Fortior Tech

FT8213

Datasheet

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1 System Introduction

1.1 Description

The FT8213 is a Three-Phase , sensorless FOC controlled DC Brushless Motor drive IC with built-in Rdson 1 Ω drive MOS. The chip is highly integrated with the components required for motor control, requiring fewer peripheral components, low noise, and low motor torque ripple. Built-in EFUSE, which can configure customer motor parameters, start and speed control modes. The speed control interface can select PWM, analog input, I2C to adjust motor speed, integrated speed indication function, and can read the motor speed in real time through FG pin or I2C interface. Speed control mode can choose constant speed, constant air volume, constant current and open loop control. It has motor speed indication function, integrated overvoltage, overcurrent, UVLO, over temperature, stall and other protection modes, sleep current 45uA.

1.2 Applications

- Refrigerator Fan
- Cooling Fan
- Water Pump

1.3 Feature

- Input Voltage Range: 5 to 18 V
- Total Driver H + L $R_{DS(on)}$: 1 Ω
- Drive Current: 1 A
- No Hall Sensor required
- FOC control to reduce motor noise and vibration
- Built-in EFUSE, which can configure motor parameters, start and speed control modes
- Speed adjustment: PWM, analog voltage,I2C
- Speed control mode: constant speed, constant air volume, constant current, open loop control
- Forward-Reverse Control with DIR Pin
- Configurable motor speed indication or blocking indication with FG Pin
- Sleep current: 45uA
- Speed pin wake-up or I2C wake up
- Configurable I2C address
- Lock protection
- Lost-phase protection
- Over current protection
- Over temperature protection
- UVLO protection
- Over-voltage protection

1.4 Application Circuit

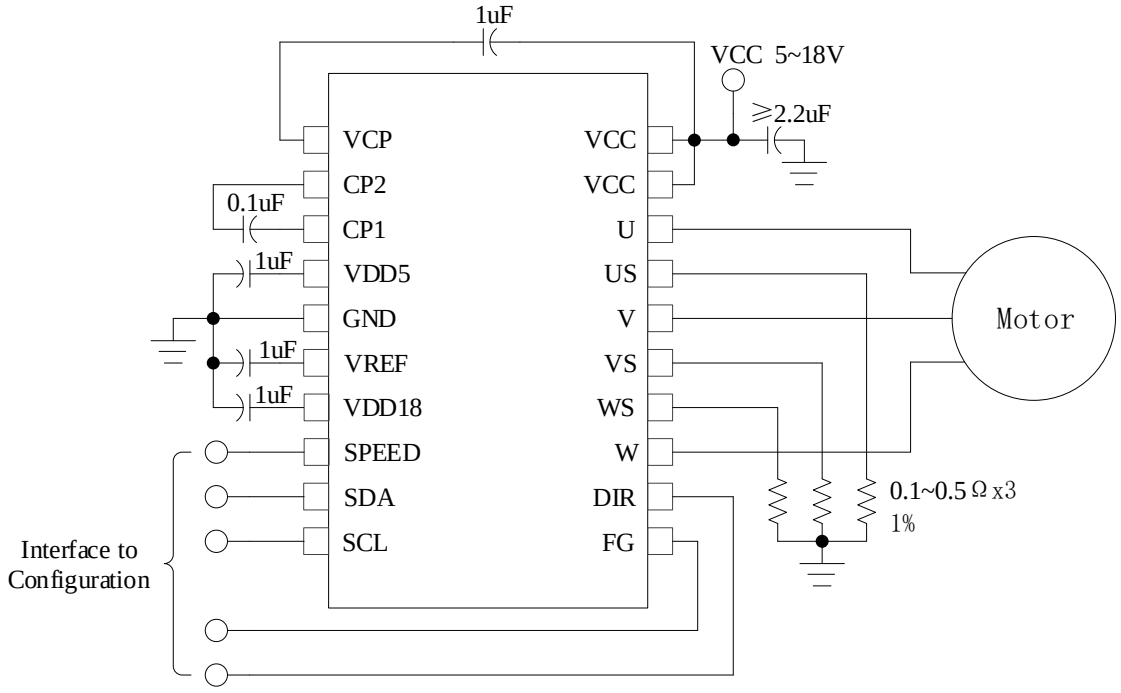


Fig 1.1 FT8213 Application Circuit

1.5 Functional Block Diagram

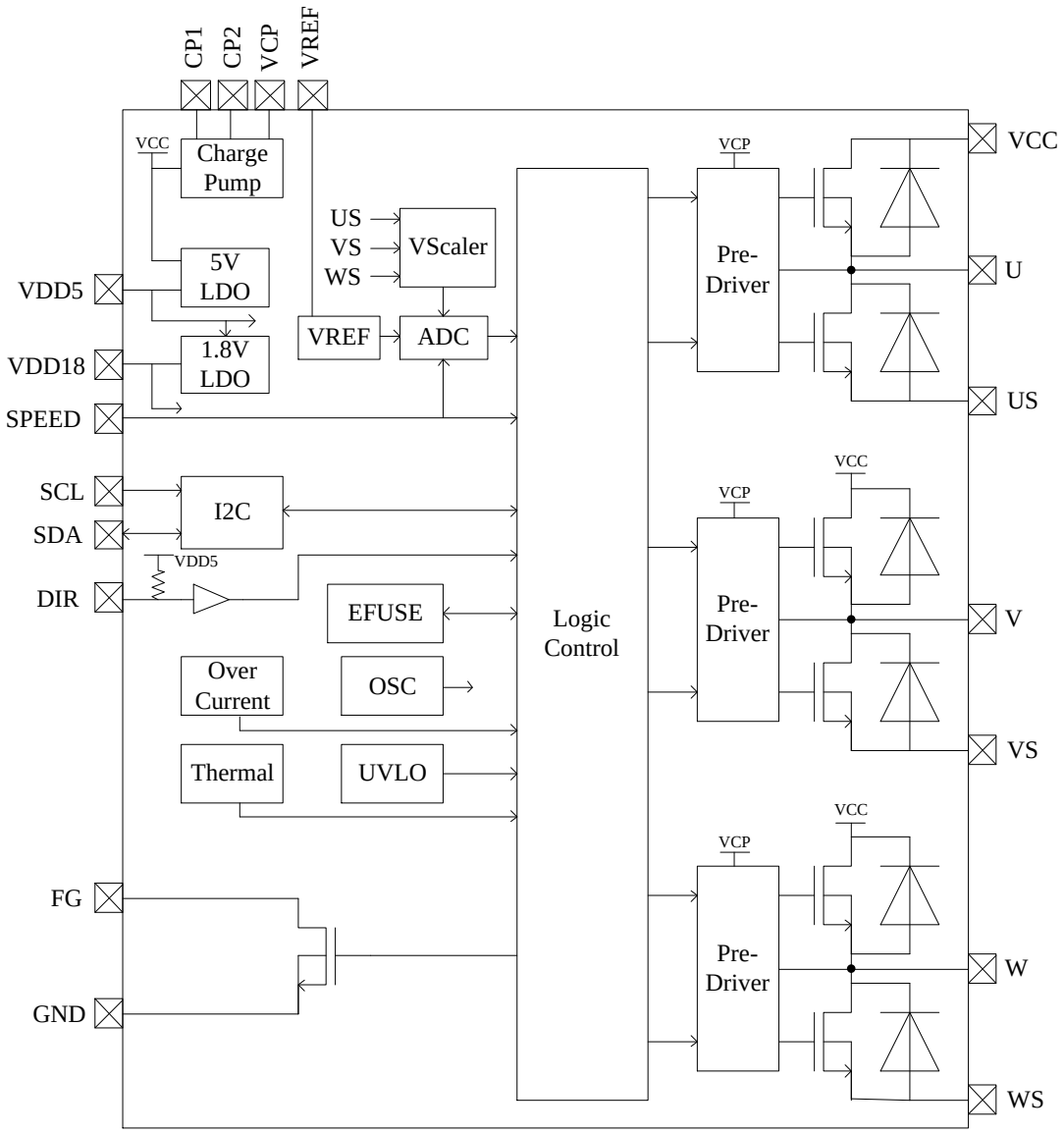


Fig 1.2 FT8213 Functional Block Diagram

1.6 Pin Assignment and Packaging

1.7 Packaging

1.7.1 FT8213 QFN28 Packaging

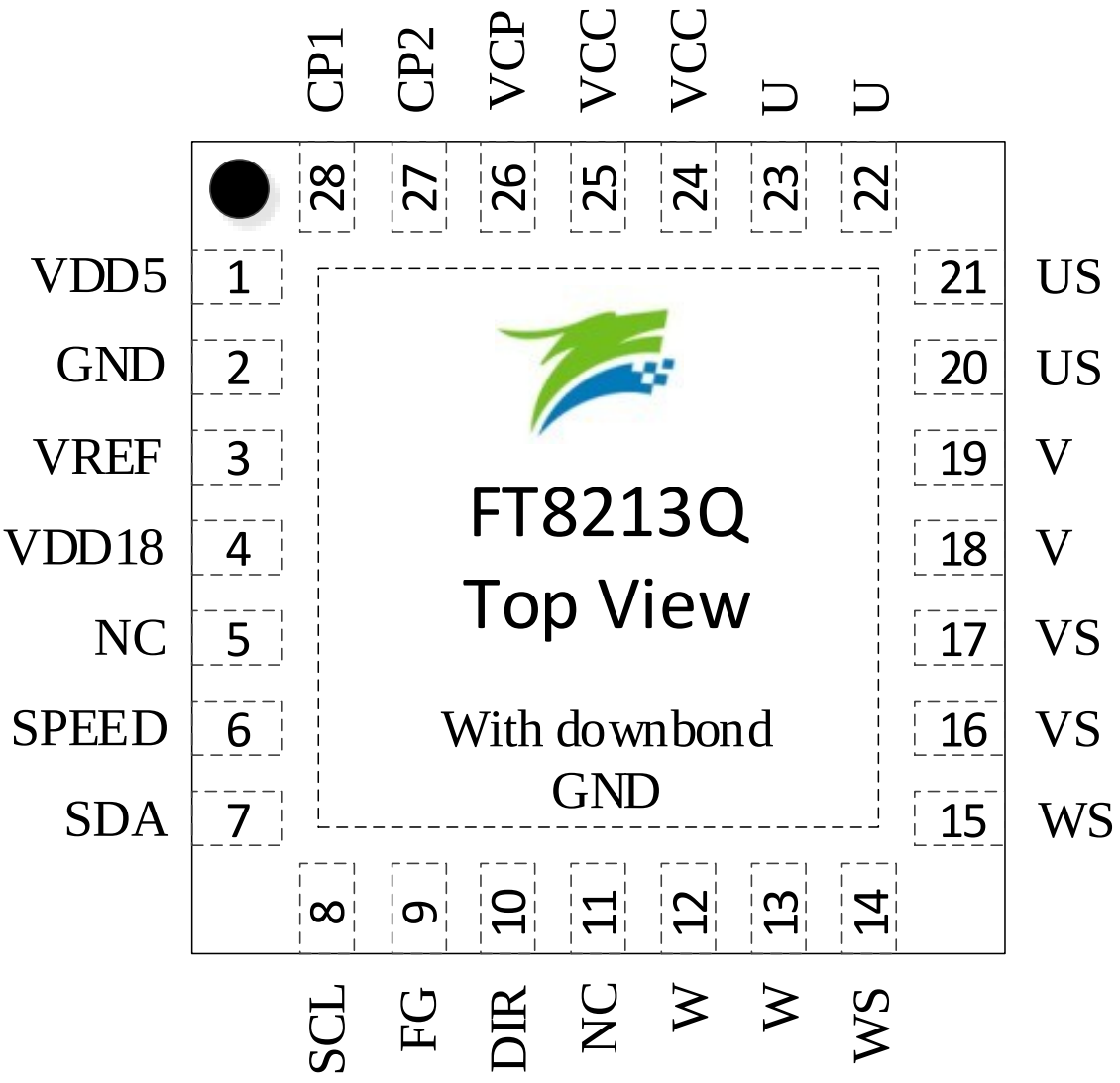


Fig 1.3 FT8213 QFN28 Top View, Package Dimensions: (5 mm * 5 mm * 0.75 mm, e= 0.5 mm)

1.8 Pin Configuration

1.8.1 FT8213 QFN28 Pin Configuration

PIN Name	FT8213 QFN28	IO Type	Description
VDD5	1	P	LDO 5V output for digital signal. Connected to the ground with a 1~4.7uF capacitor.
GND	2	P	Ground
VREF	3	AI	ADC reference voltage. Connected to the ground with an external 1uF capacitor.
VDD18	4	P	LDO 1.8V output for digital signal. Connected to the ground with a 1uF capacitor.
SPEED	6	DI/AI	Speed control signal for PWM or analog input speed command , depending on EFUSE. Internal pull-up resistor is available in PWM input mode. If I2C speed adjustment mode is selected, this pin has no effect, and is suspending or connected to VDD5.
SDA	7	DB	I2C slave data pin, open-collector output with a configurable pull-up resistor.
SCL	8	DB	I2C slave clock pin, open-collector output with a configurable pull-up resistor.
FG	9	DO	Speed signal or Motor lock-rotor indicator output. Open collector. Internal pull-up resistor.
DIR	10	DI	Input of rotation direction. Internal pull-up resistor. 1: Positive rotation. U-->V-->W 0: Reverse rotation. U-->W-->V
W	12	DO	Output of phase W
W	13	DO	Output of phase W
WS	14	AI	The ground input of phase W

PIN Name	FT8213 QFN28	IO Type	Description
WS	15	AI	The ground input of phase W
VS	16	AI	The ground input of phase V
VS	17	AI	The ground input of phase V
V	18	DO	Output of phase V
V	19	DO	Output of phase V
US	20	AI	The ground input of phase U
US	21	AI	The ground input of phase U
U	22	DO	Output of phase U
U	23	DO	Output of phase U
VCC	24	P	Power supply, 5~18V DC, connected to the ground with ≥2.2uF capacitor(According to actual condition).
VCC	25	P	Power supply
VCP	26	P	Charge pump output, connected to VCC with a 1~4.7uF capacitor.
CP2	27	AO	Charge pump pin 2. Use a 0.1uF capacitor between CP1 and CP2.
CP1	28	AO	Charge pump pin 1. Use a 0.1uF capacitor between CP1 and CP2.
NC	5, 11		No connection

Note:

1. IO Type:
   DI= Digital Input
   DO= Digital Output
   DB= Digital Input and Output
   AI= Analog Input
   AO= Analog Output
   P= Power

2 Electrical Characteristics

2.1 Absolute Maximum Ratings

Parameter	Condition	Min.	Typ.	Max.	Unit
Operating temperature T_A	(2)	-40	—	85	℃
Operating temperature T_A	FT8213Q, I(VCC)≤0.5A (2)	-40	—	105	℃
Maximum junction temperature T_J		-40	—	150	℃
Storage temperature T_{stg}		-65	—	150	℃
VCC supply voltage		-0.3	—	22	V
VCP voltage relative to VCC		-0.7	—	VCC+6.5	V
US, VS, WS voltage		-0.7	—	0.7	V
SPEED,SDA,SCL,DIR,FG voltage		-0.3	—	VDD5+0.3	V

Note:

1. It may cause permanent damage to the device, if the operating condition exceeds the above “absolute limit ratings”. It is recommended that devices run inside of the above specification. Exposure to maximum rating conditions for extended periods may affect device reliability.
2. This parameter is not mandatory, as long as the chip operation is the junction temperature TJ does not exceed the specified maximum value.

2.2 Electrical Characteristics

Table 2-1 electrical characteristics

（Unless otherwise specified, T_A = 25℃, VCC = 12V）

Parameter	Condition	Min.	Typ.	Max.	Unit
VCC operating temperature		5	—	18	V
VDD5 output voltage	T_A=-40~85℃	4.8	5	5.2	V
V_{REF} reference voltage	T_A=-40~85℃	4.3	4.5	4.7	V
I_{VCC} operating current	(1)	—	5	—	mA
I_{VCC} sleep current		—	45	100	uA
Total Driver H + L $R_{DS(on)}$		—	1	—	Ω

Parameter	Condition	Min.	Typ.	Max.	Unit
Protective properties					
V_{OVP} VCC Over-Voltage Protection(OVP) Voltage		22	24	26	V
V_{OVP_HYS} VCC OVP Hysteresis Voltage		—	0.5	—	V
V_{UVLO_F} VCC Low-Voltage Protection(LVP) Voltage		—	4.5	4.6	V
V_{UVLO_HYS} VCC LVP Hysteresis Voltage		—	0.2	—	V
I_{OCP} Over-Current Protection Threshold Current		—	1.7	—	A
T_{TSD} Thermal Protection circuit operating temperature		—	165	—	℃
T_{TSD_HYS} Temperature hysteresis width		—	15	—	℃
Analog-Regulating Input					
V_{SPDMAX}		—	VREF	—	V
IO electrical characteristics（SCL/SDA/SPEED/FG/DIR Interface Parameters）					
V_{IH} High-level input voltage		2.5	—	—	V
V_{IL} Low-level input voltage		—	—	0.6	V
I_{OL} Output Sink Current	Vout=0.3V	5	—		mA

Note：The values vary with configurations.

2.3 Package thermal resistance

Table 2-2 QFN28 Package thermal resistance

Parameter	Condition	Value	Unit
Θ_{JA} Chip temperature relative to ambient temperature	(1), (2)	43	℃/W
Θ_{JC} Chip junction temperature versus package surface	(2)	15	℃/W

temperature			

(1) JEDEC standard， 2S2P PCB

(2) The actual application conditions are different, and the test results are different

3 Function description

3.1 Operating Modes

The chip has 2 work modes: Normal, Sleep.

3.2 Communication Interface

The chip integrates the I2C slave interface, the I2C interface address is programmable, the initial I2C interface address is “0x00”, and the maximum rate does not exceed 1Mbps.

3.3 Speed Control

3.3.1 Speed Control Methods

Speed adjustment can be achieved through the digital PWM, analog voltage control, or I2C Only one method can be used at a time. Digital PWM, analog voltage control support input reverse phase. If voltage loop control is selected, Power supply voltage can also be employed to control motor speed.

3.3.2 Speed Regulating Curve

Speed regulating curve through PWM is shown as below. The horizontal coordinate is the PWM duty ratio (Please refer to speed regulating table). And the ordinate is the output, which represents different physical quantities in different strategies.

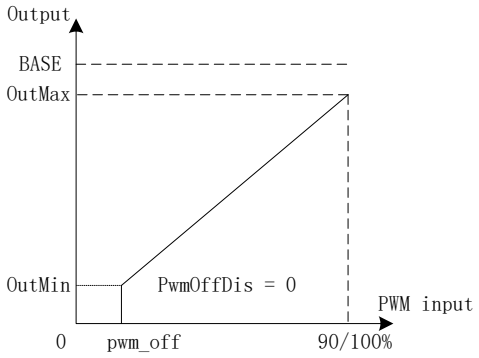


Fig 3-1 speed regulating curve when PwmOffDis equals zero

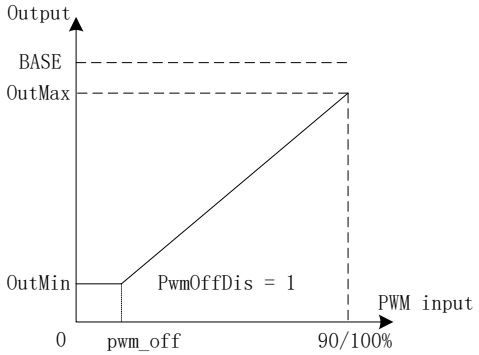


Fig 3-2 speed regulating curve when PwmOffDis equals one

3.4 Protection

FT8213 support locked-rotor protection, lost-phase protection, over-current protection, over-voltage protection, UVLO protection , and over-temperature protection.

3.5 FG

The chip provides motor speed information or motor status through the FG pin.

3.5.1 Frequency Multiplication and Frequency Division of FG

If the FG/RD bit (Efuse) is cleared, the pin FG/RD is used as FG output. The output freq is determined by FGDIV/FGMUL. FGMUL is used to set FG output frequency multiplication to 2, 3, or 4. FGDIV is used to set frequency division to 1/2, 1/3,or 1/4.

Table 1 FG configuration factor table

FG	Coefficient k	FG	Coefficient k	FG	Coefficient k	FG	Coefficient k
0000	1/1	0100	1/3	1000	1/4	1100	1/5

0001	2/1	0101	2/3	1001	2/4	1101	2/5
0010	3/1	0110	3/3	1010	3/4	1110	3/5
0011	4/1	0111	4/3	1011	4/4	1111	4/5

The number of FGs in a mechanical period equals pp*FGMUL/FGDIV.

For example, if there are four-pole motor，3 FG signals are displayed in one mechanical period, set frequency multiplication to 3, and set frequency division to 4. That is, k=3/4. Set FGDIV/FGMUL to 1010.

The following figures show the output under different k values.

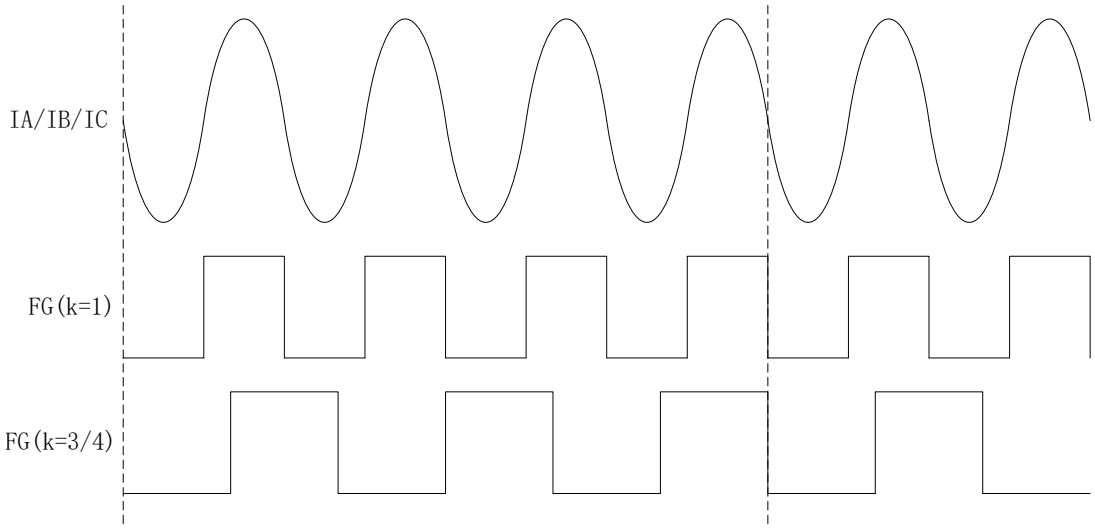


Fig 3-3 FG output wave when k=1 and k=3/4

3.5.2 FG output in open loop state

FG is used to reflect the output state of chip. In closed loop state, the output state of chip is synchronous with the actual status of motor. But in open loop state, FG does not necessarily reflect the actual speed of motor. So FGRDSet can be used to select the output signal in open loop state as shown in Fig 3-4.

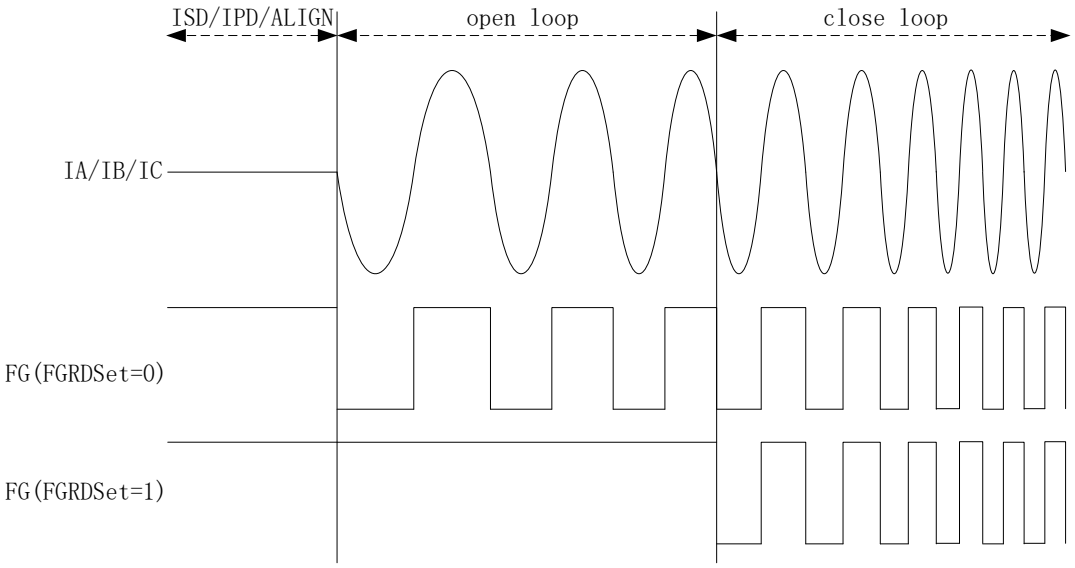


Fig 3-4 FG output wave

3.6 RD

The RD is used to display the operating status of the motor. Set the Efuse bit FG/RD=1, that is, select the FG/RD pin to output the RD signal. The chip provides two output RD options based on FGRDSet.

- FGRDSet=0: RD is high in open loop or closed loop state. Otherwise RD is low.
- FGRDSet=1: RD is low in closed loop state. Otherwise RD is high.

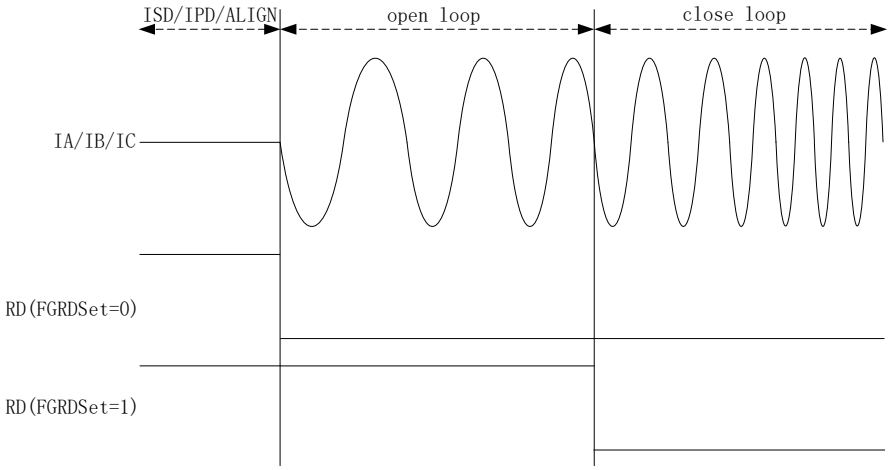
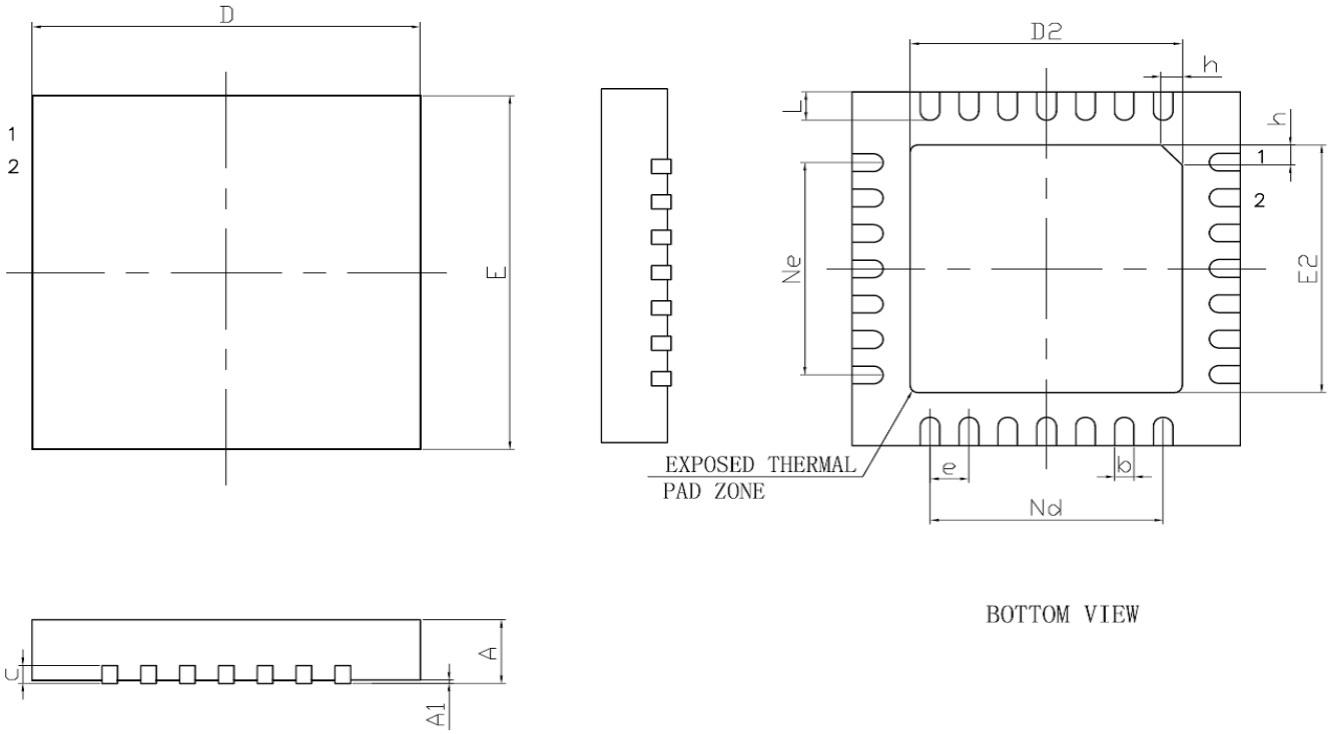


Fig 3-5 RD output wave

4 Package Information

4.1 QFN28



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0. 70	0.75	0. 80
A1	—	0.02	0. 05
b	0. 18	0.25	0. 30
c	0. 18	0.20	0. 25
D	4. 90	5. 00	5. 10
D2	3. 40	3. 50	3. 60
e	0. 50BSC		
Ne	3. 00BSC		
Nd	3. 00BSC		
E	4. 90	5. 00	5. 10
E2	3. 40	3. 50	3. 60
L	0. 35	0.40	0. 45
h	0. 30	0. 35	0. 40

Fig 4-1 QFN28 package dimensions diagram（5.0mm*5.0mm*0.75mm, e=0.5mm）

5 Order Information

Part Number	Package	Power Voltage（V）	$R_{DS(on)}$ (Ω)（Total Driver H + L	Drive Current(A)	Control Function						Protection						Operating temperature Tj（℃）	Lead-free
					Drive type	Speed Control Methods			DIR	Initial position detection	Over-Current	Over-temperature	Over-voltage	UVLO	Lock-rotor	Lost-phase		
						I2C	PWM	Analog										
FT8213Q	QFN28 (5x5 mm)	5~18	1	1	Sensorless FOC	√	√	√	√	√	√	√	√	√	√	√	-40~150	√

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Fortior Technology (Shenzhen) Co., Ltd.

Room203, 2/F, Building No.11, Keji Central Road2,
Software Park, High-Tech Industrial Park, Shenzhen, P.R. China 518057
Tel: 0755-26867710
Fax: 0755-26867715
URL: http://www.fortiortech.com