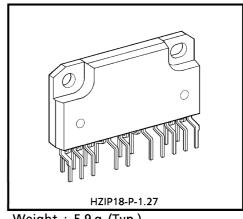
TOSHIBA TPD4005K

TENTATIVE TOSHIBA INTELLIGENT POWER DEVICE HIGH VOLTAGE MONOLITHIC SILICON POWER IC

# TPD4005K

# 3-PHASE DC BRUSH LESS MOTOR DRIVER (PWM CIRCUIT NON-INCLUDE)

The TPD4005K is a DC brush less motor driver using high voltage PWM control. It is fabricated by high voltage SOI process. It contains level shift high side driver, low side driver, IGBT outputs, FRDs and protective functions for over current, over heat and under voltage. 5 V C-MOS interface makes it easy to control a DC brush less motor by just putting logic inputs from a micro computer into the TPD4005K.

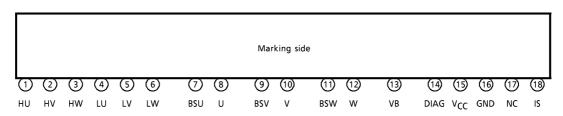


### Weight: 5.9 g (Typ.)

#### **FEATURES**

- Level shift high side driver is built in
- Bootstrap circuit gives simple high side supply
- 3-phase bridge output using 6 IGBTs
- 6 FRDs are built in
- Protective functions for over current, over heat and under voltage
- Remove a pin between high and low voltage terminals
- 18-pin ZIP package with heat sink

#### PIN ASSIGNMENT



Since this IC is a MOS product, pay attention to static charges when handling it.

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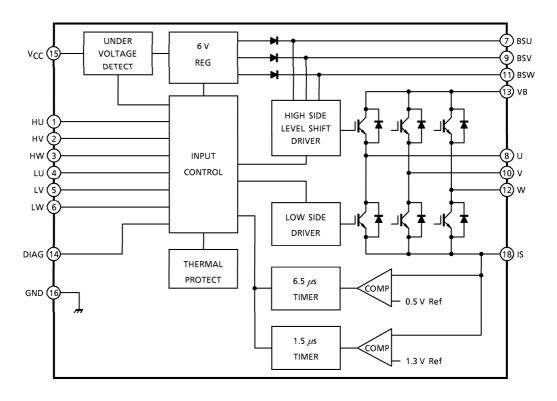
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TOSHIBA TPD4005K

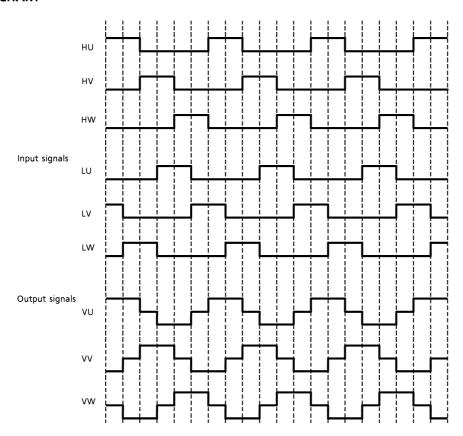
### **BLOCK DIAGRAM**



## **PIN DESCRIPTION**

PIN No.	SYMBOL	PIN DESCRIPTION
1	HU	U-phase upper-side IGBT control pin.
		Turned on at 3.5 V or above; turned off at 1.5 V or below.
2	HV	V-phase upper-side IGBT control pin.
		Turned on at 3.5 V or above; turned off at 1.5 V or below.
3	HW	W-phase upper-side IGBT control pin.
s		Turned on at 3.5 V or above; turned off at 1.5 V or below.
4	LU	U-phase lower-side IGBT control pin.
+		Turned on at 3.5 V or above; turned off at 1.5 V or below.
5	LV	V-phase lower-side IGBT control pin.
		Turned on at 3.5 V or above; turned off at 1.5 V or below.
6	LW	W-phase lower-side IGBT control pin.
		Turned on at 3.5V or above; turned off at 1.5 V or below.
7	BSU	U-phase upper-side IGBT driver power supply pin.
		Connect the positive pole of the bootstrap capacitor to this pin.
8	U	Three-phase bridge output, used to connect a motor's U phase. Also, the
		negative pole of the bootstrap capacitor is connected to this pin.
9	BSV	V-phase upper-side IGBT driver power supply pin. Connect the positive pole of
		the bootstrap capacitor to this pin.
10	V	Three-phase bridge output, used to connect a motor's V phase. Also, the
		negative pole of the bootstrap capacitor is connected to this pin.
11	BSW	W-phase upper-side IGBT driver power supply pin. Connect the positive pole of
		the bootstrap capacitor to this pin.
12	w	Three-phase bridge output, used to connect a motor's W phase. Also, the
		negative pole of the bootstrap capacitor is connected to this pin.
13	VB	Power supply pin for DC brushless motor drive.
14	DIAG	Diagnostic output pin of open-drain structure. Pull this pin high via a resistor.
		It outputs a low signal when faulty.
15	V <sub>CC</sub>	Power supply pin for IC control.
16	GND	Ground pin.
17	NC	Unused pin, which is not connected to the chip internally.
18	IS	Connect a resistor between this pin and GND to sense motor current.

## **TIMING CHART**



TRUTH TABLE

MODE	INPUT						UPPER ARM			LOWER ARM			
	IJ	HV	HW	Ŋ	LV	LW	U PHASE	V PHASE	W PHASE	U PHASE	V PHASE	W PHASE	DIAG
Normal	Н	L	L	L	Н	L	ON	OFF	OFF	OFF	ON	OFF	Н
	Н	L	L	L	L	Н	ON	OFF	OFF	OFF	OFF	ON	Н
	L	Н	L	L	L	Н	OFF	ON	OFF	OFF	OFF	ON	Н
	L	Н	L	Н	L	L	OFF	ON	OFF	ON	OFF	OFF	Н
	L	L	Н	Н	L	L	OFF	OFF	ON	ON	OFF	OFF	Н
	L	L	Н	L	Н	L	OFF	OFF	ON	OFF	ON	OFF	Н
	Н	L	L	L	Н	L	OFF	OFF	OFF	OFF	OFF	OFF	L
	Н	L	L	L	L	Н	OFF	OFF	OFF	OFF	OFF	OFF	L
Oversument	L	Н	L	L	L	Н	OFF	OFF	OFF	OFF	OFF	OFF	L
Overcurrent	L	Н	L	Н	L	L	OFF	OFF	OFF	OFF	OFF	OFF	L
	L	L	Н	Н	L	L	OFF	OFF	OFF	OFF	OFF	OFF	L
	L	L	Н	L	Н	L	OFF	OFF	OFF	OFF	OFF	OFF	L
	Н	L	L	L	Н	L	OFF	OFF	OFF	OFF	OFF	OFF	L
	Н	L	L	L	L	Н	OFF	OFF	OFF	OFF	OFF	OFF	L
Overheat	L	Н	L	L	L	Н	OFF	OFF	OFF	OFF	OFF	OFF	L
Overneat	L	Н	L	Н	L	L	OFF	OFF	OFF	OFF	OFF	OFF	L
	L	L	Н	Н	L	L	OFF	OFF	OFF	OFF	OFF	OFF	L
	L	L	Н	L	Н	L	OFF	OFF	OFF	OFF	OFF	OFF	L
	Н	L	L	L	Н	L	OFF	OFF	OFF	OFF	OFF	OFF	L
Under	Н	L	L	L	L	Н	OFF	OFF	OFF	OFF	OFF	OFF	L
	L	Н	L	L	L	Н	OFF	OFF	OFF	OFF	OFF	OFF	L
Voltage	L	Н	L	Η	L	L	OFF	OFF	OFF	OFF	OFF	OFF	L
_	L	L	Н	Н	L	L	OFF	OFF	OFF	OFF	OFF	OFF	L
	L	L	Н	L	Н	L	OFF	OFF	OFF	OFF	OFF	OFF	L

(Note) : Overheat and under voltage protection are automatically reset. Inputs all low which reset overcurrent protection.

# ABSOLUTE MAXIMUM RATING (Ta = 25°C)

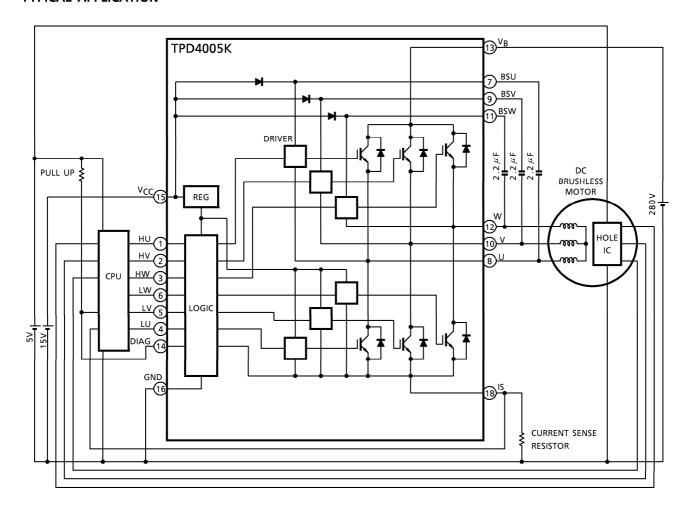
CHARACTERISTIC	SYMBOL	RATING	UNIT	
Power Supply Voltage	V <sub>BB</sub>	500	V	
Power Supply Voltage	VBB         500           VCC         16           lout         2           lout         3           VIN         -0.5~6           PC         4	\ \ \		
Output Current (DC)	lout	2	Α	
Output Current	lout	2	Α	
(Startup / Accelerating)	lout	3	_ ^	
Input Voltage	VIN	-0.5~6	V	
Power Dissipation (Ta = 25°C)	PC	4	W	
Power Dissipation (Tc = 25°C)	PC	20	W	
Operating Temperature	TOPE	<b>- 40∼85</b>	°C	
Junction Temperature	Тј	150	°C	
Storage Temperature	T <sub>stg</sub>	- 55~150	°C	

## **ELECTRICAL CHARACTERISTICS** (Ta = 25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN	TYP.	MAX	UNIT		
Operating Power Supply	V <sub>BB</sub>	_	90	_	320	V		
Voltage	V <sub>C</sub> C	_	9	12	16			
Operating Current	IBB	V <sub>BB</sub> = 320 V	_		1	A		
Operating Current	ICC	V <sub>CC</sub> = 12 V	_		5	mA		
Input Voltage	VIH	INPUT = "H" 3.5		_	_	V		
input voitage	VIL	INPUT = "L"	_	_	1.5			
Innut Current	IIH	VIN = 5 V -		_	100			
Input Current	IIL	VIN = 0 V	_	_	100	$\mu$ A		
Output Saturation Voltage	VsatU	V <sub>CC</sub> = 12 V, Ic = 1 A	_	3.0	4.0	V		
Output Saturation Voltage	VsatL	V <sub>CC</sub> = 12 V, Ic = 1 A	_	3.0	4.0			
EDD Forward Voltage	VFU	IF = 1 A	_	_	3.0	V		
FRD Forward Voltage	VFL	IF = 1 A	_	_	3.0			
Current Limiting Voltage (1)	VR (1)		_	0.5	_	V		
Current Limiting Dead Time (1)	Dt (1)		_	6.5	_	$\mu$ s		
Current Limiting Voltage (2)	VR (2)		_	1.3	_	V		
Current Limiting Dead Time (2)	Dt (2)		_	1.5	_	$\mu$ s		
Overheat Protection Temperature	TSD		150	165	200	°C		
Overheat Protection Hysteresis Temperature	∆TSD		_	10	_	°C		
Under Voltage Protection	VCCUVD		6.5	7.5	8.5	V		
Under Voltage Protection Recovery	VCCUVR		7.0	8.0	9.0	٧		
Output Codtabina Time	ton	Ic = 1A	_	1	3	_		
Output Switching Time	toff	Ic = 1A	_	1	3	$\mu$ s		
FRD Reverse Recovery Time	trr	IF = 1A	_	100	200	ns		

**TOSHIBA** 

#### TYPICAL APPLICATION

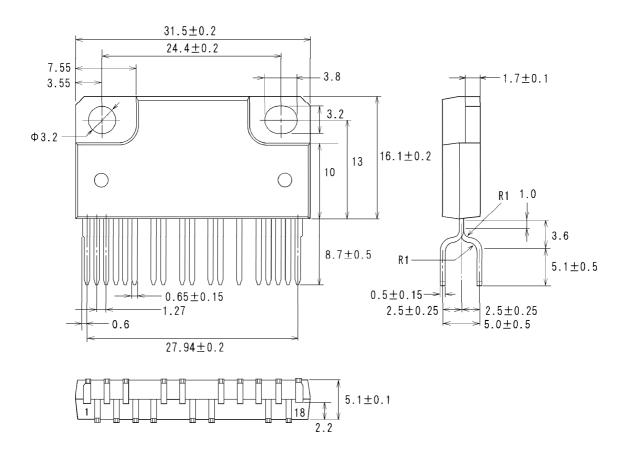


#### **USAGE PRECAUTIONS**

- Be sure to observe the sequence in which the power is turned on or off. The power-on sequence is  $\textcircled{1}V_{CC} \rightarrow \textcircled{2}V_{B}$ ; the power-off sequence is  $\textcircled{1}V_{B} \rightarrow \textcircled{2}V_{CC}$ .
- When PWM operation, be sure to apply PWM chopping on the high side when starting the motor. If low side PWM chopping is applied from the startup, the motor may not be driven because bootstrap capacitor is not charged enough.
- Although the required bootstrap capacitance varies with the motor drive conditions, care must be taken to keep the capacitor voltage above 5 V at startup and during drive.
- Because approximately 6 V is applied across the bootstrap capacitor under normal operating condition, the capacitor must have a sufficient margin for the applied voltage.
- This IC is suitable for the PWM frequency up to 20 kHz. Since ON/OFF switching times requires 2  $\mu$ s (typ.) each, the higher the PWM frequency, the greater the switching portion compare to the ON duration. This results in an increase of switching loss.

## PACKAGE DIMENSION

HZIP18-P-1.27 Unit: mm



Weight: 5.9 g (Typ.)