TB6584FNG
Usage Considerations

Summary

The TB6584FNG is a controller IC for three-phase DC brushless motor drive applications. It can generate sinusoidal current waveforms to drive a motor in either of two directions. To change the direction of the motor, first stop the motor rotation before changing the control signals. The rotational direction should not be changed while the motor is rotating. The TB6584FNG is a product intended to be used for fans.

Contents

1. Power supply voltage

Power supply voltage usage range

Characteristic	Symbol	Operation voltage range	Unit
Power supply for control block	V_{CC}	6 to 16.5	V

2. Control inputs (CW/CCW, RES, V_{SP}, ALA, LA, and UL)

1) Input method

When V_{CC} is switched off, the RES, CW/CCW, V_{SP}, ALA, LA, and UL input signals should be open or low until V_{CC} has settled.

2) V_{SP} LA input

If the input voltage exceeds 5.7 V to V_{SP} terminal, and 5.0 V to LA terminal, the voltage is clamped to a 5.7 V level and a 5.0 V level each. Input voltage should be V_{CC} or less. LA terminal should be open in auto lead angle mode.

Normal mode: V_{SP} is 7.3 V or less

Test mode (Square-wave mode): V_{SP} is 8.2 V to 10 V.

3. Oscillation circuit

1) Operation oscillation range

Characteristic	Condition	Operating voltage range	Unit
Carrier frequency	OSC/C = 330 pF, OSC/R = 9.1 kΩ	18 to 22	kHz
	OSC/C = 330 pF, OSC/R = 10 kΩ	16.2 to 19.8	

2) Connection

Place the GND of the capacitor and the resister as close as possible to the IC's GND pin.

3) Calculation formula

Typical oscillation frequency can be calculated by the equations below.

$F_{OSC} = 1/\{(2 \times Vth \times C/I) \times 2.15\}$ ・・・・・・・ $I = Vi \times G/R$

$= 1/\{2 \times Vth \times C/(Vi \times G/R) \times 2.15\}$

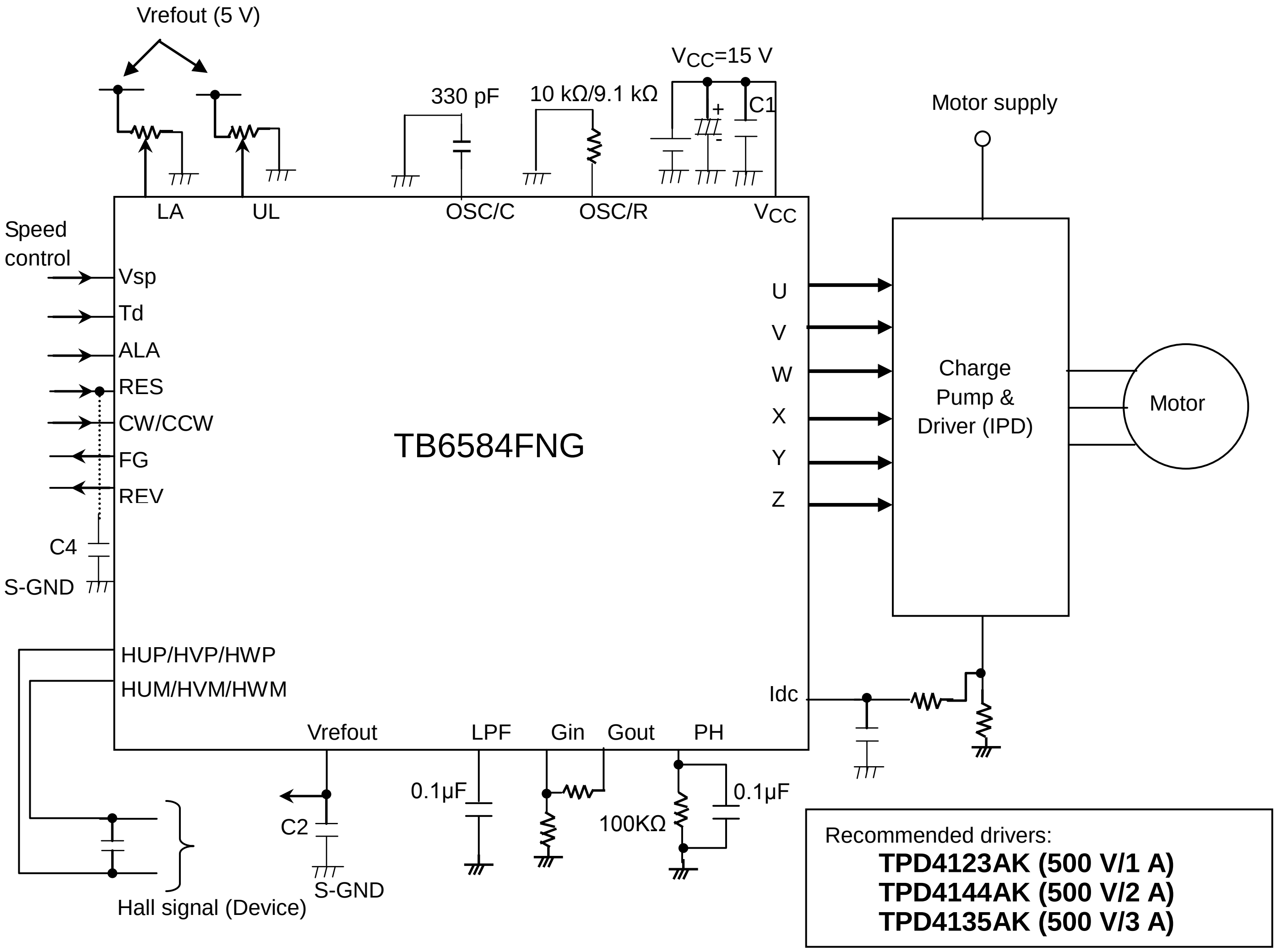
C = Exterior condenser (330 pF)
R = Exterior resistance (9.1 kΩ)
Vth = Triangle-wave slesh voltage (Design value: 0.277 V)
Vi = Current switch reference voltage (Design value: 1 V)
G = Constant current amp rate (Design value: 18)

Carrier frequency is determined by the equation below.
Carrier frequency = $F_{OSC}/252$

OSC/C and OSC/R is recommended to be set by case (1).

4. Application circuit

<In case the gate driver is included.>



1) Capacitors for power supply

Connect capacitors between V_{CC} and GND as close as possible to the IC.

Characteristic	Recommended value	Remarks
V_{CC}−GND: C1	10 μF to 33 μF	Electrolytic capacitor
	0.001 μF to 0.22 μF	Ceramic capacitor

2) Capacitor for Vrefout

Connect capacitors between Vrefout and GND as close as possible to the IC.

Characteristic	Recommended value	Remarks
Vrefout−GND: C2	0.22 μF to 1.0 μF	Ceramic capacitor

Vrefout line is applied as the reference power supply of the internal circuit of IC. So, connect a capacitor to Vrefout regardless of Vrefout usage.

3) Filter for hall signal

The hall input pin is susceptible to noise because it has high impedance. To prevent malfunction, connect a filter to each phase.

The capacitance should be 100 pF to 100000 pF. Connect the filter as close as possible to the IC.

4) Capacitor for RES

The RES terminal is susceptible to noise because it has high impedance. To prevent malfunction, connect a capacitor to the RES terminal when needed.

5) Filter for Idc

The Idc terminal includes a filter (200 kΩ+ 5 pF). However, connect a C, R filter from the outside to the Idc terminal in order to prevent this terminal from being affected by power-part noise which is occurred by connection of over-current detection resistance. Connect the ceramic capacitor as close as possible to the IC terminal. GND-line of the capacitor should be connected to S-GND.

6) GND pattern

Connect the IC's GND terminal to the signal GND line (S-GND). Design the GND pattern to avoid the influence of the power-system GND of the motor.

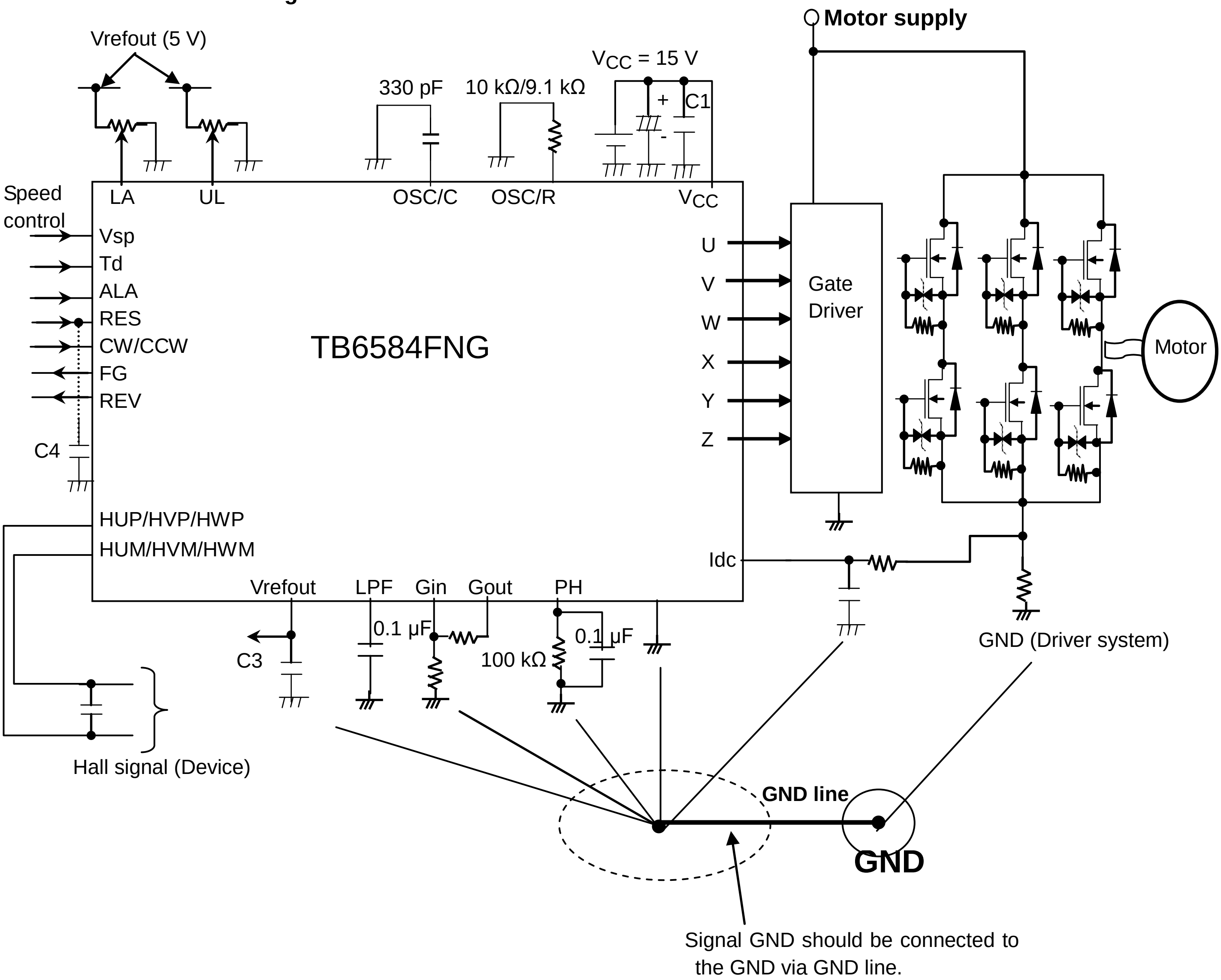
7) Notes on operation

Power supply voltage may be boosted when the motor operation changes from driving mode to halting or low-speed mode because the current regenerates in the power supply by influenced by the back EMF of the motor.

Be careful in changing the speed from high to low. Please do the experiment and confirm to control the speed to protect the power device.

8) Other applications

<In case consisting of discrete device>

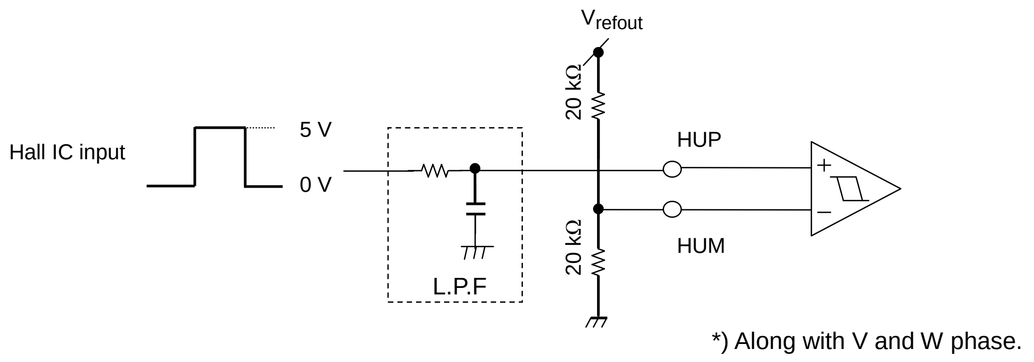


Note) The operation of TB6584FNG is controlled by synchronous rectification in sine-wave driving mode. OFF time of upper phase (U, V, and W) and lower phase (X, Y, and Z) is controlled about 2 μsec. So, please make sure to control the switch speed of the gate driver and the discrete device. When the response speed is low, there is a possibility that the device is destroyed by rush current which is generated by turning on the upper and lower phase at the same time.

5. Position detection signal

Position detection by three-phase hall device or IC can be available with this position detection signal.

When 5 V of square wave is input from hall IC, fix the minus terminal to half of Vrefout.



6. Minimum pulse width of driver output

TB6584FNG controls the sine-wave by voltage modulation (PWM signal) as a controller of sine-wave drive. It outputs as small pulse as possible (PWM signal) not to generate abnormal pole at sine-wave current. A small pulse of hundreds of nsec can be outputted by the TB6584FNG. In the case that latch-up current is generated by the small pulse, pay attention to the operation.

7. Pattern layout

Please design the pattern layout according to the package dimension written in the technical data sheet.

8. Setup auto lead angle part

Each setup value should be determined by the actual equipment because lead angle changes depending on the applied motor.

Step 1) Drive the motor with necessary rotation number.
Apply the external voltage (0 to 5 V) to the LA terminal.
Confirm the current waveform or efficiency to find the best LA voltage.

Step 2) Amplify the shunt resistance voltage converter to set the LA voltage corresponding to the voltage shown in 'Step 1' by applying external resistances of Gin and Gout (19 pin and 18 pin each).

Step 3) Drive the motor and confirm that LA voltage equals to the voltage determined in "Step 1".

Remarks) PH terminal (17 pin): 100 kΩ/ 0.1 μF (Recommended value)
LPF terminal (15 pin): 0.1 μF (Recommended value)
Gain set amplifier (19, 18 pin): Setup by resistance of 10 kΩ/100 kΩ (× 8 to × 20)

As for a fan motor of air conditioner, range of lead angle (LA) is generally set 1V to 2.2 V. In this case, UL terminal (14 pin) should be fixed of about 2.2 V.

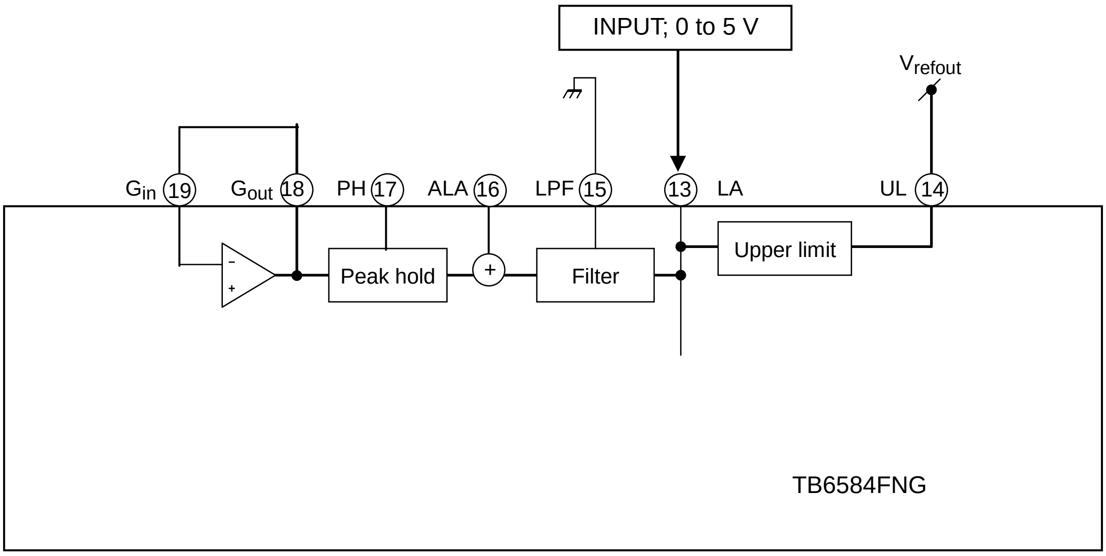
*) Characteristics of gain set amplifier (evaluation result) are shown in page 9.

8-(1) ALA terminal

Information for auto lead angle can be switched as follows; the information of motor current (Idc) only and the information of Idc and the rotation number (Vsp). Please confirm it by actual equipment.
ALA＝Low: Idc＋Vsp
ALA＝High: Idc

8-(2) In case auto lead angle function is not applied.

Please layout the devices shown below.

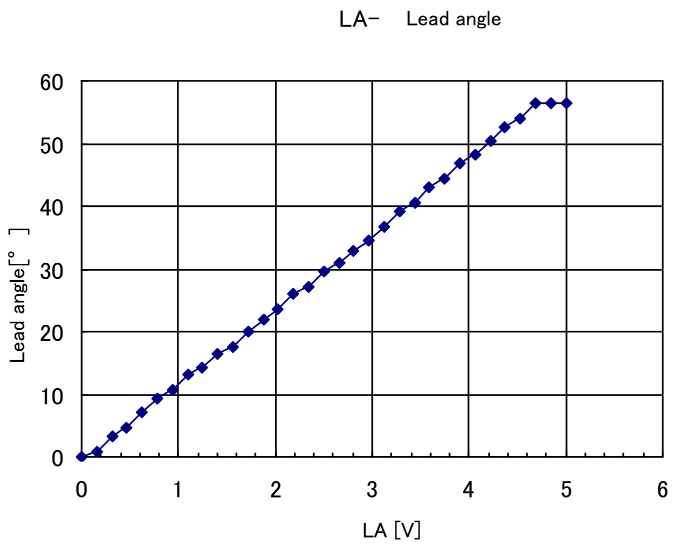


Evaluation result of lead angle corresponding to LA input

For your reference

Measure the angle by inputting voltage which corresponds to the hall signal (≈ 64 Hz ≈ 15.4 ms) logically.

STEP	LA[V]	Lead Angle [°]	Result [ms]
0	0.00	0.00	0
1	0.16	0.94	0.04
2	0.31	3.18	0.136
3	0.47	4.68	0.2
4	0.63	7.11	0.304
5	0.78	9.44	0.404
6	0.94	10.75	0.46
7	1.09	13.18	0.564
8	1.25	14.21	0.608
9	1.41	16.55	0.708
10	1.56	17.58	0.752
11	1.72	19.92	0.852
12	1.88	21.79	0.932
13	2.03	23.47	1.004
14	2.19	25.90	1.108
15	2.34	27.12	1.16
16	2.50	29.55	1.264
17	2.66	30.86	1.32
18	2.81	33.01	1.412
19	2.97	34.41	1.472
20	3.13	36.75	1.572
21	3.28	39.27	1.68
22	3.44	40.58	1.736
23	3.59	43.01	1.84
24	3.75	44.32	1.896
25	3.91	46.75	2
26	4.06	48.25	2.064
27	4.22	50.49	2.16
28	4.38	52.74	2.256
29	4.53	54.05	2.312
30	4.69	56.48	2.416
31	4.84	56.48	2.416
32	5.00	56.48	2.416

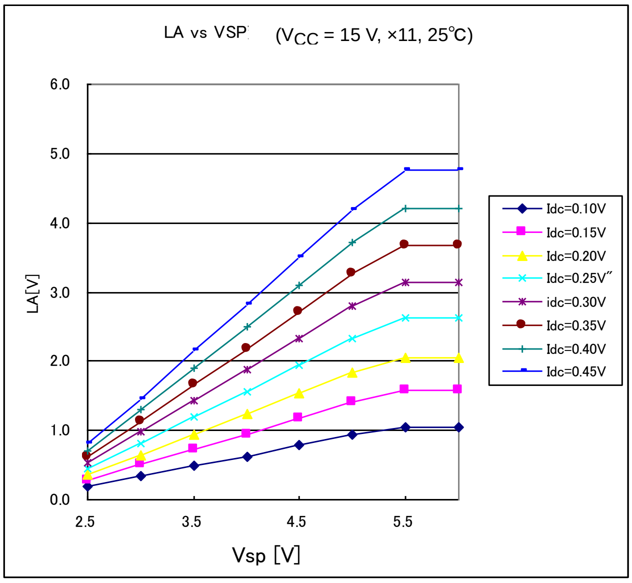


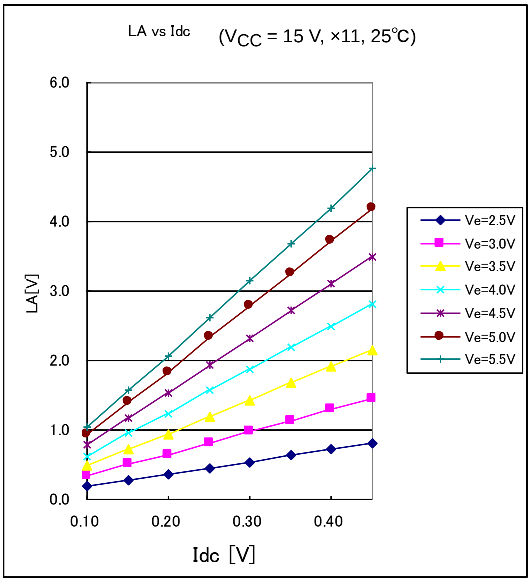
Result of LA voltage corresponding to Vsp and Idc input.

For your reference

Gain amplifier is set 11 times (10 kΩ/100 kΩ).
Measure the LA by changing V_{SP} and Idc.

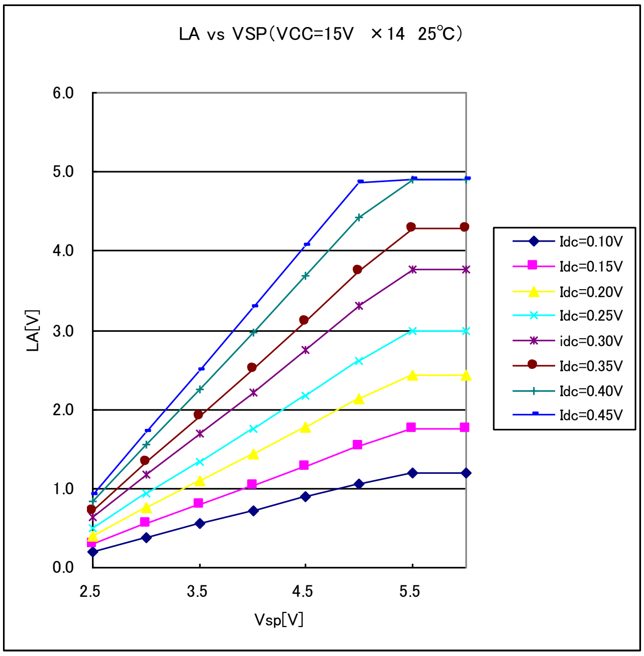
G: ×11		VSP (V)							
		2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
Idc(V) (Input: Duty 50%)	0.10	0.186	0.339	0.486	0.627	0.782	0.942	1.052	1.053
	0.15	0.276	0.502	0.728	0.948	1.176	1.412	1.585	1.585
	0.20	0.356	0.647	0.941	1.231	1.528	1.834	2.060	2.060
	0.25	0.452	0.818	1.198	1.567	1.945	2.334	2.626	2.626
	0.30	0.541	0.975	1.433	1.873	2.328	2.792	3.144	3.144
	0.35	0.629	1.135	1.672	2.186	2.716	3.258	3.676	3.676
	0.40	0.715	1.293	1.905	2.494	3.101	3.720	4.201	4.201
	0.45	0.805	1.455	2.147	2.808	3.492	4.190	4.761	4.761

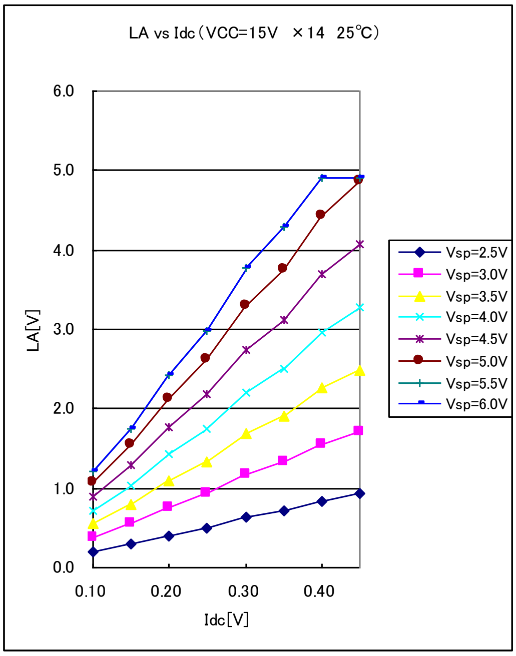




Gain amplifier is set 14 times (10 kΩ/130 kΩ).
Measure the LA by changing V_{SP} and Idc.

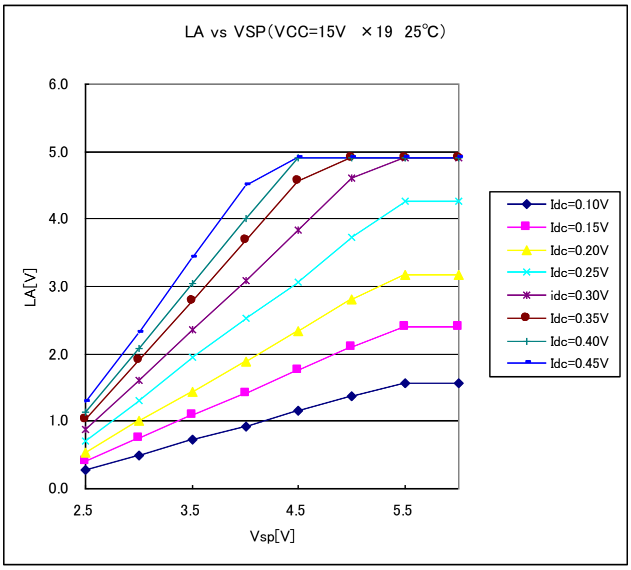
G: ×14		VSP(V)							
		2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
Idc(v) (Input: Duty50%)	0.10	0.207	0.383	0.555	0.721	0.889	1.066	1.203	1.203
	0.15	0.299	0.553	0.803	1.040	1.284	1.544	1.754	1.754
	0.20	0.407	0.760	1.095	1.427	1.776	2.128	2.426	2.426
	0.25	0.498	0.933	1.336	1.754	2.178	2.615	2.981	2.981
	0.30	0.629	1.178	1.685	2.209	2.748	3.302	3.777	3.777
	0.35	0.713	1.329	1.914	2.511	3.116	3.746	4.291	4.291
	0.40	0.840	1.553	2.258	2.962	3.691	4.427	4.913	4.913
	0.45	0.926	1.711	2.482	3.283	4.067	4.870	4.913	4.913

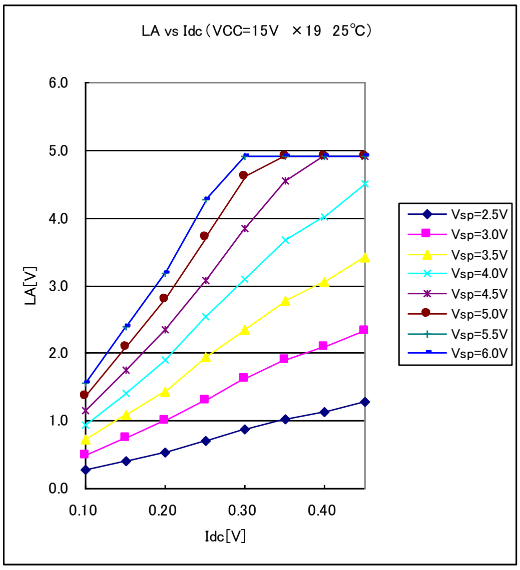




Gain amplifier is set 19 times (10 kΩ/180 kΩ).
Measure the LA by changing V_{SP} and Idc.

G: ×19		VSP(V)							
		2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
Idc(v) (Input: Duty50%)	0.10	0.268	0.497	0.718	0.932	1.148	1.375	1.563	1.563
	0.15	0.403	0.758	1.084	1.409	1.749	2.099	2.392	2.392
	0.20	0.537	1.002	1.440	1.891	2.341	2.802	3.180	3.180
	0.25	0.705	1.306	1.940	2.534	3.071	3.723	4.261	4.261
	0.30	0.872	1.615	2.353	3.096	3.844	4.615	4.911	4.911
	0.35	1.032	1.899	2.784	3.678	4.556	4.911	4.911	4.911
	0.40	1.136	2.088	3.053	4.011	4.910	4.912	4.912	4.912
	0.45	1.282	2.320	3.423	4.504	4.912	4.912	4.912	4.912





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. Absolute Maximum ratings

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 device breakdown, damage, deterioration or ignition, and may result injury by explosion or combustion.
Applications using the device should be designed so that no maximum rating will ever be exceeded under any operating conditions.
It must be ensured that the device is used within the specified operating range.

5. 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.

6. 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) 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 (TJ) 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 considerate the effect of IC heat radiation with peripheral components.

(3) 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 absolute maximum ratings. To avoid this problem, take the effect of back-EMF into consideration in system design.

RESTRICTIONS ON PRODUCT USE