■ General Description

OCH2991F is a fan motor driver for the single coil brushless DC motor. With its high efficient direct PWM control mode, OCH2991F controls the speed of brushless DC motor with an external hall switch IC. OCH2991F is suitable to drive variable speed motors for personal computer's power supply radiation fans and CPU coolers.

OCH2991F 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. OCH2991Fcan set minimum fan speed by presetting MINSP voltage. With soft start function, OCH2991F can effectively reduce the peak current when power on. To reduce fan driver audible noise and power loss, the OCH2991F features a soft on/off phase transition and automatic phase-lock function of the motor winding BEMF and current.

Robust protections inOCH2991Finclude under-voltage lockout (UVLO), rotor deadlock protection, over current protection (OCP) and thermal shutdown.

The OCH2991F requires a minimal number of external components to save solution cost. The OCH2991F is available in TSSOP16L-EP、SOP-8L-EP packages.

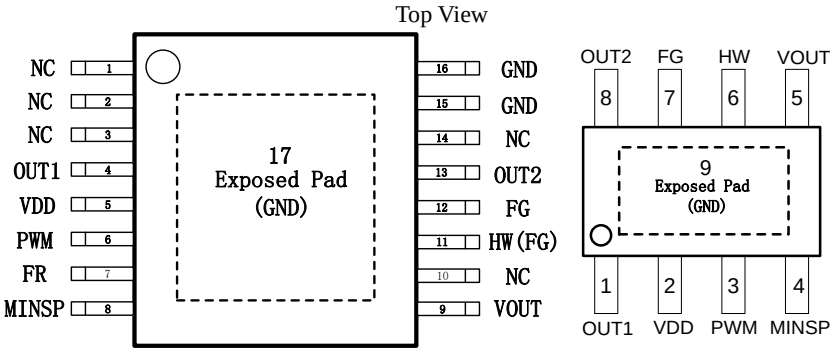
■ Features

- Supporting speed: Max. 15000 Rpm/Min.
- Wide Operating Input VoltageRange: 3.0V~18V
- Integrated Power MOSFETs: Total 230mΩ(High side + Low side)
- PWM Fan Speed Control
- Programmable Minimum Fan Speed
- MINSP Setting Minimum Fan Speed
- Soft On/Off Phase Transition
- Soft Start and SoftRestart Function
- FG Output
- Over Temperature Protection
- External Hall Switch
- Lock-shutdown protection & auto-restart function
- Automatic Phase Lock Detection of WindingBEMF and Current Zero-Crossing
- 10KHZ to 60kHz PWM Input FrequencyRange
- Fixed 26kHz Output Switching Frequency
- OCP (Over Current Protection)
- Current Limit &Soft Start and SoftRestart
- Thermal Protection and Automatic Recovery
- Built-In Input UVLO
- -40°C to + 105°C Temperature Range
- RoHS Compliant
- TSSOP-16L-EP、SOP-8L-EPpackages

■ Applications

- Power、Industrial product、Equipment orServers
- Single Coil DC Brushless DC Motor

■ Pin Configuration



TSSOP-16L-EP SOP-8L-EP

Figure 1, Pin AssignmentsOfOCH2991F

Pin Name	TSSOP16L-EP	SOP-8L-EP	Pin Function
NC	1,2,3,10,14	/	No Connection
OUT1	4	1	Output 1
VDD	5	2	Positive Power Supply
PWM	6	3	PWM Signal Input
FR	7	/	Inductive polarity Or Rotation Direction Control Pin,
MINSP	8	4	Input to set minimum speed or fan off range
VOUT	9	5	Regulator Output(Powersupply for external HALL switch)
HW/SCL	11	6	Hall switch input(connect the external Hall Switch output)
FG	12	7	Rotation Speed Detection. This is an open-drain output.
OUT2	13	8	Output 2
GND	15，16，Exposed pad	Exposed pad	Ground

■ Typical Application Circuit

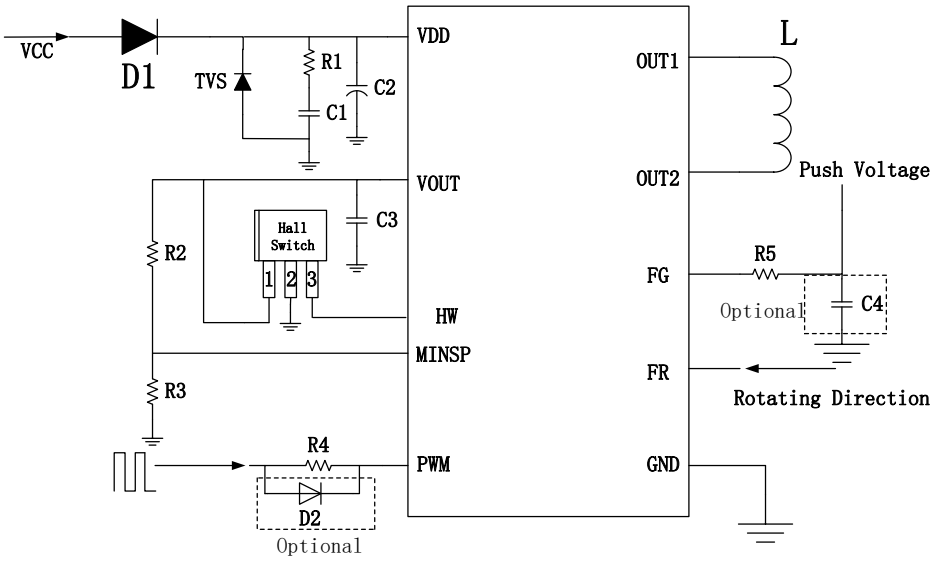


Figure 2, Typical Application Circuit Of OCH2991F（TSSOP16L-EP）

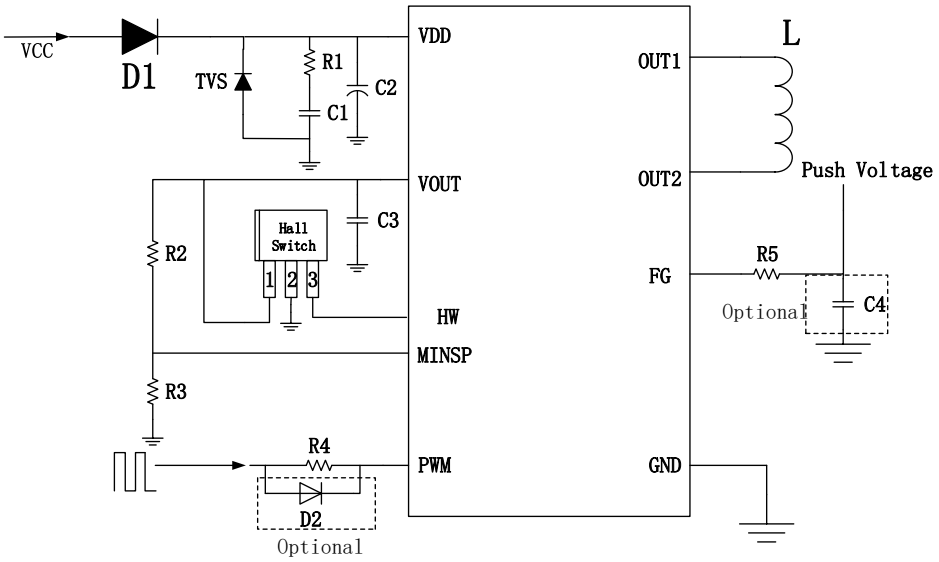


Figure 3, Typical Application Circuit Of OCH2991F（SOP-8L-EP）

Note1:

1) Must use least C1=4.7μF~10uF and R1=1~2Ω (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) C2 is Electrolytic Capacitor, the typical value is 10uF~47uF.
4) C3 is Optional, the typical value is 1uF.
5) C4 the typical value is 2.2nF
6) R2/R3 value decided the minimum output duty setting.
7) R4/R5, the typical value R4 is 10kΩ，R5 is 100Ω.
8) D2/C4 is optional.

■ Ordering Information

Part Number	Package Type	Packing Qty.	Temperature	Eco Plan	Lead
OCH2991FEFAD	TSSOP-16L-EP	2500pcs/Reel	-40~ +105°C	RoHS	Cu
OCH2991FESAD	SOP-8L-EP	4000pcs/Reel	-40~ +105°C	RoHS	Cu

■ Block Diagram

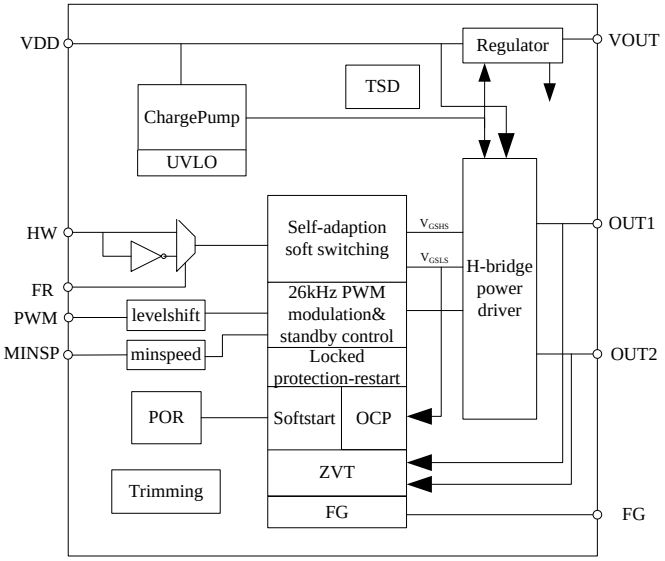


Figure 4, Block Diagram Of OCH2991F

■ 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
OUT1,2 Pin to GND	$V_{OUT1,2}$	-0.3 to +23	V
PWM Pin to GND	V_{PWM}	-0.3 to +23	V
FG Pin to GND	V_{FG}	-0.3 to +23	V
Peak Output Current	$I_{O(PEAK)}$	5.0	A
VOUT Pin to GND	V_{VOUT}	-0.3 to 7	V
HW Pin to GND	V_{HW}	-0.3 to 7	V
FR Pin to GND	V_{FR}	-0.3 to 7	V
Junction temperature	T_J	150	°C
Thermal Resistance(TSSOP16-EP)	θ_{JA}	54	°C /W
Thermal Resistance(SOP-8L-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 18	V
MINSPPin to GND	V_{MINSP}	0 to V_{VOUT}	V
HW Pin to GND	V_{HW}	0 to V_{VOUT}	V
FR Pin to GND	V_{FR}	0 to V_{VOUT}	V
Operating Temperature Range	T_A	-40 to +105	°C
Junction TemperatureRange	T_J	-40 to +125	°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, VCC=12V, unless otherwise noted.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
Supply						
V_{DD}	Input Voltage		3	-	18	V
I_{DD1}	Supply CurrentOf Operation Mode	IC is in operation mode No Load	-	2	4	mA
I_{DD2}	Supply CurrentOf Lock Mode	IC is in lock mode No Load	-	2	4	mA
I_{DD3}	Supply CurrentOf Standby Mode	IC is in standby mode No Load	-	2	4	mA
V_{VOUT}	VREF Pin Output Voltage	I_{VOUT}=5mA	-	4.8	-	V
Output						
$R_{DS(ON)}$	Output On-Resistance	I_O=1.5A Upper and Lower total	-	0.23	-	Ω
FG						
$R_{FG(ON)}$	Output On-Resistance	I_O=10mA	-	25	-	Ω
I_{FG}	FG Pin Off Leakage Current	-	-	<0.1	1	uA
HALL Switch Signal Input Threshold						
V_{HW_H}	Input Signal High level	-	1.5		5	V
V_{HW_L}	Input Signal low level	-	-	-	0.5	V
FR Signal Input Threshold						
V_{FR_H}	Input Signal High level	-	1.5	-	5	V
V_{FR_L}	Input Signal low level	-	-	-	0.5	V
Protection						
V_{UVLO}	Input UVLO rising threshold	-	-	2.85	-	V
V_{UVLO_HYS}	Input UVLO hysteresis	-		0.21		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	-	°C
T_{SH}	Thermal Shutdown Hysteresis	-	-	30	-	°C
I_{OCP}	Over-current limit protection threshold	-	-	5.5	-	A
I_{LIM1}	Output current limit1 (Operation Mode)	-	-	4.5	-	A
I_{LIM2}	Output current limit2 (Lock & Restart mode)	TSSOP-16L-EP	-	1.2	-	A
I_{LIM2}	Output current limit2 (Lock & Restart mode)	SOP-8L-EP	-	0.5	-	A
V_{ESD}	Human Body Model (HBM) ESD		4	-	-	KV
Soft Start						
Tss	Soft Start Time	TSSOP-16L-EP	-	1.4	-	Sec
Tss	Soft Start Time	SOP-8L-EP	-	2.5	-	Sec
PWM Control						
V_{PWM_H}	Pulse Mode PWM Input High Level Voltage	-	1.5		5	V
V_{PWM_L}	Pulse Mode PWM Input Low Level Voltage	-	-	-	0.5	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	-	°

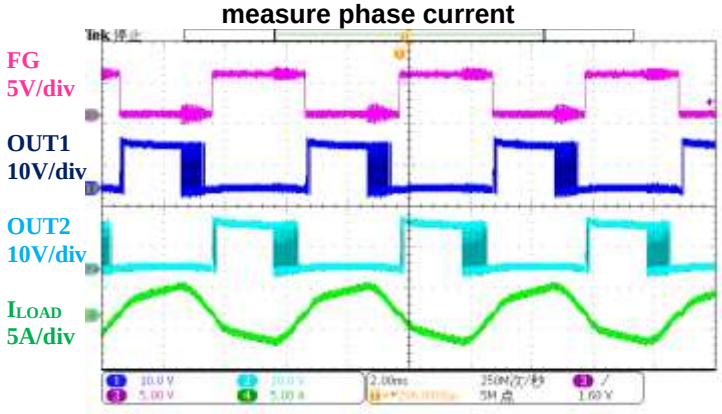
■ Truth Table

INPUT		OUTPUT			Mode
FR	HW(FG)	OUT1	OUT2	FG	
H	H	H	L	H	Operation Mode
H	L	L	H	L	
L	H	L	H	L	
L	L	H	L	H	
H	Hold H	L	L	OFF	Lock Mode
H	Hold L	L	L	OFF	
L	Hold H	L	L	OFF	
L	Hold L	L	L	OFF	

■ Operating Diagram

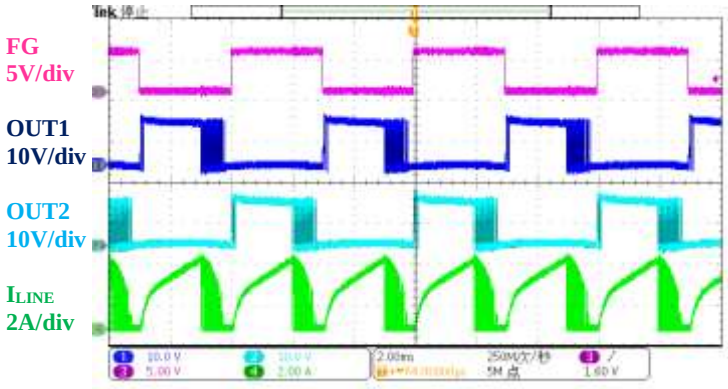
VCC = 12V, T_A = 25°C, tested with fan unit, unless otherwise noted.

Typical Waveform, Full speed, measure phase current



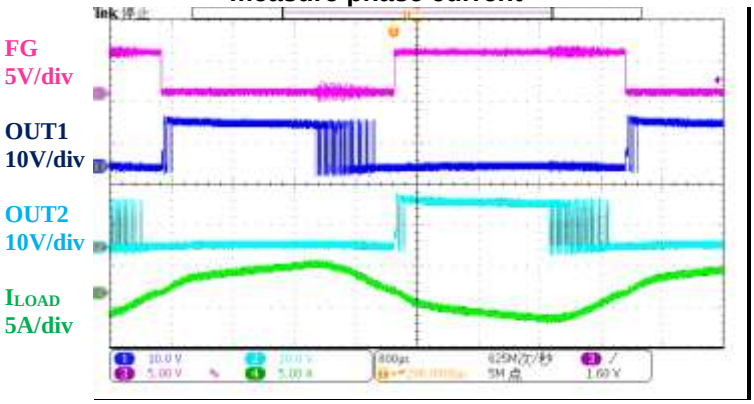
2ms/div

Typical Waveform, Full speed, measure line current



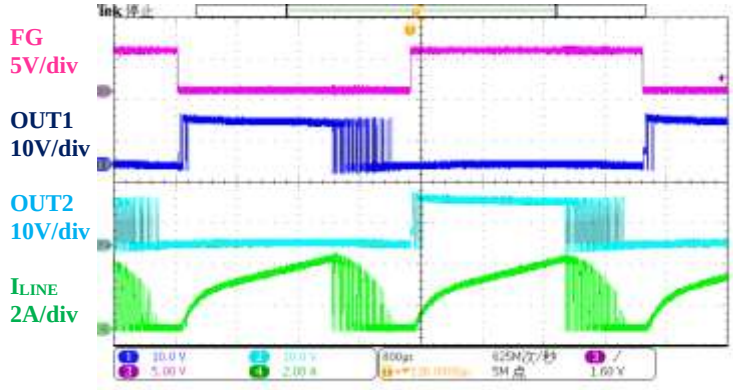
2ms/div

Typical Waveform, Switch Soft ON&SoftOFF, measure phase current



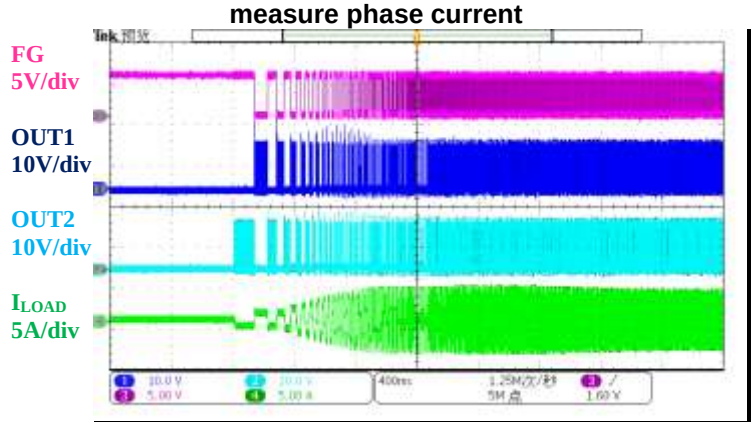
800us/div

Typical Waveform, Switch Soft ON&Soft OFF, measure line current



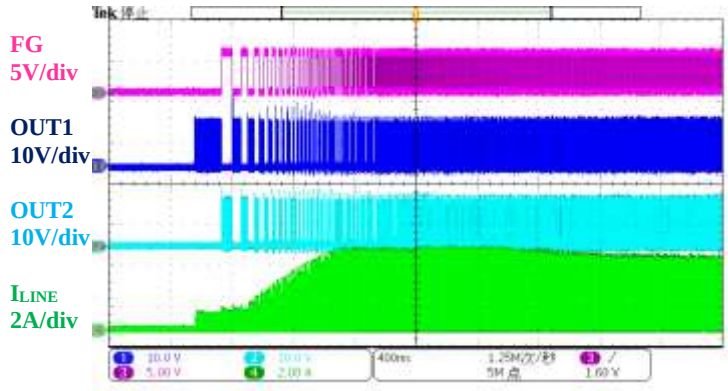
800us/div

Typical Waveform, Soft Start, measure phase current



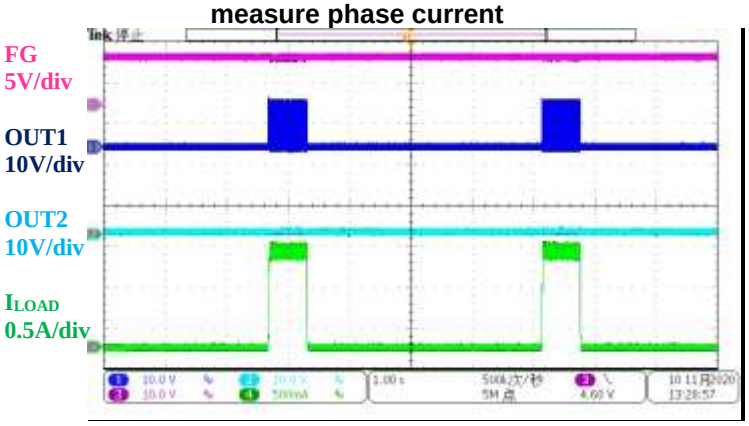
400ms/div

Typical Waveform, Soft Start, measure line current



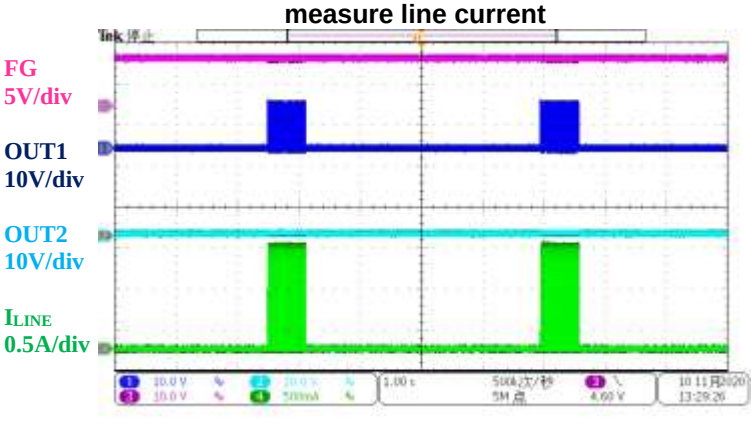
400ms/div

Typical Waveform, Lock &Restart, measure phase current



1s/div

Typical Waveform, Lock & Restart, measure line current



1s/div

■ Function Description

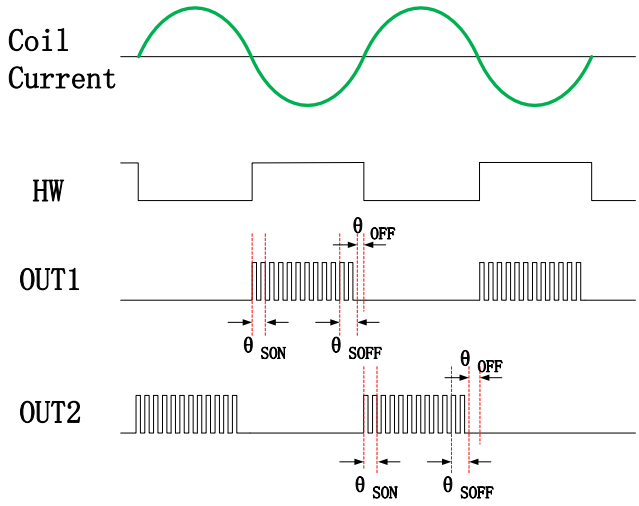
Speed Control

The OCH2991F is controlled using a PWM input interface, which is compatible with industrystandarddevices. The IC detects the PWMinput signal duty cycle and linearly controls theH-bridge output duty cycle, so the fan speedincreases as the input duty cycle increases. The PWM input accepts a wide input frequencyrange (10KHZ to 60 kHz), while the outputfrequency is kept constant at 26 kHz above theaudible frequency range.

PWM Output Drive

The IC controls the H-bridge MOSFETswitching to reduce speed variation andincrease systemefficiency (see Figure 2).

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



Soft Switch

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

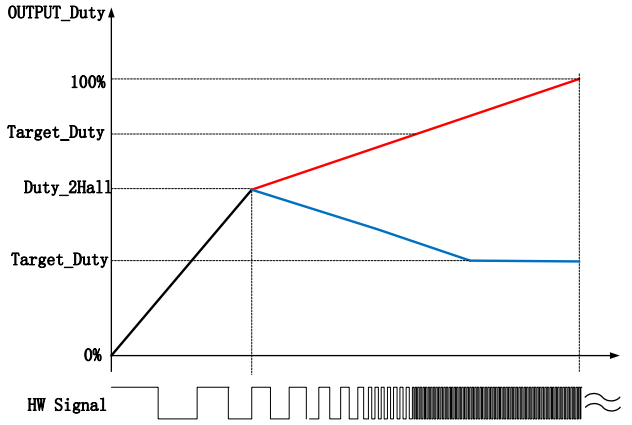
During soft turn-off section, OUT1 continues switching, and the duty cycle decreases gradually from thetarget setting duty cycle to 0 in max.16 stepswhile OUT2 remains low. The soft on angle lastfor 45° when output duty cycle is 100%.

During off time, OUT1 remains at high impedance. OUT2 remains low. The timeduration is adaptive from 0° to 45° . In steadystate, this function block maintains the phaselock of the HW signal falling edge and windingcurrent zero-crossing edge.

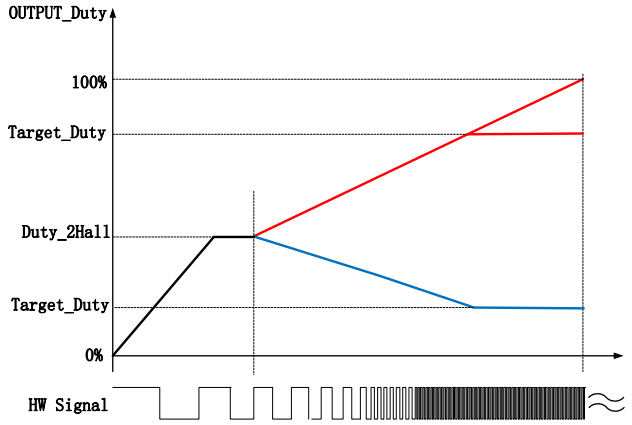
For the HW signal low interval, the conductingphase changes, but the switching sequence remains the same.

Soft Start

The OCH2991F provides the soft-start function to avoid peak current at power-on and lock-restart moments. The softstartfunction initial duty is 0%,ifHW signal change four times the duty will trace input target duty, else dutyfrom Duty_2Hall to 100% in 1.4or 2.5 sec(typ).



In order to further reduce the peak current, the OCH2991F is built in current limit (typical 1.2A/0.5A determined by package) 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.

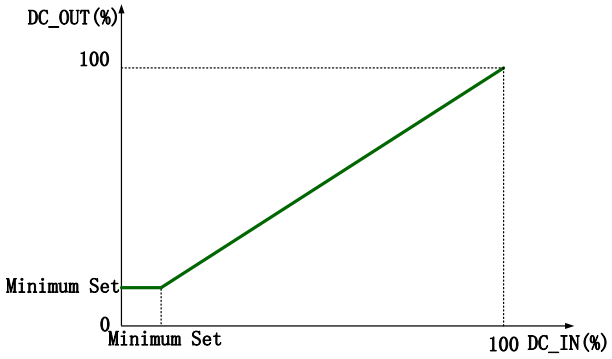


Minimum Output Duty setting

OCH2991F is built in minimum output duty setting function. It's set by the MINSP voltage.

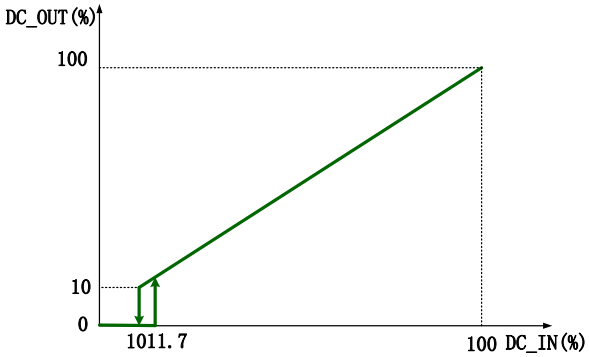
1) V_{MINSP}>0.6*V_{VOUT}

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}

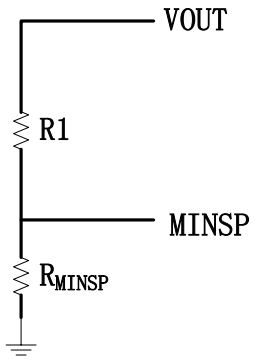
When VMINSP ＜ 0.2*VVOUT(include MINSP pin connect to GND),if PWM input duty is less than the 10%, the IC will enter into shutdown mode.

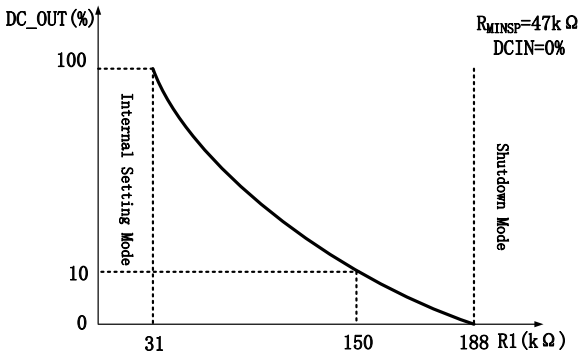


3) 0.2*V_{VOUT}＜V_{MINSP}＜0.6*V_{VOUT}

When 0.2*VVOUT ＜ VMINSP ＜ 0.6*VVOUT, the minimum output duty setting function is set by RMINSP 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 OCH2991F 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-voltagelockout (UVLO) threshold voltage, all circuitry inthe device is disabled, and the internal logic isreset. Operation resumes when VCC risesabove the UVLO threshold.

Over-Current Protection (OCP) and Power OnShort-Circuit Detection

The OCH2991F protects againstshort circuit by detecting the current flowingthrough two low-side MOSFETs (LS-FET). If the current flowingthrough any MOSFET exceeds the over-currentprotection (OCP) threshold after about 1.5μs ofblanking time, that all MOSFETs turns offimmediately. After approximately 3.6s of delay, the bridge is re-enabled automatically. The OCP current threshold is5.5A (typical).

And When IC power on, if OUT1or OUT2 is short to GND, the built short circuit by detectingtwo 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

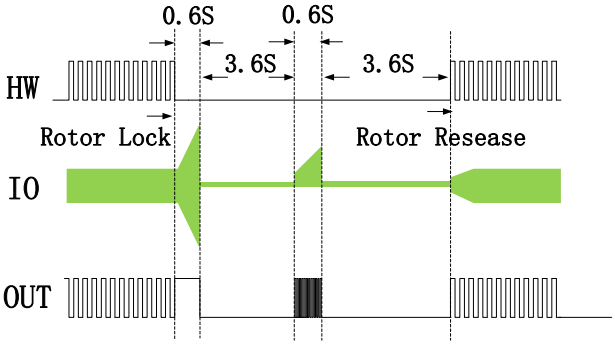
During normal switching, if the current flowingthrough the low-side MOSFET (LS-FET) of theH-bridge exceeds the threshold after around 1.5μs ofblanking time, the HS-FET turns off immediately. The HS-FET resumes switching in the next switching cycle. The overload current limit is4.5A (typical).

Thermal Shutdown

Thermal monitoring is also integrated into the OCH2991F. If the die temperature rises above155℃, the IC turns off the two HS-FETs andturns on the two low-side MOSFETs (LS-FET). Once the die temperature hasfallen to a safe level, operation resumesautomatically.

Rotor Lock and Restart Protection

If the ICcannot see the HW signal edge change duringthe 0.6s detection time, all MOSFETs of the H-bridgeare turned off. After 3.6s of recovery time, theIC 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 keepthe input voltage stable and reduce inputswitchingvoltage noise and ripple. The inputcapacitor impedance must be low at theswitching frequency. Ceramic capacitors withX7R dielectrics are recommended for their lowESR characteristics. Ensure that the ceramic capacitance is dependent on the voltage rating. The DC bias voltage and value can lose asmuch as 50% of its capacitance at its ratedvoltage rating. Leave enough voltage rating margin when selecting the component. Formost 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

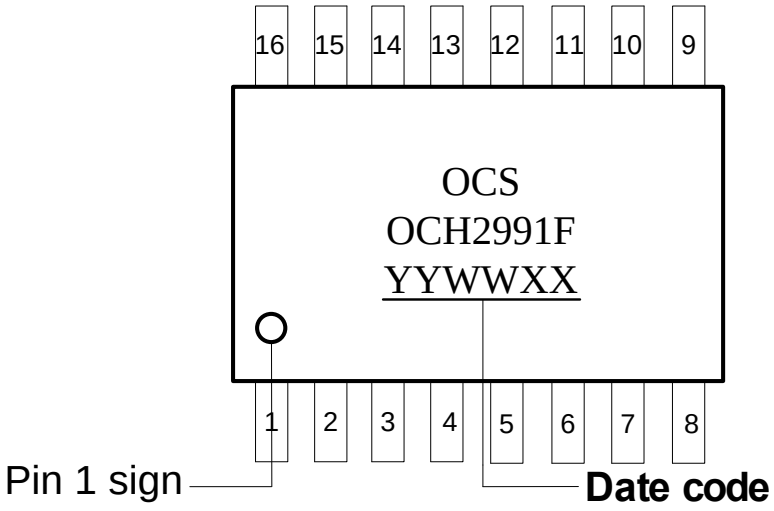
Due to the input capacitor energy charge/discharge during the phase transition soft switching, the input current has switching cycle ringing. If needed, add a 1~2Ω resistor in series with a 4.7~10μF capacitor as an R-C.

Input Clamping TVS

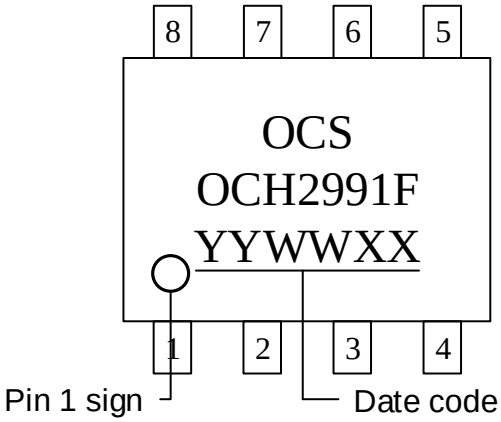
To avoid high voltage spikes caused by the energy stored in the motor inductor charges back to the input capacitor side, must add a voltageclamping transient voltage suppressor (TVS)diode. For a 12V case, a 16.8V/SOD-323package TVS diode is sufficient.

■ Marking Information

1）TSSOP-16L-EP:

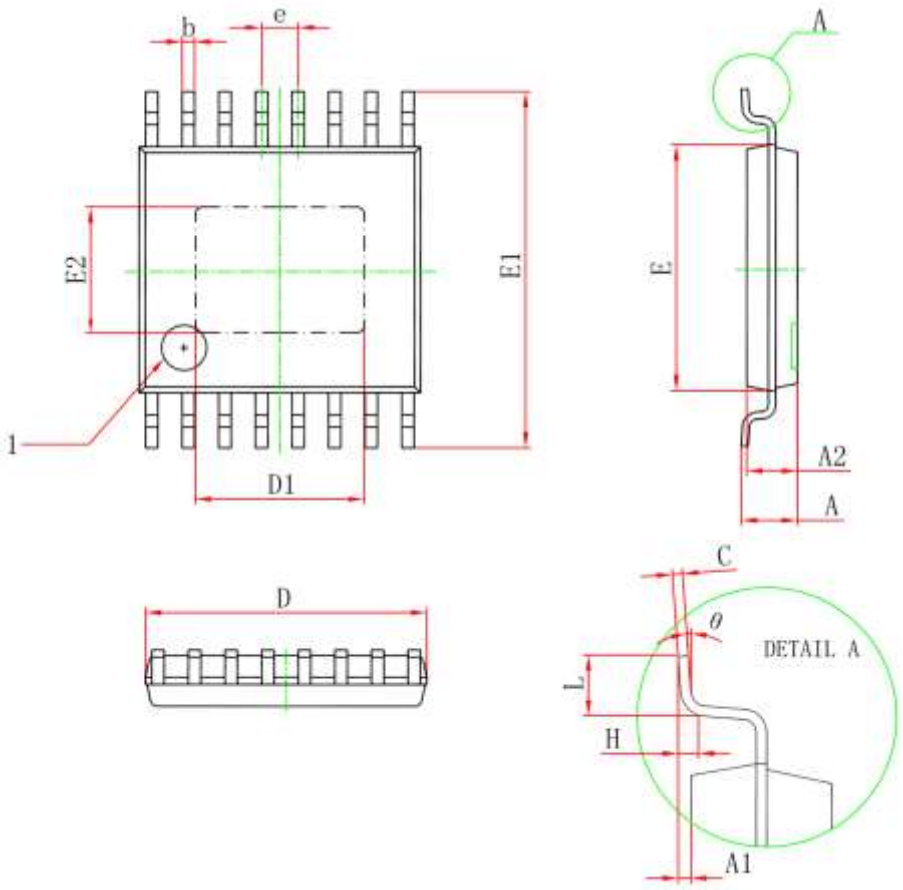


2）SOP-8L-EP:



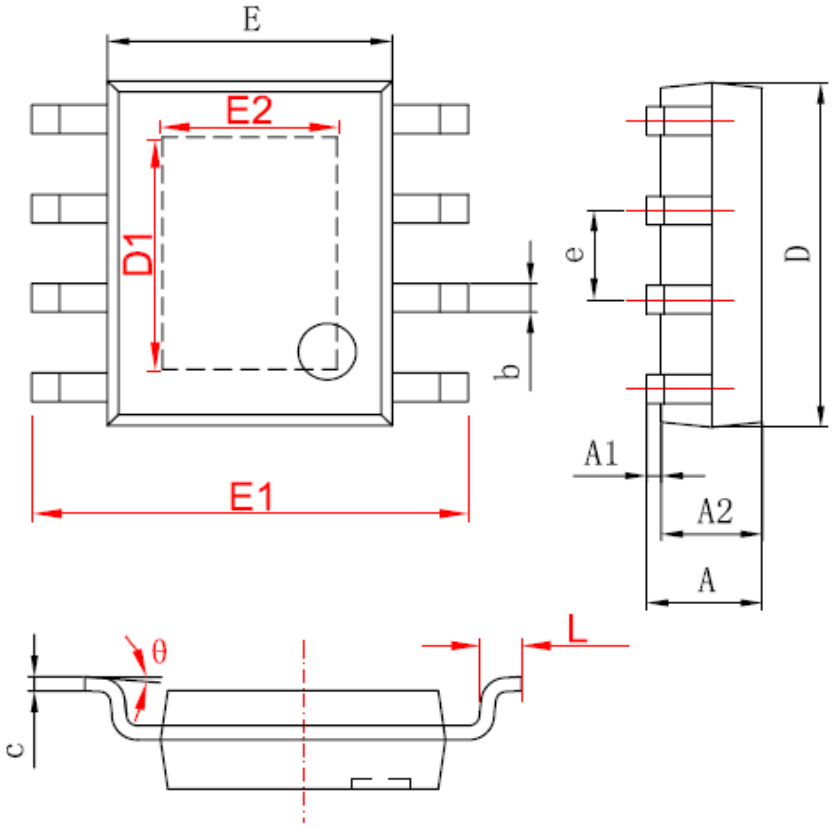
■ Package Information

1) TSSOP-16L-EP



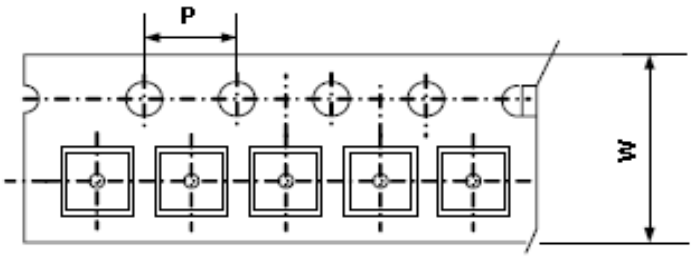
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
D	4.900	5.100	0.193	0.201
D1	2.900	3.100	0.114	0.122
E	4.300	4.500	0.169	0.177
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
E1	6.250	6.550	0.246	0.258
E2	2.200	2.400	0.087	0.094
A		1.150		0.043
A2	0.800	1.000	0.031	0.039
A1	0.020	0.150	0.001	0.006
e	0.65（BSC）		0.026(BSC)	
L	0.500	0.700	0.02	0.028
H	0.25(T YP)		0.01(T YP)	
θ	1°	7°	1°	7°

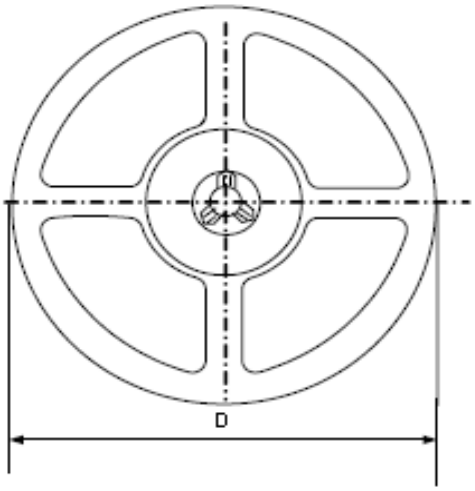
2) SOP-8L-EP



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
TSSOP-16L-EP	12.0±0.1 mm	4.0±0.1 mm	330±1 mm	2500pcs
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

IMPORTANT NOTICE

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