

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

Chip Description

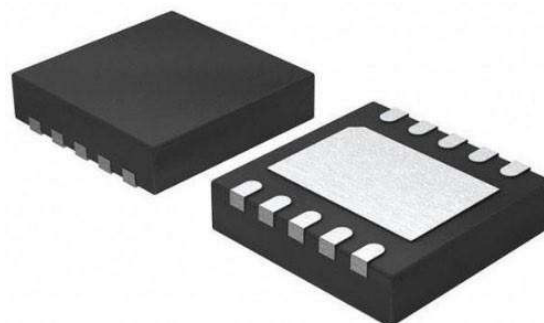
The GC5331 provides all the circuitry for sensor-less speed control of three-phase brushless DC motor. The Sine-wave Driver method will be better sound quality. The controller functions include start-up circuit, back-EMF commutation control, Pulse Width Modulation (PWM) speed control, lock protection, and thermal shutdown circuit. The GC5331 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, 1/2FG, 1/3FG or 2/3FG Output
- Power Saving Function (PWM Duty Input is 0%)
- Built-In Lock Protection and Auto Restart Function
- Thermal Shutdown Circuit

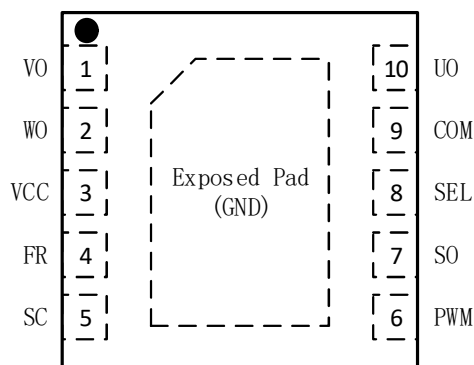
Chip Application

- Motor Drivers for Silent Fans
- Variable Speed Control Fans



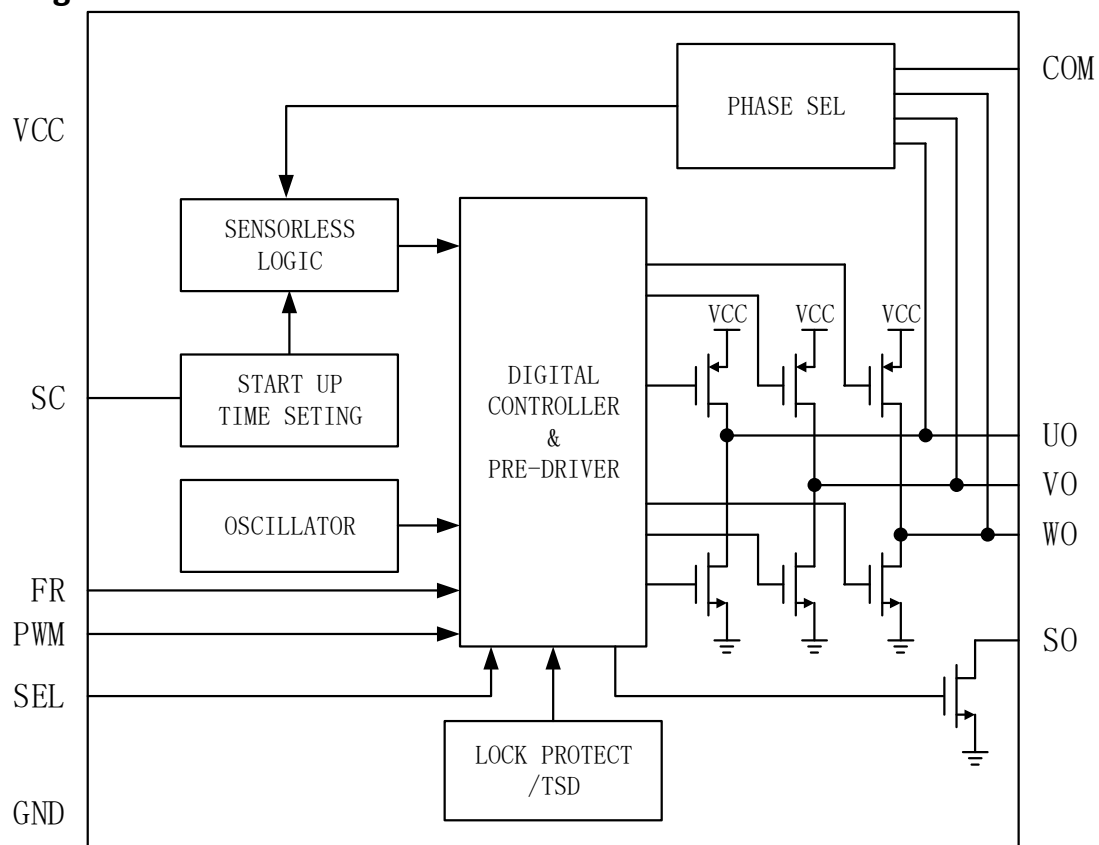
Product name	Package Type	Detail description
GC5331	DFN3x3-10	3.0*3.0, 0.55, e=0.5

Pin Map



Pin Description

Pin No.	Pin Name	I/O	Pin Function
1	VO	O	Driver Output Pin. Output signal for driving motor phase V.
2	WO	O	Driver Output Pin. Output signal for driving motor phase W.
3	VCC	power	Supply Pin.
4	FR	I	Motor Spin Direction Control Pin. High Level (FR=VCC): $U \rightarrow V \rightarrow W$ Low Level (FR=GND): $U \rightarrow W \rightarrow V$
5	SC	I/O	Start-up Commutation Time Setting. Connect a capacitor to GND to set start-up commutation time.
6	PWM	I	PWM Signal Input Pin. Input PWM signal to control rotation speed.
7	SO	O	Rotation Speed Output. This is an open-drain output.
8	SEL	I	Mode Setting. Use a voltage divider from VCC to set SEL pin voltage for setting.
9	COM	I	Motor Neutral Point Input Pin
10	UO	O	Driver Output Pin. Output signal for driving motor phase U.
ExposedPad	GND	ground	Ground Pin.

Block Diagram


Absolute Maximum Ratings

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

Symbol	Parameter	Rating	Unit
V _{CC}	Power supply	-0.3 to 6.5	V
I _{OUT}	UO/VO/WO Pin Output Current	1.4	A
V _(UO/VO/WO)	UO/VO/WO Pin Output Voltage	-0.3 to 6	V
V _{PWM}	PWM Pin Maximum Input Voltage	-0.3 to 6	V
V _{SO}	SO Pin Output Voltage	-0.3 to 6	V
I _{SO}	SO Pin Sink Current	10	mA
V _{FR}	FR Pin Input Voltage	-0.3 to 6	V
T _J	Junction Temperature	-40 to 150	°C
T _{STG}	Storage Temperature	-60 to 150	°C
ESD	HBM	±8000	V
	CDM	±2000	V
LU		±200	mA

Recommended Operating Conditions

Symbol	Parameter	Range	Unit
V _{CC}	VCC Pin Supply Voltage Range	1.8 to 6	V
V _{PWM}	PWM Pin Input Voltage Range	0 to VCC	V
T _A	Ambient Temperature	-40 to 105	°C
I _{OUT}	UO/VO/WO Pin Average Output Current	0 to 850	mA

Electrical Characteristics

(VCC=5V, TA=25°C, unless otherwise specified)

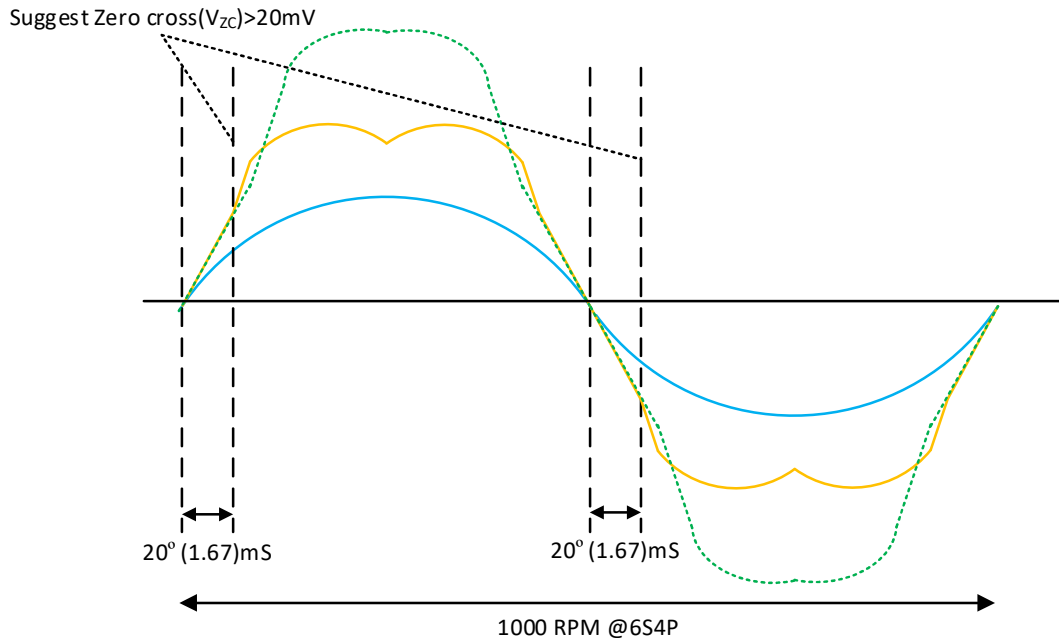
Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
Supply Current						
I _{CC1}	Operating Current	Rotation Mode	-	3	5	mA
I _{CC2}		Standby Mode(PWM=0)	-	100	150	uA
PWM Control						
V _{PWMH}	PWM Input High Level Voltage	VCC=5V	1.8	-	V _{CC} +0.3	V
V _{PWML}	PWM Input Low Level Voltage		-0.3	-	0.8	V
I _{PWMH}	PWM High Input Current	PWM=VCC	-	0	-	uA
I _{PWML}	PWM Low Input Current	PWM=GND	-	-10	-	uA
F _{PWM}	PWM Input Frequency		2	-	50	kHz
F _{OUT}	Output Switch Frequency		-	60	-	kHz

Output Drivers						
V _O	Output Driver Saturation Voltage	I _{OUT} =250mA	-	0.175	0.35	V
V _{SO}	SO Pin Low Voltage	I _{SO} =5mA	-	0.1	0.3	V
I _{SOL}	SO Pin Leakage Current	V _{SO} =5V	-	0.1	1	uA
Lock Protection						
T _{ON}	Lock Detection On Time		0.55	0.7	0.85	sec
T _{OFF}	Lock Detection Off Time		4.25	5	5.75	sec
FR						
V _{FRH}	FR Pin High Level Voltage		2.5	-	VCC	V
V _{FRL}	FR Pin Low Level Voltage		0	-	0.8	V
Quick Start						
T _{QS}	Quick Start Enable Time		-	10	-	ms
Thermal Shutdown						
OTS	Over Temperature Shutdown Threshold		-	165	-	°C
	Over Temperature Shutdown Hysteresis		-	30	-	°C

Function Description

BEMF Zero Crossing

It has a BEMF detected comparator. However, BEMF characteristic at zero cross point is very flat, if rotor was at this position, the BEMF would not be able to detected. The fan makes drive need adequate BEMF.

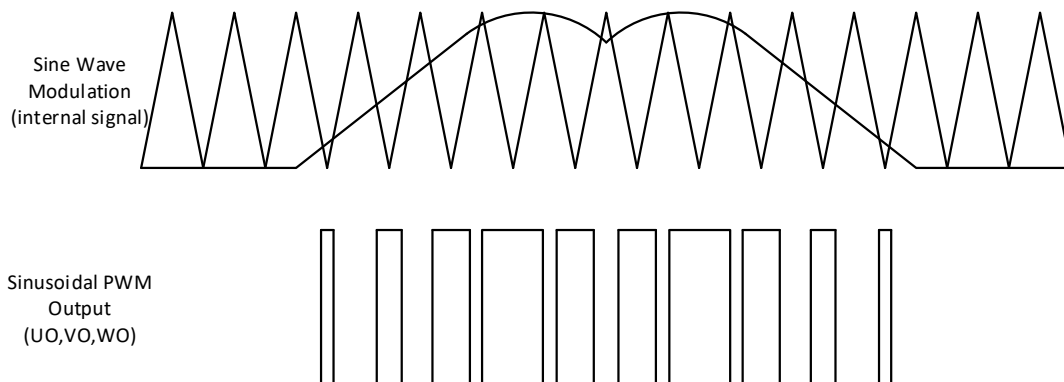


PWM Speed Control (fixed-frequency output)

It 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 60KHz typically.

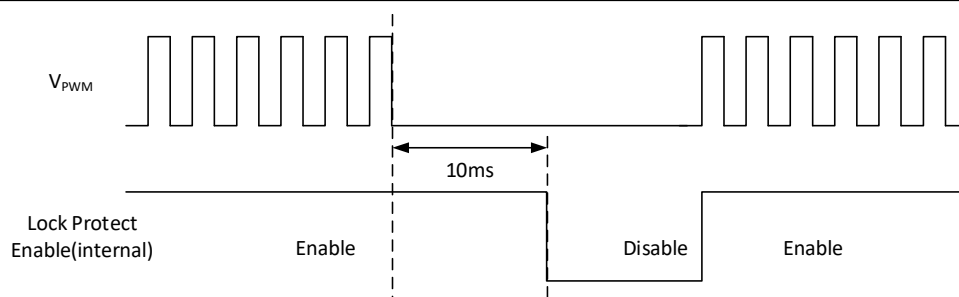
Soft Switch (sine-wave output)

This is a soft switch PWM output to make the phase current smoother, which can reduce the noise of motor in switch interval. Using PWM duty control to simulate the idea sine wave output current.



Quick Start and Standby Mode

This IC would enter standby mode when the PWM input keeps low level for more than 10ms typically. In standby mode, the supply current is around 100uA and the lock protection function doesn't work, therefore, starting fan is unobstructed when releasing standby mode.



SEL Control

It supports FG, 1/2FG, 1/3FG, or 2/3FG Output.

SEL Pin Input Voltage	R_{SEL1}/R_{SEL2}	SO Output
GND	Open/GND	1/3FG
$0.24 \times V_{CC}(V) - 0.54 \times V_{CC}(V)$	$20k\Omega/10k\Omega$	2/3FG
$0.58 \times V_{CC}(V) - 0.8 \times V_{CC}(V)$	$10k\Omega/20k\Omega$	1/2FG
VCC	VCC/Open	FG

SC Control

T_{SC} and Auto mode controlled by R_{SC} and C_{SC} .

R_{SC}	C_{SC}	T_{SC}	Mode
floating	4.7nF	145(ms)	Non-auto
	3.3nF	100(ms)	
	2.2nF	65(ms)	
	1nF	28(ms)	
	floating	115(ms)	
30k Ω	4.7nF	178(ms)	Auto
	3.3nF	124(ms)	
	2.2nF	80(ms)	
	1nF	33(ms)	
	floating	115(ms)	
GND	floating	115(ms)	Auto

Lock Protection and Automatic Restart

It 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 start-up operation for 0.7 second. Then, the IC will switch to lock protection mode to turn off output driver for 5 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.

Thermal Protection

It 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.

Input Protection Diode and Capacitor

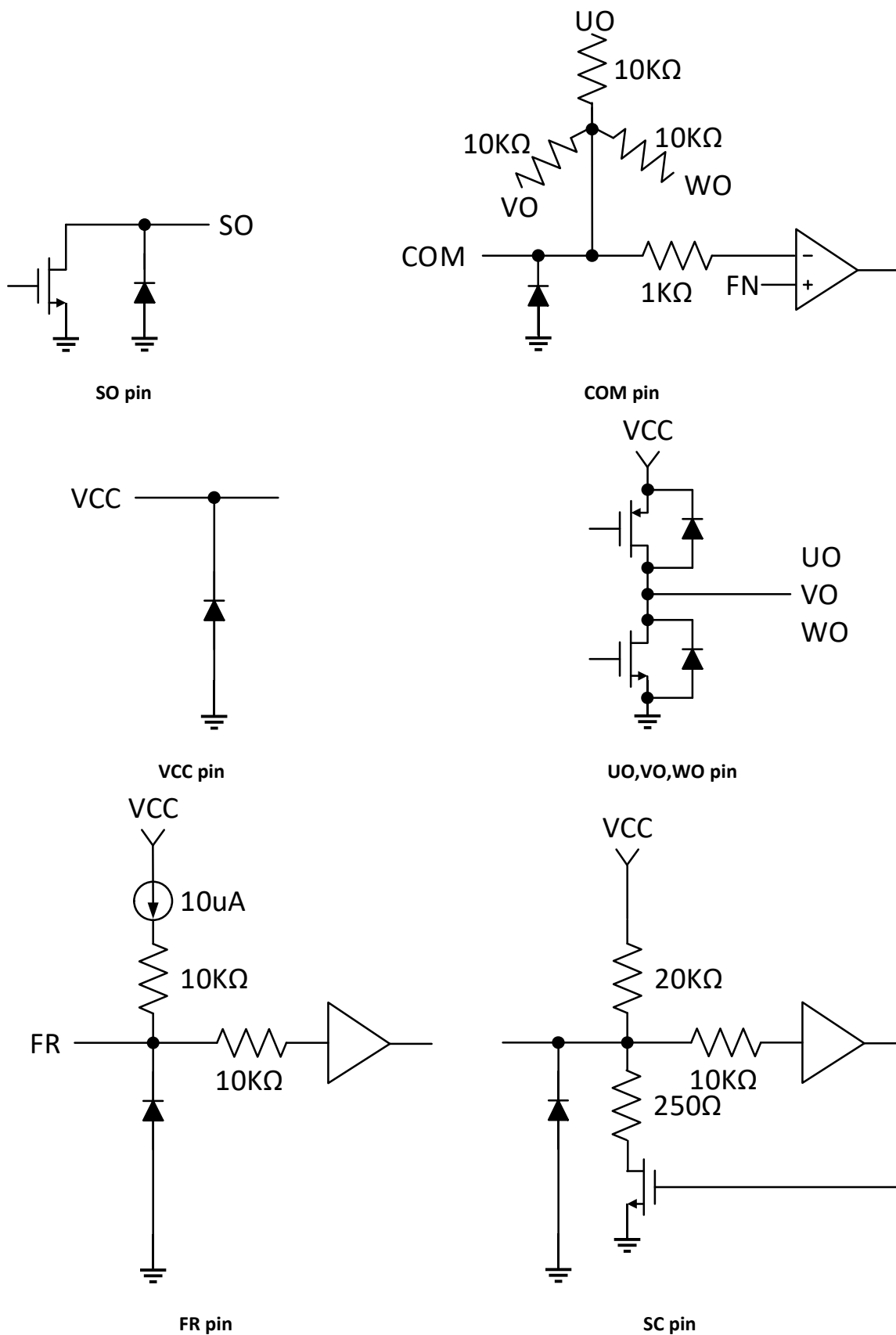
It is necessary to add a protection diode (D1) to prevent the damage from the power reverse connection. However, the protection diode will cause a voltage drop on the supply voltage. The current rating of the diode must be larger than the maximum output current. For the noise reduction purpose, a capacitor (C1) is connected between VCC and GND. It's suggested that C1 should be placed as close as possible in the VCC pin. (see Typical Application)

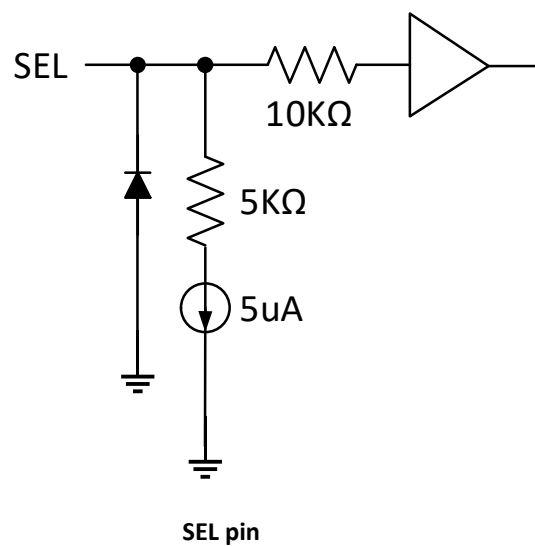
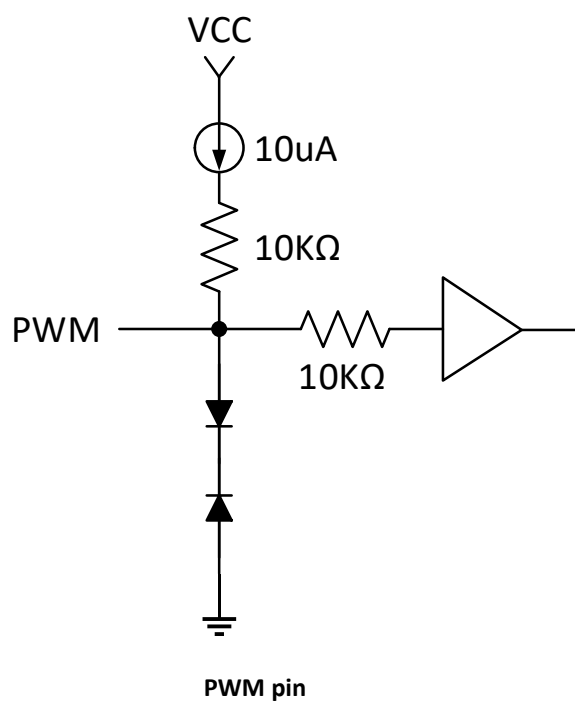
SO Resistor

The value of the SO resistor could be decided by the following equation: $R_{SO} = \frac{V_{CC} - V_{SO}}{I_{SO}}$

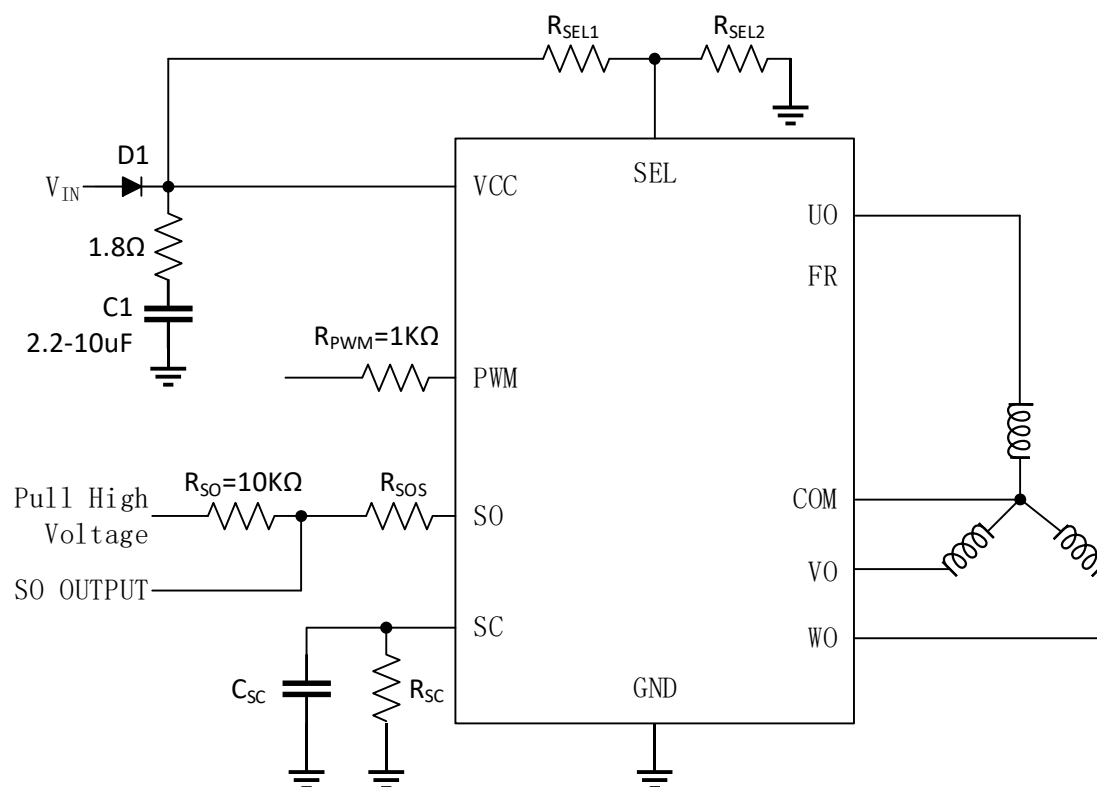
For example: $V_{CC} = 5V$, $I_{SO} = 5mA$, $V_{SO} = 0.1V$, $R_{SO} = 980\Omega$

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

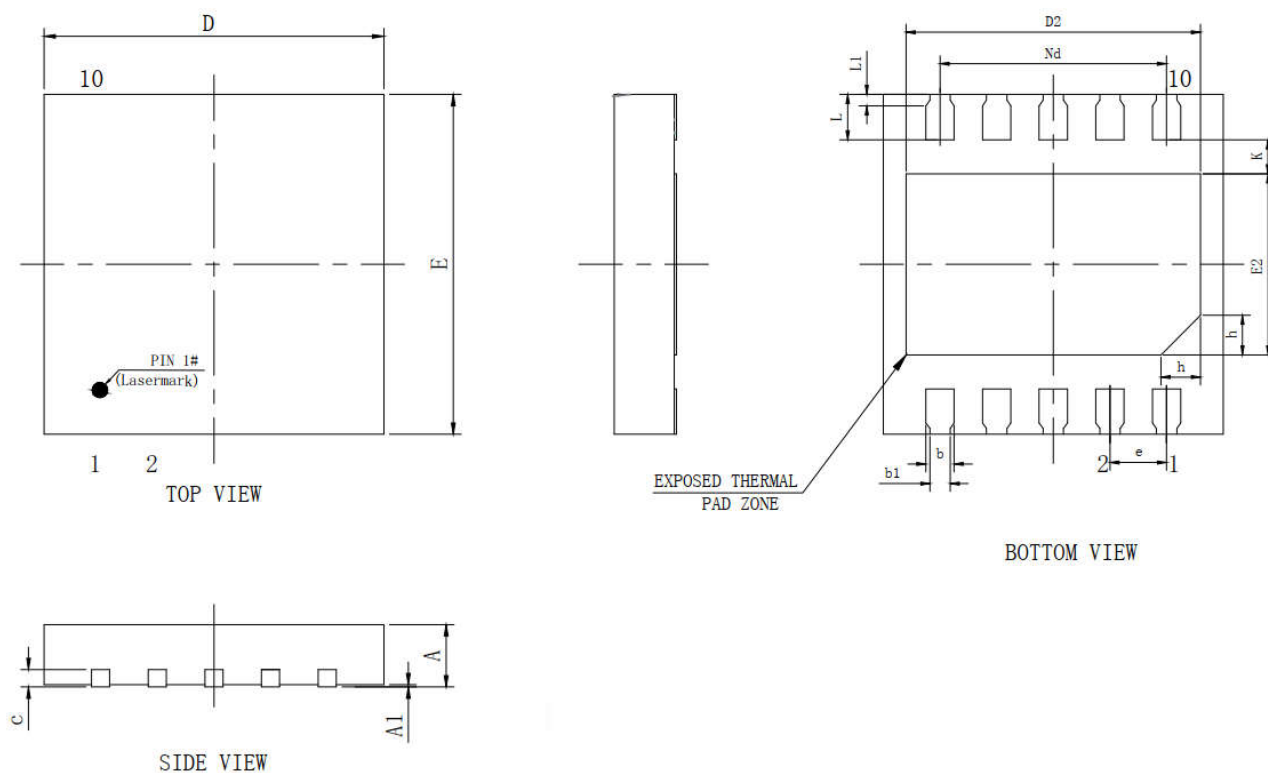
I/O Equivalent Circuits




Typical Application

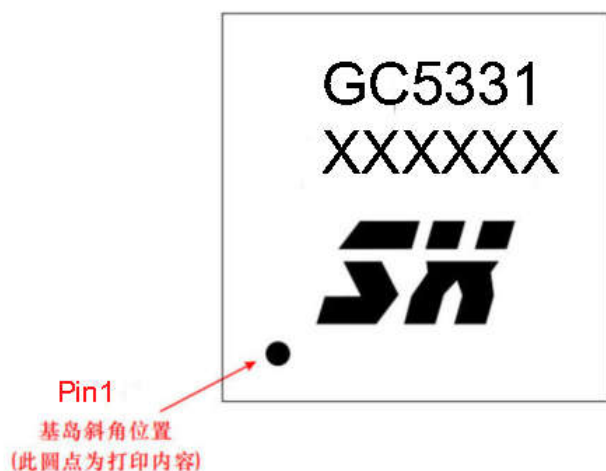


Package Information



SYMBOL	MILLIMETER			SYMBOL	MILLIMETER		
A	0.50	0.55	0.60	E	2.90	3.00	3.10
A1	-	0.02	0.05	E2	1.50	1.60	1.70
b	0.18	0.25	0.30	L	0.30	0.40	0.50
b1	0.18REF			L1	0.10REF		
c	0.152REF			K	0.25	0.30	0.35
e	0.50 BSC			h	0.20	0.25	0.30
D	2.90	3.00	3.10	Nd	2.00 BSC		
D2	2.50	2.60	2.70	NA	NA		

Description of Lot Code



Printing instructions:

- 1.The first line GC5331 represents the product model;
- 2.The second line represents the traceability code;

Release Notes

Revision	Description
1.0	Initial version