TI Spins Motors.

Smarter. Safer. Greener.

IntegratedFanDriver Technology Overview
集成風扇馬達驅動器技術概要

Wilson Zuo /左巍

Motor Application Team (MAT) /馬達應用團隊
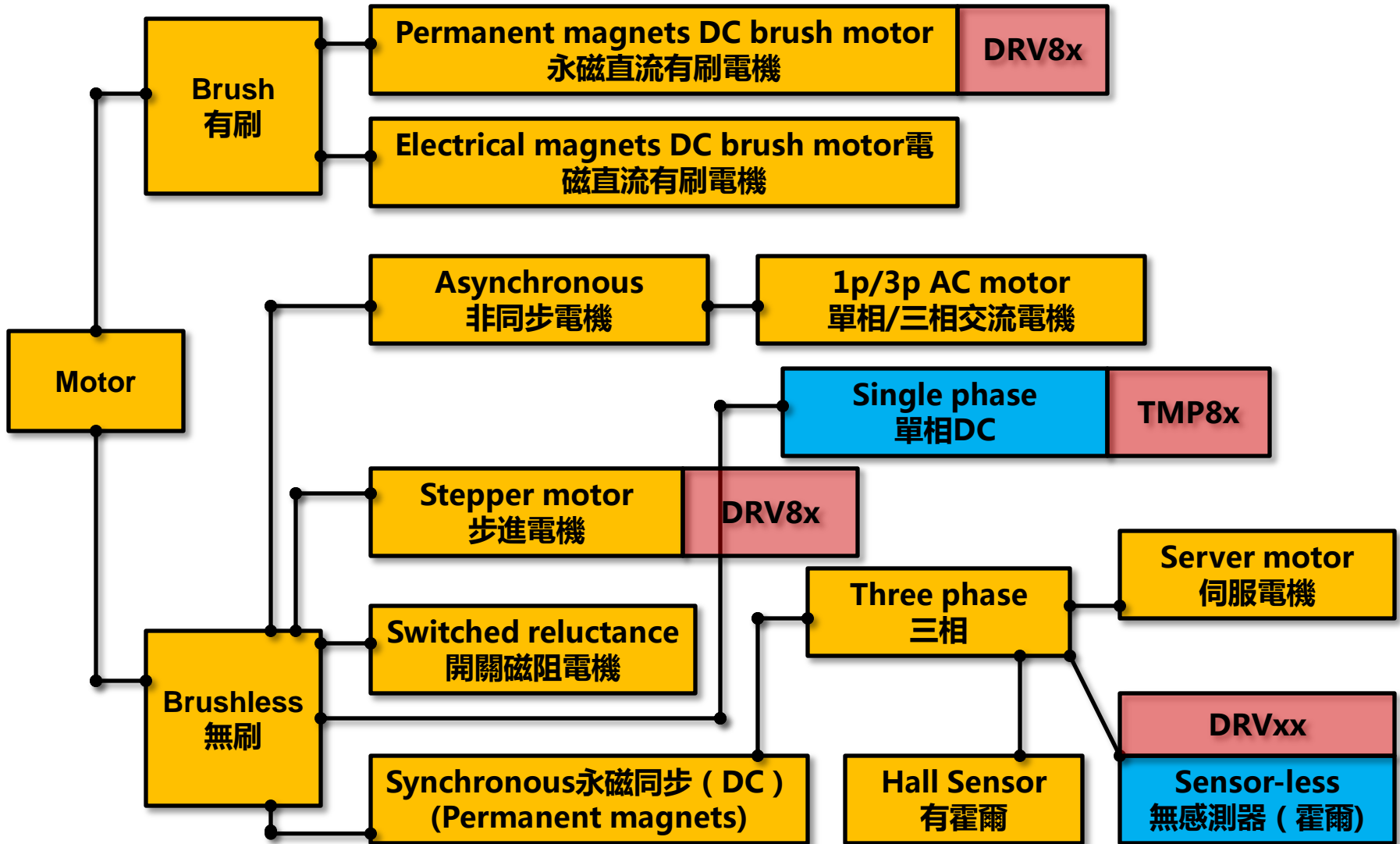
Motor Drive Business Unit

Introduction- motors 引言

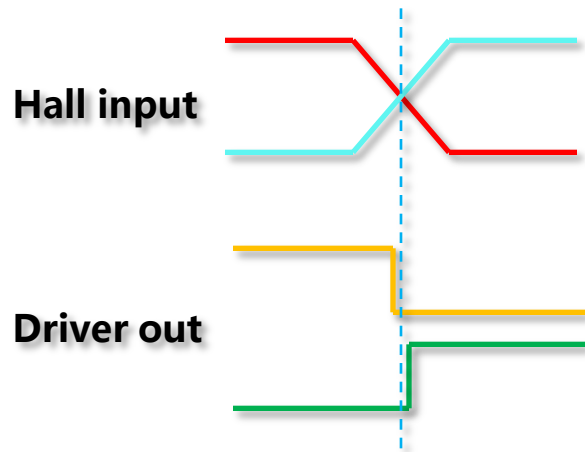**1 PhaseBLDC Driver 單相無刷驅動器**

3 Phase Senor-less Driver Tech 三相驅動技術

Fan Application Collection應用集錦
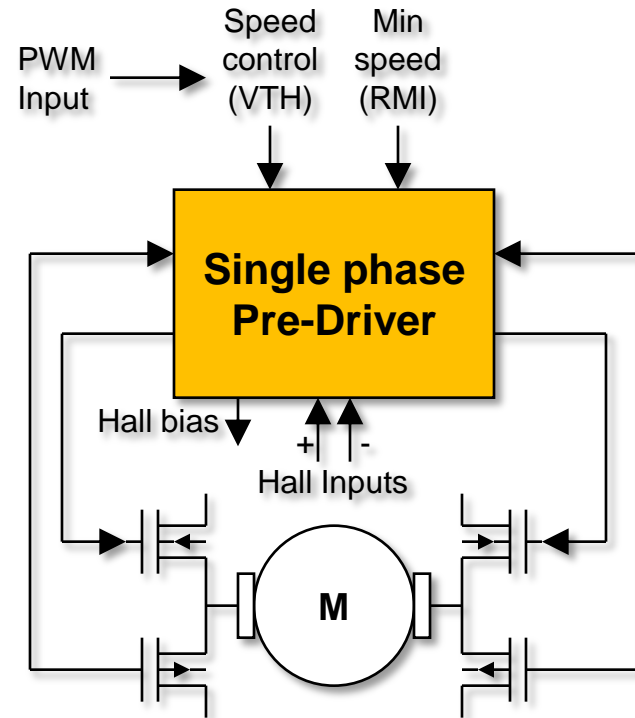
Introduction– Motors

1 PhaseBLDC Driver 單相無刷驅動器

Single Phase BLDC Driver
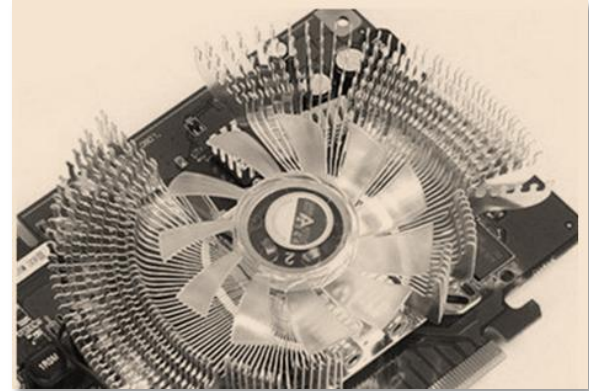
Hall input

Driver out

To avoid the motor startup when hall outputs are both around zero. Single phase fan will always stop at a position that the hall signal In+ and In- differ from each other due to the magnetic structure.

PWM Input

Speed control (VTH)

Min speed (RMI)

Single phase Pre-Driver

Hall bias

+ -
Hall Inputs

M

Single Phase BLCD Application

Application應用

- ✓ Computer fan桌上型電腦風扇
- ✓ Notebook fan筆記本風扇
- ✓ GPU fan顯卡風扇
- ✓ Other on-board card fan其它板卡風扇
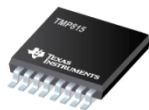- ✓ Equipment fan儀器風扇
- ✓ Air condition fan空調風扇

TMP815

Single-Phase Full-Wave Fan Motor Pre-Driver
單相馬達全波前級驅動器

Features特性

- Single-phase, full-wave pre-driver單相全波
- Supply voltage: 5.5 to 16V
- Output current: -20 to 20mA
- Variable speed control withPWM脈寬調速
- Integrated protection:集成保護
  - Current limit限流保護
  - Lock protection堵轉保護
  - Thermal shutdown過溫保護
- Minimum speed set最低速度設置
- Soft-start settingpin 帶軟啟動設置引腳
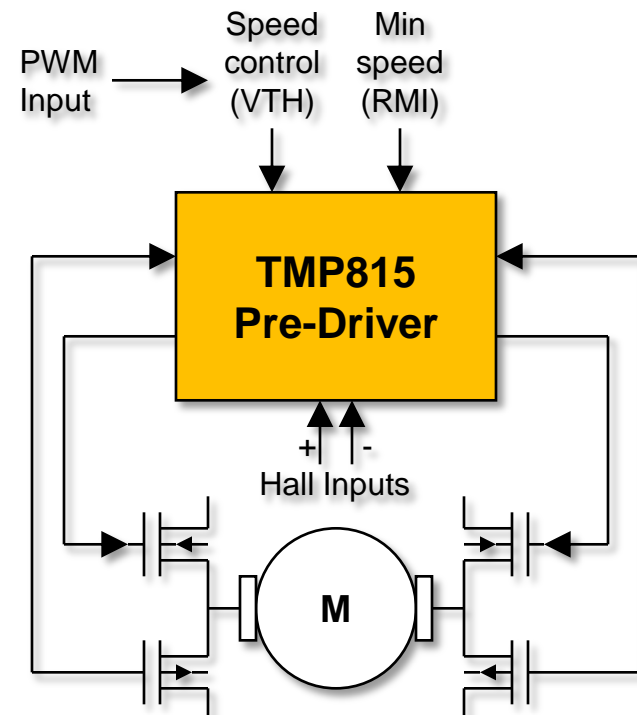- 5 x 4.4mm TSSOP, compatible with LB11867

Applications應用

- Server / PC cooling fans伺服器/PC電腦 風扇

5mm x 4.4mm x 1mm
16-pin TSSOP package

Benefits優勢

- High-efficiency, low power consumption drive with external PNP-NMOS FETs高效 低功耗 前級
- Silent and low-consumption drive due to cutting reactive current before phase change換向反沖控制實現平穩高效驅動
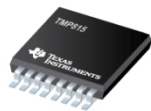- Integrated protection集成保護，高可靠性

TEXAS INSTRUMENTS

TMP814

Single-Phase Full-Wave Fan Motor Pre-Driver
單相馬達全波前級驅動器

Features特性

- Single-phase, full-wave pre-driver單相全波
- Supply voltage: 6 to 16V
- Output current: 50mAMAX
- Compatible with 12V, 24V and 48V systems相容 12V，24V，48V系統
- Variable speed control withPWM脈寬調速
- Integrated protection:集成保護
    - Current limit限流保護
    - Lock protection堵轉保護
    - Thermal shutdown過溫保護
- Minimum speed set最低速度設置
- LDO for Hall Bias output穩壓霍爾偏置輸出
- 6.5 x 4.4mm TSSOP, compatible with LB11967
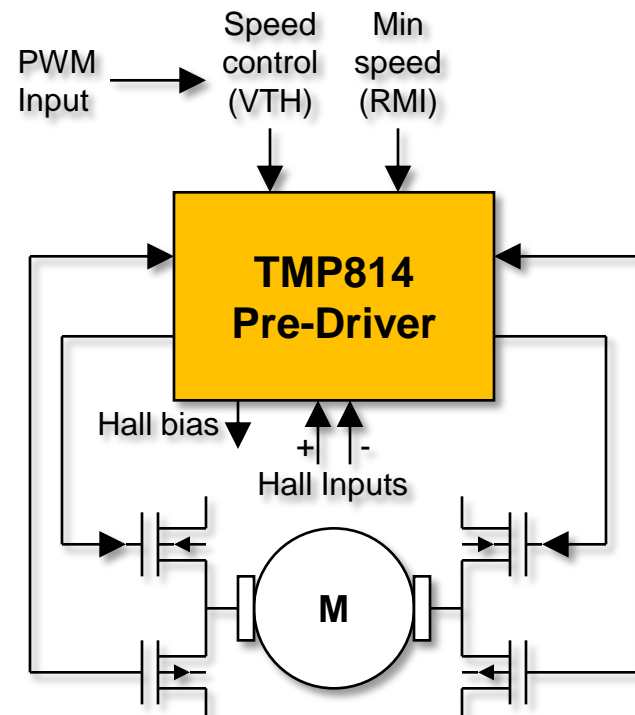
Applications應用

- Large Scale fan大尺寸（功率）單相風扇

6.5mm x 4.4mm x 1mm
20-pin TSSOP package

Benefits優勢

- High-efficiency, low power consumption drive with external PNP-NMOS FETs高效 低功耗 前級
- Silent and low-consumption drive due to cutting reactive current before phase change換向反沖控制實現平穩高效驅動
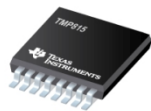- Integrated protection集成保護，高可靠性

TMP816

Single-Phase Full-Wave Fan Motor Pre-Driver
單相馬達全波前級驅動器

Features特性

- Single-phase, full-wave pre-driver單相全波
- **TMP814 + Soft-Start Setting Capacitor**
- Supply voltage:　　　　6 to 16V
- Output current:　　　　50mAMAX
- Compatible with 12V, 24V and 48V systems相容 12V，24V，48V系統
- Variable speed control withPWM脈寬調速
- Integrated protection:集成保護
  - Current limit限流保護
  - Lock protection堵轉保護
  - Thermal shutdown過溫保護
- Minimum speed set最低速度設置
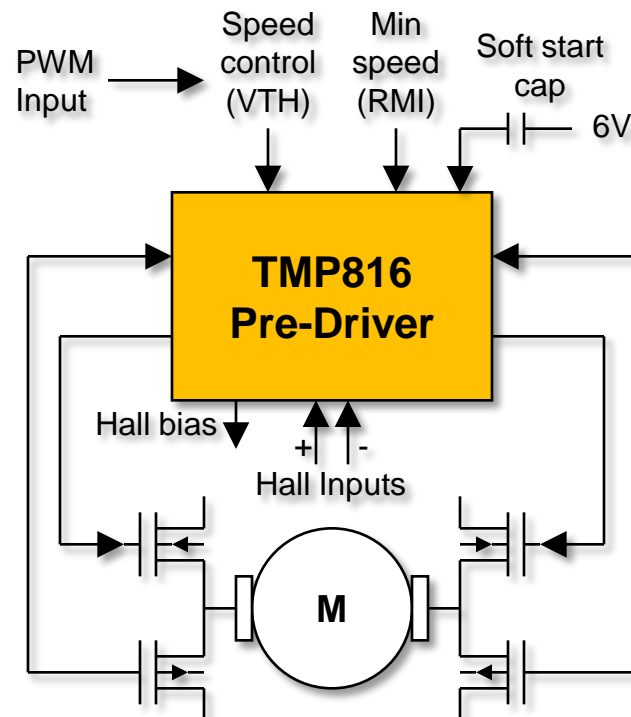- LDO for Hall Bias output穩壓霍爾偏置輸出
- 6.5 x 4.4mm TSSOP

Applications應用

- Large Scale fan大尺寸（功率）單相風扇

6.5mm x 4.4mm x 1mm
20-pin TSSOP package

Benefits優勢

- High-efficiency, low power consumption drive with external PNP-NMOS FETs高效 低功耗 前級
- Silent and low-consumption drive due to cutting reactive current before phase change換向反沖控制實現平穩高效驅動
- Integrated protection集成保護，高可靠性

TMP821

Two-Phase Half-Wave Fan Motor Pre-Driver
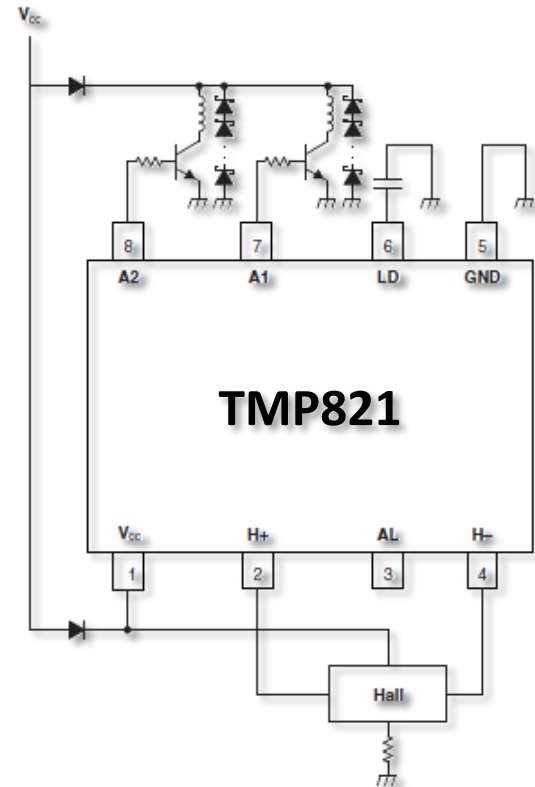## 兩相電機半波前級驅動器

Features / Benefits

- Two-phase, half-wave driving pre-driver兩相半波前級
- Supply voltage: 4 to 28V
- Output current: 70mA max
- Integration reduces number of required external components外接器件少
- Built-in lock detection and rotational speed sensing mechanisms內置堵轉檢測和保護
- Automatic restart when motor lock is undone
- Hall amplifier inputs have hysteresis帶滯回霍爾輸入
- SOIC package, compatible with BA6406

Applications

- Two Phase Cooling fans兩相散熱風扇
- Desk fan小型桌面風扇

3.9 x 4.9mm
8-pin SOIC package

3 Phase Senor-less Driver Tech
三相驅動技術

TEXAS INSTRUMENTS

Sensor-less motor driver

Advantage of Sensor-less :無感測器優點

✓ No Hall Sensor Needed Lower Cost無需霍爾感測器，低成本

✓ Extend System durability提高系統壽命和可靠性

✓ Better temperature feature無霍爾器件，提升系統溫度範圍和穩定性

✓ Multi-Protection along with Control Algorithm伴隨控制演算法的多種保護措施

Also by using sensor-less driver

▪ Simple Circuit and Easy to Use簡化電路，減少器件，使用簡單
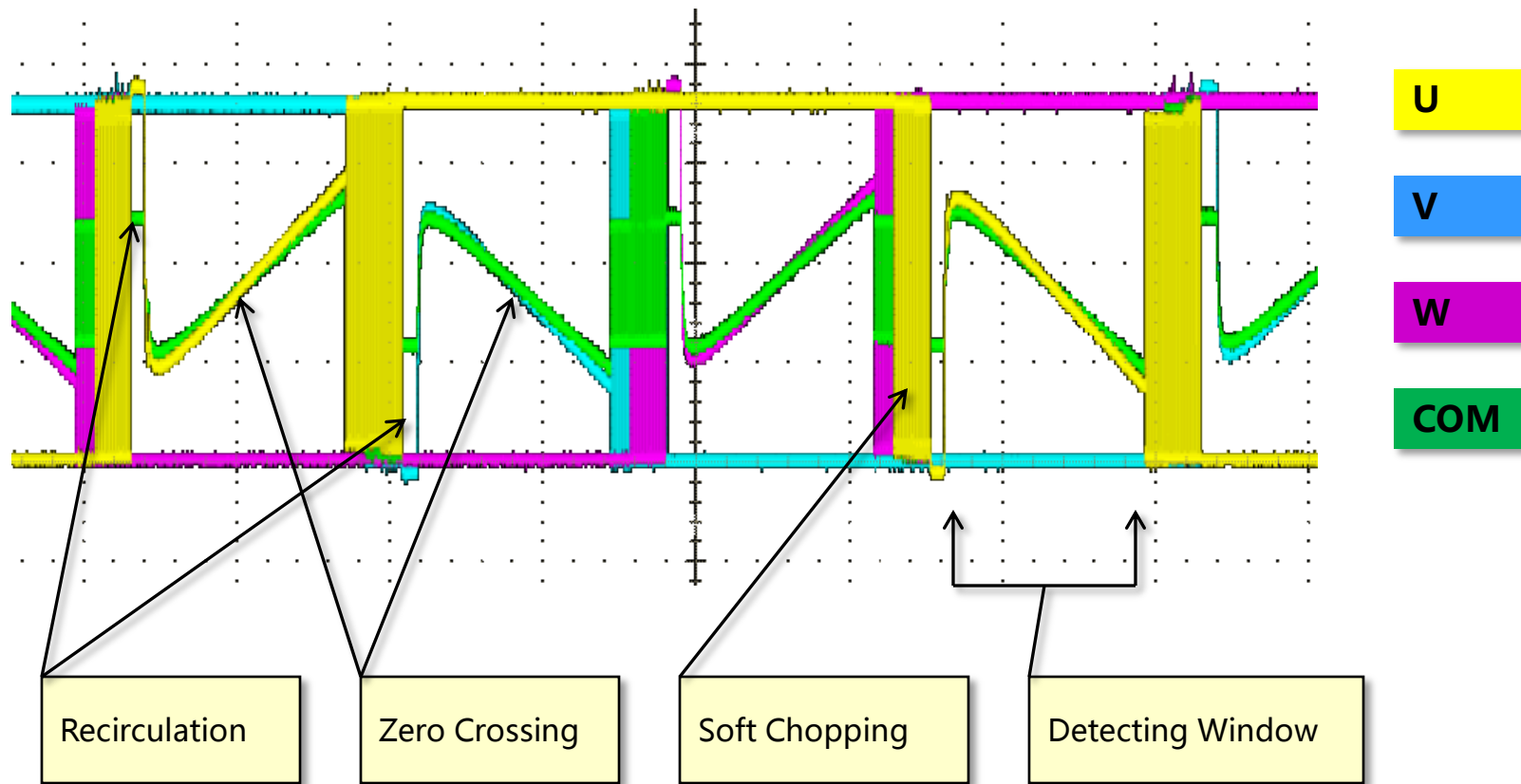
▪ Fast Developing加快應用開發速度，節省研發成本和週期

（Benefit Customer）

Shortage :無感測器缺點

✓ Complex Control Logic控制邏輯較複雜（Leave to TI）

✓ Difficult to Adapt all motor types較難適應各種馬達參數（Leave to TI）

✓ Startup, Lock detect Strategies are much more complex than Sensor one啟動策略，堵轉檢測策略相比有感測器方案要複雜許多（Leave to TI）

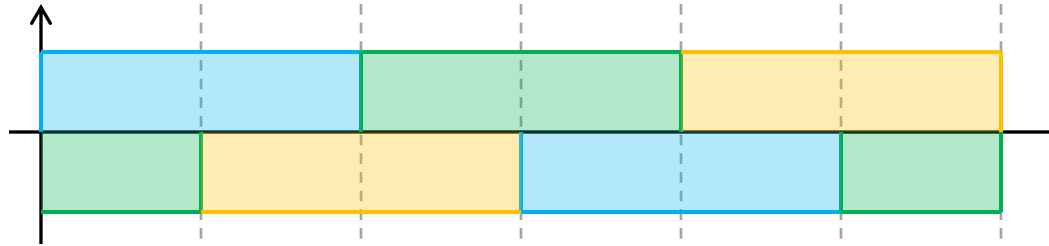✓ Problem debug or fix are more difficult一旦需要調試將較為複雜（Leave to TI）

Sensor-less Technology

Recirculation

Zero Crossing

Soft Chopping

Detecting Window

U
V
W
COM

TEXAS INSTRUMENTS

Driving Technology

120°驅動

Phase V相電壓

Phase I相電流

Torque轉矩

Driving Technology

150°驅動

Phase V相電壓

Phase I相電流

Torque轉矩

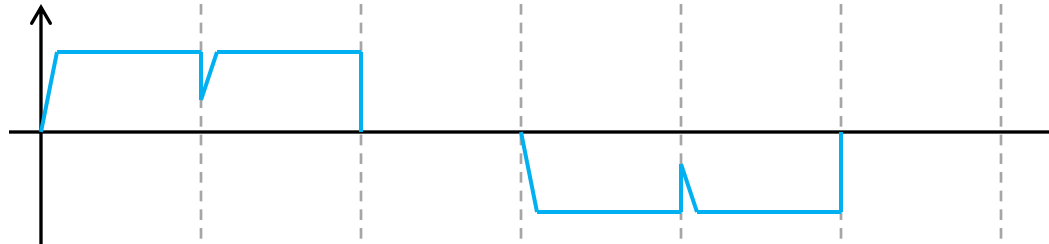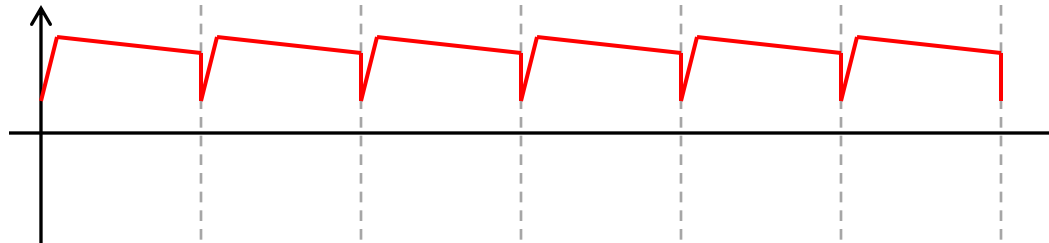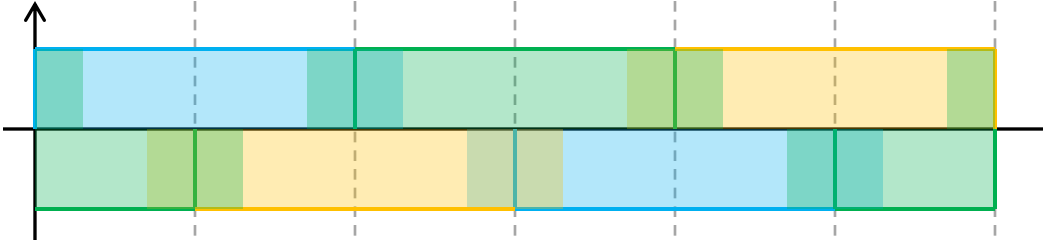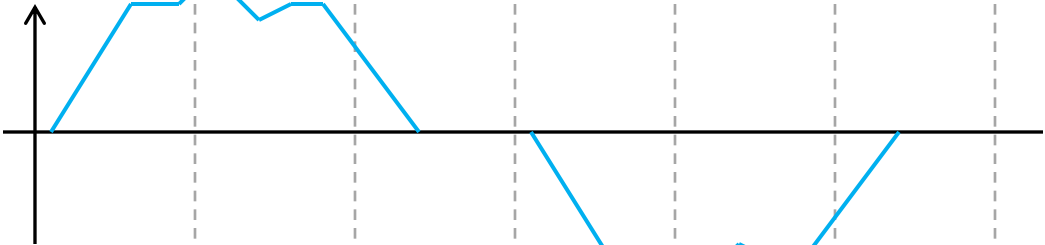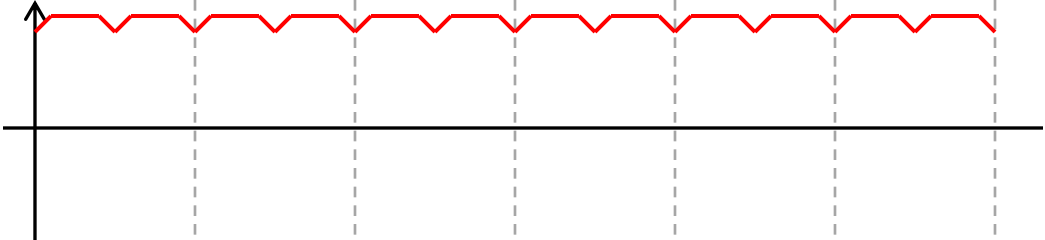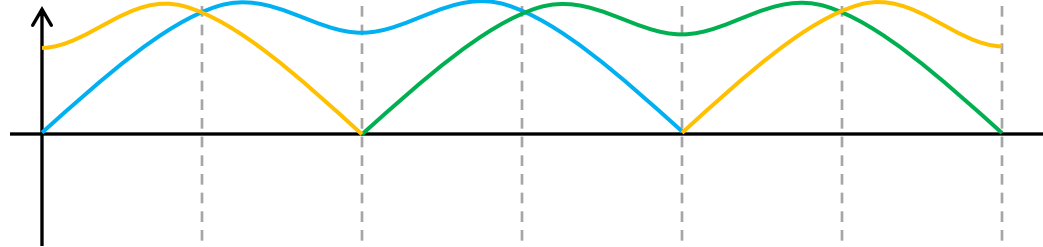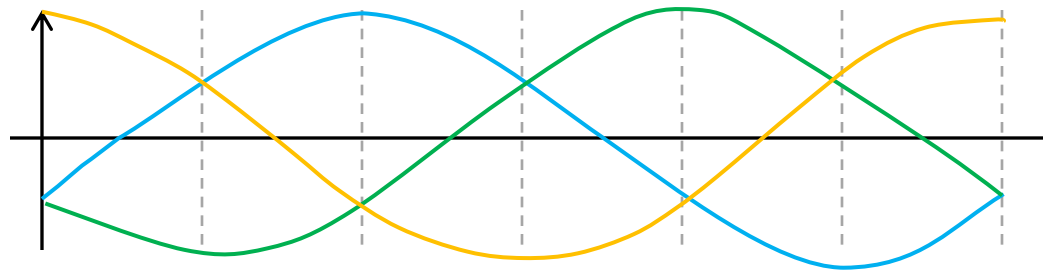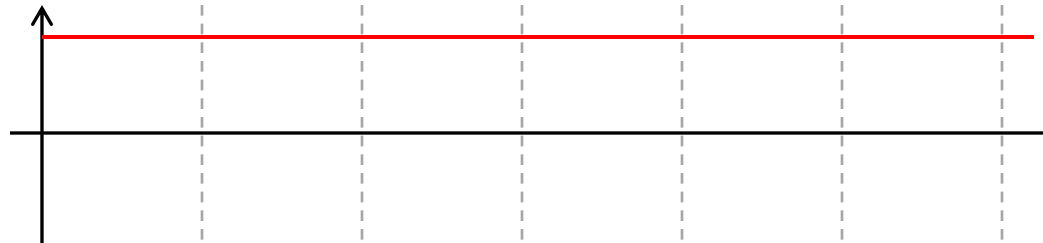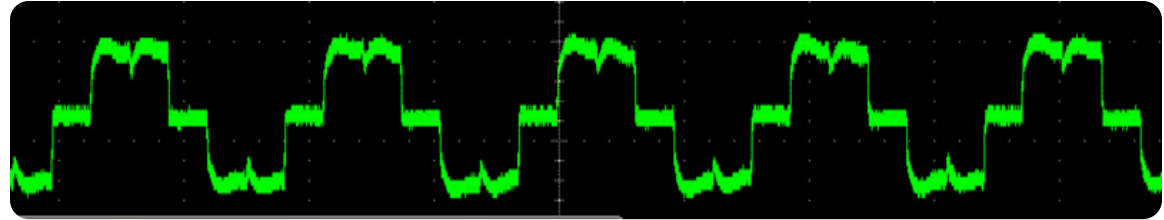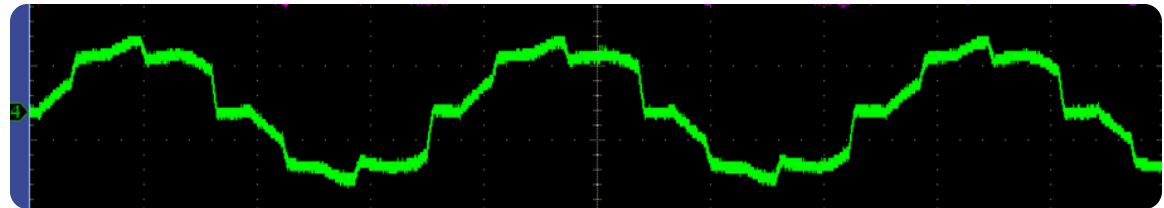# Driving Technology

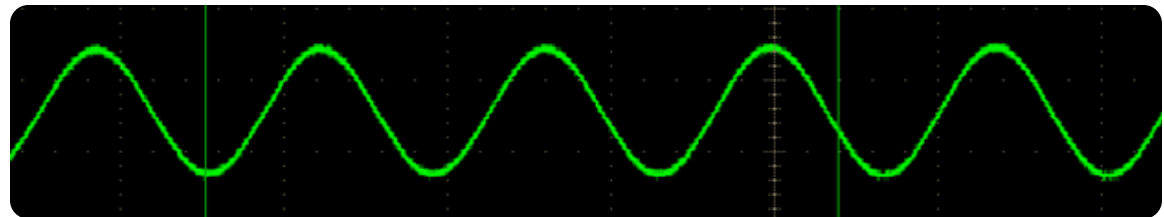180°驅動

Phase V相電壓

Phase I相電流

Torque轉矩

Driving Technology

120° Driving Phase current
驅動相電流波形

150° Driving Phase current
驅動相電流波形

180° Driving Phase current
驅動相電流波形

Fan Application Collection應用集錦

TEXAS INSTRUMENTS

3-Phase Sensor-less BLDC Fan Driver
3相 無刷 無感測器 集成馬達驅動器
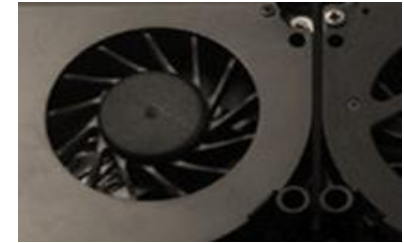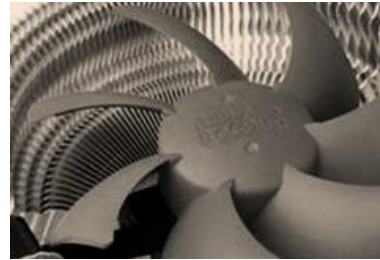
Application應用

- ✓ Notebook Cooling fan筆記本風扇
- ✓ CD/DVD Spindle碟機主軸驅動
- ✓ Game Station CPU Cooling fan遊戲機風扇
- ✓ GPU Cooling fan顯卡風扇
- ✓ Server fan伺服器風扇
- ✓ Fridge fan冰箱迴圈，除霜風扇
- ✓ Scanner條碼掃描機主軸
- ✓ Desk/Ceiling fan台扇/吊扇
- ✓ Toy玩具

Benefits優勢

- ✓ Full Integrated全集成
- ✓ Sensor-less 無感測器控制
- ✓ Efficiency, Durable, Low Cost高效率，高壽命，低成本
- ✓ Multi-Protection完善的保護措施

TEXAS INSTRUMENTS

DRV10866

5V 3-Phase Sensor-less BLDC Fan Driver
5V 3相 無刷 無感測器 集成馬達驅動器

Features特性

- ✓ Supply voltage: 1.65~5.5V
- ✓ Output Current: 0.5A
- ✓ Total RDSON (上臂+下臂):800mΩ
- ✓ 150°無感測器BEMF控制
- ✓ 無外接電流採樣電阻
- ✓ Synchronous PWM 高效同步PWM調速
- ✓ 5μA Stand by休眠待機模式
- ✓ Lock detect堵轉檢測和保護
- ✓ OCP過流限制保護
- ✓ Thermal Protection過熱保護
- ✓ UVLO欠壓保護
- ✓ OVP過壓保護

微型化10PIN
3mm×3mm×0.75mm
SON Package封裝

Coming Soon

DRV10866

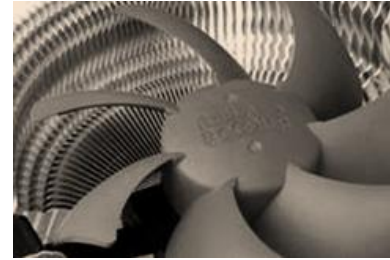5V 3-Phase Sensor-less BLDC Fan Driver
5V 3相 無刷 無感測器 集成馬達驅動器

Application應用

- ✓ Notebook Cooling fan筆記本風扇
- ✓ Ultra-book fan超級本風扇
- ✓ CD/DVD Spindle碟機主軸驅動
- ✓ Game Station CPU Cooling fan遊戲機風扇
- ✓ GPU Cooling fan顯卡風扇
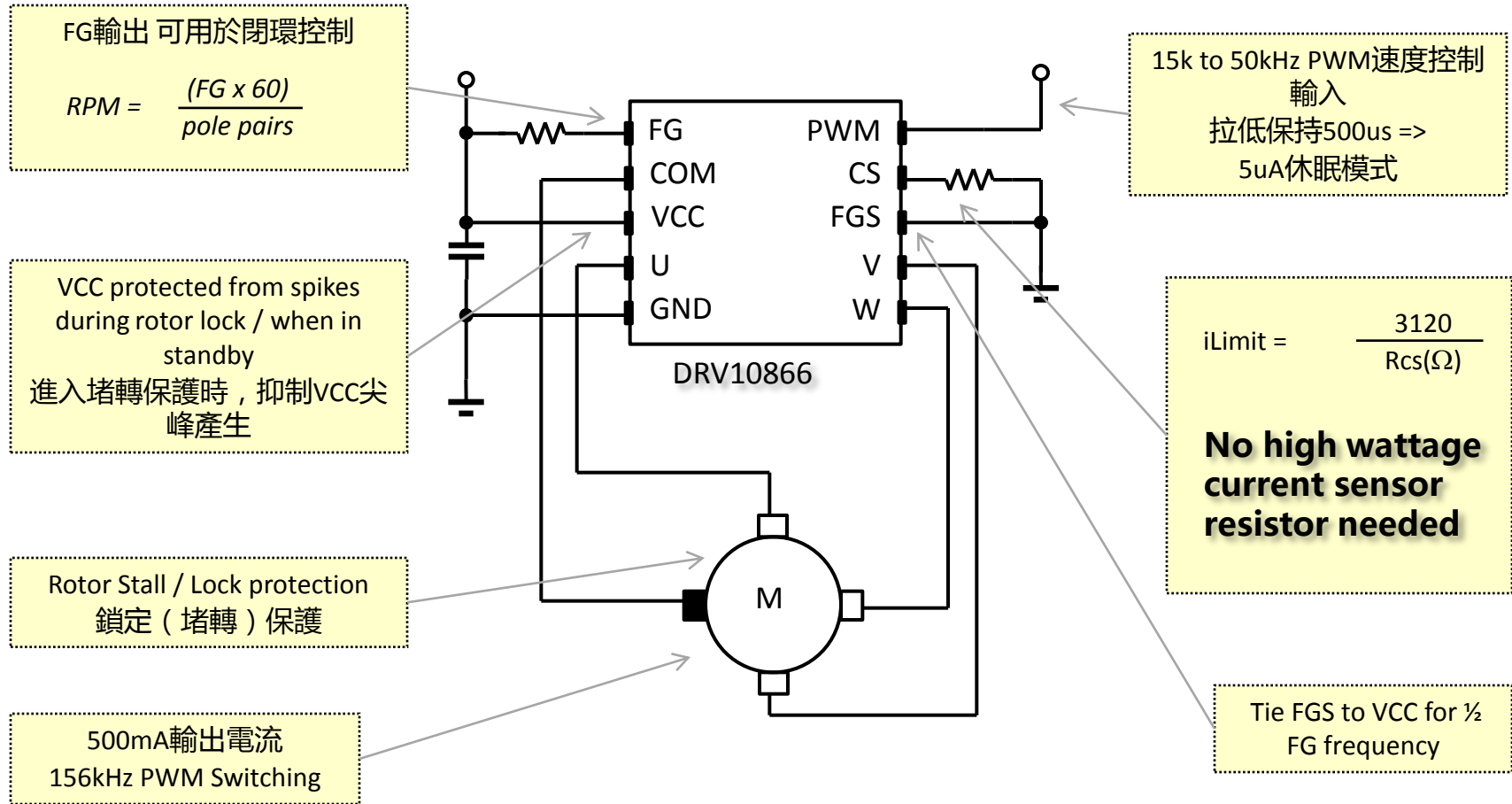- ✓ Scanner條碼掃描機主軸
- ✓ USB fan   USB風扇
- ✓ Toy玩具
- ✓ ......

Benefits優勢

- ✓ Full Integrated全集成
- ✓ Sensor-less 無感測器控制
- ✓ Efficiency, Durable, Low Cost高效率，高壽命，低成本
- ✓ Multi-Protection完善的保護措施

DRV10866

FG輸出 可用於閉環控制

$$RPM = \frac{(FG \times 60)}{pole\ pairs}$$

15k to 50kHz PWM速度控制輸入
拉低保持500us =>
5uA休眠模式

VCC protected from spikes during rotor lock / when in standby
進入堵轉保護時，抑制VCC尖峰產生

$$iLimit = \frac{3120}{Rcs(\Omega)}$$

No high wattage current sensor resistor needed

FG	PWM
COM	CS
VCC	FGS
U	V
GND	W

DRV10866

M

Rotor Stall / Lock protection
鎖定（堵轉）保護

Tie FGS to VCC for ½ FG frequency

500mA輸出電流
156kHz PWM Switching

Layout Guide

✓ VCC Cap Close to VCC PIN and GND PINVCC電容要儘量接近VCC和GND引腳

✓ Unsplit GND Plane完整GND平面，降低GND阻抗

✓ Track width match the Current區分強弱電流線，匹配線寬和阻抗

✓ Avoid Crossing talk區分輸入和輸出引腳，加強走線隔離和遮罩，防止串擾

✓ Efficient Thermal connection有效連接熱焊盤，有效散熱佈局（雙層以上並注意散熱平面輻射狀連續性）

✓ Components related to Charge pump, switch regulator, LDO should be close to the PINs電荷泵，開關穩壓器等相關的器件要儘量靠近晶片，連線儘量短

Driving Waveform

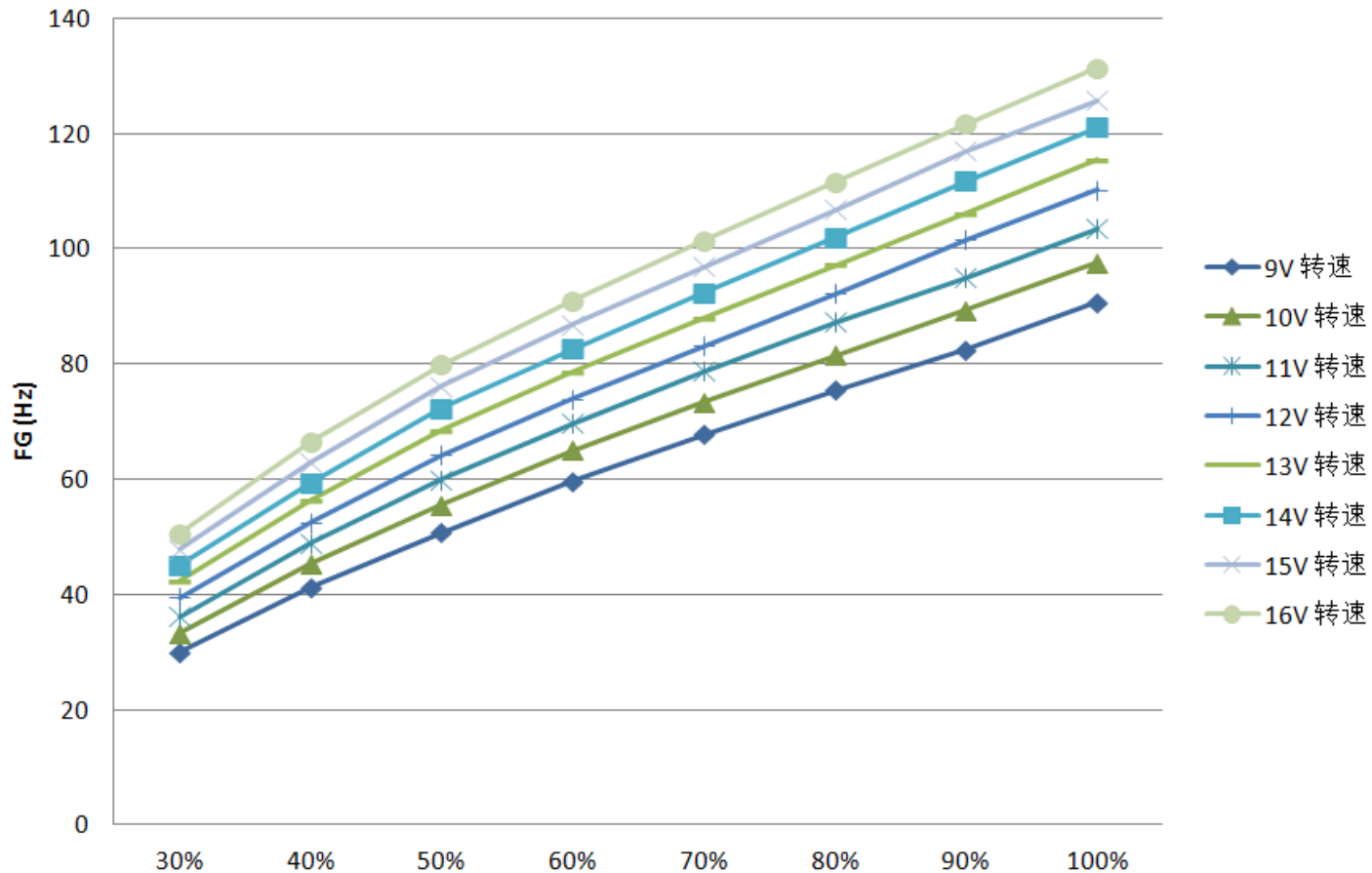**Typical Driving Waveform of 150 °**

Driving Waveform

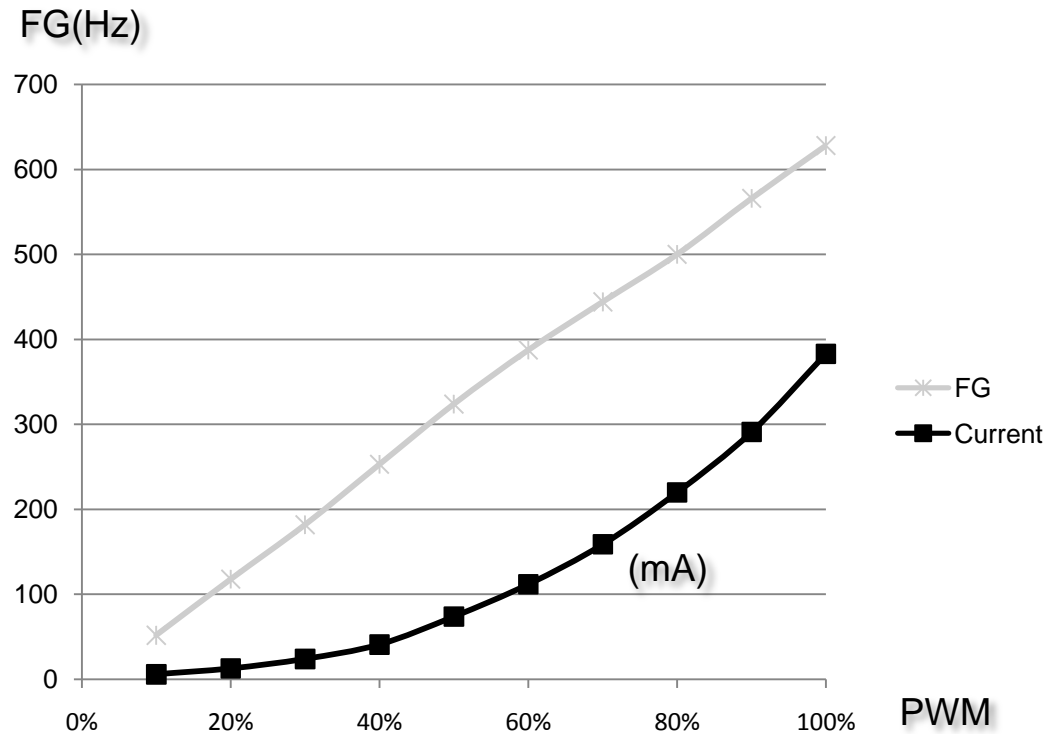Phase Voltage

Phase Current

Typical Driving Waveform of 180 °

Speed Control

Speed curve of different PWM and VCC

Speed Control

PWM	12V VCC		
	FG(Hz)	I(mA)	RPM
10%	51.9	6	1557
20%	118	13	3540
30%	182	24	5460
40%	253	41	7590
50%	324	74	9720
60%	387.5	112	11625
70%	444.2	159	13326
80%	500	220	15000
90%	566	291	16980
100%	628	383	**18840**

FG(Hz)

(mA)

PWM

FG
Current

Driving high speed motor

TEXAS INSTRUMENTS

Let's spinning with TI motor driver !

Thank you!