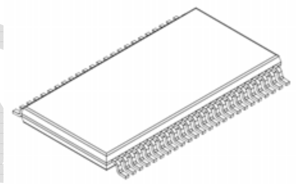
TENTATIVE

TOSHIBA BiCD Integrated Circuit Silicon Monolithic

TB62215FNG

PWM method clock Inn bipolar stepping motor driver

The TB62215FNG is a two-phase bipolar stepping motor driver using a PWM chopper.
Fabricated with the BiCD process, the TB62215FNG is rated at 40 V/3.0 A (provisional).
The on-chip voltage regulator allows control of a stepping motor with a single V_M power supply.
The TB62215FNG is RoHS-compatible.



HTSSOP48

質量 (g)

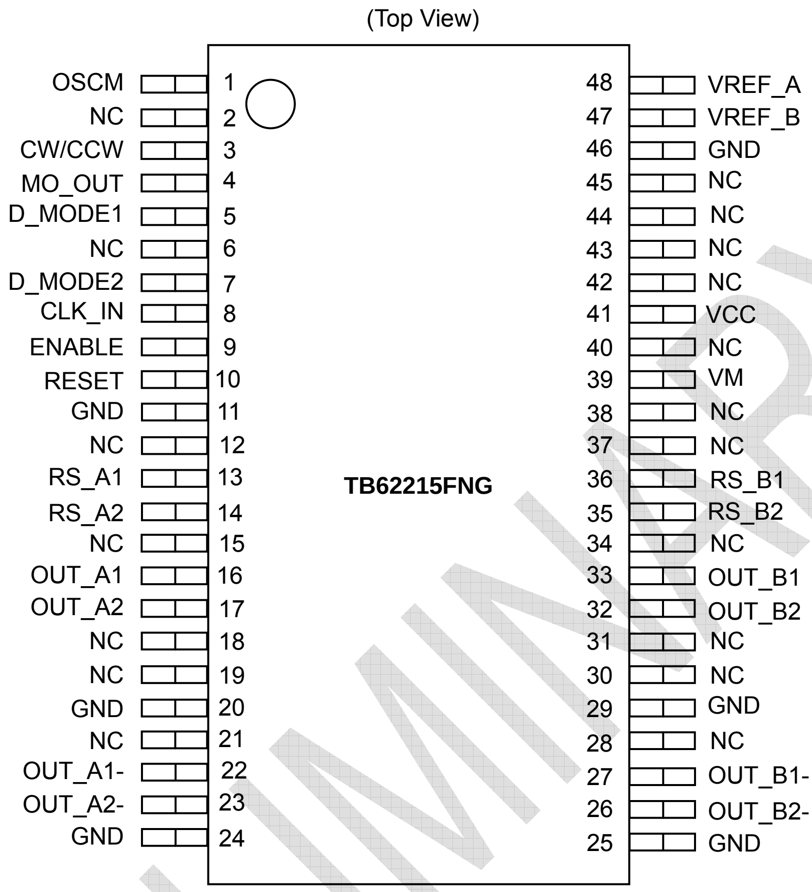
Features

- Bipolar stepping motor driver
- PWM constant-current drive
- Clock input control
- Allows two-phase, 1-2-phase and W1-2-phase excitations.
- BiCD process: Uses DMOS FETs as output power transistors.
- High voltage and current: 40 V/3.0 A (absolute maximum ratings)
- Thermal shutdown (TSD), overcurrent shutdown (ISD), and power-on-resets (PORs)
- Packages

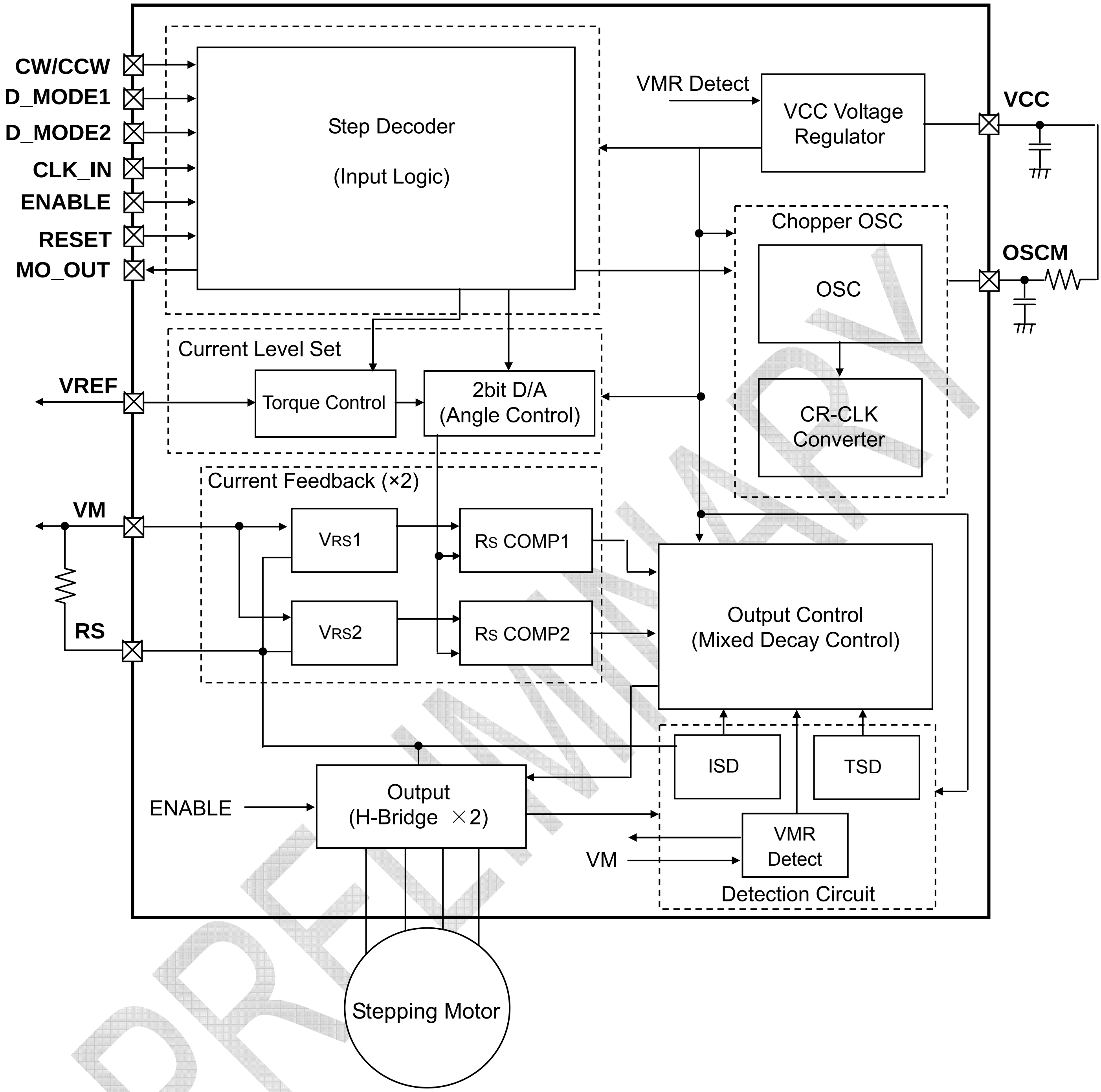
  TB62215FNG: (HTSSOP48-P-300-0.50)

Note: Please note a thermal condition enough when you use it.

Pin layout chart



Block chart



To explain the function, a part of functional block/circuit/constant in the block chart etc. are omitted and simplified.

Application Notes

Careful attention should be paid to the layout of the output, V_{DD} (V_M) and GND traces, to avoid short-circuits across output pins or to the power supply or ground. If such a short-circuit occurs, the TB62215FNG may be permanently damaged.

Also, utmost care should be taken for pattern designing and implementation of the TB62215FNG since it has the power supply pins (V_M, R_S, OUT, GND) particularly a large current can run through. If these pins are wired incorrectly, an operation error or even worse a destruction of the TB62215FNG may occur.

The logic input pins must be correctly wired, too; otherwise, the TB62215FNG may be damaged due to a current larger than the specified current running through the IC.

TENTATIVE

Terminal function explanation
TB62215FNG (HTSSOP48)

Function explanation of terminal number 1～28

Terminal number	Terminal name	Function
1	OSCM	Setting of frequency of oscillation circuit terminal for chopper
2	NC	No connection
3	CW/CCW	Normal rotation/reversal of motor operation
4	MO_OUT	Electric corner monitor terminal
5	D_MODE1	Excitation setting terminal 1
6	D_MODE2	Excitation setting terminal 2
7	NC	No connection
8	CLK_IN	Clock input terminal that decides rotational speed of motor. An electric corner advances by standing up.
9	ENABLE	Output ON (5V)/turning off (GND) switch terminal of A and B channel.
10	RESET	An electric corner is initialized.
11	GND	GND of logic circuit
12	NC	No connection
13	RS_A1(Note 1)	Sense resistance connection terminal for current value setting of A channel output (Power supply terminal)
14	RS_A2(Note 1)	Sense resistance connection terminal for current value setting of A channel output (Power supply terminal)
15	NC	No connection
16	OUT_A1(Note 1)	A channel output plus terminal
17	OUT_A2(Note 1)	A channel output plus terminal
18	NC	No connection
19	NC	No connection
20	GND	Power GND for motor drive
21	NC	No connection
22	OUT_A1-(Note 1)	A channel output minus terminal
23	OUT_A2-(Note 1)	A channel output minus terminal
24	GND	Power GND for motor drive
25	GND	Power GND for motor drive
26	OUT_B2-(Note 1)	B channel output minus terminal
27	OUT_B1-(Note 1)	B channel output minus terminal
28	NC	No connection

Function explanation of terminal number 29～48

Terminal number	Terminal name	Function
29	GND	Power GND for motor drive
30	NC	No connection
31	NC	No connection
32	OUT_B2(Note 1)	B channel output plus terminal
33	OUT_B1(Note 1)	B channel output plus terminal
34	NC	No connection
35	RS_B2(Note 1)	Sense resistance connection terminal for current value setting of B channel output (Power supply terminal)
36	RS_B1(Note 1)	Sense resistance connection terminal for current value setting of B channel output (Power supply terminal)
37	NC	No connection
38	NC	No connection
39	VM	Motor power supply monitor terminal
40	NC	No connection
41	VCC	Monitor terminal for internal generation 5V
42	NC	No connection
43	NC	No connection
44	NC	No connection
45	NC	No connection
46	GND	GND of logic circuit
47	VREF_B	Bias terminal for current value setting of B channel output
48	VREF_A	Bias terminal for current value setting of A channel output

・Please use the pin of NC with Open.

Note 1: Be short-circuited of two or more existing pins of TB62215FNG in the terminal neighborhood.

・CLK Function

The electrical angle leads one by one in the manner of the clocks. The clock signal is reflected to the electrical angle on the rising edge.

CLK Input	Function
Rise	The electrical angle leads by one on the rising edge.
Fall	Remains at the same position.

ENABLE Function

The ENABLE pin controls whether or not to let the current flow through a given phase for a stepper motor drive. This pin serves to select if the motor is stopped in Off mode or activated. The pin must be fixed to Low on the power-on or power-down of the TB62215FNG.

ENABLE Input	Function
H	Output transistors are enabled (normal operation mode).
L	Output transistors are disabled (high impedance state).

CW/CCW Function

The CW/CCW pin switches rotation direction of stepper motors.

CW/CCW Input	Function
H	Forward (CW)
L	Reverse (CCW)

Excitation Mode Select Function

D_MODE_1	D_MODE_2	Function
L	L	OSC_M, output transistors are disabled (in Standby mode)
L	H	Two-phase excitation
H	L	1-2-phase excitation
H	H	W1-2-phase excitation

RESET Function

RESET Input	Function
L	Normal operation mode
H	The electrical angle is reset.

Each phase current when RESET is put is as follows.

In this case, the terminal MO_OUT becomes Low.

Excitation mode	A aspect current	B aspect current	Electric corner
2 phase excitation	100%	100%	45°
1-2phase excitation	100%	100%	45°
W1-2 phase excitation	71%	71%	45°

Protection Features

Thermal shutdown (TSD)

The thermal shutdown circuit turns off all the outputs when the junction temperature (T_j) exceeds 150°C (typ.). The outputs retain the current states.
The TB62215FNG exits TSD mode and resume normal operation when the TB62215FNG is rebooted or both the D_MODE_1 and D_MODE_2 pins are switched to Low.

Power-ON-resets (PORs) for V_{MR} and V_{CCR} (V_M and V_{CC} voltage monitor)

The outputs are forced off until V_M and V_{CC} reach the rated voltages.

Overcurrent shutdown (ISD)

Each phase has an overcurrent shutdown circuit, which turns off the corresponding outputs when the output current exceeds the shutdown trip threshold (above the maximum current rating: 3.1 A minimum).
The TB62215FNG exits ISD mode and resumes normal operation when the TB62215FNG is rebooted or both the D_MODE_1 and D_MODE_2 pins are switched to Low.
This circuit provides protection against a short-circuit by temporarily disabling the device. Important notes on this feature will be provided later.

絶対最大定格 (Ta = 25°C)

Characteristics	Symbol	Rating	Unit	Remarks
Motor power supply	V_M	40	V	—
Motor output voltage	V_{OUT}	40	V	—
Motor output current	I_{OUT_S}	3.0	A per phase	(Note 1)
Logic power supply	V_{CC}	6	V	When externally applied.
Digital input voltage	V_{IN}	6	V	—
MO output voltage	V_{MO}	6	V	—
Power dissipation	P_D		W	(Note 2)
Operating temperature	T_{opr}	-20～85	℃	—
Storage temperature	T_{str}	-55～150	℃	—
Junction temperature	$T_{j(Max)}$	150	℃	—

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 ratings.
Exceeding the rating (s) may cause the device breakdown, damage or deterioration, and may result injury by explosion or combustion.
The value of even one parameter of the absolute maximum ratings should not be exceeded under any circumstances. The TB62215FNG does not have overvoltage protection. Therefore, the device is damaged if a voltage exceeding its rated maximum is applied.
All voltage ratings including supply voltages must always be followed. The other notes and considerations described later should also be referred to.

Note 1: As a guide, the maximum output current should be kept below 2.4 A per phase. The maximum output current may be further limited by thermal considerations, depending on ambient temperature and board conditions.

Note 2: Stand-alone (Ta = 25°C)
Ta: Ambient temperature
T_{opr}: Ambient temperature while the TB62215FNG is active
T_j: Junction temperature while the TB62215FNG is active. The maximum junction temperature is limited by the thermal shutdown (TSD) circuitry. It is advisable to keep the maximum current below a certain level so that the maximum junction temperature, $T_{j\,(MAX)}$, will not exceed 120°C.

Operation guarantee condition (Note 1)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Motor power supply	V_M	-	10	24	38	V
Motor output current	I_{OUT}	Ta=25°C,1corresponding worth	-	1.8	2.4	A
Digital input voltage	$V_{IN(H)}$	H level of logic	2.0	3.3	5.5	V
	$V_{IN(L)}$	L level of logic	GND	-	0.8	V
Clock input frequency	f_{CLK}	-	1.0	-	150	kHz
Chopper frequency	f_{chop}	-	40	100	150	kHz
V_{ref} reference voltage	V_{ref}	-	GND	3.0	4.0	V

(Note 1) : Please have and use the margin for the absolute maximum rating.
(Note 2) : There is no problem in the condition of 500ns or less at the risetime of the CLK signal even if the frequency less than it is input though the lower bound of the frequency of the input of the signal of the CLK input is assumed to be 1kHz.

Please note that the repetition input of the signal by chattering can be generated when standing up of the signal becomes duller.

Electrical Characteristics 1 (Ta = 25°C, V_M = 24 V, unless otherwise specified)

Characteristics		Symbol	Test Condition	Min	Typ.	Max	Unit
Digital input voltage		V_{IH}	Digital input pins (Note)	2.0	-	5.0	V
		V_{IL}		GND	-	0.8	
Input hysteresis voltage		$V_{IN(HIS)}$	Digital input pins (Note)	100	200	300	mV
Digital input current	High	$I_{IN(H)}$	V_{IN} = 5 V at the digital input pins under test	35	50	75	μA
	Low	$I_{IN(L)}$	V_{IN} = 0 V at the digital input pins under test	-	-	1	μA
MO output voltage		$V_{OL(MO)}$	I_{OL} = 24 mA when the output is Low	-	-	0.5	V
Supply current		I_{M1}	Outputs open, In standby mode	-	2	3	mA
		I_{M2}	Outputs open, ENABLE = Low	-	3.5	5	mA
		I_{M3}	Outputs open (two-phase excitation)	-	5	7	mA
Output leakage current	High-side	I_{OH}	V_{RS} = V_M = 40 V, V_{OUT} = 0 V	-	-	1	μA
	Low-side	I_{OL}	V_{RS} = V_M = V_{OUT} = 40 V	1	-	-	μA
Channel-to-channel differential		ΔI_{OUT1}	Channel-to-channel error	-5	0	5	%
Output current error relative to the predetermined value		ΔI_{OUT2}	I_{OUT} = 2.0	-5	0	5	%
R_S pin current		I_{RS}	V_{RS} = V_M = 24V, DMODE_1 = L , DMODE_2 = L, ENABLE = L	0	-	10	μA
Drain-source ON-resistance of the output transistors (upper and lower sum)		$R_{ON(D-S)}$	I_{OUT} = 2.0, Tj = 25℃	TBD (0.4)	0.6	TBD (0.8)	Ω
Chopper current		Vector	Step0 (Note 2)	-	0	-	%
			Step1 (Note 2)	33	38	43	%
			Step2 (Note 2)	66	71	76	%
			Step3 (Note 2)	-	100	-	%

Note: $V_{IN\ (L \to H)}$ is defined as the V_{IN} voltage that causes the outputs to change when a pin under test is gradually raised from 0 V. $V_{IN\ (H \to L)}$ is defined as the V_{IN} voltage that causes the outputs to change when the pin is then gradually lowered.
The difference between $V_{IN\ (L \to H)}$ and $V_{IN\ (H \to L)}$ is defined as the input hysteresis.

Electrical Characteristics 2 (Ta = 25°C, V_M = 24 V, unless otherwise specified)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Power-supply voltage for internal circuit operation	V_{CC}	I_{CC}=5.0mA	4.75	5.00	5.25	V
Power-supply current for internal circuit operation	I_{CC}	TBD	-	2.5	5.0	mA
Vref input voltage range	V_{ref}	Modes other than STANDBY MODE ,fLogic = 1kHz	GND	3.0	4.0	V
V_{ref} input current	I_{ref}	V_{ref} = 3.0 V	-	0	1.0	μA
V_{ref} decay rate	V_{ref} (GAIN)	V_{ref} = 2.0 V	1/4.8	1/5.0	1/5.2	Ratio
TSD threshold (Note 1)	T_jTSD	-	140	150	170	°C
V_M recovery voltage	V_{MR}	Modes other than STANDBY MODE	7.0	8.0	9.0	V
Overcurrent trip threshold (Note 2)	ISD	-	3.0	4.0	5.0	A
Voltage of current detection terminal (It is a difference voltage between VM-RS.)	V_{RS}	It is a standard as for the voltage of the terminal VM.	0.9	1.5	TBD	V

Note 1: Thermal shutdown (TSD) circuitry
When the junction temperature of the device has reached the threshold, the TSD circuitry is tripped, causing the internal reset circuitry to turn off the output transistors.
The TSD circuitry is tripped at a temperature between 140°C (min) and 170°C (max). Once tripped, the TSD circuitry keeps the output transistors off until both the D_MODE_1 and D_MODE_2 pins are switched to Low or the TB62215FNG is rebooted.

Note 2: Overcurrent shutdown (ISD) circuitry
When the output current has reached the threshold, the ISD circuitry is tripped, causing the internal reset circuitry to turn off the output transistors.
To prevent the ISD circuitry from being tripped due to switching noise, it has a masking time of four CR oscillator cycles. Once tripped, it takes a maximum of four cycles to exit ISD mode and resume normal operation.
The ISD circuitry remains active until both the D_MODE_1 and D_MODE_2 pins are switched to Low or the TB62215FNG is rebooted.
The TB62215FNG remains in Standby mode while in ISD mode.

Back-EMF

While a motor is rotating, there is a timing at which power is fed back to the power supply. At that timing, the motor current recirculates back to the power supply due to the effect of the motor back-EMF.

If the power supply does not have enough sink capability, the power supply and output pins of the device might rise above the rated voltages. The magnitude of the motor back-EMF varies with usage conditions and motor characteristics. It must be fully verified that there is no risk that the TB62215FNG or other components will be damaged or fail due to the motor back-EMF.

Cautions on Overcurrent Shutdown (ISD) and Thermal Shutdown (TSD)

- The ISD and TSD circuits are only intended to provide temporary protection against irregular conditions such as an output short-circuit; they do not necessarily guarantee the complete IC safety.
- If the device is used beyond the specified operating ranges, these circuits may not operate properly: then the device may be damaged due to an output short-circuit.
- The ISD circuit is only intended to provide a temporary protection against an output short-circuit. If such a condition persists for a long time, the device may be damaged due to overstress. Overcurrent conditions must be removed immediately by external hardware.

IC Mounting

Do not insert devices in the wrong orientation or incorrectly. Otherwise, it may cause the device breakdown, damage and/or deterioration.

AC Electrical Characteristics (Ta = 25°C, V_M = 24, 6.8 mH/5.7Ω)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Logic input frequency	fLogic	OSC=1600ｋHz	1.0	-	150	kHz
Width of minimum clock pulse	tw(tLogic)	-	100	-	-	ns
	twp	-	50	-	-	
	twn	-	50	-	-	
Output transistor Switching characteristic	tr	-	0.15	0.20	0.25	μs
	tf	-	0.12	0.15	0.18	
	tpLH(CLK)	CLK Signal～OUT, 6.8 mH/5.7 Ω（At the load）	-	1.0	-	
	tpHL(CLK)		-	1.5	-	
	tpLH(OSC)	OSCM～OUT, 6.8 mH/5.7 Ω（At the load）	-	0.5	-	
	tpHL(OSC)		-	1.0	-	
Blanking time for current spike prevention	tBLANK	Iout = 2.0A (tentative) and VM = Analog tBLANK value by 24V	300	400	500	ns
OSC_M oscillation frequency	fosc	C_{osc} = 270 pF, R_{osc} = 3.6 kΩ	1200	1600	2000	kHz
Chopper frequencye rang	fchop(Min) fchop(Typ.) fchop(Max)	Output operation (Iout = 2.0A)	40	100	150	kHz
[Chopper setting frequency	fchop	Output operation (Iout = 2.0A) OSC = For 1600kHz	-	100	-	kHz
ISD masking time	tISD(Mask)	After ISD threshold is exceeded due to an output short-circuit to power or ground	-	4	-	CR-CLK
ISD on-time	tISD		-	-	8	

Timing Charts of Output Transistors Switching

Timing charts may be simplified for explanatory purposes.

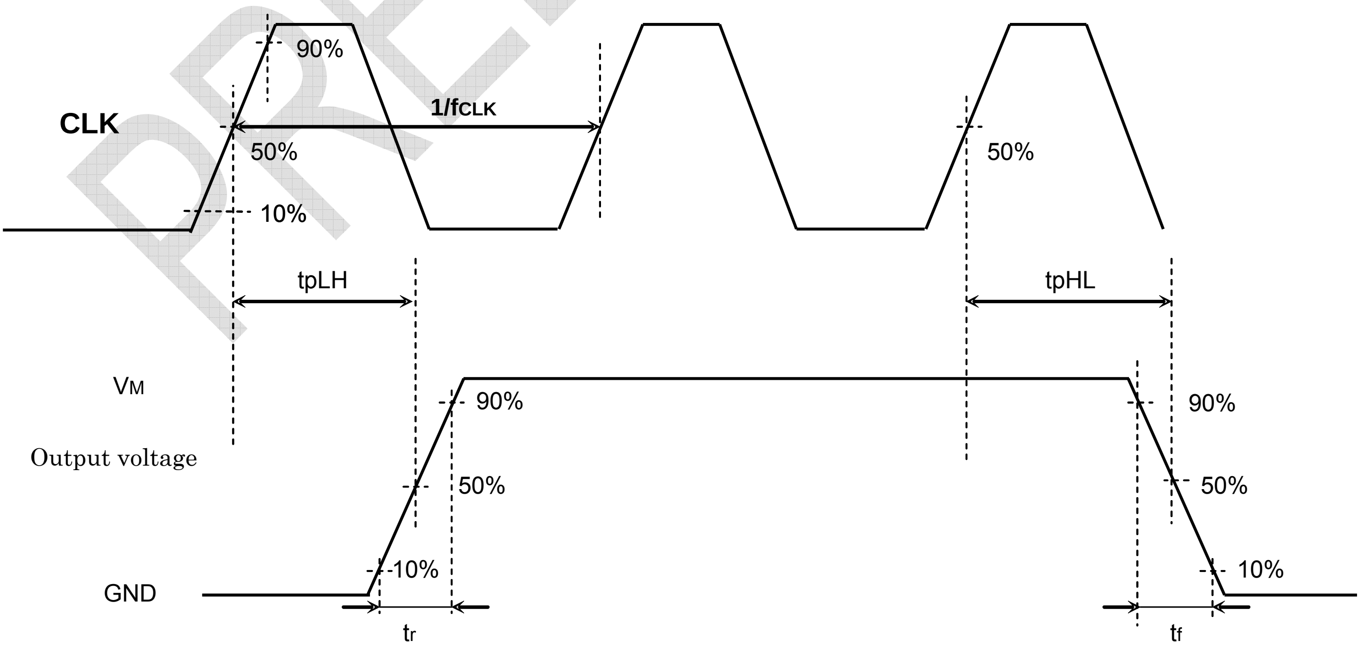


Fig1 Timing Charts of Output Transistors Switching

Calculation of the Predefined Output Current

For PWM constant-current control, the TB62215FNG uses a clock generated by the CR oscillator. The peak output current can be set via the current-sensing resistor (R_{RS}) and the reference voltage (V_{ref}), as follows:

$I_{OUT} = V_{ref}/5 \div R_{RS}$ (Ω)

where, 1/5 is the V_{ref} decay rate, $V_{ref\ (GAIN)}$. For the value of $V_{ref\ (GAIN)}$, see the Electrical Characteristics table.

For example, when V_{ref} = 3 V, to generate an output current (I_{OUT}) of 1.8 A, R_{RS} is calculated as:

RRS = (V_{ref} /5) ÷ I_{OUT} = (3/5) ÷ 1.8 = 0.33Ω. (≥ 1.1 W)

Calculation of the OSCM oscillation frequency (chopper reference frequency)

OSCM oscillation frequency (fOSCM) and chopper frequency (fchop) are computable in the following expressions.

fOSCM=1/[0.60x{Cx(R1+500)}] ………C,R1 : External constant for OSCM (C=270pF , R1=3.6kΩ)

fchop = fOSCM / 16

Because the loss of the gate in IC rises, generation of heat grows though wavy reproducibility goes up because the pulsating flow of the current decreases when the chopper frequency is raised.

There is a possibility that the current pulsating flow increases though a decrease in generation of heat can be expected by lowering the chopper frequency.

The thing set within the range of the frequency from 50 to about 100kHz based on the frequency of about generally 70 the kHz is recommended.

IC Power Consumption

The power consumed by the TB62215FNG is approximately the sum of the following two: 1) the power consumed by the output transistors, and 2) the power consumed by the digital logic and pre-drivers.

The power consumed by the output transistors is calculated, using the $R_{ON\ (D\text{-}S)}$ value of 0.8 Ω.

Whether in Charge, Fast Decay or Slow Decay mode, two of the four transistors comprising each H-bridge contribute to its power consumption at a given time.

Thus the power consumed by each H-bridge is given by:

$$P\ (out) = 2\ (Hsw) \times Iout\ (A) \times VDS\ (V) = 2\ (Hsw) \times Iout\ (A)^2 \times Ron\ (\Omega) \quad \text{(1)}$$

In two-phase excitation mode (in which two phases have a phase difference of 90°), the average power consumption in the output transistors is calculated as follows:

Ron = 0.8Ω (@2.0 A), Iout (peak : Max) = 1.8 A, VM = 24 V

$$P\ (out) = 2\ (Tr) \times 1.8\ (A)^2 \times 0.8(\Omega) \quad \text{(2)}$$
$$= 5.2\ (W)$$

The power consumption in the I_M domain is calculated separately for normal operation and standby modes:

Normal operation mode: I (I_{M3}) ＝ 5.0 mA (typ.)
Standby mode: I (I_{M1}) ＝ 3.5 mA (typ.)

The current consumed in the digital logic portion of the TB62215FNG is indicated as I_{Mx}. The digital logic operates off a voltage regulator that is internally connected to the V_M power supply. It consists of the digital logic connected to V_M (24 V) and the network affected by the switching of the output transistors. The total power consumed by I_{Mx} can be estimated as:

$$P\ (IM) = 24\ (V) \times 0.005\ (A) \quad \text{(3)}$$
$$= 0.12\ (W)$$

Hence, the total power consumption of the TB62215FNG is:

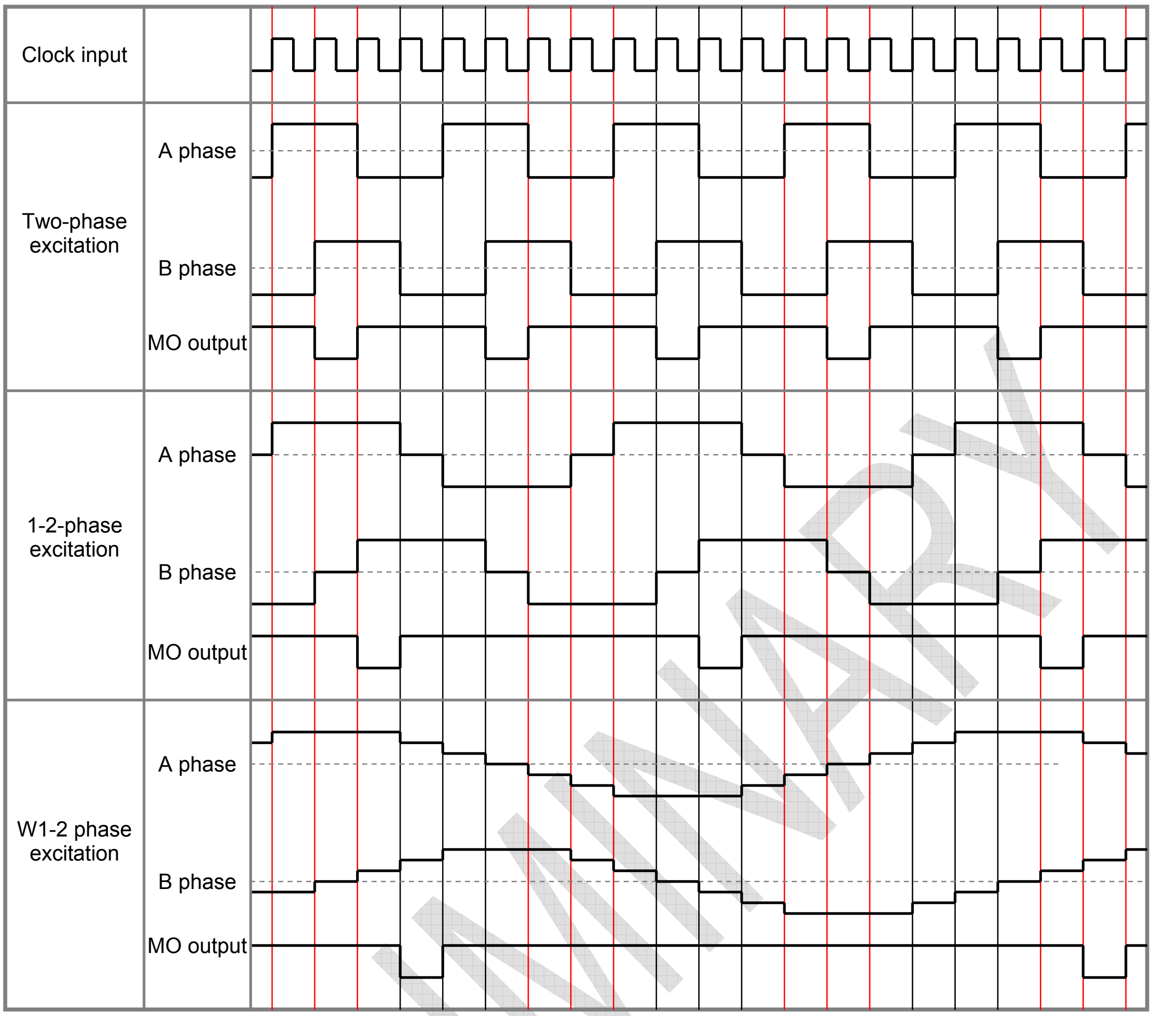
P = P (out) + P (IM) = 5.32 (W)

The standby power consumption is given by:

P (Standby)= 24 (V) × 0.0035 (A) = 0.084 (W)

Board design should be fully verified, taking thermal dissipation into consideration.

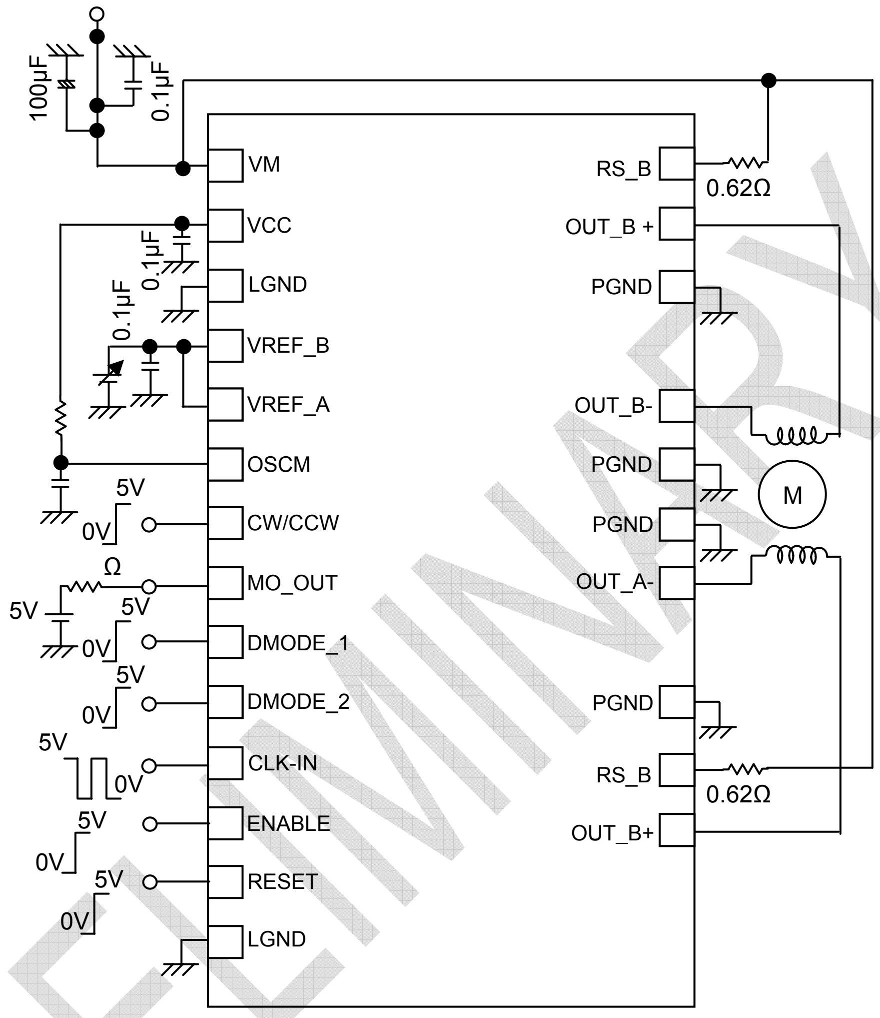
Excitation drive



The MO output is terminal corrugate in the state that Pull Up is done.

TB62215FNG Recommendation and application circuits

The numerical value that exists in each element is a recommended value.

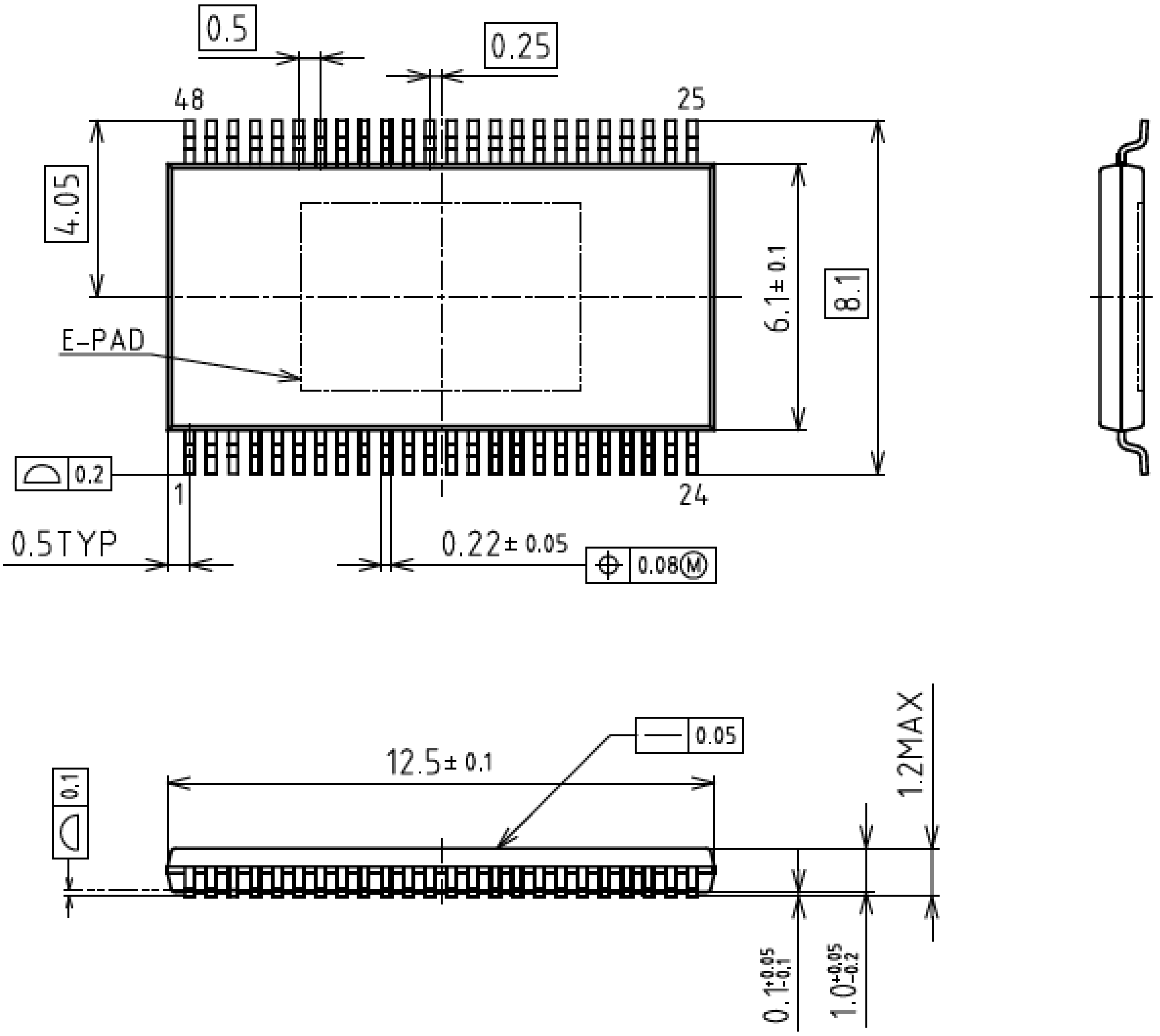


Note: I will recommend the addition of capacitor if necessary. The GND wiring must become one point as much as possible-earth.

The example of applied circuit is an example of the reference, and do an enough evaluation before the mass production design, please.
Moreover, it is not the one to permit the use of the industrial property.

Package Dimensions

HTSSOP48



Notes on Contents

Block Diagrams

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

Equivalent Circuits

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

Timing Charts

Timing charts may be simplified for explanatory purposes.

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.

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

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.

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.

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.

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.

Carefully select external components (such as inputs and negative feedback capacitors) and load components (such as speakers), for example, power amp and regulator.
If there is a large amount of leakage current such as input or negative feedback condenser, the IC output DC voltage will increase. If this output voltage is connected to a speaker with low input withstand voltage, overcurrent or IC failure can cause smoke or ignition. (The over current can cause smoke or ignition from the IC itself.) In particular, please pay attention when using a Bridge Tied Load (BTL) connection type IC that inputs output DC voltage to a speaker directly.

Points to remember on handling of ICs

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.

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.

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.

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.

RESTRICTIONS ON PRODUCT USE

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