



PRELIMINARY

Switching Regulator Controller

OVERVIEW

The AA18380 is a single-channel PWM DC-DC regulator control IC that supports low-voltage operation. This IC features a low minimum operating voltage of 1.8 V and low current consumption, is optimal for use in high-efficiency power supplies for portable electronic equipment.

FEATURES

- Wide operating supply voltage range: 1.8 V to 15 V
- Stable reference voltage circuit: 1.25V.
- Low current consumption: Typically 5.5 mA in operation, 1 μ A or less in stand-by
- Wide PWM output frequency range: 10 kHz to 1 MHz
- Incorporates a soft start circuit and adjustable soft start time.
- Timer latch short-circuit protection circuit (SCP).
- Low input voltage malfunction prevention circuit (U.V.L.O.)
- On/off control function
- Totem-pole type output by using an external resistor to set the output current (for NPN transistors)

PIN Configuration

(TOP VIEW)

IN-	1	8	FB
SCP	2	7	OSC
VCC	3	6	GND
BR/CTL	4	5	OUT

APPLICATIONS

- LCD Displays
- PDAs
- Digital Still Cameras
- Hand-held and portable instruments





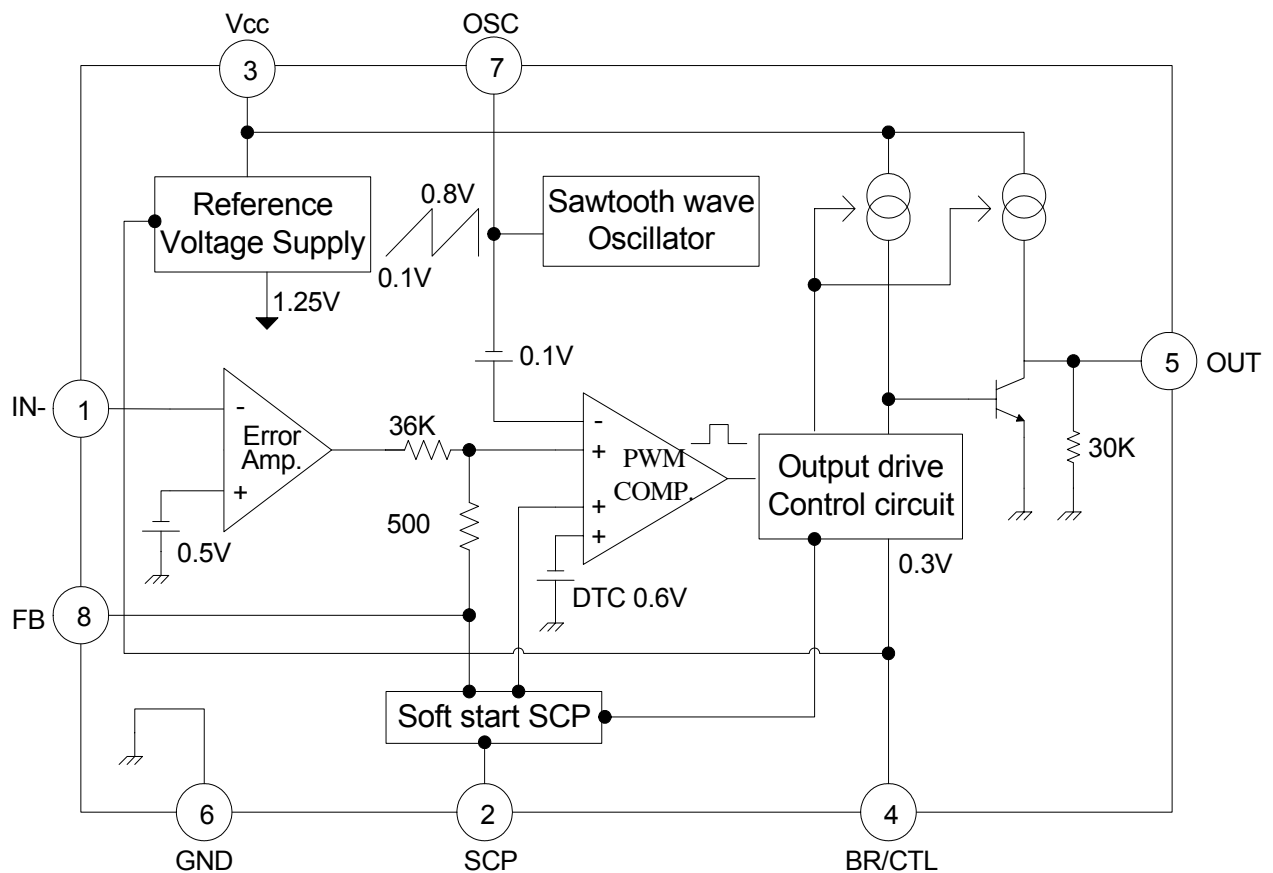
PRELIMINARY

Switching Regulator Controller

PIN DESCRIPTIONS

Pin No.	Symbol	I/O	Description
1	IN-	I	Internal error amplifier inverting input pin
2	SCP	—	Soft start and short circuit protection setting capacitor connection pin
3	V _{cc}	—	IC power supply pin
4	BR/CTL	I	Output current setting and control pin
5	OUT	O	Output voltage monitoring pin
6	GND	—	Ground pin
7	OSC	—	Timing capacitor & resistor connection pin for setting the internal PWM frequency
8	FB	O	Error amplifier output pin

BLOCK DIAGRAM





PRELIMINARY

Switching Regulator Controller

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
BR/CTL pin input voltage	V _{BR}	-0.2	—	V _{CC}	V
Output source current	I _{O+}	-40	—	—	mA
Output sink current	I _{O-}	—	—	40	mA
SCP 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	
Timing resistance	R _T	1.0	3.0	10.0	kΩ
Timing capacitance	C _T	100	270	10000	pF
Oscillation frequency	f _{OSC}	10	500	1000	kHz
Operating temperature	T _{OP}	-30	+25	+85	°C



PRELIMINARY

Switching Regulator Controller

ELECTRICAL CHARACTERISTICS

($V_{CC} = +2\text{ V}$, $T_a = +25^\circ\text{ C}$)

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}	$V_{SCP} = 0\text{ V}$	-1.5	-1.0	-0.7	$\mu\text{ A}$	
	Voltage at soft start completion	V_{IS}	—	0.7	0.8	0.9	V	
Short circuit detection (S.C.P.)	Charging current	I_{CPC}	$V_{SCP} = 0\text{ V}$	-1.5	-1.0	-0.7	$\mu\text{ A}$	
	Threshold voltage	V_{IPC}	—	0.7	0.8	0.9	V	
Sawtooth wave oscillator (OSC)	Oscillation frequency	f_{OCS}	$R_T = 3.0\text{ k}\Omega$, $C_T = 270\text{ pF}$	400	500	600	kHz	
	Frequency input stability	f_{dV}	$V_{CC} = 2\text{ V to }15\text{ V}$	—	2	10	%	
	Frequency variation with temperature	f_{dT}	$T_a = -30^\circ\text{ C to }+85^\circ\text{ C}$	—	5	—	%	
Error amplifier	Input threshold voltage	V_T	$V_{FB} = 450\text{ mV}$	480	500	520	mV	
	V_T input stability	V_{TdV}	$V_{CC} = 2\text{ V to }15\text{ V}$	—	5	20	mV	
	V_T variation with temperature	V_{TdT}	$T_a = -30^\circ\text{ C to }+85^\circ\text{ C}$	—	1	—	%	
	Input bias current	I_B	$V_{IN} = 0\text{ V}$	-1.0	-0.2	1.0	$\mu\text{ A}$	
	Voltage gain	A_V	—	70	100	145	V/V	
	Frequency bandwidth	BW	$A_V = 0\text{ dB}$	—	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+}	$V_{FB} = 0.45\text{ V}$	—	—	-40	-24	$\mu\text{ A}$
Output sink current	I_{OM-}	24			40	—	$\mu\text{ A}$	
Idle period adjustment section	Maximum duty cycle	t_{DUTY}	$R_T = 3.0\text{ k}\Omega$, $C_T = 270\text{ pF}$ $V_{FB} = 0.8\text{ V}$	65	75	85	%	



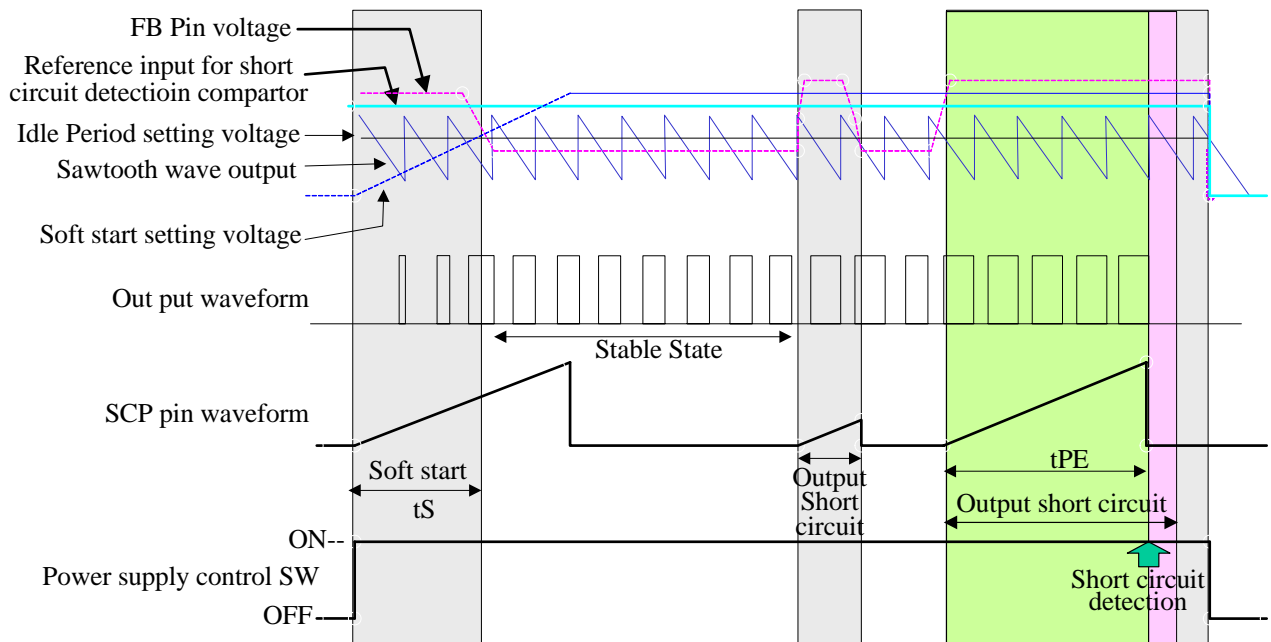
PRELIMINARY

Switching Regulator Controller

(Continued)

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

TIMING DIAGRAM



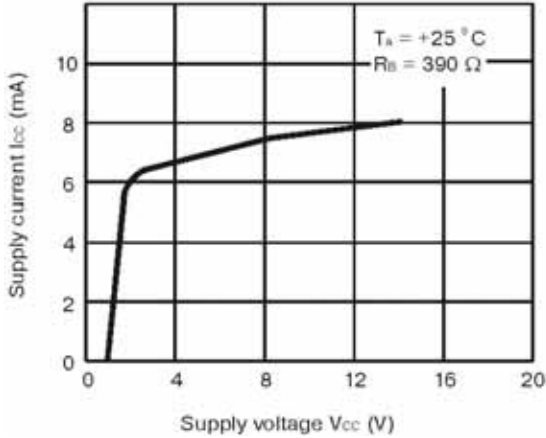


PRELIMINARY

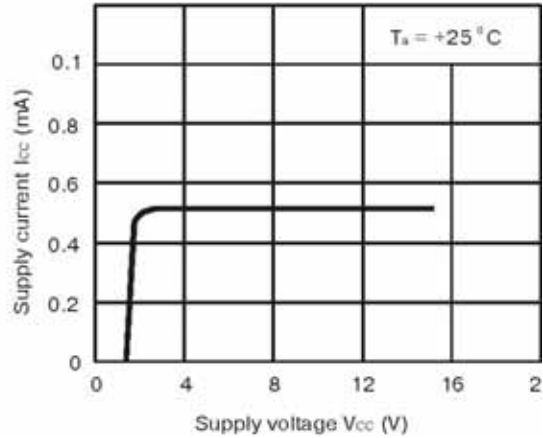
Switching Regulator Controller

TYPICAL CHARACTERISTICS

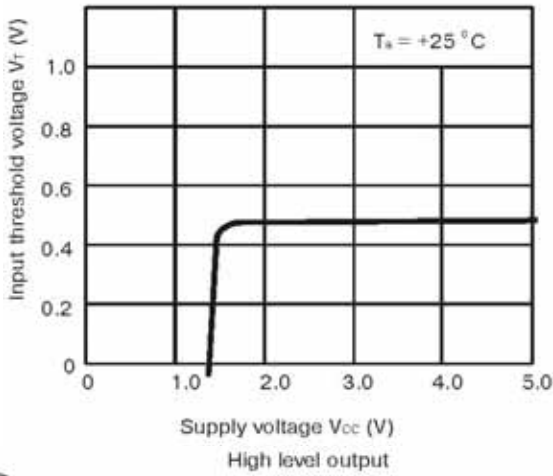
Supply voltage vs. Supply current



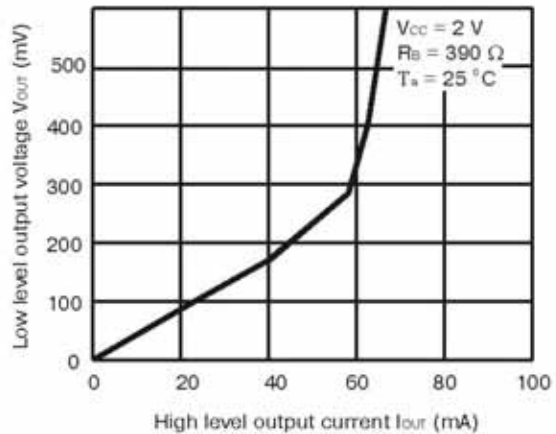
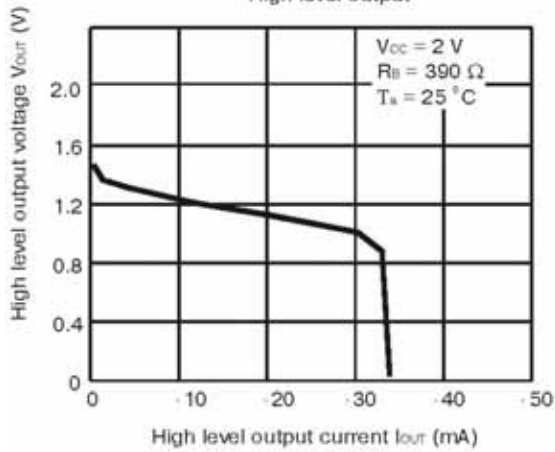
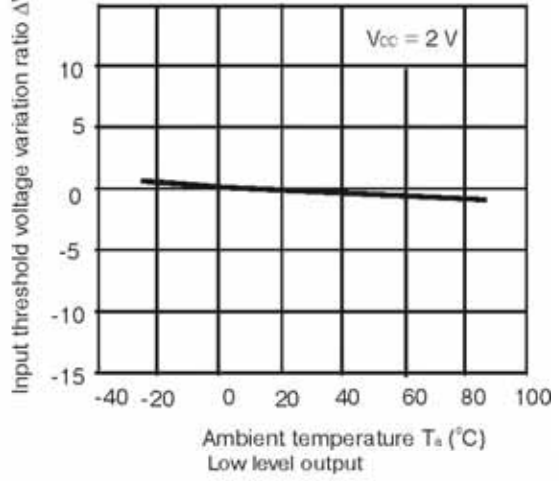
Supply voltage vs. Input threshold voltage



Supply voltage vs. Input threshold voltage



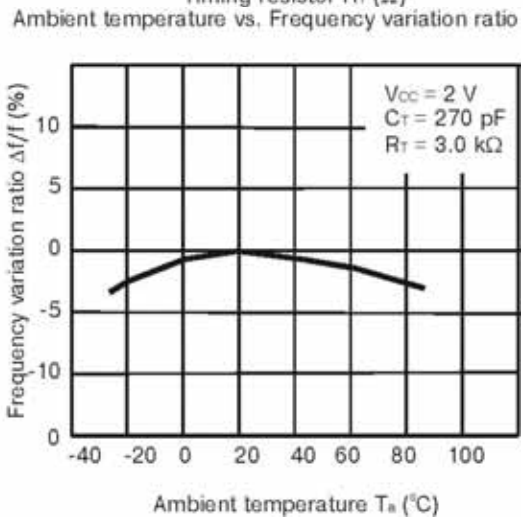
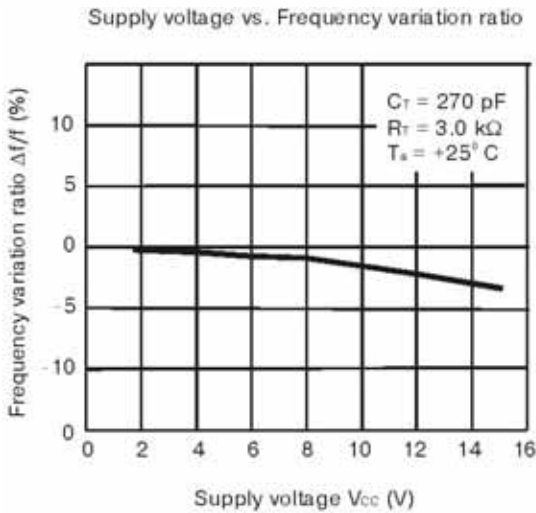
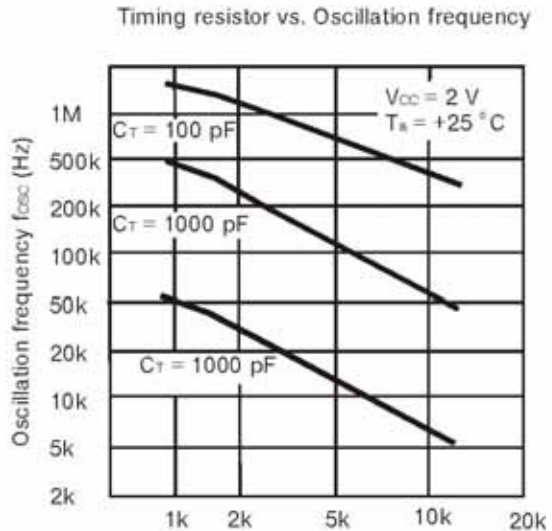
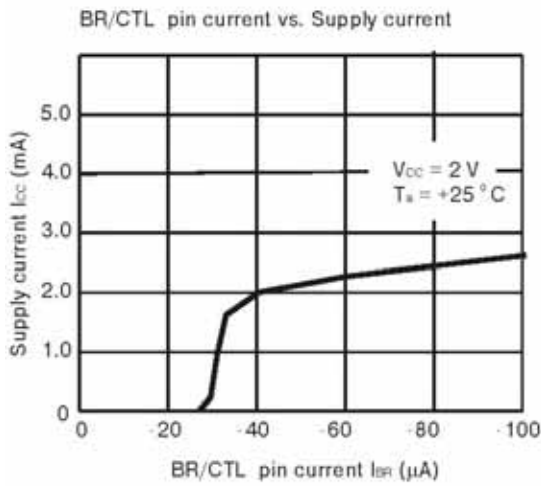
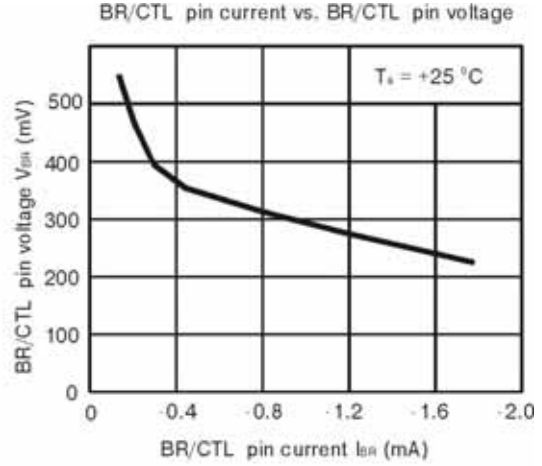
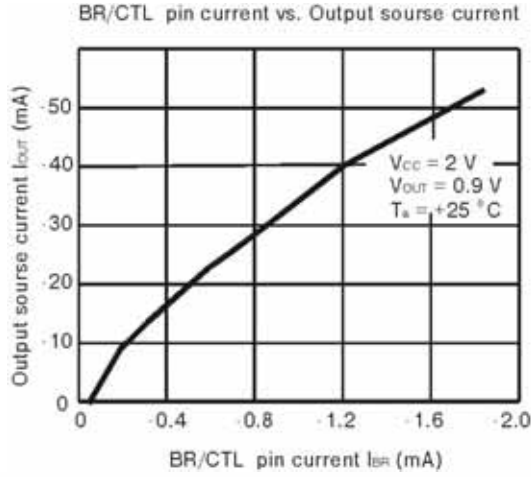
Ambient temperature vs. Input threshold voltage variation ratio





PRELIMINARY

Switching Regulator Controller

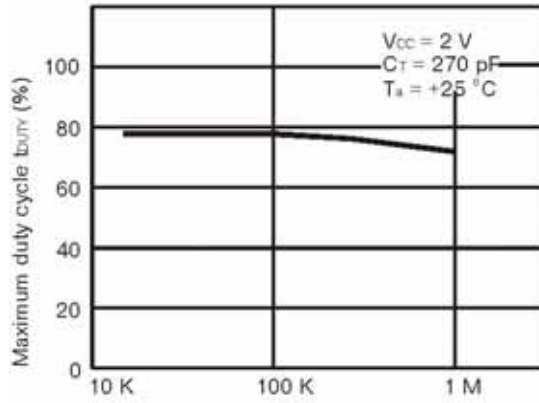




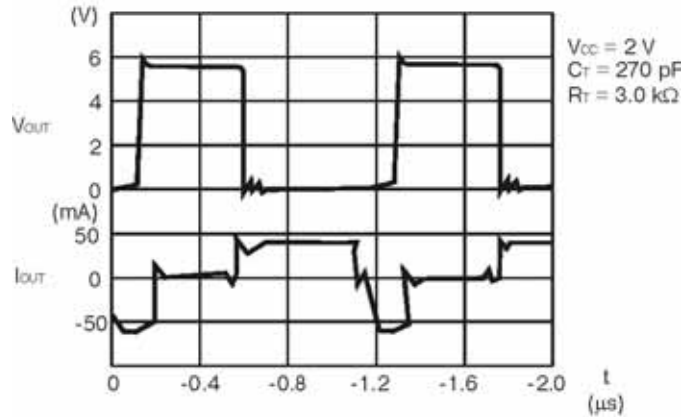
PRELIMINARY

Switching Regulator Controller

Oscillator frequency vs. Maximum duty cycle

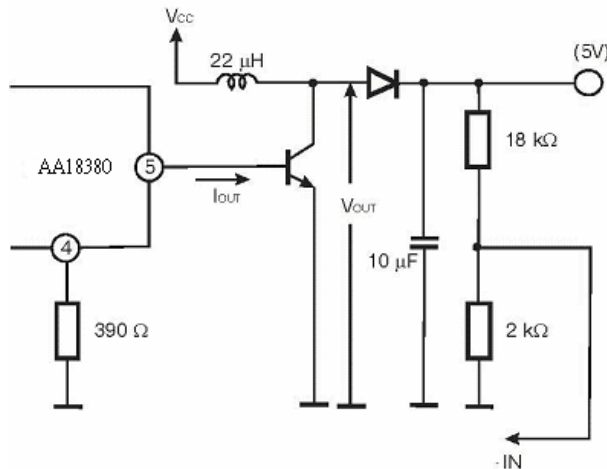


Output pin voltage and current waveforms (reference data)



Note: The OFF delay time of V_{OUT} depends on the characteristics of the external transistor.

Measurement circuit diagram





PRELIMINARY

Switching Regulator Controller

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 SCP pin. This can prevent rush currents and overshoot when the power supply is turned on.

At power on, the capacitor C_{PE} connected to the SCP pin starts charging. The PWM comparator compares the soft start setting voltage as a proportion of the voltage at the SCP pin with the sawtooth waveform. The comparison controls the ON duty of the OUT pin, causing the soft start operation. On completion of soft start operation, the voltage at the SCP pin stays low, the soft start setting voltage stays high, and the circuit enters the output short circuit detection wait state.

Soft start time (The time until the output ON duty reaches approximately 50%)

$$t_s [s] = 0.35 \times C_{PE} [\mu F]$$

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 SCP 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

$$t_{PE} [s] = 0.8 \times C_{PE} [\mu F]$$

FUNCTIONAL DESCRIPTION

1. Switching Regulator Function

(1) Reference voltage circuit

This circuit is composed of a band gap circuit, and outputs a 1.25-volt temperature compensated reference voltage. This reference voltage is stabilized when the supply voltage is 1.8 V or higher. In addition to providing the reference voltage for the switching regulator, the circuit also sets the idle period.

(2) Sawtooth wave oscillator

This circuit generates a triangular wave like sawtooth with a peak of 0.8V (V_{OSCH}) and a trough of 0.1V (V_{OSCL}) using a capacitor (for the time constant) and resistor connected to the OSC 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.

$$f_{OSC} = \frac{-1}{C_T \times R_T \times \ln \frac{V_{OSCL}}{V_{OSCH}}} = 0.48 \times \frac{1}{C_T \times R_T} \quad [HZ]$$

(3) 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).



PRELIMINARY

Switching Regulator Controller

(4) 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 OSC pin (pin 7) triangular waveform is lower than the error amplifier output voltage, soft start setting voltage, and idle period setting voltage.

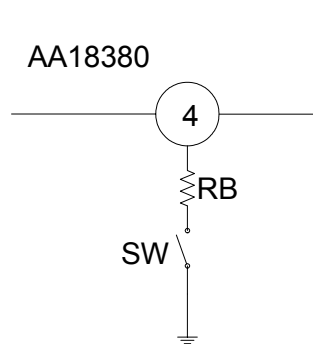
(5) Output driver

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 BR/CTL pin (pin 4).

2. Power Supply On/Off Function

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

SW	Mode
OFF	Stand-by mode
ON	Operating mode



3. Other Functions

(1) Soft start and short circuit detection

Soft start operation can be set by connecting capacitor C_{PE} to the SCP pin (pin 2). Soft start prevents current spike and overshoot.

When the soft start operation completes, the AA18380 enters the normal mode and enable short circuit detection function. When the output voltage drops, the error amplifier output is fixed at V_{OM+} and capacitor C_{PE} starts charging. When it charges to above 0.8V, the output pin (pin 5) is set low and the SCP pin (pin 2) stays low.

Once the protection circuit operates, the output latch circuit will not reset until power is restarted. (See "■ HOW TO SET THE TIME CONSTANT FOR SOFT START AND SHORT CIRCUIT DETECTION".)

(2) Circuit to prevent malfunction at low input voltage

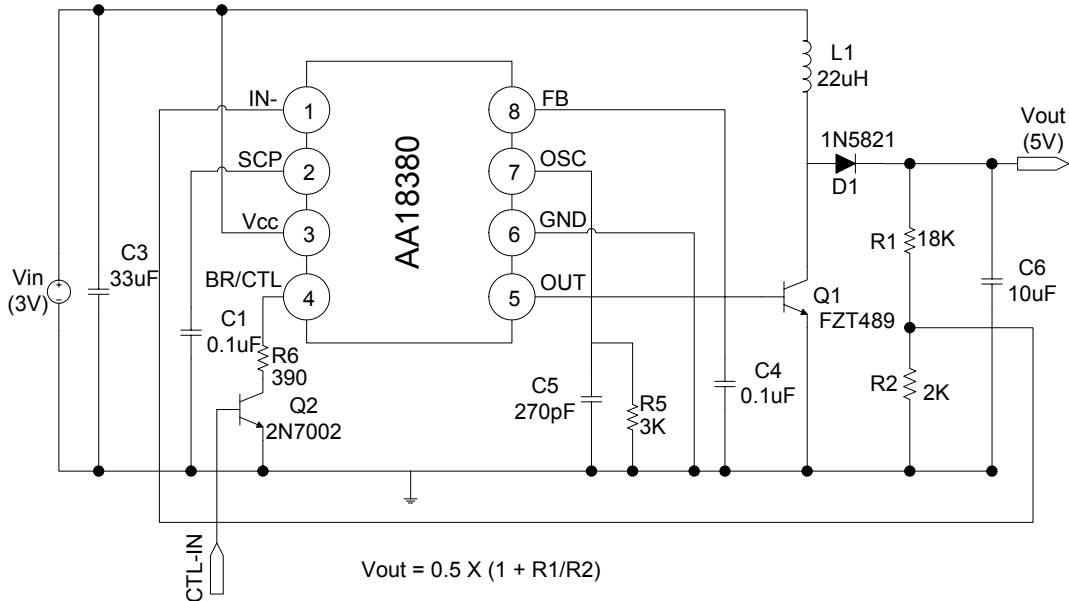
This circuit protects the system against degradation or destruction due to incorrect control operation when the power supply voltage falls during power on or power off.

The low input voltage malfunction prevention circuit detects the internal reference voltage that changes with the supply voltage level. While the supply voltage is rising, On detection, the circuit fixes the output pin to low. The system recovers when the supply voltage rises back above the threshold voltage of the malfunction prevention circuit.

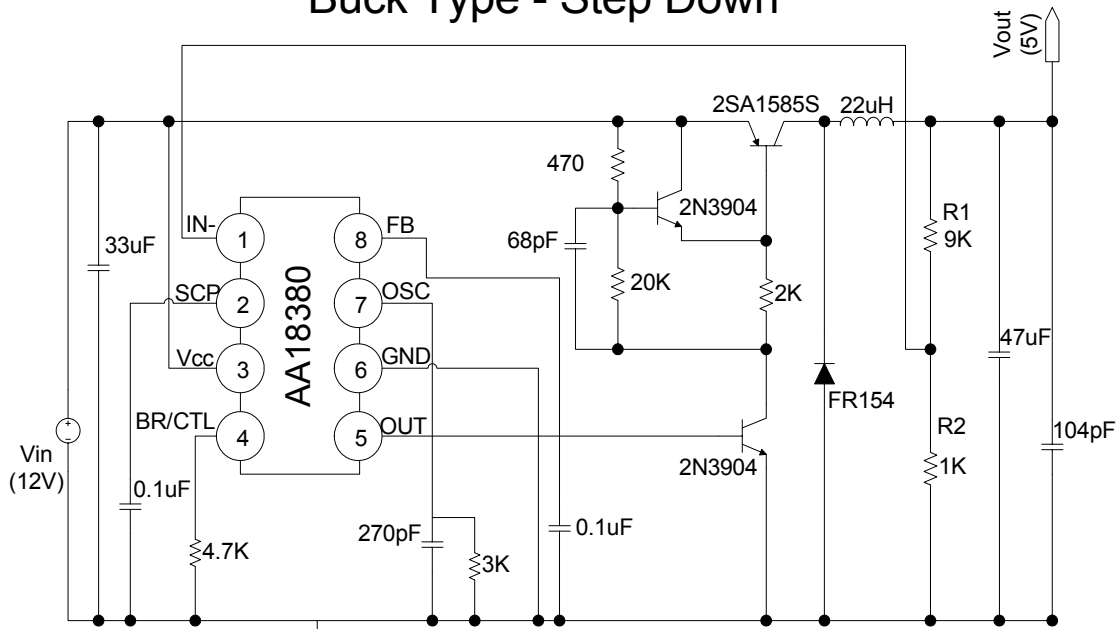


TYPICAL APPLICATION EXAMPLE

Boost Type - Step Up



Buck Type - Step Down



1. bootstrap, single end push pull style.
2. $V_{out} = 0.5 \times (1 + R1/R2)$
3. For example, $R1=5.6K$, $R2=1K$, $V_{out}=3.3V$

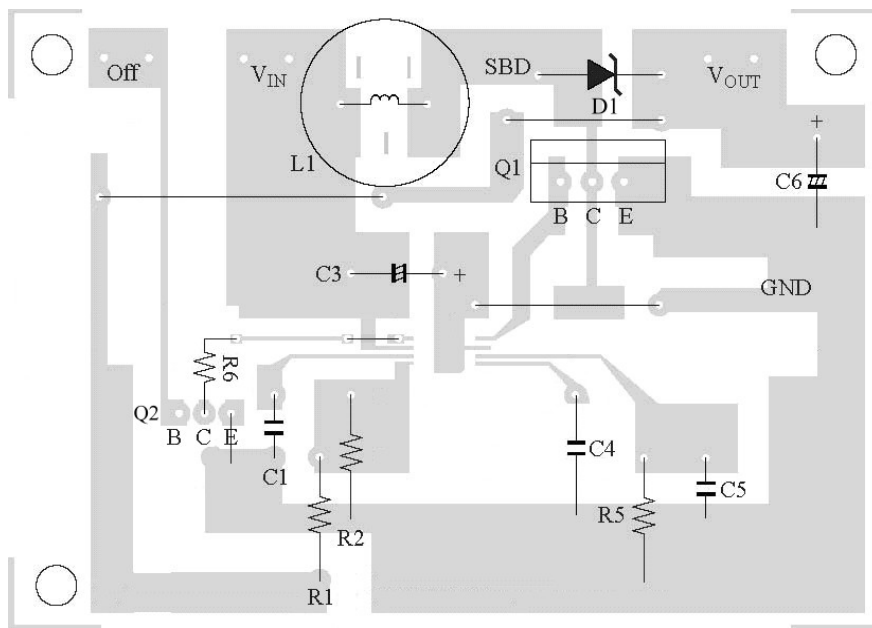
PRELIMINARY

Switching Regulator Controller

PC Board Layout Guideline

PCB layout is very important for DC-DC operation. Please follow the notes and sample layout below.

- Create a power ground island consisting of the input and output capacitor grounds and GND pins. Connect all of these together with short, wide traces or a small ground plane and isolate the IC ground from the power system.
- Make the lines in the high-current loop as wide as possible and placing the inductor, rectifier diode, and output capacitors near the input capacitors and near the OUT and GND pins.
- Position the input filter capacitor C3 as close as possible to the VCC and ground pins, and assure that there are no other paths for switching noise to enter the IC.
- Keep the length of the line between the OUT pin and the switching device (MOSFET or other transistor) as short as possible to provide a clean switching pulse to the switching device.
- The inductor and rectifier diode need to be close with OUT pin.
- Place the feedback resistor – R2 as close to the IN1- pin as possible. The divider's center trace should be kept short. Placing the resistors far away causes picking up switching noise. Avoid running the feedback trace near OUT pin.
- Minimize the length and maximize the width of the traces between the output capacitors and the load for best transient responses. (Please refer to boost type application circuit for this PCB layout sample.)



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.



PRELIMINARY

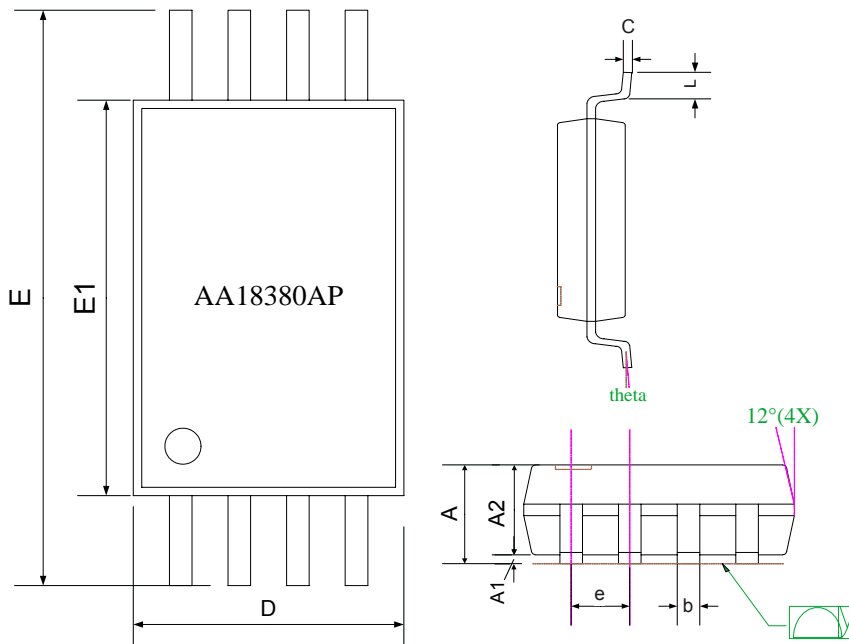
Switching Regulator Controller

ORDERING INFORMATION

Part number	Package	Remarks
AA18380AP	8-pin Plastic TSSOP	
AA18380SP	8-pin Plastic SOP	

PACKAGE DIMENSIONS

AA18380AP - 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°

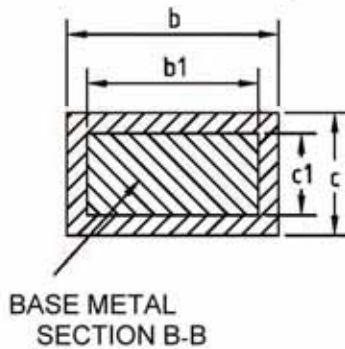
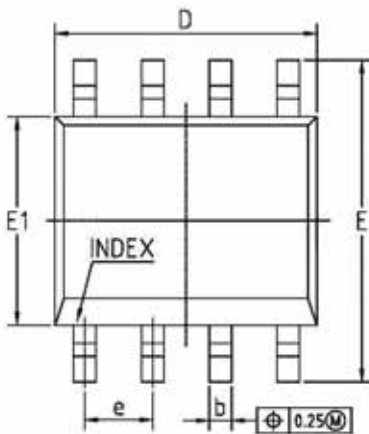
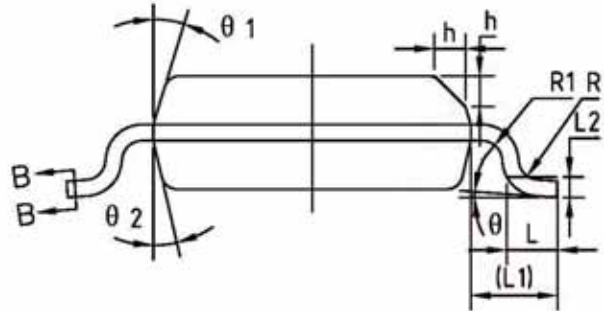
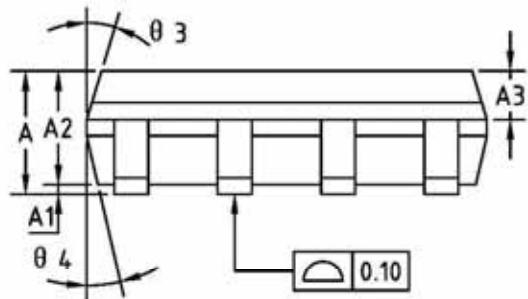
- NOTE
1. PACKAGE BODY SIZES EXCLUDE MOLD FLASH PROTRUSIONS OR GATE BURRS
 2. TOLERANCE +/-0.1 mm UNLESS OTHERWISE SPECIFIED
 3. COPLANARITY : 0.1 mm
 4. CONTROLLING DIMENSION IS MILLIMETER. CONVERTED INCH DIMENSIONS ARE NOT NECESSARILY EXACT.
 5. FOLLOWED FROM JEDEC MO-153



PRELIMINARY

Switching Regulator Controller

AA18380SP - 8-pin Plastic SOP



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
theta	0°	-	8°
theta 1	15°	17°	19°
theta 2	11°	13°	15°
theta 3	15°	17°	19°
theta 4	11°	13°	15°