FEELING TECHNOLOGY

FD125Kf
FD125Sf

All-In-One Variable Speed Motor Driver IC

Features

Halogen Free

- Built-in high sensitivity Hall-effect sensor
- H-bridge MOS driver for single-phase DC motor
- Rotor lock shutdown & auto-restart function
- Two mode variable speed control(PWM, DC)
- Tachometer signal output(FG only for FD125Kf)
- Alarm signal output(RD only for FD125Sf)
- Output soft-switching
- Thermal shutdown protection(TSD)
- Available in TS826 package
- For 12V DC motor / FAN systems

General Description

FD125K/Sf is a single-phase full wave motor driver with embedded Hall-effect sensor IC for high voltage operation DC motor / FAN. It integrates a H-bridge MOS driver, a high sensitivity hall-effect sensor, a digital control logic with internal clock for rotor locked, tachometer or alarm output logic and motors' speed control functions only in TS826 package, which make the motors' PCBs(printed circuit boards) design easy and fabricate the small and tiny size DC motors or FANs as simply as possible.

For safety, Lock-shutdown function would turn the IC's internal drivers off avoiding over-heat when the rotor is locked, and IC will try to re-start the rotor's torque after the time of these drivers' shutdown.

FD125K/Sf is built-in the tachometer signal or alarm signal output function, the external system could be readout the motor's speed (FG) or rotation status (RD) from the signal pin of FD125K/Sf IC.

Thermal-shutdown protection (TSD) ensures the internal drivers of IC are operating under a safe operating temperature range.

There are two variable speed control modes in FD125K/Sf, the programmable PWM duty cycle and DC voltage level to the same pin of IC.

Block Diagram

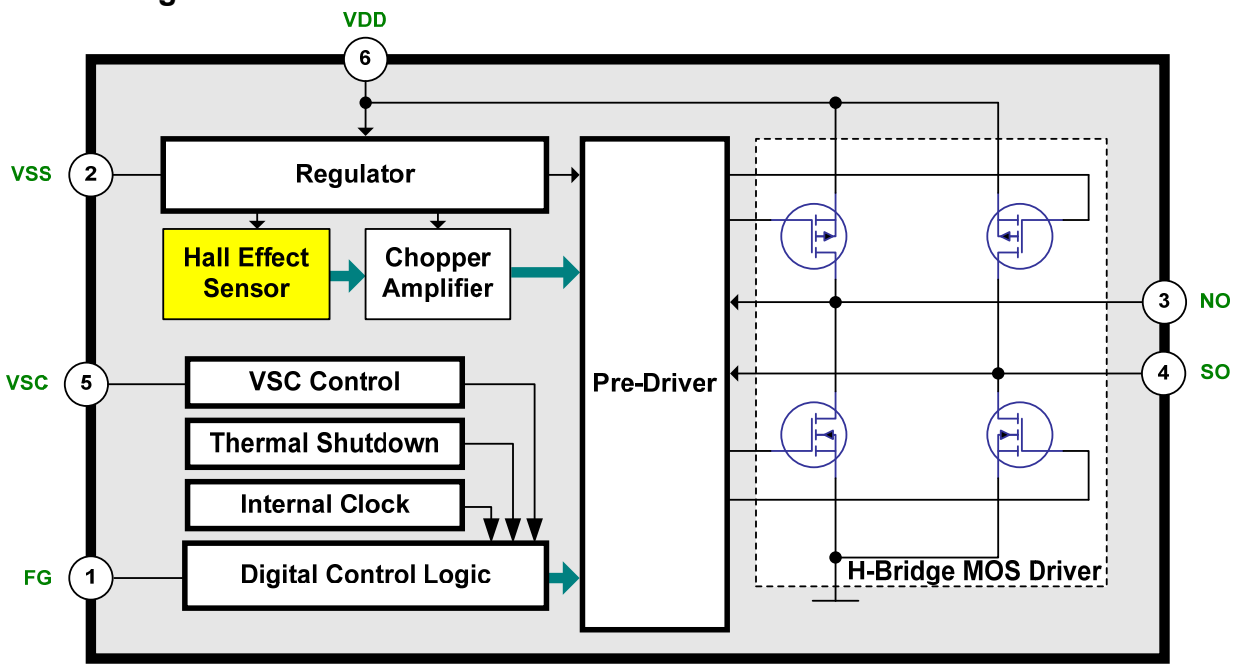


Figure 1

Pin Connection

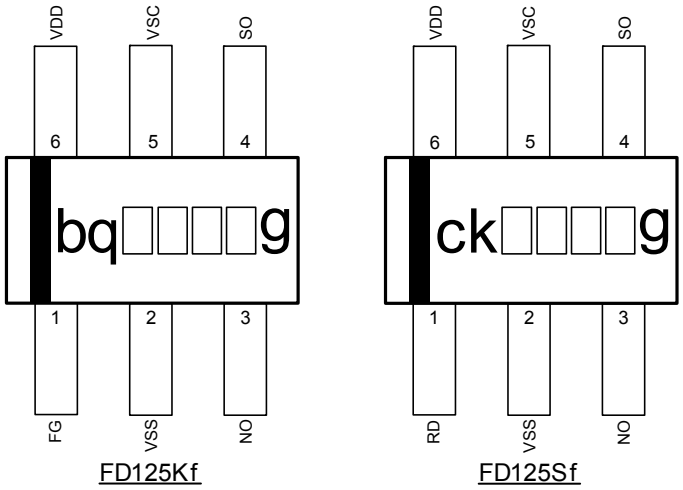


Figure 2

Pin Descriptions

Name	I/O	FD125Kf	FD125Sf	Description
FG	O	1	-	Tachometer Signal Output
RD	O	-	1	Alarm Signal Output
VSS	G	2	2	Ground
NO	O	3	3	Driver Output 1
SO	O	4	4	Driver Output 2
VSC	I	5	5	PWM / DC Variable Speed Control Input
VDD	P	6	6	Positive Power Supply

Legend: I=input, O=output, I/O=input/output, P=power supply, G=ground

Functional Descriptions

Refer to the block diagram (Figure 1), FD125K/Sf is composed of the following building blocks:

- **Regulator**

The regulator provides a precise, low temperature coefficient bias reference for internal analog/digital blocks.

- **Hall-Effect Sensor with Chopper Amplifier**

To achieve a higher magnetic sensitivity the chopper amplifier structure is adopted in this design. Use of this structure dynamically removes both the offset and flicker noise at the same time.

- **Digital Control Logic with Internal Clock**
  - Timer part – generates an interval of time when rotor locked event is occurred.
  - Signal part – generates the tachometer or alarm signal output.
- **H-Bridge MOS Driver with Pre-Driver**

The driver provides DC motor / FAN coil driving capability.

- **Variable Speed Control**
  - ***PWM Mode***

    The PWM control provides PWM mode and DC level mode for DC motor variable speed control. PWM(pulse-width modulation) is used for the speed control for FD125K/Sf. PWM input signal can be used directly to the VSC pin of FD125K/Sf and it will pass this pulse to the coil drivers with the original duty-cycle ratio.

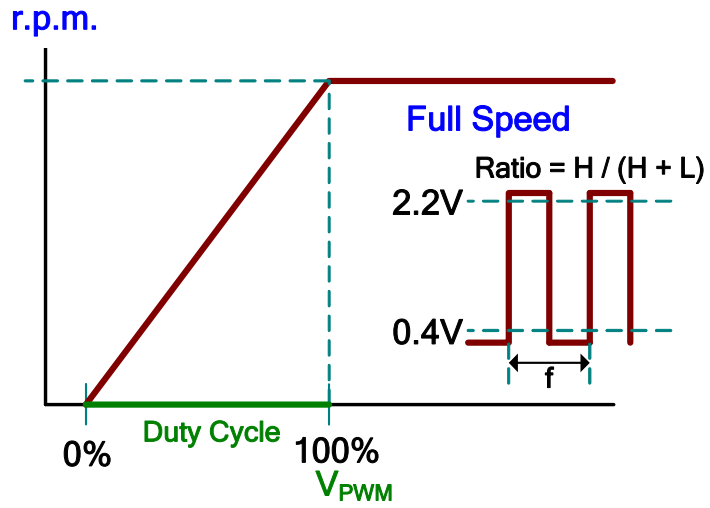


Figure 3

Note:

(1) The lower-limit for the PWM pulse frequency is 200Hz, and the recommended frequency range is in the range of 25~30kHz where the PWM input pulses will not generate acoustic noise.

(2). The VSC pin contains an internal pull-up resistor, the BLDC motor becomes full speed operation when this pin is left un-connected(floating).

(3). Under low duty(< 20%) the BLDC motor perhaps cannot rotate, but IC still has an on torque to re-start the BLDC motor until the duty cycle is 0%.

Note. *The "PWM" pin contains an internal pull-up resistor so the FD125K/Sf will rotate at full-speed(100% ON) when this pin is left un-connected(floating).*

➢ ***DC Level Mode***

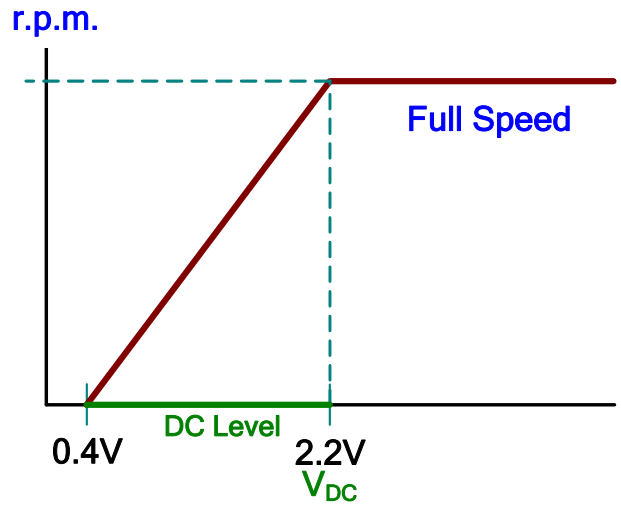


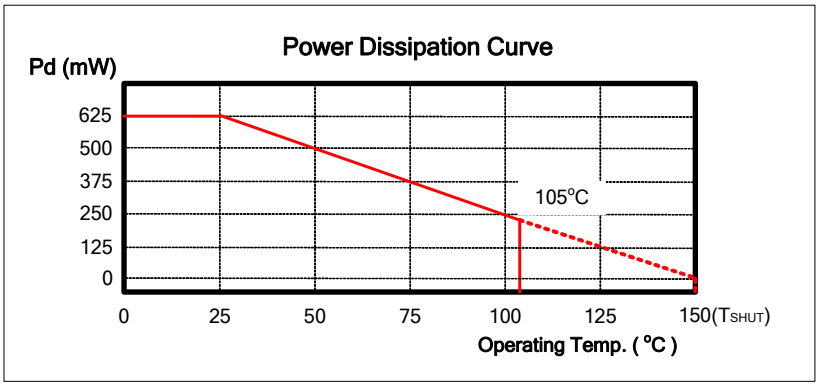
Figure 4

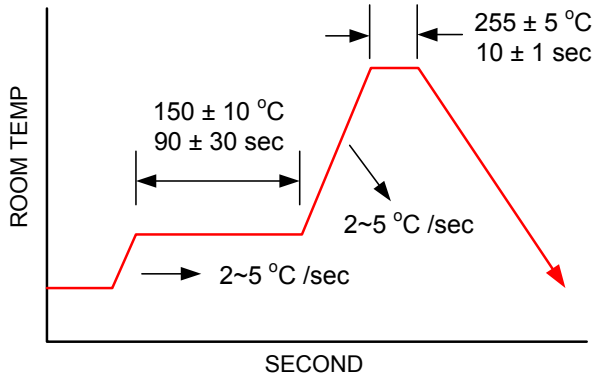
Applying a DC voltage to the VSC pin and the FD125K/Sf will generate PWM pulses internally with duty cycle ratio in output "ON" state according to the diagram below(Figure 4), which can be utilized by the user to control the speed of the motor. The rotation speed will be higher if the voltage applied to the VSC pin is higher.

Absolute Maximum Ratings

Parameter		Symbol	Values			Unit
			Min.	Typ.	Max.	
Operating Temperature		$T_{OP.}$	-20	-	105	℃
Storage Temperature		$T_{ST.}$	-40	-	150	℃
DC Supply Voltage		$V_{DD(MAX.)}$	-0.3	-	18	V
DC Input Voltage		V_{VSC}	-0.3	-	V_{DD}	V
DC Supply Current		I_{DD}	-	-	8	mA
Output Continuous Current		$I_{O(CON.)}$	-	-	250	mA
Output Holding Current		$I_{O(HOLD)}$	-	-	500	mA
Signal Sink Current		$I_{S(ON)}$	-	-	25	mA
Signal Off Voltage		$V_{S(OFF)}$	-	-	18	V
Junction Temperature		T_j	-	-	170	℃
Power Dissipation	Note 1	$P_{D(TS826)}$	-	-	625	mW
Junction-Case Thermal Resistance		Θ_{jc}	-	0.056	-	℃/mW
Junction-Ambient Thermal Resistance		Θ_{ja}	-	0.200	-	℃/mW

Note1: *device mounted with copper area of approximately 35mm^{2,} 1oz, no air flow. (room temperature: 25 ℃)*





IR-ReFlow Soldering Condition

Figure 5

Recommended Operating Conditions

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Supply Voltage Range	V_{DD}	-	4.0	-	15	V
Operating Temperature Range	$T_{OP.}$	-	-20	-	105	℃

Electrical Characteristics V_{DD}=12V, $T_{OP.}$=25℃ (unless otherwise specified)

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Average Supply Current	I_{DD}	No Loading	-	5	-	mA
On Resistance ($R_{(PMOS)}$ + $R_{(NMOS)}$)	$R_{DS(ON)}$	VDD = +5.0V	-	10	-	Ω
		VDD = +12V	-	5	-	
Signal On Voltage (FG, RD)	$V_{S(ON)}$	$I_{S(SINK)}$ = 5mA	-	-	0.4	V
Signal Off Leakage Current	$I_{S(OFF)}$	$V_{S(OFF)}$ = +12V	-	-	50	μA
VSC Threshold Voltage	$V_{TH(L)}$		-	0.4	-	V
	$V_{TH(H)}$		-	2.2	-	
VSC Sync. Frequency	f_{SVC}		-	40	-	KHz
Internal PWM Frequency	f_{OSC}		-	25	-	KHz
PWM Frequency Deviation	$\triangle f_{OSC}$		-	20	-	%
Thermal Shutdown Threshold	T_{SHUT}		150	-	-	℃
Thermal Shutdown Hysteresis	T_{HYS}		-	30	-	℃
Locked Rotor On Period	T_{ON}		-	0.4	-	s
Locked Rotor Off Period	T_{OFF}		-	4.0	-	s

Magnetic Characteristics

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Operating Point	B_{OP}		5	30	45	G
Release Point	B_{RP}		-45	-30	-5	G
Hysteresis	B_{HYS}		10	-	90	G

Hysteresis Characteristics

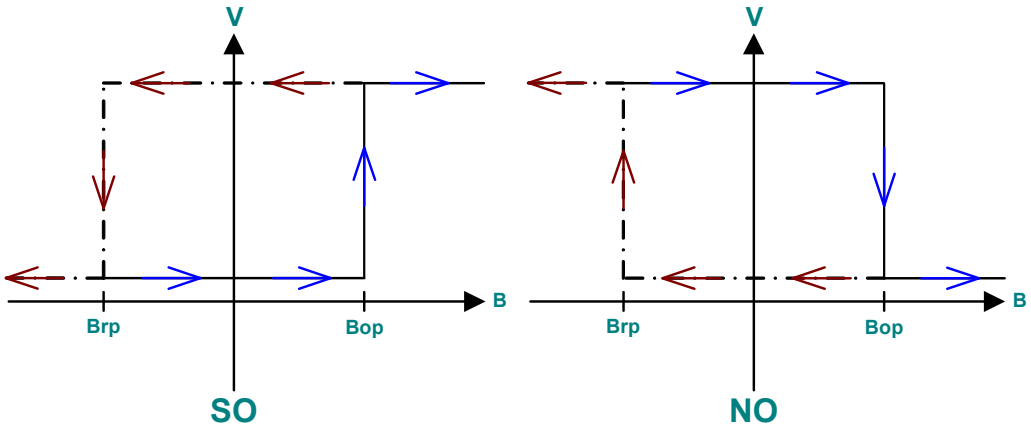


Figure 6

Performance Graphs

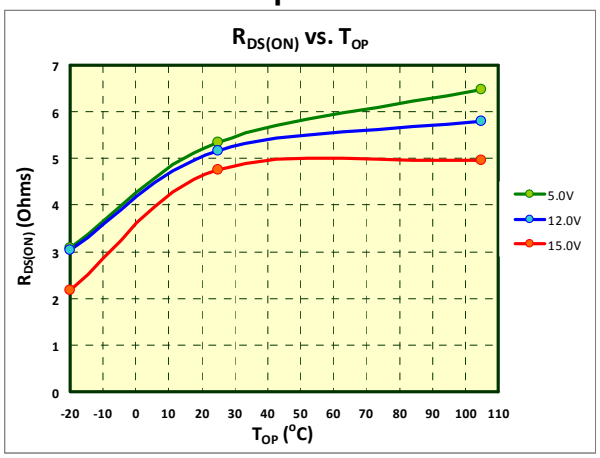


Figure 7

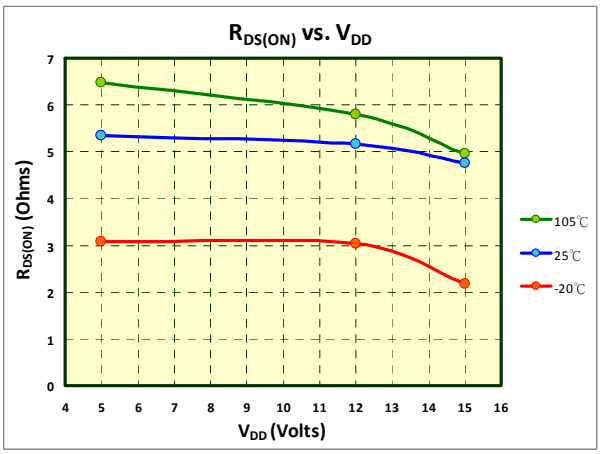


Figure 8

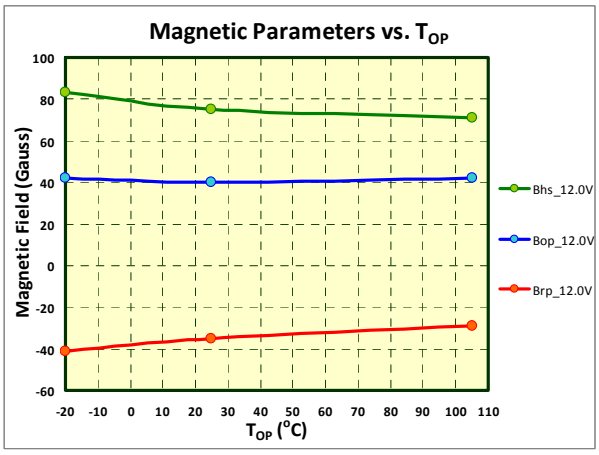


Figure 9

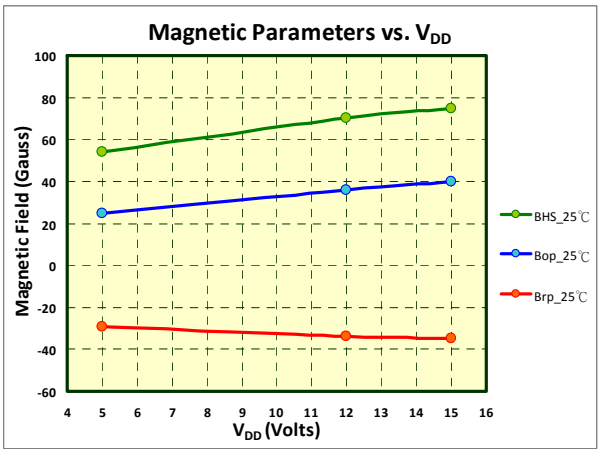


Figure 10

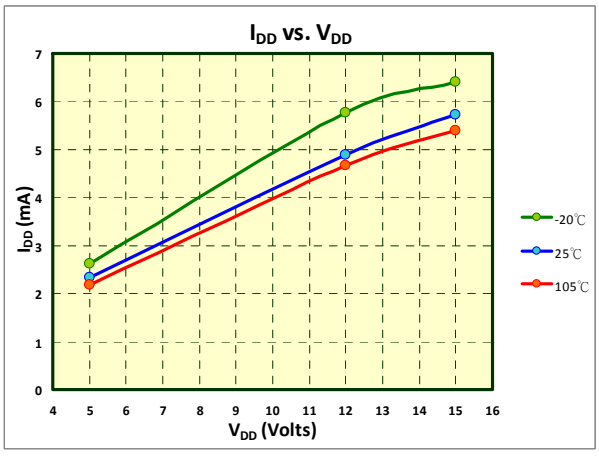


Figure 11

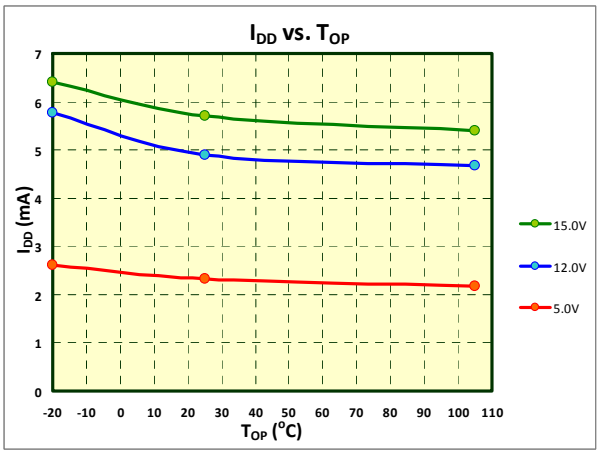


Figure 12

Tachometer Signal(FG) Description

The output on voltage of FG signal is relative to the ambient temperature and supply voltage of the IC. Figure 13 is a curve of this relationship at the condition of a 5mA sink current. If the signal level isn't correct, the tachometer signal(FG) will be incorrectly detected by the succeeding system.

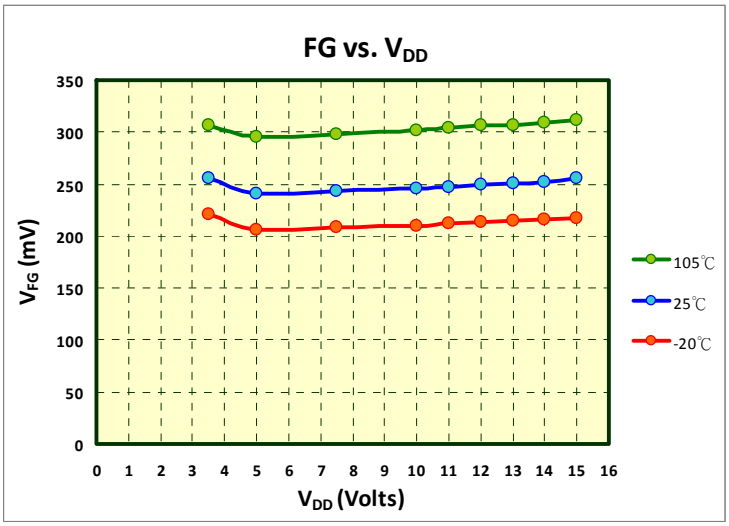


Figure 13

Power Loss Calculation

The main power loss of FD125Kf is composed of four parts, the first is from the IC internal supply current (I_{DD}) with the IC operation voltage (V_{DD}), the second is the ON loss from the IC high-side and low-side on voltage with coil on current, the third is the soft-switching loss and the fourth is the signal turn on loss.

The following are the approximate formulas which express the relationships. If the PCB thermal resistance condition and power loss calculation are known, the chip junction temperature can be estimated as well.

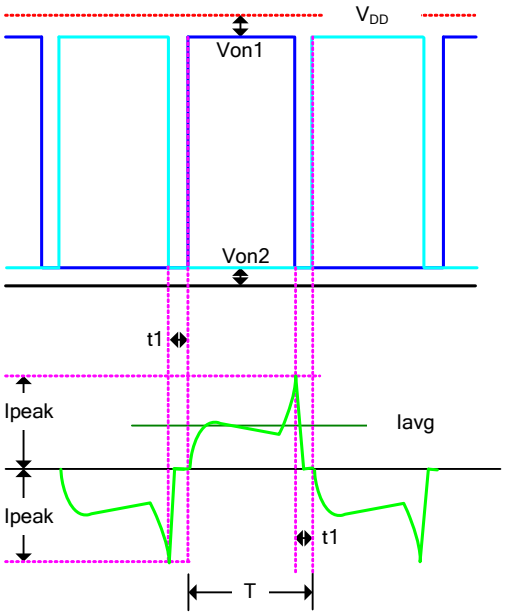


Figure 14

Total Power Loss Calculation Formula:

$$Pc = V_{DD} \times I_{DD} + (Von1 + Von2) \times Iavg \times \frac{(T - t1)}{T} + \frac{1}{2} \times V_{on(FG)} \times I_{sink(FG)}$$

$$Tj = Pc \times \theta ja + Ta \le k \times TSD \quad k = 0.8 \sim 0.9$$

Application Circuits Reference

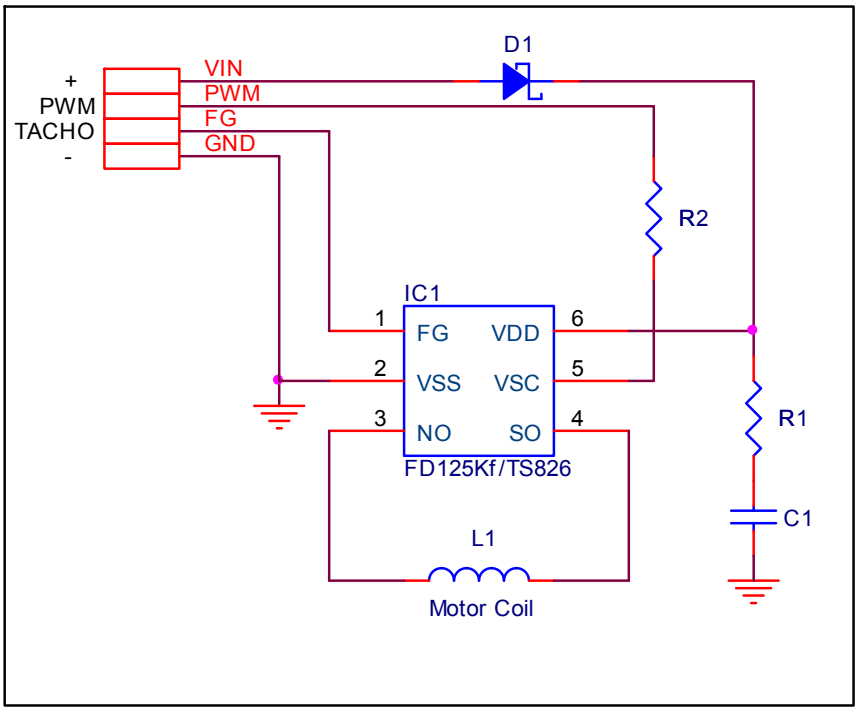


Figure 15 FD125Kf 4-Wire PWM Pulse Variable Speed BLDC Motor Application Circuits

The IC laying aside mode declaration is as follows:

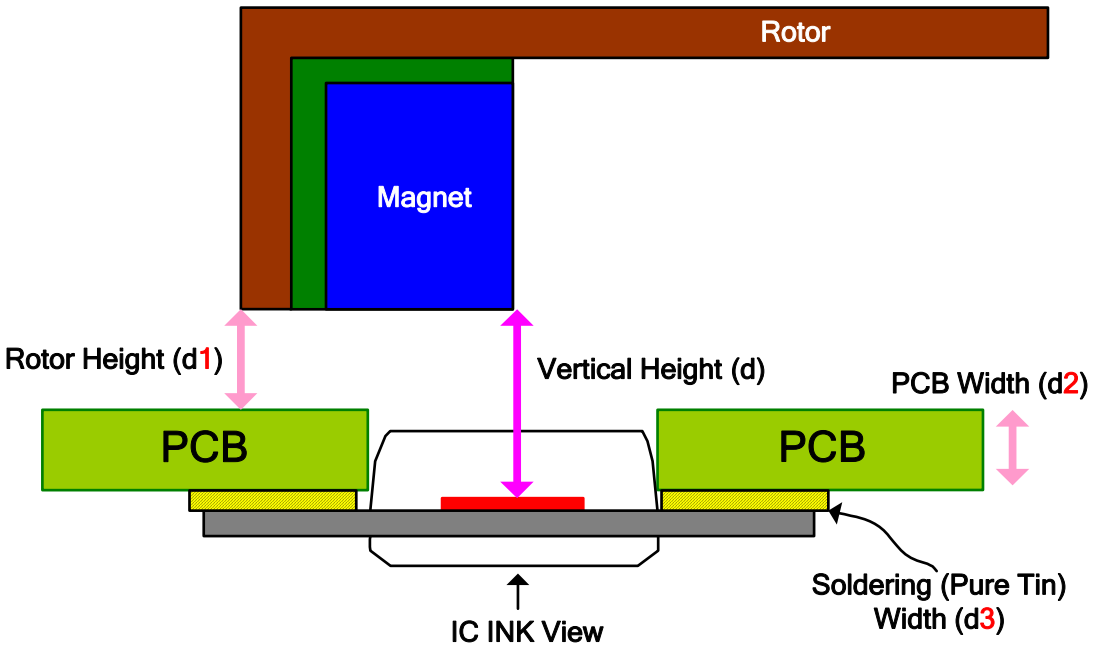


Figure 16

FD125Kf/FD125Sf Output Waveforms Description(Full Speed Operation)

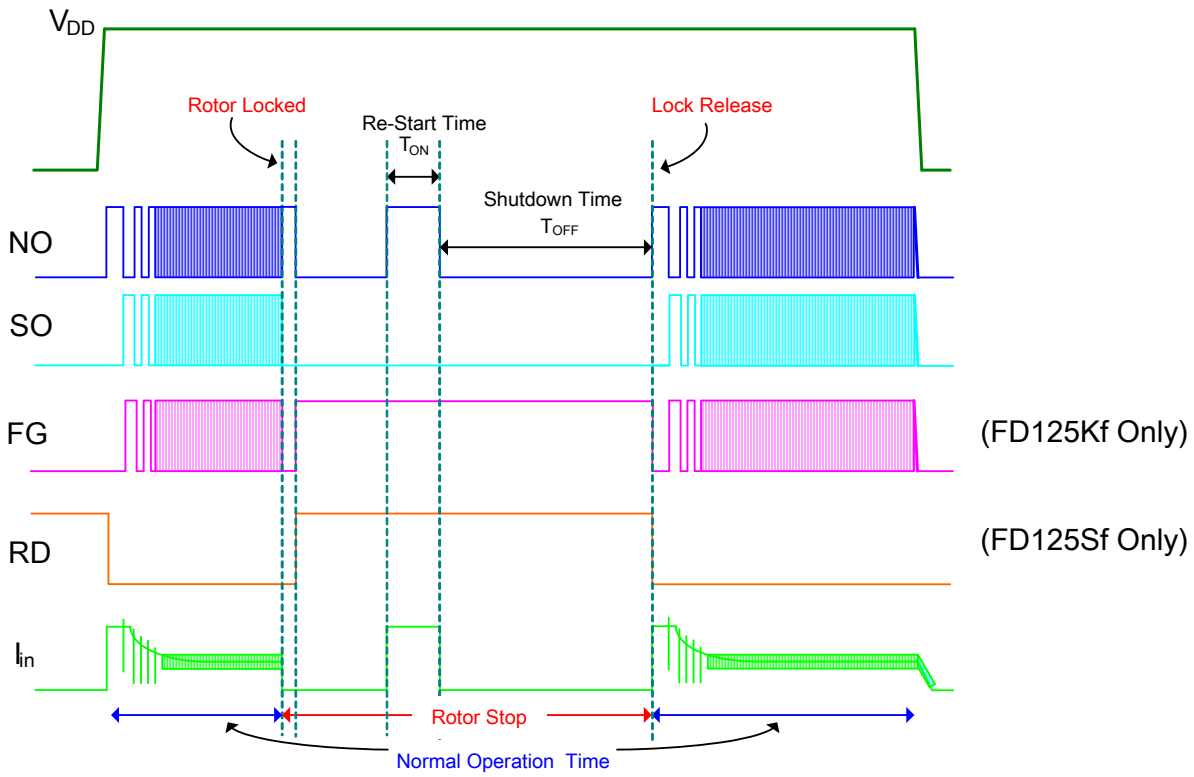
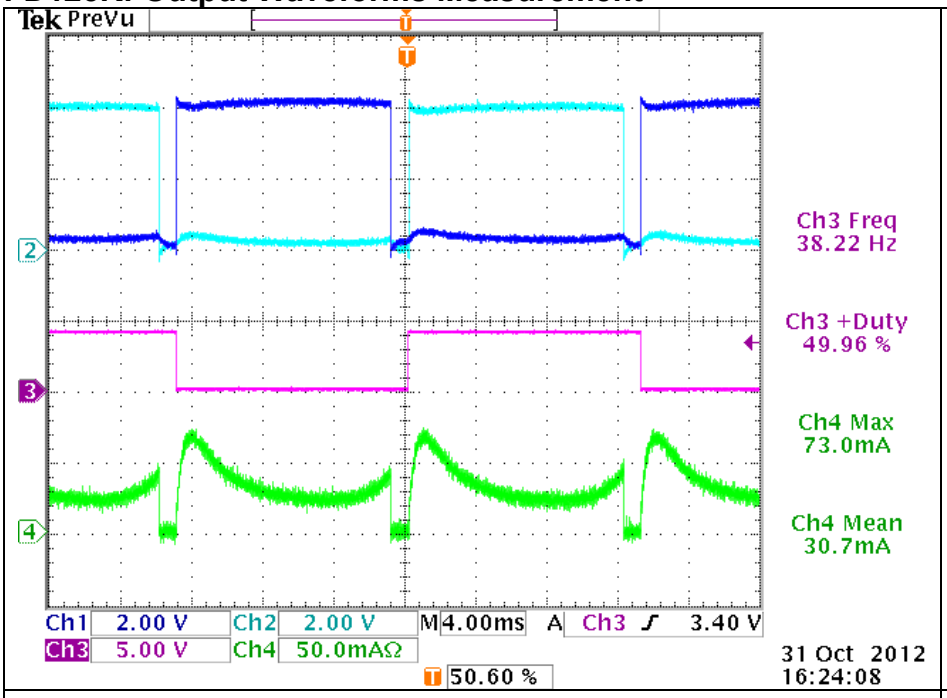


Figure 17

FD125Kf Output Waveforms Measurement



FD125Kf +4.0V
Normal Operation
Ch1: NO Output
Ch2: SO Output
Ch3: FG Output
Ch4: Input Current

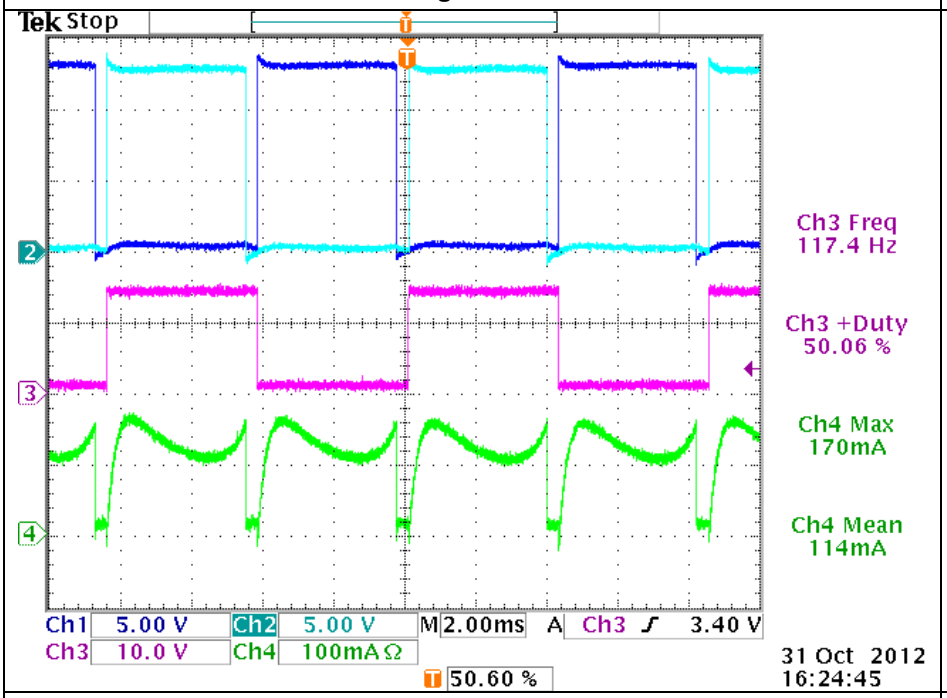
Motor Speed
(~ 1,147 rpm)

Input Average Current
(~ 30.7 mA)

Input Peak Current
(~ 73.0 mA)

FG Signal Duty Ratio
(~ 1.002)

Figure 18



FD125Kf +13.2V
Normal Operation
Ch1: NO Output
Ch2: SO Output
Ch3: FG Output
Ch4: Input Current

Motor Speed
(~ 3,522 rpm)

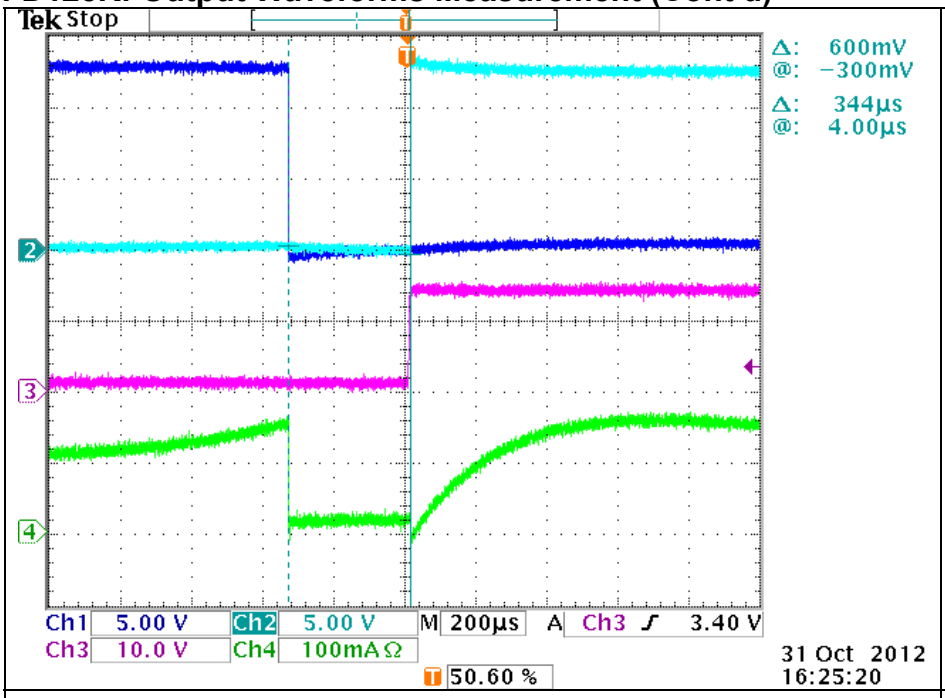
Input Average Current
(~ 114 mA)

Input Peak Current
(~ 170 mA)

FG Signal Duty Ratio
(~ 1.002)

Figure 19

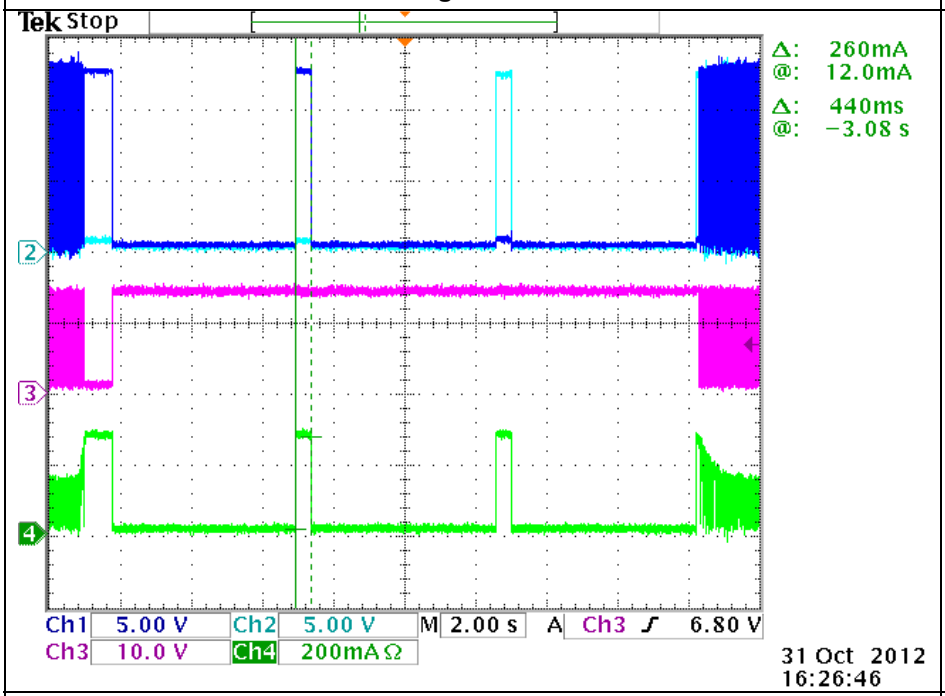
FD125Kf Output Waveforms Measurement (Cont'd)



FD125Kf +13.2V
Soft-Switching
Ch1: NO Output
Ch2: SO Output
Ch3: FG Output
Ch4: Input Current

Switching time
(~ 344 µs)

Figure 20



FD125Kf +13.2V
Motor Locked

Ch1: NO Output
Ch2: SO Output
Ch3: FG Output
Ch4: Input Current

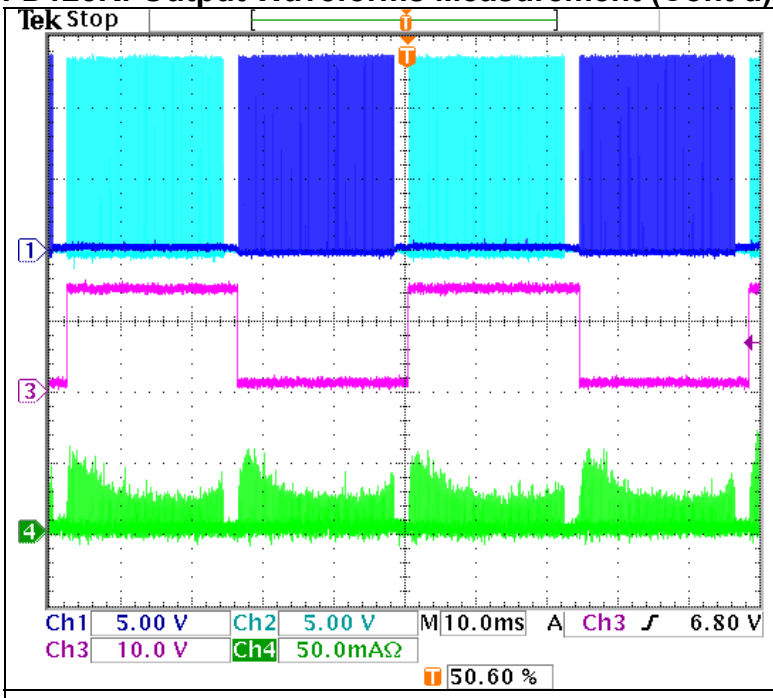
On time
(~ 0.44 s)

Off time
(~ 5.0 s)

Input Hold Current
(~ 260 mA)

Figure 21

FD125Kf Output Waveforms Measurement (Cont'd)



FD125Kf +13.2V
20% PWM Duty Operation
Ch1: NO Output
Ch2: SO Output
Ch3: FG Output
Ch4: Input Current

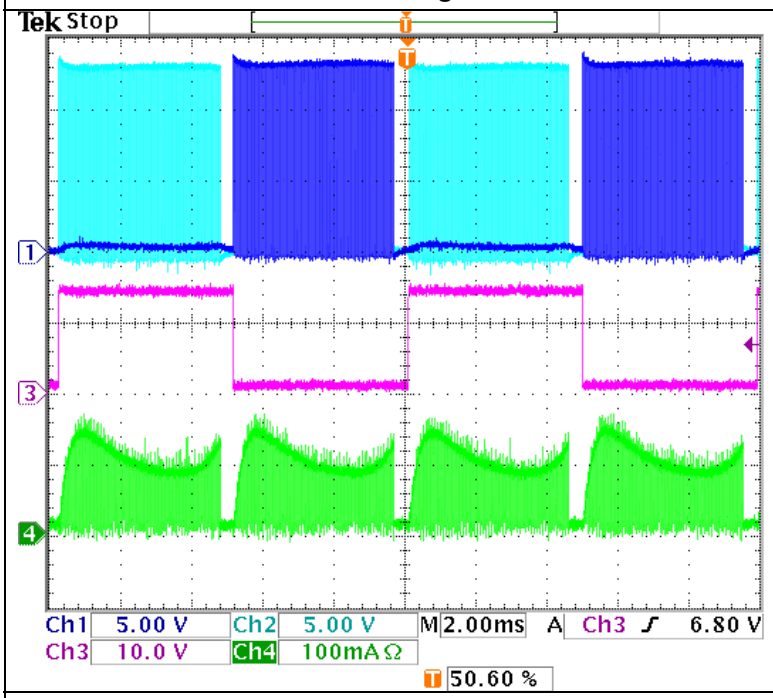
Motor Speed
(~ 624 rpm)

Input Average Current
(~ 6.54 mA)

Input Peak Current
(~ 71 mA)

FG Signal Duty Ratio
(~ 1.001)

Figure 22



FD125Kf +13.2V
80% PWM Duty Operation
Ch1: NO Output
Ch2: SO Output
Ch3: FG Output
Ch4: Input Current

Motor Speed
(~ 3,048 rpm)

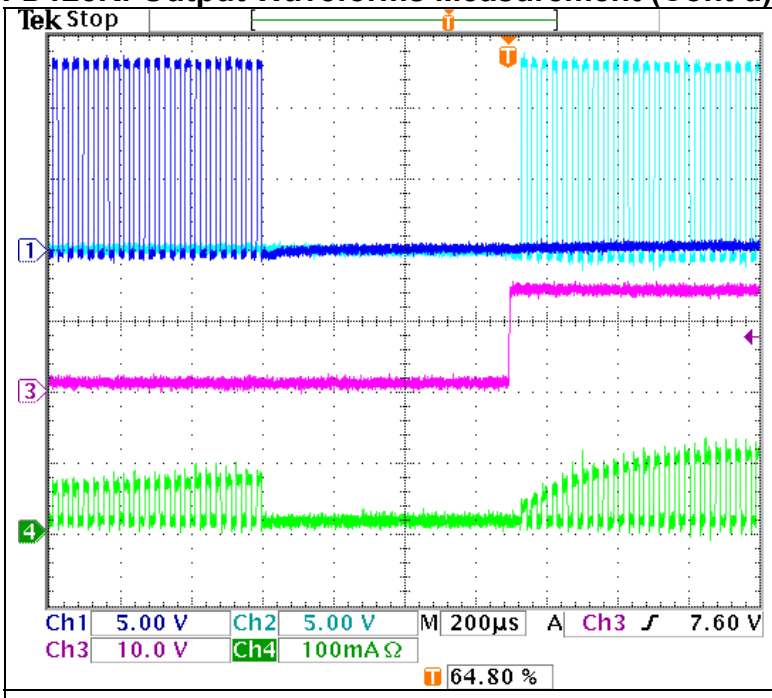
Input Average Current
(~ 83.6 mA)

Input Peak Current
(~ 168 mA)

FG Signal Duty Ratio
(~ 1.004)

Figure 23

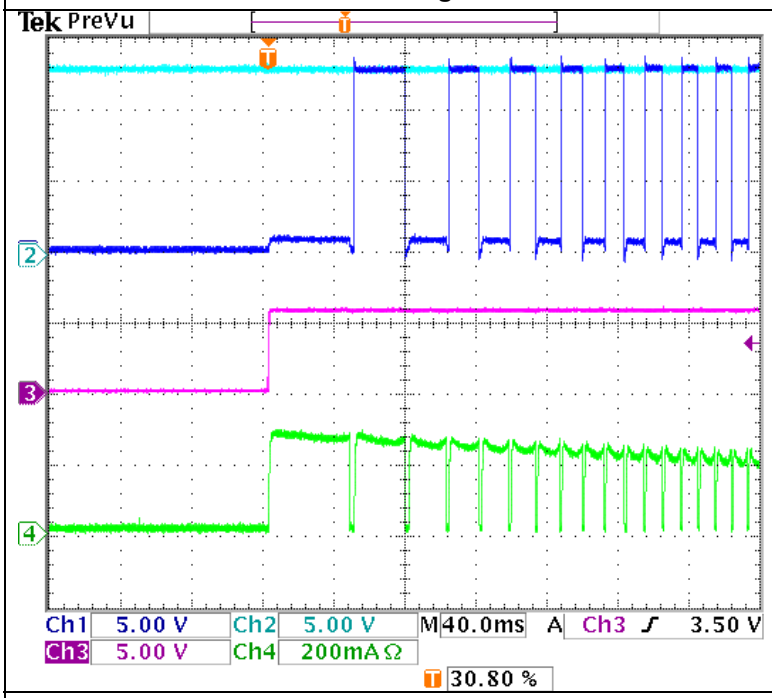
FD125Kf Output Waveforms Measurement (Cont'd)



FD125Kf +13.2V
50% PWM Duty Operation
Ch1: NO Output
Ch2: SO Output
Ch3: FG Output
Ch4: Input Current

Switching time
(~ 720 µs)

Figure 24



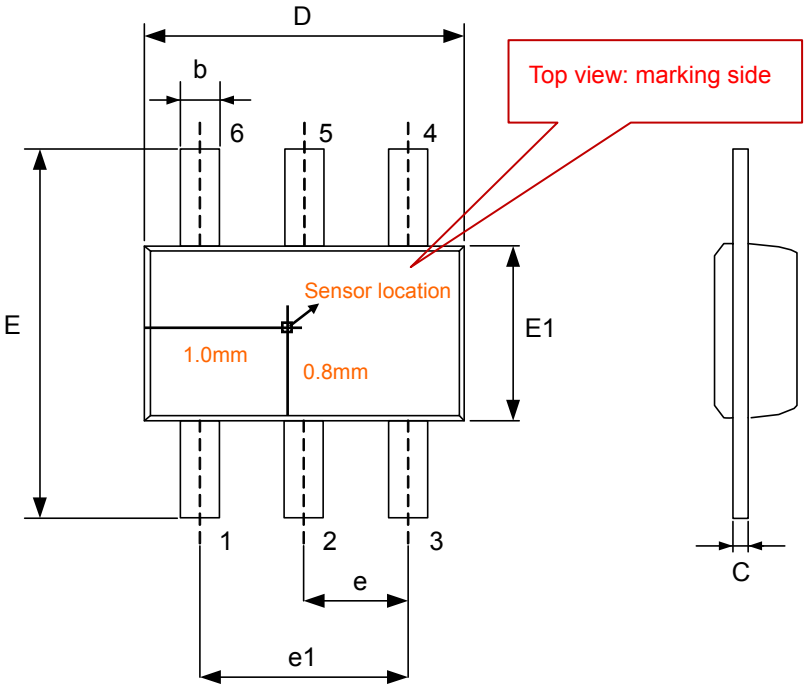
FD125Kf +13.2V
Quick-Start Mode

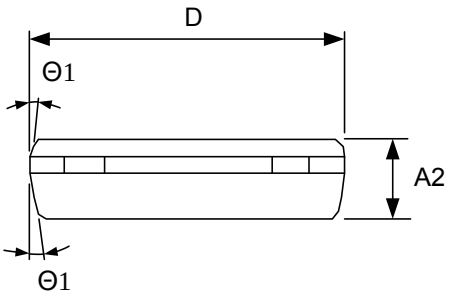
Ch1: NO Output
Ch2: Input Voltage
Ch3: VSC Input(> 2.2V)
Ch4: Input Current

Figure 25

Package Dimension (Unit: mm)

TS826 (Halogen Free)

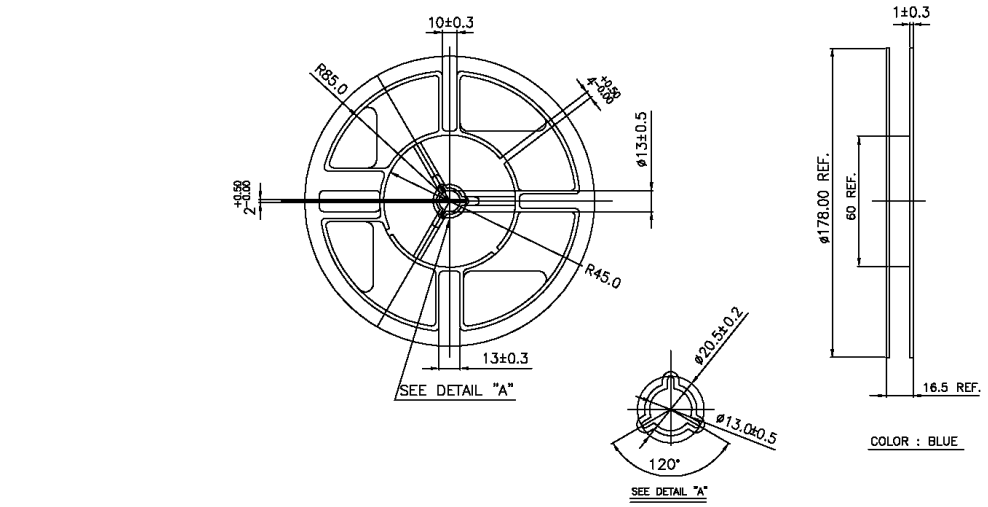


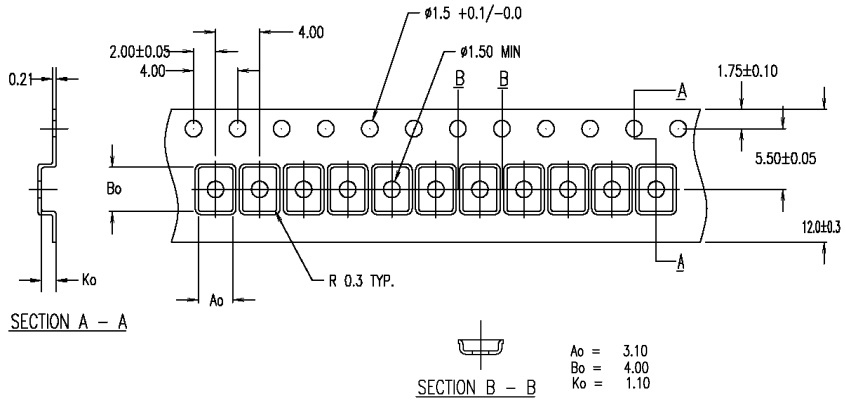


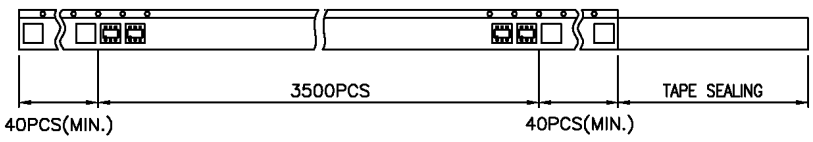
Symbols	Dimension In Millimeters		
	Min	Nom	Max
A2	0.700	0.750	0.775
b	0.350	-	0.500
c	0.100	-	0.200
D	2.800	2.900	3.100
E	3.700	3.800	3.900
E1	1.500	1.600	1.700
e	0.950 BSC		
e1	1.900 BSC		
Θ1	4°	10°	12°

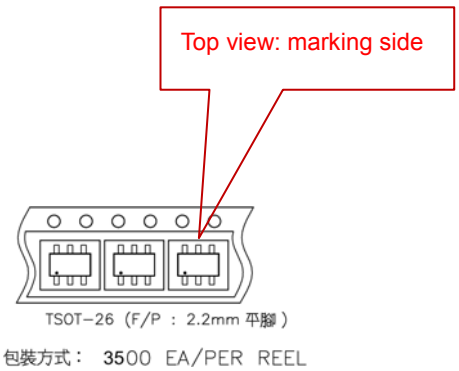
Packing Specification (Tapping Reel)

TS826









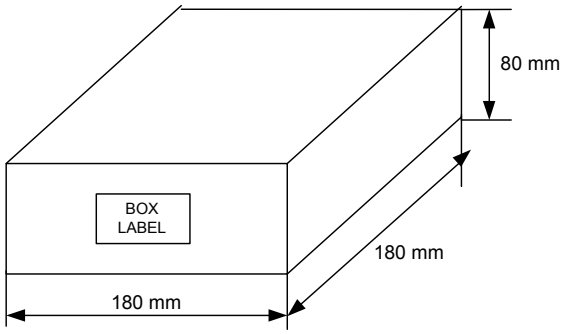
包装方式： 3500 EA/PER REEL

USER DIRECTION OF FEED

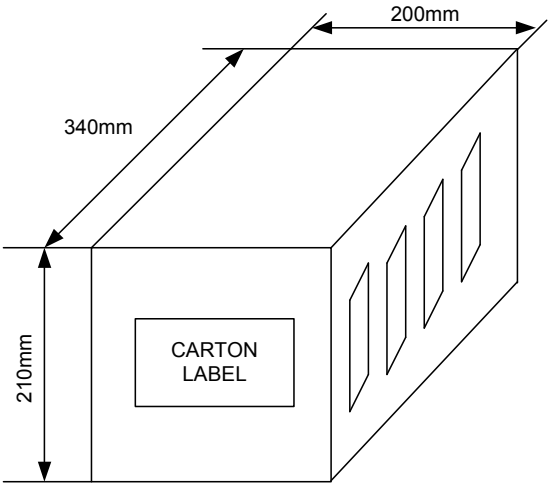
1. 10 sprocket hole pitch cumulative tolerance ± 0.2mm
2. Camber not to exceed 1mm in 100mm.
3. Material: Anti-Static Black Advantek Polystyrene.
4. Ao and Bo measured on a plane 0.3mm above the bottom of the pocket.
5. Ko measured from a plane on the inside bottom of the pocket to the top surface of the carrier.
6. Pocket position relative to sprocket hole measured as true position of pocket, not pocket hole.

TS826

Bag & Box Dimension



INSIDE BOX

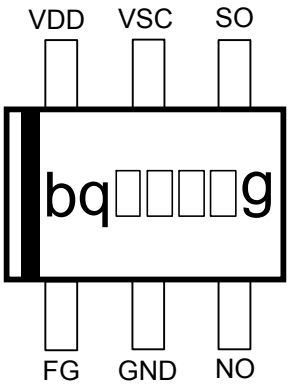


CARTON

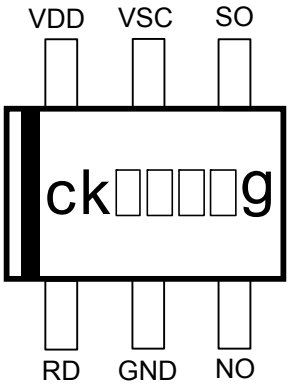
TS826 Packing Quantity Specification

	Quantity
3,500 ea /1 Reel	3,500 ea / Reel
3 Reels /1 Inside Box	10,500 ea / Inside Box
4 Inside Boxes /1 Carton	42,000 ea / Carton

IC Pin Connection

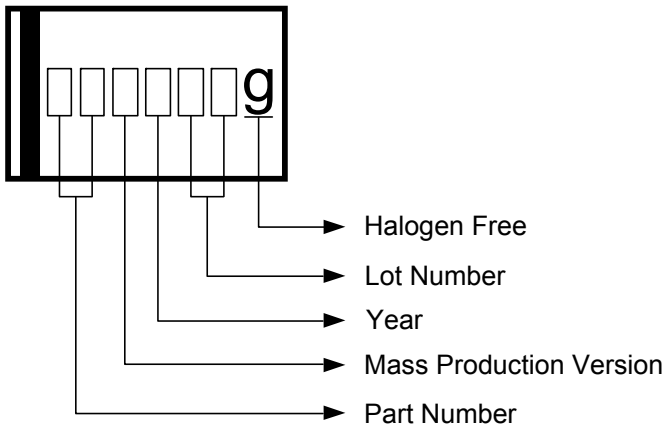


FD125Kf



FD125Sf

Marking Distinguish



Order Information

Part Number	Operating Temperature	Package	Description		MOQ	MSL
FD125KfR-G1	-40 °C to +125 °C	TS826	±25G (B)	Tachometer O/P	3,500EA / BAG	3
FD125SfR-G1				Alarm O/P		