■ General Description

The OCH2985 is a single-phase, brushless, DC motor drivers with integrated power MOSFETs and a Hall Effect sensor. The OCH2985 drives single-phase brushless DC fan motors with up to 1.3A of output current limit. The IC has a 3.5V to 16V input voltage range and input line reverse voltage protection to save the external diode on the supply line.

The OCH2985 controls the rotational speed through the PWM signal on the PWM pin. The OCH2985 has a rotational speed detection feature and rotor lock fault indication on FG/RD with an open-drain collector output. The output speed versus the input duty curve can be programmed easily for flexible use. To reduce fan driver audible noise and power loss, the OCH2985 features a soft on/off phase transition and automatic phase-lock function of the motor winding BEMF and current.

Full protection features include input overvoltage protection (OVP), over current protection (OCP), under-voltage lockout (UVLO), rotor deadlock protection, thermal shutdown, and input reverse protection.

The OCH2985 requires a minimal number of external components to save solution cost. TheOCH2985 is available in TSOT23-6L, SOP-8F packages.

■ Features

- Embedded Hall Sensor with High Sensitivity
- Wide 3.5V to 16V Operating Input Range
- Up to 1.3A Programmable Current Limit
- Integrated Power MOSFETs: Total 1.0Ω(HS+LS)
- High Sensitivity Hall Sensor
  BOP (6GS), BRP (-6GS)
- Programmable Speed Curve
- Built-In Adjustable Speed Curve Corner Setting
- Automatic Phase Lock Detection of Winding BEMF and Current Zero-Crossing
- Soft On/Off Phase Transition
- Soft Start and Soft Restart Function
- Rotational Speed Indicator (FG) Signal
- 100Hz to 50kHz PWM Input Frequency Range
- Fixed 26kHz Output Switching Frequency
- Built-In Reverse Voltage Protection
- Built-In input OVP, OCP, UVLO
- Lock-shutdown protection & auto-restart function
- Thermal Protection and Automatic Recovery
- -40°C to + 125°C Temperature Range
- RoHS Compliant
- Available in TSOT23-6L, SOP-8F

■ Applications

- CPU Fan for Personal Computers or Servers
- Brushless DC Motor

■ Pin Configuration

(Top View)

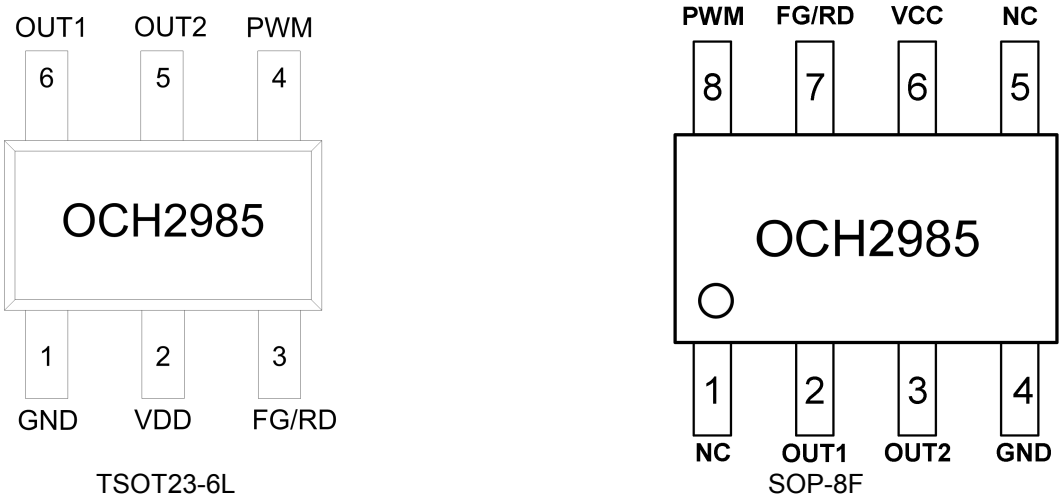


Figure 1, Pin Assignments of OCH2985

Pin Name	Pin No.		Pin Function
	FTSOT23-6F	SOP-8F	
VDD	2	6	Positive Power Supply
OUT1	6	2	Output 1
OUT2	5	3	Output 2
GND	1	4	Ground
PWM	4	8	PWM Signal input
FG/RG	3	7	Rotation Speed output. This is an open-drain output.
NC	-	1、5	NC Pin

■ Typical Application Circuit

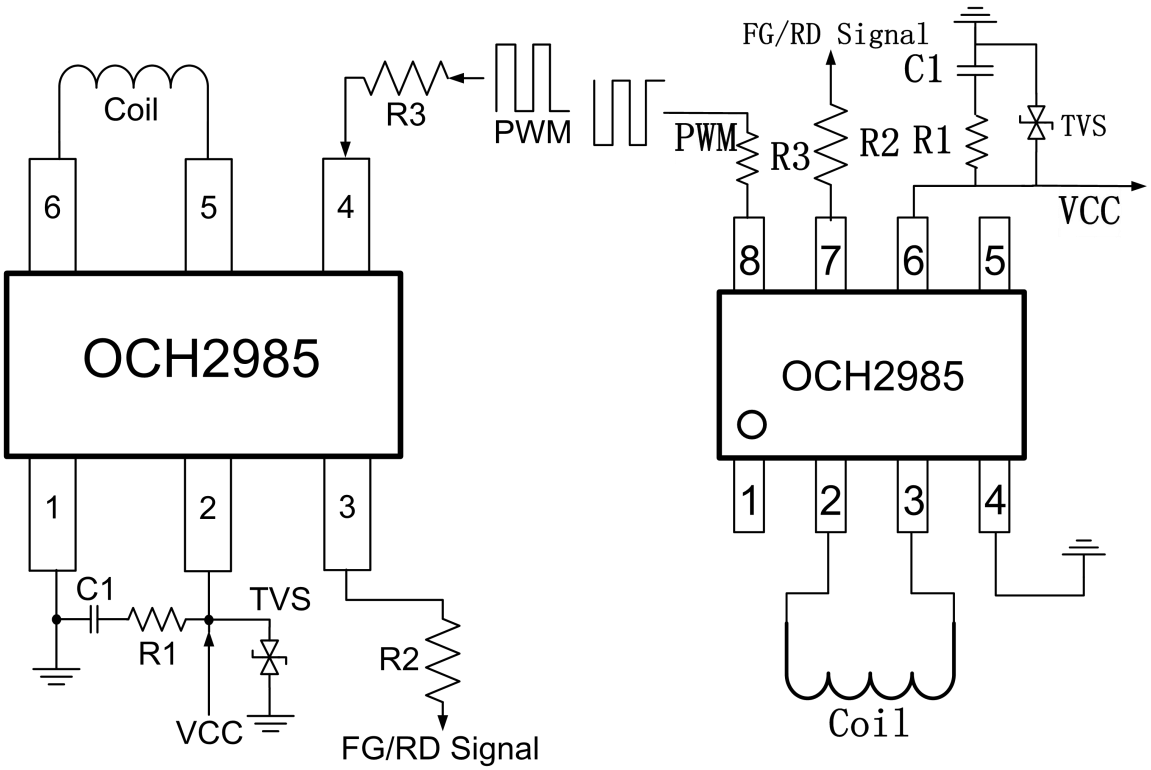


Figure 2, Typical Application Circuit of OCH2985

Note1:

1) Must use least C1=2.2~10uF and R1=1 Ω (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
3) The R2 & R3 is used to prevent PWM and FG/RD pin，typical value is 100 Ω.

■ Ordering Information

Part Number	Package Type	Packing Quantity	B_{OP}/B_{RP} (Gauss)	Temperature	Eco Plan	Lead
OCH2985TWAD	TSOT23-6L	3000pcs /Reel	±6 (Typ.)	-40~ +125°C	ROHS	Cu
OCH2985SFAD	SOP-8F	4000pcs /Reel	±6 (Typ.)	-40~ +125°C	ROHS	Cu

■ Block Diagram

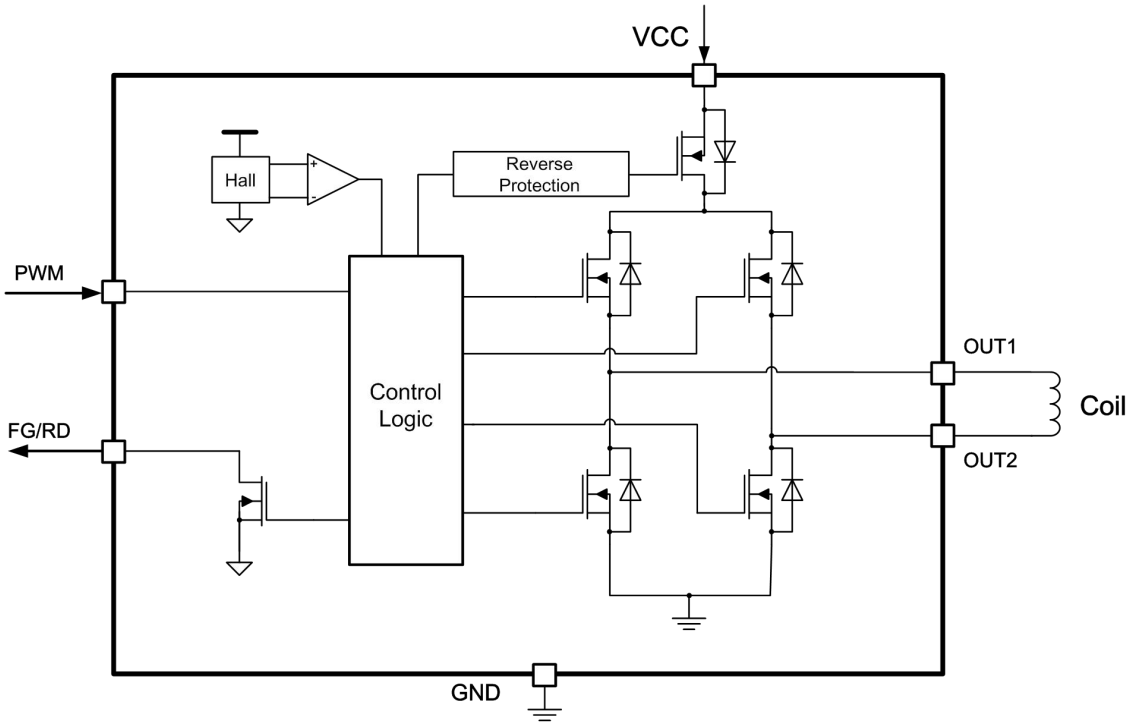


Figure 3, Block Diagram of OCH2985

■ Absolute Maximum Ratings[1] (T_A=25°C, unless otherwise noted)

Parameter	Symbol	Rating	Unit
V_{DD} Pin to GND	V_{DD}	±20	V
FG/RD		-0.3 to VCC+0.3	V
All other pins		-0.3 to +6.5	V
Hold Output Current	$I_{O(HOLD)}$	0.8	A
Peak Output Current	$I_{O(PEAK)}$	1.3	A
Junction temperature	T_J	160	°C
Thermal Resistance(SOP-8F)	θJA	43	°C /W
Thermal Resistance(TSOT23-6L)	θJA	55	°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 - TA）/ θJA，TJ＝160°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.
Note3: Stresses above those listed in absolute maximum ratings may cause permanent damage to the device. Functional operation at conditions other than the operating conditions specified is not implied. Only one absolute maximum rating should be applied at any one time.
Note 4: The device is not guaranteed to function outside of its operating conditions.

■ Recommended Operating Conditions[2]

Parameter	Symbol	Rating	Unit
V_{DD} Pin Voltage to GND	V_{DD}	3.5 to 16	V
Operating junction Temperature Range	T_{OP}	-40 to +125	°C

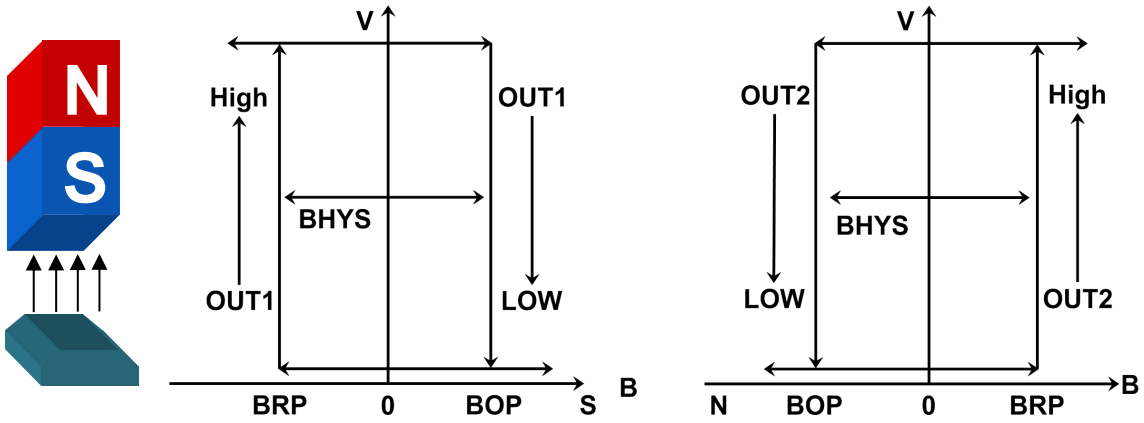
Note5：In practical application, the effect of fan coil heating on the chip must take into account, with the actual over temperature protection point of actual test of high temperature fan for reference. On the basis of every leave relatively safe temperature allowance, avoid chip in the critical limit (maximum ratings) for a long time and affects the reliability.

■ Electrical Characteristics

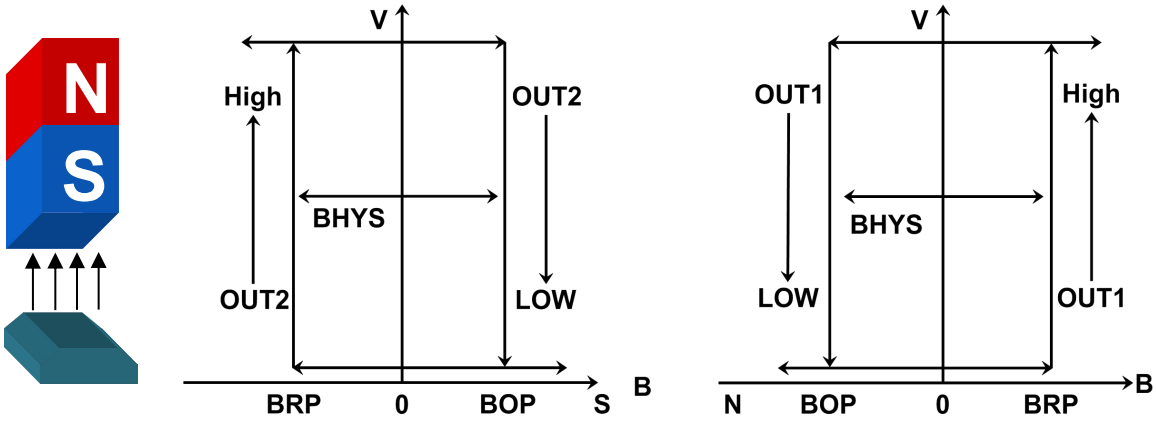
(VCC=12V, TJ = -40 to +125°C unless otherwise noted.)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Input UVLO rising threshold	V_{UVLO}			3.25		V
Input UVLO hysteresis				0.3		V
Operating supply current	I_{CC}			6.5		mA
Reverse supply current	I_{CCREV}	VCC= -18V			0.1	mA
PWM input high voltage	V_{PWMH}		0.9		5	V
PWM input low voltage	V_{PWML}				0.7	V
PWM input frequency	F_{PWM}		0.1		50	kHz
PWM input internal pull-up resistance				100		kΩ
HS switch-on resistance(SOP-8F)	R_{HSON1}	I_O=100mA,including reversed MOSFET		600		mΩ
LS switch-on resistance(SOP-8F)	R_{LSON1}	I_O=100mA		400		mΩ
HS switch-on resistance(SOT23-6L)	R_{HSON2}	I_O=100mA,including reversed MOSFET		550		mΩ
LS switch-on resistance(SOT23-6L)	R_{LSON2}	I_O=100mA		330		mΩ
Over-current limit protection threshold	I_{OCP}			3		A
Over Voltage Protection	V_{ov}			19.4		V
Over Voltage Protection Hysteresis	V_{ov_H}			1		V
Output current limit	I_{LMT}	Operation Mode	-15%	1.3	+15%	A
Output current limit	I_{LMT}	Lock Mode		0.5		A
Internal oscillator frequency	f_{CLK}		-15%	7	+15%	MHz
PWM output frequency	F_S		-15%	26	+15%	kHz
FG output low-level voltage	V_{FG_L}	IFG/RD=3mA,V_{PULL}=5V			0.35	V
FG leakage current					1	μA
Rotor-lock detection time	T_{RD}			0.6		s
Soft turn-on angle		PWMO=100%		23.9		°
Soft turn-off angle		PWMO=100%		45		°
Minimum recommended magnetic field				±10		GS
Thermal shutdown threshold				170		°C
Thermal shutdown hysteresis				30		°C

■ Operating Characteristics



TSOT23-6L



SOP-8F

Figure 4, Magnetic Hysteresis Characteristics OCH2985

■ Truth Table

SOP-8F

Input	Output			Mode
B	DO	DOB	FG	
Bop	H	L	OFF	Operation Mode
Brp	L	H	L	
Bop	L	L	OFF	Lock Mode
Brp	L	L	OFF	

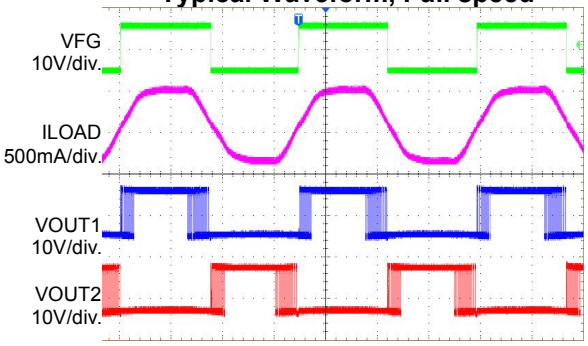
TSOT23-6L

Input	Output			Mode
B	DO	DOB	FG	
Bop	L	H	L	Operation Mode
Brp	H	L	OFF	
Bop	L	L	OFF	Lock Mode
Brp	L	L	OFF	

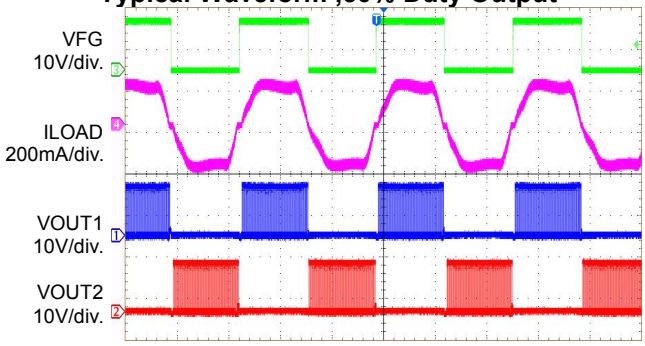
■ Typical Performance Characteristics

VCC = 12V, TA = 25°C, tested with fan unit, unless otherwise noted.

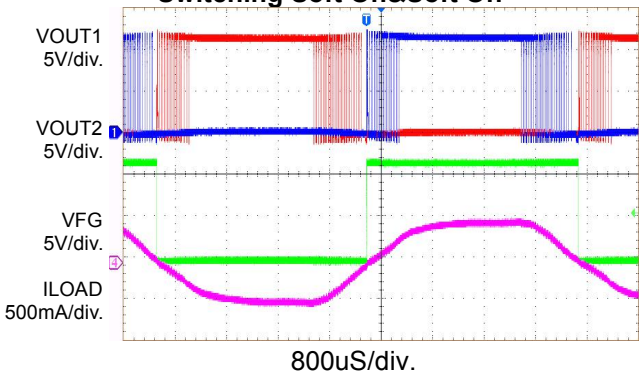
Typical Waveform, Full speed



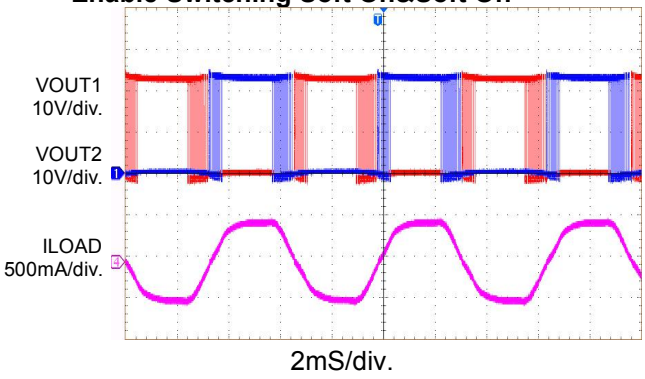
Typical Waveform ,50% Duty Output



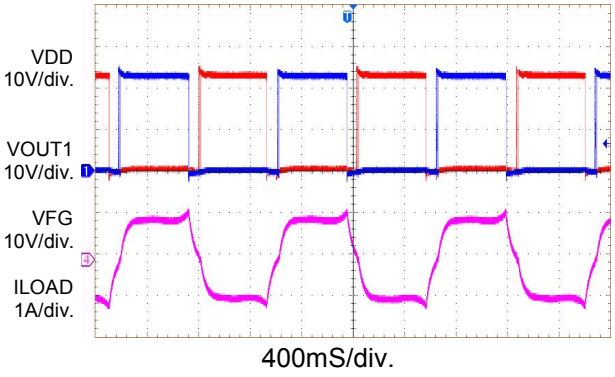
**Typical Waveform,
Switching Soft On&Soft Off**



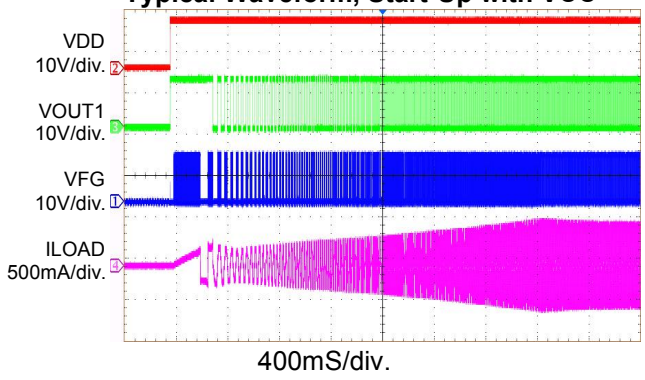
**Typical Waveform,
Enable Switching Soft On&Soft Off**



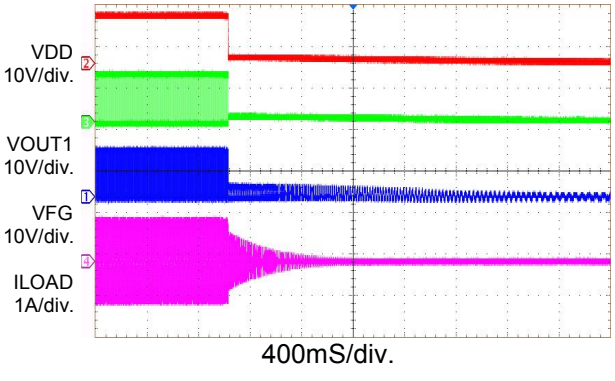
**Typical Waveform, Disable
Soft On&Soft Off**



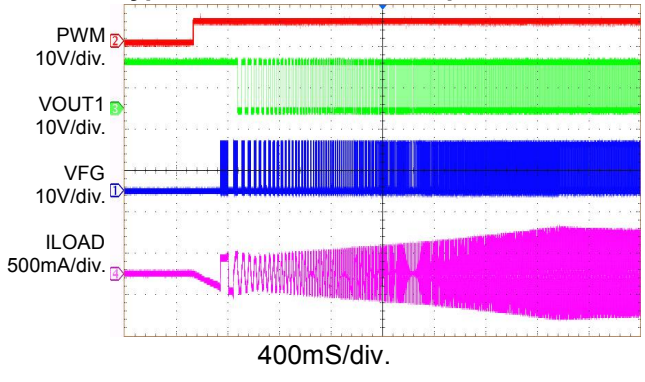
Typical Waveform, Start-Up with VCC



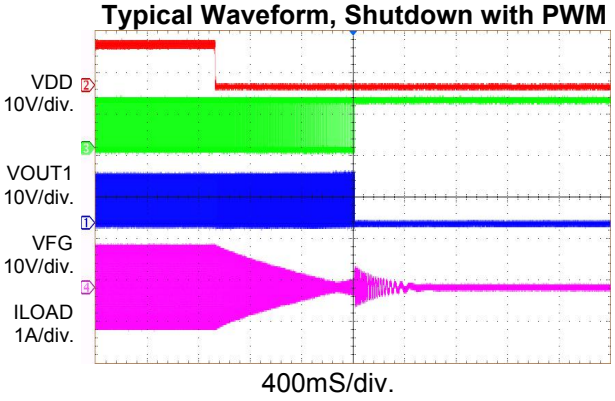
Typical Waveform, Shutdown with VCC



Typical Waveform, Start-Up with PWM

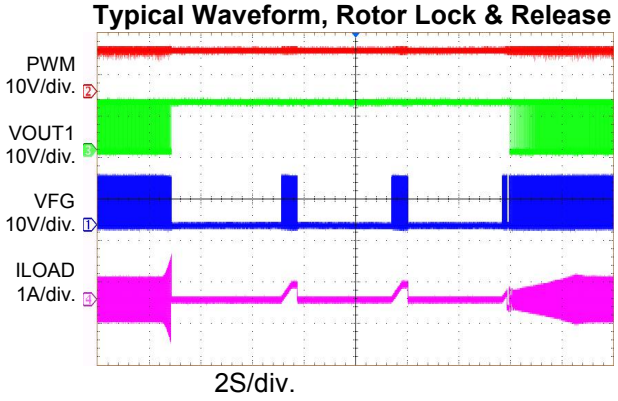


Typical Waveform, Shutdown with PWM



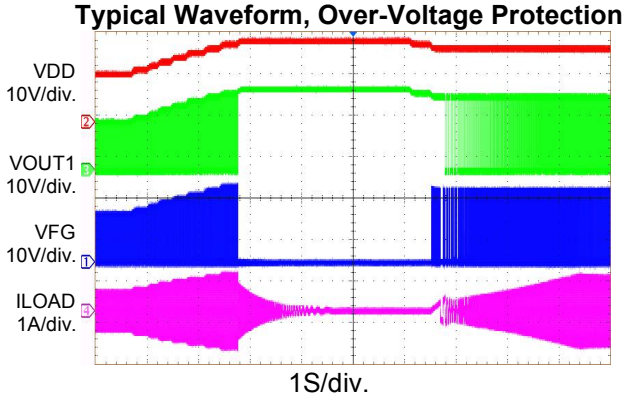
400mS/div.

Typical Waveform, Rotor Lock & Release



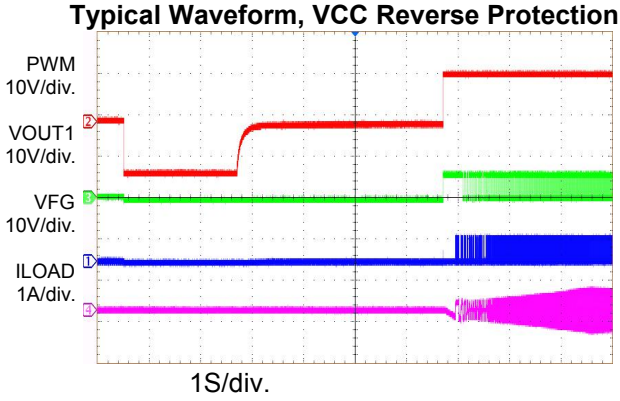
2S/div.

Typical Waveform, Over-Voltage Protection



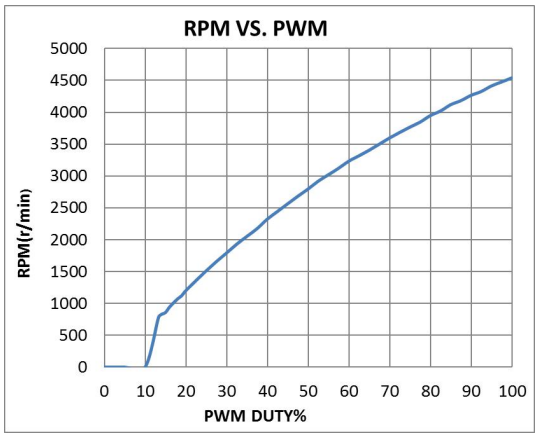
1S/div.

Typical Waveform, VCC Reverse Protection

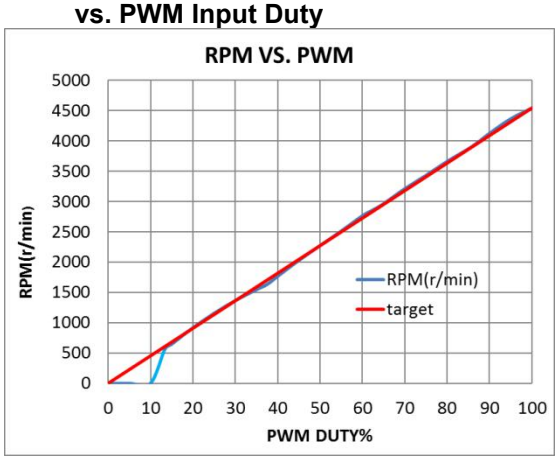


1S/div.

Typical Curve, RPM Output vs. PWM Input Duty



Optimized Curve RPM Output vs. PWM Input Duty



■ Function Description

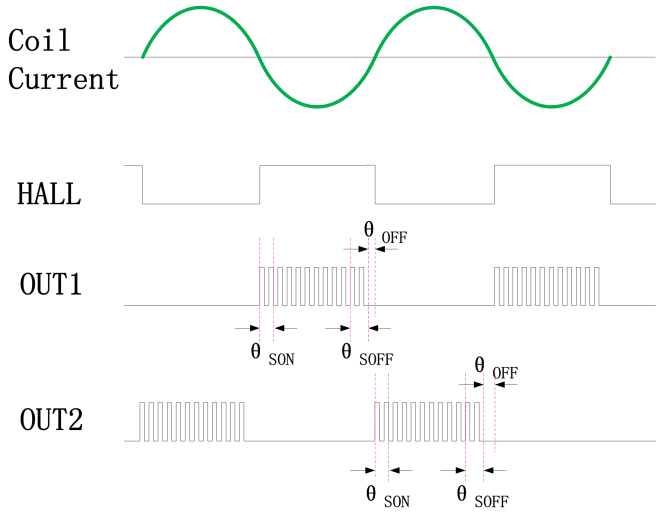
The OCH2985 are single-phase, brushless, DC motor drivers with integrated power MOSFETs and a Hall effect sensor.

Speed Control

The OCH2985 is controlled using a pulse-width modulation (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 (100Hz to 50kHz), while the output frequency is kept constant at 26kHz above the audible frequency range.

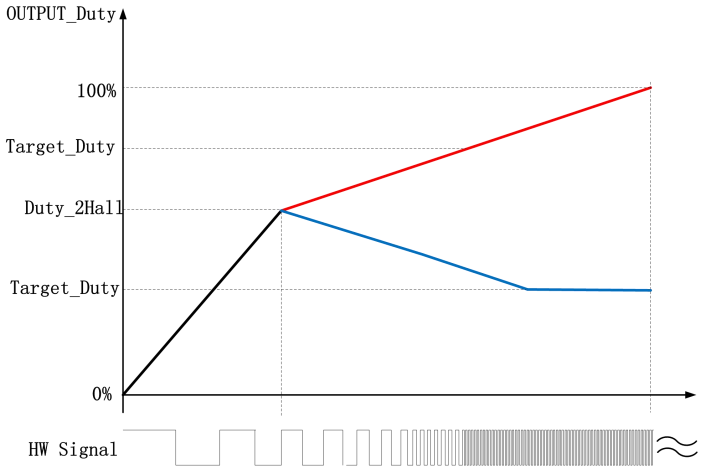
PWM Output Drive

The IC controls the H-bridge MOSFET switching to reduce speed variation and increase system efficiency.
When the rotor magnet pole S comes around the internal Hall sensor outputs high. When the rotor magnet pole N comes around, the internal Hall sensor outputs low. With this Hall signal, IC does soft on transition and soft off transition to keep smooth current and reduce fan vibration.



Soft Start

The OCH2985 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 2.8sec(typ.).

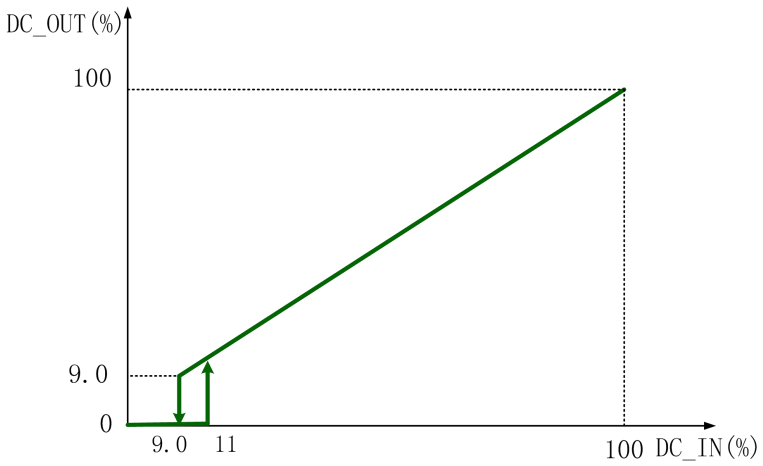


Minimum Output Duty setting

OCH2985 is built in minimum output duty setting function. An example is below.

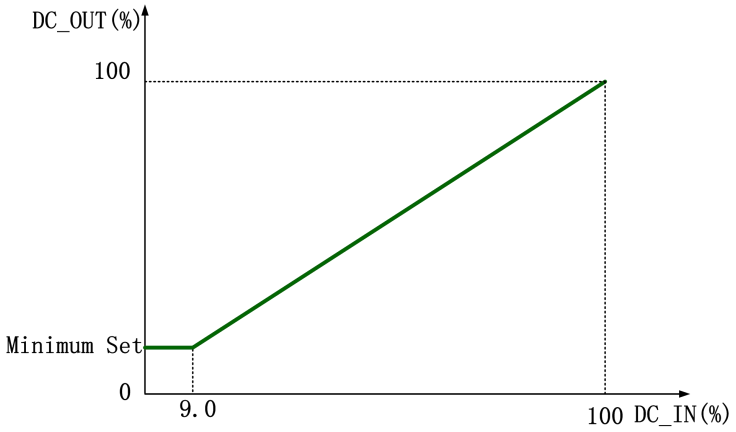
- **SPD_ZERO=1,**

When input duty is less than 9%, fan keeps zero speed. When input duty is above11 %(hysteresis 2%), fan starts rotating.



- **SPD_ZERO=0,**

When input duty is less than 9%, fan keeps a minimum PWM output duty cycle.



■ Protection Circuits

The OCH2985 is fully protected against over-voltage, under-voltage, over-current, current-limit, over temperature events and has lock and restart protection.

Over-Voltage Protection (OVP)

If VCC exceeds the over-voltage threshold (typ. 19.5V), the IC turns off the two HS-FETs and turns on the two low-side MOSFETs (LS-FET)until VCC drops below (typ. 18.5V). Then the IC resumes normal operation.

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) and Power On Short-Circuit Detection

The OCH2985 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 2.0A (typical). And When IC power on, if OUT1or OUT2 is short to GND, the built short circuit by detecting two high-side MOSFETs, the HS-FET turns off immediately and turns on the two low-side MOSFETs (LS-FET)until the short-circuit condition is removed.

Overload Current Limit

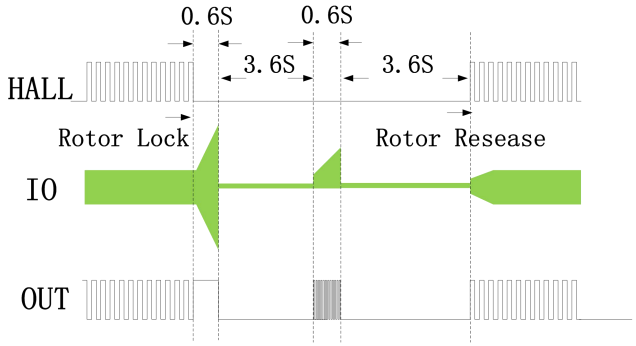
During normal switching, if the current flowing through the low-side MOSFET (LS-FET) of the H-bridge exceeds the threshold after around 1.5μs of blanking time, the HS-FET turns off immediately. The HS-FET resumes switching in the next switching cycle. The overload current limit is 1.3A (typical).

Thermal Shutdown

Thermal monitoring is also integrated into the OCH2985. If the die temperature rises above165℃, 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.



Input Reverse Connection Protection

If the input line is reverse-connected to VCC and GND, the IC detects the fault condition automatically and shuts down to avoid damage.

■ 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 margins when selecting the component. For most applications, a 2.2μF 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 2.2μF to 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, add a voltage clamping transient voltage suppressor (TVS) diode. For a 12V case, an 15V/SOD-323package TVS diode is sufficient.

■ Hall Sensor Location

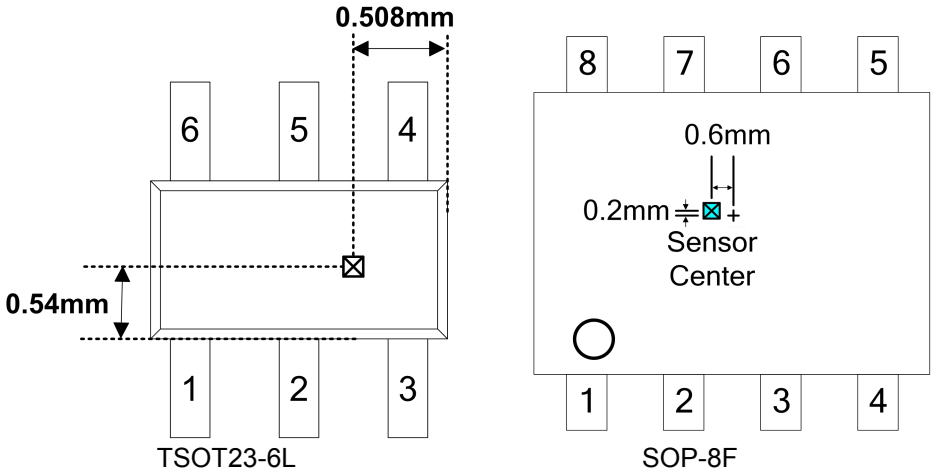
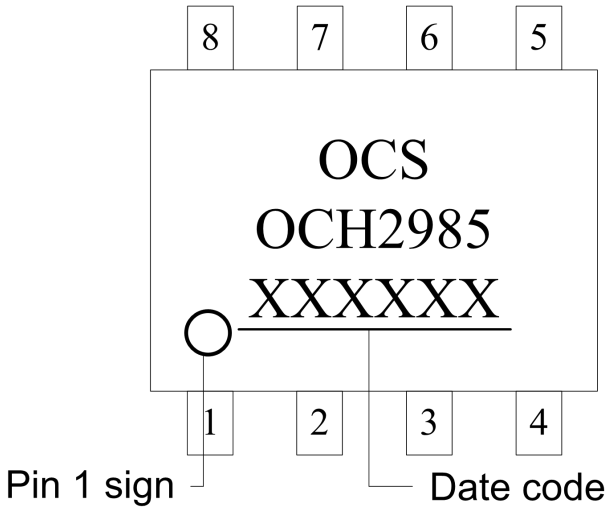


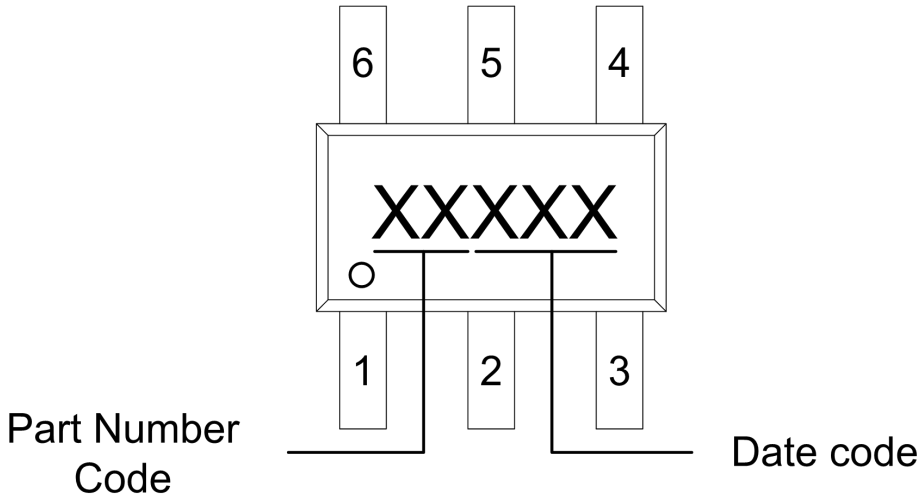
Figure5, Hall Sensor Location

■ Marking Information

1）SOP-8F:

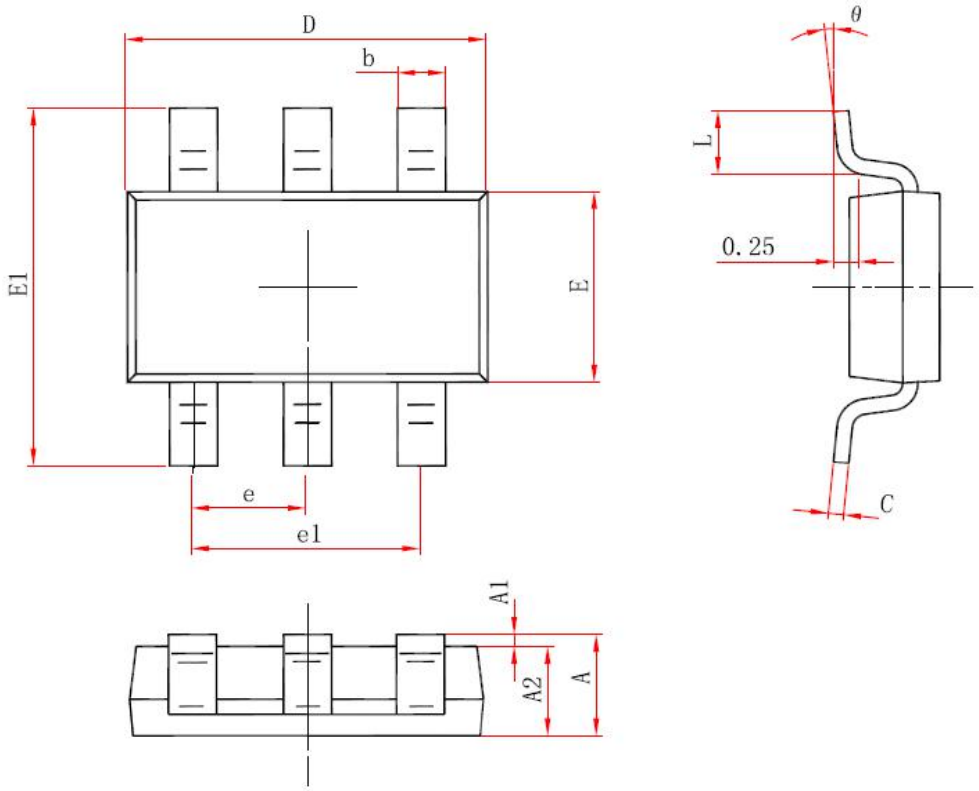


2）TSOT23-6L



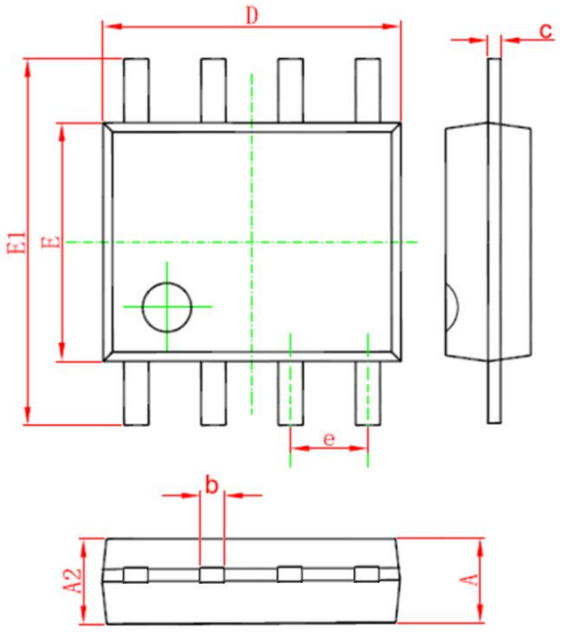
■ Package Information

1) TSOT23-6L



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	0.700	0.950	0.028	0.037
A1	0.000	0.100	0.000	0.004
A2	0.750	0.850	0.030	0.033
b	0.380	0.460	0.015	0.018
c	0.130	0.170	0.005	0.007
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.600	3.000	0.102	0.118
e	0.950 (BSC)		0.037 (BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.500	0.012	0.020
θ	0°	8°	0°	8°

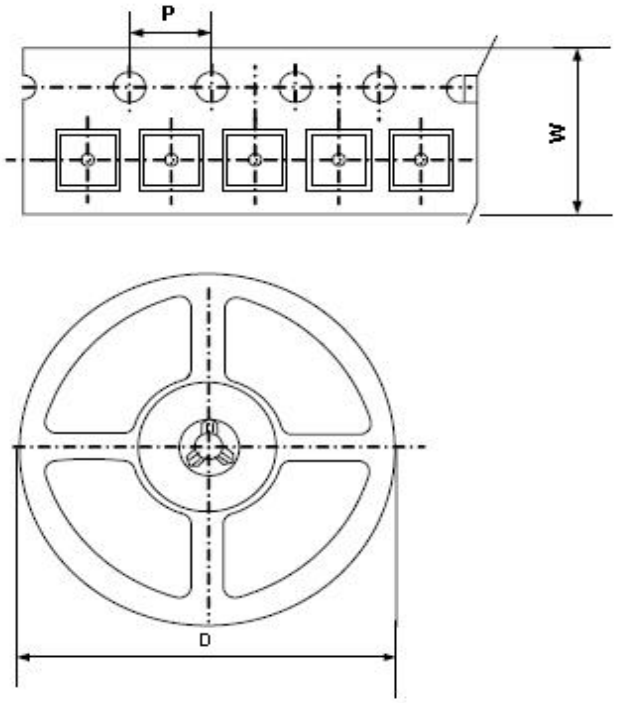
2) SOP-8F



Symbol	Dimensions In Millimeters			Dimensions In Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	1.350	1.550	1.750	0.053	0.061	0.069
A1	0.100	0.175	0.250	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
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
e	1.270 (BSC)			0.050 (BSC)		

■ Packing Information

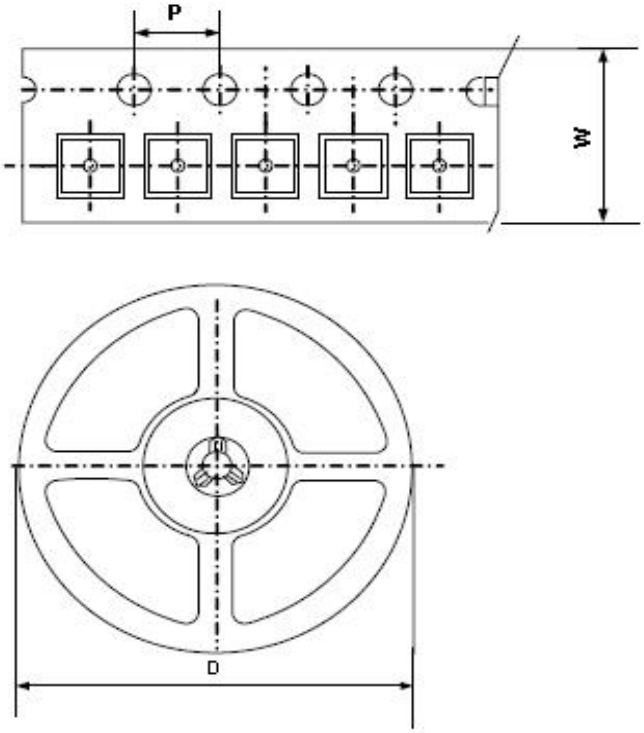
1) TSOT23-6L



Package Type	Carrier Width (W)	Pitch (P)	Reel Size(D)	Packing Minimum
TSOT23-6L	8.0±0.1 mm	4.0±0.1 mm	180±1 mm	3000pcs

Note: Carrier Tape Dimension, Reel Size and Packing Minimum

2) SOP-8F



Package Type	Carrier Width(W)	Pitch(P)	Reel Size(D)	Packing Minimum
SOP-8F	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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