

### 2 PHASE DC MOTOR DRIVE IC

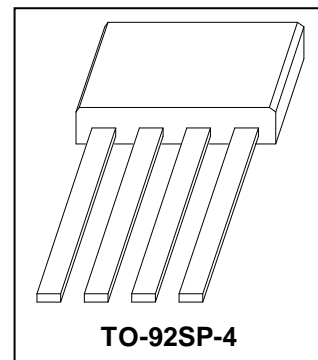
#### GENERAL DESCRIPTION

The FS211F, a 1-chip composed of hall sensor and output coil drivers, applied to 2-phase DC motor. The high sensitivity of Hall effect sensor is suitable for motors from mini-type CPU coolers to blowers and DC fans. Typical operation current is 0.4A and operating voltage range is wide. FG signal, an open collector, provides a square waveform output for the detection of the motor speed.

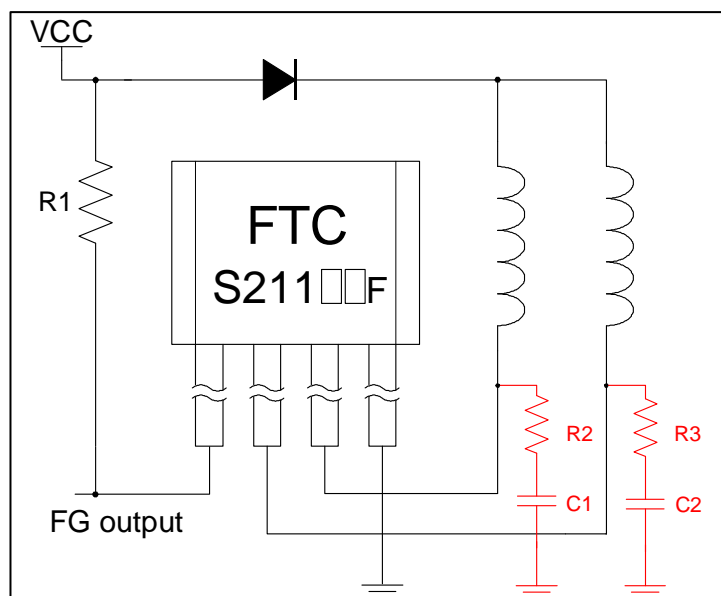
Using few external components, FS211F, a high performance integrated IC, is designed for a 2-phase DC motor circuit. The circuit diagram of the typical application example is as below.

#### FEATURES

- 1 chip hall sensor/drivers
- Wide operating voltage range: 4.0V~20V
- Output sink current up to 0.4A
- Low quiescent supply current under 5mA
- Built-in FG output
- Package: TO-92SP-4

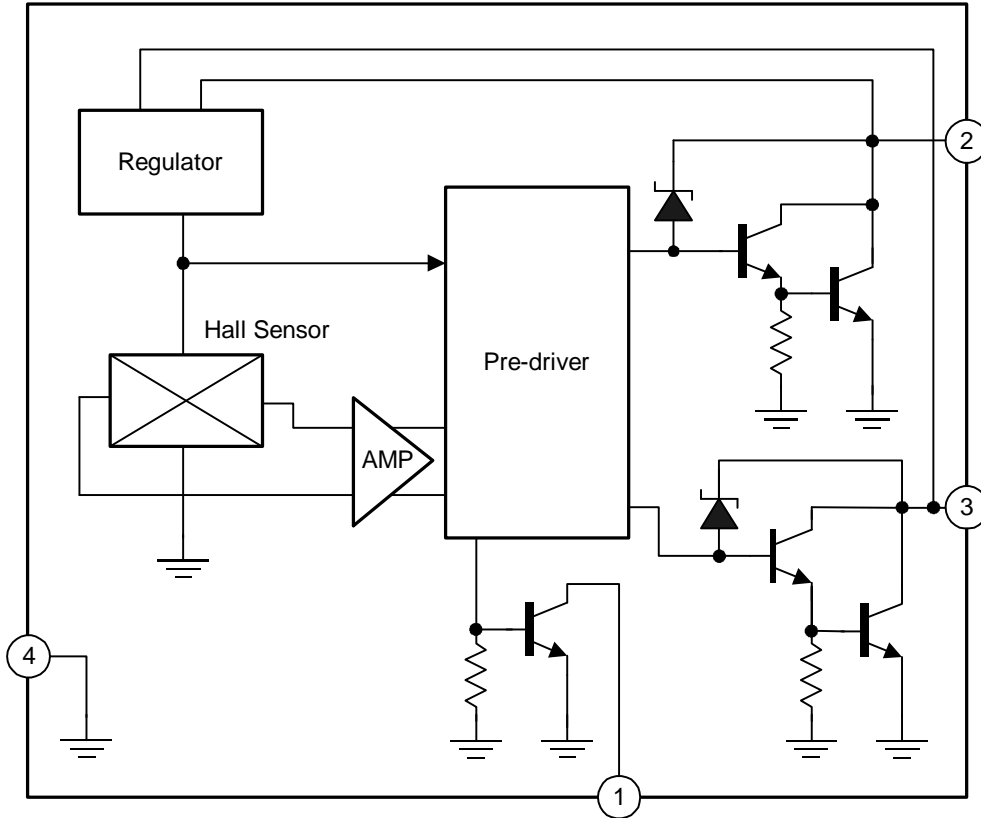


#### TYPICAL APPLICATION CIRCUIT

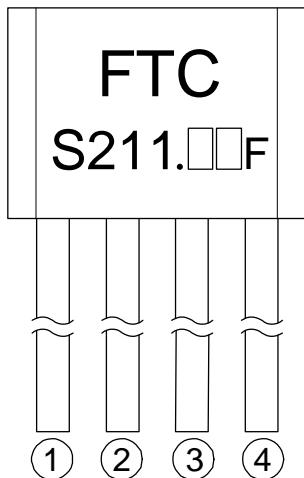


**C1,C2,R2,R3 is optional for reduce electromagnetism noise. R2,R3 must greater than 50 ohm**

## FUNCTIONAL BLOCK DIAGRAM



### MARK VIEW



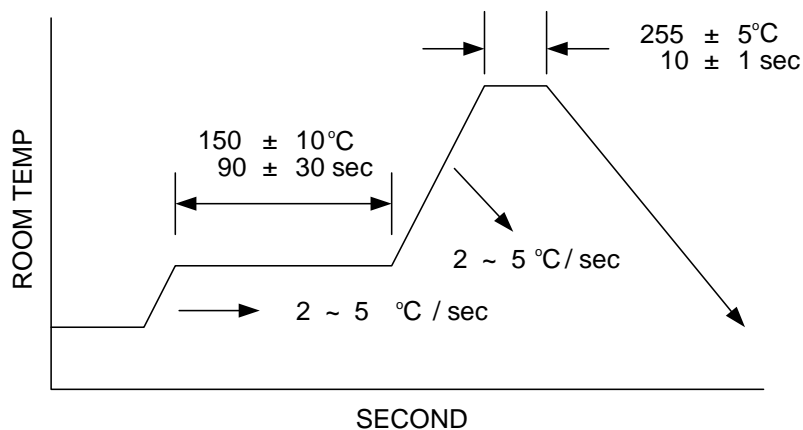
### PIN DESCRIPTION

NAME	NO.	STATUS	DESCRIPTION
FG	1	O	Rotation speed output (O.C.)
NO	2	O/P	Coil driver output It is low state during the N magnetic field. / Power input
SO	3	O/P	Coil driver output It is low state during the S magnetic field. / Power input
GND	4	P	IC Ground

## ABSOLUTE MAXIMUM RATINGS

Zener Breakdown Voltage ( $V_Z$ )	-----	35V
NO/SO Pin Voltage ( $V_{CP}$ (Note 1))	-----	30V
Peak Sink Current ( $I_o$ )		
Hold Current	-----	550mA
Continuous Current	-----	400mA
Peak Reverse Current ( $I_R$ )	-----	100mA
FG Pin OFF Voltage ( $V_{FG}$ )	-----	30V
FG Sink Current ( $I_{FG}$ )	-----	10mA
Power Dissipation		
$T_a=25^\circ\text{C}$	-----	600mW
$T_a=70^\circ\text{C}$	-----	450mW
Operating Temperature Range	-----	$-20^\circ\text{C}\sim+90^\circ\text{C}$
Storage Temperature Range	-----	$-65^\circ\text{C}\sim+150^\circ\text{C}$
Junction Temperature	-----	$+150^\circ\text{C}$
Lead Temperature (Soldering, 10 sec)	-----	$+260^\circ\text{C}$

Note 1:  $V_{CP}$  mean Coil Power



**Soldering Condition**

## DC ELECTRICAL CHARACTERISTICS

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Minimum Operating Voltage	$V_{CP}$	No use pin is open (Fig1)		4.0		V
Maximum Operating Voltage	$V_{CP}$	$I_{CP} < 10\text{mA}$ No use pin is open (Fig1)		20.0		V
Quiescent Supply current	$I_{CP}$	No use pin is open $V_{CP}$ : 4.0V ~ 20V (Fig1)	2.0		7.0	mA
NO/SO Saturation Voltage	$V_{SAT}$	$I_o = 300\text{mA}$ (Fig1)			1.5	V
FG OFF Leakage Current	$I_{OFF}$	(Fig2)			1	$\mu\text{A}$
FG ON Saturation Voltage	$V_{ON}$	$I_C = 5\text{mA}$ (Fig2)		0.2	0.5	V
Note: Fig1 The IC output state is under N magnetic field.						

## AC ELECTRICAL CHARACTERISTICS

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Rise time	$(t_r)$	$R_L = 1\text{K}$ $C_L = 10\text{pF}$ (Fig3)			500	nS
Fall time	$(t_f)$	$R_L = 1\text{K}$ $C_L = 10\text{pF}$ (Fig3)			500	nS

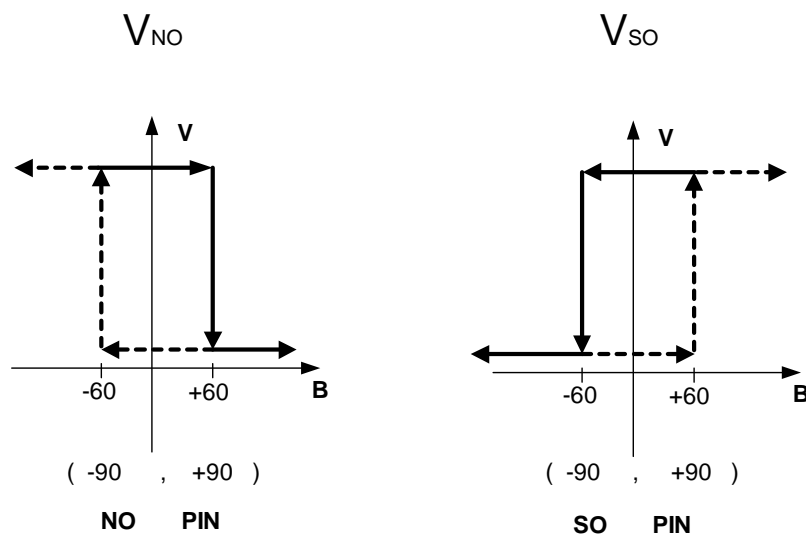
## MAGNETIC CHARACTERISTICS

FS211F_LF-A		Ta=-20 °C~+90 °C		
PARAMETER	MIN	TYP	MAX	UNIT
Bop		+60		G
Brp		-60		G
Bhys			120	G

FS211F_LF-B		Ta=-20 °C~+90 °C		
PARAMETER	MIN	TYP	MAX	UNIT
Bop		+90		G
Brp		-90		G
Bhys			120	G

FS211F_LF-C1		Ta=-20 °C~+90 °C		
PARAMETER	MIN	TYP	MAX	UNIT
Bop		+110		G
Brp		-110		G
Bhys			120	G

## FS211 HYSTERESIS CHARACTERISTICS



## TEST CIRCUITS

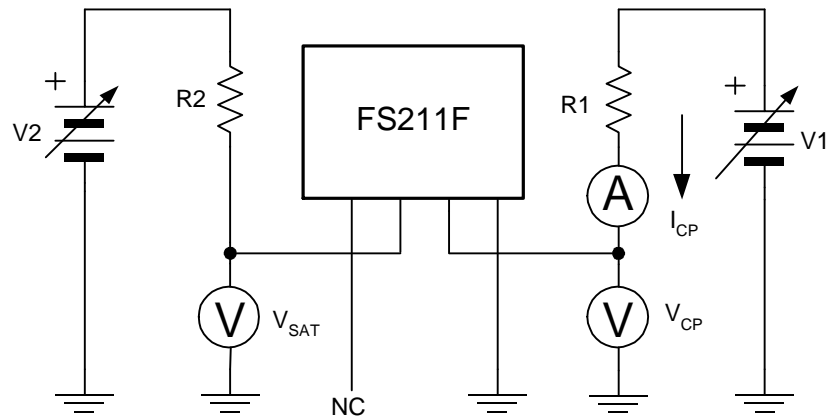


Fig.1 Test Circuit

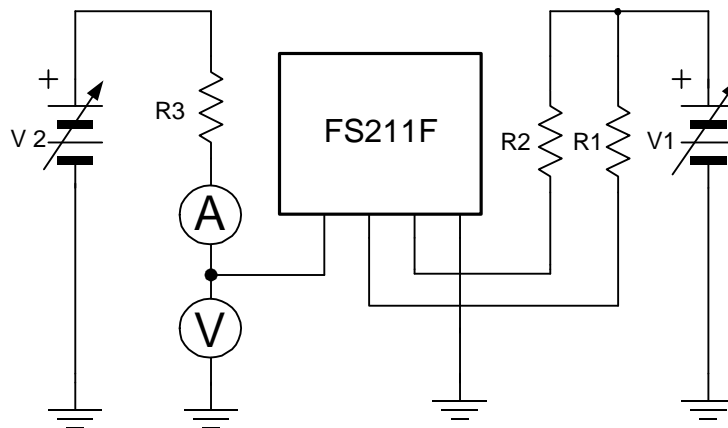


Fig.2 Test Circuit

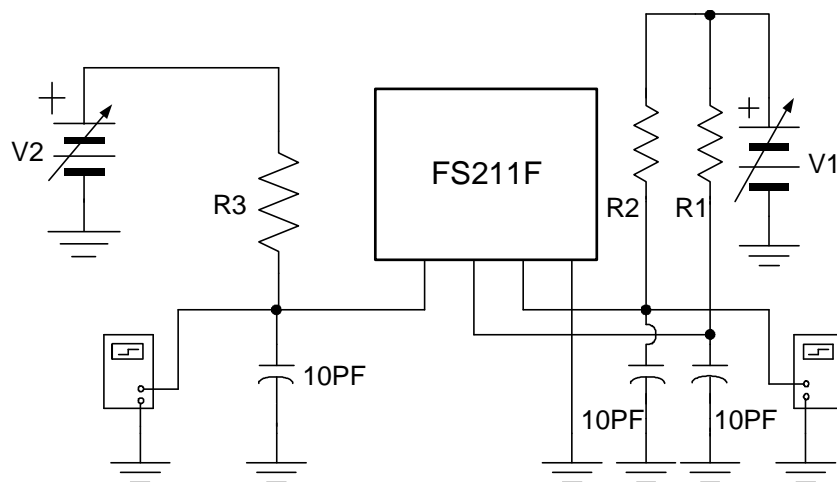


Fig. 3 Test Circuit

## FUNCTION DESCRIPTIONS

### Hall Sensor Location

The figure 4 is the hall sensor location, where marks the IC number. The best sensitivity, which can be intensified as much as possible, depends on the vertical distance and position between magnetic pole and the hall sensor (figure 5). For the 2-phase motor, this design is very important.

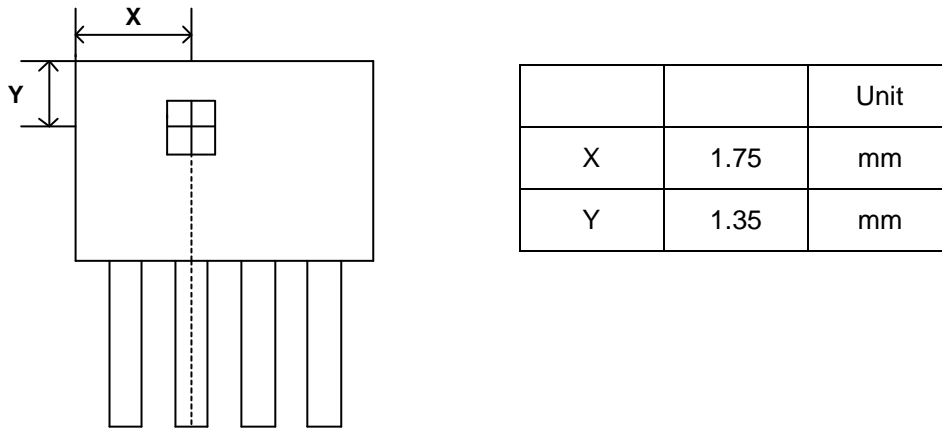


Fig.4 FS211F Hall Sensor Location

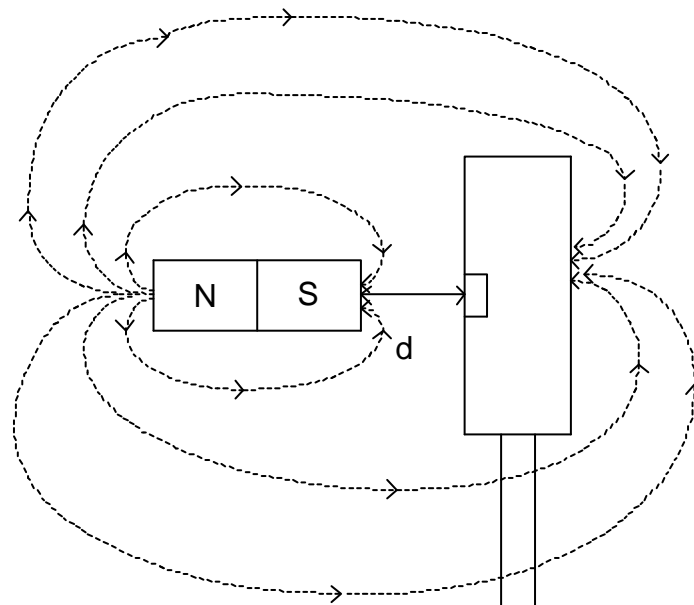


Fig.5 Magnetic Distribution

## Darlington-pair Transistor Output

The figure 6 is the circuit diagram of Darlington-pair transistor. Under the heavy current loading, the power loss of the high saturation voltage can be calculated into the following formula:

$$P_C = (V_{BEQ1} + V_{CE(SAT)Q2}) * I_o$$

According to the IC package and the curve of the power loss, the  $P_C$  should be applied to and within the safety value.

30V is the voltage of Zener breakdown diode. However, if the voltage, excluding that of the power supply, is more than 30V under the long-time operation, the diode will be destroyed.

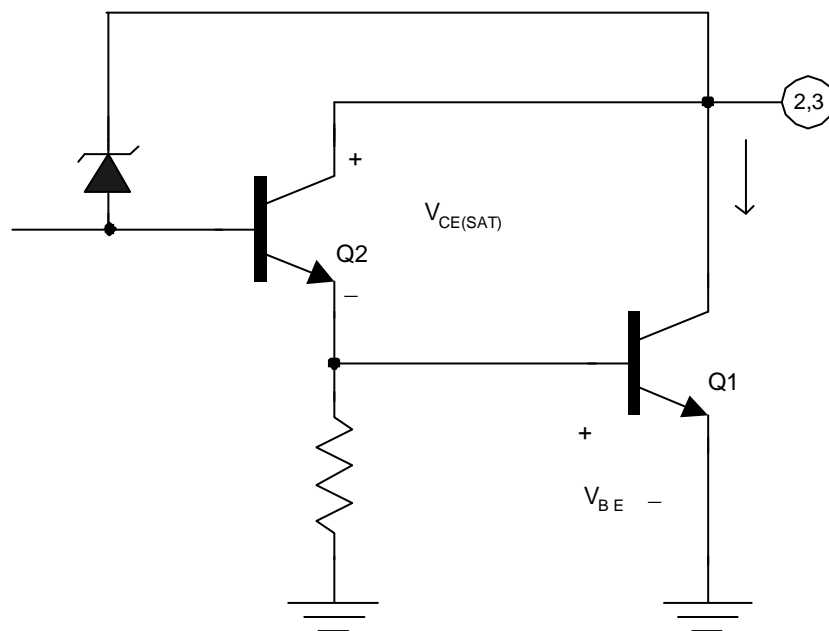


Fig. 6 Darlington-pair Transistor Output



### FG Output: The Circuit Diagram of Open Collector Transistor

Figure 7 the small signal transistor output connected with the pull-up resistance is to limit the current and confirm the voltage level of rotation speed. The situation of the long-time operation with the high voltage or with the high current will do damage to the transistor and cause FG malfunction.

Figure 8 illustrates the relation between dynamic magnetic field and FG.

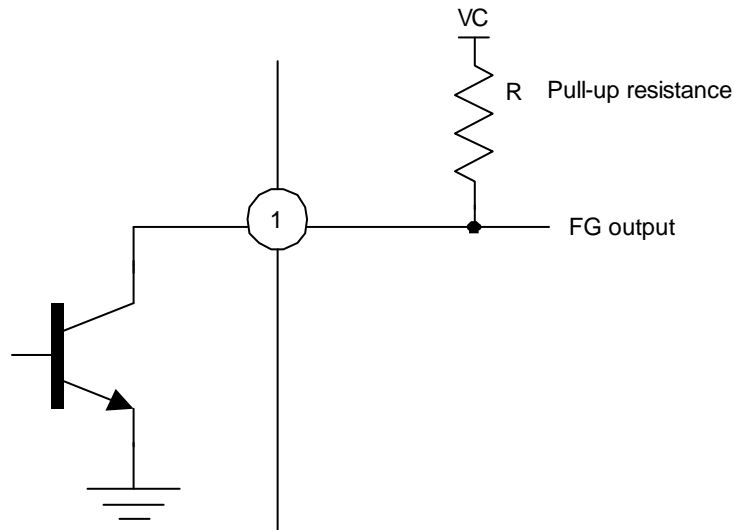


Fig.7 FG Circuit Diagram

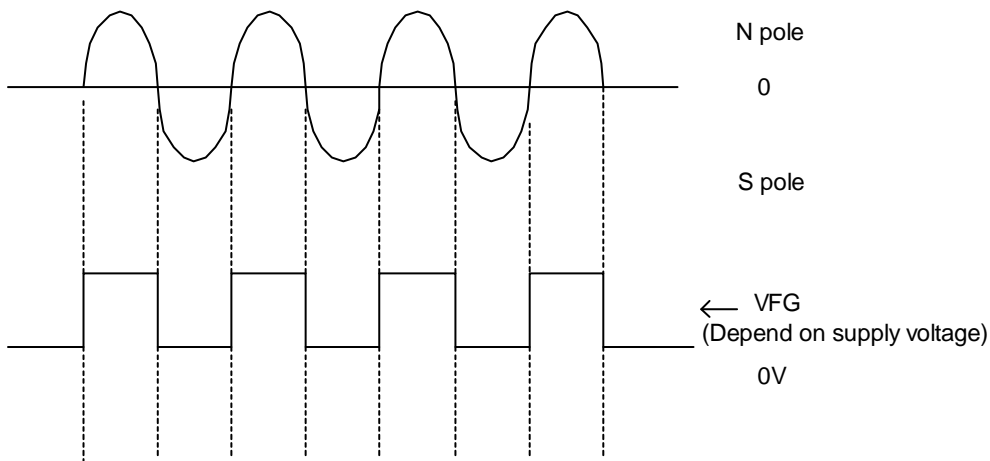


Fig.8 FG Waveform

## APPLICATION NOTE

### The Example of Typical Application Circuit

Figure 9 is the example of typical application circuit. The red, yellow, and black wires are the input points of the motor system: red, the inputs of power supply; yellow, the output of FG; black, the ground signal. Rc is an external pull-up resistance for the use of measuring FG signal. In view of the design, the value of Rc could be decided by the transistor saturation voltage ( $V_{ON}$ ), sink current ( $I_C$ ), and off-level voltage ( $V_C$ ).

The formula is:  $R_C = (V_C - V_{ON}) / I_C$

For example:

$V_C = +5V$  for TTL level.

$I_C = 5mA$  at 0.5V saturation voltage (IC specification.)

The safety value of  $R_C = 1K\Omega$

D1 is the reverse protection diode. As if the red and black wires reversely connect with the power source, the current will flow through the ground via IC and coils L1 and L2 to power supply. Under such kind of circumstances, the IC and coils are easy to be burned out. Therefore, D1, the reverse protection diode, is necessary for the design. However, D1 will also cause an extra voltage drop on the supply voltage.

C1 is a capacitor to reduce the ripple noise caused during the transient of the output stages. The volume of the ripple noise depends on the coil impedance and characteristics.

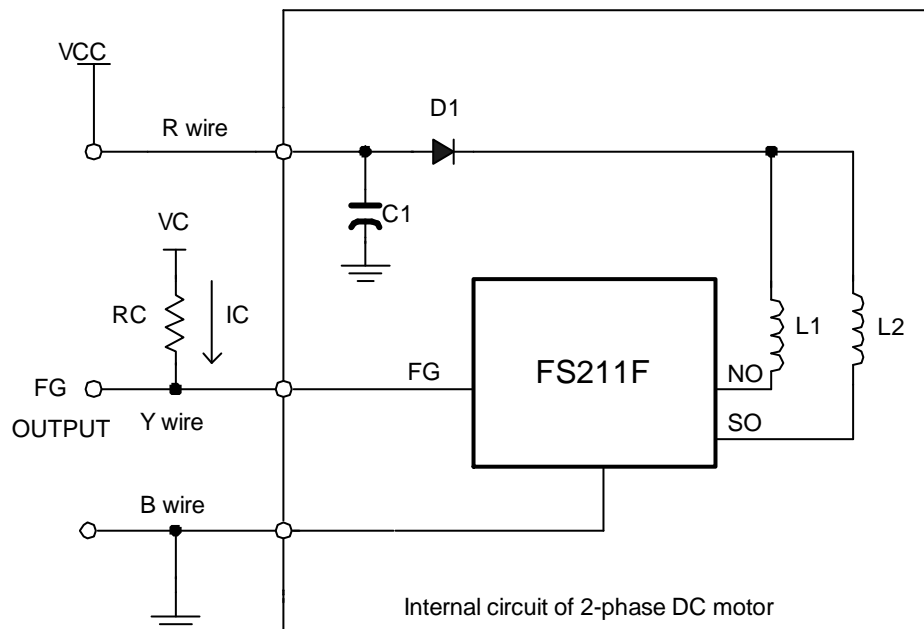
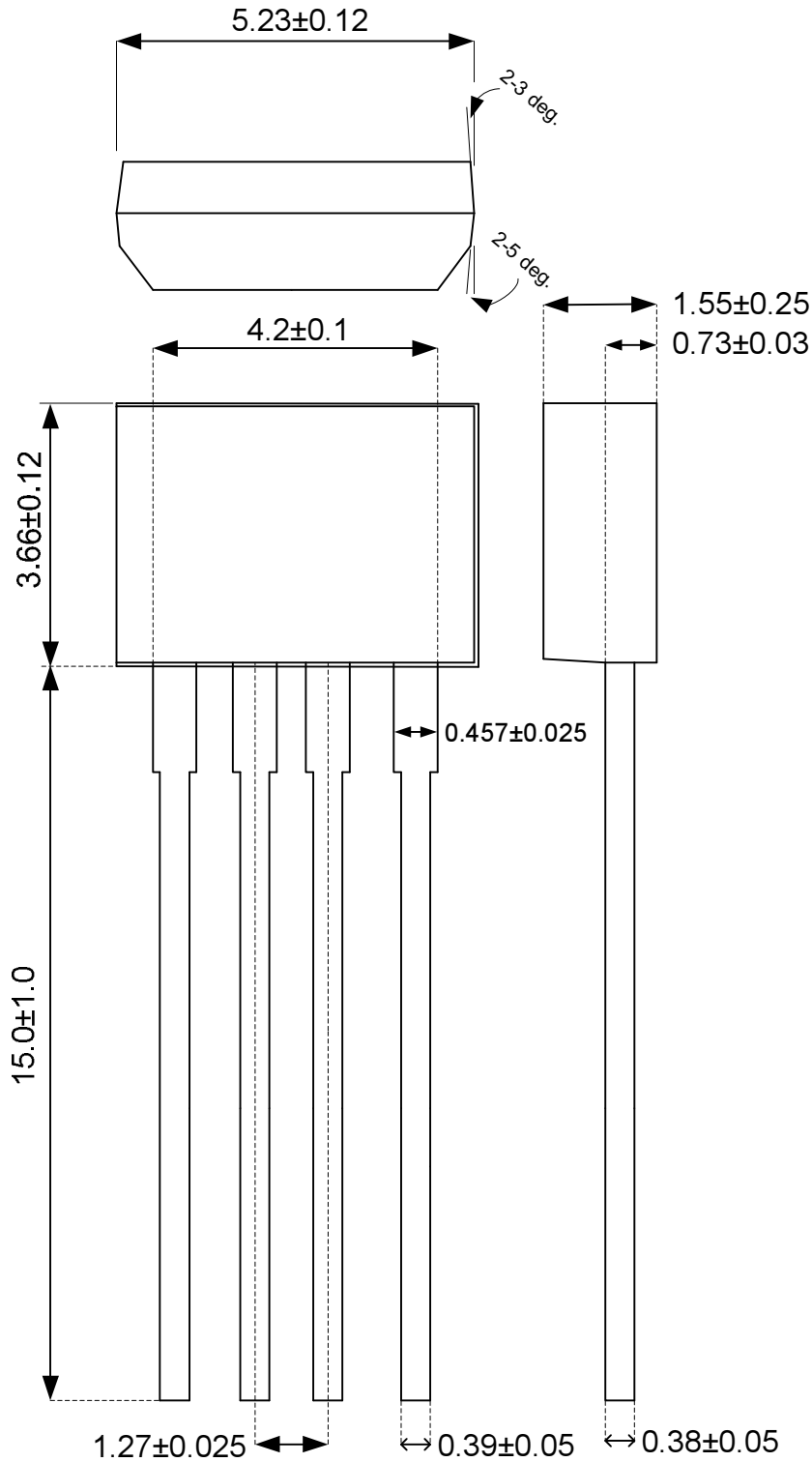
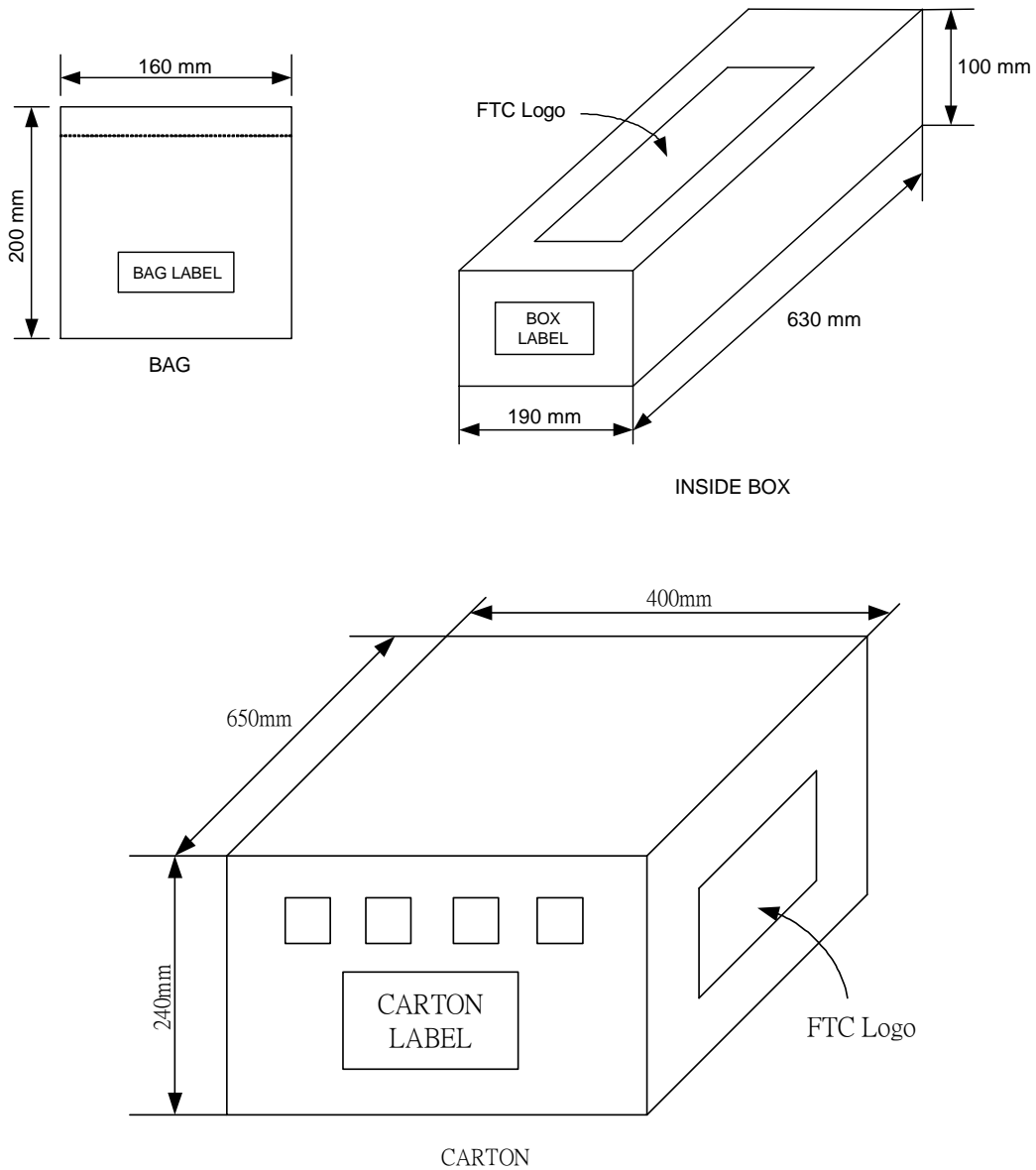


Fig.9 Application Circuit

Package Outline (LEAD FREE) Unit:mm



## BAG & BOX DIMENSION



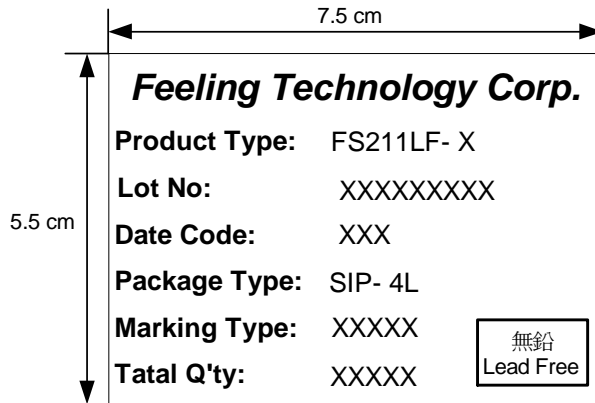
## PACKING QUANTITY SPECIFICATIONS

1000 EA/1 BAG

25 BAGS/1 INSIDE BOX

4 INSIDE BOXES/1 CARTON

## LABEL SPECIFICATIONS



BAG LABEL, INSIDE BOX & CARTON LABEL

## ORDER INFORMATION

Part Number	Operating Temperature	Package	Description
FS211LF-A	-20°C ~ +90°C	TO-92SP-4	±60G (B)
FS211LF-B	-20°C ~ +90°C	TO-92SP-4	±90G (B)
FS211LF-C1	-20°C ~ +90°C	TO-92SP-4	±110G (B)