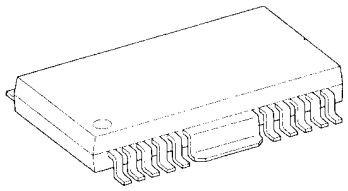
Preliminary Toshiba Bi-CMOS Integrated Circuit Silicon Monolithic

TB6549F, TB6549P

Bridge Driver

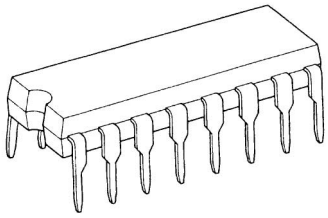
TB6549F/P is a full-bridge driver IC for DC motor with output transistor in MOS structure. Efficient driven at high temperature is possible by MOS process with low ON-resistor and PWM drive system. Two input signals, IN1 and IN2, can chose one of four modes such as CW, CCW, short brake, and stop mode.

TB6549F



HSOP20-P-450-1.00

TB6549P



DIP16-P-300-2.54A

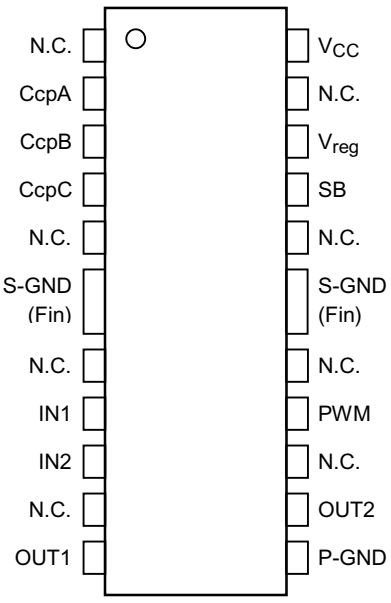
Weight:
HSOP20-P-450-1.00: 0.79 g (typ.)
DIP16-P-300-2.54A: 1.11 g (typ.)

Features

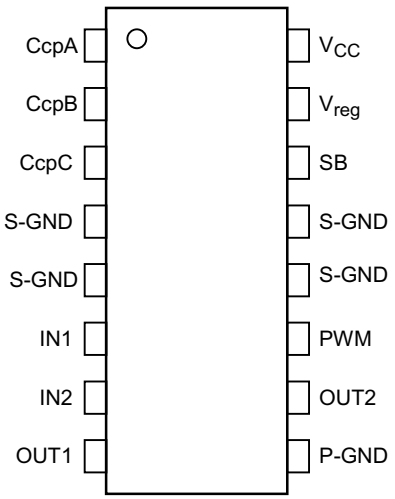
- Power supply voltage: 30 V (max)
- Output current: 4.5 A (max)
- Low ON resistor: 0.5 Ω (typ.)
- Capable of PWM controlling
- Standby system
- CW/CCW/short brake/stop function modes.
- Built-in overcurrent protection
- Built-in thermal shutdown circuit
- Package: HSOP-20/DIP-16

Pin Assigument

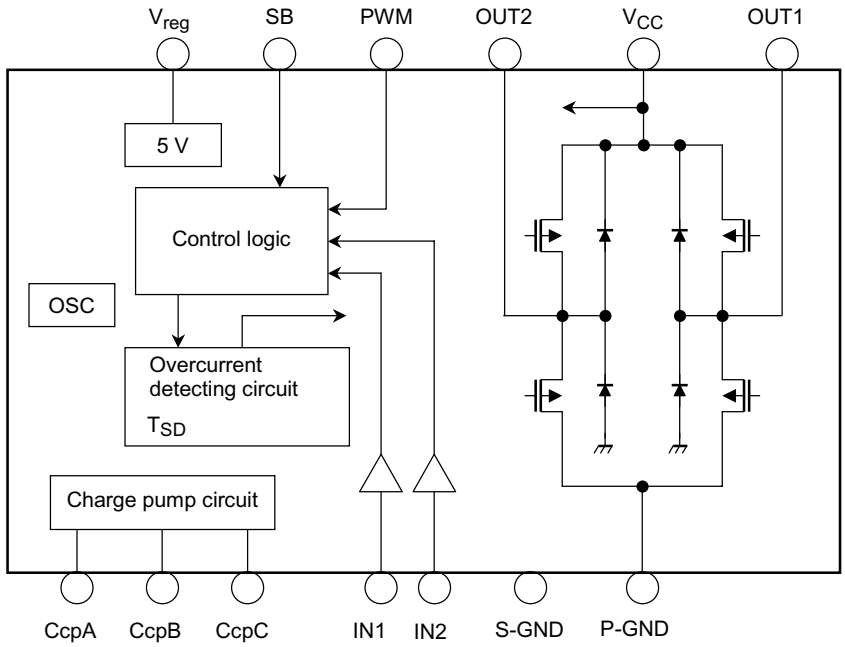
HSOP20-P-450-1.00



DIP16-P-300-2.54A



Block Diagram



Pin Functions

Pin No.		Pin Name	Functional Description	Remarks
F	P			
1	—	(NC)	No Connection	—
2	1	CcpA	Capacitor connection pin for charge pump A	Connect a capacitor for charge pump
3	2	CcpB	Capacitor connection pin for charge pump B	Connect a capacitor for charge pump
4	3	CcpC	Capacitor connection pin for charge pump C	Connect a capacitor for charge pump
5	—	(NC)	No Connection	—
6	—	(NC)	No Connection	—
7	6	IN1	Control signal input 1	Input 0/5-V signal
8	7	IN2	Control signal input 2	Input 0/5-V signal
9	—	(NC)	No Connection	—
10	8	OUT1	Output pin 1	Connect to motor coil pin
11	9	P-GND	Power supply GND	—
12	10	OUT2	Output pin 2	Connect to motor coil pin
13	—	(NC)	No Connection	—
14	11	PWM	PWM control signal input pin	Input 0/5-V PWM signal
15	—	(NC)	No Connection	—
16	—	(NC)	No Connection	—
17	14	SB	Standby pin	H: Start, L: Standby
18	15	V_{reg}	5-V output pin	Connect a capacitor to S-GND
19	—	(NC)	No Connection	—
20	16	V_{CC}	Power supply input pin	$V_{CC\ (ope)}$ = 10 to 27 V
FIN	4, 5, 12, 13	S-GND	GND pin	—

Maximum Ratings (Ta = 25°C)

Characteristics		Symbol	Rating	Unit
Supply voltage		V_{CC}	30	V
Output current		I_O	4.5	A
Power dissipation	F	P_D	2.5 (Note 1)	W
	P		2.5 (Note 2)	
Operating temperature		T_{opr}	−20 to 85	°C
Storage temerature		T_{stg}	−55 to 150	°C

Note 1: This value is obtained by 115 × 75 × 1.6 mm PCB mounting occupied 30% of copper area.

Note 2: This value is obtained by 50 × 50 × 1.6 mm PCB mounting occupied 50% of copper area.

Operating Range (Ta = 25°C)

Characteristics	Symbol	Rating	Unit
Supply voltage	V_{CC}	10 to 27	V
PWM frequency	f_{CLK}	100	kHz

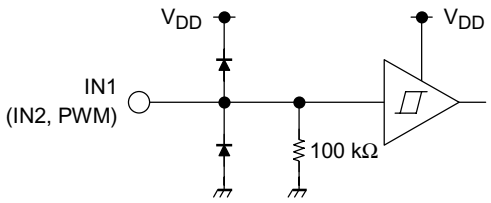
Electrical Characteristics (V_{CC} = 24 V, Ta = 25°C)

Characteristics		Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Supply current		I_{CC1}	—	Stop mode	—	10		mA
		I_{CC2}	—	CW/CCW mode	—	10		
		I_{CC3}	—	Short break mode	—	10		
		I_{CC4}	—	(Standby mode)	—	1		
Control circuit	Input voltage	V_{INH}	—		2	—	V_{reg}	V
		V_{INL}	—		—	—	0.8	
	Hysteresis voltage	$V_{IN\ (HIS)}$	—	(Not tested)		0.2		
	Input current	I_{INH}	—		—	50	75	μA
		I_{INL}	—		—	—	5	
Standby circuit	Input voltage	V_{INSH}	—		2	—	V_{reg}	V
		V_{INSL}	—		—	—	0.8	
	Hysteresis voltage	$V_{IN\ (HIS)}$	—	(Not tested)		0.2		
	Input current	I_{INSH}	—		—	50	75	μA
		I_{INSL}	—		—	—	5	
Saturation voltage		$V_{sat\ (U+L)}$	—	I_o = 0.2 A	—	0.2		V
			—	I_o = 1.5 A	—	1.5		
Leakage current		$I_{L\ (U)}$	—	V_{CC} = 30 V	—	—	10	μA
		$I_{L\ (L)}$			—	—	10	
Diode forward voltage		$V_{F\ (U)}$	—	I_o = 1.5 A		1.5		V
		$V_{F\ (L)}$		I_o = 1.5 A		1.5		
Internal constant voltage		V_{reg}	—			5		V
Overcurrent detection		I_{SD}	—			5		A
Overcurrent detection offset time		$I_{SD\ (OFF)}$	—	(Not tested)		50		μs
PWM control circuit	PWM frequency	f_{CLK}	—				100	kHz
	Minimum clock pulse width	$t_{w\ (CLK)}$	—					μs
Charge pump riging time		t_{ONG}	—	C_1 = 0.22 μF, C_2 = 0.01 μF (Note 3)		2		ms
Thermal shutdown circuit operating temperature		T_{SD}	—	Not tested	—	160	—	°C

Note 3: C_1 is a capacitor between CcpA and GND. C_2 is a capacitor between CcpB and CcpC.

Component Description

1. Control Input/PWM Input Circuit

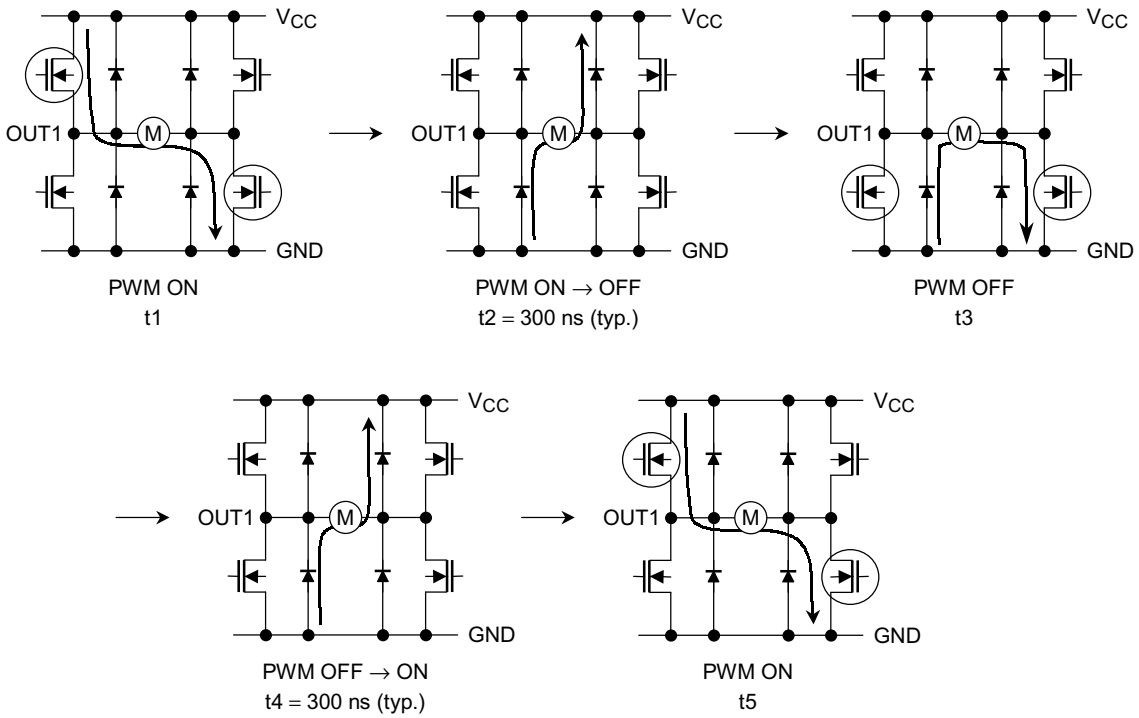


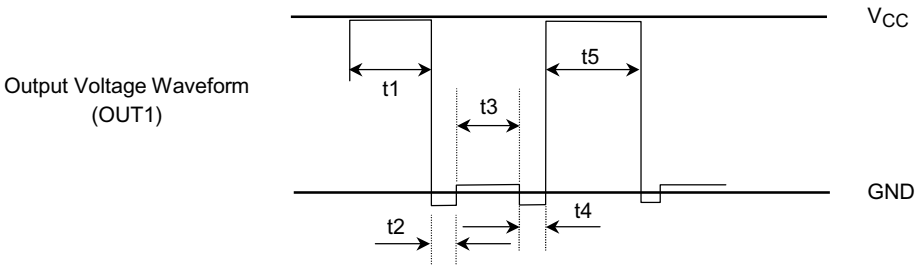
- The input signals are shown below. Input at the CMOS and TTL levels can be provided. Note that the input signals have a hysteresis of 0.2 V (typ.).
  V_{INH}: 2 to V_{reg} V
  V_{INL}: GND to 0.8 V
- The PWM input frequency should be 100 kHz or less.

Input/Output Function

Input				Output		
IN1	IN2	SB	PWM	OUT1	OUT2	Mode
H	H	H	H	L	L	Short brake
			L			
L	H	H	H	L	H	CW/CCW
			L	L	L	Short brake
H	L	H	H	H	L	CCW/CW
			L	L	L	Short brake
L	L	H	H	OFF (high impedance)		Stop
			L			
H/L	H/L	L	H	OFF (high impedance)		Standby
			L			

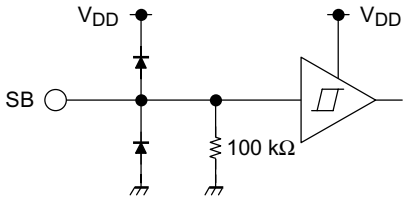
- PWM control function
  Speed can be controlled by inputting the 0/5 V PWM signal to the PWM terminal.
  When PWM control is provided, normal operation and short brake operation are repeated.
  If the upper and lower power transistors in the output circuit were ON at the same time, a penetrating current would be produced. To prevent this current from being produced, a dead time of 300 ns (design target value) is provided in the IC when either of the transistors changes from ON to OFF, or vice versa. Therefore, PWM control by synchronous rectification is enabled without an OFF time being inserted by external input. Note that a dead time is also provided in the IC at the time of transition between CW and CWW or between CW (CCW) and short brake mode, thereby eliminating the need for an OFF time.





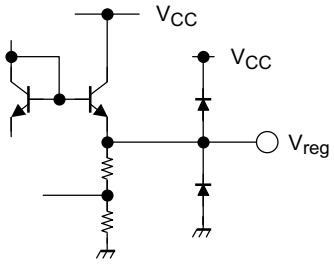
*: Please set the pin PWM to high when PWM control functionn is not used.

2. Standby Circuit



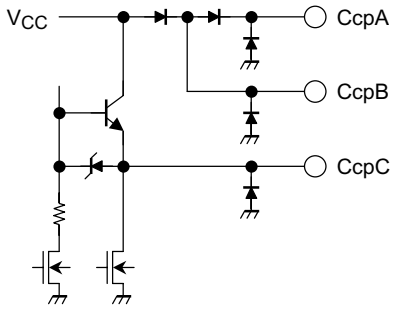
- Turn all circuits OFF except the standby circuit and the charge pump circuit under the standby condition.
- Input voltage range is shown below. Input at CMOS and TTL level is possible. Input signal has 0.2-V (typ.) hysteresis.
  V_{INSH}: 2 to V_{reg} V
  V_{INSL}: GND to 0.8 V

3. Internal Constant-Voltage (5 V) Circuit



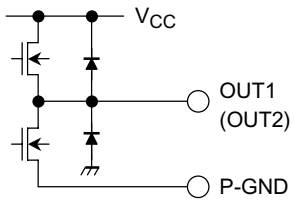
- This IC includes a 5-V power supply for biasing the control circuit.
- A capacitor for prevention of oscillation should be connected to S-GND associated with the V_{reg} terminal. No other loads should be connected to S-GND.
- This IC has a power monitoring function and turns the output OFF when the voltage becomes 3.0 V (design target value) or less. With a hysteresis of 0.3 V (design target value), the voltage is reset to 3.3 V (design target value).

4. Charge Pump Circuit

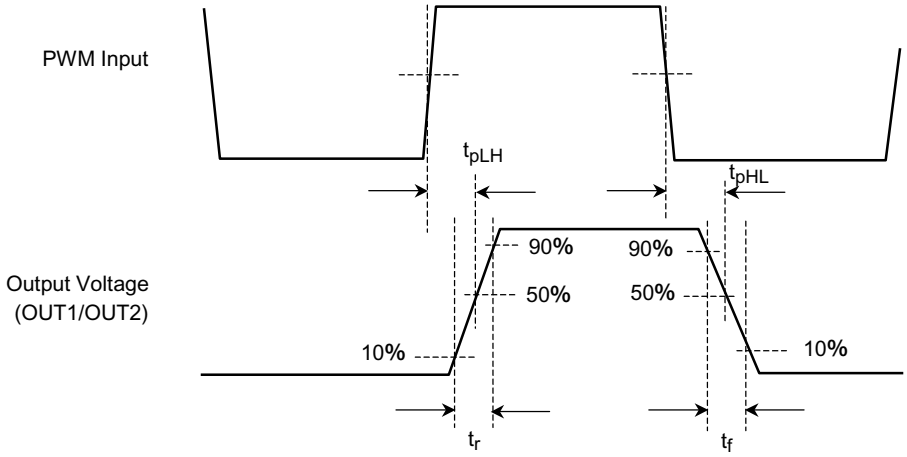


- This IC has a charge pump circuit for driving the gate for the upper power transistor in the output circuit. A voltage of V_{CC} + 5 V (typ.) is generated by connecting an external capacitor to this IC.
  It takes about 2 ms to boost V_{CC} at its rising edge to V_{CC} + 5 V (typ.) (while CcpA = 0.22 μF, and CcpB and CcpC are connected through 0.01 μF).
- The proper capacitance of the external capacitor varies depending on the PWM frequency. Thus, determine the constant by referring to the following data:
- Reference oscillation is performed by using the internal capacitor.

5. Output Circuit



- This IC uses Nch MOS transistors as the upper and lower transistors in the output circuit.
- As output R_{on} is 1 Ω (sum for the upper and lower parts/typ.), this IC is a device of the low R_{on} type.
- The switching characteristics of the output transistors are shown below.



<Typical Value>

Item	Typical Value	Unit
t_{pLH}	350	ns
t_{pHL}	800	
t_r	60	
t_f	100	

*: OUT 1, OUT 2; open

6. V_{CC} Power Supply Section

- The V_{CC} power supply delivers a voltage to the output circuit, charge pump circuit, and internal 5 V circuit.
- The operating voltage range is shown below.
  $V_{CC\ (opr.)}$ = 10 to 27 V
- This IC has a power monitoring function for preventing an output malfunction on power-up. However, Toshiba recommends that IN1, IN2, and SB be set at the "L" level on power-up.

7. GND Sections

- This IC includes two separate GND sections: S-GND for control and P-GND for output. Be sure to place a short circuit between these sections. Whenever practicable, avoid using common impedance for wires or for conductor patterns on the printed circuit board in order to create the short.

8. Power Monitoring Circuit

- This circuit turns the output OFF when V_{reg} becomes 3.0 V (design target value) or less. At this time, V_{CC} = 4.6 V (typ.)
- With a hysteresis of 0.3 V (design target value), the output turns back ON when V_{reg} exceeds 3.3 V (design target value) after this circuit starts operating.

9. Thermal Shutdown (T_{SD}) Circuit

This IC includes a thermal shutdown circuit which turns the output OFF when the junction temperature (Tj) exceeds 160°C (typ.). The output turns back ON automatically. The thermal hysteresis is 20°C.

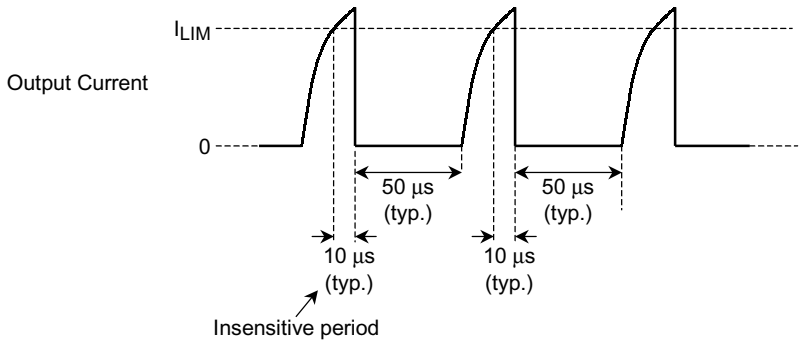
T_{SD} = 160°C (design target value)

ΔT_{SD} = 20°C (design target value)

10. Overcurrent Detection (I_{SD}) Circuit

This IC includes a circuit which detects a current flowing through the output power transistors. The current limit is set to 5 A (typ.). The circuit detects a current flowing through each of the four output power transistors. If the current in any one output power transistor exceeds the set limit, this circuit turns all the outputs OFF.

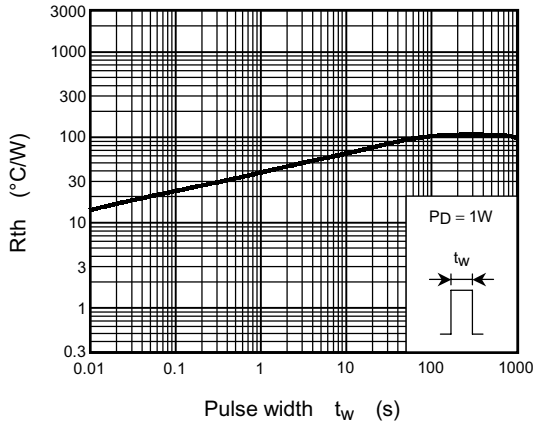
This circuit includes a timer which causes the outputs to be OFF for 50 μs (typ.) after detection of an overcurrent and then turn back ON automatically. If the overcurrent continues to flow, this ON-OFF operation is repeated. Note that to prevent a malfunction due to a spike, an insensitive period of 10 μs (typ.) is provided.



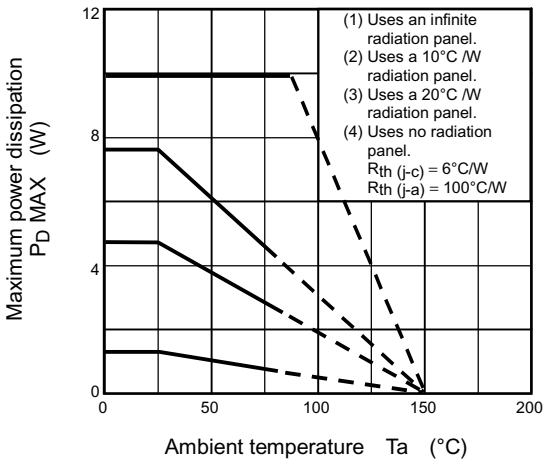
The set limit is 5 A (typ.) as a design target value. The distributions shown below exist because of the variations in thermal characteristics of different ICs. These distributions should be fully considered in the motor torque design.

Detected current: (3.5 to 6.5 A)

Transient Thermal Resistance (TB6549F)



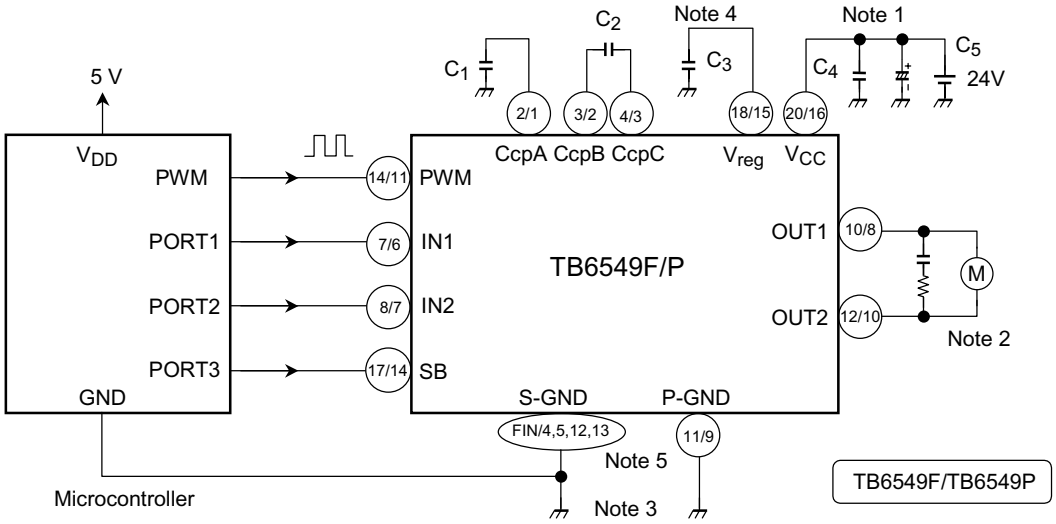
P_D – Ta (TB6549F)



External Attachments

Symbol	Use	Recommended Value	Remarks
C_1	Charge pump	0.22 μF	—
C_2	Charge pump	0.01 μF	—
C_3	Prevention of V_{reg} oscillation	0.1 μF to 1.0 μF	—
C_4	Absorption of power noise	0.001 μF to 1 μF	—
C_5	Absorption of power noise	10 μF to 100 μF	—

Example Application



TB6549F: Pins 1, 5, 6, 9, 13, 15, 16, and 19 are not connected.

Note 1: Connect V_{CC} and P-GND through the power supply capacitor. This capacitor should be as close as possible to the IC.

Note 2: When connecting the motor terminals through the capacitor for reducing noise, connect a resistor to the capacitor for limiting the charge current. The switching loss increases for PWM control. Therefore, whenever practicable, avoid connecting the capacitor if PWM control is required.

Note 3: Avoid using common impedance for S-GND and P-GND.

Note 4: Connect the capacitor to S-GND.

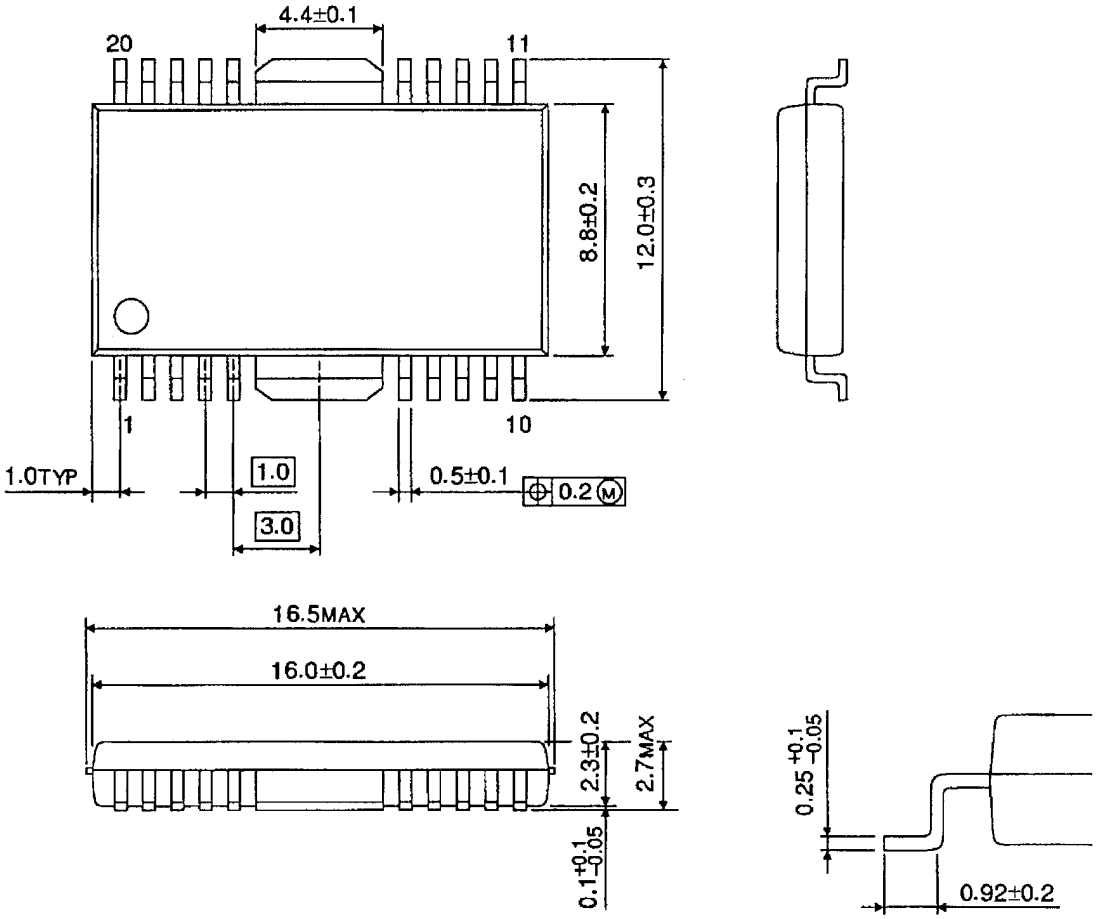
Note 5: Pins 4, 5, 12, and 13 of the P type are connected to the chip's bed. Therefore, expanding their round area produces a better heat radiation effect.

Usage Precautions

- This IC includes an overcurrent detection circuit. However, if a short circuit takes place between output terminals or if an output terminal is connected to the voltage source or ground, a heavy current temporarily flows through the IC. It might destroy the IC. This possibility should be fully considered in the design of the output line, V_{CC} line, and GND line. If the IC is destroyed, a heavy current might continuously flow through it as a secondary effect. Therefore, Toshiba recommends that a fuse be connected to the power supply line.
- Install this IC properly. If you make a mistake in its installation (e.g., if you install it in the wrong position), the IC might be destroyed.

Package Dimensions

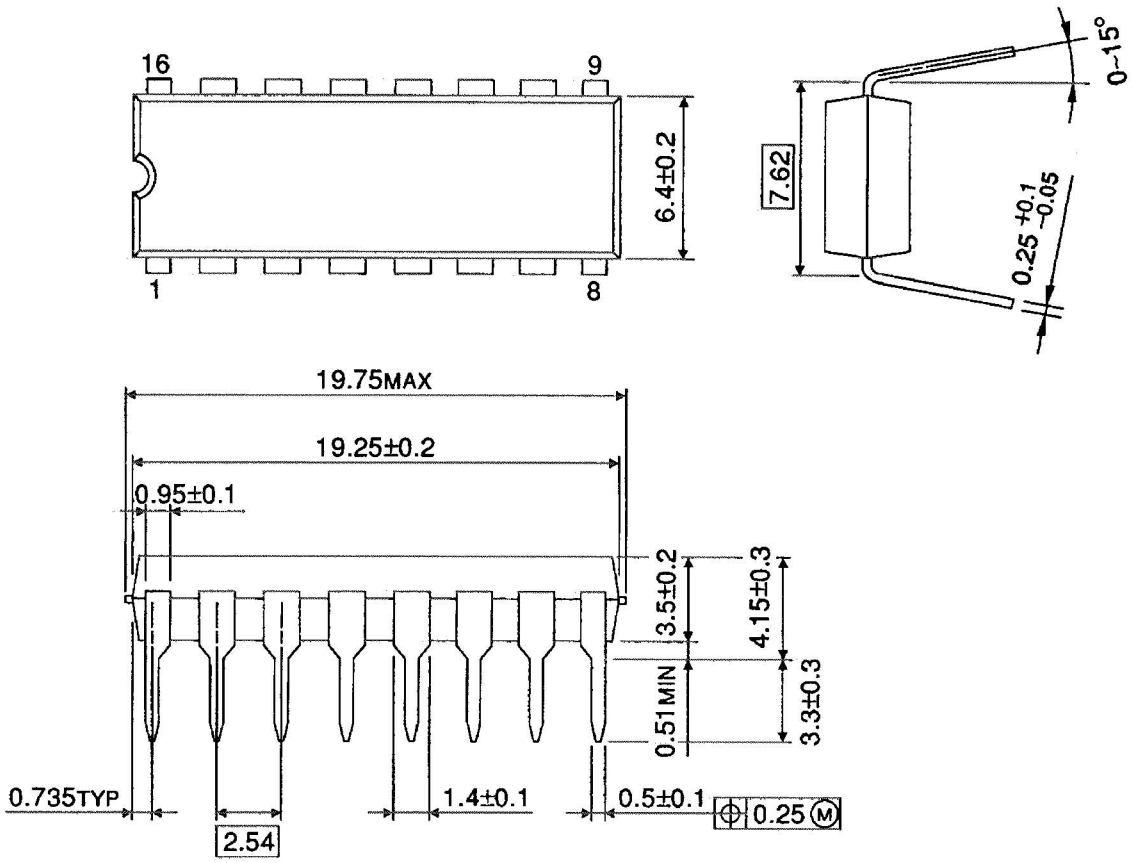
HSOP20-P-450-1.00 Unit : mm



Weight: 0.79 g (typ.)

Package Dimensions

DIP16-P-300-2.54A Unit : mm



Weight: 1.11 g (typ.)

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000707EBA

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