

TOSHIBA BIPOLAR LINEAR INTEGRATED CIRCUIT SILICON MONOLITHIC

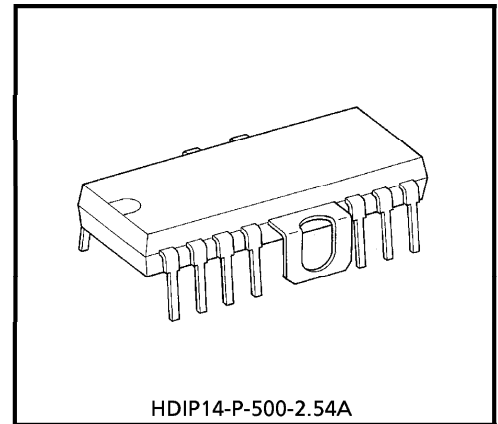
# TA8483CP

## THREE-PHASE ALL WAVE DRIVER IC

The TA8483CP is a three-phase all wave driver IC that makes possible PWM sensorless driving.

### FEATURES

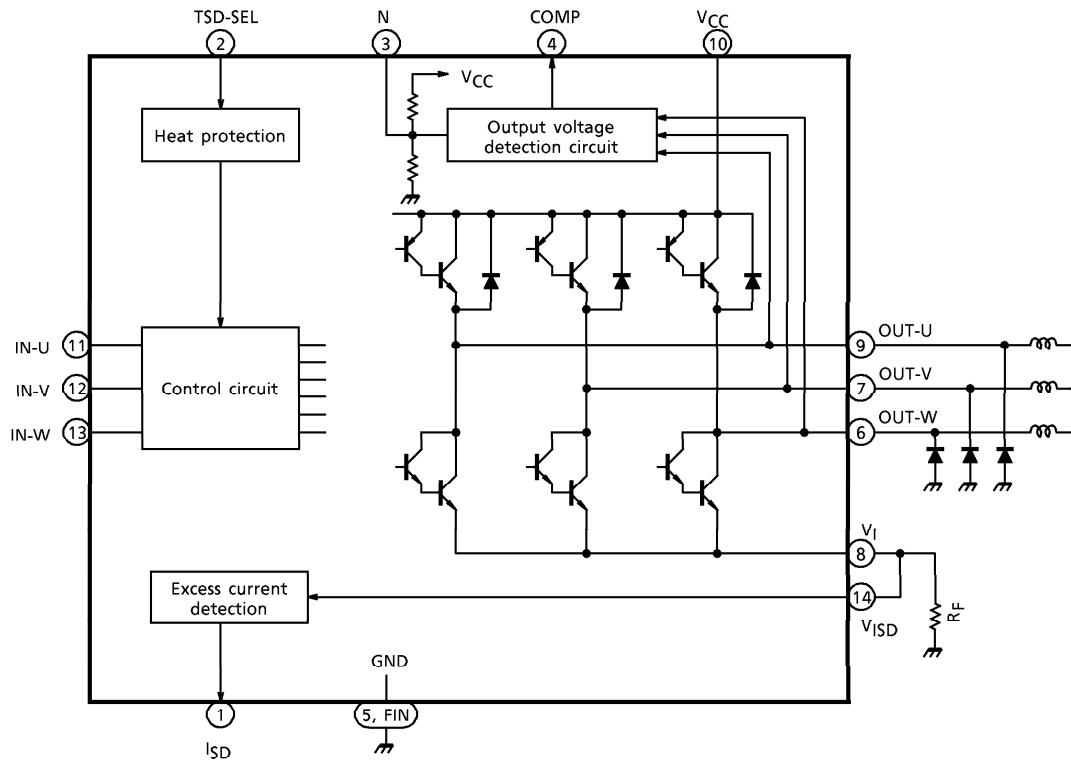
- Built-in excess current detection function
- Built-in heat protection function



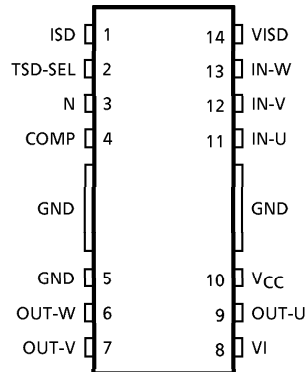
HDIP14-P-500-2.54A

Weight : 3.0 g (Typ.)

BLOCK DIAGRAM



**PIN CONNECTION**



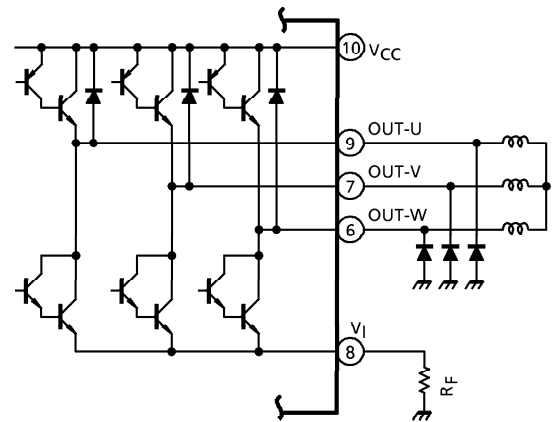
**PIN FUNCTION**

PIN No.	SYMBOL	I/O	FUNCTIONAL DESCRIPTION
1	ISD	O	Excess current detection signal output
2	TSD-SEL	I	Heat protection circuit selecting pin
3	N	—	Mid-point voltage pin
4	COMP	O	Majority logical sum output (power output pin voltage detection circuit)
5	GND	—	GND
6	OUT-W	O	W-phase output pin
7	OUT-V	O	V-phase output pin
8	VI	O	Current detection resistance connecting pin
9	OUT-U	O	U-phase output pin
10	VCC	I	Supply voltage pin
11	IN-U	I	U-phase input pin
12	IN-V	I	V-phase input pin
13	IN-W	I	W-phase input pin
14	VISD	I	Excess current detection input pin

**FUNCTIONAL DESCRIPTION**

1. Output section (OUT-U, OUT-V, OUT-W)

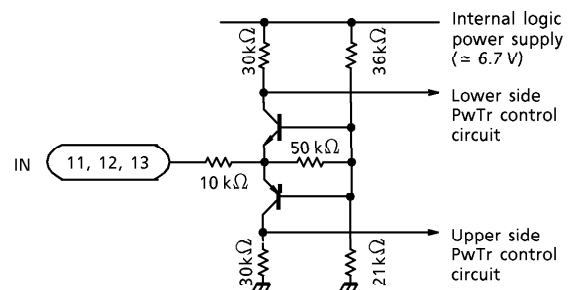
- The configuration of the output stage is shown in the chart to the right.
- The PWM operation takes OFF-ON control of the upper side transistor.
- Be sure to set the schottky barrier diode outside, because the current flows to the lower-side diode when PWM is off.



<Output circuit>

2. Input circuit (IN-U, IN-V, IN-W)

- The three-phase input receives three-state impedance (high, low, high impedance) from the controller side.



<Input circuit>

3. Overheat protection circuit

- When junction temperature  $T_j$  is  $T_j \geq TSD$  (ON) (overheat protection operation temperature) when TSD-SEL = "LOW", the entire output maintains an OFF state.

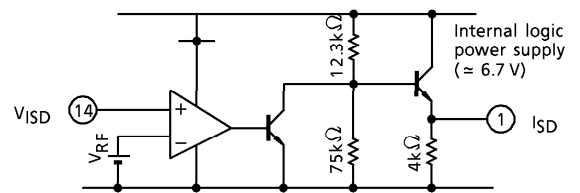
To cancel this state,

- ① Reapply the supply voltage.
- ② Apply " " signal to the TSD-SEL pin.

- When TSD-SEL = "HIGH", an automatic return mode takes place.

4. Excess current detection circuit ( $V_{ISD}$ ,  $I_{SD}$ )

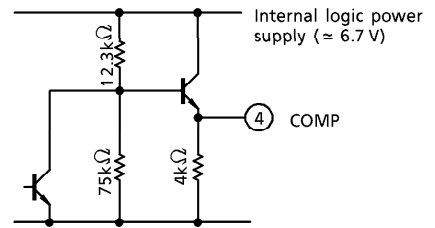
- The voltage in current detection resistor RF outside  $V_I$  pin is input to the  $V_{ISD}$  pin.
- When  $V_{ISD}$  voltage rises above internal reference voltage  $V_{RF}$  ( $\approx 0.5V$ ), excess current detection circuit  $I_{SD}$  becomes "HIGH".



<Excess current detection circuit>

5. Output voltage detection circuit (COMP)

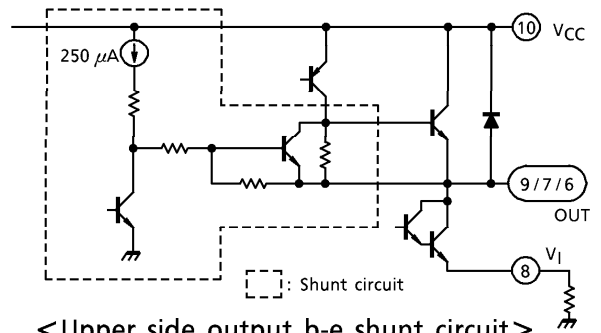
- Brings about majority logical sum output.  
(When two-phase output or higher out of three-phase output is larger than mid-point voltage  $V_{CC}/2$ , "HIGH" is output; when it is smaller, "LOW" is output.)



<Output voltage detection circuit>

6. Upper side output B-E shunt circuit

- A Base-Emitter shunt circuit is incorporated to turn off the upper side power transistor.



<Upper side output b-e shunt circuit>

**MAXIMUM RATINGS** ( $T_a = 25^\circ\text{C}$ )

CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	$V_S$	35	V
Output Current	$I_{OUT}$ (PEAK)	2.0	A
Power Dissipation	$P_D$	2.3 (Note)	W
Operating Temperature	$T_{opr}$	-30~85	$^\circ\text{C}$
Storage Temperature	$T_{stg}$	-55~150	$^\circ\text{C}$
Input Voltage	$V_{IN}$	6.0	V

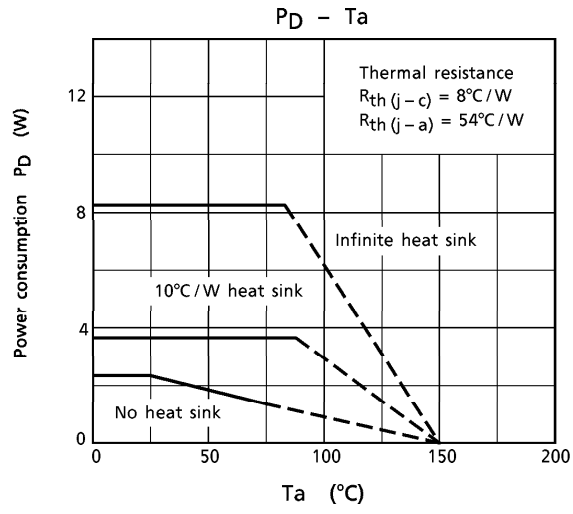
(Note) No heat sink

**RECOMMENDED OPERATING CONDITIONS** ( $T_a = -30$  to  $85^\circ\text{C}$ )

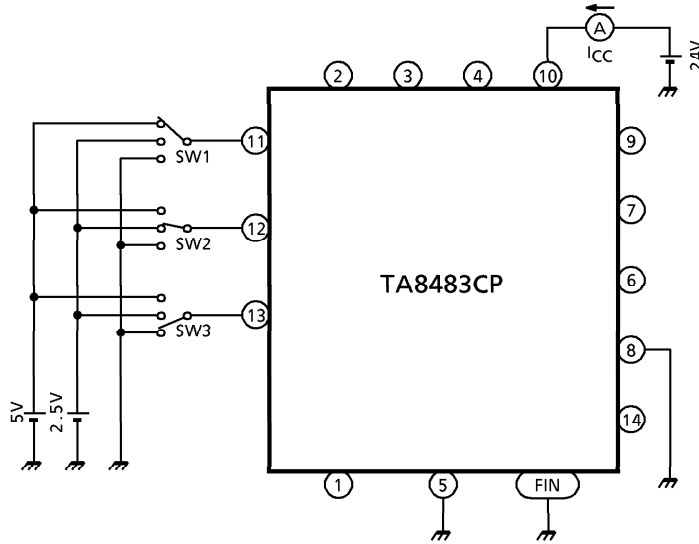
CHARACTERISTIC	SYMBOL	MIN	TYP.	MAX	UNIT
Supply Voltage	$V_S$	20	—	30	V
Output Current	$I_{OUT}$	—	—	1.5	A
Chopping Frequency	$f_{PWM}$	—	20	40	kHz

**ELECTRICAL CHARACTERISTICS** (Ta = 25°C, VCC = 24 V)

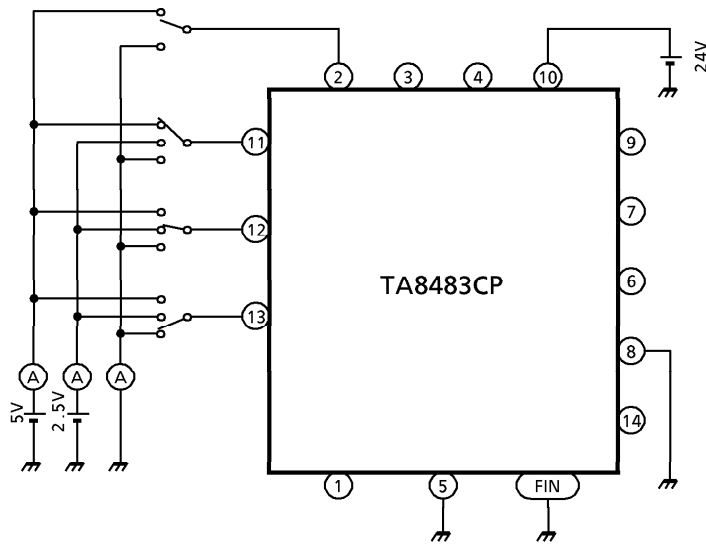
CHARACTERISTIC	SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Current consumption	I <sub>CC</sub> (1)	1	CHOP ON	—	40	51	mA
	I <sub>CC</sub> (2)		CHOP OFF	—	24	30	
	I <sub>CC</sub> (3)		OFF	—	22	28	
Input Current	I <sub>IN1</sub> (L)	2	V <sub>IN</sub> = 0 V, IN-U, IN-V, IN-W	-350	—	-100	μA
	I <sub>IN1</sub> (OFF)		V <sub>IN</sub> = 2.5 V, IN-U, IN-V, IN-W	—	0	—	
	I <sub>IN1</sub> (H)		V <sub>IN</sub> = 5 V, IN-U, IN-V, IN-W	100	—	350	
	I <sub>IN2</sub> (L)		V <sub>IN</sub> = 0 V, TSD-SEL, T <sub>j</sub> = 150°C	—	0	—	
	I <sub>IN2</sub> (H)		V <sub>IN</sub> = 5 V, TSD-SEL, T <sub>j</sub> = 150°C	—	5.5	100	
Input Voltage	V <sub>IN1</sub> (L)	3	V <sub>CC</sub> = 20 V, IN-U, IN-V, IN-W	0	—	0.7	V
	V <sub>IN1</sub> (OFF)		V <sub>CC</sub> = 20 V, IN-U, IN-V, IN-W	1.9	—	3.0	
	V <sub>IN1</sub> (H)		V <sub>CC</sub> = 20 V, IN-U, IN-V, IN-W	4	—	5.5	
	V <sub>IN2</sub> (L)		TSD-SEL, T <sub>j</sub> = 150°C	0	—	0.5	
	V <sub>IN2</sub> (H)		TSD-SEL, T <sub>j</sub> = 150°C	1.1	—	5.5	
Mid-point Potential	V <sub>N</sub>	4		0.95 × VS / 2	VS / 2	1.05 × VS / 2	V
Pin Voltage Detection Level	V <sub>CMP</sub>	5		0.95 × VS / 2	VS / 2	1.05 × VS / 2	V
Pin Voltage Detection Output Voltage	V <sub>OV</sub>	5	I <sub>O</sub> = 50 μA	4.3	—	5.15	V
Excess Current Detection Level	V <sub>RF</sub>	6		0.43	0.50	0.52	V
Excess Current Detection Output Voltage	V <sub>OC</sub>	6	I <sub>O</sub> = 50 μA	4.3	—	5.15	V
Output Saturation Voltage	V <sub>SAT</sub> (H)	7	V <sub>CC</sub> = 20 V, I <sub>O</sub> = 1 A	—	1.3	1.7	V
			V <sub>CC</sub> = 20 V, I <sub>O</sub> = 1.5 A	—	1.6	2.1	
	V <sub>SAT</sub> (L)	8	V <sub>CC</sub> = 20 V, I <sub>O</sub> = 1 A	—	1.3	1.7	
			V <sub>CC</sub> = 20 V, I <sub>O</sub> = 1.5 A	—	1.5	2.0	
Upper Side Diode Forward Voltage	V <sub>F</sub> (H)	9	I <sub>O</sub> = 1 A	—	1.8	2.5	V
Output Leakage Voltage	I <sub>L</sub> (L)	10	V <sub>L</sub> = 35 V	—	0	50	
Upper Side Output B-E Shunt Circuit Current	I <sub>S</sub>	11	V <sub>CC</sub> = 35 V	—	250	400	
Heat Protection Operative Temperature	TSD (ON)	—	T <sub>j</sub>	—	175	—	°C
	TSD (OFF)			—	150	—	
	TSD (HYS)			—	25	—	
Output Transmission Time	t <sub>on</sub>	—		—	0.2	—	μs
	t <sub>off</sub>			—	6.1	—	
Comparator Output Transmitting Duration	t <sub>pLH</sub>	—		—	0.5	—	μs
	t <sub>pHL</sub>			—	1.5	—	
Excess Current Detection Duration	t <sub>r</sub>	—		—	1	—	μs
	t <sub>f</sub>			—	7	—	



TEST CIRCUIT 1 :  $I_{CC}$

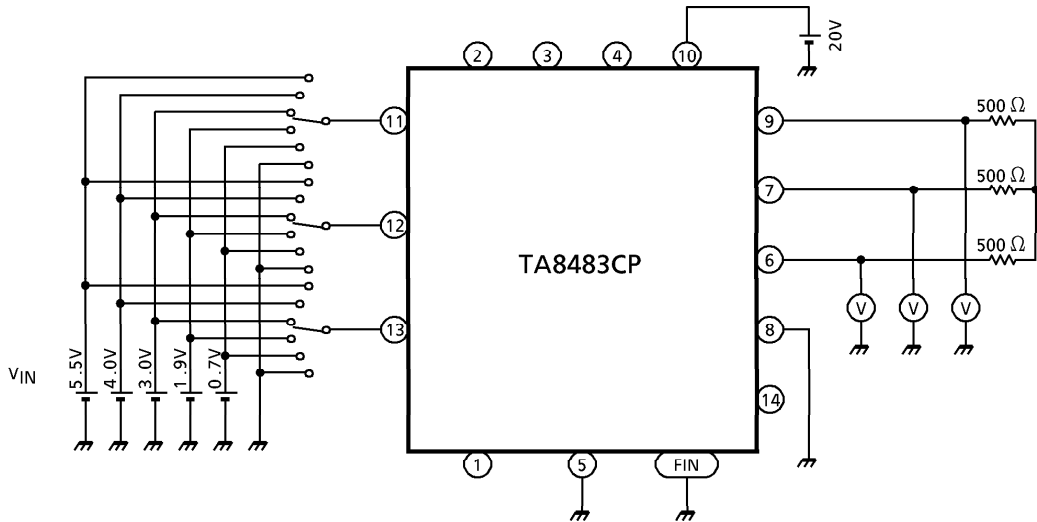


TEST CIRCUIT 2 :  $I_{IN}$



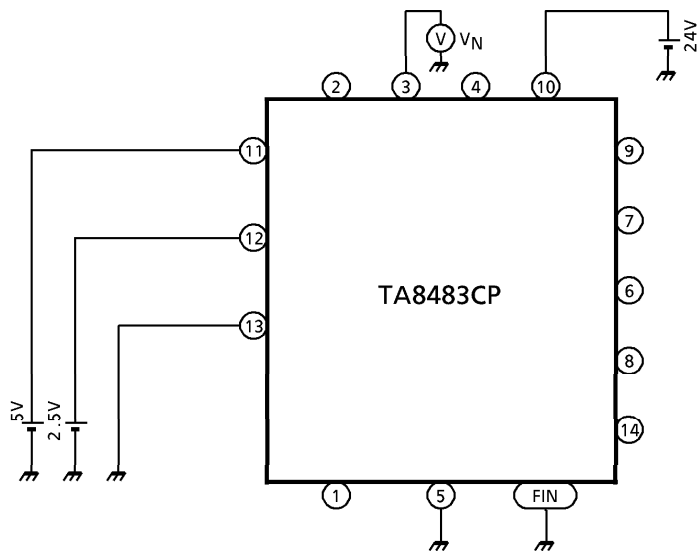


**TEST CIRCUIT 3 :  $V_{IN}$**

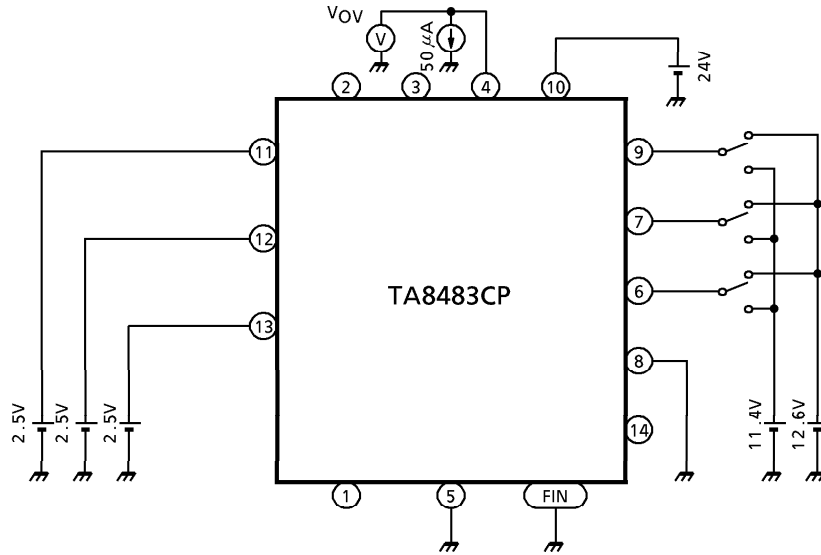


(Note) Confirm output voltage by inputting regular  $V_{IN}$ .

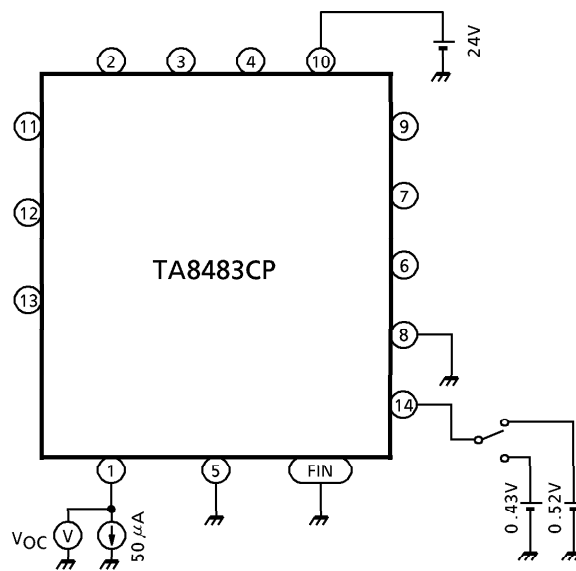
**TEST CIRCUIT 4 :  $V_N$**



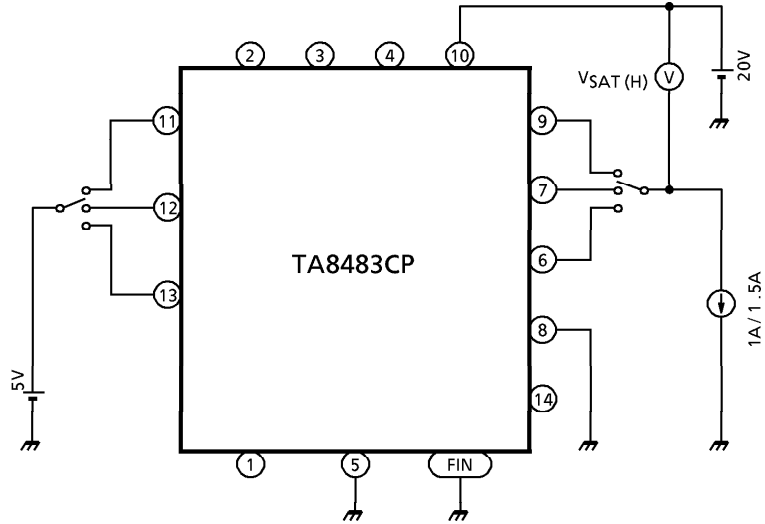
**TEST CIRCUIT 5 :  $V_{CMP}$ ,  $V_{OV}$**



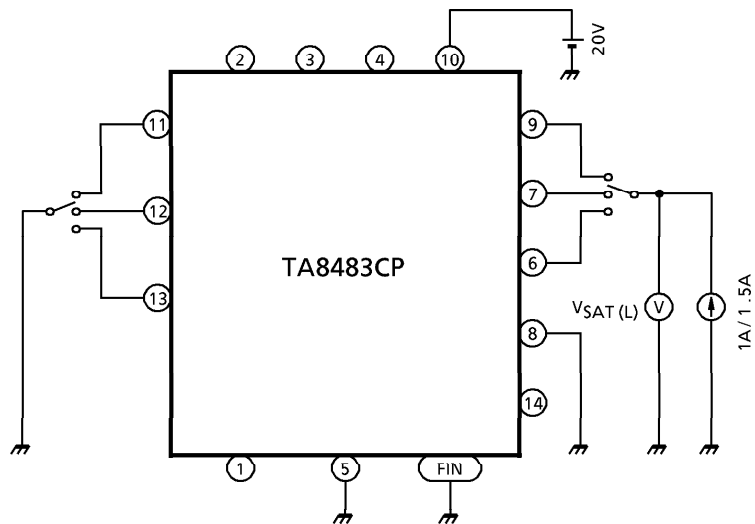
**TEST CIRCUIT 6 :  $V_{RF}$ ,  $V_{OC}$**



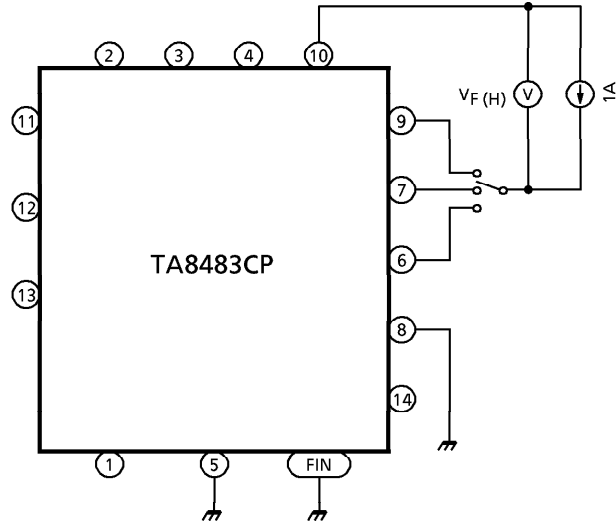
TEST CIRCUIT 7 :  $V_{SAT} (H)$



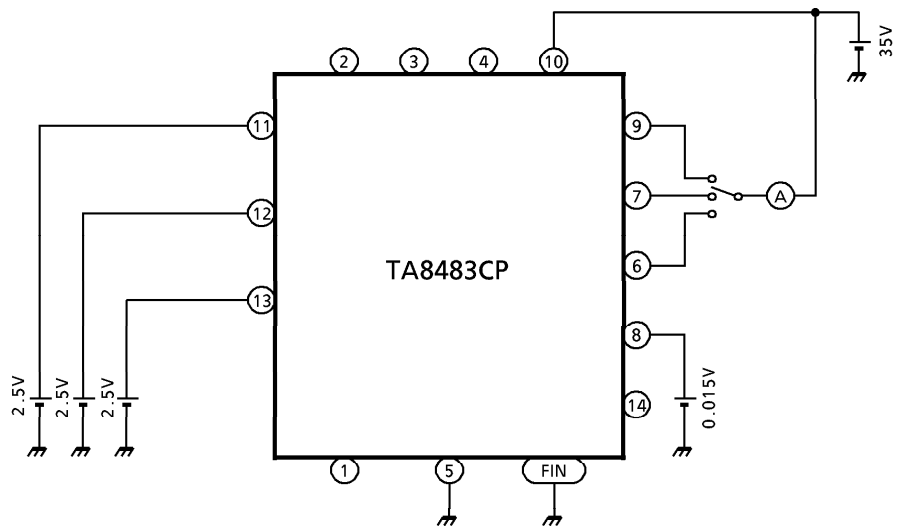
TEST CIRCUIT 8 :  $V_{SAT} (L)$



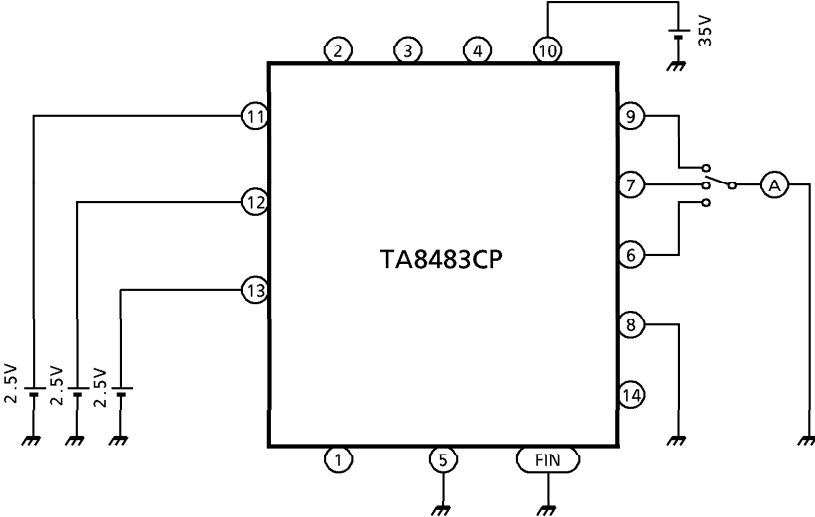
TEST CIRCUIT 9 :  $V_F(H)$



TEST CIRCUIT 10 :  $I_L(L)$



TEST CIRCUIT 11 : I<sub>S</sub>



FUNCTION DESCRIPTION OF TB6520P + TA8483CP

- Three-phase sensorless drive

The TB6520P detects the motor's induced voltage (motor's terminal voltage), compares it with VM (motor's power supply voltage) divided by 2, and generates a commutation signal based on the comparison result. Therefore, the TB6520P eliminates the need for the Hall elements and Hall ICs that have conventionally been used to detect the motor's rotor position.

- PWM drive

The TB6520P allows output duty cycles to be controlled by using its DUTY input voltage.

PWM operation is chopped by the upper-side output on/off operation.

Position detection is accomplished by monitoring the motor's terminal voltage at falling edges of PWM and comparing the detected voltage with the reference voltage. In this way, avoid effects of the terminal voltage on PWM are avoided. But this causes a position detection error associated with the PWM signal frequency. Therefore, care must be taken when using the controller for high-speed motors.

- Startup method

At startup, no induced voltage develops because the motor is not turning yet. For this reason, the TB6520P forcibly applies a predetermined commutation pattern to the motor as it starts.

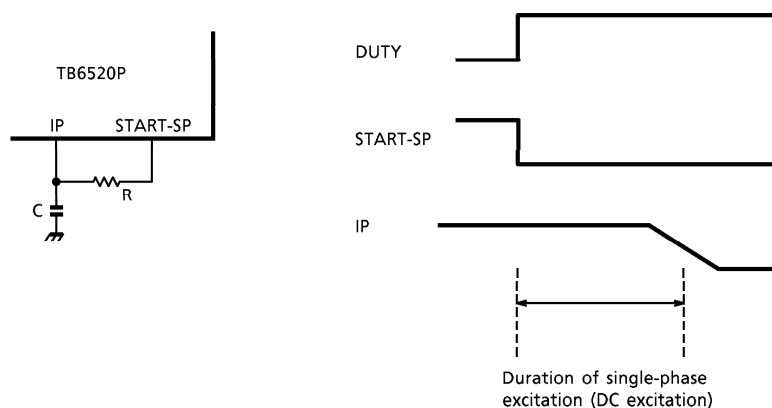
In this case, a problem occurs that the motor cannot be started smoothly depending on its rotor position.

To solve this problem, the TB6520P uses single-phase excitation (by setting the IP pin high to fix the phase and allow current to conduct in only one phase) for a predetermined period. This helps to move the rotor position at startup forcibly to a ready to start position.

However, since the duration of single-phase excitation and the power applied for it (DUTY input voltage) varies with each motor, adjustment is required.

- About the duration of single-phase excitation

The duration of single-phase excitation (DC excitation) can be changed by adjusting the RC constant in the application circuit shown below.



Setup example : C = 4.7  $\mu$ F, R = 220 k $\Omega$

- Changing and stopping revolutions

(1) The motor speed or revolutions can be changed by adjusting the  $V_{DUTY}$  voltage (TB6520P input voltage).

(2) To stop the motor, drop  $V_{DUTY}$  to 0 V.

- About stepping-out

Monitor the TB6520P's speed detection signal (FG output) to see if a FG signal of the designated frequency is returned. If not, the motor has stepped out of synchronization, so restart it.

- About overcurrent limiting operation

The TA8483CP's overcurrent detection function works in such a way that the motor current is detected using an external resistor and when the voltage that develops in the resistor exceeds the reference voltage  $V_{RF}$ , the ISD signal is driven high. The TB6520P limits the ON-time of the PWM signal (output by the TB6520P) at a rising edge of the ISD signal. The ON-time of the upper-side power transistor in the TA8483CP is thereby limited.

- Lead angle control

The TB6520P determines the commutation timing based on the changeover point (zero-cross point) of the induced voltage and reference voltage  $V_n$  (=  $V_M$  (motor's power supply voltage) divided by 2).

During forced starting commutation, the motor operates with a lead angle of 0 degrees. After the motor switches over to normal-speed operation, the lead angle is automatically changes to 15 degrees.

(Lead angle of 0 degrees : For 120-degree switch-on, current starts conducting 30 degrees behind the zero-cross point. Lead angle of 15 degrees : Current starts conducting 15 degrees behind the zero-cross point.)

Note that depending on motor characteristics, the waveform of the induced voltage may be distorted, causing the zero-cross point to slip out of place. The commutation timing also is thereby made to drift.

### Precautions on Using TB6520P + TA8483CP

- About DC Power supply voltage and control voltage on / off sequence

The power-on sequence dictates that  $V_{CC}$  (TA8483CP power supply) be turned on after  $V_{DD}$  (TB6520P power supply) becomes steadily on.

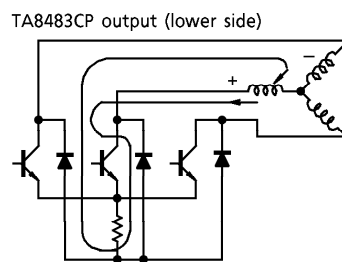
When powering on, make sure  $V_{DUTY}$  (PWM control input to the TB6520P) is dropped to 0 V.

When powering off, make sure  $V_{DUTY}$  (PWM control input to the TB6520P) is dropped to 0 V.

Before shutting off  $V_{DD}$  (TB6520P power supply voltage) wait until  $V_{CC}$  (TA8483CP power supply voltage) is sufficiently low (5 V or less).

The thing that especially requires caution is that shutting off  $V_{DD}$  during high-speed rotation or floating GND causes a short-circuit current to flow in due to counterelectromotive force, which could break down the output transistors.

When  $V_{DD}$  is shut off, the TB6520P output is pulled to GND and the TA8483CP input goes low, causing all of the lower-side output transistors to turn on. Because the motor is turning, a short-circuit current is generated by counterelectromotive force and flows into the transistors as shown below. This current, if large enough to exceed the rated current, may break the transistors. (This trouble tends to occur when the motor is not loaded.)



- About an external oscillator for the TB6520P

The TB6520P has an external oscillator attached as the reference clock source to generate PWM control and commutation signals. Selection of this oscillator requires caution.

Some oscillator may oscillate erratically if the power supply turn-on time is fast (1 ms or less), causing the TB6520P to malfunction. In this case, the drive IC, the TB8483CP, may break down. (This is because the TB6520P output is uncertain and the overcurrent limiting function becomes unable to work.)

- About the TB6520P DUTY input

When the DUTY pin is open, the duty cycle is full (100%).

If the motor with the TA8483CP connected to it is made to run without turning on the power supply voltage, the induced voltage in the motor wraps around into the TB6520P, causing it to malfunction, which in turn may break down the TA8483CP.

Make sure the DUTY pin is pulled low via a resistor (approx. 100 k $\Omega$ ).

- About external diode

For reason of PWM control, when PWM turns off, a regenerative current flows in the lower-side diodes at the output stage.

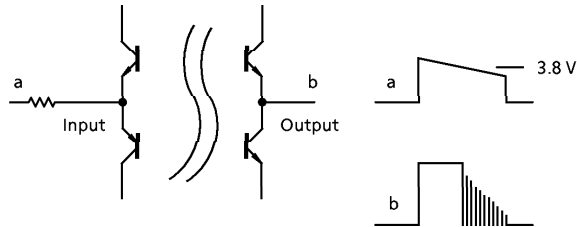
Always be sure to attach an external diode. This external diode must have a sufficient current capacity to satisfy the maximum value of the motor current. Another thing to be noted is that a through current flows depending on the diode's reverse recovery time.

Toshiba recommends attaching a Schottky diode (2GWJ42 or equivalent).

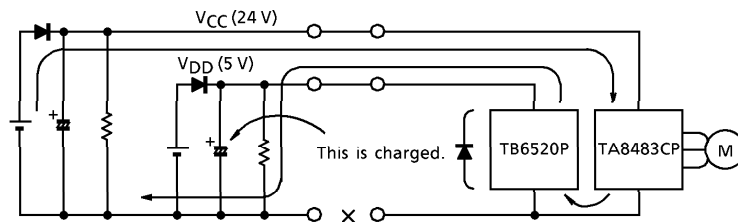


• Other precautions to be observed

(1) When  $V_{DD}$  changes slowly (1 V/s or less) between 2 to 4 V (near 3.8 V), the TA8483CP's output transistors are placed in an oscillating state and could thereby be broken.

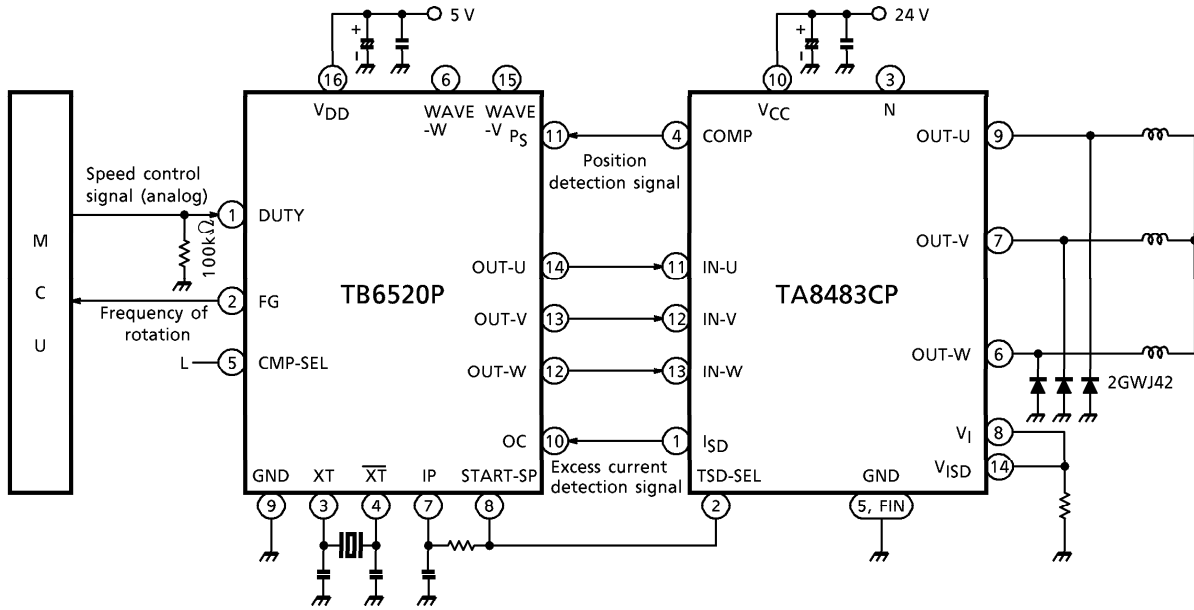


(2) If  $V_{CC}$  and  $V_{DD}$  are connected to the GND line that is floating, the device may break down.



When the GND line goes open, the capacitor on the low-voltage power supply side is charged with a high voltage from the 24 V line through a circuit shown above. When GND is connected next time, the device may be broken by that voltage.

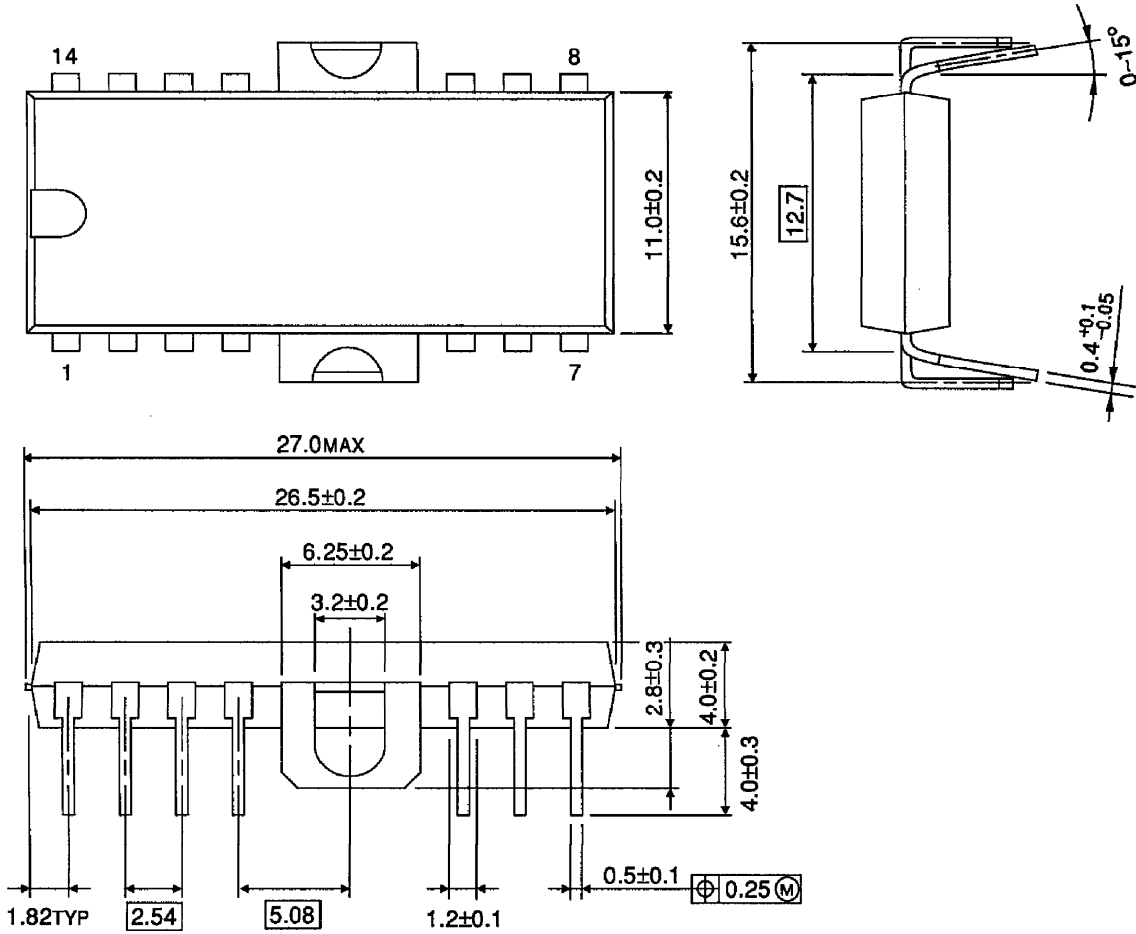
APPLICATION CIRCUIT



(Note) Utmost care is necessary in the design of the output line,  $V_{CC}$  and GND line since IC may be destroyed due to short-circuit between outputs, air contamination fault, or fault by improper grounding.

**PACKAGE DIMENSIONS**  
 HDIP14-P-500-2.54A

Unit : mm



Weight : 3.0 g (Typ.)

**RESTRICTIONS ON PRODUCT USE**

000707EBA

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