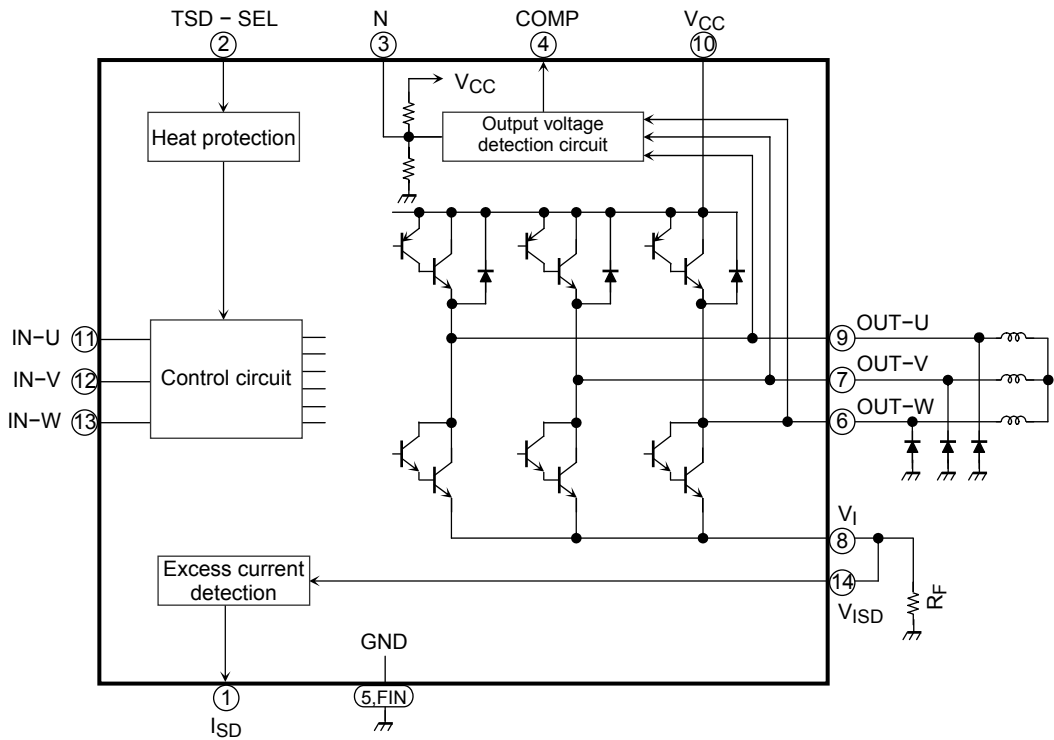
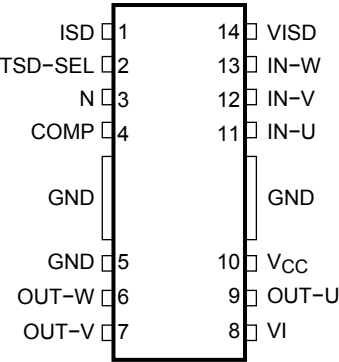


Block Diagram



Pin Connection



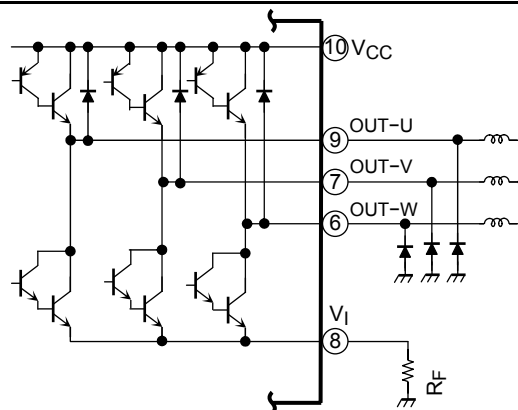
Pin Function

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

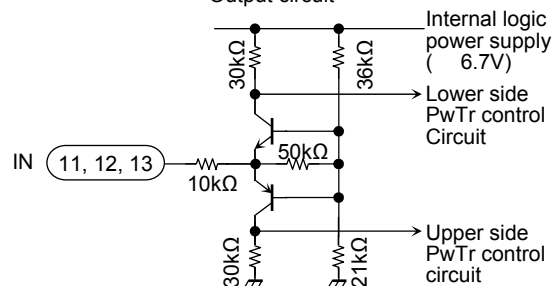
Functional Description

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 >



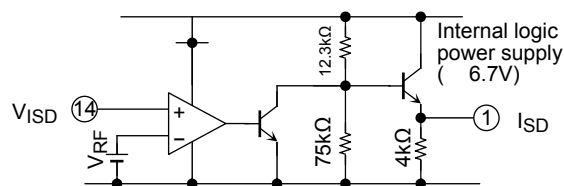
< Input circuit >

3. Overheat protection circuit

- When junction temperature T_j is $T_j \geq T_{SD}$ (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.

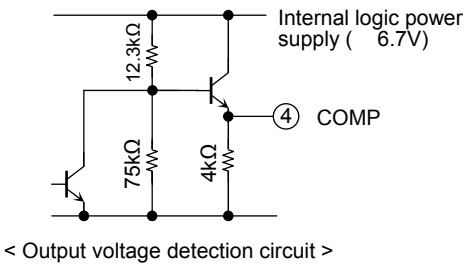
4. Excess current detection circuit (V_{ISD}, I_{SD})

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

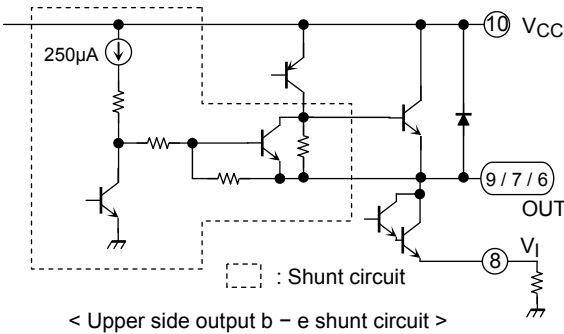


< Excess current detection circuit >

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.)



6. Upper side output B-E shunt circuit
- A base-emitter shunt circuit is incorporated to turn off the upper side power transistor.



Absolute Maximum Ratings (Ta = 25°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	°C
Storage temperature	T_{stg}	-55~150	°C
Input voltage	V_{IN}	6.0	V

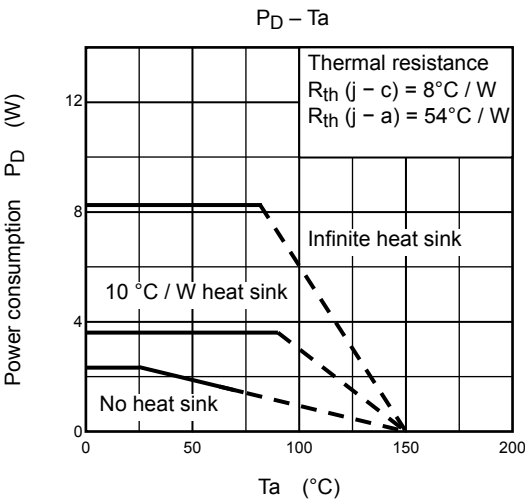
(Note) No heat sink

Recommended Operating Conditions (Ta = -30 to 85°C)

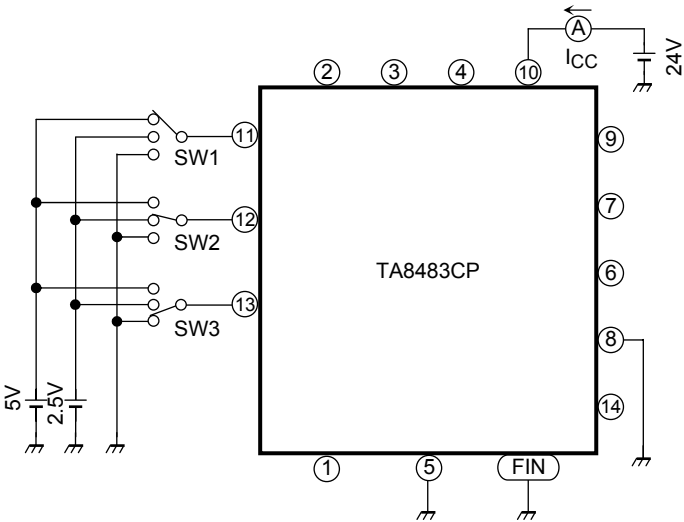
Characteristic	Symbol	Min	Typ.	Max	Unit
Supply voltage	V_S	20	—	30	V
Output current	I_{OUT}	—	—	1.5	A
Chopping frequency	f_{PWM}	—	20	40	kHz

Electrical Characteristics (Ta = 25°C, VCC = 24V)

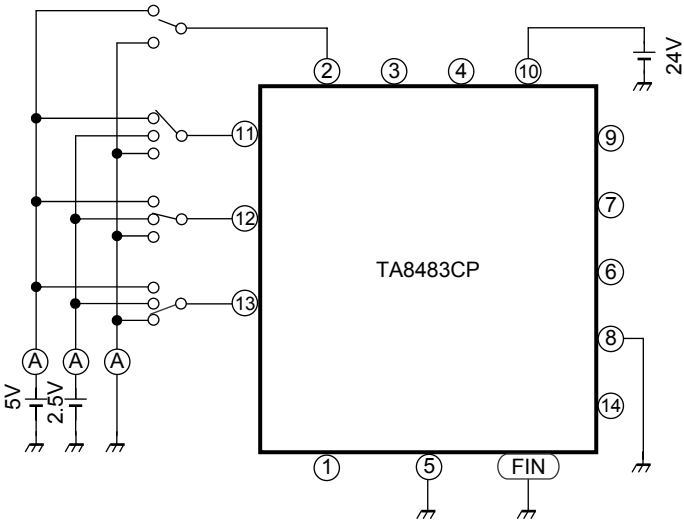
Characteristic	Symbol	Test Cir- cuit	Test Condition	Min.	Typ.	Max.	Unit
Current consumption	I _{CC} (1)	1	Chop on	—	40	51	mA
	I _{CC} (2)		Chop off	—	24	30	
	I _{CC} (3)		Off	—	22	28	
Input current	I _{IN1} (L)	2	V _{IN} = 0V, IN-U, IN-V, IN-W	-350	—	-100	μA
	I _{IN1} (OFF)		V _{IN} = 2.5V, IN-U, IN-V, IN-W	—	0	—	
	I _{IN1} (H)		V _{IN} = 5V, IN-U, IN-V, IN-W	100	—	350	
	I _{IN2} (L)		V _{IN} = 0V, TSD-SEL, T _j = 150°C	—	0	—	
	I _{IN2} (H)		V _{IN} = 5V, TSD-SEL, T _j = 150°C	—	5.5	100	
Input voltage	V _{IN1} (L)	3	V _{CC} = 20V, IN-U, IN-V, IN-W	0	—	0.7	V
	V _{IN1} (OFF)		V _{CC} = 20V, IN-U, IN-V, IN-W	1.9	—	3.0	
	V _{IN1} (H)		V _{CC} = 20V, IN-U, IN-V, IN-W	4	—	5.5	
	V _{IN2} (L)		TSD-SEL, T _j = 150°C	0	—	0.5	
	V _{IN2} (H)		TSD-SEL, T _j = 150°C	1.1	—	5.5	
Mid -point potential	V _N	4		0.95× VS / 2	VS / 2	1.05× VS / 2	V
Pin voltage detection level	V _{CMP}	5		0.95× VS / 2	VS / 2	1.05× VS / 2	V
Pin voltage detection output voltage	V _{OV}	5	I _O = 50μA	4.3	—	5.15	V
Excess current detection level	V _{RF}	6		0.43	0.50	0.52	V
Excess current detection output voltage	V _{OC}	6	I _O = 50μA	4.3	—	5.15	V
Output saturation voltage	V _{SAT} (H)	7	V _{CC} = 20V, I _O = 1A	—	1.3	1.7	V
			V _{CC} = 20V, I _O = 1.5A	—	1.6	2.1	
	V _{SAT} (H)	8	V _{CC} = 20V, I _O = 1A	—	1.3	1.7	
			V _{CC} = 20V, I _O = 1.5A	—	1.5	2.0	
Upper side diode forward voltage	V _F (H)	9	I _O = 1A	—	1.8	2.5	V
Output leakage voltage	I _L (L)	10	V _L = 35V	—	0	50	
Upper side output B-E shunt circuit current	I _S	11	V _{CC} = 35V	—	250	400	
Heat protection operative temperature	TSD (ON)	—	T _j	—	175	—	°C
	TSD (OFF)			—	150	—	
	TSD (HYS)			—	25	—	
Output transmission time	t _{on}	—		—	0.2	—	μs
	t _{off}			—	6.1	—	
Comparator output transmitting duration	t _{pLH}	—		—	0.5	—	μs
	t _{pHL}			—	1.5	—	
Excess current detection duration	t _r	—		—	1	—	μs
	t _f			—	7	—	



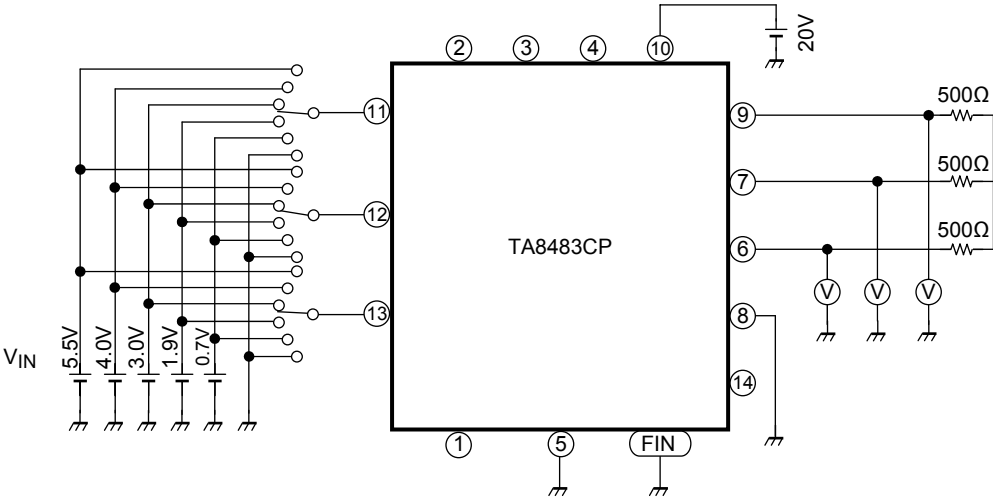
Test Circuit 1: I_{CC}



Test Circuit 2: I_{IN}

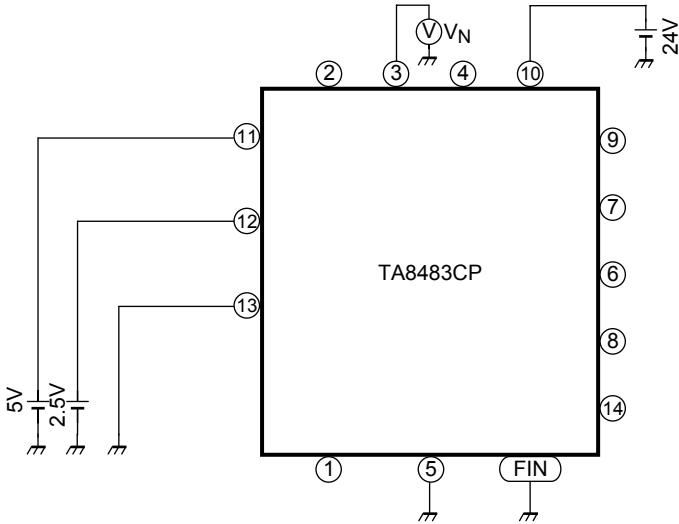


Test Circuit 3: V_{IN}

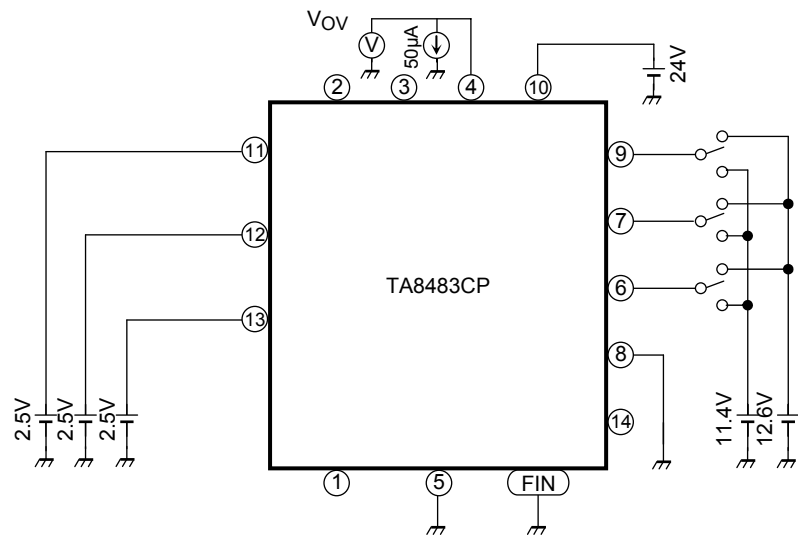


(Note) Confirm output voltage by inputting regular V_{IN} .

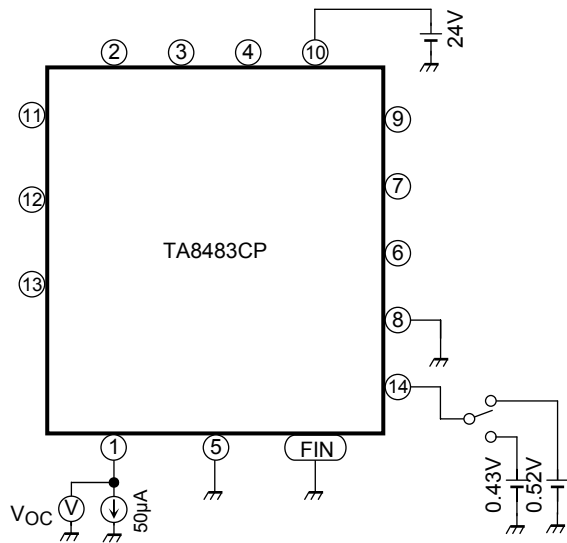
Test Circuit 4: V_N



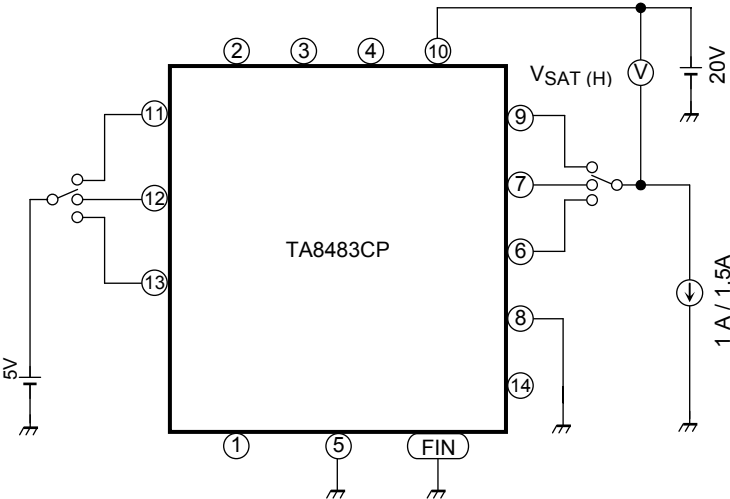
Test Circuit 5: V_{CMP} , V_{OV}



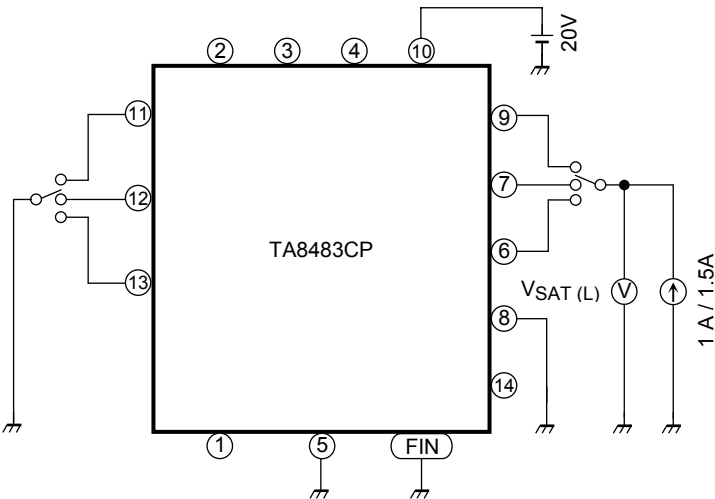
Test Circuit 6: V_{RF} , V_{OC}



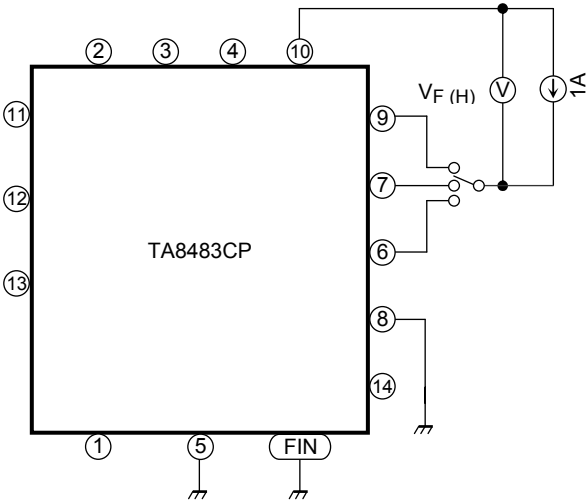
Test Circuit 7: V_{SAT} (H)



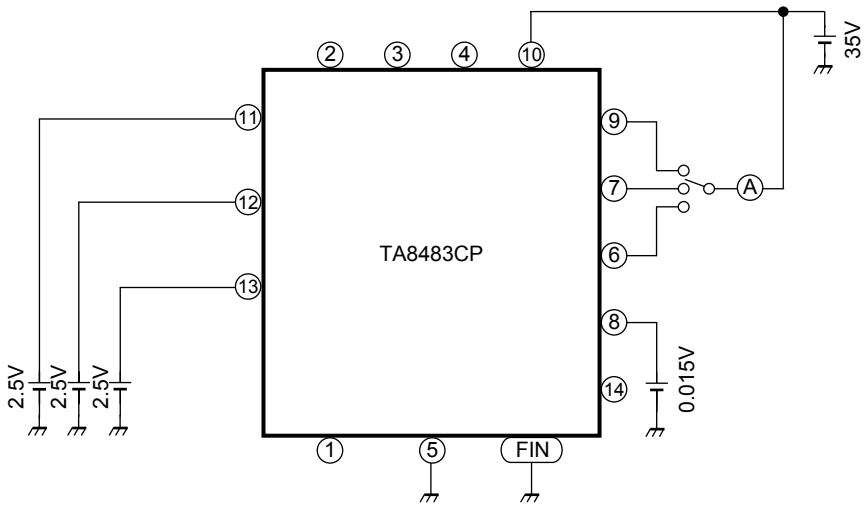
Test Circuit 8: V_{SAT} (L)



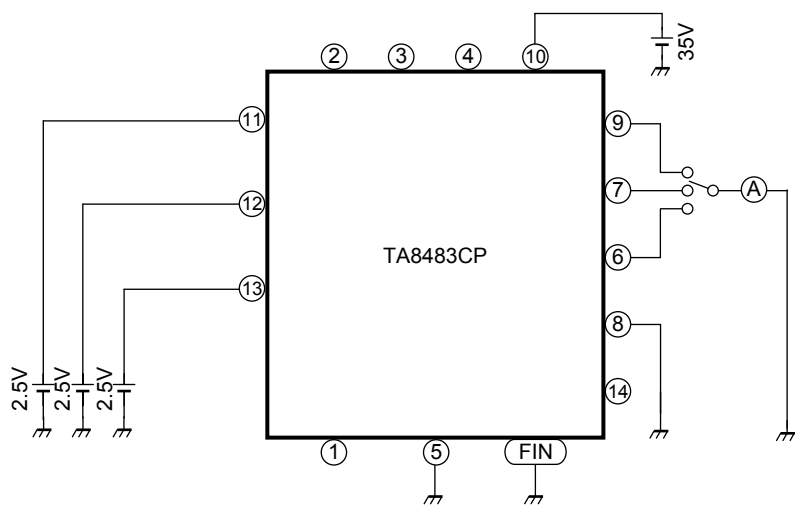
Test Circuit 9: V_F (H)



Test Circuit 10: I_L (L)

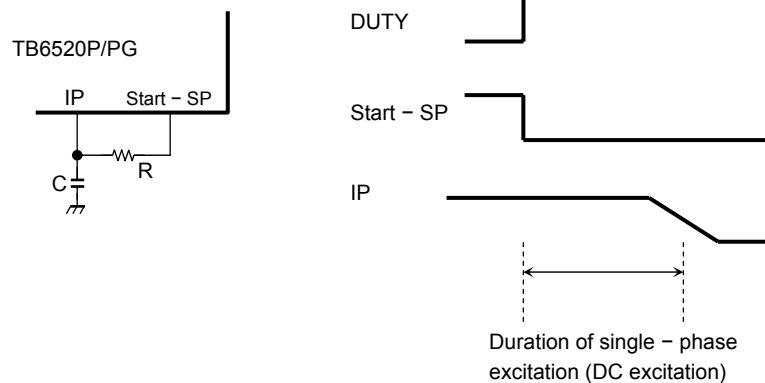


Test Circuit 11: I_S



Function Description Of TB6520P/PG+TA8483CP

- Three-phase sensorless drive**
 The TB6520P/PG 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/PG 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/PG 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 PWN 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/PG 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/PG 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 = 4.7μF, R = 220kΩ

- Changing and stopping revolutions
 - (1) The motor speed or revolutions can be changed by adjusting the V_{DUTY} voltage (TB6520P/PG input voltage).
 - (2) To stop the motor, drop V_{DUTY} to 0V.
- About stepping-out

Monitor the TB6520P/PG'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/PG limits the on-time of the PWM signal (output by the TB6520P/PG) 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/PG 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.

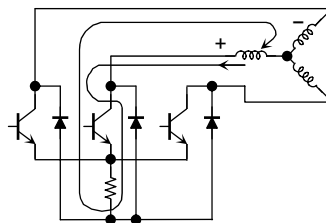
(Lead angle of 0 degrees: For 120-degree switch-on, current starts conducting 30 degrees behind the zero-cross point. Lead angle of 15 degrees: Current starts conducting 15 degrees behind the zero-cross point.)

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/PG+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/PG power supply) becomes steadily on.
When powering on, make sure V_{DUTY} (PWM control input to the TB6520P/PG) is dropped to 0V.
When powering off, make sure V_{DUTY} (PWM control input to the TB6520P/PG) is dropped to 0V.
Before shutting off V_{DD} (TB6520P/PG power supply voltage) wait until V_{CC} (TA8483CP power supply voltage) is sufficiently low (5V 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/PG 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.)

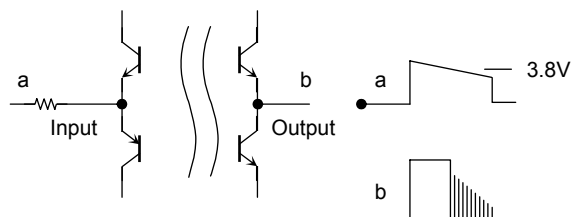
TA8483CP output (lower side)



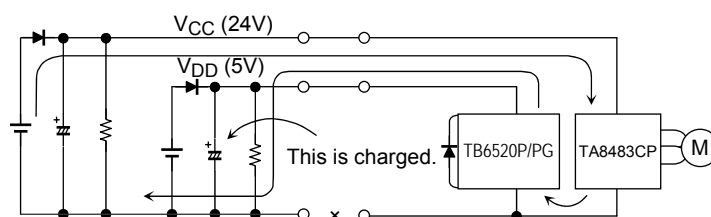
- About an external oscillator for the TB6520P/PG
The TB6520P/PG has an external oscillator attached as the reference clock source to generate PWM control and commutation signals. Selection of this oscillator requires caution.
Some oscillator may oscillate erratically if the power supply turn-on time is fast (1ms or less), causing the TB6520P/PG to malfunction. In this case, the drive IC, the TB8483CP, may break down.
(This is because the TB6520P/PG output is uncertain and the overcurrent limiting function becomes unable to work.)
- About the TB6520P/PG 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/PG, 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 Ω).
- 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 (1V / s or less) between 2 to 4V (near 3.8V), the TA8483CP's output transistors are placed in an oscillating state and could thereby be broken.

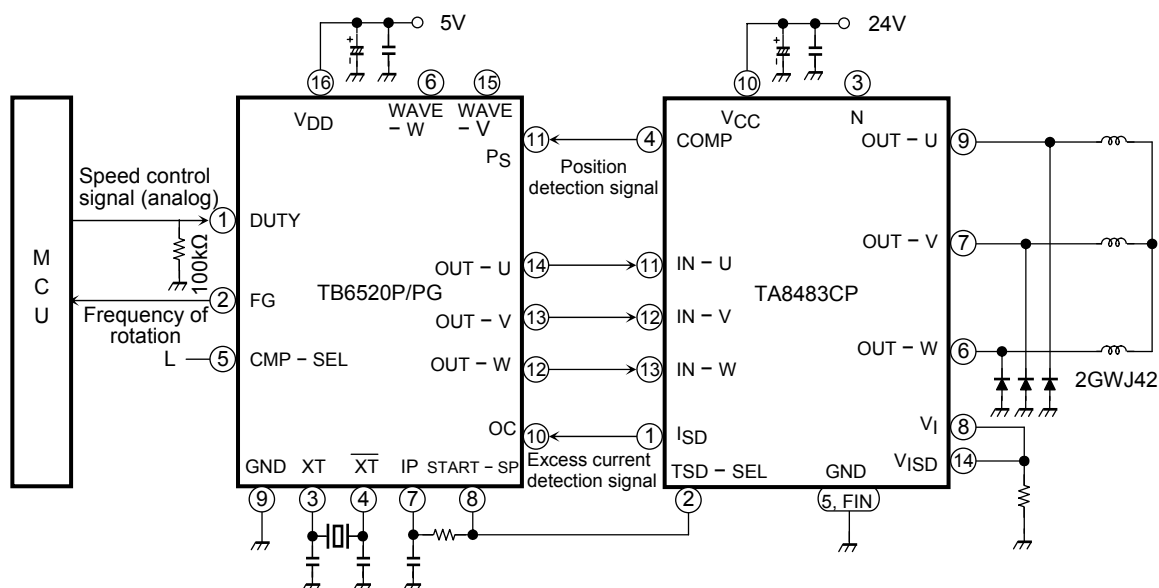


- (2) If V_{CC} and V_{DD} are connected to the GND line that is floating, the device may break down.



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

Application Circuit

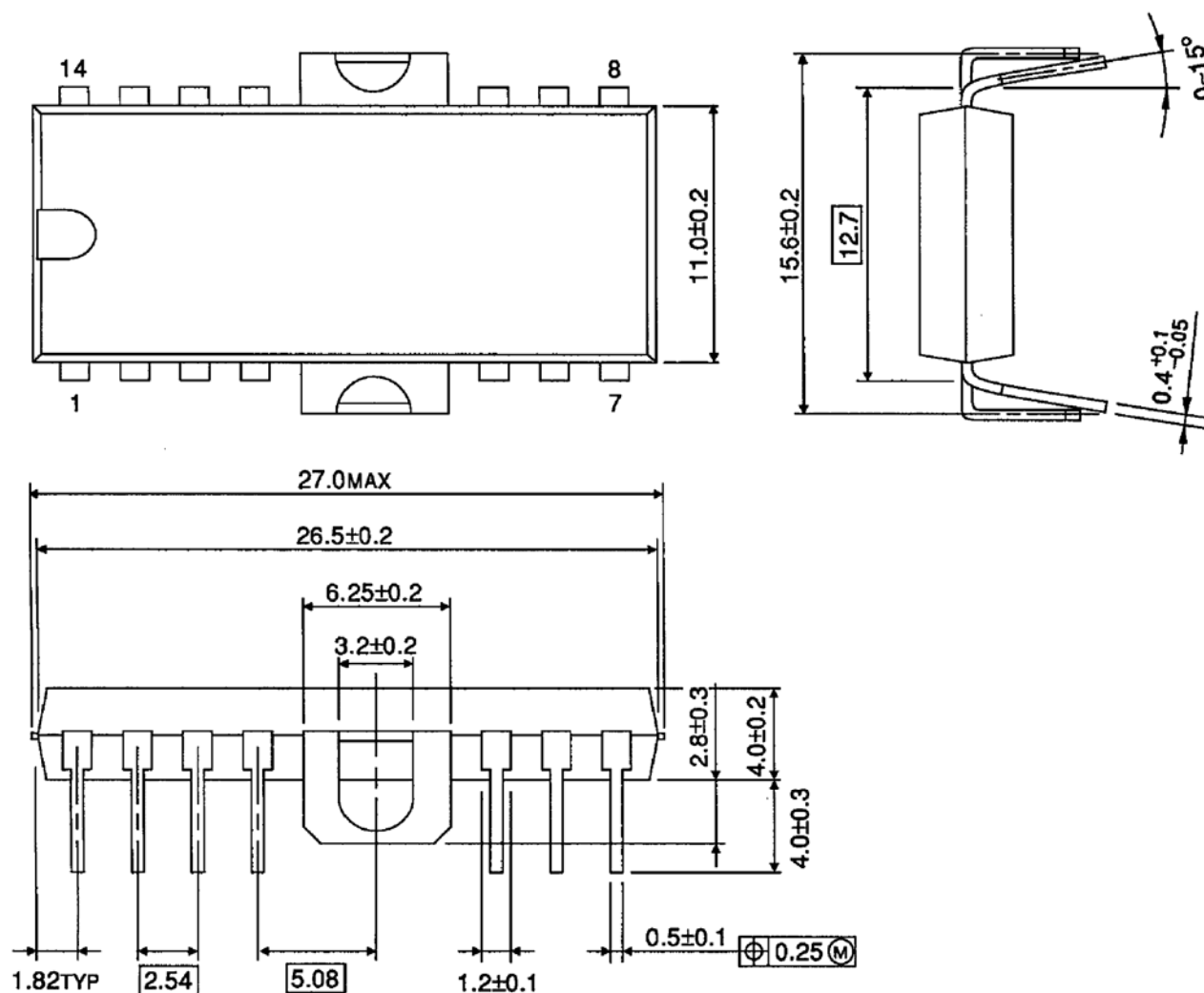


(Note) Utmost care is necessary in the design of the output, V_{CC} , V_M , and GND lines since the IC may be destroyed by short-circuiting between outputs, air contamination faults, or faults due to improper grounding, or by short-circuiting between contiguous pins.

Package Dimensions

HDIP14-P-500-2.54A

Unit : mm



Weight: 3.0g (typ.)

Notes on Contents

1. Block Diagrams

Some of the functional blocks, circuits, or constants in the block diagram may be omitted or simplified for explanatory purposes.

2. Equivalent Circuits

The equivalent circuit diagrams may be simplified or some parts of them may be omitted for explanatory purposes.

3. Timing Charts

Timing charts may be simplified for explanatory purposes.

4. Application Circuits

The application circuits shown in this document are provided for reference purposes only. Thorough evaluation is required, especially at the mass production design stage.

Toshiba does not grant any license to any industrial property rights by providing these examples of application circuits.

5. Test Circuits

Components in the test circuits are used only to obtain and confirm the device characteristics. These components and circuits are not guaranteed to prevent malfunction or failure from occurring in the application equipment.

IC Usage Considerations

Notes on handling of ICs

- [1] The absolute maximum ratings of a semiconductor device are a set of ratings that must not be exceeded, even for a moment. Do not exceed any of these ratings.
Exceeding the rating(s) may cause the device breakdown, damage or deterioration, and may result injury by explosion or combustion.
- [2] Use an appropriate power supply fuse to ensure that a large current does not continuously flow in case of over current and/or IC failure. The IC will fully break down when used under conditions that exceed its absolute maximum ratings, when the wiring is routed improperly or when an abnormal pulse noise occurs from the wiring or load, causing a large current to continuously flow and the breakdown can lead smoke or ignition. To minimize the effects of the flow of a large current in case of breakdown, appropriate settings, such as fuse capacity, fusing time and insertion circuit location, are required.
- [3] If your design includes an inductive load such as a motor coil, incorporate a protection circuit into the design to prevent device malfunction or breakdown caused by the current resulting from the inrush current at power ON or the negative current resulting from the back electromotive force at power OFF. IC breakdown may cause injury, smoke or ignition.
Use a stable power supply with ICs with built-in protection functions. If the power supply is unstable, the protection function may not operate, causing IC breakdown. IC breakdown may cause injury, smoke or ignition.
- [4] Do not insert devices in the wrong orientation or incorrectly.
Make sure that the positive and negative terminals of power supplies are connected properly. Otherwise, the current or power consumption may exceed the absolute maximum rating, and exceeding the rating(s) may cause the device breakdown, damage or deterioration, and may result injury by explosion or combustion.
In addition, do not use any device that is applied the current with inserting in the wrong orientation or incorrectly even just one time.

Points to remember on handling of ICs**(1) Over current Protection Circuit**

Over current protection circuits (referred to as current limiter circuits) do not necessarily protect ICs under all circumstances. If the Over current protection circuits operate against the over current, clear the over current status immediately.

Depending on the method of use and usage conditions, such as exceeding absolute maximum ratings can cause the over current protection circuit to not operate properly or IC breakdown before operation. In addition, depending on the method of use and usage conditions, if over current continues to flow for a long time after operation, the IC may generate heat resulting in breakdown.

(2) Thermal Shutdown Circuit

Thermal shutdown circuits do not necessarily protect ICs under all circumstances. If the thermal shutdown circuits operate against the over temperature, clear the heat generation status immediately.

Depending on the method of use and usage conditions, such as exceeding absolute maximum ratings can cause the thermal shutdown circuit to not operate properly or IC breakdown before operation.

(3) Heat Radiation Design

In using an IC with large current flow such as power amp, regulator or driver, please design the device so that heat is appropriately radiated, not to exceed the specified junction temperature (T_J) at any time and condition. These ICs generate heat even during normal use. An inadequate IC heat radiation design can lead to decrease in IC life, deterioration of IC characteristics or IC breakdown. In addition, please design the device taking into consideration the effect of IC heat radiation with peripheral components.

(4) Back-EMF

When a motor rotates in the reverse direction, stops or slows down abruptly, a current flow back to the motor's power supply due to the effect of back-EMF. If the current sink capability of the power supply is small, the device's motor power supply and output pins might be exposed to conditions beyond maximum ratings. To avoid this problem, take the effect of back-EMF into consideration in system design.

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060116EBA

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