General Description

SDC11170 is a single-phase full-wave driver for fan motor. It features a variable speed control method using both PWM input and thermistor and a high-efficiency driver architecture. An external filter is introduced to reduce the vibration and acoustic noise. SDC11170 is ideal for a quiet and high-efficiency cooler fan.

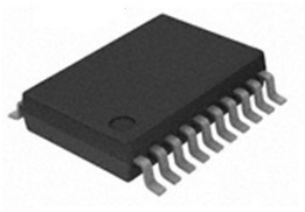
Applications

- CPU cooler fan motor

Features

- Single-phase full-wave drive(18V~1.2A output transistor incorporated)
- Triangular wave oscillation voltage and minimum speed settable
- 6V , Hall bias and FG output
- Kick-back absorption circuit incorporated
- Ineffective current reduced during phase shift
- Regeneration diodes incorporated with less external parts

Pin Configuration



SSOP-20

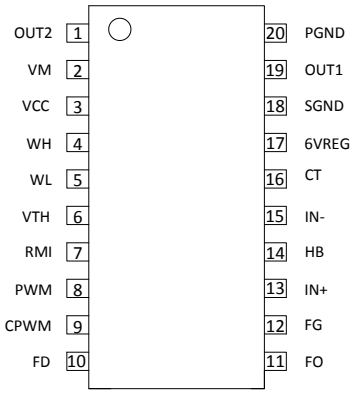


Figure 1. Pin Configuration

Pin Number	Pin Name	Function
1	OUT2	Output 2
2	VM	Motor power
3	VCC	Chip power
4	WH	Triangular wave oscillation upper voltage
5	WL	Triangular wave oscillation lower voltage
6	VTH	Thermistor input
7	RMI	Minimum pulse width setting
8	PWM	PWM input
9	CPWM	Triangular wave oscillation capacitor
10	FD	External filter driver

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Pin Number	Pin Name	Function
11	FO	External filter output
12	FG	Frequency generation
13	IN+	Positive hall signal
14	HB	Hall bias
15	IN-	Negative hall signal
16	CT	Lock detection capacitor
17	6VREG	6V regulator output
18	S-GND	Signal GND
19	OUT1	Output 1
20	P-GND	Power GND

Table 1. Pin Description

Functional Block Diagram

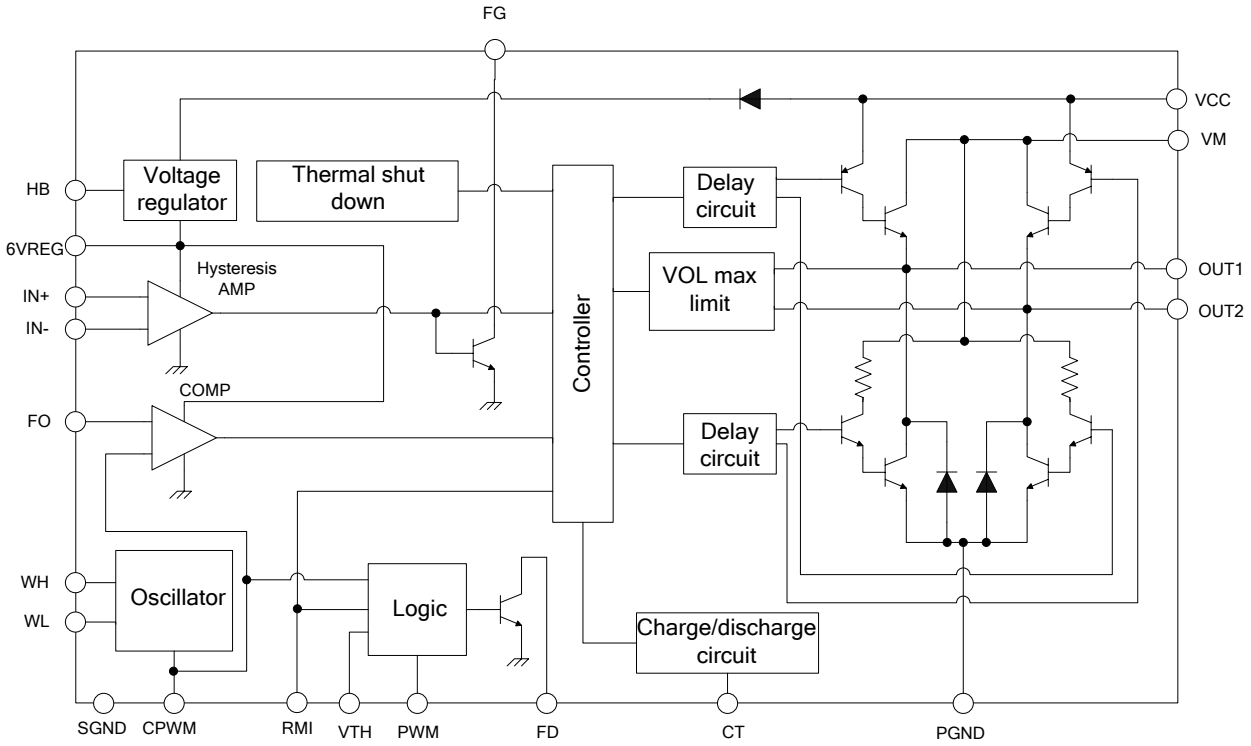

Figure 2. Functional Block Diagram

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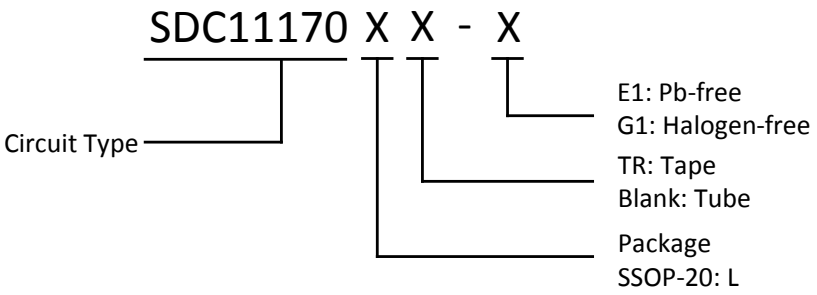
Ordering Information



Package	Temperature Range	Part Number		Marking ID		Packing Type
		Pb-free	Halogen-free	Pb-free	Halogen-free	
SSOP-20	-30°C~95°C	SDC11170LTR-E1	SDC11170LTR-G1	SDC11170	SDC11170-G	Tape
		SDC11170L-E1	SDC11170L-G1	SDC11170	SDC11170-G	Tube

Absolute Maximum Ratings (Note: Stresses greater than those listed under Absolute Maximum Ratings may cause permanent damage to the device.)

Parameter	Symbol	Conditions	Min	Max	Unit
VCC maximum supply voltage	V_{CCMAX}	-	-	17	V
VM maximum supply voltage	V_{MMAX}	-	-	V_{CC}	V
OUT pin maximum output current	I_{OUTMAX}	-	-	1.2	A
OUT pin maximum withstand voltage	V_{OUTMAX}	-	-	18	V
PGND to SGND voltage		-	-0.3	0.3	V
HB pin maximum output current	I_{HBMAX}	-	-	10	mA
VTH, RMI, PWM, FO pin withstand voltage	V_{THMAX}	-	-	7.0	V
FG pin withstand voltage	V_{FGMAX}	-	-	18	V
6VREG pin output source current	$I_{6VREGMAX}$	-	-	10	mA
FG output current	I_{FGMAX}	-	-	10	mA
Allowable power dissipation	Pd_{MAX}	-	-	0.8	W
Operating temperature range	T_{OPR}	-	-30	95	°C
Storage temperature range	T_{STG}	-	-55	150	°C

Table 2. Absolute Maximum Ratings

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Recommend Operating Conditions

Parameter	Symbol	Conditions	Min	Max	Unit
VCC supply voltage	V_{CC}	-	4.5	16	V
VM supply voltage	V_M	-	3.5	V_{CC}	V
VTH、RMI、PWM、FO input voltage range	V_{TH}	-	0	6.0	V
Triangular wave input range	V_{CPWM}	-	0.5	4.0	V
HALL input common-phase input voltage range	V_{ICM}	-	0.2	3.0	V

Table 3. Commended Operating Conditions

Electrical Characteristics (Ta=25°C, V_{CC}=12V, unless otherwise specified)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Supply current	I_{CC1}	During drive	17	20	23	mA
	I_{CC2}	During lock protection	-	7	10	mA
HB voltage	V_{HB}	I_{HB}=-5mA	1.1	1.25	1.4	V
6V voltage	$6V_{REG}$	I_{6VREG}=-5mA	5.8	6	6.2	V
CT pin high level voltage	V_{CTH}	-	3.4	3.6	3.8	V
CT pin low level voltage	V_{CTL}	-	1.4	1.6	1.8	V
CT pin charge current	I_{CT1}	-	1.8	2.2	2.6	uA
CT pin discharge current	I_{CT2}	-	0.18	0.22	0.26	uA
CT charge/discharge current ratio	R_{CT}	$R_{CD}= I_{CT1}/ I_{CT2}$	8	10	12	-
OUT output L saturation voltage	V_{OL}	I_O=200mA	-	0.1	0.2	V
OUT output H saturation voltage	V_{OH}	I_O=200 mA, V_M=V_{CC}	-	0.6	0.8	V
Hall input sensitivity	V_{HN}	Including offset and hysteresis	-	±10	±20	mV
FG output pin L voltage	V_{FG}	I_{FG}=5mA	-	0.2	0.3	V
FG output pin leak current	I_{FGL}	V_{FG}=7V	-		30	uA
Over current protection voltage	V_{OLMAX}	-	-	1.5	-	V
Overheat protection temperature	T_{SD}	*Design guarantee value	-	170	-	°C

Table 4. Electrical Characteristics

Truth Table

PWM	VTH（RMI）	FD
H	L	L
H	H	OFF
L	X	OFF

VTH (RMI)-L: VTH<CPWM or RMI<CPWM

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CT	IN-	IN+	FO	OUT1	OUT2	FG	Mode
L	H	L	L	H	L	L	Running-drive
	L	H		L	H	OFF	
	H	L	H	OFF	L	L	Running-regeneration
	L	H		L	OFF	OFF	
H	H	L	X	H	OFF	L	Lock protection
	L	H		OFF	H	OFF	

FO-L: FO<CPWM ; FO-H: FO>CPWM

Table 5. Truth Table

Power Dissipation Curve

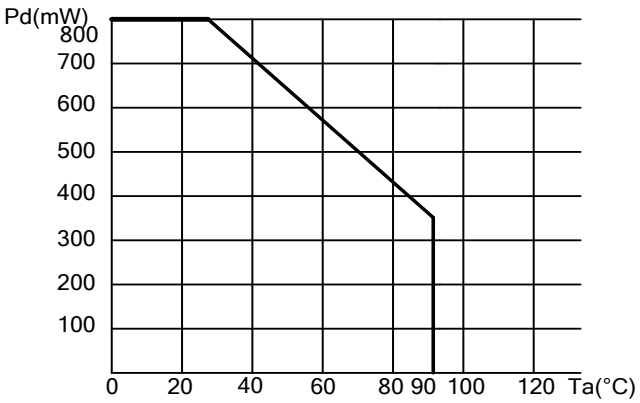

Figure 3. Power Dissipation Curve(SSOP-20)

Typical Application

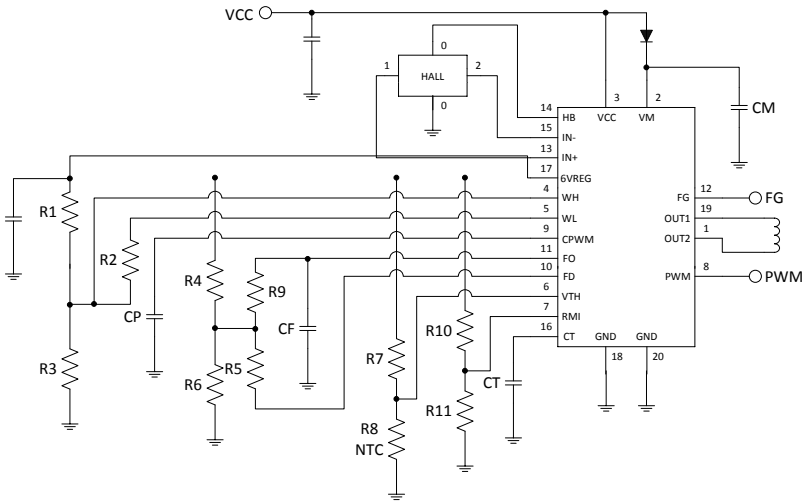

Figure 4. Typical Application

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Function Description

PWM and Thermistor Speed Control

For advanced CPU cooler fans, SDC11170 provides speed control by temperature and external PWM signal at the same time. Using the thermistor to determine VTH pin voltage by temperature and use RMI pin voltage to set minimum temperature for speed control. Set the L level of triangular wave to set maximum temperature and H level of triangular wave to set the minimum pulse width for temperature speed control. Internal circuit generates a pulse width signal by comparing VTH and RMI with triangular wave, and mixes it with external PWM signal at FD pin.

The RC filter transfers the mixed signal at FD pin to a dc voltage at FO pin. External resistors are used to define the voltage range of the FO pin. Since the final pulse width is obtained by comparing the voltage of FO with triangular wave, the voltage range of FO define the minimum pulse width at the output stage, and the frequency on the output stage is the same of the triangular wave.

To avoid nonlinearity in speed characteristics, the resistor in RC filter should have a much larger resistance than those defining the voltage range.

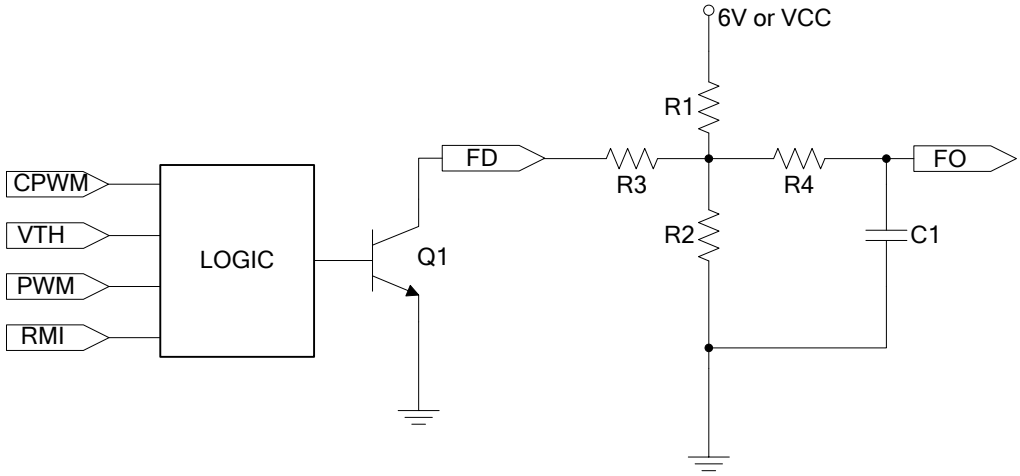

Figure 5.

The control method is filed under patent pending.

Driver Architecture

In prior art, a protection diode is introduced to prevents the damage from the power reverse connection. However, the protection diode will cause a voltage drop on the supply voltage. The voltage drop from power supply to output pin is the sum of V_F (Voltage drop of the protection diode), V_{PSAT} (saturation voltage of the PNP transistor driving the upper output transistor) and V_{BE} (of the upper output transistor), normally it is about 1.7V, and about $0.8V*I_{OUT}$ become the IC's power dissipation.

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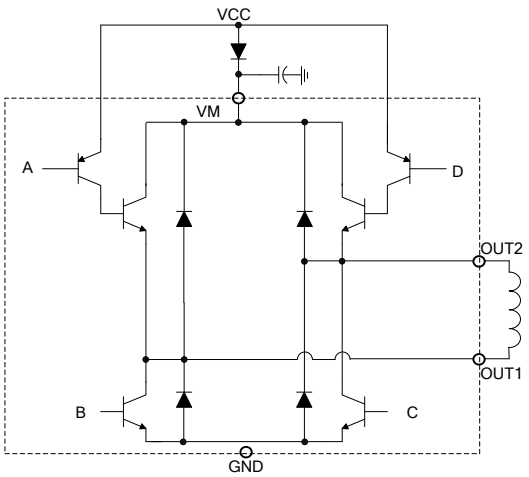

Figure 6.

SDC11170 adapt a new architecture, placing the protection diode between power supply and VM pin. With VCC directly connected to power supply, the voltage drop from power supply to output pin has been reduced to about 1.1V, and only 0.2V*I_{OUT} contribute to the IC's power dissipation. This innovation made a boost to the IC's continuous output current, without increasing the cost of the package.

This architecture is filed under patent pending.

Protections

Lock-shutdown and auto-restart use a capacitor connecting to CT pin to decide lock detection time and lock protection time. Charged by a 2.2uA current, the capacitor will try to reach the voltage of 3.6V and trigger lock-shutdown. However, a hall phase change will cause a complete discharge of the capacitor. In normal operation, the capacitor will be discharged frequently and the voltage of CT will not reach 1.6V.

If the fan is stopped by force, lock-shutdown will be triggered when the voltage of CT reaches 3.6V, shut the lower transistors down to prevent overheating. Then the capacitor will be discharged by a 0.22uA current, until the voltage of CT reaches 1.6V and enter restart mode.

During restart, if VM pin voltage is higher than 6V, the FD pin pulse width will be 0.5 times of the original pulse width in order to achieve a low temperature rise in lock condition (shown in the illustration below); if not, the pulse width will be normal.

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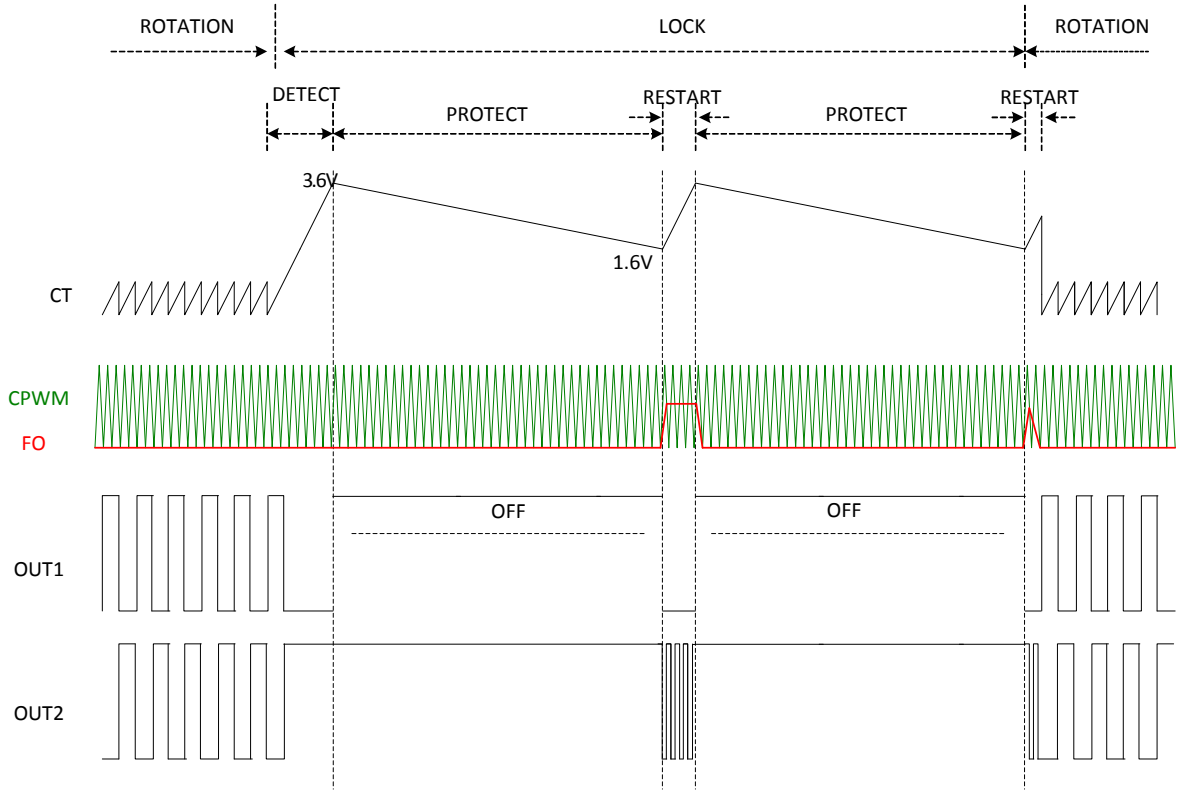

Figure 7.

Thermal-shutdown protection will shutdown the chip if the junction temperature reaches 170°C, it has about 30°C hysteresis, that is, when the junction temperature reduced to 140°C, the chip will operate again.

Over current protection (OCP) circuit will shutdown the upper transistor if the output L saturation voltage reaches 1.5V, this will only happen if the output current exceeds 1.2A. When this happens, the current in the coil will decrease, and the saturation voltage will drop. When the saturation voltage drops to 1V or below, the OCP circuit will release control and the output stage will go back to normal operation.

The OCP detecting circuitry is filed under patent pending.

Internal VCC protection diode was incorporated, if a -12V voltage is given to VCC, the reverse current is normally smaller than 10mA and will not cause damage to the chip. However, VM pin have direct connections to the collectors of NPN transistors, so it is recommended to use an external diode in order to achieve a full polarity protection.

Thermistor trip protection activates when the voltage of V_{TH} approach 6V or above, so it is suggested to use V_{CC} as the power supply of the external thermistor.

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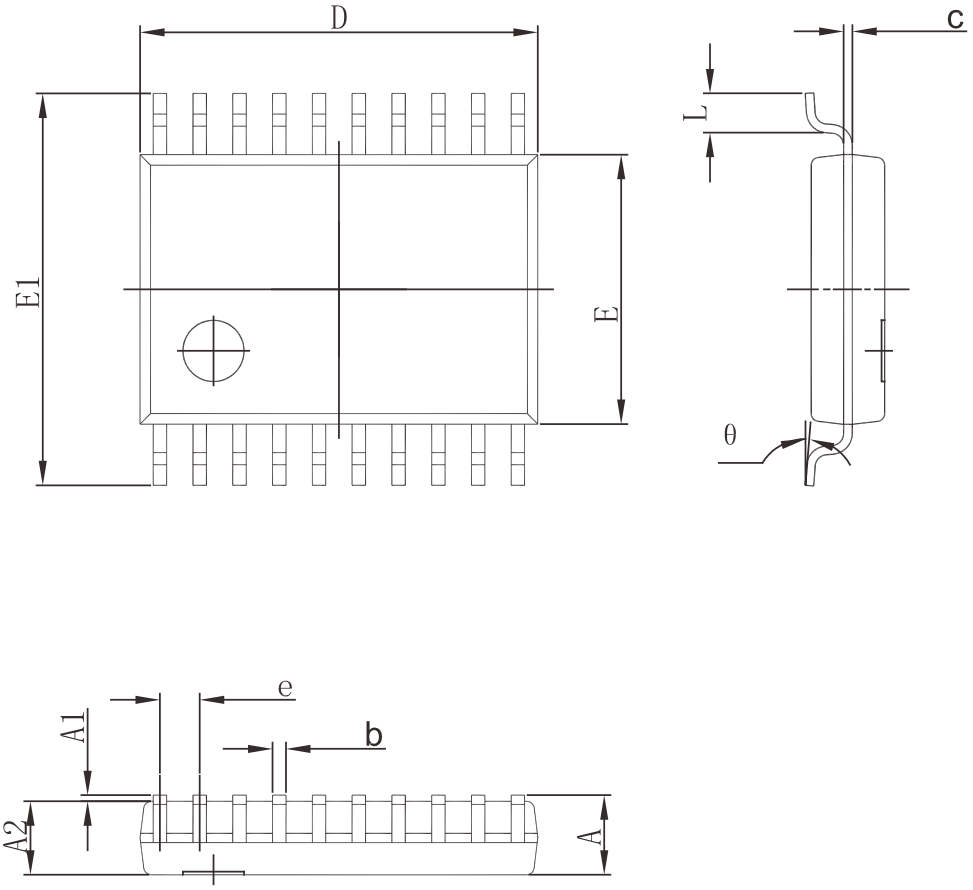
Package Dimension

SSOP-20



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	--	1.450	--	0.057
A1	0.050	0.200	0.002	0.008
A2	1.150	1.250	0.045	0.049
b	0.200	0.310	0.008	0.013
c	0.090	0.200	0.004	0.008
D	6.300	6.700	0.248	0.264
e	0.65(BSC)		0.026(BSC)	
E1	6.200	6.600	0.244	0.260
E	4.200	4.500	0.169	0.177
L	0.450	0.750	0.018	0.030
θ	0°	8°	0°	8°

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