CTL pin open or V_{CC}	—	—	1	μ A
	Average supply current	I_{CC}	R_B = 390 Ω	—	5.5	9.3	mA

■HOW TO SET THE TIME CONSTANT FOR SOFT START AND SHORT CIRCUIT DETECTION

1. Soft Start

A soft start function, which gradually increases the width of the output pulses at power on, will be applied if a capacitor is connected to the SP pin. This can prevent rush currents and overshoot when the power supply is turned on.

Soft start time can be measured by the following equation. (The time until the output ON duty reaches approximately 50%)

t_S [s] = 0.35 × C_{PE} [uF]

2. Timer Latch Short Circuit Protection

When the load conditions suddenly change due to load effect, the short-circuit protection comparator outputs the high-level signal (V_{OM}^{+}) and the capacitor C_{PE} connected to the SP terminal starts charging. When the external capacitor C_{PE} has been charged to approximately 0.8V, the latch circuit is set, the output terminal is fixed to low level, and the dead-time is set to 100%. However, the latch circuit is not reset unless the power for the latch circuit is turned off or restarted by the on/off control.

- Short circuit detection time

t_{PE} [s] = 0.8 × C_{PE} [uF]

■FUNCTIONAL DESCRIPTION

1. Switching Regulator Function

(1) Sawtooth wave oscillator

This circuit generates a triangular wave like sawtooth with a peak of 0.8V (V_{CLKH}) and a trough of 0.1V (V_{CLKL}) using a capacitor (for the time constant) and resistor connected to the CLK pin (pin 7). The oscillator frequency can be set to any value by selecting appropriate values for the external capacitor and resistor, C_T and R_T. This oscillator can provide a frequency in the range 10 kHz to 1 MHz.

$$f_{CLK} = \frac{-1}{C_T \times R_T \times \ln \frac{V_{CLKL}}{V_{CLKH}}} = 0.48 \times \frac{1}{C_T \times R_T} \quad [HZ]$$

(2) Error amplifier

This error amplifier detects and amplifies the DC-DC converter output voltage, and inputs that signal to a PWM comparator. The 0.5 V internal reference voltage is applied to the non-inverting input. Arbitrary gain and phase compensation can be connected by inserting a resistor and capacitor in series between the error amplifier output pin (pin 8) and the inverting input pin (pin 1).

(3) PWM comparator

The voltage comparator has one inverting and three non-inverting inputs. The comparator is a voltage/pulse width converter that controls the on-period of the output pulse according to its input voltage. The output transistors are turned on during periods when the CLK pin (pin 7) triangular waveform is lower than the error amplifier output voltage, soft start setting voltage, and idle period setting voltage.

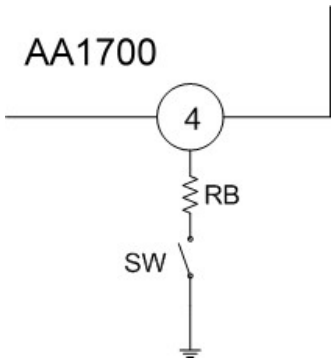
(4) Output driver

The output circuit has a totem pole structure. A constant-current source output with line regulation can be set up at an arbitrary voltage by connecting a current setting resistor to the CTL pin (pin 4).

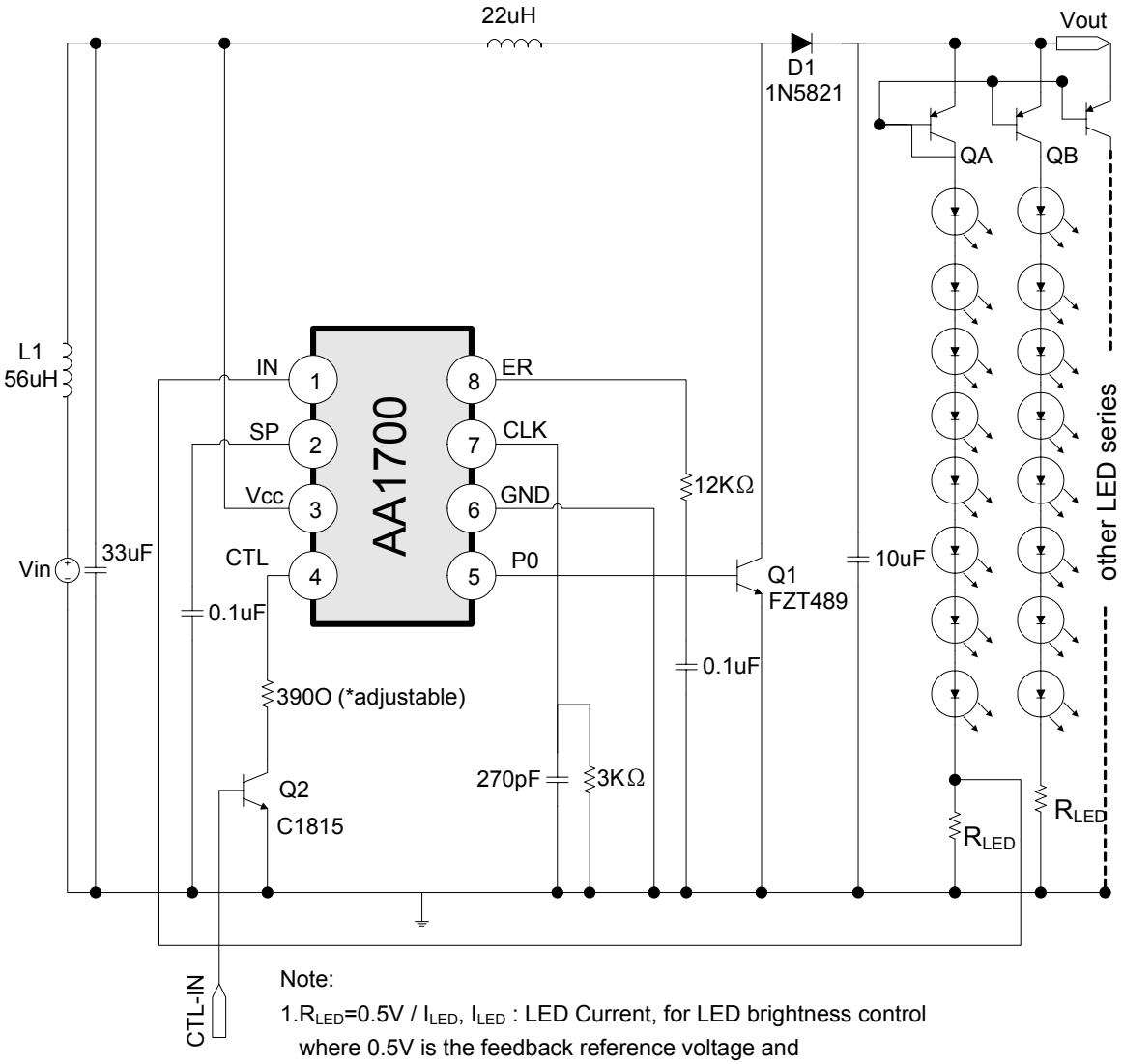
2. Power Supply On/Off Function

Stand-by mode (supply current 1 μA or less) can be set by connecting the CTL pin (pin 4) to V_{CC} or by making the pin open circuit.

SW	Mode
OFF	Stand-by mode
ON	Operating mode



■ TYPICAL APPLICATION EXAMPLE



Note:

1.R_{LED}=0.5V / I_{LED}, I_{LED} : LED Current, for LED brightness control
where 0.5V is the feedback reference voltage and
I_{LED} = 20mA (R_{LED} = 25Ω) for typical application

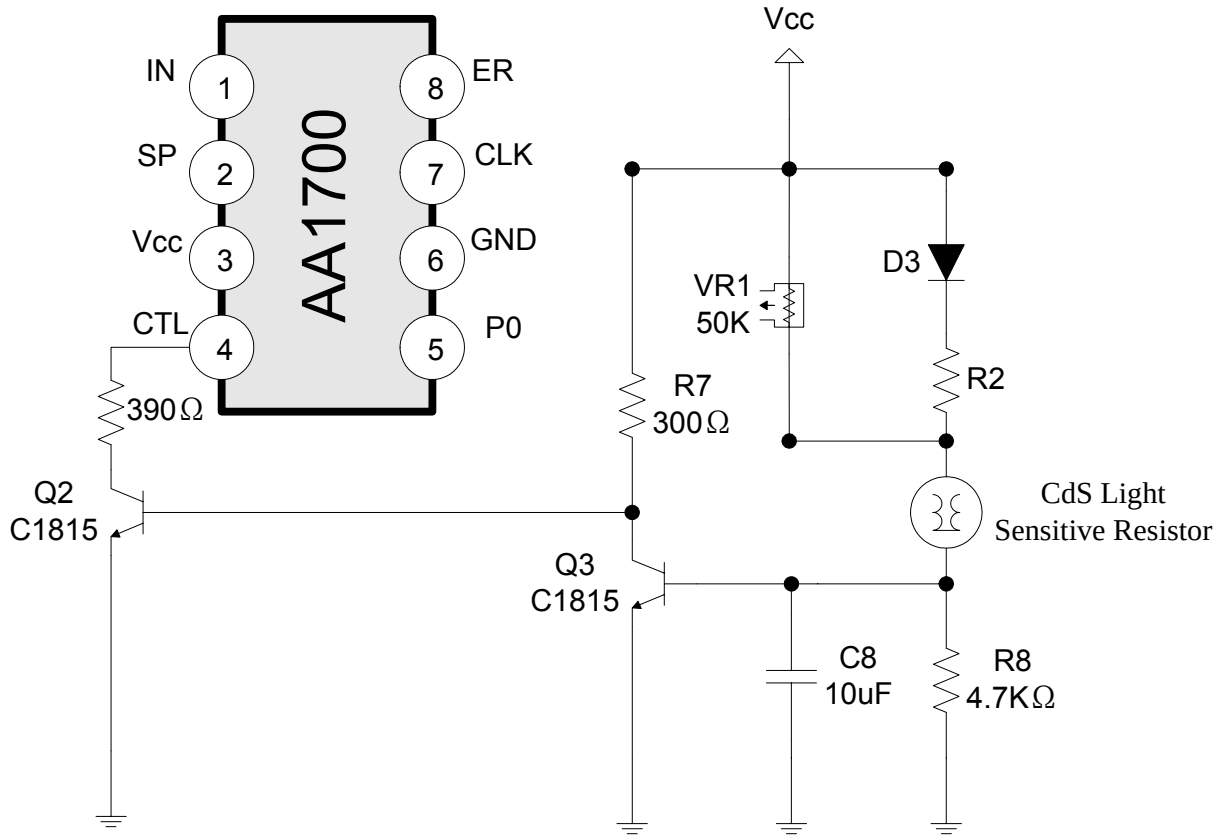
2.Output voltage Vout is given by Vout=n * Vf + 0.5V where
Vf : LED forward voltage drop
n : Number of LEDs in series connection

3. The sample described above is an inductive-boost driver, so it should follow the following equation.
$V_{IN} < V_{OUT} + V_{D1}$, where V_{D1} is forward voltage drop of diode D1.

4.To avoid some LEDs are damaged and conduce to high current of damaged LED series, the constant current control should be Included by QA, QB, etc. .

5. The chock Inductor (L1) Is for noise filter.

CDS Control for IR LED



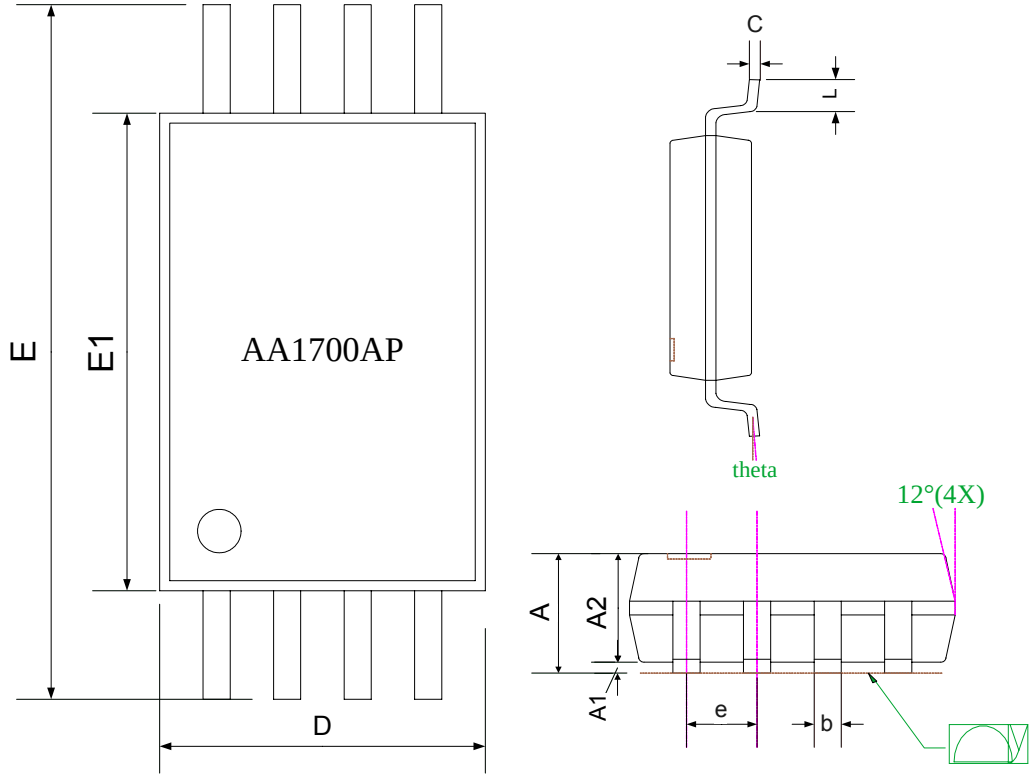
Note:

1.Light striking the surface of the Cds causes a decrease in resistance, while darkness produces a higher resistance. When the light is bright, Q3 is on and Q2 is off, AA1700 will enter stand-by mode and there is no output current provided. When the light is dark, Q3 is off and Q2 is on, AA1700 will output current and driver the IR LEDs. If the light Is gray, the Q2 and Q3 will enter active mode, the impedance of Cds will decide the collector current of Q3 and also Impact on the Internal impedance of Q2, so the driving current can be controlled.

2.VR1 is for light sensitive control, the value will decide how darkness of the light source the IR LEDs will brighten.

■PACKAGE DIMENSIONS

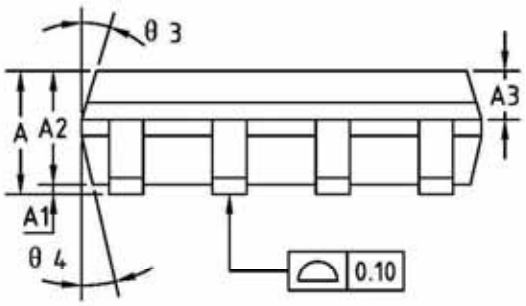
AA1700AP - 8-pin Plastic TSSOP

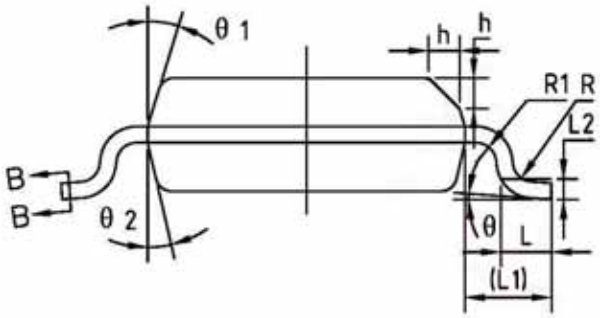


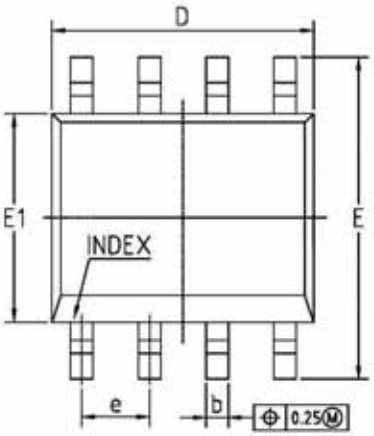
SYMBOLS	DIMENSIONS IN MILLIMETERS			DIMENSIONS IN INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	---	---	1.20	---	---	0.048
A1	0.05	---	0.15	0.002	---	0.006
A2	0.80	1.00	1.05	0.031	0.039	0.041
b	0.19	---	0.30	0.007	---	0.012
C	0.09	---	0.20	0.004	---	0.008
D	2.90	3.00	3.10	0.114	0.118	0.122
E	6.20	6.40	6.60	0.244	0.252	0.260
E1	4.30	4.40	4.50	0.169	0.173	0.177
e	---	0.65	---	---	0.026	---
L	0.45	0.60	0.75	0.018	0.024	0.030
y	---	---	0.10	---	---	0.004
theta	0°	---	8°	0°	---	8°

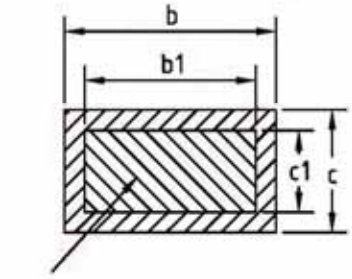
NOTE
1. PACKAGE BODY SIZES EXCLUDE MOLD FLASH PROTRUSIONS OR GATE BURRS
2. TOLERANCE +/-0.1 mm UNLESS OTHERWISE SPECIFIED
3. COPLANARITY : 0.1 mm
4. CONTROLLING DIMENSION IS MILLIMETER. CONVERTED INCH DIMENSIONS ARE NOT NECESSARILY EXACT.
5. FOLLOWED FROM JEDEC MO-153

AA1700SP - 8-pin Plastic SOP









BASE METAL
SECTION B-B

COMMON DIMENSIONS
(UNITS OF MEASURE=MILLIMETER)

SYMBOL	MIN	NOM	MAX
A	1.35	1.55	1.75
A1	0.10	0.15	0.25
A2	1.25	1.40	1.65
A3	0.50	0.60	0.70
b	0.38	–	0.51
b1	0.37	0.42	0.47
c	0.16	–	0.25
c1	0.15	0.20	0.25
D	4.80	4.90	5.00
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e		1.27BSC	
L	0.45	0.60	0.80
L1		1.04REF	
L2		0.25BSC	
R	0.07	–	–
R1	0.07	–	–
h	0.30	0.40	0.50
θ	0°	–	8°
θ 1	15°	17°	19°
θ 2	11°	13°	15°
θ 3	15°	17°	19°
θ 4	11°	13°	15°

■NOTES ON USE

- **The information described herein is subject to change without notice.**
- The specifications for the product described in this document are for reference only. Upon actual use, therefore, please request that specifications to be separately delivered.
- The application circuit examples explain typical applications of the products, and do not guarantee the success of any specific mass-production design.
- Application circuit diagrams and circuit constants contained herein are shown as examples of standard use and operation. Please pay careful attention to the peripheral conditions when designing circuits and deciding upon circuit constants in the set.
- Take account of common impedance when designing the earth line on a printed wiring board.