■ General Description

OCH2992 is a fan motor driver for the single coil brushless DC motor. With its high efficient direct PWM control mode, OCH2992 controls the speed of brushless DC motor with an external hall switch IC. OCH2992 is suitable to drive variable speed motors for personal computer's power supply radiation fans and CPU coolers.

OCH2992 integrates PWM fan speed control, minimum speed mode, soft start, soft switch，fan tachometer, lock protection, auto restart and Hall IC power circuit. PWM mode controls fan speed in low noise and low vibration ways by adjusting PWM signal duty. OCH2992can set minimum fan speed by presetting MINSP voltage. With soft start function, OCH2992 can effectively reduce the peak current when power on. To reduce fan driver audible noise and power loss, theOCH2992 features a soft on/off phase transition and automatic phase-lock function of the motor winding BEMF and current.

Robust protections in OCH2992 include under-voltage lockout (UVLO), rotor deadlock protection, over current protection (OCP) and thermal shutdown.

The OCH2992 requires a minimal number of external components to save solution cost.TheOCH2992 is available in, SOP-8L-EP packages.

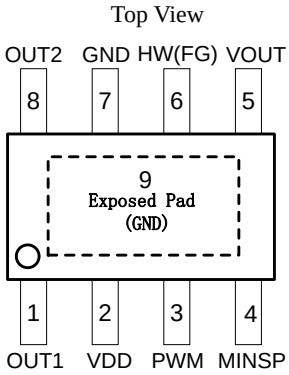
■ Features

- Supporting speed: Max. 15000 Rpm/Min.
- Wide Operating Input Voltage Range: 3.0V~16V
  Integrated Power MOSFETs: Total 350mΩ(High side + Low side)
- PWM Fan Speed Control
- Programmable Minimum Fan Speed
- MINSP Setting Minimum Fan Speed
- Soft Start And Soft Restart Function
- FG Output
- External Hall Switch
- Lock-shutdown protection & auto-restart function
- Automatic Phase Lock Detection of Winding BEMF and Current Zero-Crossing
- 10kHz to 60kHz PWM Input Frequency Range
- Fixed 26kHz Output Switching Frequency
- OCP (Over Current Protection)
- Current Limit
- Thermal Protection and Automatic Recovery
- Built-In Input UVLO
- -40°C to + 105 °C Temperature Range
- RoHS Compliant
- SOP-8L-EP packages

■ Applications

- Single Coil Brushless DC Motor
- Single Coil Brushless DC Fan

■ Pin Configuration



SOP-8L-EP

Figure 1, Pin Assignments Of OCH2992

Pin Name	Pin Number	Pin Function
OUT1	1	Output 1
VDD	2	Positive Power Supply
PWM	3	PWM Signal Input
MINSP	4	Input to set minimum speed or fan off range
VOUT	5	Regulator Output(Power supply for external HALL switch)
HW(FG)/SCL	6	Rotation Speed Detection(connect the external Hall Switch output)
GND	7	Ground
OUT2	8	Output 2
GND	Exposed pad	Ground

■ Typical Application Circuit

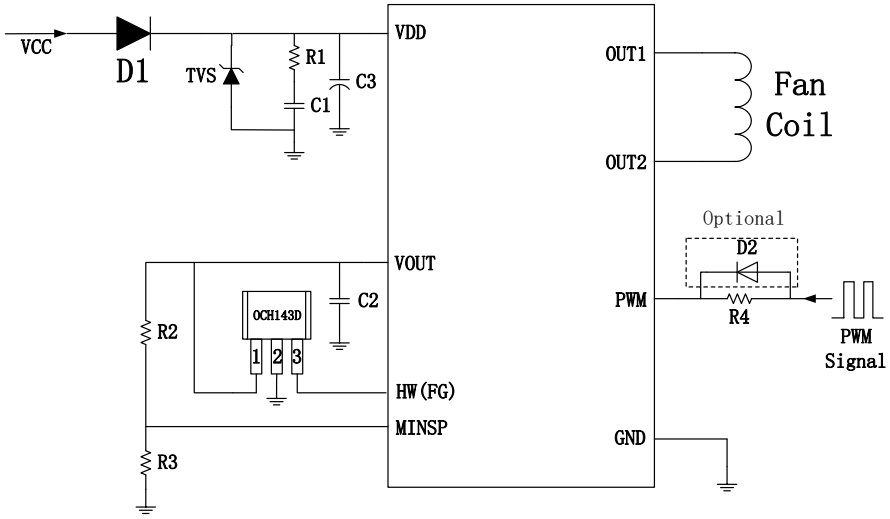


Figure 2, Typical Application Circuit Of OCH2992

Note1:

1) Must use least C1=4.7μF~10uF and R1=1Ω(Typ.)for the decoupling between VDD and GND and place the capacitor as close to the IC as Possible.
2) A TVS diode is needed in application，for a 12V case, an 15V/SOD-123package TVS diode is sufficient.
3) C2 is Optional, the typical value is 1uF.
4) C3 is Electrolytic Capacitor, the typical value is 10uF~47uF.
5) R2/R3 value decided the minimum output duty setting.
6) D2 is optional, the typical value R4 is 10kΩ，the D2 is used to prevent the negative voltage interference.

■ Ordering Information

Part Number	Package Type	Packing Quantity	Temperature	Eco Plan	Lead
OCH2992ESAD	SOP-8L-EP	4000pcs/Reel	-40~ +105°C	RoHS	Cu

■ Block Diagram

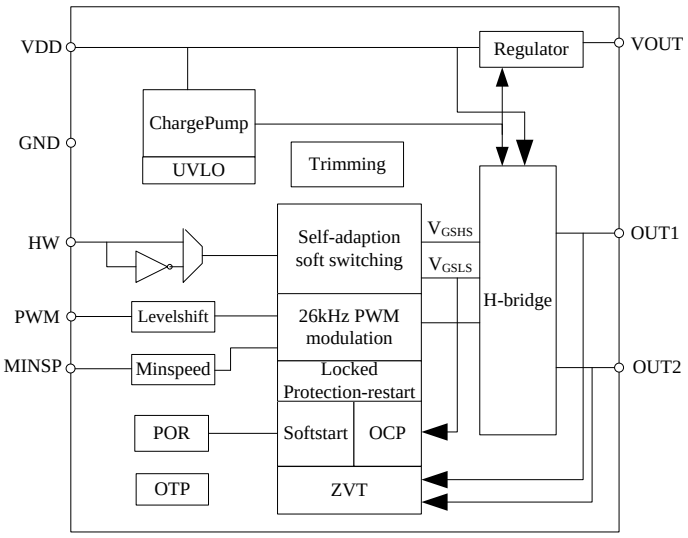


Figure 3, Block Diagram Of OCH2992

■ Absolute Maximum Ratings[2/3] (T_A=25°C, unless otherwise noted)

Parameter	Symbol	Rating	Unit
V_{DD} Pin to GND	V_{DD}	-0.3 to +23	V
OUT1、OUT2 Pin to GND	$V_{OUT1,2}$	-0.3 to +23	V
PWM Pin to GND	V_{PWM}	-0.3 to +23	V
Peak Output Current	$I_{O(PEAK)}$	2.7	A
VOUT Pin to GND	V_{VOUT}	-0.3 to 7	V
HW Pin to GND	V_{HW}	-0.3 to 7	V
MINSP Pin to GND	V_{MNISP}	-0.3 to 7	V
Junction temperature	T_J	150	°C
Thermal Resistance(SOP8-EP)	θ_{JA}	43	°C/W
Storage Temperature Range	T_S	-55 to +150	°C
Maximum Soldering Temperature (at leads, 10 sec)	T_{LEAD}	260	°C

Note2:The maximum dissipation power P_D allowed at any ambient temperature point is calculated: P_D（max）=（T_J-T_A）/θ_{JA}，T_J=150°C。When applied, do not exceed the maximum rating to prevent chip damage, and work for a long time at maximum rating may affect chip reliability.
Note 3: The device is not guaranteed to function outside of its operating conditions.

■ Recommended Operating Conditions[4]

Parameter	Symbol	Rating	Unit
V_{DD} Pin Voltage to GND	V_{DD}	3 to 16	V
MINSP Pin to GND	V_{MINSP}	0 to V_{VOUT}	V
HW Pin to GND	V_{HW}	0 to V_{VOUT}	V
Operating Temperature Range	T_A	-40 to +105	°C

Note4：In practical application, the effect of fan coil heating on the chip must take into account, with the actual over temperature protection point of actual test of high temperature fan for reference. On the basis of pre leave relatively safe temperature allowance, avoid chip in the critical limit (maximum ratings) for a long time and affects the reliability.

■ Electrical Characteristics

Typical values are at T_A = +25°C, VDD=12V, unless otherwise noted.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
Supply						
V_{DD}	Input Voltage		3	-	16	V
I_{DD1}	Supply Current Of Operation Mode	IC is in operation mode No Load	-	2.1	4.5	mA
I_{DD2}	Supply Current Of Lock Mode	IC is in lock mode No Load	-	2.1	4.5	mA
I_{DD3}	Supply Current Of Standby Mode	IC is in standby mode No Load	-	2.1	4.5	mA
V_{VOUT}	VREF Pin Output Voltage	I_{VOUT}=5mA	-	4.75	-	V
HALL Switch Signal Input Threshold						
V_{HW_H}	Input Signal High level	-	0.8		-	V
V_{HW_L}	Input Signal low level	-	-	-	0.4	V
Protection						
V_{UVLO}	Input UVLO rising threshold	-	-	2.87	-	V
V_{UVLO_HYS}	Input UVLO hysteresis	-		0.2		V
T_{ON}	Locked Protection On Time	-	-	0.6	-	Sec
T_{OFF}	Locked Protection Off Time	-	-	3.6	-	Sec
T_{SD}	Thermal Shutdown Temperature	-	-	175	-	℃
T_{SH}	Thermal Shutdown Hysteresis	-	-	30	-	℃
I_{OCP}	Over-current limit protection threshold	-	-	4.8	-	A
I_{LIM1}	Output current limit1 (Operation Mode)	-	-	2.7	-	A
I_{LIM2}	Output current limit2 (Lock & Restart mode)		-	1	-	A
Soft Start						
Tss	Soft Start Time	-	-	1.4	-	Sec
PWM Control						
V_{PWM_H}	Pulse Mode PWM Input High Level Voltage	-	0.8		-	V
V_{PWM_L}	Pulse Mode PWM Input Low Level Voltage	-	-	-	0.4	V
F_{PWM}	PWM Input Frequency	-	10	-	60	kHz
F_{OUT}	Output PWM Switch Frequency	-	-	26	-	kHz
Soft Switch						
θ_{SON_100}	Soft turn-on angle	IC is in operation mode PWM floating	-	24	-	°
θ_{SOFF_100}	Soft turn-off angle	IC is in operation mode PWM floating	-	45	-	°

■ Truth Table

OUTPUT			Mode
HW(FG)	**OUT1**	**OUT2**	
H	H	L	Operation Mode
L	L	H	
H	L	H	
L	H	L	
Hold H	L	L	Lock Mode
Hold L	L	L	
Hold H	L	L	
Hold L	L	L	

■ Function Description

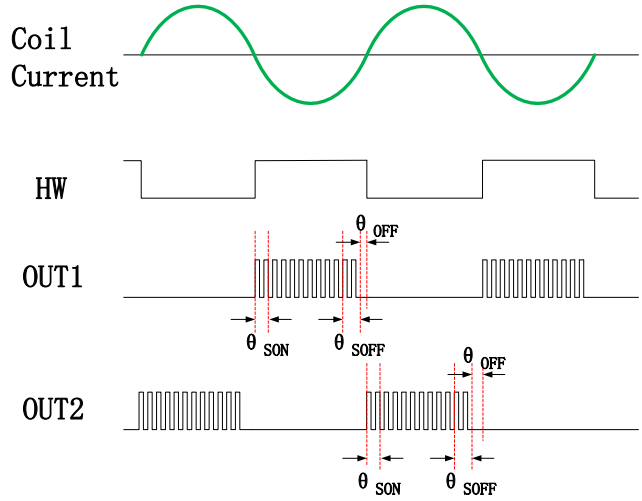
Speed Control

The OCH2992 is controlled using a PWM input interface, which is compatible with industry standard devices. The IC detects the PWM input signal duty cycle and linearly controls the H-bridge output duty cycle, so the fan speed increases as the input duty cycle increases. The PWM input accepts a wide input frequency range (10 kHz to 60 kHz), while the output frequency is kept constant at 26 kHz above the audible frequency range.

PWM Output Drive

The IC controls the H-bridge MOSFET switching to reduce speed variation and increase system efficiency (see Figure 2).

With this HW signal of external Hall switch IC, IC does soft on transition and soft off transition to keep smooth current and reduce fan vibration.



Soft Switch

During soft turn-on section, OUT1 continues switching, and the duty cycle increases gradually from 0 to the target setting duty cycle in max.16 steps while OUT2 remains low. The soft on angle last for 24°when output duty cycle is 100%.

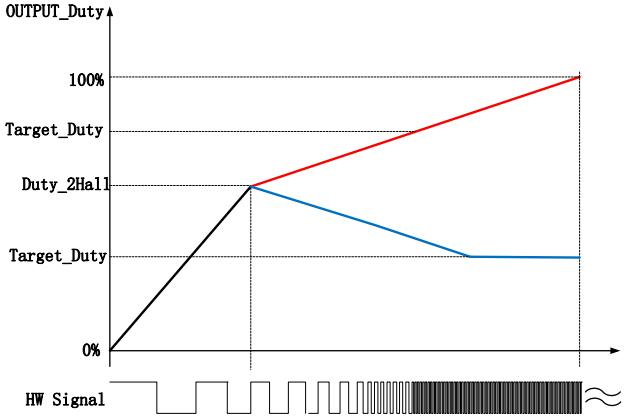
During soft turn-off section, OUT1 continues switching, and the duty cycle decreases gradually from the target setting duty cycle to 0 in max.16 steps while OUT2 remains low. The soft on angle last for 45° when output duty cycle is 100%.

During off time, OUT1 remains at high impedance. OUT2 remains low. The time duration is adaptive from 0° to 45°. In steady state, this function block maintains the phase lock of the HW signal falling edge and winding current zero-crossing edge.

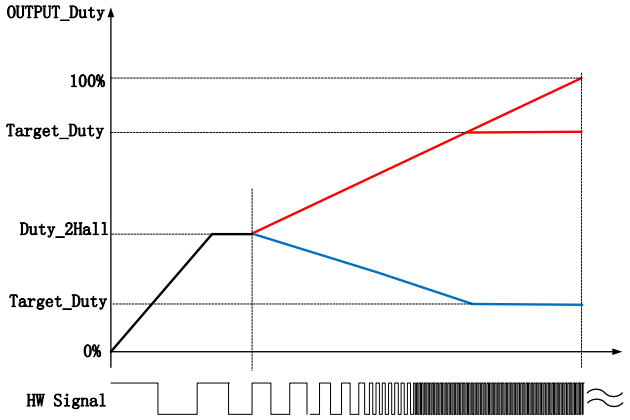
For the HW signal low interval, the conducting phase changes, but the switching sequence remains the same.

Soft Start

The OCH2992 provides the soft-start function to avoid peak current at power-on and lock-restart moments. The soft start function initial duty is 0%,if HW signal change four times the duty will trace input target duty, else duty from Duty_2Hall to 100% in 1.4 sec(typ).



In order to further reduce the peak current, the OCH2992 is built in current limit (typical 800mA) at power-on and lock-restart moments. When the current limit function is triggered, the output duty will be maintained until HW signal change four times, and then the duty traces input target duty.

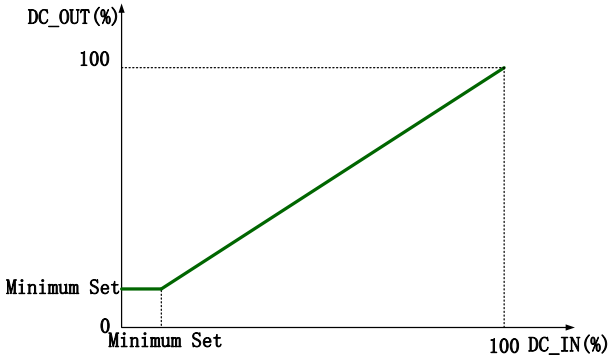


Minimum Output Duty setting

OCH2992 is built in minimum output duty setting function. It's set by the MINSP voltage.

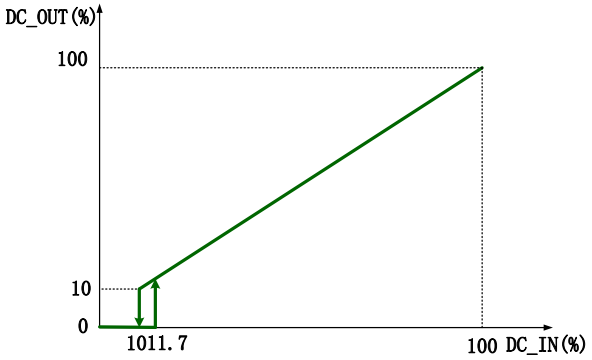
1) V_{MINSP}>0.6*V_{VOUT}

When **V_{MINSP}>0.6*V_{VOUT}** (include MINSP pin floating), the minimum output duty setting function is set internally (default 10%). In this Case, if PWM input duty is less than the minimum output duty setting internally, IC will enter into minimum speed mode.



2) V_{MINSP}＜0.2V_{VOUT}

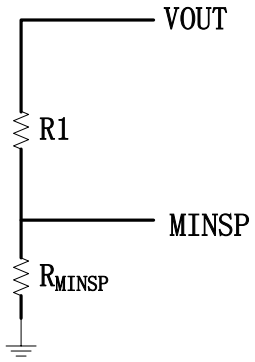
When V_{MINSP}＜**0.2*V_{VOUT}**(include MINSP pin connect to GND),if PWM input duty is less than the 10%, the IC will enter into shutdown mode.

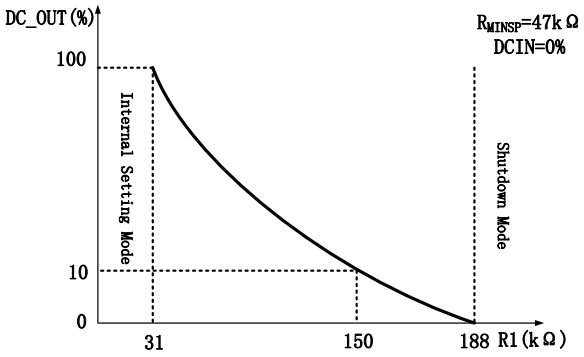


3) 0.2*V_{VOUT} ＜V_{MINSP}＜0.6*V_{VOUT}

When **0.2*V_{VOUT} ＜V_{MINSP}＜0.6*V_{VOUT}**, the minimum output duty setting function is set by R_{MINSP} and R1 . In this Case, if PWM input duty is less than the minimum output duty setting, IC will enter into minimum speed mode.

In this case，the Minimal Speed input allows setting of a minimum required rotation speed of the motor by using 2inexpensive resistors. This is especially useful for applications where minimum cooling is a requirement to avoid system damage (example: computer CPU, graphics processor, etc).





Protection Circuits

The OCH2992 is fully protected against overvoltage, under-voltage, over-current, current-limit, over temperature events and has lock and restart protection.

Under-Voltage Lockout (UVLO)

If at any time VCC falls below the under-voltage lockout (UVLO) threshold voltage, all circuitry in the device is disabled, and the internal logic is reset. Operation resumes when VCC rises above the UVLO threshold.

Over-Current Protection (OCP)

The OCH2992 protects against short circuit by detecting the current flowing through two low-side MOSFETs (LS-FET). If the current flowing through any MOSFET exceeds the over-current protection (OCP) threshold after about 1.5μs of blanking time, that all MOSFETs turns off immediately. After approximately 3.6s of delay, the bridge is re-enabled automatically. The OCP current threshold is 4.8A (typical).

Overload Current Limit

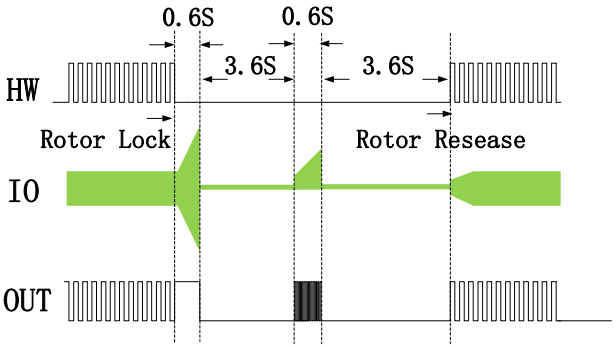
During normal switching, if the current flowing through the low-side MOSFET (LS-FET) of the H-bridge exceeds the threshold after around 1.5μs of blanking time, the HS-FET turns off immediately. The HS-FET resumes switching in the next switching cycle. The overload current limit is 2.7A (typical).

Thermal Shutdown

Thermal monitoring is also integrated into theOCH2992. If the die temperature raises above175°C, the IC turns off the two HS-FETs and turns on the two low-side MOSFETs (LS-FET). Once the die temperature has fallen to a safe level, operation resumes automatically.

Rotor Lock and Restart Protection

If the IC cannot see the HW signal edge change during the 0.6s detection time, all MOSFETs of the H-bridge are turned off. After 3.6s of recovery time, the IC attempts to start up again automatically.



■ Application Information

Input Protection Diode & Capacitor

The IC should be added a protection diode (D1) to prevent the damage from the power reverse connection. However, the protection diode will cause a voltage drop on the supply voltage. The current rating of the diode must be greater than the maximum output current.

Place an input capacitor (C1) near VCC to keep the input voltage stable and reduce input switching voltage noise and ripple. The input capacitor impedance must be low at the switching frequency. Ceramic capacitors withX7R dielectrics are recommended for their low ESR characteristics. Ensure that the ceramic capacitance is dependent on the voltage rating. The DC bias voltage and value can lose as much as 50% of its capacitance at its rated voltage rating. Leave enough voltage rating margin when selecting the component. For most applications, a 4.7μF to 10μF ceramic capacitor is sufficient. In some applications, add an additional, large, electrolytic capacitor to absorb inductor energy if needed.

Input Snubber Circuit

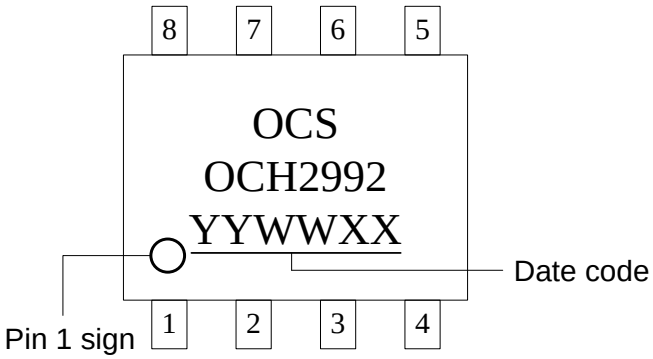
Due to the input capacitor energy charge/discharge during the phase transition soft switching, the input current has switching cycle ringing. If needed, add a 1Ω resistor in series with a 4.7~10μF capacitor as an R-C.

Input Clamping TVS

To avoid high voltage spikes caused by the energy stored in the motor inductor charges back to the input capacitor side, must add a voltage clamping transient voltage suppressor (TVS)diode. For a 12V case, an 15V/SOD-123package TVS diode is sufficient.

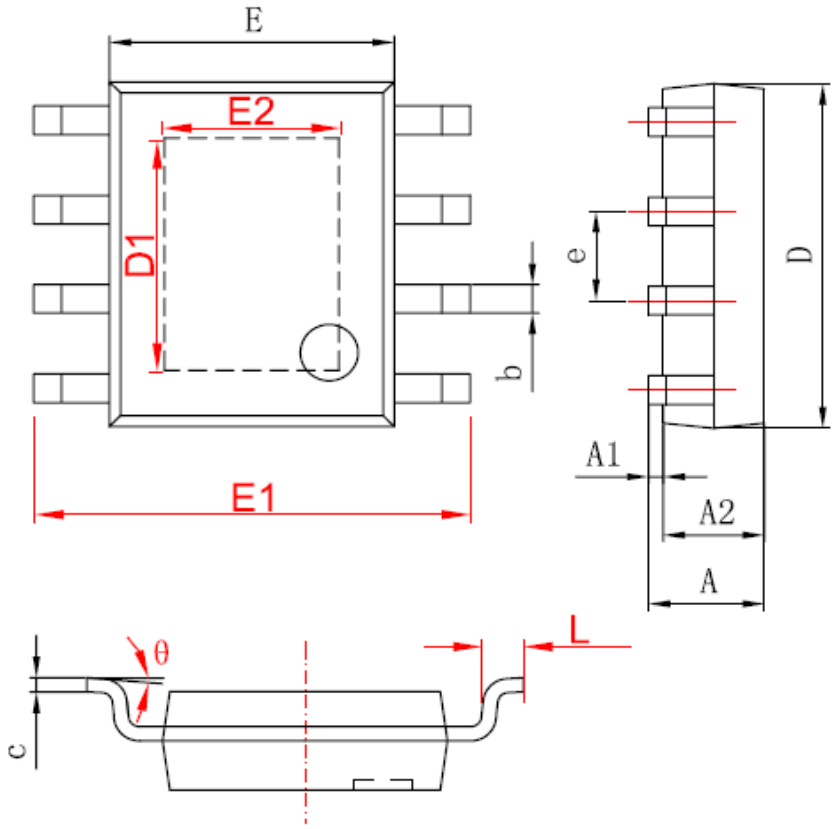
■ Marking Information

1）SOP-8L-EP:



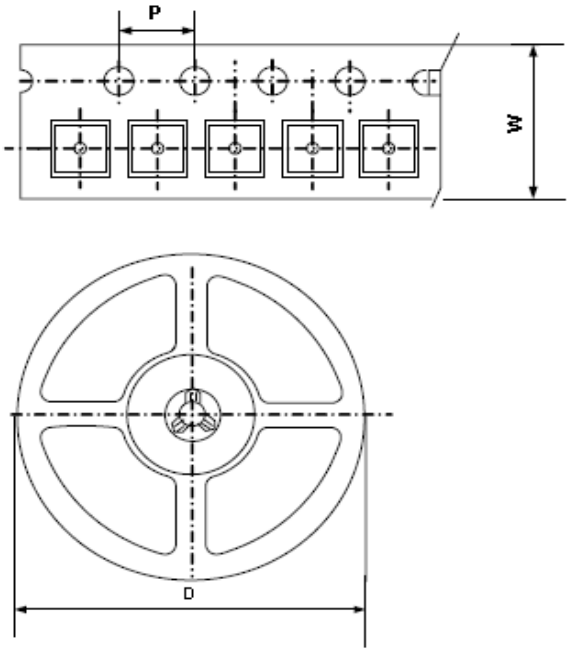
■ Package Information

1) SOP-8L-EP



Symbol	Dimensions In Millimeters			Dimensions In Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	1.350	1.550	1.750	0.053	0.061	0.069
A1	0.050	0.100	0.150	0.004	0.007	0.010
A2	1.350	1.450	1.550	0.053	0.057	0.061
b	0.330	0.420	0.510	0.013	0.017	0.020
c	0.170	0.210	0.250	0.006	0.008	0.010
D	4.700	4.900	5.100	0.185	0.192	0.200
D1	3.202	3.302	3.402	0.126	0.130	0.134
E	3.800	3.900	4.000	0.150	0.154	0.157
E1	5.800	6.000	6.200	0.228	0.236	0.244
E2	2.313	2.413	2.513	0.091	0.095	0.099
e	1.270 (BSC)			0.050 (BSC)		
L	0.400	0.835	1.270	0.016	0.033	0.050
θ	0°	-	8°	0°	-	8°

■ Packing information



Package Type	Carrier Width(W)	Pitch(P)	Reel Size(D)	Packing Minimum
SOP-8L-EP	12.0±0.1 mm	4.0±0.1 mm	330±1 mm	4000pcs

Note: Carrier Tape Dimension, Reel Size and Packing Minimum

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