

3-Phase Sine-Wave Sensor-Less Fan Motor Driver

Chip Description

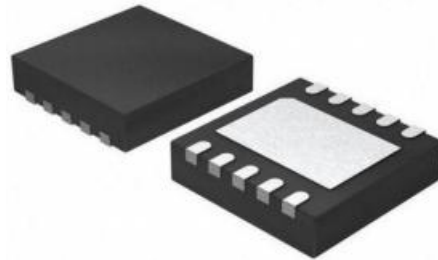
The GC5958 provides all the circuitry for sensor-less speed control of three-phase brushless DC motor. The Sine-wave Driver method will be better sound quality. The controller functions include start-up circuit, back-EMF commutation control, Pulse Width Modulation (PWM) speed control, lock protection, and thermal shutdown circuit. The GC5958 is suitable for both game machine and CPU cooler that need silent drivers. It is available in DFN3x3-10 package.

Chip Features

- PWM Sine-wave Driver
- Three-Phase Sensor-Less Drive Method
- Adjustable Forced Commutation Frequency (for Start-up)
- Built-In External PWM Speed Control
- Built-In Quick Start Function
- FG (Rotation Speed Detection) Output
- Power Saving Function (PWM Duty Input is 0%)
- Built-In Lock Protection and Auto Restart Function
- Thermal Shutdown Circuit

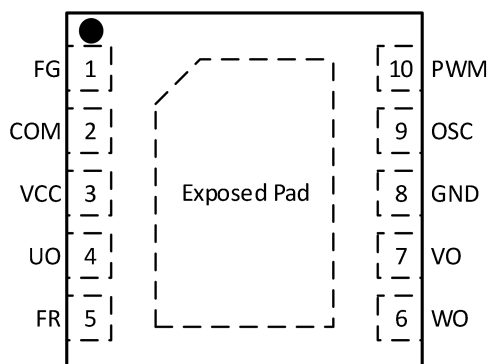
Chip Application

- Motor Drivers for Silent Fans
- Variable Speed Control Fans



Part Number	Package Type	Body Size
GC5958	DFN10	3*3*0.55, e=0.5

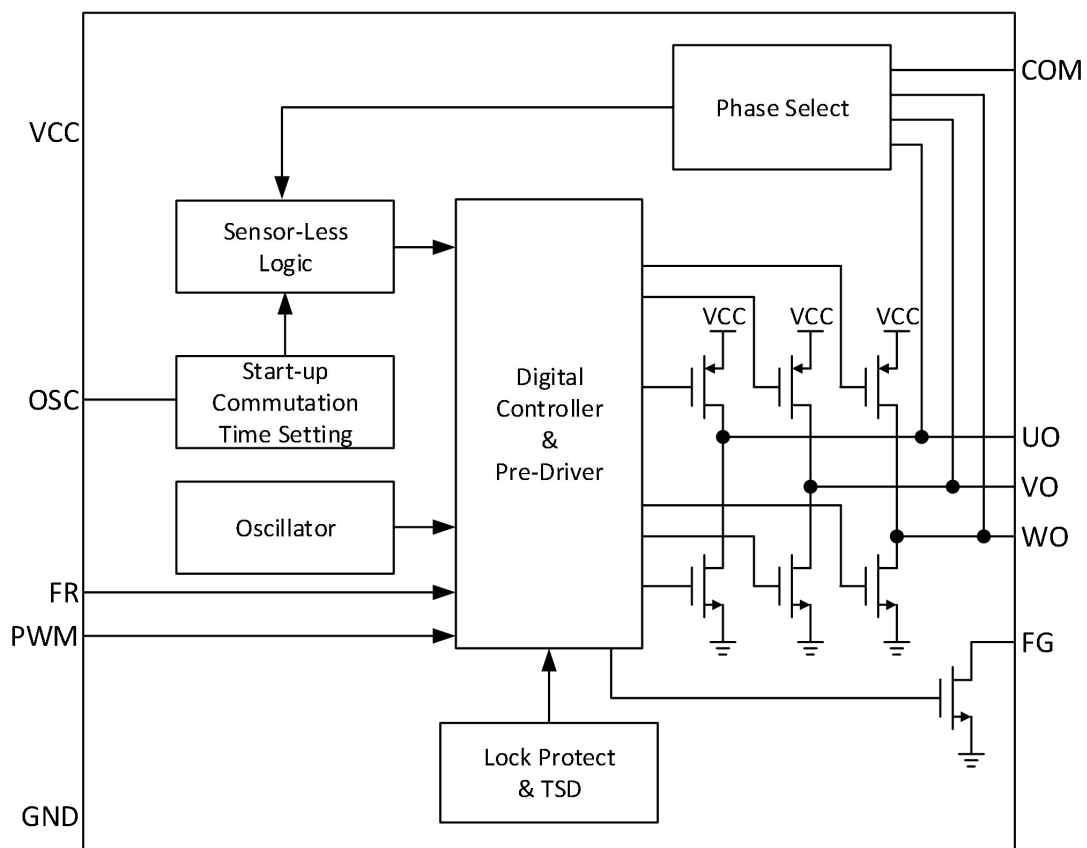
Pin Map



Pin Description

Pin.num	Pin Name	I/O	Pin Function
1	FG	O	Rotation Speed Output. This is an open-drain output.
2	COM	I	Motor Neutral Point Input Pin.
3	VCC	Power	Supply Pin.
4	UO	O	Driver Output Pin. Output signal for driving motor phase U.
5	FR	I	Motor Spin Direction Control Pin. High Level (FR=VCC): U → V → W Low Level (FR=GND): U → W → V
6	WO	O	Driver Output Pin. Output signal for driving motor phase W.
7	VO	O	Driver Output Pin. Output signal for driving motor phase V.
8	GND	Ground	Ground Pin.
9	OSC	I/O	Start-up Commutation Time Setting. Connect a capacitor to GND to set start-up commutation time.
10	PWM	I	PWM Signal Input Pin. Input PWM signal to control rotation speed.
	Exposed Pad		Not connected. Exposed pad to be shorted to GND on pcb.

Block Diagram



Absolute Maximum Ratings

(over operating free-air temperature range, unless otherwise noted)

Symbol	Parameter	Rating	Unit
V _{VCC}	Power supply	-0.3~7.0	V
I _{OUT}	UO/VO/WO Pin Output Current	1.0	A
V _(UO/VO/WO)	UO/VO/WO Pin Output Voltage	-0.3~7.0	V
V _{PWM}	PWM Pin Maximum Input Voltage	-0.3~7.0	V
V _{FG}	FG Pin Output Voltage	-0.3~7.0	V
I _{FG}	FG Pin Sink Current	10	mA
V _{FR}	FR Pin Input Voltage	-0.3~7.0	V
T _J	Junction Temperature	-40~150	°C
T _{STG}	Storage Temperature	-60~150	°C
ESD	HBM	±3000	V

Recommended Operating Conditions

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
VCC Pin Supply Voltage	V _{VCC}		1.8		6.0	V
PWM Pin Input Voltage	V _{PWM}		0		V _{VCC}	V
Ambient Temperature	T _A		-40		105	°C
UO/VO/WO Pin Average Output Current	I _{OUT}		0		500	mA

Electrical Characteristics

 (unless otherwise specified, $V_{VCC} = 5V$, $T_A = 25^\circ C$)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Supply Current						
Operating Current	I_{VCC1}	Rotation Mode, $FR = V_{VCC}$	-	2.9	4.0	mA
	I_{VCC2}	Standby Mode(PWM = 0)	-	130	180	μA
PWM Control						
PWM Input High Level Voltage	V_{PWMH}		2.5	-	$V_{VCC} + 0.3$	V
PWM Input Low Level Voltage	V_{PWML}		-0.3	-	0.8	V
PWM High Input Current	I_{PWMH}	PWM = V_{VCC}	-	0	-	μA
PWM Low Input Current	I_{PWML}	PWM = GND	-	2.6	3	μA
PWM Input Frequency	F_{PWM}		2	-	50	kHz
Output Switch Frequency	F_{OUT}		-	22	-	kHz
Output Drivers						
Output Driver Saturation Voltage	V_O	$I_{OUT} = 250mA$	-	0.3	0.44	V
FG Pin Low Voltage	V_{FG}	$I_{FG} = 5mA$	-	0.2	0.3	V
FG Pin Leak Current	I_{FGL}	$V_{FG} = 7V$	-	-	10	μA
Lock Protection						
Lock Detection On Time	T_{ON}		1.1	1.3	1.5	sec
Lock Detection Off Time	T_{OFF}		5.78	6.6	7.5	sec
FR						
FR Pin High Level Voltage	V_{FRH}		$0.5 \times V_{VCC}$	-	V_{VCC}	V
FR Pin Low Level Voltage	V_{FRL}		0	-	$0.1 \times V_{VCC}$	V
Quick Start						
Quick Start Enable Time	T_{QS}		-	18	-	ms
Thermal Shutdown						
Over Temperature Shutdown Threshold	T_{OTS}		-	165	-	$^\circ C$
Over Temperature Shutdown Hysteresis	ΔT_{OTS}		-	30	-	$^\circ C$

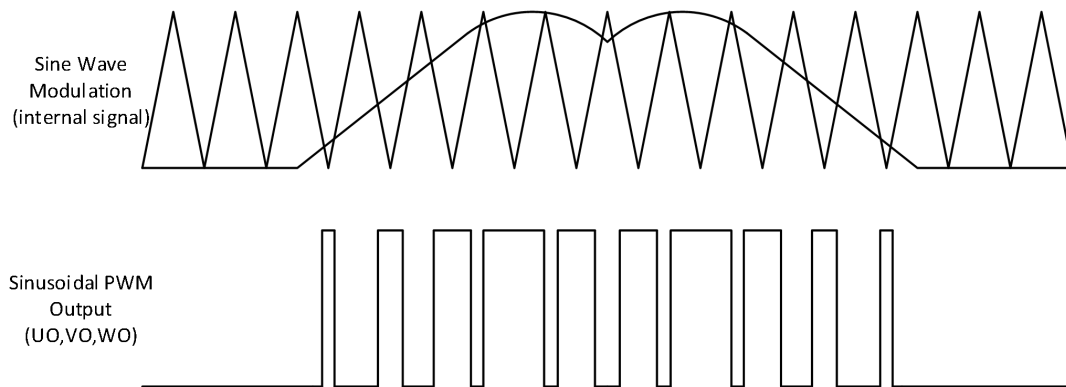
Function Description

1. PWM Speed Control (fixed-frequency output)

The GC5958 is possible to change rotation speed of the motor by switching output transistor. The on-duty of switching depends on the signal from input to PWM terminal. The output PWM frequency is fixed to 22KHz typically.

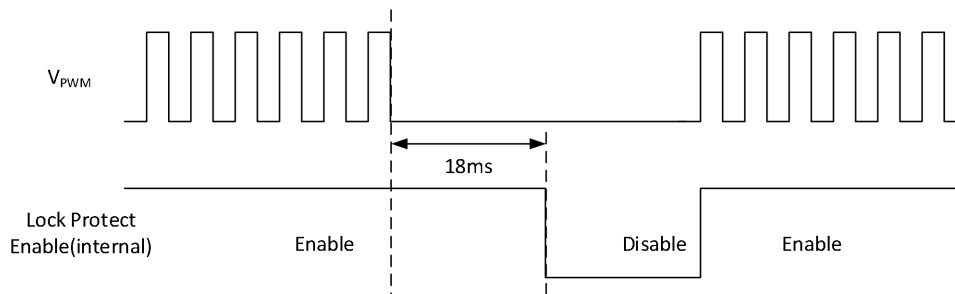
2. Soft Switch (sine-wave output)

This is a soft switch function to make phase current become smooth, which can reduce the noise of motor in switching interval. Using PWM duty cycle control to create the sinusoidal current waveform. BEMF detection window is opened on phase W in order to measure the rotor position so as to define the modulation timing. close to the ideal sine wave output.



3. Quick Start and Standby Mode

The GC5958 disables the lock protection function when the PWM input keeps low level for more than 18ms.



4. Lock Protection and Automatic Restart

The GC5958 provides the lock protection and automatic restart functions to prevent the coil burnout while the fan is locked. As the fan is locked, the IC will come into startup operation for 1.3 second. Then, the IC will switch to lock protection mode to turn off output driver for 6.6 seconds. After lock protection mode, the IC switches to start-up operation again. If the locked condition still remains, the lock-and-restart process will be recurred until the locked condition is released.

5. Thermal Protection

The GC5958 has thermal protection. When internal junction temperature reaches 165°C, the output devices will be switched off. When the IC's junction temperature cools down 30°C, the thermal sensor will turn on the output devices again, resulting in a pulsed output during continuous thermal protection.

6. Input Protection Diode and Capacitor

It is necessary to add 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 larger than the maximum output current. For the noise reduction purpose, a capacitor (C1) is connected between VCC and GND. It's suggested that C1 should be placed as close as possible in the VCC pin.

7. FG Resistor

The value of the FG resistor could be decided by the following equation:

$$R_{FG} = \frac{V_{VCC} - V_{FG}}{I_{FG}}$$

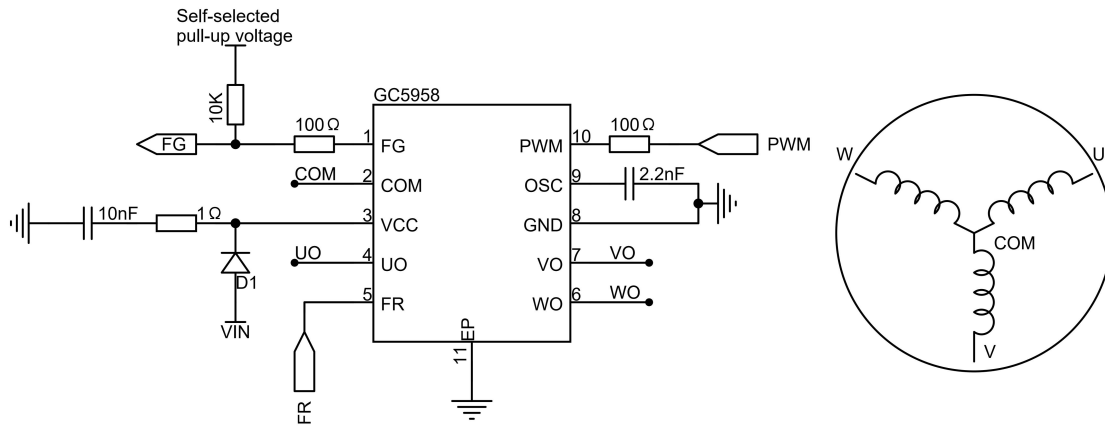
For example: $V_{VCC} = 5V$, $I_{FG} = 5mA$, $V_{FG} = 0.2V$, $R_{FG} = 960\Omega$

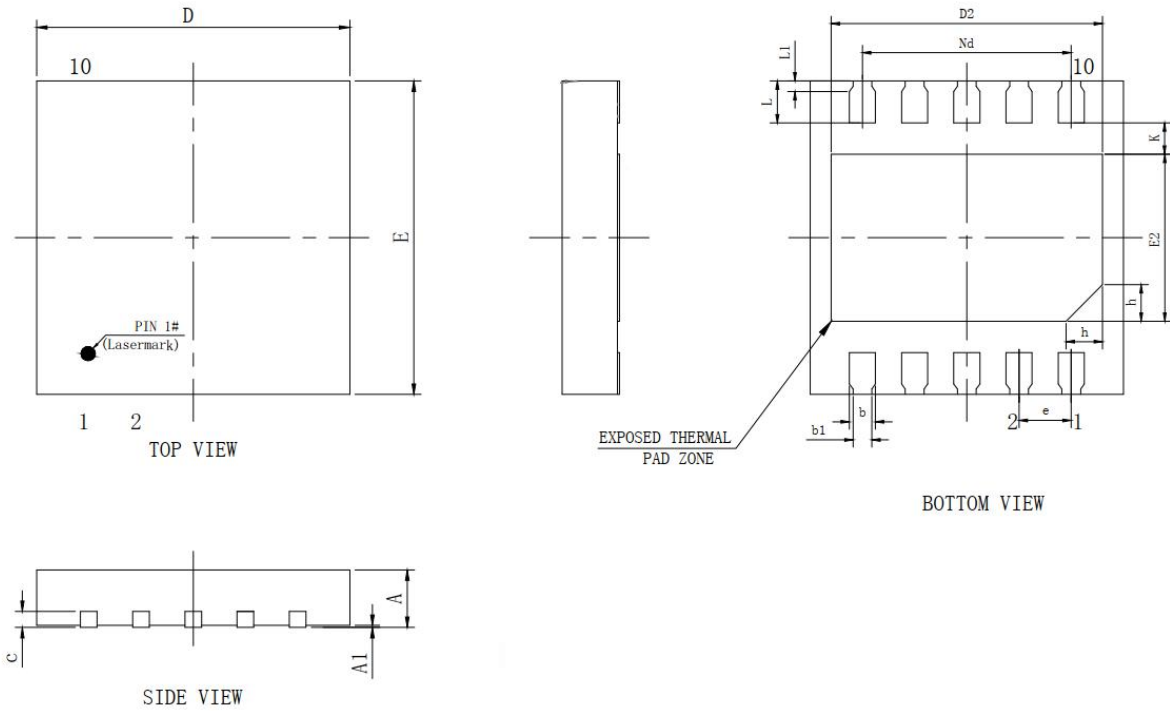
The value of resistor in the range of $1k\Omega$ to $10k\Omega$ is recommended.

8. OSC Capacitor

The capacitor connects from OSC pin to GND can be determined the frequency of force commutation. The optimal design of the frequency could make sure the motor start-up in succeed. Its capacitance from $1000pF$ to $3300pF$ is recommended.

Typical Application



Package Information
DFN10
UNIT: mm


SYMBOL	MIN	NOM	MAX
A	0.50	0.55	0.60
A1	0	0.02	0.05
b	0.20	0.25	0.30
b1	0.18REF		
c	0.152REF		
D	2.90	3.00	3.10
D2	2.50	2.60	2.70
Nd	2.00BSC		
E	2.90	3.00	3.10
E2	2.50	2.60	2.70
e	0.50BSC		
K	0.25	0.30	0.35
L	0.35	0.40	0.45
L1	0.10REF		
h	0.30	0.35	0.40

Description of Lot Code



Printing instructions:

1. The first line GC5958 represents the product model;
2. The second line represents the traceability code.

Revision History

Version	Description
V1.0	Initial version
V1.1	Updated some format
V1.2	Updated some format
V1.3	Updated packaging information
V1.4	Updated packaging information
V1.5	Updated some electrical data