

### Features

- 1.8 to 13 V supply voltage operating range
- Low current consumption: 5 mA in operation, 1  $\mu$ 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.

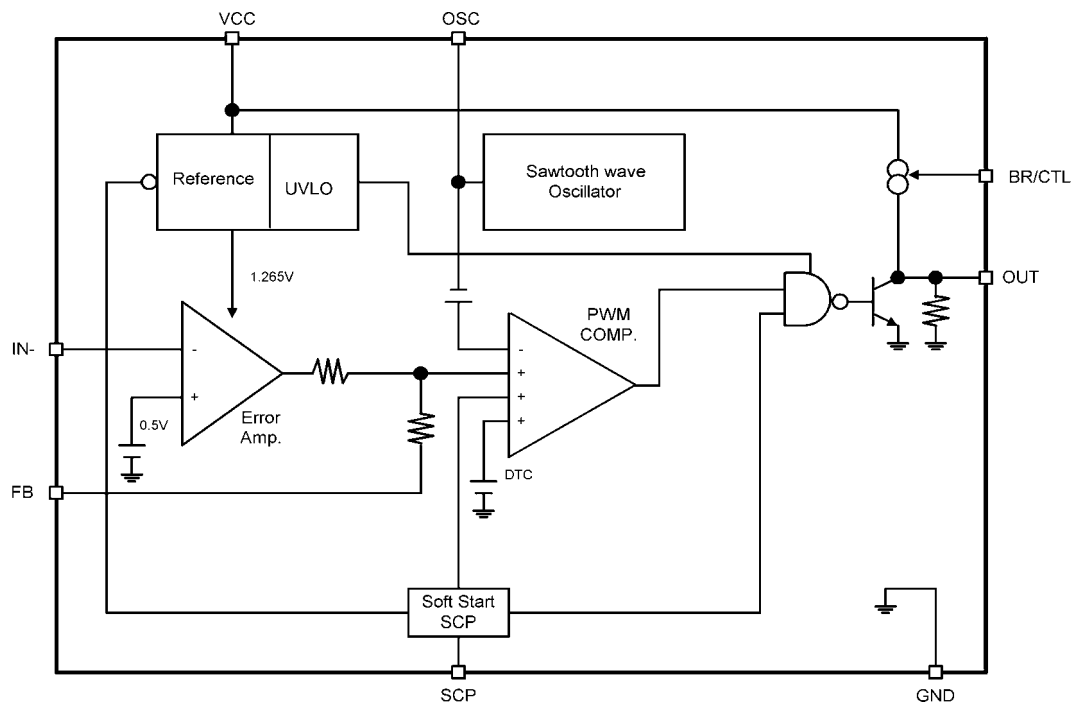
### General Description

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

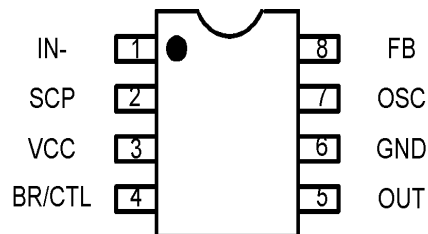
### Block Diagram



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

### Pin Configuration

AT1380 (8-Pin SOL )



\*Pb-free Data Code is one underline

### 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<sub>a</sub>=+25°C)

Parameter	Symbol	Condition	Rated Value		Unit
			Min.	Max.	
Power supply voltage	V <sub>CC</sub>	—	—	13	V
Output source current	I <sub>O</sub> <sup>+</sup>	—	—	-50	mA
Output sink current	I <sub>O</sub> <sup>-</sup>	—	—	50	mA
Allowable dissipation	P <sub>D</sub>	SOP-8, Ta ≤ +25°C	—	570	mW
	P <sub>D</sub>	TSSOP-8, Ta ≤ +25°C	—	430	mW
Operating temperature	T <sub>OP</sub>	—	0	+85	°C
Storage temperature	T <sub>stg</sub>	—	-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 <sub>CC</sub>	1.8	--	12.0	V
Error amplifier input voltage	V <sub>IERR</sub>	-0.2	--	1.0	V
BR/CTL pin input voltage	V <sub>BR</sub>	-0.2	--	V <sub>CC</sub>	V
Output source current	I <sub>O</sub> <sup>+</sup>	-20	--	--	mA
Output sink current	I <sub>O</sub> <sup>-</sup>	--	--	40	mA
SCP pin capacitance	C <sub>PE</sub>	--	0.1	--	μF
Phase compensation capacitance	C <sub>P</sub>	--	0.1	--	μF
Output current setting resistance	R <sub>B</sub>	150	390	5000	Ω
Timing resistance	R <sub>T</sub>	1.0	3.0	10.0	kΩ
Timing capacitance	C <sub>T</sub>	100	270	10000	pF
Oscillation frequency	f <sub>OSC</sub>	10	500	1000	kHz
Operating temperature	T <sub>OP</sub>	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.

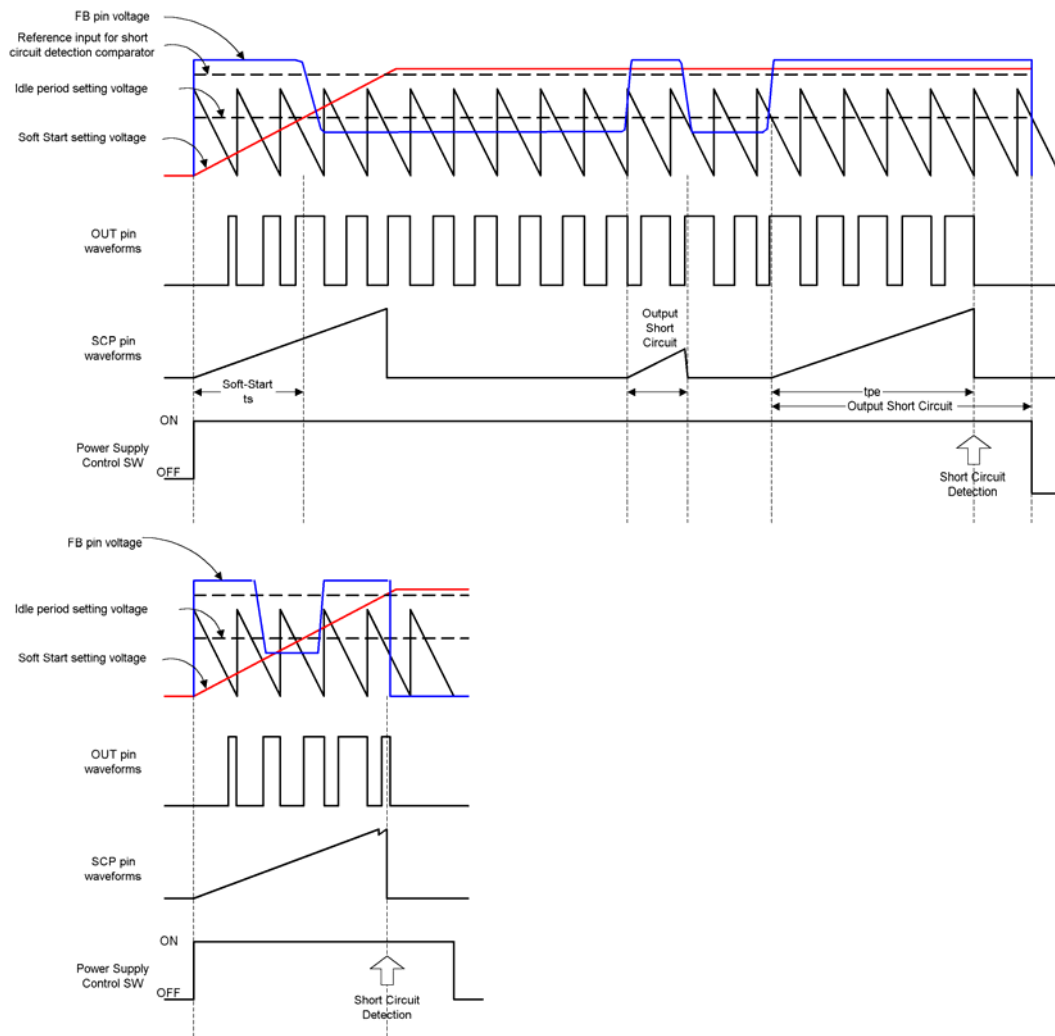
**Electrical Characteristics**

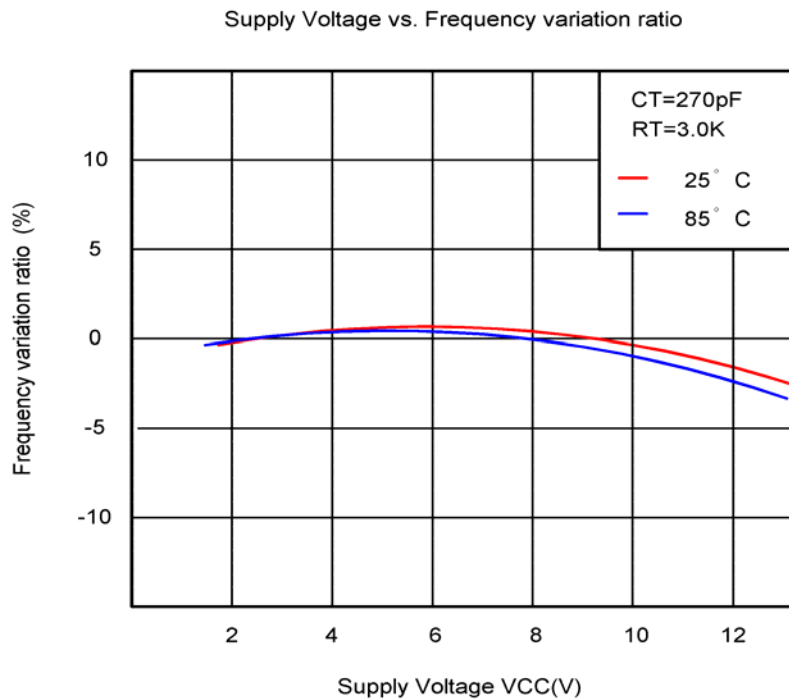
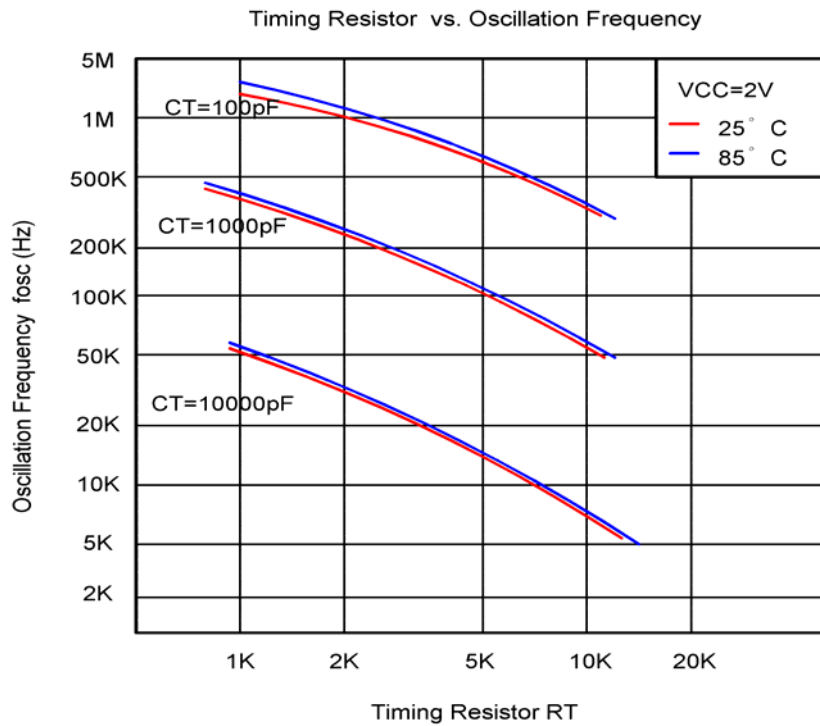
(V<sub>CC</sub>=+2V, Ta=+25°C)

Parameter		Symbol	Condition	Values			Unit
				Min.	Typ.	Max.	
Under voltage lockout to prevent malfunction at low input voltage (UVLO)	Reset voltage	V <sub>R</sub>	--	--	--	0.9	V
	Threshold voltage	V <sub>TH</sub>		1.1	1.3	1.5	V
Soft start	Charging current	I <sub>CS</sub>	V <sub>SCP</sub> =0V	-1.5	-1.0	-0.7	μA
	Voltage at soft start completion	V <sub>IS</sub>	--	0.7	0.8	0.9	V
Short circuit detection and protection (S.C.P.)	Charging current	I <sub>CSCP</sub>	V <sub>SCP</sub> =0V	-1.5	-1.0	-0.7	μA
	Threshold voltage	V <sub>ISCP</sub>	--	0.7	0.8	0.9	V
Sawtooth waveform oscillator (OSC)	Oscillation frequency	f <sub>OSC</sub>	R <sub>T</sub> =3.0kΩ, C <sub>T</sub> =270pF	400	500	600	kHz
	Frequency input Stability	f <sub>ΔV</sub>	V <sub>CC</sub> =2V to 12V	--	2	10	%
	Frequency variation with temperature	f <sub>ΔT</sub>	Ta = 0°C to 85°C	--	5	--	%
Error amplifier	Input threshold Voltage	V <sub>T</sub>	V <sub>FB</sub> = 450mV	480	500	520	mV
	V <sub>T</sub> input stability	V <sub>TΔV</sub>	V <sub>CC</sub> =2V to 12V	--	5	20	mV
	V <sub>T</sub> variation with Temperature	V <sub>TΔT</sub>	Ta = 0°C to 85°C	--	1	--	%
	Input bias current	I <sub>B</sub>	V <sub>IN</sub> = 0V	-1.0	-0.2	1.0	μA
	Voltage gain	A <sub>V</sub>	--	70	100	145	V/V
	Frequency bandwidth	BW	A <sub>V</sub> = 0 dB	--	6	--	MHz
	Maximum output voltage range	V <sub>OMax</sub> <sup>+</sup>	--	0.78	0.87	--	V
		V <sub>OMax</sub> <sup>-</sup>		--	0.05	0.2	V
Output source current	I <sub>OMax</sub> <sup>+</sup>	V <sub>FB</sub> = 450mV	--	-40	-24	μA	
Output sink current	I <sub>OMax</sub> <sup>-</sup>	--	24	40	--	μA	
Idle period adjustment section	Maximum duty cycle	T <sub>DUTY</sub>	R <sub>T</sub> =3.0kΩ, C <sub>T</sub> =270pF V <sub>FB</sub> = 0.8V	75	--	85	%
Output section	Output voltage	V <sub>OH1</sub>	R <sub>B</sub> = 390Ω, I <sub>O</sub> = -15 mA	1.0	1.2	--	V
		V <sub>OH2</sub>	R <sub>B</sub> = 750Ω, V <sub>CC</sub> = 1.8V I <sub>O</sub> = -10 mA	0.8	1.0	--	V
		V <sub>OL1</sub>	R <sub>B</sub> = 390Ω, I <sub>O</sub> = -15 mA	--	0.1	0.2	V
		V <sub>OL2</sub>	R <sub>B</sub> = 750Ω, V <sub>CC</sub> = 1.8V I <sub>O</sub> = -10 mA	--	0.1	0.2	V
	Output source current	I <sub>O</sub> <sup>+</sup>	R <sub>B</sub> = 390Ω, V <sub>O</sub> = 0.9V	--	-30	-20	mA
	Output sink current	I <sub>O</sub> <sup>-</sup>	R <sub>B</sub> = 390Ω, V <sub>O</sub> = 0.3V	30	60	--	mA
	Pull down resistance	R <sub>O</sub>	--	20	30	40	kΩ

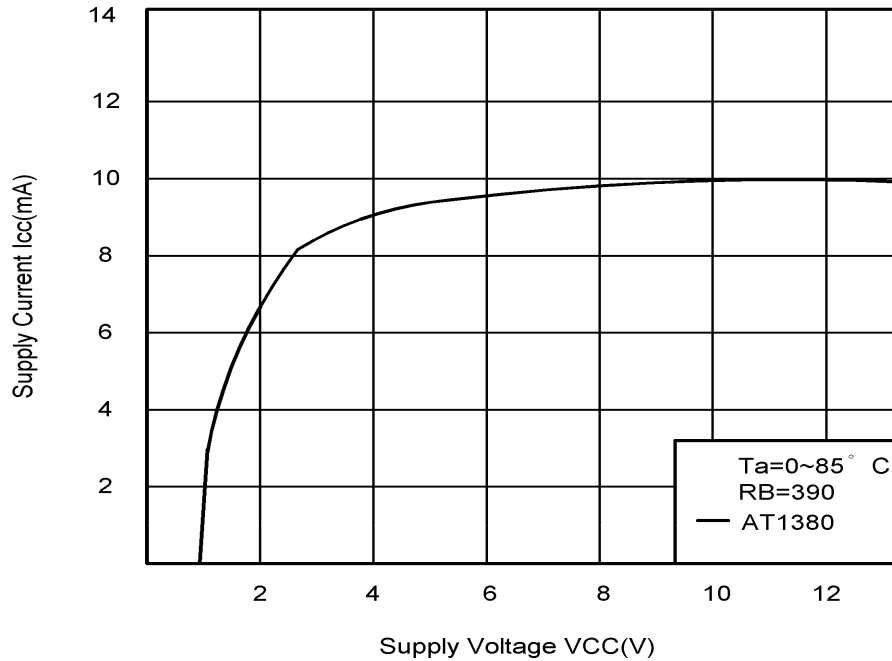
Output current Setting section/ Control section	Pin voltage	$V_{BR}$	$R_B = 390\Omega$	0.10	0.19	0.25	V
	Input off condition	$I_{OFF}$	--	-20	--	0	$\mu A$
	Input on condition	$I_{ON}$		--	--	-45	$\mu A$
	Pin current range	$I_{BR}$		-1.8	--	-0.1	m A
Entire device	Stand-by current	$I_{CCS}$	BR/CTL pin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

### Timing Chart

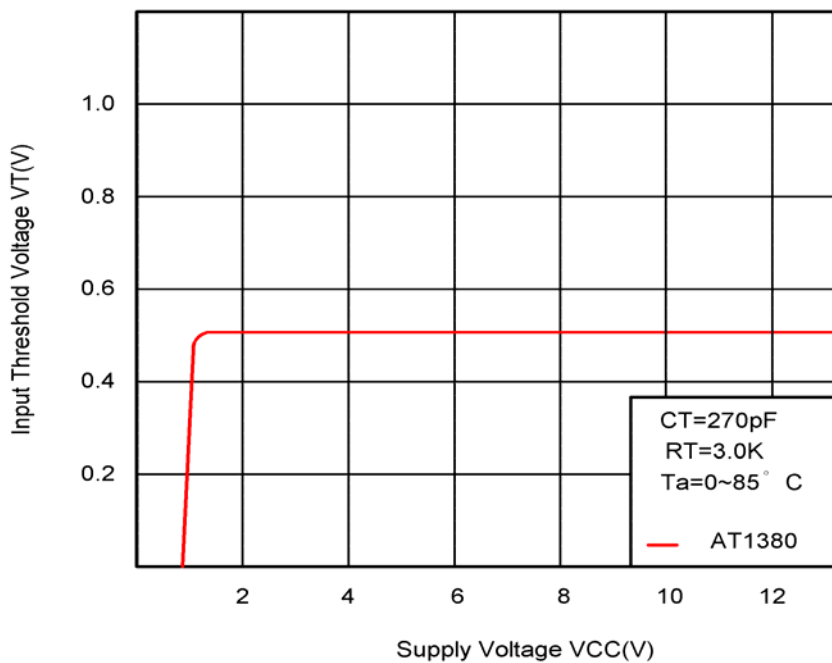




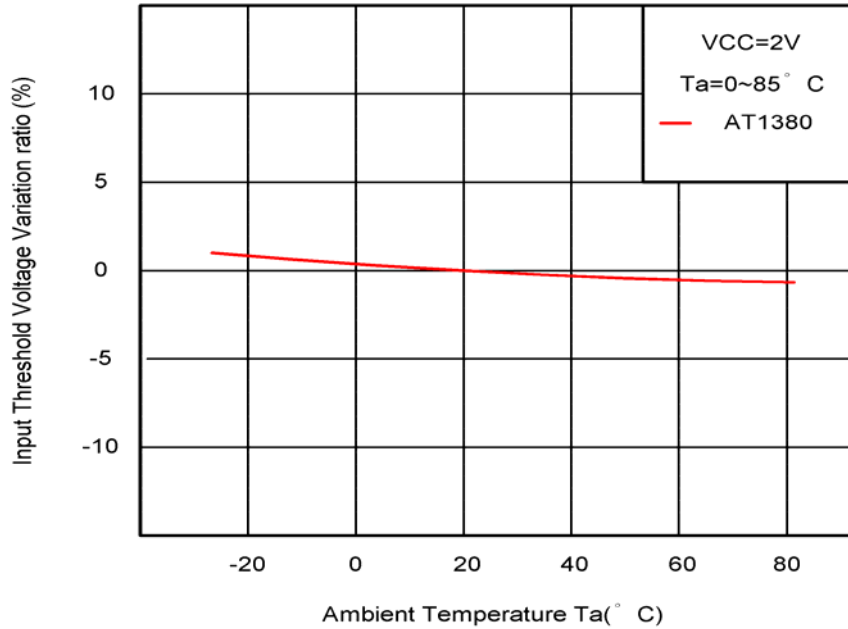
Supply Voltage vs. Supply Current



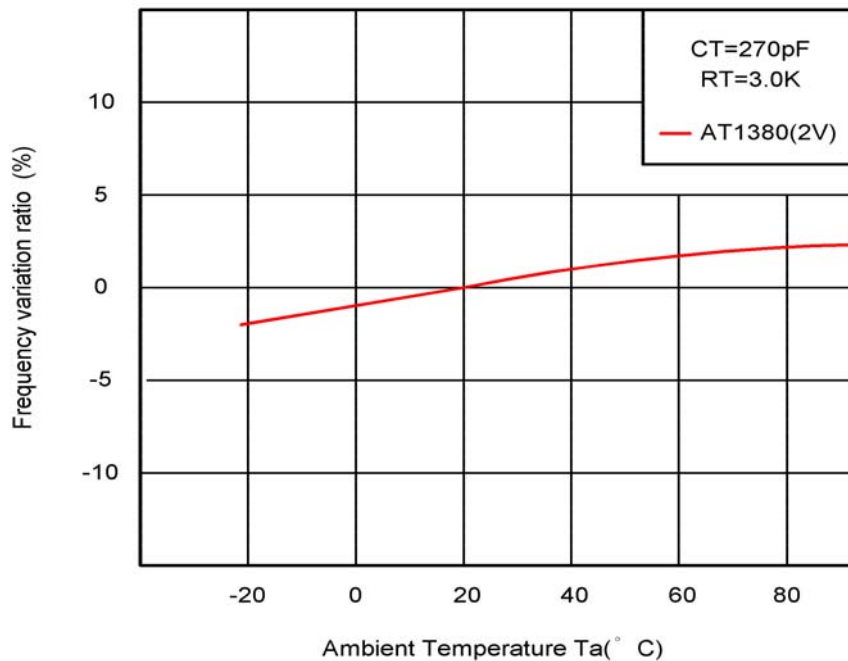
Supply Voltage vs. Input Threshold voltage



Ambient Temperature vs. Input Threshold Voltage Variation ratio

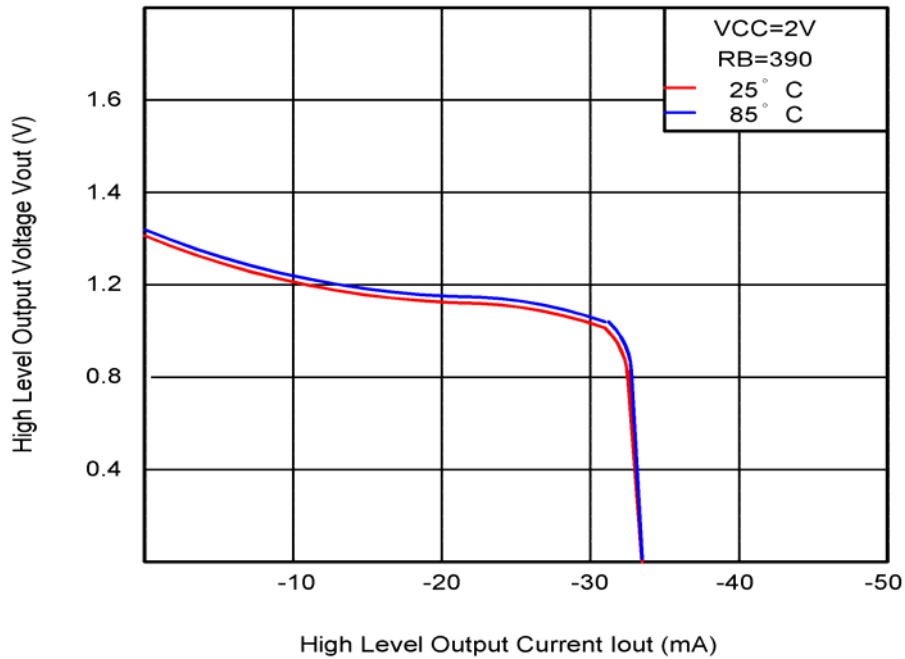


Ambient Temperature vs. Frequency variation ratio

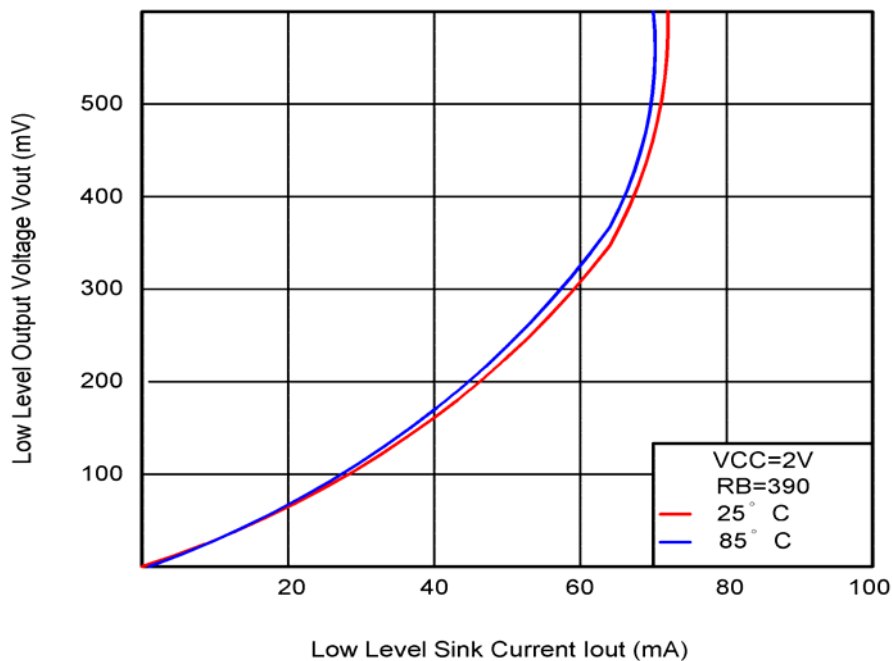


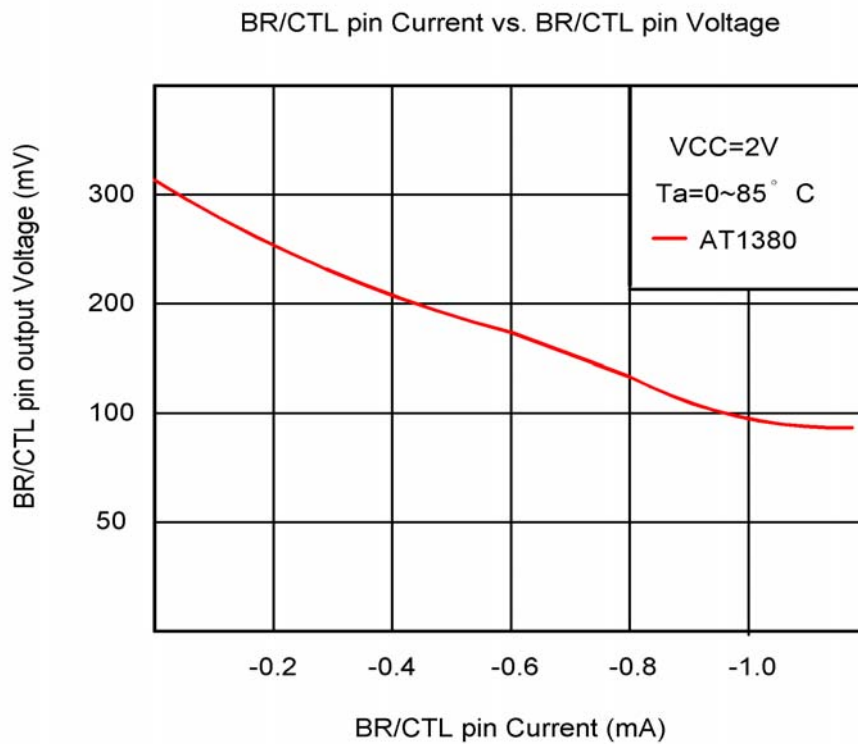
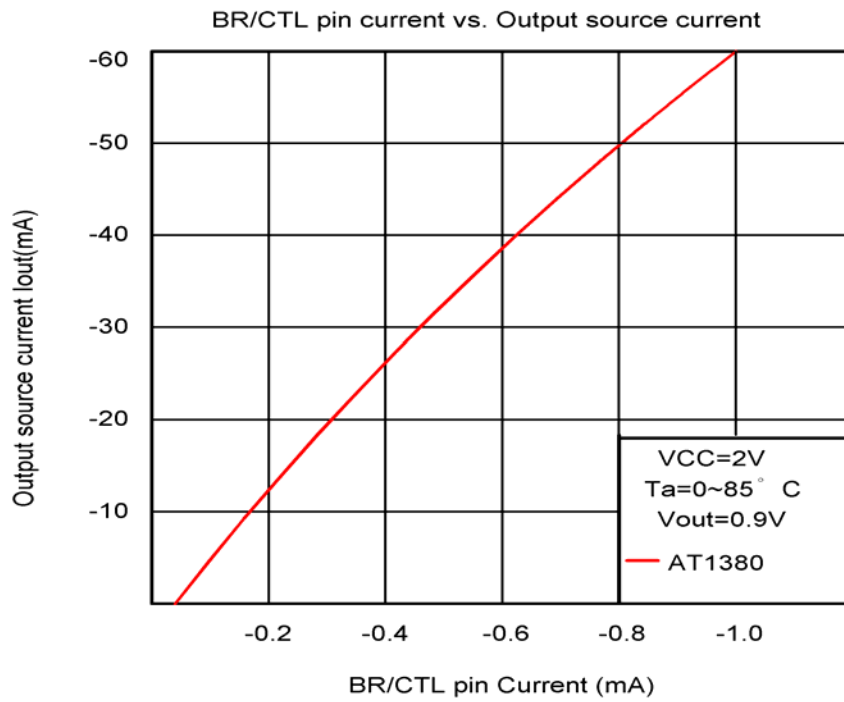


High Level Output Characteristic

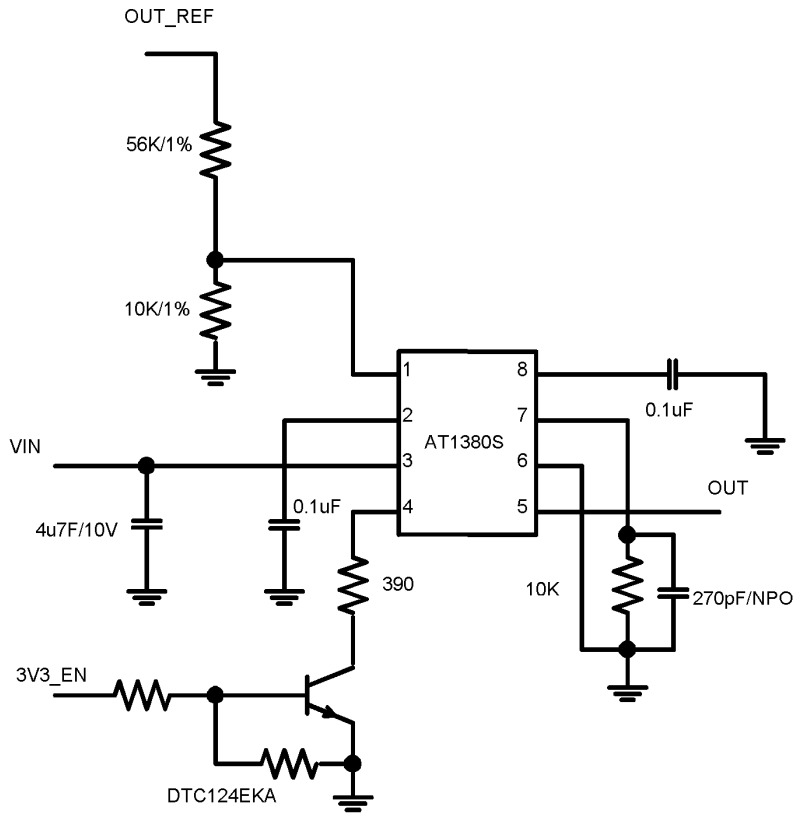


Low Level Output Characteristic

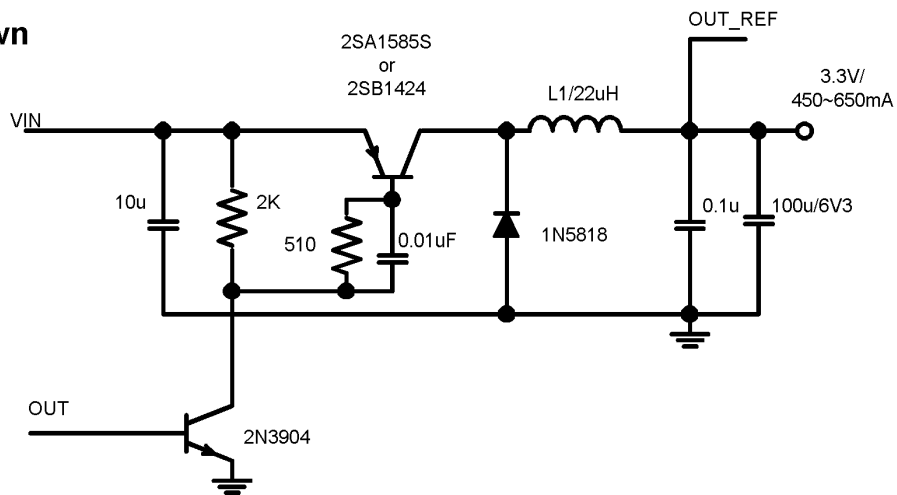


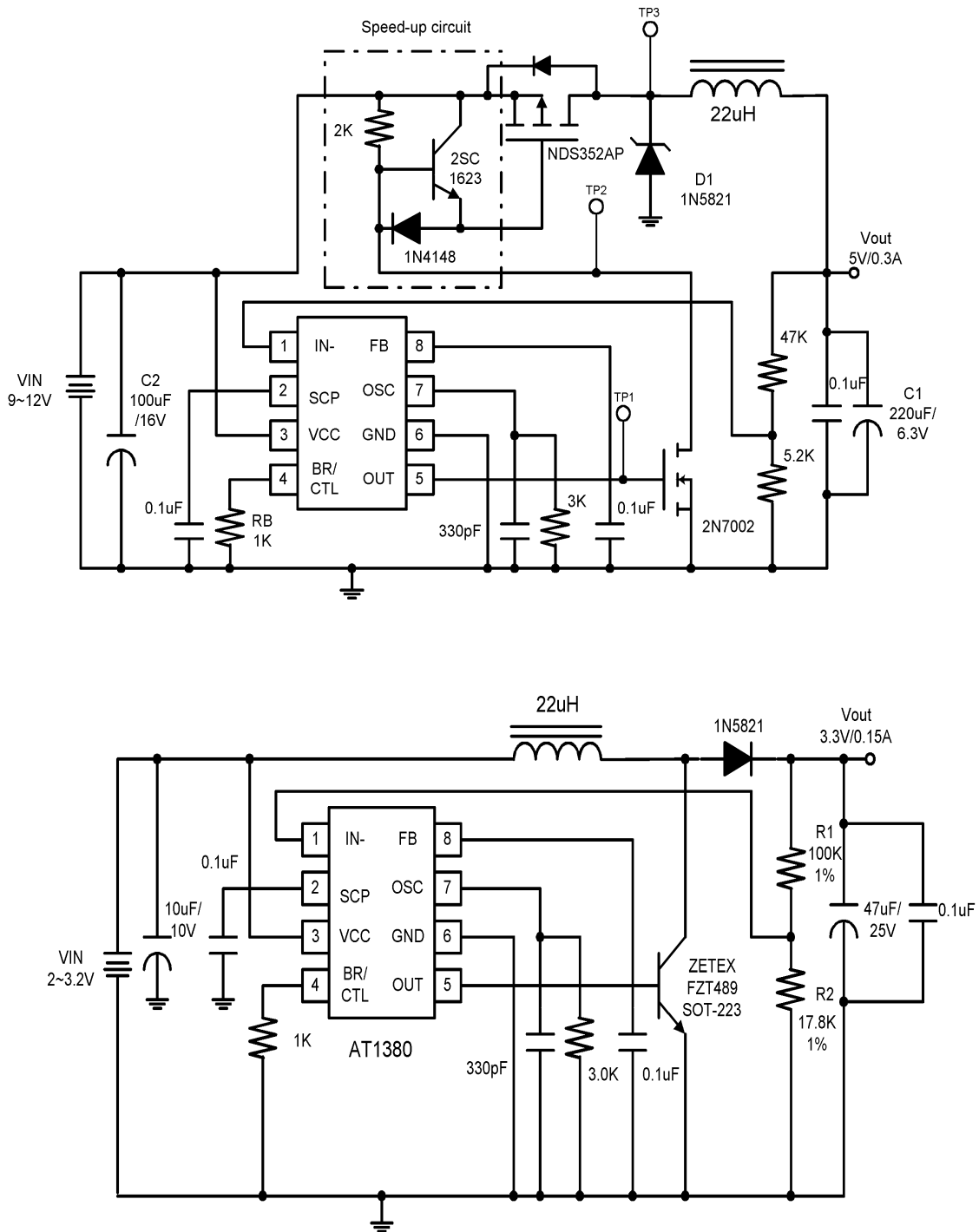


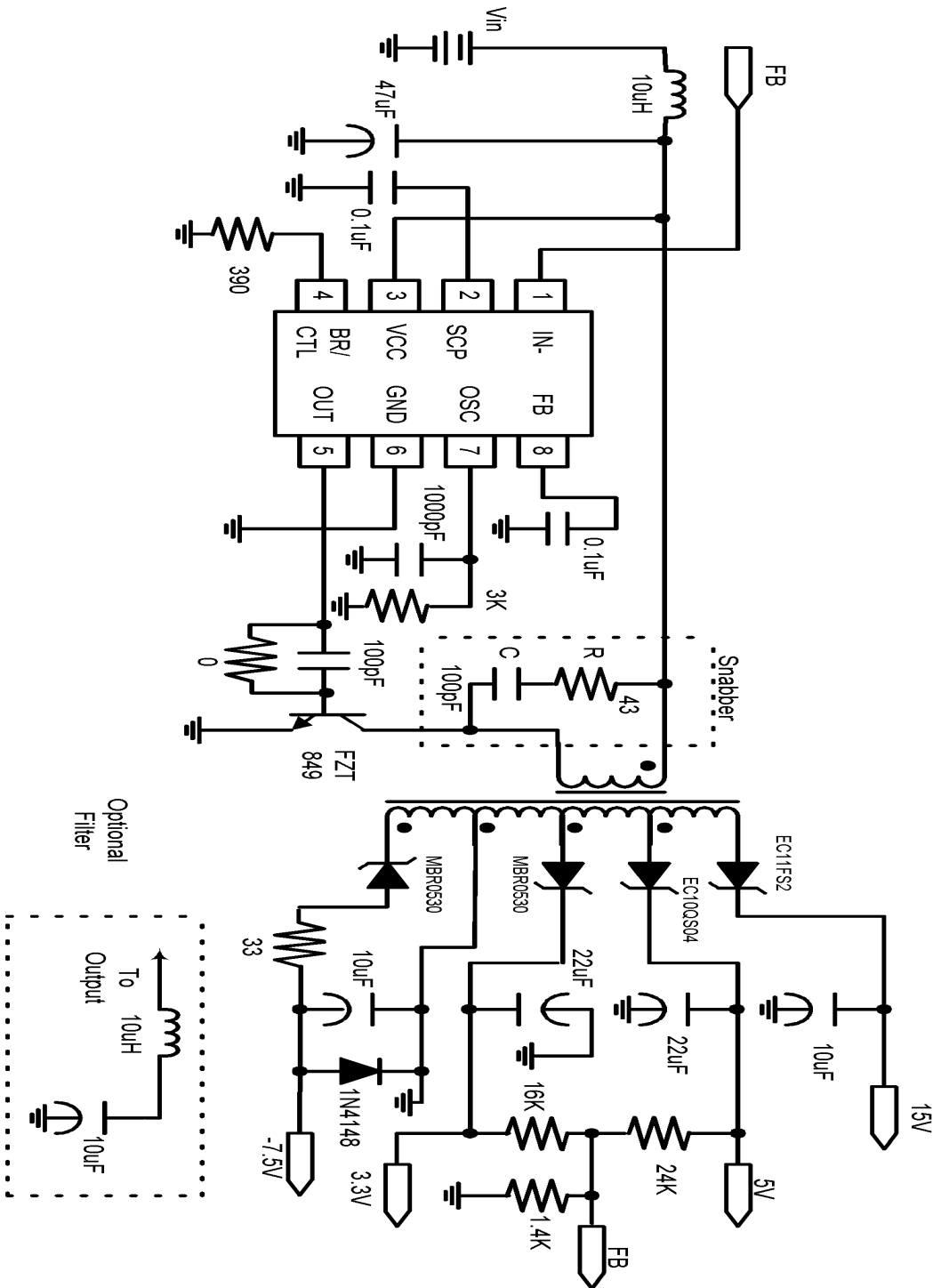
**Typical Application Schematic**

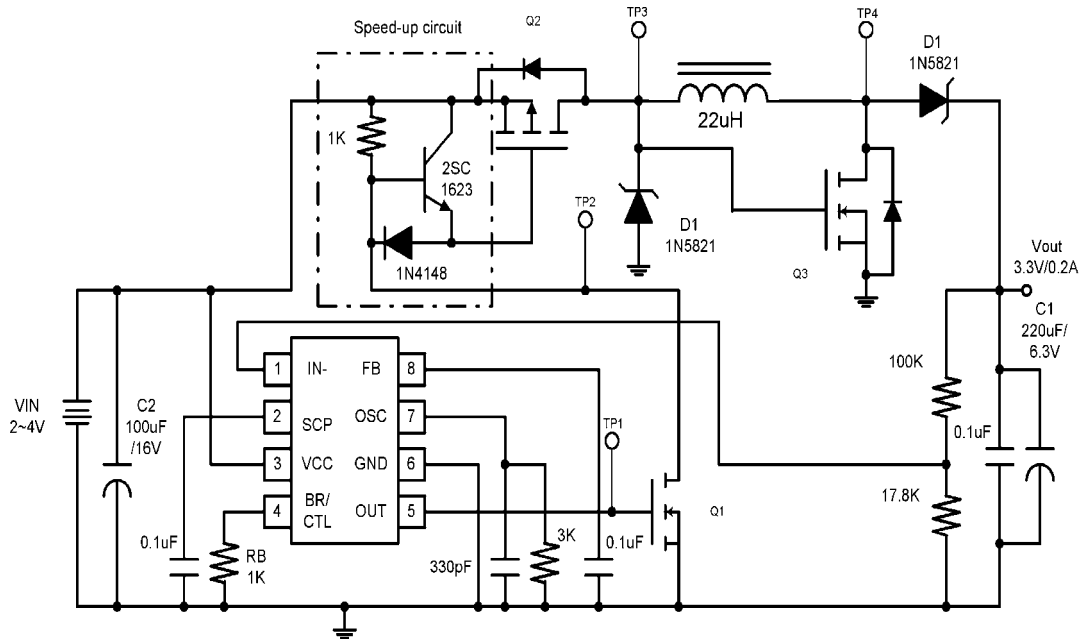


**STEP-Down**

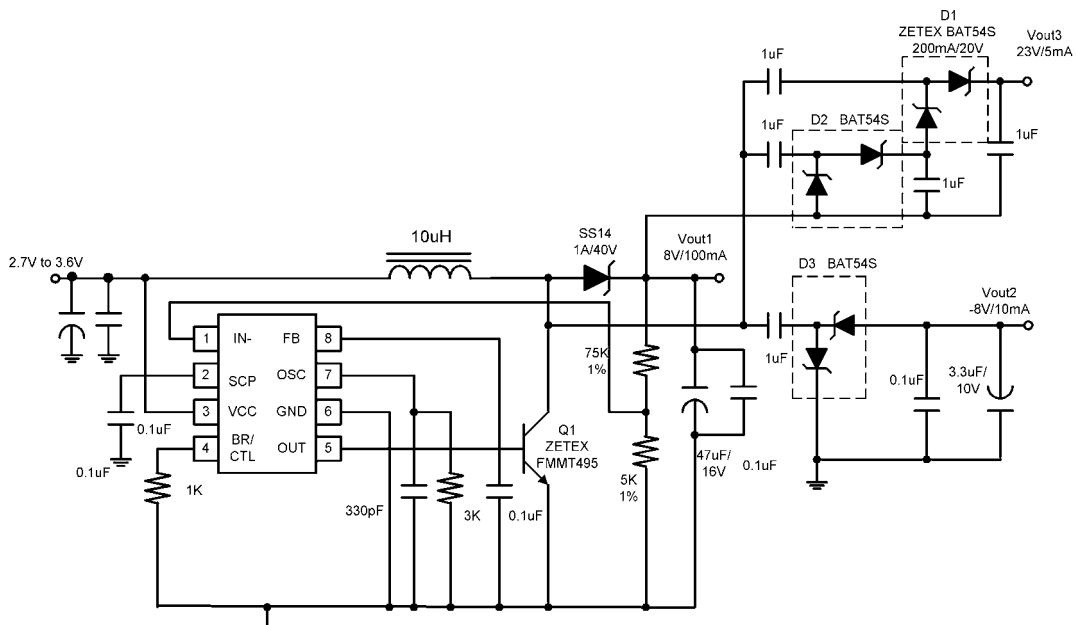








\*Q1,Q2,Q3 Low VT MOSFET  
or use Transistor NPN & PNP



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

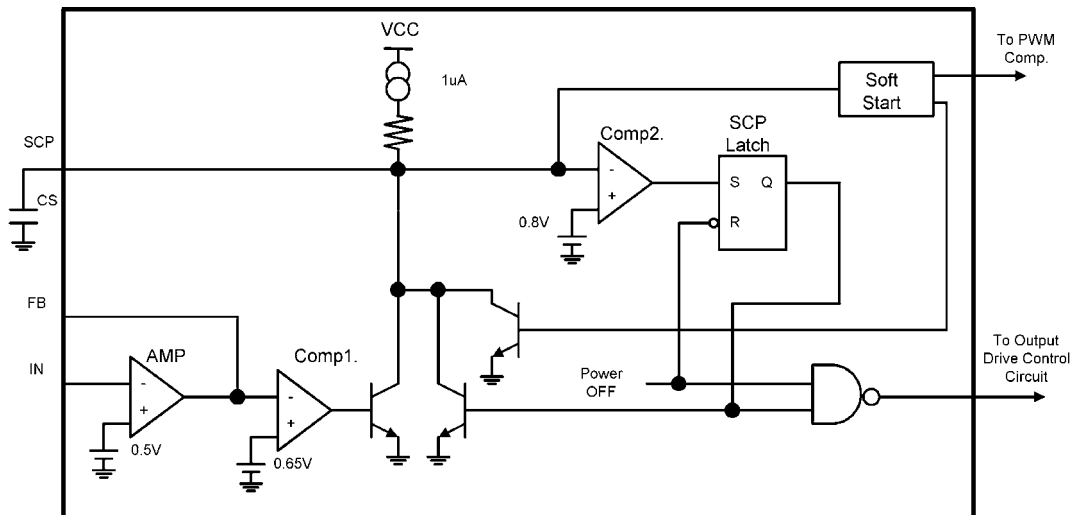


Figure 1. Soft-Start SCP circuit

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

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

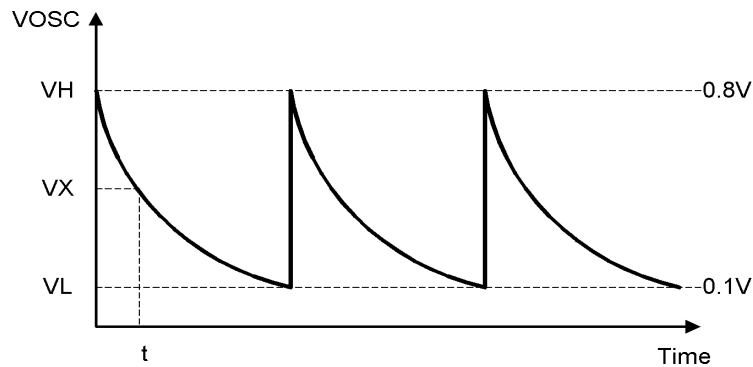
When  $V_{SCP}$  reaches 0.8V, the AT1380 leaves the soft-start mode to enter the normal mode and enable the SCP function. If the output load conditions change rapidly causing the output to drop suddenly, the external capacitor CS will start to charge because the error amplifier output (FB pin) is fixed 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:

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

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

### 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**

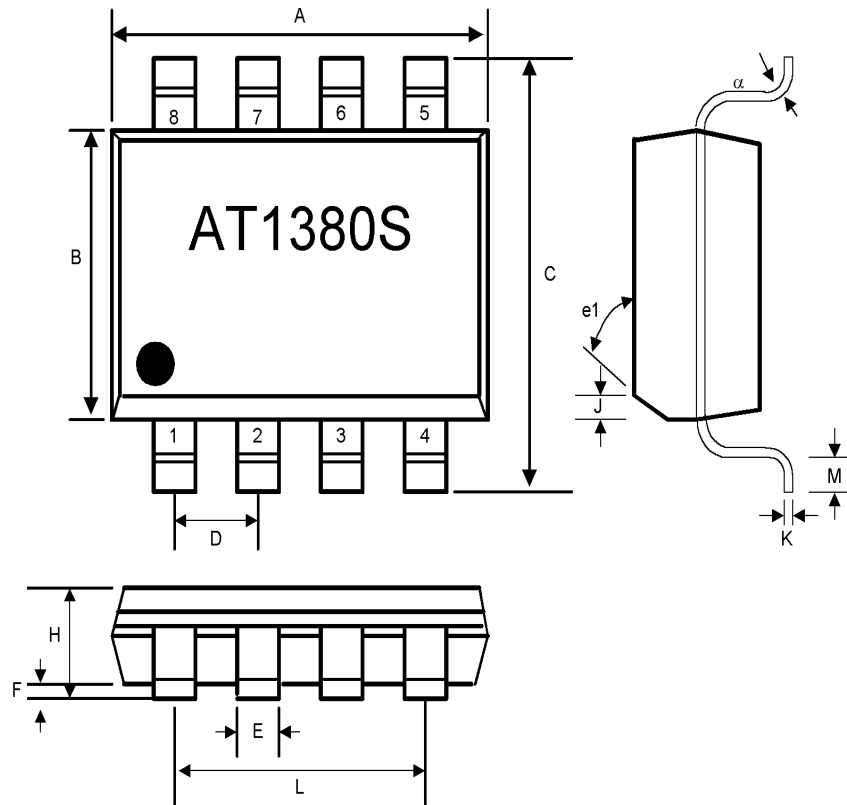
The output circuit can drive an external NPN transistor directly and has a totem pole configuration. The value of the ON/OFF current can be set by a resistor connected to the BR/CTL pin (pin 4). Stand-by mode (supply current 1 $\mu$ A or less) can be set by connecting the BR/CTL pin (pin4) to VCC or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

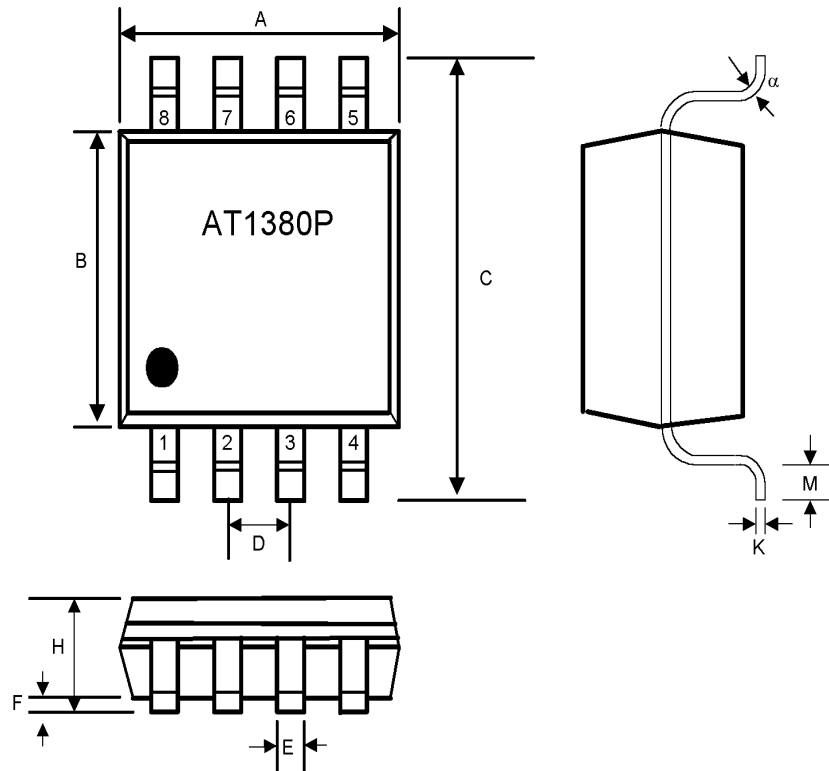
To cancel the status, set  $V_{CC}$  below the reset voltage  $V_R$  (0.9V) and then set  $V_{CC}$  up to the recommended operation range and the latch will be restored to operate normally.

**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°	-

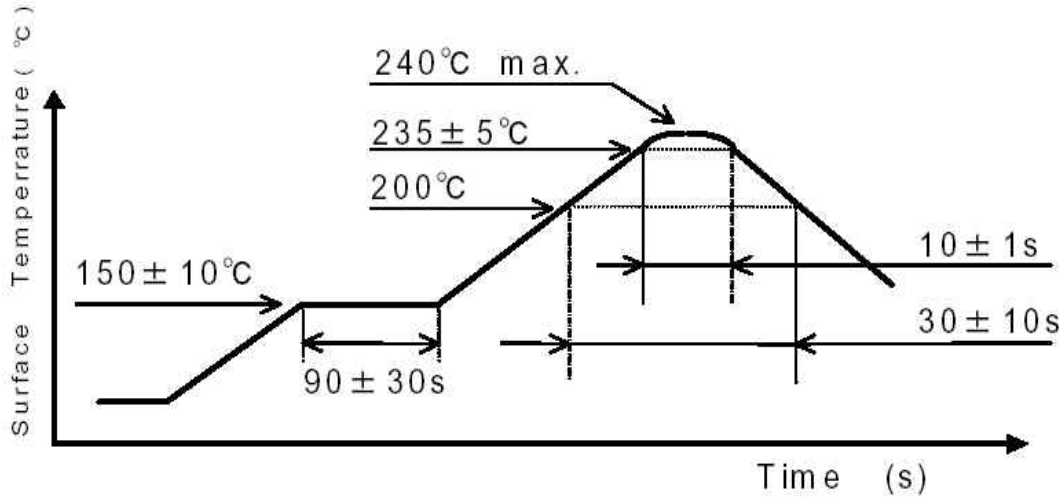
**Small Outline 8-pin TSSOP**



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	-
$\alpha$	0°	8°	0°	8°	-

**Reflow Condition**

**1. Infrared-Ray Reflow**



**2. Infrared-Ray Reflow (Pb-free)**

