Features

•2.5 to 15 V supply voltage operating range.
•Low current consumption: 6 mA in operation,
  1 µA 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 short circuit detection and
protection circuit (SCP).

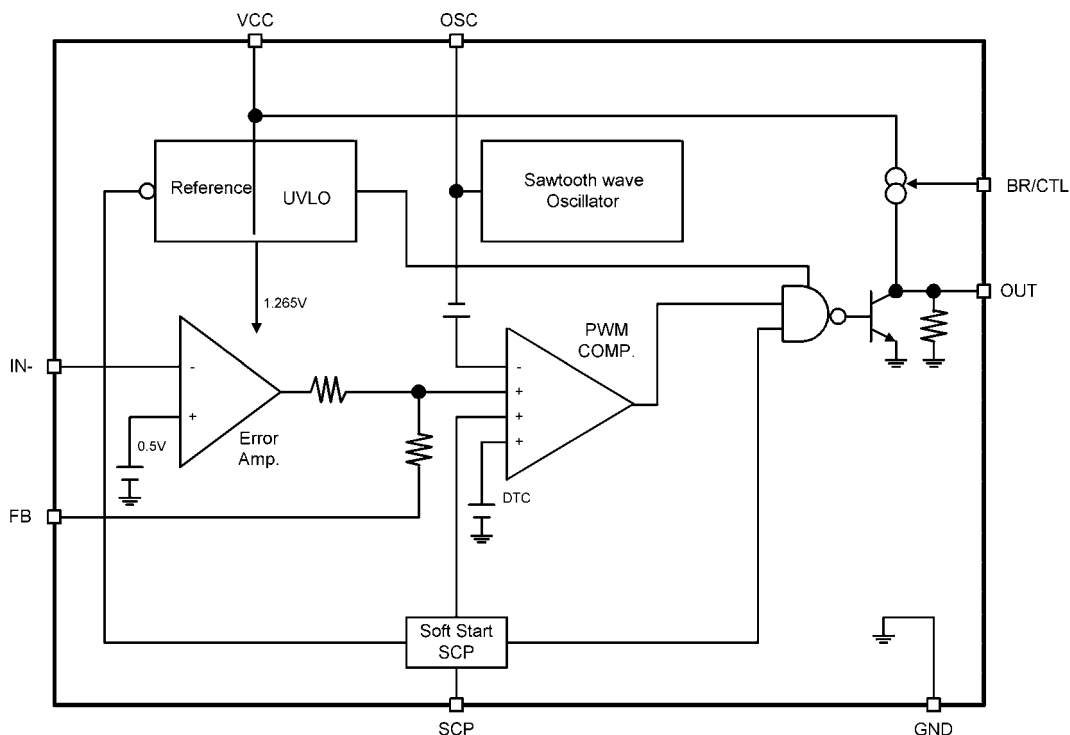## Applications

• LCD Displays
• PDAs
• Digital Still Cameras

General Description

The AT1380A 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 SCP
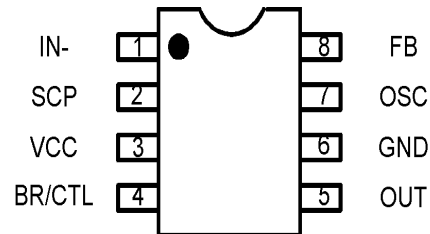pin. The AT1380A is ideal for up, down and fly-
back conversion.

Block Diagram

Pin Configuration

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IN-    ┌─1─●    8─┐    FB
SCP    ┌─2      7─┐    OSC
VCC    ┌─3      6─┐    GND
BR/CTL ┌─4      5─┐    OUT
```

Ordering Information

Part number	Package	Remarks
AT1380A	8-pin Plastic SOP	AT1380AS
AT1380A	8-pin TSSOP	AT1380AP

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
5	OUT	O	Totem-pole type output
6	GND	—	Ground
7	OSC	—	Capacitor and resistor connection pin for setting the oscillation frequency
8	FB	O	Error amplifier output

Absolute Maximum Ratings

$(T_a=+25^0C)$

Parameter	Symbol	Condition	Rated Value		Unit
			Min.	Max.	
Power supply voltage	V_{CC}	—	—	15	V
Output source current	I_O^+	—	—	-50	mA
Output sink current	I_O^-	—	—	50	mA
Allowable dissipation	P_D	SOP-8, Ta $\leqq$+25°C	—	570	mW
	P_D	TSSOP-8, Ta $\leqq$+25°C	—	430	mW
Operating temperature	T_{OP}	—	-30	+85	^0C
Storage temperature	T_{stg}	—	-55	+125	^0C
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

$(Ta=+25^0C)$

Parameter	Symbol	Values			Unit
		Min.	Typ.	Max.	
Power supply voltage	V_{CC}	2.5	--	13.5	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^+	-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	$k\Omega$
Timing capacitance	C_T	100	270	10000	pF
Oscillation frequency	f_{OSC}	10	500	1000	kHz
Operating temperature	T_{OP}	-30	+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.
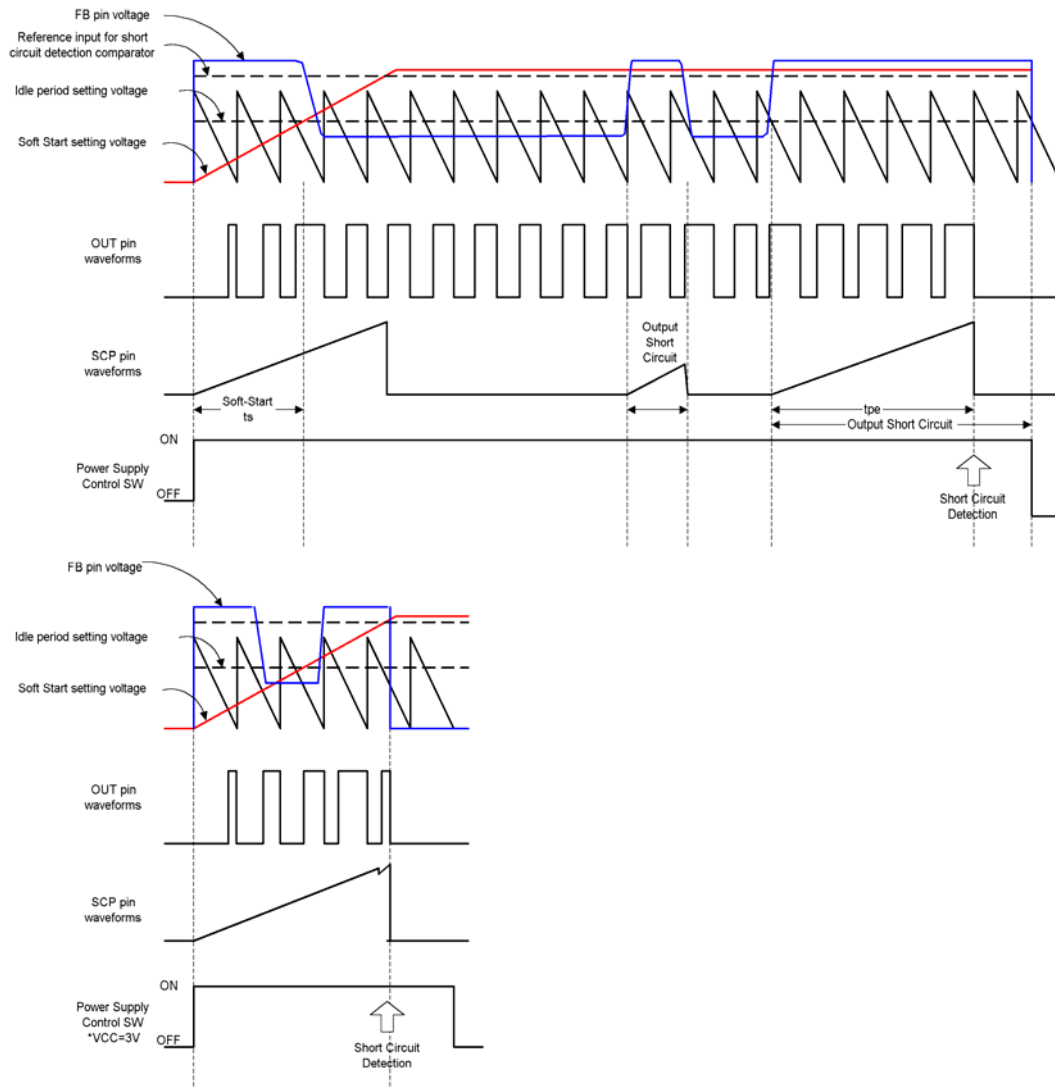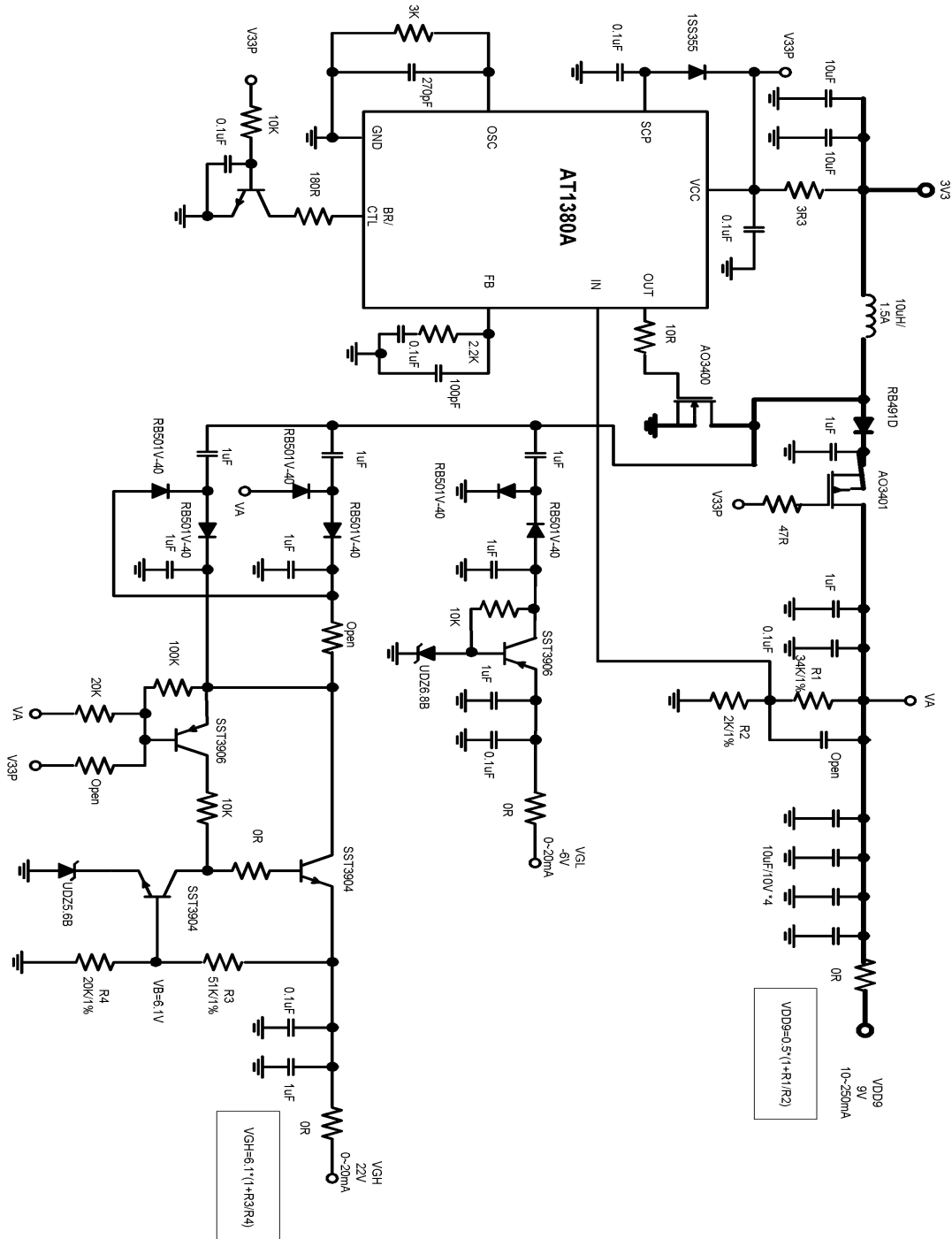
Electrical Characteristics

$(V_{CC}=+3.0V, Ta=+25^0C)$

Parameter		Symbol	Condition	Values			Unit
				Min.	Typ.	Max.	
VCC Under voltage Lockout (U.V.L.O.)	Reset voltage for falling Vcc. OUT remains off if Vcc is below this level.	V_R	--	--	1.8	1.9	V
	Startup voltage for rising Vcc.	V_{TH}		2.4	2.5	2.6	V
Soft start	Charging current	I_{CS}	$V_{SCP}=0V$	-1.5	-1.0	-0.7	μA
	Voltage at soft start completion	V_{ts}	--	0.7	0.8	0.9	V
Short circuit detection (S.C.P.)	Charging current	I_{CPC}	$V_{SCP}=0V$	-1.5	-1.0	-0.7	μA
	Threshold voltage	V_{tPC}	--	0.7	0.8	0.9	V
Sawtooth waveform oscillator (OSC)	Oscillation frequency	f_{OSC}	$R_T=3k\Omega$, $C_T=270pF$	400	500	600	kHz
	Frequency input Stability	$f_{\Delta V}$	$V_{CC}=2.5V$ to 13.5V	--	2	10	%
	Frequency variation with temperature	$f_{\Delta T}$	Ta =-30^0C to 85^0C	--	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 13.5V	--	5	20	mV
	V_T variation with Temperature	$V_{T\Delta T}$	Ta = -30^0C to 85^0C	--	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_{OM}^+	--	0.78	0.87	--	V
		V_{OM}^-		--	0.05	0.2	V
	Output source current	I_{OM}^+	$V_{FB} = 450mV$	--	-40	-24	μA
	Output sink current	I_{OM}^-		24	40	--	μA
Idle period adjustment section	Maximum duty cycle	T_{DUTY}	$R_T=3.3k\Omega$, $C_T=270pF$ $f_{OSC} = 500KHz$	75	--	85	%
Output section	Output voltage	V_{OH1}	$R_B= 390\Omega$, $I_O= -15$ mA	1.0	1.2	--	V
		V_{OH2}	$R_B= 750\Omega$, $V_{CC} = 3.0V$ $I_O= -10$ mA	0.8	1.0	--	V
		V_{OL1}	$R_B= 390\Omega$, $I_O= -15$ mA	--	0.1	0.2	V
		V_{OL2}	$R_B= 750\Omega$, $V_{CC} = 3.0V$ $I_O= -10$ mA	--	0.1	0.2	V
	Output source current	I_O^+	$R_B= 390\Omega$, $V_O = 0.9V$	--	-40	-30	mA
	Output sink current	I_O^-	$R_B= 390\Omega$, $V_O = 0.3V$	40	70	--	mA
	Pull down resistance	R_O	--	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	μA
	Input on condition	I_{ON}		--	--	-45	μA
	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	μA
	Average supply current	I_{CC}	$R_B = 390$, $V_{CC} = 2.5 \sim 13.5V$	--	6	10.0	mA

Timing Chart

Typical Application Schematic

Functional Description
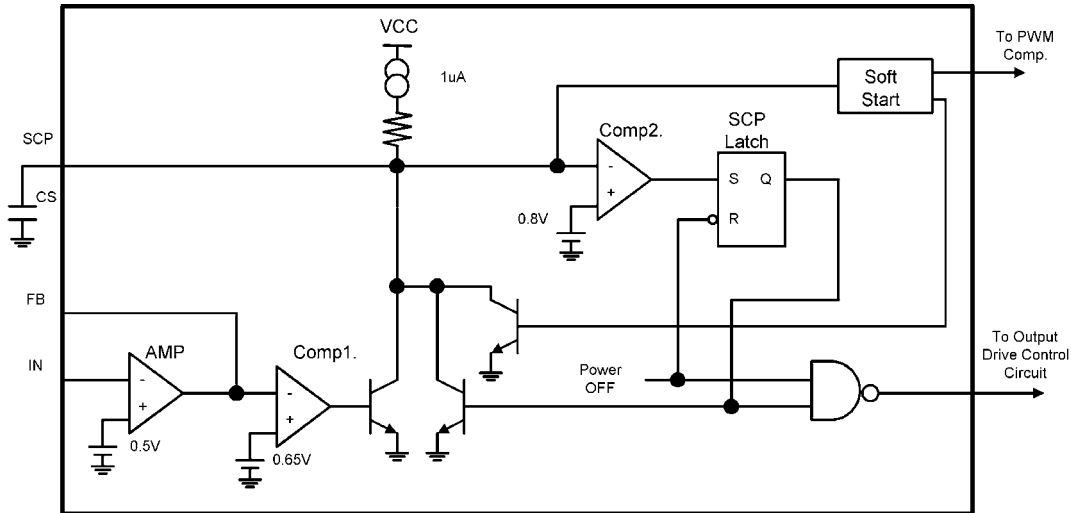
Soft Start SCP

Figure 1. Soft-Start SCP circuit

At power-on, the AT1380A 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 to reach 50%

$$t_S = 0.35 \times CS(\mu F)$$

When V_{SCP} reaches 0.8V, the AT1380A 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_{OM+}. 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.
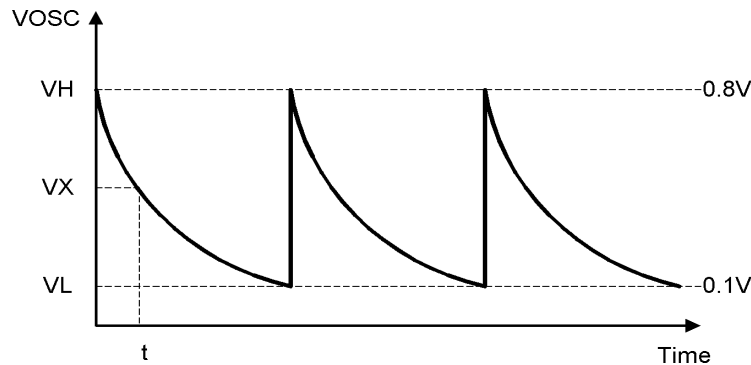
Short-circuit detection time (or full soft-start time) :

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

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:

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

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

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.
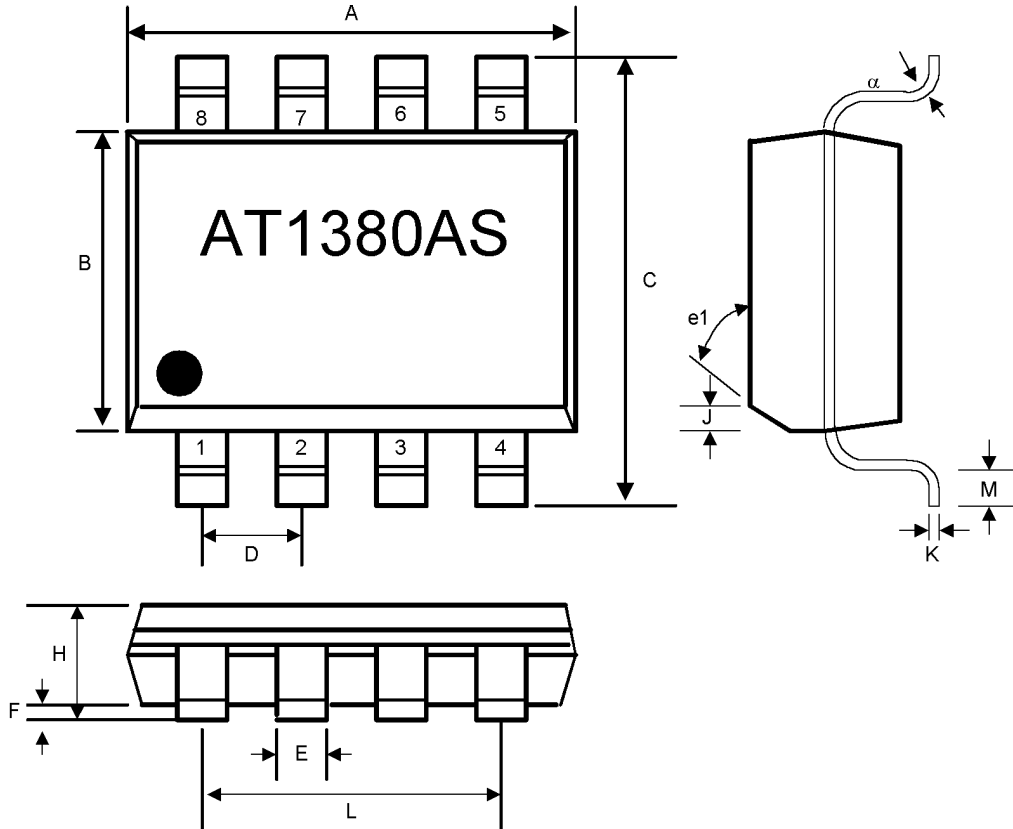
(4) Output circuit

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

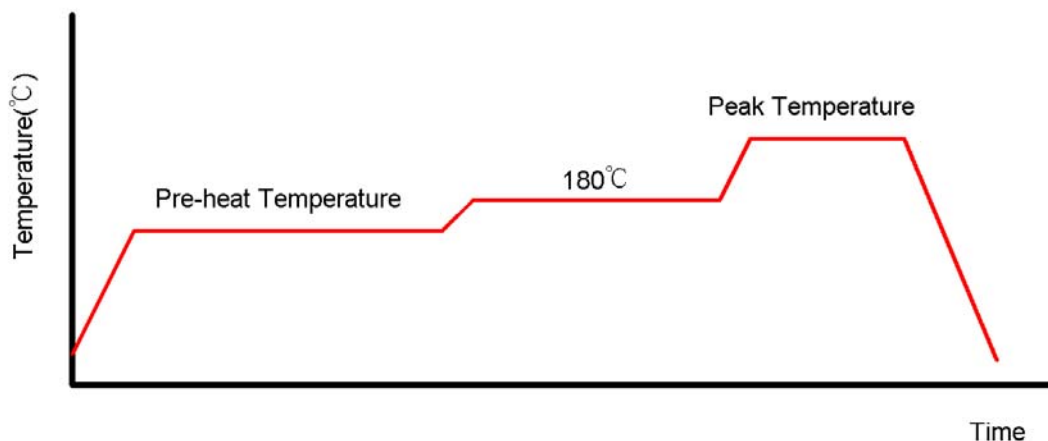
SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
A	0.188	0.197	4.80	5.00	-
B	0.149	0.158	3.80	4.00	-
C	0.228	0.244	5.80	6.20	-
D	0.050	BSC	1.27	BSC	-
E	0.013	0.020	0.33	0.51	-
F	0.004	0.010	0.10	0.25	-
H	0.053	0.069	1.35	1.75	-
J	0.011	0.019	0.28	0.48	
K	0.007	0.010	0.19	0.25	-
M	0.016	0.050	0.40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

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	0^0	8^0	0^0	8^0	-

Reflow Condition (IR/Convection or VPR Reflow)

Reference JEDEC Standard J-STD-020A

Classification Reflow Profiles

	Convection or IR/Convction	VPR
Average Heating Rate(180℃ to peak)	5°C/second max.	10°C/second max.
Preheat Temperature(125±20℃)	120 seconds max.	
Temperature maintained above 180℃	10~150 seconds	
Time within 5°C of actual Peak Temperature	10~20 seconds	60 seconds
Peak Temperature Range(Note 1)	219~225°C or 235~240°C	219~225°C or 235~240°C
Cooling Rate	6°C /second max.	10°C/second max.
Time 25°C to Peak Temperature	6 minutes max.	

*1 The maximum peak temperatures for IR and VP reflow are depending on package dimensions.

Package Reflow Conditions

Pkg. Thickness ≥2.5mm and all bags	Pkg. Thickness <2.5mm and Pkg. Volume ≥350 mm^3	Pkg. Thickness <2.5mm and Pkg. Volume <350 mm^3
Convection 219~225℃		Convection 235~240℃
VPR 219~225℃		VPR 235~240℃
IR/Convection 219~225℃		IR/Convection 235~240℃