TOSHIBA Bi-CMOS Integrated Circuit Silicon Monolithic

TB67B054FTG

Sine-wave PWM Drive Three-phase Full Wave Brushless Motor Controller

The TB67B054FTG is developed for three-phase brushless DC motors of motor fans.

Features

- Sine-wave PWM control
- Triangular-wave generator (carrier frequency = $f_{osc}/252$ Hz)
- Lead angle control (0° to 58° in 32 separate steps) External setting or automatic internal control
- Current-limiting input pin
- Internal voltage regulator circuit (V_{refout} = 5 V (typ.), 30 mA (max))
- Operating supply voltage range: $V_{CC} = 6 V$ to 16.5 V



Weight: 0.07 g (typ.)

Block diagram



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

Pin assignment

<Top View>



Pin description

Pin No.	Symbol	Function	Description
5	OSC/C	Oscillator capacitor	
6	OSC/R	Oscillator resistor	
7	HUP	Hall signal input	
8	HUM		
9	HVP	Hall signal input V	Gate block protection is activated when hall signals of U, V, and W phases are all "H" or "L".
10	HVM		These inputs have internal digital filters (≈ 500 ns)
11	HWP	Hall signal input. W	
12	HWM		
13	GND	Ground	—
14	RES	Reset input	L: Motor operates, H: Motor stops (commutation output signals are forced low.) Built in pulldown resistor
15	CW/CCW	Clockwise/counterclo ckwise rotation	L: Clockwise rotation, H: Counterclockwise rotation Built-in pullup resistor
16	NC	NC pin	No connection
17	V _{sp}	Voltage command input	Built-in pulldown resistor
18	LA	Lead angle control input	LA input allows the lead angle to be adjusted between 0° and 58° in 32 separate steps.
19	UL	Upper limit for LA	UL input determines the upper limit for the lead angle (UL = 0 V to 5.0 V).
20	LPF	RC low-pass filter capacitor	A capacitor for the RC low-pass filter is connected to this pin. (Built-in a 100 k Ω resistor)
21	ALA	Auto lead angle mode select input	Built-in pulldown resistor L or open: Feeds back ldc and Vsp to generate the modulated waves per electrical angle of 60°. H: Feeds back ldc to generate the modulated waves per electrical angle of 360°.
22	PH	Peak hold	A peak-hold capacitor and a discharge resistor are connected to this pin.
23	Gout	Gain setting	The Gin and Gout ning are used to amplify the Ide level so that the lead angle will be optimal
24	Gin	Call Setting	
25	ldc	Current limit control input	The DC-link current is applied to the ldc input. The reference voltage is 0.5 V. The ldc input has an internal RC filter (with a time constant of 1 μ s) and a digital filter (with a time constant of 1 μ s).
26	V _{CC}	Power supply	V _{CC} = 6 V to 16.5 V
27	NC	NC pin	Non connection
28	V _{refout}	Reference voltage output	5 V (typ.), 30 mA (max) A capacitor for oscillation prevention is connected to the V _{refout} output.
29	U	Commutation signal output U, (U high-side)	
30	V	Commutation signal output V, (V high-side)	
31	W	Commutation signal output W, (W high-side)	High-active
32	х	Commutation signal output X, (U low-side)	
1	Y	Commutation signal output Y, (V low-side)	
2	Z	Commutation signal output Z, (W low-side)	
3	FG	FG signal output	The FG output gives two pulses per electrical revolution.
4	REV	Reverse rotation detection signal	The REV output is used to detect an occurrence of reverse rotation.

Input/output equivalent circuits

Equivalent circuit diagrams may be partially omitted or simplified for explanatory purposes.

Pin	Symbol	Input/output signal	Internal circuit
Hall signal input, U Hall signal input, V Hall signal input, W	HUP HUM HVP HVM HWP HWM	Analog Hysteresis: ± 7.5 mV (typ.)	Vrefout Vrefout
Clockwise/counterclockwise rotation L: forward (CW) H: reverse (CCW)	cw/ccw	Digital L: 0.8 V (max) H: V _{refout} − 1 V (min)	Vrefout Vrefout
Reset input L: Motor operation H: Motor stop (Reset)	RES	Digital L: 0.8 V (max) H: V _{refout} − 1 V (min)	
Auto lead angle mode select L or open: ldc and Vsp / 60° H: ldc / 360°	ALA	Digital L: 0.8 V (max) H: V _{refout} - 1 V (min)	Vrefout 100 Ω S S 00 0 0 0 0 0 0 0 0 0 0 0 0
Voltage command signal 1.0 V < Vsp ≤ 2.1 V Refresh operation (The X, Y and Z pins have a conduction duty cycle of 8 %.)	V _{sp}	Analog Vsp voltage range: 0 V to 10 V When 5.7 V \leq Vsp \leq 7.3 V, the PWM duty cycle is fixed at 92% (typ.). When 8.2 V \leq Vsp \leq 10 V, the TB67B054FTG is put in test mode.	

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Pin	Symbol	Input/output signal	Internal circuit
Lead angle control input 0 V: 0° 5 V: 58° (5-bit ADC)	LA	To fix the lead angle externally, UL and V_{refout} should be connected together. The lead angle is linearly determined according to the voltage applied to the LA input. LA voltage range: 0 to 5.0 V (V_{refout}) If LA > V_{refout} , the commutation occurs with the maximum lead angle of 58°. When configured for auto lead angle control, the LA input should be left open. At this time, the LA input can be used to check the lead angle in real time.	V _{CC}
Gain setting (Lead angle control circuitry)	Gin Gout	Non-inverting amplifier 25 dB max Gout: Output voltage L: GND H: V _{CC} – 1.7 V	Gin O Gin O H Idc To peak hold circuitry
Peak hold (Lead angle control circuitry)	РН	A peak-hold capacitor and a discharge resistor are connected to the PH pin. Recommended R/C values: 100 k Ω /0.1 μ F	$\begin{array}{c} V_{CC} \\ 100 \Omega \\ 100 \Omega \\ 100 \Omega \end{array}$
Low-pass filter (Lead angle control circuitry)	LPF	A capacitor for the RC low-pass filter is connected to this pin. Built-in a 100 k Ω (typ.) resistor Recommended C value: 0.1 μ F	
Upper limit for LA	UL	If the voltage applied to the LA input exceeds the upper limit set by this input, it is clipped to limit the lead angle. UL = 0 to 5.0 V	

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Pin	Symbol	Input/output signal	Internal circuit
Current limit control input	ldc	Analog filter time constant: 1 μs (typ.) Digital filter time constant: 1 μs (typ.) Gate block protection is activated when the ldc voltage exceeds 0.5 V. (It is disabled after every carrier cycle.) If ldc is left unconnected, all the commutation outputs are disabled.	Vrefout 100Ω $200 k\Omega$ Gout 0 Gout
Reference voltage output	Vrefout	5 ± 0.5 V (30 mA max)	Vcc VccVcc
Reverse rotation detection signal	REV	Digital Push-pull output (±1 mA max)	Vrefout Vrefout Vrefout 100 Ω 77
FG signal output	FG	Digital Push-pull output (±1 mA max) The FG output gives two pulses per electrical revolution.	Vrefout Vrefout 100 Ω
Commutation signal output, U Commutation signal output, V Commutation signal output, W Commutation signal output, X Commutation signal output, Y Commutation signal output, Z	U V W X Y Z	Digital Push-pull outputs (±2 mA max) L: 0.78 V (max) H: V _{refout} – 0.78 V (min)	V _{refout}

Absolute maximum ratings (Ta = 25°C)

Characteristics	Symbol	Rating	Unit	
Supply voltage	V _{CC}	18	V	
Input voltage	V _{IN (1)}	-0.3 to V _{CC} (Note 1)	V	
input voltage	V _{IN (2)}	-0.3 to V _{refout} + 0.3 (Note 2)	v	
Commutation output current	IOUT	2	mA	
V _{refout} output current	I _{refout}	30 (Note 3)	mA	
Power dissipation	PD	4.1 (Note 4)	W	
Operating temperature	T _{opr}	-30 to 115 (Note 5)	°C	

Note: 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 absolute maximum ratings. Exceeding the absolute maximum rating (s) may cause the device breakdown, damage or deterioration, and may result injury by explosion or combustion. Please use the IC within the specified operating ranges.

Note 1: VIN (1) pin: Vsp, LA, and UL

Note 2: VIN (2) pins: HUP, HVP, HWP, HUM, HVM, HWM CW/CCW, RES, Idc, ALA, and Gin

Note 3: Since the V_{refout} pin delivers a maximum output current of 30 mA, care should be exercised to the output impedance.

Note 4: When mounted on a board (4 layers, FR4, 76.2 mm×114.3 mm×1.6 mm), Rth (j-a) = 29.9° C/W

Note 5: The operating temperature range is determined by the 'PD – Ta characteristics'.

Operating ranges (Ta = 25°C)

Characteristics	Symbol	Min	Тур.	Max	Unit
Supply voltage	V _{CC}	6	15	16.5	V
Oscillation frequency	f _{osc}	3	4.5	6	MHz

Power dissipation (for reference only)

When mounted on a board (4 layers, FR4, 76.2 mm \times 114.3 mm \times 1.6 mm), Rth (j-a) = 29.9°C/W



Electrical characteristics (Ta = 25° C, V_{CC} = 15 V)

Characteristics		Syn	nbol	Test Condition	Min	Тур.	Max	Unit
Supply current		١c	C	V _{refout} = OPEN	—	5	8	mA
		I _{IN (}	(1)-1	V _{IN} = 5 V LA	_	25	50	
		I _{IN (1)-2}		V _{IN} = 5 V V _{sp}	_	35	70	1.
Input current		I _{IN} ((2)-1	V _{IN} = 5 V ALA, RES	_	50	100	μΑ
		I _{IN} ((2)-2	V _{IN} = 0 V CW/CCW	-100	-50	_	
		VIN	н	CW/CCW, RES, ALA	V _{refout} −1	_	V _{refout}	
			L		_	—	0.8	
Input voltage			т	Forced 120° commutation, conduction duty cycle = 92% -3.8μ s (typ.)	8.2	_	10	v
		Vsn	Н	PWM duty 92%	5.1	5.4	5.7	1
		op	М	Refresh \rightarrow Motor startup	1.8	2.1	2.4	
			L	Commutation off \rightarrow Refresh	0.7	1.0	1.3	1
	Input sensitivity	V	's	Differential inputs	100	_	_	mVpp
Hall sensor inputs	Common-mode input voltage	V	W	_	1.5	_	3.5	V
	Input hysteresis	V _H	(1)	(Note)	±5.5	±7.5	±9.5	mV
land delay the	-	Τլ	от	Hall inputs (f _{osc} = 4.5 MHz)	_	1.0	—	
Input delay time	e	Τ _[DC	ldc (f _{osc} = 4.5 MHz)	_	2.5	_	μs
		Vout	- (H)-1	I _{OUT} = 2 mA U, V, W, X, Y, Z	V _{refout} - 0.78	V _{refout} - 0.3	_	
		VOUT	Г (L)-1	I _{OUT} = -2 mA U, V, W, X, Y, Z	_	0.3	0.78	
		V _{RE}	V (H)	I _{OUT} = 1 mA REV	V _{refout} - 1.0	V _{refout} - 0.2	_	
Output voltage		V _{RE}	V (L)	I _{OUT} = -1 mA REV	_	0.2	1.0	V
		V _{FC}	G (H)	I _{OUT} = 1 mA FG	V _{refout} - 1.0	V _{refout} - 0.2	_	
		V _{FG (L)}		I _{OUT} = -1 mA FG	_	0.2	1.0	
		V _{re}	fout	I _{OUT} = 30 mA V _{refout}	4.5	5.0	5.5	
Output lookogo	ourroat	١L	(H)	V _{OUT} = 0 V U, V, W, X, Y, Z	_	0	10	
Oulput leakage	current	١L	(L)	V _{OUT} = V _{refout} U, V, W, X, Y, Z	_	0	10	μΑ
Dead time (cross conducti	ion protection)	Τ _C)FF	$(f_{OSC} = 4.5 \text{ MHz}), I_{OUT} = \pm 2 \text{ mA}$	1.7	2.0	2.3	μs
Current sensing	g	V _{DC}		ldc	0.46	0.5	0.54	V
LA gain setting amp		AMPOUT		Gin, Gout 100 kΩ/10 kΩ Idc = 0.2 V, I _{OUT} = 1 mA	2.0	2.2	2.4	v
		AMF	OFS	Gin, Gout 100 kΩ/10 kΩ, ldc = 0.2 V	_	5	—	mV
LA limit setting error		Δ	U	UL = 2.0 V	-20	_	20	mV
LA peak hold output voltage		PHO	DUT	Gin, Gout 100 kΩ/10 kΩ Idc = 0.2 V, I _{OUT} = 5 mA	2.0	2.2	2.4	v
Lead angle correction		TLA	A (0)	LA = 0 V or Open, Hall inputs = 100 Hz	_	0	_	<u> </u>
		T _{LA}	(2.5)	LA = 2.5 V, Hall inputs = 100 Hz	26	30	33	•
		TLA	A (5)	LA = 5 V, Hall inputs = 100 Hz	52	57	60	1
		Vcc	; (H)	Output turn-on threshold	4.2	4.5	4.8	<u> </u>
V _{CC} monitor		Vcc	; (L)	Output turn-off threshold	3.7	4.0	4.3	V
		V	н	Input hysteresis width	—	0.5	—	1

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Characteristics	Symbol	Test Condition	Min	Тур.	Max	Unit
PWM oscillation frequency	F _C (20)	OSC/C = 330 pF, OSC/R = 9.1 k Ω	18	20	22	
(carrier frequency)	F _C (18)	OSC/C = 330 pF, OSC/R = 10 k Ω	16.2	18	19.8	κΠΖ
Maximum conduction duty cycle	T _{ON} (max)	OSC/C = 330 pF, OSC/R = 10 kΩ Vsp = 5.7 V	89	92	95	%

Note: No shipping inspection.

Functional description

1. Basic operation

During startup, the motor is driven by square-wave commutation signals that are generated according to the hall signals. When the hall signals indicate a rotational speed (f) of 5.7 Hz or more, the TB67B054FTG estimates the rotor positions from the hall signals and modulate them. The TB67B054FTG then generates sine-wave by comparing the modulated signals against a triangular waveform.

 $0 \text{ (startup)} \le f < 5.7 \text{ Hz}$: Square-wave drive (120° commutation); $f = f_{\text{OSC}} / (2^{12} \times 32 \times 6)$

5.7 Hz \leq f : Sine-wave PWM drive (180° commutation); f will be approximately 5.7 Hz when f_{osc} = 4.5 MHz

2. Voltage command (Vsp) signal and bootstrap voltage regulation

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(1) When Vsp \le 1.0 V:
The commutation signal outputs are disabled (i.e., gate protection is activated).
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- (2) When $1.0 \text{ V} < \text{Vsp} \le 2.1 \text{ V}$: The low-side transistors are turned on at a regular (PWM carrier) frequency. (The conduction duty cycle is approx. 8 %.)
- (3) When 2.1 V < Vsp ≤ 7.3 V : During sine-wave PWM drive, the commutation signals directly appear externally. During square-wave drive, the low-side transistors are forced on at a regular (PWM carrier) frequency. (The conduction duty cycle is approx. 8 %.)
- (4) When 8.2 V \leq Vsp \leq 10 V (test mode) :

The TB67B054FTG is forced into square-wave drive mode. The drive mode switches from sine-wave PWM to square-wave drive at a Vsp of 7.9 V (typ.). The conduction duty cycle during square-wave drive is calculated as PWM carrier period \times 92% - 3.8 µs (typ.)



3. Dead time insertion (cross conduction protection)

To prevent a short-circuit between external low-side and high-side power devices during sine-wave PWM drive, a dead time is digitally inserted between the turn-on of one side and the turn-off of the other side. (The dead time is also implemented at the full duty cycle during square-wave drive.)





4. Lead angle control

The lead angle can be adjusted between 0° and 58° in 32 separate steps according to the induced voltage level on the LA input, which works with 0 to 5 V.

 $0 V = 0^{\circ}$

 $5 \text{ V} = 58^{\circ}$ (A lead angle of 58° is assumed when the LA voltage exceeds 5 V.)

5. PWM carrier frequency

The triangular waveform generator provides a carrier frequency of fosc/252 necessary for PWM generation. (The triangular wave is also used to force the switch-on of low-side transistors during square-wave drive.) Carrier frequency = fosc/252 (Hz), where fosc = reference clock (CR oscillator) frequency

6. Reverse rotation signal

The rotational direction of the motor is detected every 360 electrical degrees. When REV pin is L level, the operation moves to the 180° commutation mode (with Hall signal inputs ≥ 5.7 Hz)

CW/CCW pin	CW/CCW pin Actual motor rotation direction	
	CW (forward)	L
L (CVV)	CCW (reverse)	Н
	CW (forward)	Н
H(CCVV)	CCW (reverse)	L

7. Rotation frequency pulse output

Rotational pulses (2 pulses per electrical revolution) are outputted from FG pin. When the frequency of the hall signal input is 5.7 Hz (when fosc is 4.5 MHz) or more, 2 pulses are outputted per one cycle of the hall signal. Moreover, when the frequency of the hall signal input is less than 5.7 Hz, L level is outputted.



8. Protection-related input pins

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- Overcurrent protection (Idc pin)
 If the voltage of the DC-link current exceeds the internal reference voltage, the commutation signals are forced L. Overcurrent protection is disabled after every carrier cycle.
 Reference voltage = 0.5 V (typ.)
- (2) Gate block protection (RES pin)

When the RES input is H, the commutation outputs are disabled. When the RES input is then set L or open, the commutation outputs are re-enabled.

Any irregular conditions of the motor should be detected by external hardware; such indications should be presented to the RES input.

RES pin	Commutation output signals (U, V, W, X, Y, Z)
н	L
L or open	Motor can be driven

(When RES = H, charging of the bootstrap capacitor stops. Also when the operation re-enable, charging of the bootstrap capacitor stops.)

- (3) Internal protection
 - Abnormal hall signal protection

When the hall signal inputs (UVW) are all H or all L, the commutation outputs are forced off (i.e., set L). When these inputs are then set to any other combination, the commutation outputs are re-enabled. (The all-H and all-L conditions are internal hall amplifier outputs.)

• Under voltage lockout (V_{CC} monitor)

While the power supply voltage is outside the rated range during power-on or power-off, the commutation outputs are set to the high-impedance state to prevent external power devices from damage due to short-circuits.

Operation flow

Note: The conduction time is reduced by the dead period. (carrier cycle×92% – Td×2)

Timing of modulated signals

Reset timing	for modulation can	be selected by	setting ALA pin.	
Moreover, the	e auto lead angle mo	ode can be also	selected by ALA	pin configuration

ALA	Modulated signal generation	Auto lead angle mode	
Ц	Modulated for each 360 electrical	Feedback Idc	
п	degrees		
	Modulated for each 60 electrical	Foodback Ide and Ven	
L	degrees	Feedback luc and vsp	

Modulated when ALA= H

The hall signals from Hall sensors are modulated, and the modulated signals are then compared against a triangular waveform to generate a sinusoidal PWM waveform.

The counter measures the period from a given falling edge of the HU input to its next falling edge (360 electrical degrees). This period is then used as 360° phase data for the next modulation.

A total of 192 ticks comprise 360 electrical degrees; the length of a tick equals 1/192nds the time period of the immediately preceding 360° phase.

In the above diagram, the modulated waveforms have an interval (T1') that is equal to the interval between a falling edge of HU to its next falling edge (T1) of the previous cycle. If there is not an HU falling edge before T1' ends, T2' becomes equal to T1' until the next falling edge of HU.

Modulation is reset on each falling edge of HU, which occurs every 360 electrical degrees. While the motor is accelerating or decelerating, the modulated waveform becomes discontinuous upon each reset.

Note: In the above diagram, hall signals are shown as square waveforms for the sake of simplicity.

<u>Modulated when ALA = L</u>

The hall signals from Hall sensors are modulated, and the modulated signals are then compared against a triangular waveform to generate a sinusoidal PWM waveform.

The counter measures the period from a given rising edge (falling edge) of three Hall signals to its next falling edge (rising edge) where electrical angle is 60°. This period is then used as 60° phase data for the next modulation. A total of 32 ticks comprise 60 electrical degrees; the length of a tick equals 1/32nds the time period of the immediately preceding 60° phase.

In the above diagram, the modulated waveforms have an interval (1)' that is equal to the interval between a rising edge of HU to a falling edge of HW (1) of the previous cycle. In the same way, the modulated waveforms have an interval (2)' that is equal to the interval between a falling edge of HW to a rising edge of HV (2) of the previous cycle. If there is not a next edge before 32 ticks end, next 32 ticks become equal to the next period until the next edge.

Phase matching between the hall signal and the modulated waveform is carried out for every zero cross of the hall signal.

Modulation is reset on each rising edge and falling edge of the hall signal, which occurs every 60 electrical degrees. While Hall signal is shifted or the motor is accelerating or decelerating, the modulated waveform becomes discontinuous upon each reset.

Note: Square waveforms are used in the above diagram for the sake of simplicity.

Forward rotation timing chart (CW/CCW = L, LA = GND)

*: When the Hall input frequency is 5.7 Hz or more (@ f_{osc} = 4.5 MHz), lead angle control is activated according the LA input.

Forward rotation timing chart (CW/CCW = L, LA = GND)

*: When CW/CCW = L, inverted Hall signals put the TB67B054FTG in 120° commutation mode with a lead angle of 0° (reverse rotation).

Reverse rotation timing chart (CW/CCW = H, LA = GND)

*: When the Hall input frequency is 5.7 Hz or more (@ fosc = 4.5 MHz), lead angle control is activated according the LA input.

Reverse rotation timing chart (CW/CCW = H, LA = GND)

*: When CW/CCW = H, non-inverted Hall signals put the TB67B054FTG in 120° commutation mode with a lead angle of 0° (reverse rotation).

Square-wave drive waveform (CW/CCW = L)

Note: Square waveforms are used in the above diagram for the sake of simplicity.

To obtain an adequate bootstrap voltage, the low-side outputs (X, Y and Z) are always turned on for eight percent of the carrier period (T_{ONL}) even during the off time of the low side in 120° commutation mode. As shown in the enlarged view, the high-side outputs (U, V and W) are turned off for a dead time period while the low-side outputs are on. (Td varies with the Vsp input.)

Carrier frequency = $f_{osc}/252$ (Hz) Dead time: $T_d = 9/f_{osc}$ (s) (Vsp ≥ 5.0 V)

 T_{ONL} = carrier period × 8% (s) (constant regardless of the Vsp input)

In square-wave drive mode, the changing of the motor speed is enabled, depending on the Vsp voltage; the motor speed is determined by the duty cycle of T_{ONU} . (See the Square-wave drive mode diagram on page 14.)

Note: At startup, the motor is driven by a square wave when the Hall signal frequency is less than 5.7 Hz (@ fosc = 4.5 MHz) and when the motor is rotating in the direction reverse to the settings of the TB67B054FTG (REV = H).

Sine-wave drive waveform (CW/CCW = L)

In sine-wave drive mode, the amplitude of the modulated signals varies with the Vsp voltage and the motor speed changes with the conduction duty cycle of the output waveforms. (See the Sine-wave drive mode diagram on page 14.)

Triangular wave frequency = carrier frequency = $f_{osc}/252$ (Hz)

Note: At startup, the motor is driven by a sine wave when the Hall signal frequency is 5.7 Hz or more (@ fosc = 4.5 MHz) and when the motor is rotating in the same direction as settings of the TB67B054FTG (REV = L).

Application circuit example

Note1: Connect to ground as necessary to prevent IC malfunction due to noise.

Note2: Connect GND to signal ground on the application circuit.

Note3: Utmost care is required in the design of the output, V_{CC}, and GND lines since the IC may shatter or occur fire, or over voltage or over current may be applied to peripheral components due to short-circuits between outputs, short to V_{CC} or short to ground.

The IC may also shatter or occur fire when it is installed in a wrong orientation.

Package dimensions

P-VQFN32-0505-0.50-005

Unit: mm

Weight: 0.07 g (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.

Providing these application circuit examples does not grant a license for industrial property rights.

IC Usage Considerations

Notes on handling of ICs

- 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

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.

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