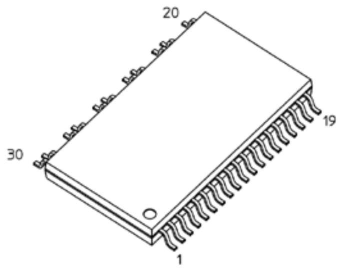
TOSHIBA Intelligent Power Device
High Voltage 3-phase motor driver IC

TPD4207F

The TPD4207F is a DC brush less motor driver using high voltage PWM control. It is fabricated by high voltage MOSFET (600 V). It is three-shunt resistor circuit for current sensing. It contains level shift high-side driver, low-side driver, MOSFET outputs, and protective functions for over-current circuit and shutdown function and under voltage protection circuits and thermal shutdown circuit. It is easy to control a DC brush less motor by just putting logic inputs from a MPU or motor controller to the TPD4207F.



P-SSOP30-1120-1.00-001

Weight: 1.2 g (typ.)

Features

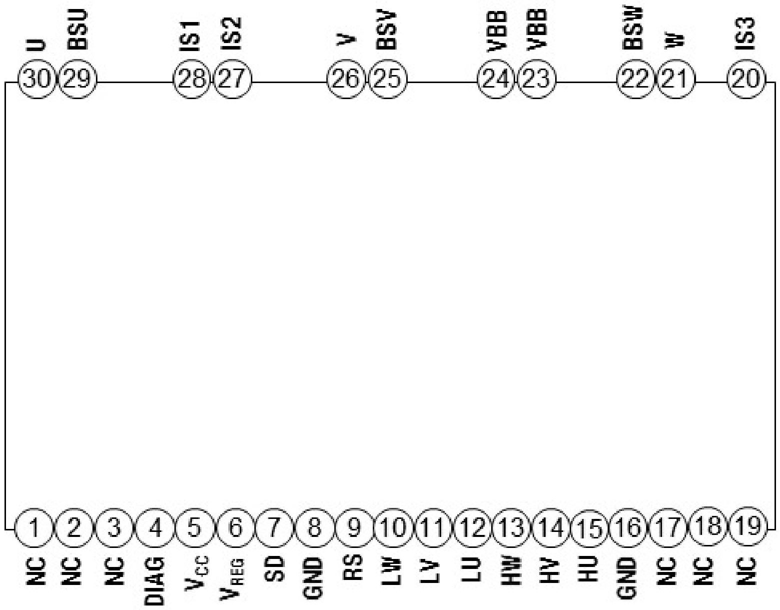
- High voltage power side and low voltage signal side terminal are separated.
- It is the best for current sensing in three shunt resistance.
- Bootstrap circuit gives simple high-side supply.
- Bootstrap diodes are built in.
- A dead time can be set as a minimum of 1.4 μs, and it is suitable for a Sine-wave drive.
- 3-phase bridge output using MOSFETs.
- Included over-current and under-voltage protection and shutdown, and thermal shutdown.
- The regulator of 7 V (typ.) is built in.
- The package is a surface mount type 30 pin package.

This product has a MOS structure and is sensitive to electrostatic discharge. When handling this product, ensure that the environment is protected against electrostatic discharge.

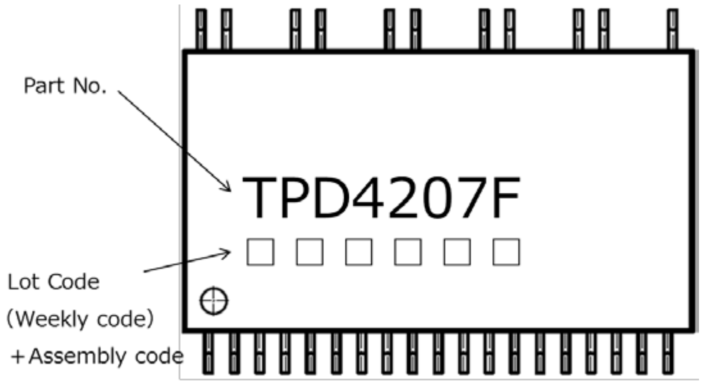
The TSD and UVLO circuits are only intended to provide temporary protection against irregular condition such as an output short-circuit; they do not necessarily guarantee the complete IC safety. If the device is used beyond the specified operating ranges, these circuits may not operate properly; then the device may be damaged. Such a condition must be removed immediately by external hardware.

Start of commercial production
2017-03

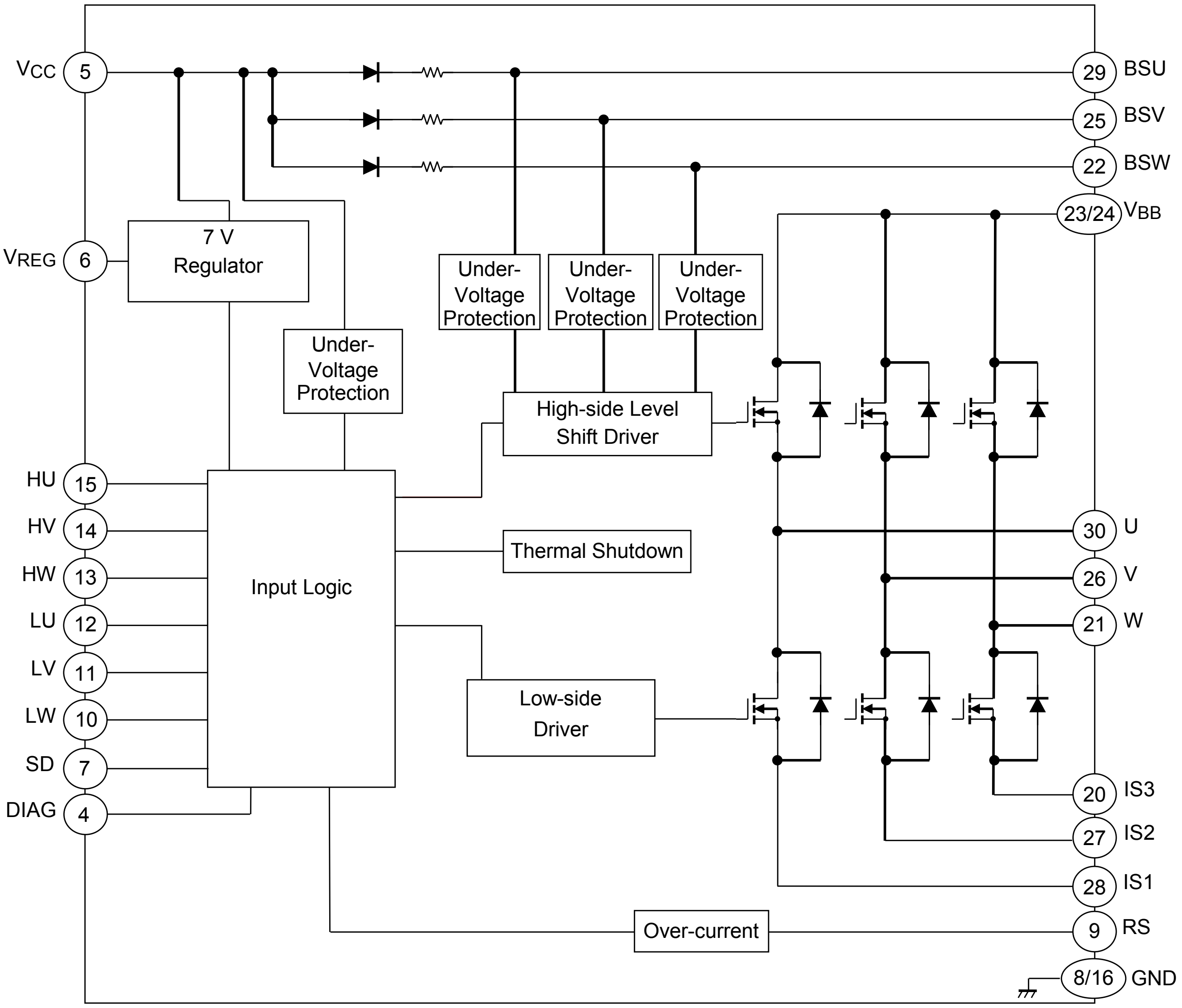
Pin Assignment



Marking



Block Diagram

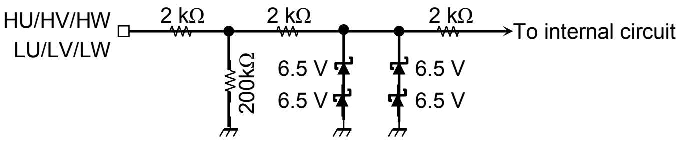


Pin Description

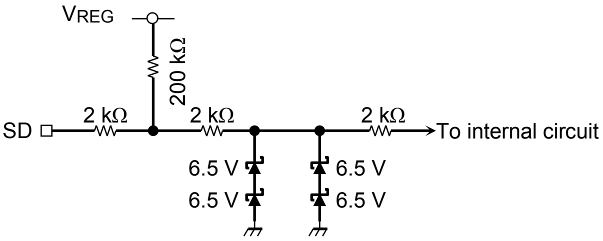
Pin No.	Symbol	Pin Description
1	NC	Unused pin, which is not connected to the chip internally.
2	NC	Unused pin, which is not connected to the chip internally.
3	NC	Unused pin, which is not connected to the chip internally.
4	DIAG	With the diagnostic output terminal of open drain, a pull-up is carried out by resistance. It turns on at the time of unusual.
5	V_{CC}	Control power supply pin. (15 V (typ.))
6	V_{REG}	7 V regulator output pin.
7	SD	Input pin of external protection. (“L” active, It doesn't have hysteresis.)
8	GND	Ground pin.
9	RS	Over current detection pin.
10	LW	The control terminal of MOSFET by the low side of W. It turns off less than 1.5 V. It turns on more than 2.5 V.
11	LV	The control terminal of MOSFET by the low side of V. It turns off less than 1.5 V. It turns on more than 2.5 V.
12	LU	The control terminal of MOSFET by the low side of U. It turns off less than 1.5 V. It turns on more than 2.5 V.
13	HW	The control terminal of MOSFET by the high side of W. It turns off less than 1.5 V. It turns on more than 2.5 V.
14	HV	The control terminal of MOSFET by the high side of V. It turns off less than 1.5 V. It turns on more than 2.5 V.
15	HU	The control terminal of MOSFET by the high side of U. It turns off less than 1.5 V. It turns on more than 2.5 V.
16	GND	Ground pin.
17	NC	Unused pin, which is not connected to the chip internally.
18	NC	Unused pin, which is not connected to the chip internally.
19	NC	Unused pin, which is not connected to the chip internally.
20	IS3	The source terminal of MOSFET by the low side of W.
21	W	W-phase output pin.
22	BSW	W-phase bootstrap capacitor connecting pin.
23	V_{BB}	High-voltage power supply input pin.
24	V_{BB}	High-voltage power supply input pin.
25	BSV	V-phase bootstrap capacitor connecting pin.
26	V	V-phase output pin.
27	IS2	The source terminal of MOSFET by the low side of V.
28	IS1	The source terminal of MOSFET by the low side of U.
29	BSU	U-phase bootstrap capacitor connecting pin.
30	U	U-phase output pin.

Equivalent Circuit of Input Pins

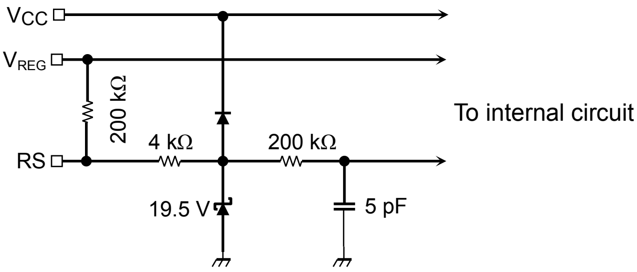
Internal circuit diagram of HU, HV, HW, LU, LV, LW input pins



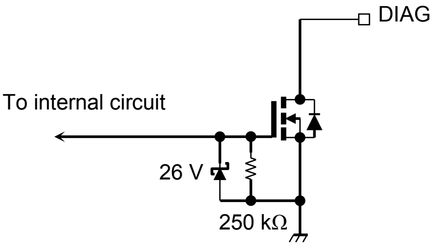
Internal circuit diagram of SD pin



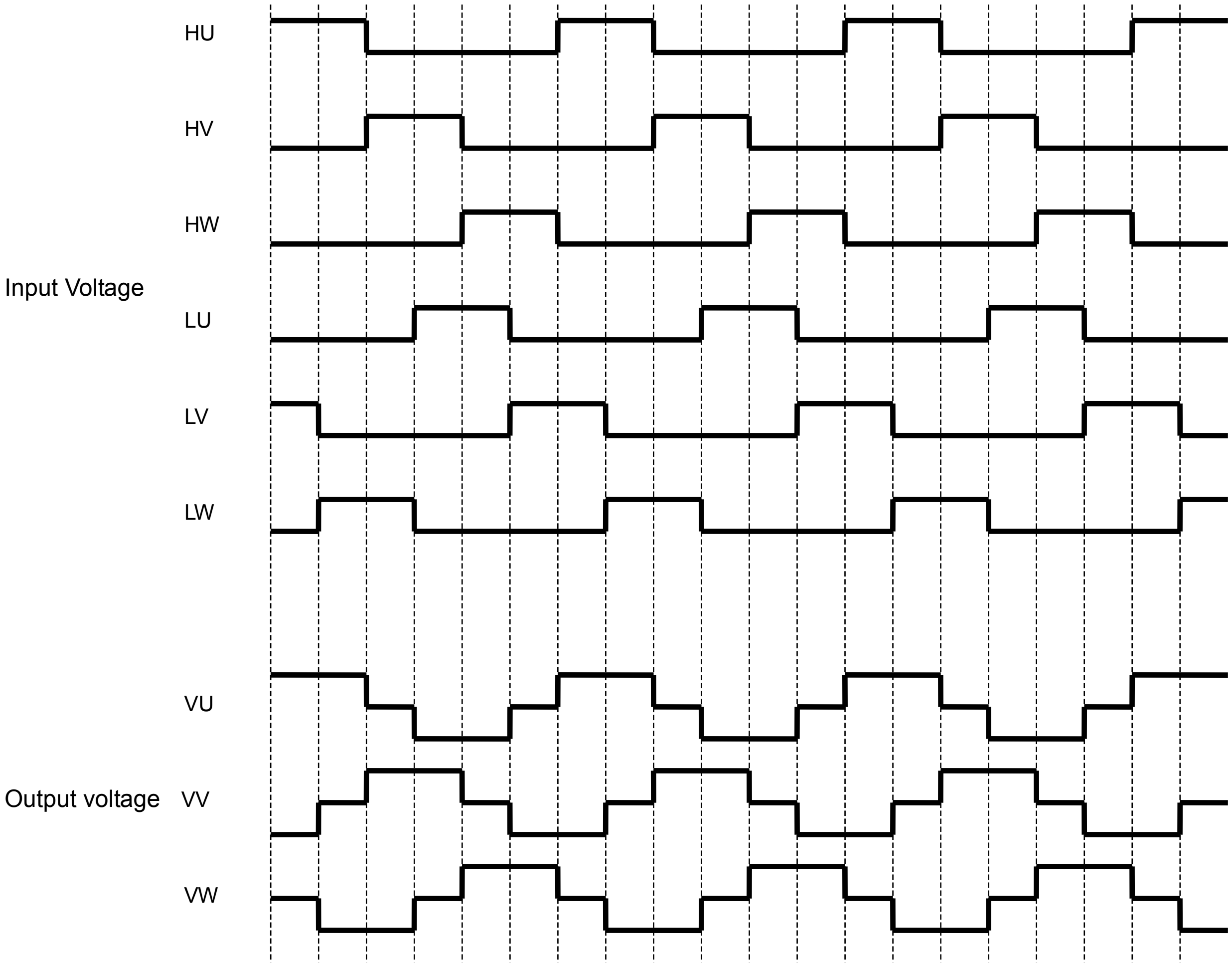
Internal circuit diagram of RS pin



Internal circuit diagram of DIAG pin



Timing Chart



Truth Table

	Input							High side			Low side			DIAG
Mode	HU	HV	HW	LU	LV	LW	SD	U phase	V phase	W phase	U phase	V phase	W phase	
Normal	H	L	L	L	H	L	H	ON	OFF	OFF	OFF	ON	OFF	OFF
	H	L	L	L	L	H	H	ON	OFF	OFF	OFF	OFF	ON	OFF
	L	H	L	L	L	H	H	OFF	ON	OFF	OFF	OFF	ON	OFF
	L	H	L	H	L	L	H	OFF	ON	OFF	ON	OFF	OFF	OFF
	L	L	H	H	L	L	H	OFF	OFF	ON	ON	OFF	OFF	OFF
	L	L	H	L	H	L	H	OFF	OFF	ON	OFF	ON	OFF	OFF
Over-current	H	L	L	L	H	L	H	OFF	OFF	OFF	OFF	OFF	OFF	ON
	H	L	L	L	L	H	H	OFF	OFF	OFF	OFF	OFF	OFF	ON
	L	H	L	L	L	H	H	OFF	OFF	OFF	OFF	OFF	OFF	ON
	L	H	L	H	L	L	H	OFF	OFF	OFF	OFF	OFF	OFF	ON
	L	L	H	H	L	L	H	OFF	OFF	OFF	OFF	OFF	OFF	ON
	L	L	H	L	H	L	H	OFF	OFF	OFF	OFF	OFF	OFF	ON
Thermal shutdown	H	L	L	L	H	L	H	OFF	OFF	OFF	OFF	OFF	OFF	ON
	H	L	L	L	L	H	H	OFF	OFF	OFF	OFF	OFF	OFF	ON
	L	H	L	L	L	H	H	OFF	OFF	OFF	OFF	OFF	OFF	ON
	L	H	L	H	L	L	H	OFF	OFF	OFF	OFF	OFF	OFF	ON
	L	L	H	H	L	L	H	OFF	OFF	OFF	OFF	OFF	OFF	ON
	L	L	H	L	H	L	H	OFF	OFF	OFF	OFF	OFF	OFF	ON
V_{CC} Under-voltage	H	L	L	L	H	L	H	OFF	OFF	OFF	OFF	OFF	OFF	ON
	H	L	L	L	L	H	H	OFF	OFF	OFF	OFF	OFF	OFF	ON
	L	H	L	L	L	H	H	OFF	OFF	OFF	OFF	OFF	OFF	ON
	L	H	L	H	L	L	H	OFF	OFF	OFF	OFF	OFF	OFF	ON
	L	L	H	H	L	L	H	OFF	OFF	OFF	OFF	OFF	OFF	ON
	L	L	H	L	H	L	H	OFF	OFF	OFF	OFF	OFF	OFF	ON
V_{BS} Under-voltage	H	L	L	L	H	L	H	OFF	OFF	OFF	OFF	ON	OFF	OFF
	H	L	L	L	L	H	H	OFF	OFF	OFF	OFF	OFF	ON	OFF
	L	H	L	L	L	H	H	OFF	OFF	OFF	OFF	OFF	ON	OFF
	L	H	L	H	L	L	H	OFF	OFF	OFF	ON	OFF	OFF	OFF
	L	L	H	H	L	L	H	OFF	OFF	OFF	ON	OFF	OFF	OFF
	L	L	H	L	H	L	H	OFF	OFF	OFF	OFF	ON	OFF	OFF
Irregular (Note)	H	L	L	H	L	L	H	OFF	OFF	OFF	OFF	OFF	OFF	OFF
	L	H	L	L	H	L	H	OFF	OFF	OFF	OFF	OFF	OFF	OFF
	L	L	H	L	L	H	H	OFF	OFF	OFF	OFF	OFF	OFF	OFF
SD	X	X	X	X	X	X	L	OFF	OFF	OFF	OFF	OFF	OFF	ON

X: Don’t care

Note: The output of the input logic is OFF if the high side input and low side input are ON at the same time

Absolute Maximum Ratings (Ta = 25°C)

Characteristics	Symbol	Rating	Unit
Power supply voltage	V_{BB}	600	V
	V_{CC}	18	V
Output current (DC)	I_{out}	5.0	A
Output current (pulse 100 μs)	I_{outp}	8.0	A
Input voltage	V_{IN}	-0.5 to 7	V
V_{REG} current	I_{REG}	50	mA
DIAG voltage	V_{DIAG}	20	V
DIAG current	I_{DIAG}	20	mA
Power dissipation (All phase (Tc = 25°C))	P_C	3	W
Thermal Resistance (Junction to Case) (Note 1)	$R_{j\text{-}c}$	15	°C/W
Operating Case temperature	T_{copr}	-40 to 100	°C
Junction temperature	T_j	150	°C
Storage temperature	T_{stg}	-55 to 150	°C

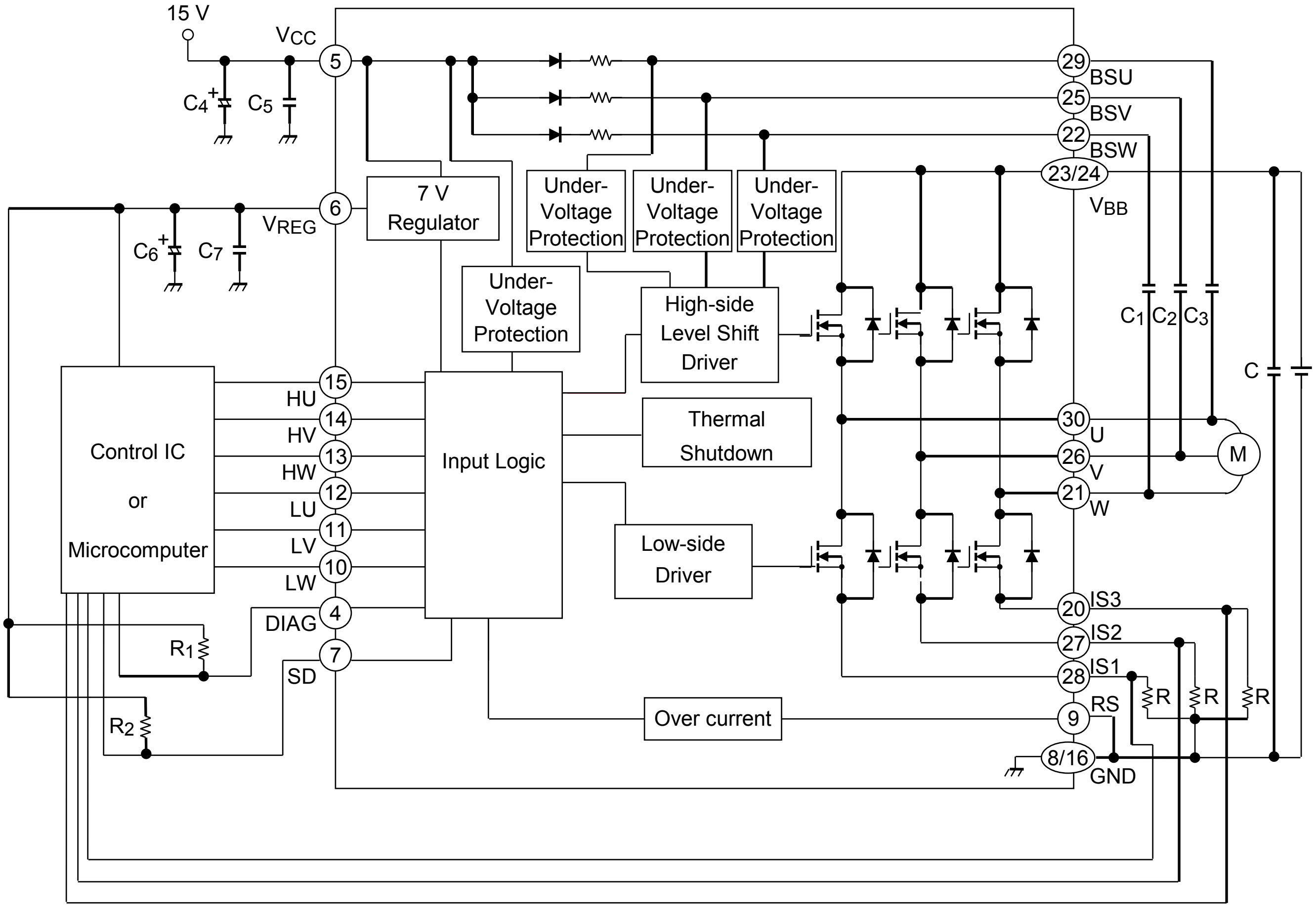
Note 1**:** Mounted on two layers of JEDEC standard PCB, 76.2 mm × 114.3 mm × 1.6 mm, in still air.

Note**:** Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings and the operating ranges.
Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook (“Handling Precautions”/“Derating Concept and Methods”) and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

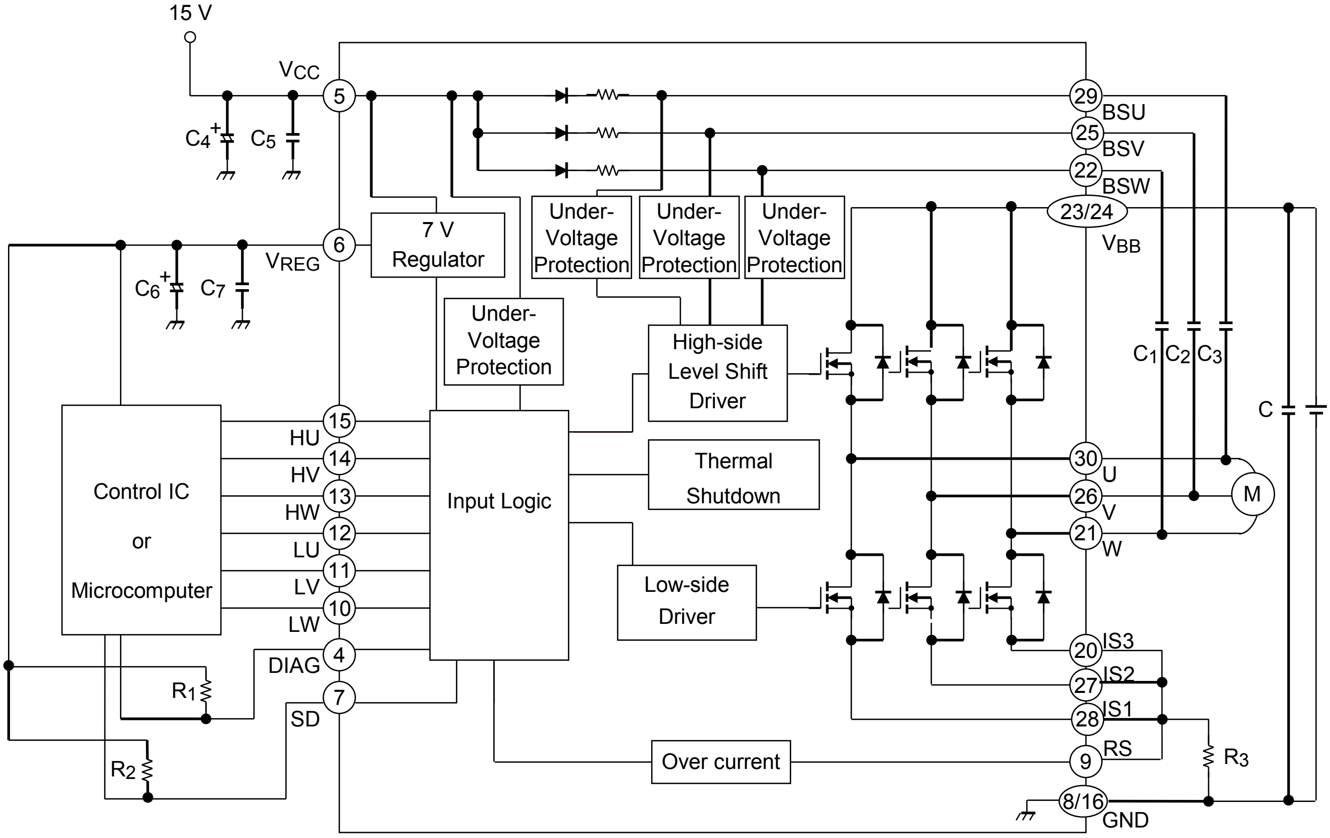
Electrical Characteristics (Ta = 25°C)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Operating power supply voltage	V_{BB}	—	50	280	450	V
	V_{CC}	—	13.5	15	16.5	
Current dissipation	I_{BB}	V_{BB} = 450 V	—	—	0.5	mA
	I_{CC}	V_{CC} = 15 V	—	0.9	5	
Bootstrap Current dissipation	$I_{BS\ (ON)}$	V_{BS} = 15 V, high side ON	—	230	410	μA
	$I_{BS\ (OFF)}$	V_{BS} = 15 V, high side OFF	—	190	370	
Input voltage	V_{IH}	V_{IN} = "H", V_{CC} = 15 V	2.5	—	—	V
	V_{IL}	V_{IN} = "L" , V_{CC} = 15 V	—	—	1.5	
Input current	I_{IH}	V_{IN} = 5 V	—	—	150	μA
	I_{IL}	V_{IN} = 0 V	—	—	100	
SD Input voltage	V_{SD}	V_{CC} = 15 V	—	2.5	—	V
SD Input current	I_{SDH}	V_{IN} = 5 V	—	—	100	μA
	I_{SDL}	V_{IN} = 0 V	—	—	150	
MOSFET Leakage Current	I_{DSS}	V_{BB} = 600 V	—	—	100	μA
MOSFET On State Resistance	$R_{DSON}H$	V_{CC} = 15 V, I_C = 2.5 A, high side	—	0.44	0.56	Ω
	$R_{DSON}L$	V_{CC} = 15 V, I_C = 2.5 A, low side	—	0.44	0.56	
Diode forward voltage (MOSFET)	V_FH	I_F = 2.5 A, high side	—	1.0	2.0	V
	V_FL	I_F = 2.5 A, low side	—	1.0	2.0	
BSD forward voltage	$V_{F\ (BSD)}$	I_F = 500 μA	—	0.9	1.2	V
Regulator voltage	V_{REG}	V_{CC} = 15 V, I_{REG} = 30 mA	6.5	7	7.5	V
Current limiting voltage	V_R	—	0.46	0.5	0.54	V
Current limiting delay time	Dt	—	1.5	3	5	μs
Thermal shutdown temperature	TSD	V_{CC} = 15 V	135	—	185	°C
Thermal shutdown hysteresis	∆TSD	V_{CC} = 15 V	—	50	—	°C
V_{CC} under voltage protection	$V_{CC}UVD$	—	10	11	12	V
V_{CC} under voltage protection recovery	$V_{CC}UVR$	—	10.5	11.5	12.5	V
V_{BS} under voltage protection	$V_{BS}UVD$	—	9	10	11	V
V_{BS} under voltage protection recovery	$V_{BS}UVR$	—	9.5	10.5	11.5	V
DIAG saturation voltage	$V_{DIAGsat}$	I_{DIAG} = 5 mA	—	—	0.5	V
Output on delay time	t_{on}	V_{BB} = 280 V, V_{CC} = 15 V, I_C = 2.5 A	—	0.7	1.4	μs
Output off delay time	t_{off}	V_{BB} = 280 V, V_{CC} = 15 V, I_C = 2.5 A	—	0.4	1.0	μs
Dead time	t_{dead}	V_{BB} = 280 V, V_{CC} = 15 V, I_C = 2.5 A	1.4	—	—	μs
Diode reverse recovery time (MOSFET)	t_{rr}	V_{BB} = 280 V, V_{CC} = 15 V, I_C = 2.5 A	—	80	—	ns

Application Circuit Example1: (Operate an overcurrent protection function with a control IC or a microcomputer.)



Application Circuit Example2: (Operate an overcurrent protection function with this product.)



External Parts

Typical external parts are shown in the following table.

Part	Typical	Purpose	Remarks
C_1, C_2, C_3	25 V/2.2 μF	Bootstrap capacitor	(Note 1)
C_4	25 V/10 μF	V_{CC} power supply stability	(Note 2)
C_5	25 V/0.1 μF	V_{CC} for surge absorber	(Note 2)
C_6	25 V/1 μF	V_{REG} power supply stability	(Note 2)
C_7	25 V/1000 pF	V_{REG} for surge absorber	(Note 2)
R_1	5.1 kΩ	DIAG pull-up resistor	(Note 3)
R_2	10 kΩ	SD pull-up resistor	-
R_3	0.15 Ω ± 1 % (1 W)	Current detection	(Note 4)

Note 1: The required bootstrap capacitance value varies according to the motor drive conditions. The capacitor is biased by V_{CC} and must be sufficiently derated for it.

Note 2: When using this product, adjustment is required in accordance with the use environment. When mounting, place as close to the base of this product leads as possible to improve the ripple and noise elimination.

Note 3: The DIAG pin is open drain. If not using the DIAG pin, connect to the GND.

Note 4: The following formula shows the detection current: $I_O = V_R \div R_3$ (For $V_R = 0.5$ V (typ.))

Handling precautions

(1) Please control the input signal in the state to which the V_{CC} voltage is steady. Both of the order of the V_{BB} power supply and the V_{CC} power supply are not cared about either.
Note that if the power supply is switched off as described above, this product may be destroyed if the current regeneration route to the V_{BB} power supply is blocked when the V_{BB} line is disconnected by a relay or similar while the motor is still running.

(2) The RS pin connecting the current detection resistor is connected to a comparator in the IC and also functions as a sensor pin for detecting over current. As a result, over voltage caused by a surge voltage, for example, may destroy the circuit. Accordingly, be careful of handling the IC or of surge voltage in its application environment.

Description of Protection Function

(1) Under voltage protection

This product incorporates under voltage protection circuits to prevent the MOSFET from operating in unsaturated mode when the V_{CC} voltage or the V_{BS} voltage drops.

When the V_{CC} power supply falls to this product internal setting $V_{CC}UVD$ (= 11 V (typ.), all MOSFET outputs shut down regardless of the input. This protection function has hysteresis. When the V_{CC} power supply reaches 0.5 V higher than the shutdown voltage ($V_{CC}UVR$ (= 11.5 V (typ.)), this product is automatically restored and the MOSFET is turned on again by the input. DIAG output is reversed at the time of V_{CC} under-voltage protection. When the V_{CC} power supply is less than 7 V, DIAG output isn't sometimes reversed. When the V_{BS} supply voltage drops $V_{BS}UVD$ (= 10 V (typ.), the high-side MOSFET output shuts down. When the V_{BS} supply voltage reaches 0.5 V higher than the shutdown voltage ($V_{BS}UVR$ (= 10.5 V (typ.)), the MOSFET is turned on again by the input signal.

(2) Over-current protection

This product incorporates an over-current protection circuit to protect itself against over-current at startup or when a motor is locked. This protection function detects voltage generated in the current detection resistor connected to the RS pin. When this voltage exceeds V_R (= 0.5 V (typ.)), the MOSFET output, which is on, temporarily shuts down after a delay time, preventing any additional current from flowing to this product. The next all “L” signal releases the shutdown state.

(3) Thermal shutdown

This product incorporates a thermal shutdown circuit to protect itself against the abnormal state when its temperature rises excessively.

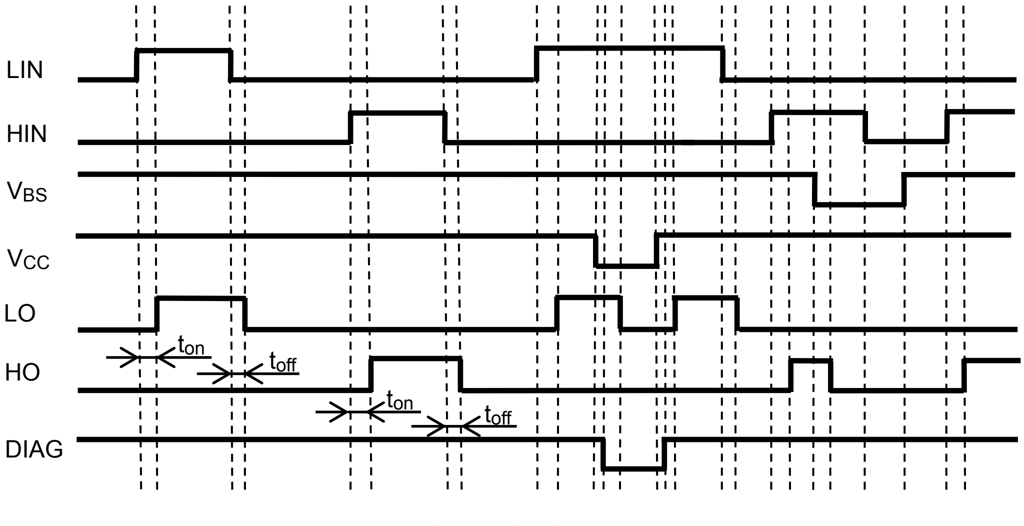
When the temperature of this chip rises to the internal setting TSD due to external causes or internal heat generation, all MOSFET outputs shut down regardless of the input. This protection function has hysteresis ΔTSD (= 50 °C (typ.)). When the chip temperature falls to TSD - ΔTSD, the chip is automatically restored and the MOSFET is turned on again by the input.

Because the chip contains just one temperature detection location, when the chip heats up due to the MOSFET, for example, the differences in distance from the detection location in the MOSFET (the source of the heat) cause differences in the time taken for shutdown to occur. Therefore, the temperature of the chip may rise higher than the thermal shutdown temperature when the circuit started to operate.

(4) SD function

SD pin is the input signal pin to shut down the internal output MOSFET. Output of all MOSFET is shut down after delay times (2 μs (typ.)) when "L" signal is input to the SD pin from external circuit (MCU etc.). It is possible to shut down IC when overcurrent and others is detected by external circuit. Shut down state is released by all of IC input signal "L". At open state of SD pin, shut down function can not operate.

Timing Chart of Under voltage protection

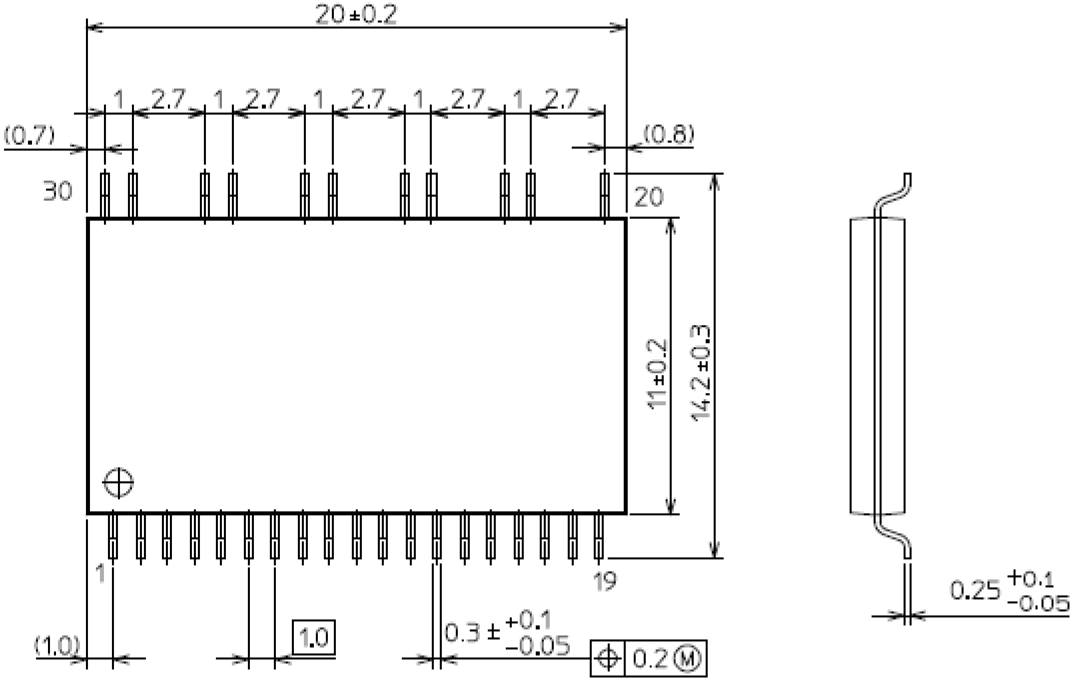


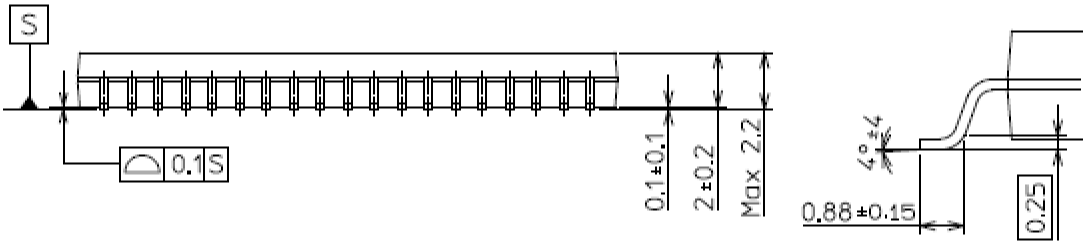
Note: The above timing chart is considering the delay time

Package Dimensions

Unit: mm

P-SSOP30-1120-1.00-001





Package Name(s)
TOSHIBA : P-SSOP30-1120-1.00-001
Nickname : SSOP30

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- Поставка более 17-ти миллионов наименований электронных компонентов;
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- Лицензия ФСБ на осуществление работ с использованием сведений, составляющих государственную тайну;
- Поставка специализированных компонентов (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Aeroflex, Peregrine, Syfer, Eurofarad, Texas Instrument, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits,General Dynamics и др.);

Помимо этого, одним из направлений компании «ЭлектроПласт» является направление «Источники питания». Мы предлагаем Вам помощь Конструкторского отдела:

- Подбор оптимального решения, техническое обоснование при выборе компонента;
- Подбор аналогов;
- Консультации по применению компонента;
- Поставка образцов и прототипов;
- Техническая поддержка проекта;
- Защита от снятия компонента с производства.

Как с нами связаться

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