

Features

- 1.8 to 13 V supply voltage operating range
- Low current consumption: 5 mA in operation, 1 μ A or less in stand-by.
- 20 kHz to 1 MHz operation frequency range
- Provides a fixed output current with minimal supply voltage fluctuations by using an external resistor to set the output current
- Totem-pole output.
- Built-in soft start circuit.
- Built-in timer-latch type short circuit detection and protection (SCP) circuit.

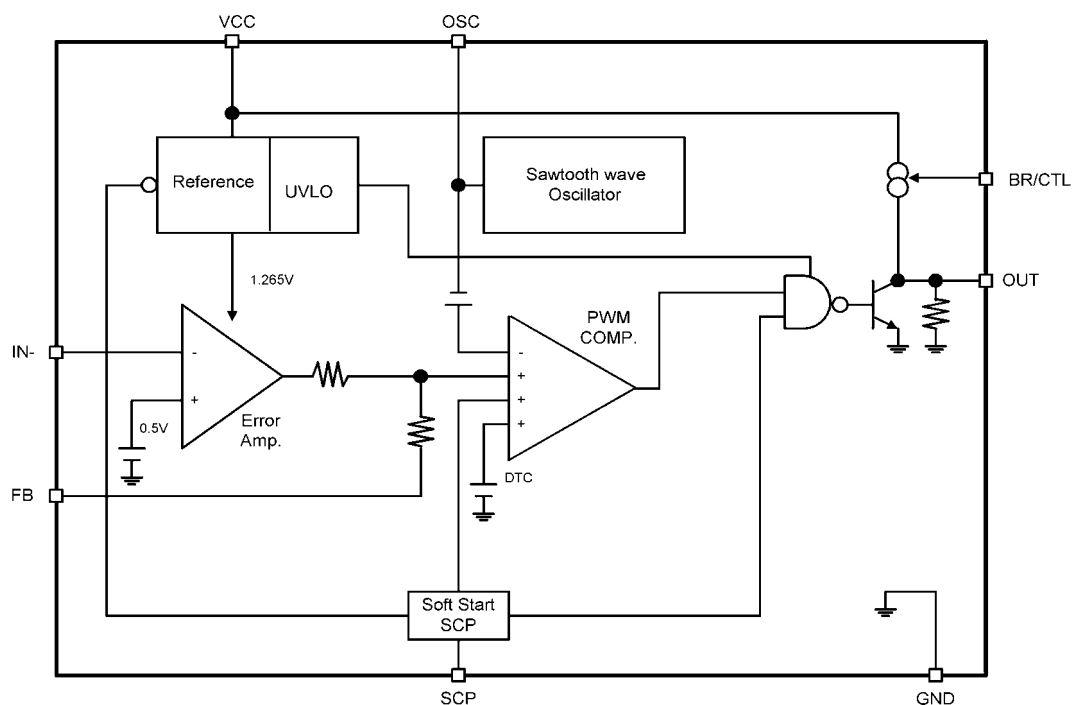
General Description

The AT1380 is a single-channel PWM control IC for DC/DC conversion with soft start function and short circuit detection. Adjustable soft start is programmed with an external capacitor on the SCP pin. The AT1380 is ideal for up, down and fly-back conversion.

Applications

- LCD Displays
- PDAs
- Digital Still Cameras

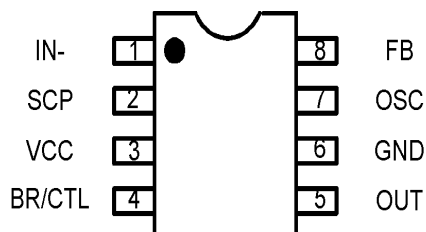
Block Diagram



Aimtron reserves the right without notice to change this circuitry and specifications.

Pin Configuration

AT1380 (8-Pin SOL)



Pin Description

Pin No.	Symbol	I/O	Description
1	IN-	I	Error amplifier inverting input
2	SCP	—	Soft start and SCP setting capacitor connection
3	VCC	—	Power supply
4	BR/CTL	I	Output current setting and control
5	OUT	O	Totem-pole output
6	GND	—	Ground
7	OSC	—	Capacitor and resistor connection pin for setting the oscillation frequency
8	FB	O	Error amplifier output

Ordering Information

Part number	Package	Remarks
AT1380	8-pin Plastic SOL	AT1380S
AT1380	8-pin TSSOP	AT1380P

Absolute Maximum Ratings

(T_a=+25°C)

Parameter	Symbol	Condition	Rated Value		Unit
			Min.	Max.	
Power supply voltage	V _{CC}	—	—	13	V
Output source current	I _O ⁺	—	—	-50	mA
Output sink current	I _O ⁻	—	—	50	mA
Allowable dissipation	P _D	SOP-8, Ta ≤ +25°C	—	570	mW
	P _D	TSSOP-8, Ta ≤ +25°C	—	430	mW
Operating temperature	T _{OP}	—	0	+85	°C
Storage temperature	T _{stg}	—	-55	+125	°C
ESD Classification		MIL-STD-883	Class 2		

* : When mounted on a 10 cm square double-sided epoxy board

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

Recommended Operating Conditions

(Ta=+25°C)

Parameter	Symbol	Values			Unit
		Min.	Typ.	Max.	
Power supply voltage	V _{CC}	1.8	--	12.0	V
Error amplifier input voltage	V _{IERR}	-0.2	--	1.0	V
BR/CTL pin input voltage	V _{BR}	-0.2	--	V _{CC}	V
Output source current	I _O ⁺	-20	--	--	mA
Output sink current	I _O ⁻	--	--	40	mA
SCP pin capacitance	C _{PE}	--	0.1	--	μF
Phase compensation capacitance	C _P	--	0.1	--	μF
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 _{OSC}	10	500	1000	kHz
Operating temperature	T _{OP}	0	+25	+85	°C

WARNING: Recommended operating conditions are normal operating ranges for the IC device. All the device's electrical characteristics are warranted for operation within these ranges. Use IC devices only within the recommended operating conditions. Operation outside these ranges may adversely affect the reliability and can result in device failure.

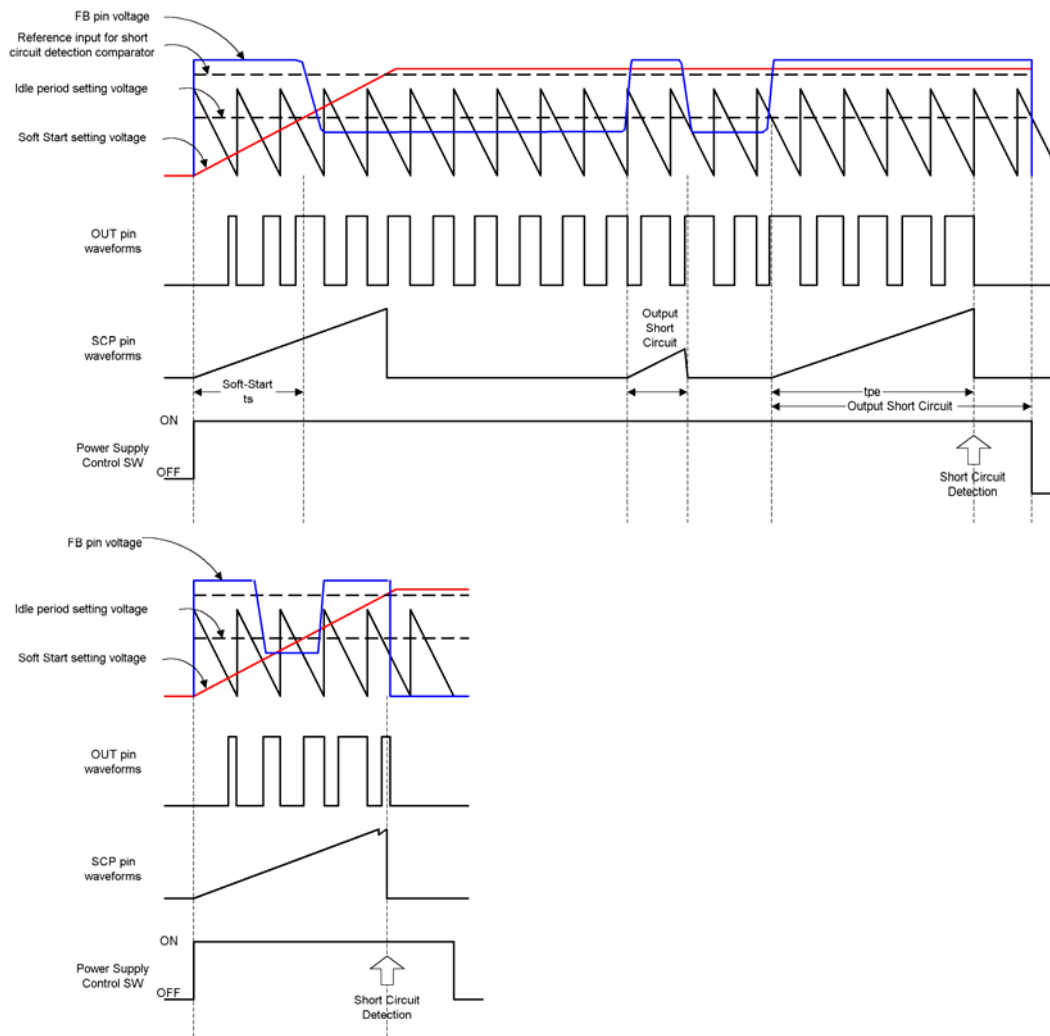
Electrical Characteristics

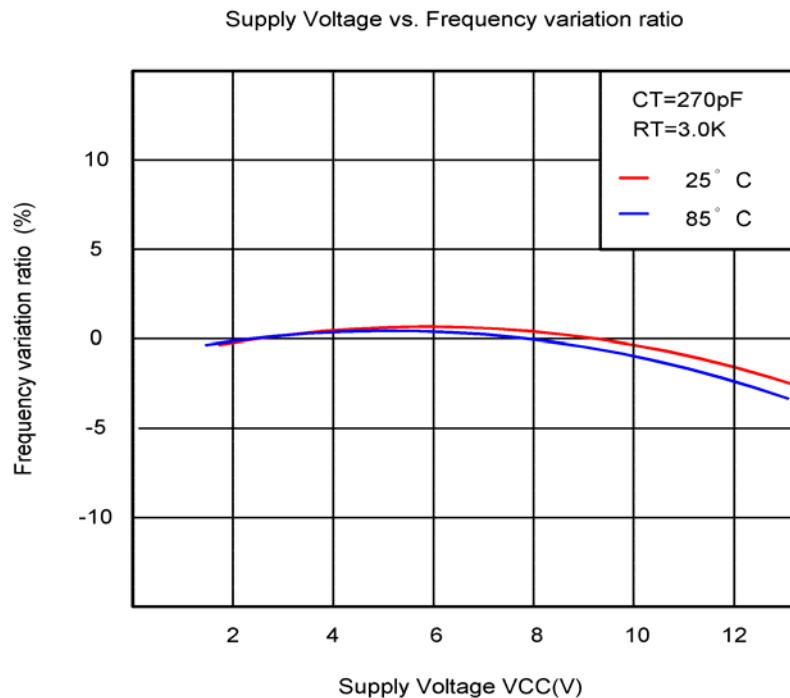
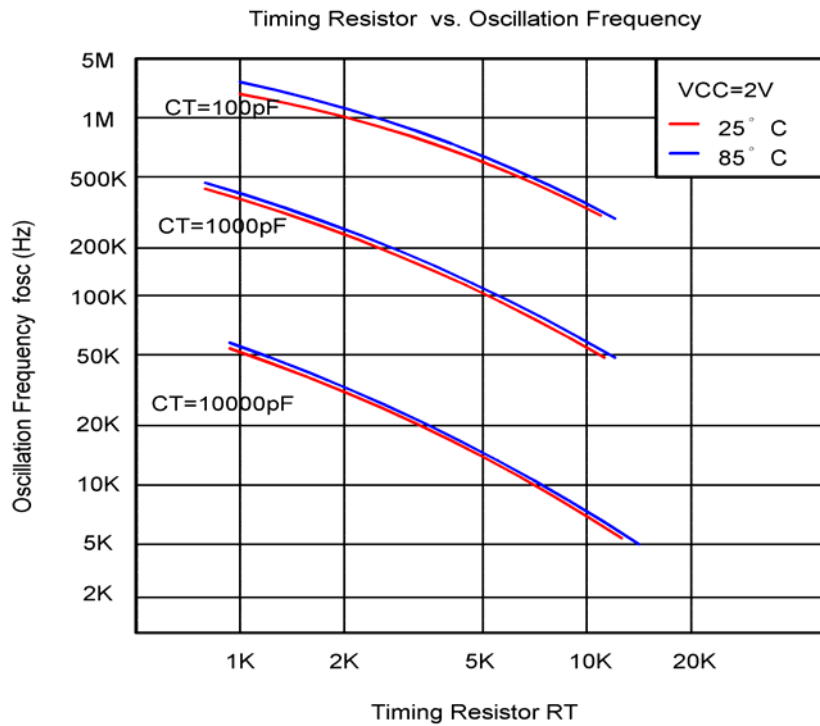
($V_{CC}=+2V$, $T_a=+25^{\circ}C$)

Parameter		Symbol	Condition	Values			Unit
				Min.	Typ.	Max.	
Under voltage lockout to prevent malfunction at low input voltage (UVLO)	Reset voltage	V_R	--	--	--	0.9	V
	Threshold voltage	V_{TH}		1.1	1.3	1.5	V
Soft start	Charging current	I_{CS}	$V_{SCP}=0V$	-1.5	-1.0	-0.7	μA
	Voltage at soft start completion	V_{IS}	--	0.7	0.8	0.9	V
Short circuit detection and protection (S.C.P.)	Charging current	I_{CSCP}	$V_{SCP}=0V$	-1.5	-1.0	-0.7	μA
	Threshold voltage	V_{ISCP}	--	0.7	0.8	0.9	V
Sawtooth waveform oscillator (OSC)	Oscillation frequency	f_{OSC}	$R_T=3.0k\Omega$, $C_T=270pF$	400	500	600	kHz
	Frequency input Stability	$f_{\Delta V}$	$V_{CC}=2V$ to $12V$	--	2	10	%
	Frequency variation with temperature	$f_{\Delta T}$	$T_a=0^{\circ}C$ to $85^{\circ}C$	--	5	--	%
Error amplifier	Input threshold Voltage	V_T	$V_{FB}=450mV$	480	500	520	mV
	V_T input stability	$V_{T\Delta V}$	$V_{CC}=2V$ to $12V$	--	5	20	mV
	V_T variation with Temperature	$V_{T\Delta T}$	$T_a=0^{\circ}C$ to $85^{\circ}C$	--	1	--	%
	Input bias current	I_B	$V_{IN}=0V$	-1.0	-0.2	1.0	μA
	Voltage gain	A_V	--	70	100	145	V/V
	Frequency bandwidth	BW	$A_V=0$ dB	--	6	--	MHz
	Maximum output voltage range	V_{OMax}^{+}	--	0.78	0.87	--	V
		V_{OMax}^{-}		--	0.05	0.2	V
	Output source current	I_{OMax}^{+}	$V_{FB}=450mV$	--	-40	-24	μA
	Output sink current	I_{OMax}^{-}		24	40	--	μA
Idle period adjustment section	Maximum duty cycle	T_{DUTY}	$R_T=3.0k\Omega$, $C_T=270pF$ $V_{FB}=0.8V$	75	--	85	%
Output section	Output voltage	V_{OH1}	$R_B=390\Omega$, $I_O=-15$ mA	1.0	1.2	--	V
		V_{OH2}	$R_B=750\Omega$, $V_{CC}=1.8V$ $I_O=-10$ mA	0.8	1.0	--	V
		V_{OL1}	$R_B=390\Omega$, $I_O=-15$ mA	--	0.1	0.2	V
		V_{OL2}	$R_B=750\Omega$, $V_{CC}=1.8V$ $I_O=-10$ mA	--	0.1	0.2	V
	Output source current	I_O^{+}	$R_B=390\Omega$, $V_O=0.9V$	--	-30	-20	mA
	Output sink current	I_O^{-}	$R_B=390\Omega$, $V_O=0.3V$	30	60	--	mA
	Pull down resistance	R_O	--	20	30	40	k Ω

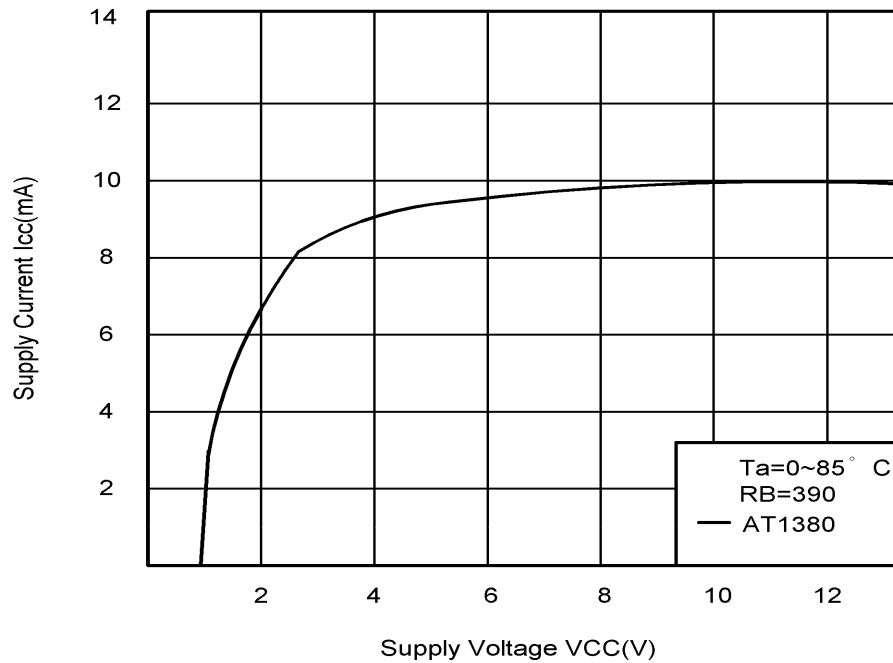
Output current Setting section/ Control section	Pin voltage	V_{BR}	$R_B = 390\Omega$	0.10	0.19	0.25	V
	Input off condition	I_{OFF}	--	-20	--	0	μA
	Input on condition	I_{ON}	--	--	--	-45	μA
	Pin current range	I_{BR}	--	-1.8	--	-0.1	m A
Entire device	Stand-by current	I_{CCS}	BR/CTL pin open or V_{CC}	--	--	1	μA
	Average supply current	I_{CC}	$R_B = 390, V_{CC} = 2 \sim 12V$	--	5.5	10.0	m A

Timing Chart

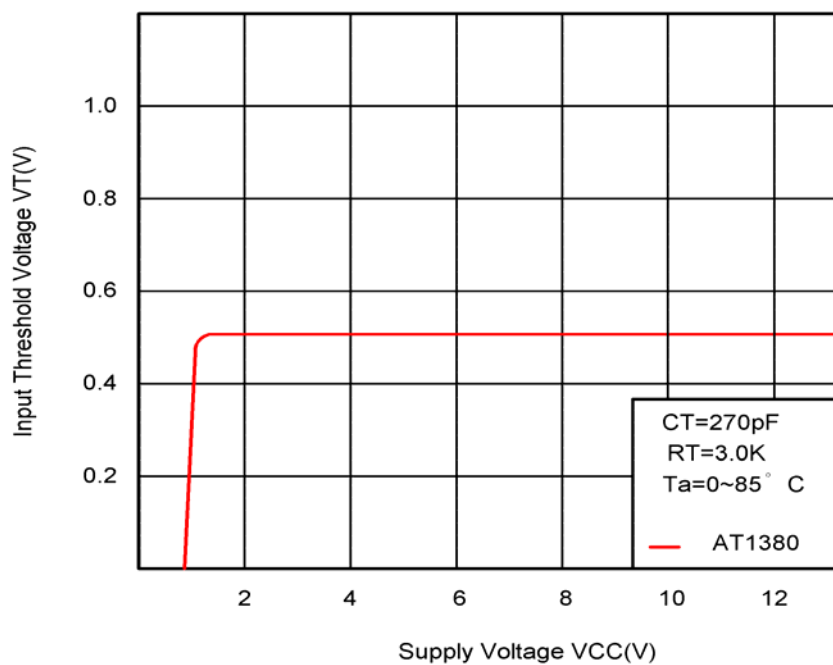




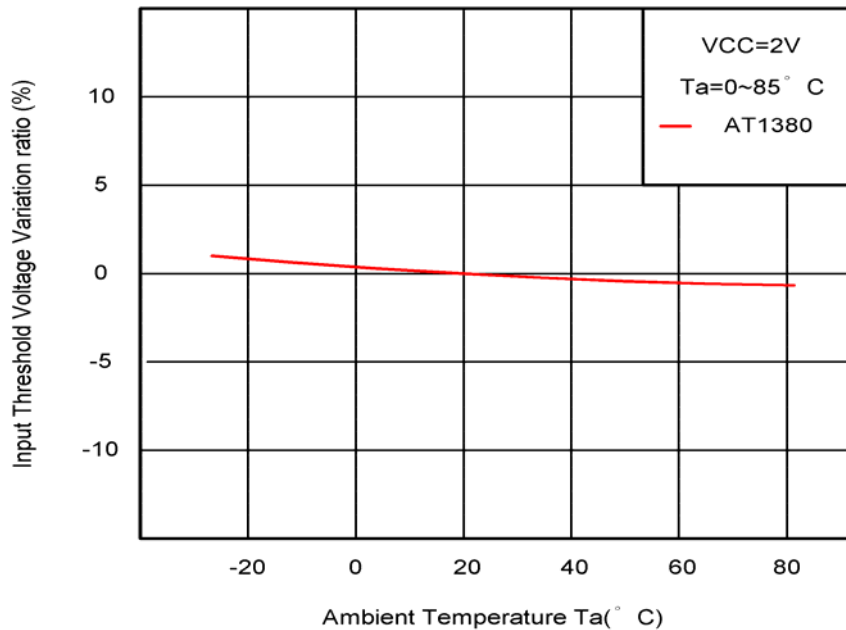
Supply Voltage vs. Supply Current



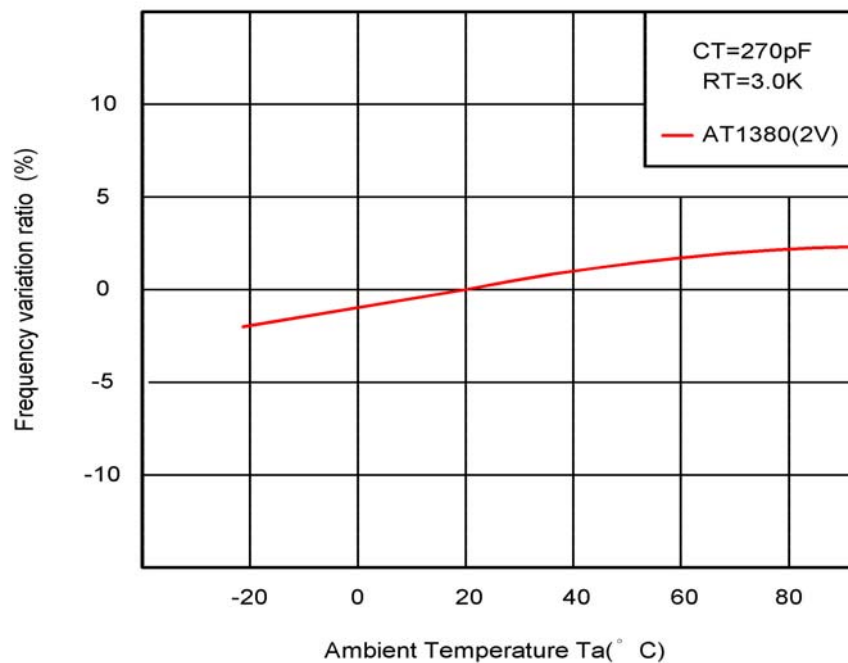
Supply Voltage vs. Input Threshold voltage



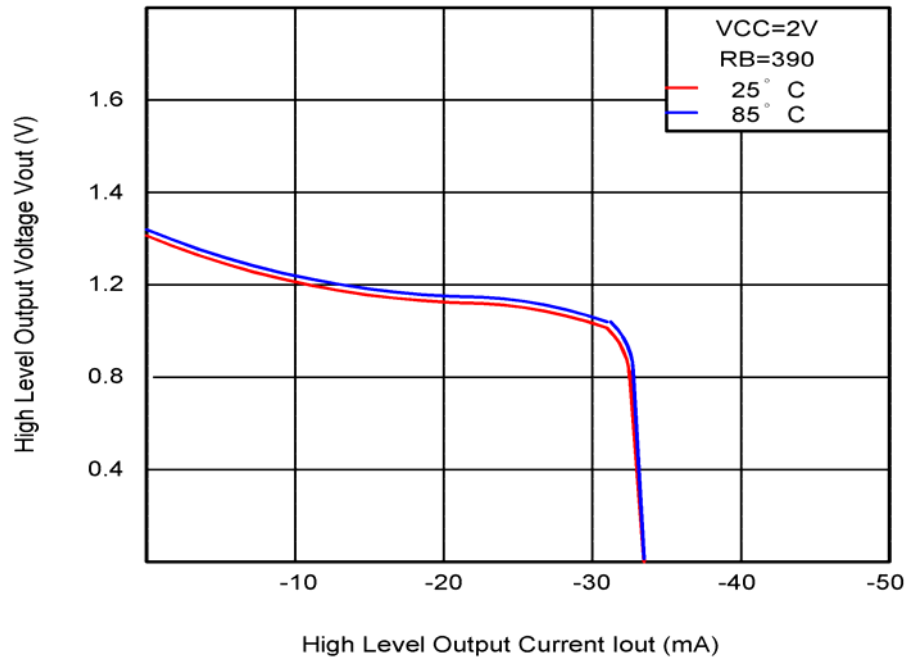
Ambient Temperature vs. Input Threshold Voltage
Variation ratio



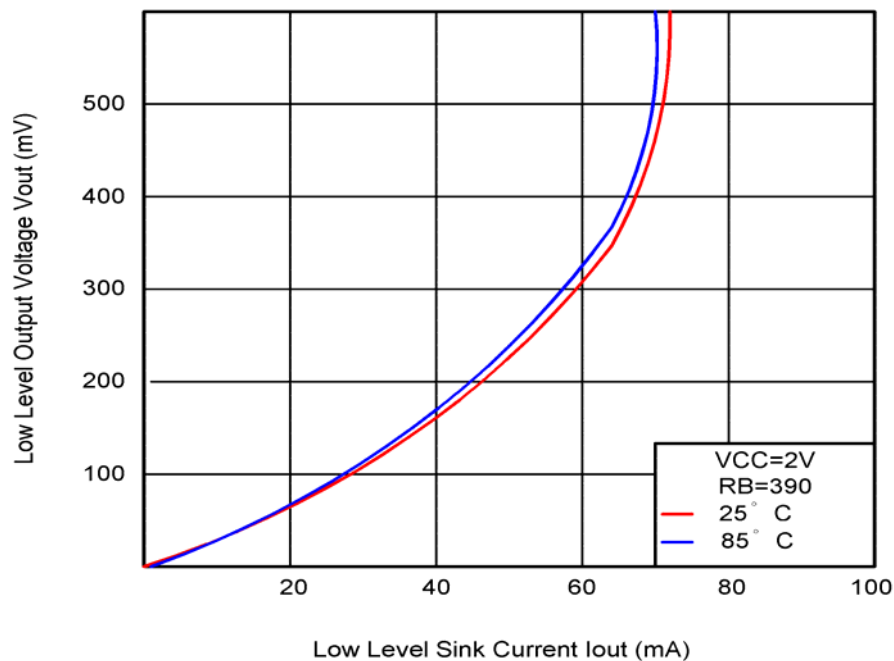
Ambient Temperature vs. Frequency variation ratio

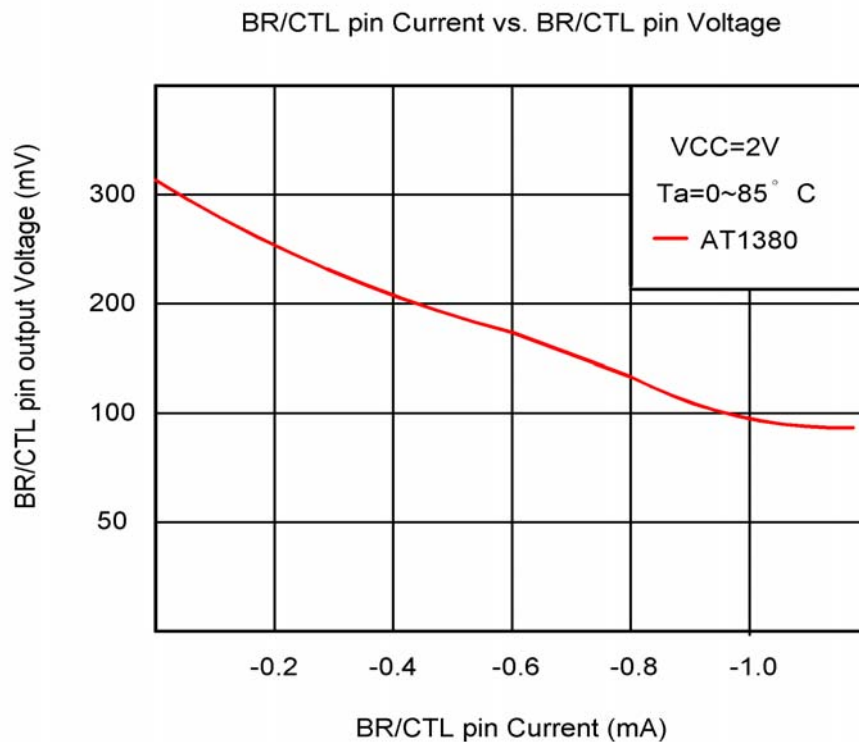
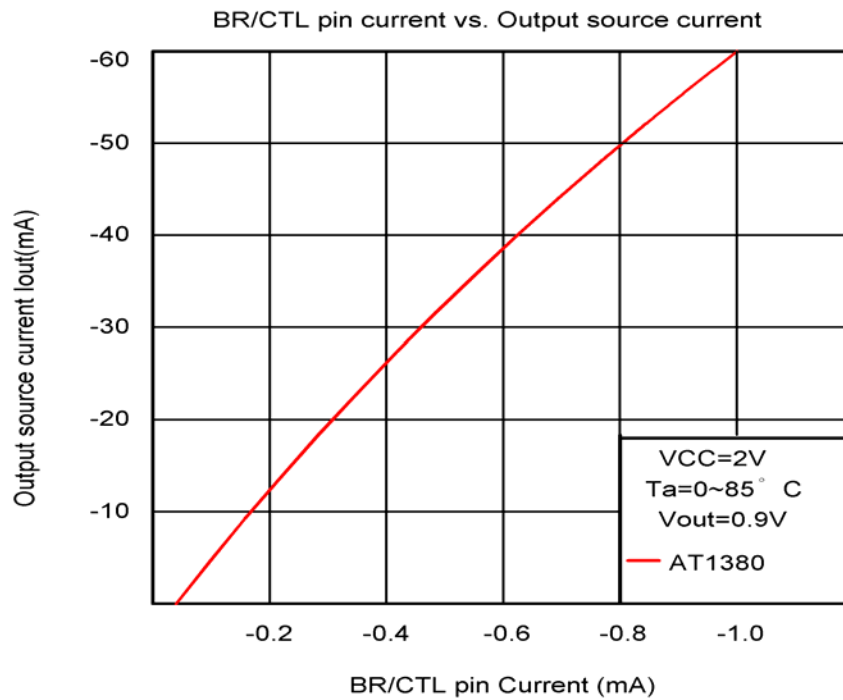


High Level Output Characteristic

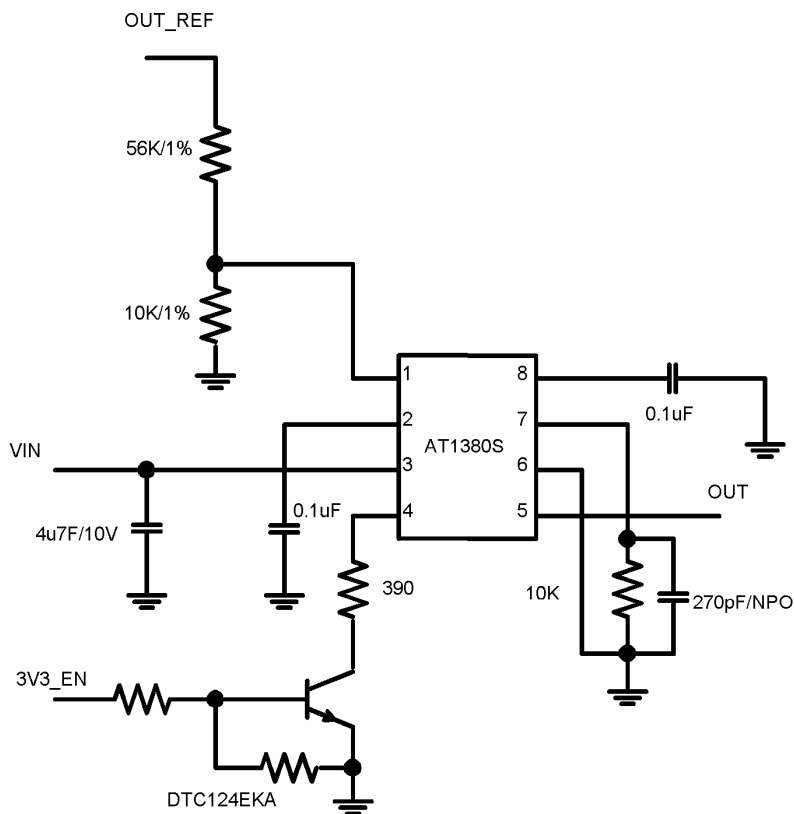


Low Level Output Characteristic

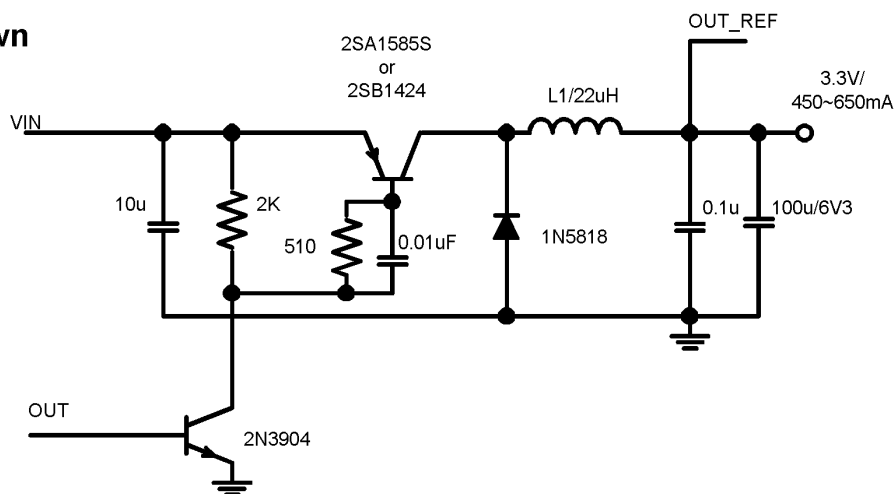


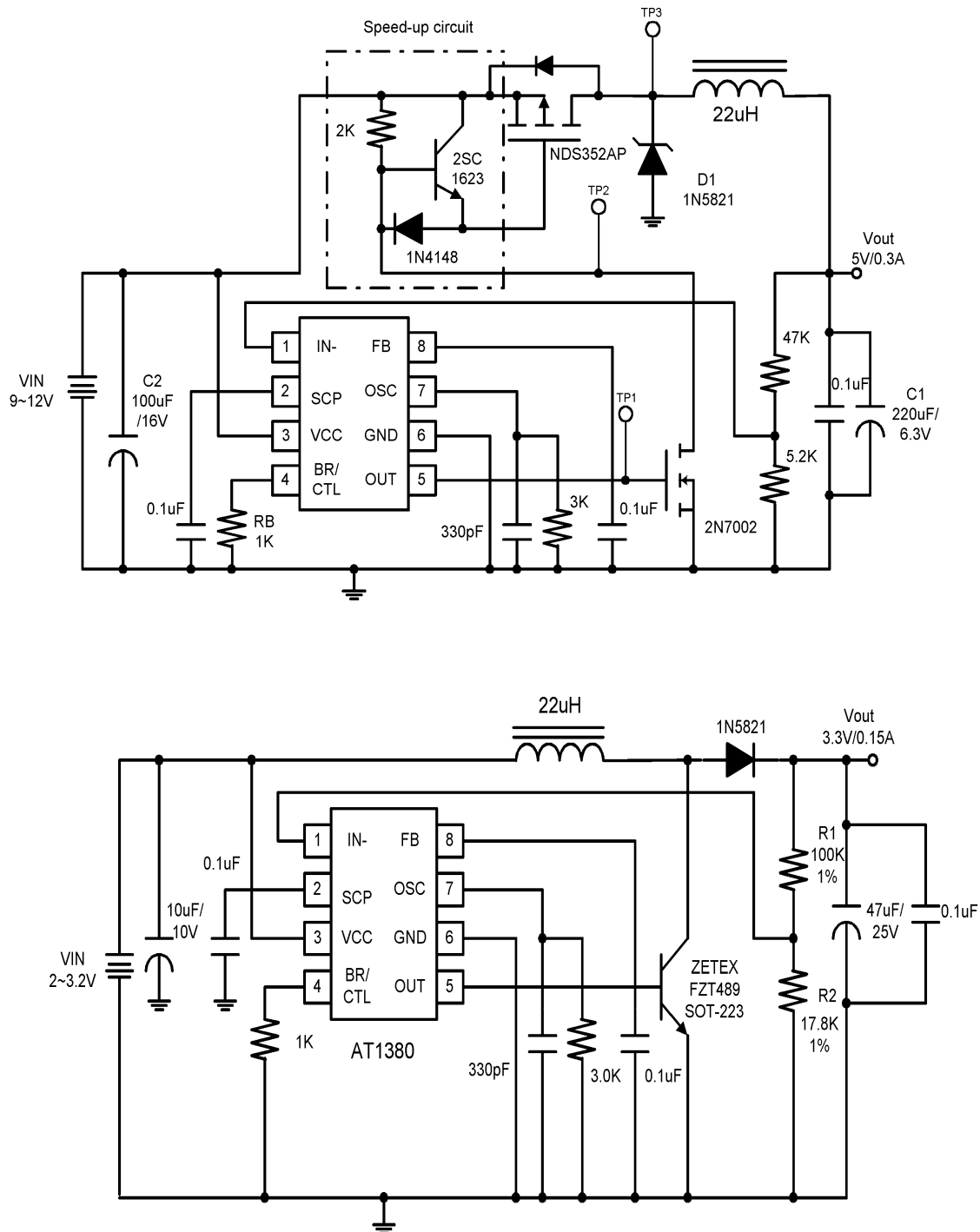


Typical Application Schematic

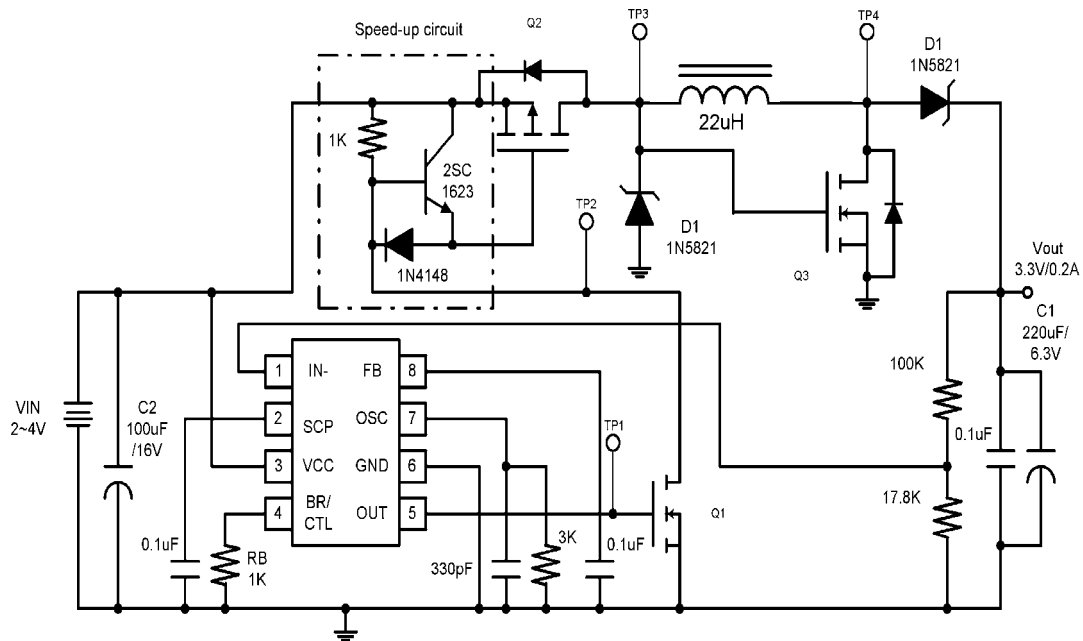


STEP-Down

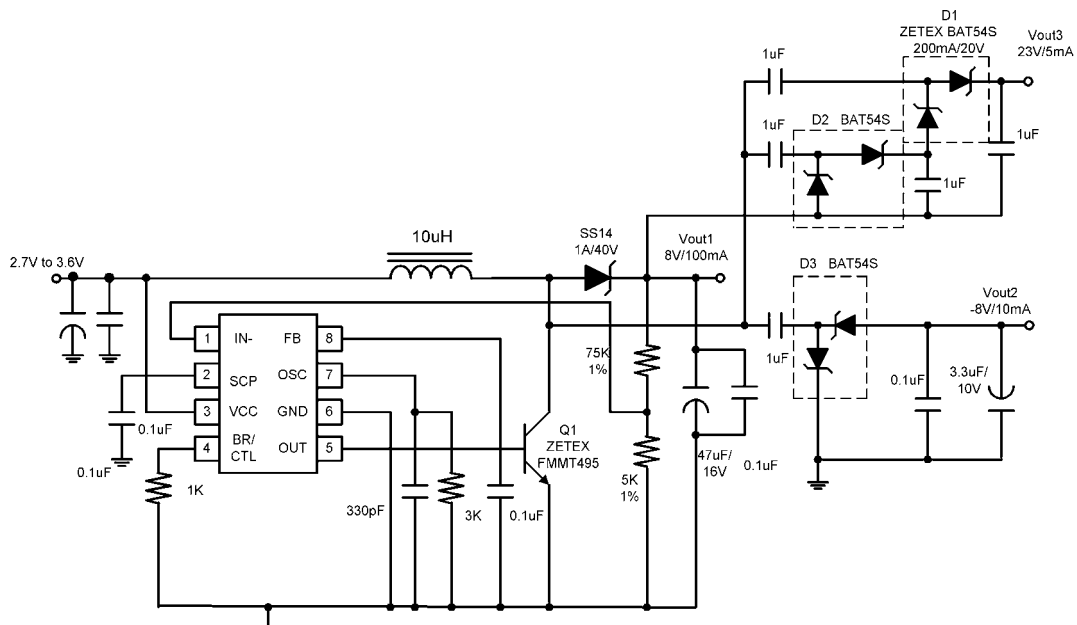








*Q1,Q2,Q3 Low VT MOSFET
or use Transistor NPN & PNP



1. Q1 can use low threshold Vt N Channel MOSFET (NDS339AN)
2. Vout2 and Vout3 outputs are unregulated (can use zener diode to regulate it)
3. $V_{out3} = V_{out1} * 3 - V_{diode} * 3$ (V_{diode} is Schottky Diode forward drop voltage)
4. Operation frequency 500~600KHz

Functional Description

Soft Start SCP

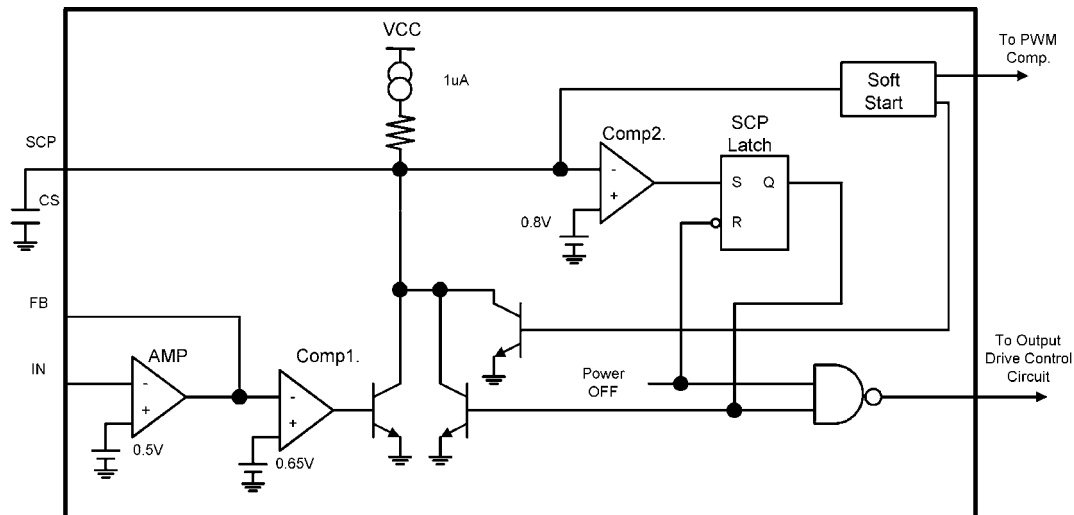


Figure 1. Soft-Start SCP circuit

At power-on, the AT1380 enters the soft-start mode to prevent current spike and overshoot. The capacitor CS is charged from 0V at a constant current of 1μA.

The soft-start time for the duty cycle

$$t_s = 0.8 \times CS(\mu F)$$

When V_{SCP} reaches 0.8V, the AT1380 leaves the soft-start mode to enter the normal mode and enable the SCP function. If the output load conditions change rapidly causing the output to drop suddenly, the external capacitor CS will start to charge because the error amplifier output (FB pin) is fixed at V_{OMax+} . When the external capacitor is charged above 0.8V, the output pin is set low. Once the latch circuit has set, the capacitor CS will be discharged to low state and the latch circuit will not reset until power is turned off or the power supply is restarted.

Short-circuit detection time (or full soft-start time) :

$$t_{PE} = 0.8 \times CS(\mu F)$$

Setting Oscillating Frequency

The oscillator circuit generates a triangular sawtooth wave with a peak of 0.8V and a trough of 0.1V using the timing capacitor (CT) and the timing resistor (RT) that are connected to the OSC pin. This oscillator can provide oscillating frequency in the range from 20KHz to 1MHz. The waveform of the OSC pin is shown as Figure 2.

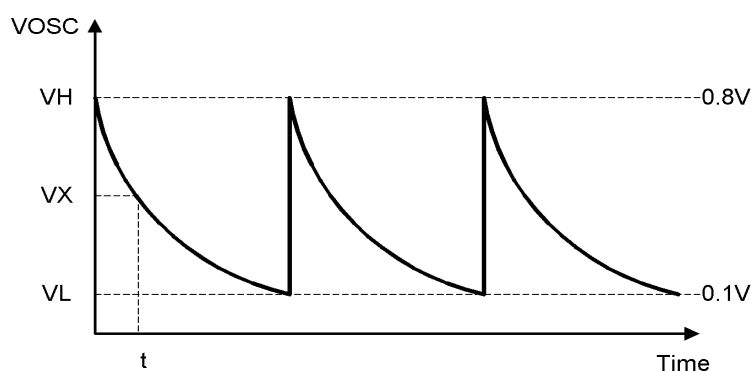


Figure 2 Oscillator Waveform

The cycle (T) can be determined as follows:

$$VX = VHe^{-\frac{t}{CT \times RT}} \quad t = -CT \times RT \times \log_e \left(\frac{VX}{VH} \right)$$

$$T = -CT \times RT \times \log_e (0.1 / 0.8) = 2.1 \times CT \times RT [s]$$

Switching Regulator Function

(1) Reference voltage circuit

A temperature-compensated reference voltage (~1.25V) is generated by the reference voltage circuit from the voltage supplied by the power supply pin (pin 3). The circuit also sets the idle period besides providing the reference voltage for the switching regulator.

(2) Error amplifier

The error amplifier detects the output voltage of the switching regulator and sets the PWM control signal. The voltage gain is fixed. The system is made stable by connecting a phase compensation capacitor to the FB pin (pin 8).

(3) PWM comparator

The voltage comparator includes one inverting and three non-inverting inputs. The comparator is a voltage to pulse width converter that controls the ON time of the output pulse depending on the level of input voltage. The output level remains high when the sawtooth wave is lower than the error amplifier output voltage, the soft start setting voltage, and the idle period setting voltage.

(4) Output circuit

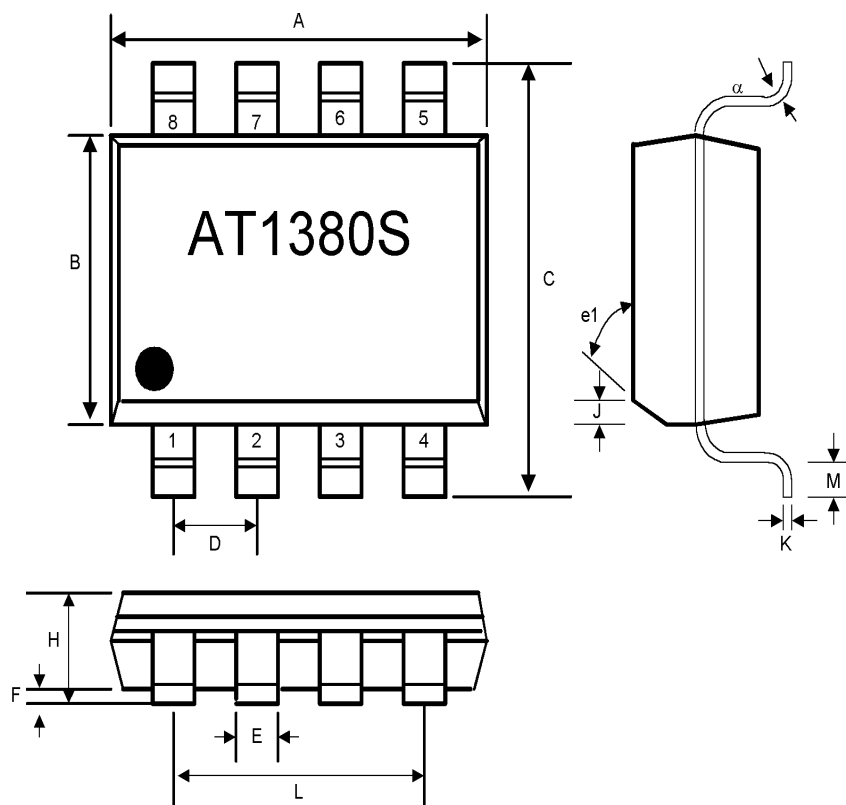
The output circuit can drive an external NPN transistor directly and has a totem pole configuration. The value of the ON/OFF current can be set by a resistor connected to the BR/CTL pin (pin 4). Stand-by mode (supply current 1μA or less) can be set by connecting the BR/CTL pin (pin4) to VCC or by making the pin open.

(5) Under-Voltage Lockout (UVLO)

Transients during powering on or instantaneous glitches in the supply voltage can cause the control IC to malfunction and damage the system. To prevent malfunction at low input voltage, the circuit compares the supply voltage to the internal reference voltage to detect a low input voltage. Once detected, the circuit sets the output pin low.

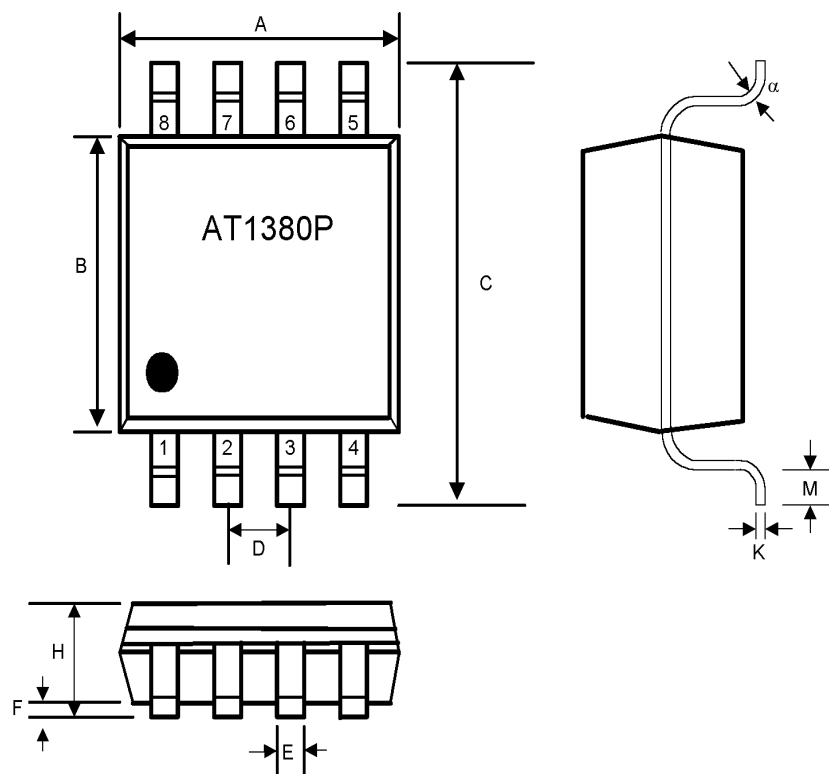
To cancel the status, set V_{CC} below the reset voltage V_R (0.9V) and then set V_{CC} up to the recommended operation range and the latch will be restored to operate normally.

Small Outline 8-pin Plastic SOL



SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
A	0.188	0.197	4.80	5.00	-
B	0.149	0.158	3.80	4.00	-
C	0.228	0.244	5.80	6.20	-
D	0.050 BSC		1.27 BSC		-
E	0.013	0.020	0.33	0.51	-
F	0.004	0.010	0.10	0.25	-
H	0.053	0.069	1.35	1.75	-
J	0.011	0.019	0.28	0.48	-
K	0.007	0.010	0.19	0.25	-
M	0.016	0.050	0.40	1.27	-
L	0.150 REF		3.81 REF		-
e1	45°		45°		-
α	0°	8°	0°	8°	-

Small Outline 8-pin TSSOP



SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
A	0.114	0.122	2.90	3.10	-
B	0.169	0.177	4.30	4.50	-
C	0.244	0.260	6.20	6.60	-
D	0.026	BSC	0.65	BSC	-
E	0.010	0.012	0.25	0.30	-
F	0.002	0.006	0.05	0.15	-
H	0.041	0.047	1.05	1.20	-
K	0.005	BSC	0.127	BSC	-
M	0.020	0.028	0.50	0.70	-
α	0°	8°	0°	8°	-