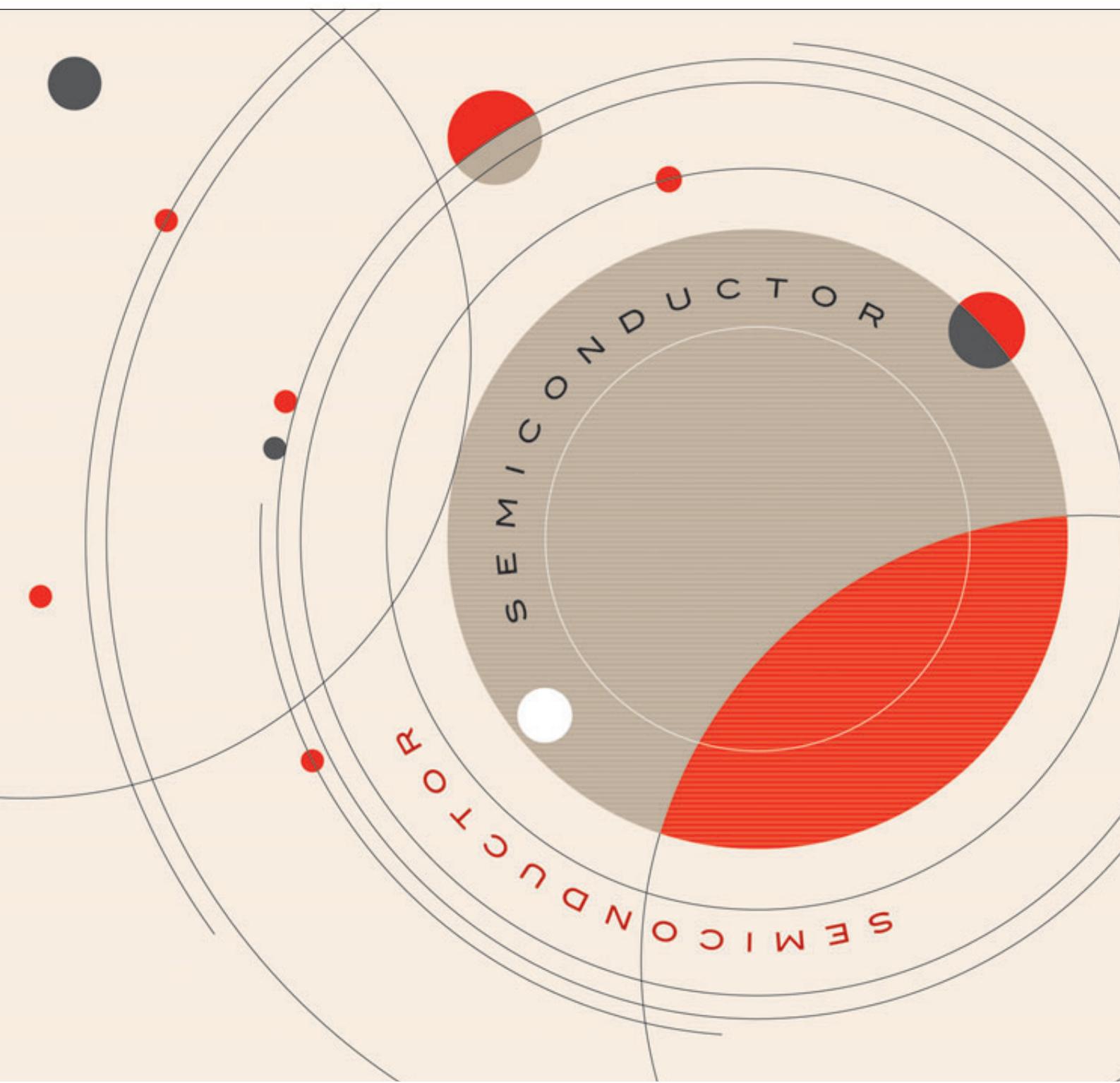


SYSTEM CATALOG**Motor Solutions Guide**

Toshiba's Semiconductors for Motor Control

Many of the things we use in our daily lives such as mobile devices, office equipment, amusement equipment and toys are driving the need to reduce size, cut power consumption and improve performance.

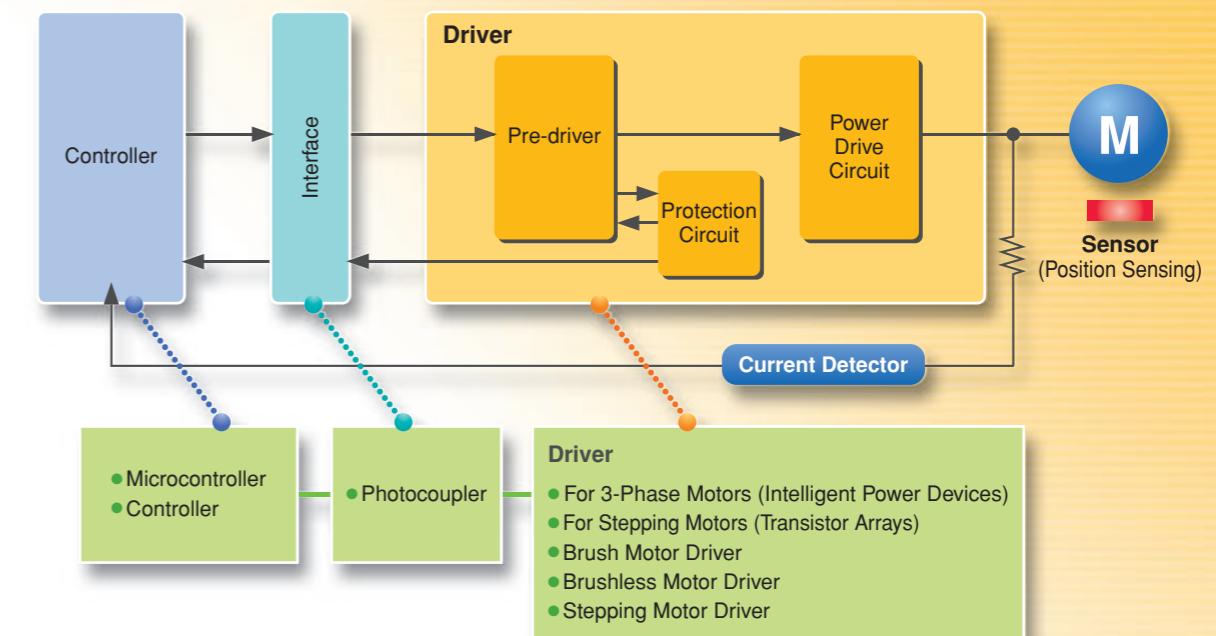
Toshiba offers multifaceted solutions by leveraging its unique technologies, including:

- Compact packages to allow smaller product size
- Single-chip ICs capable of driving multiple motors
- Low power consumption and high-accuracy control to extend battery life

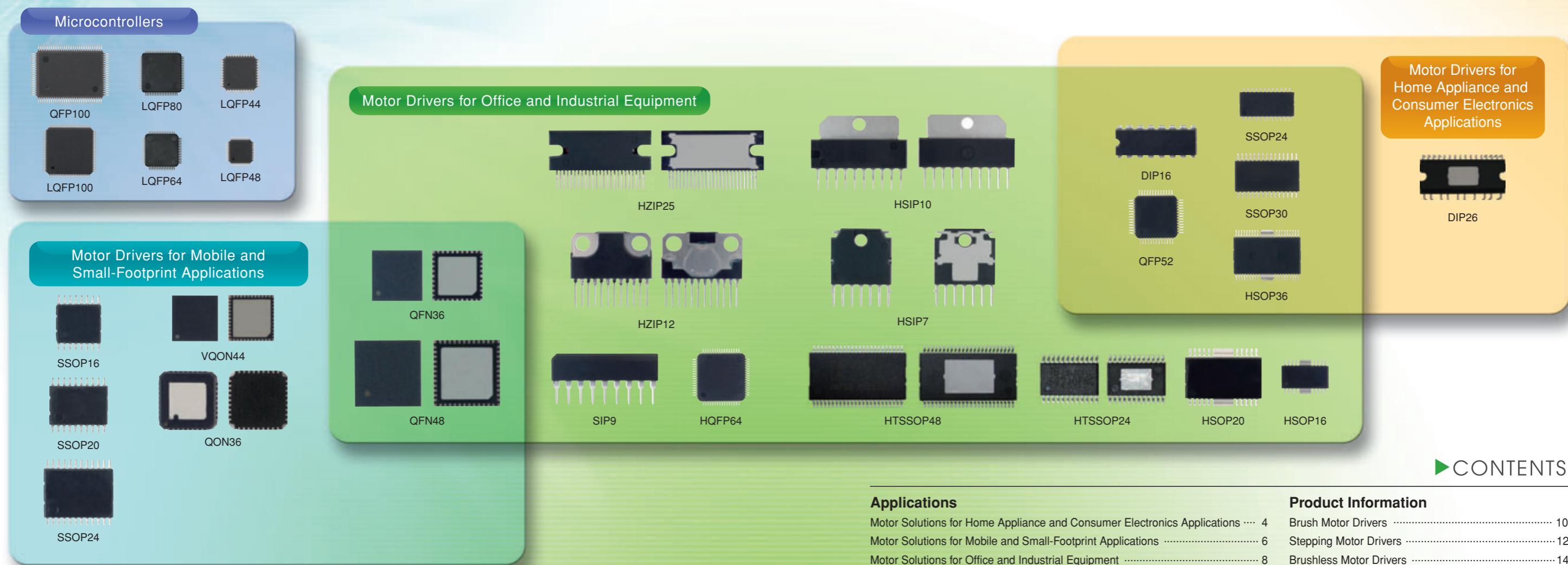
To meet customer needs, Toshiba is developing various semiconductor devices for motor control applications that embody its state-of-the-art technologies.



Motor Driver Subsystem Example



Packaging Options for Motor Drivers and Microcontrollers



The above package photos are not actual size and do not reflect the relative size.

► CONTENTS

Applications

- Motor Solutions for Home Appliance and Consumer Electronics Applications 4
- Motor Solutions for Mobile and Small-Footer Applications 6
- Motor Solutions for Office and Industrial Equipment 8

Product Information

- Brush Motor Drivers 10
- Stepping Motor Drivers 12
- Brushless Motor Drivers 14
- Microcontrollers 16
- Intelligent Power Devices (IPDs) 18
- Photocouplers 19

Motor Solutions for Home Appliance and Consumer Electronics Applications

MOTOR SOLUTIONS GUIDE

Toshiba offers a suite of motor solutions ideal for DC inverter applications that require low power consumption and quiet motor control, such as motor controllers, microcontrollers with an integrated vector engine and intelligent power devices (IPDs).

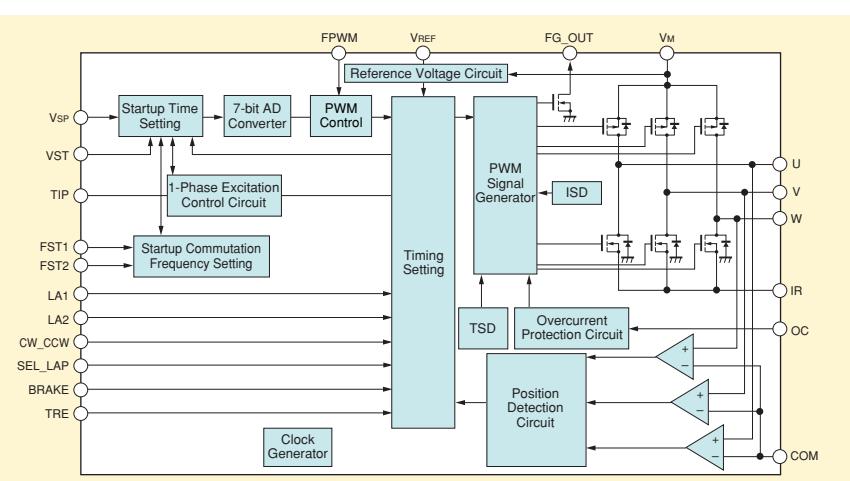
Toshiba's Unique Motor Control Technologies

- **Sensorless PWM drive:** The back-EMF voltage from the motor coil is sensed and fed back to the commutation signals.
- **Sine-wave drive:** The motor windings are energized with sine-wave currents to reduce vibration and acoustic noise. Sine-wave PWM control is implemented as a hardware core.
- **Lead angle control:** Lead angle control and automatic lead angle correction help to improve motor efficiency.
- **Vector control:** The hardware specifically designed for vector control enables sensorless sine-wave drive.

Product Overview

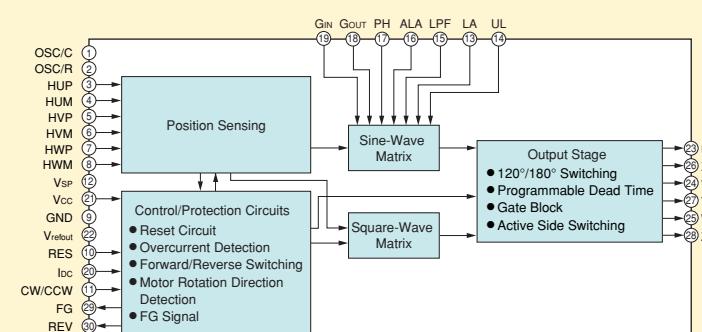
● Sensorless Square-Wave PWM Three-Phase Brushless DC Motor Drivers (TB6633FNG/AFNG)

- Sensorless PWM drive
- Improved overlapping commutation (135°/150° commutation)
- Lead angle control
- FNG: FG = 3 ppr
AFNG: FG = 1 ppr
- Package: SSOP24-P-300-0.65A



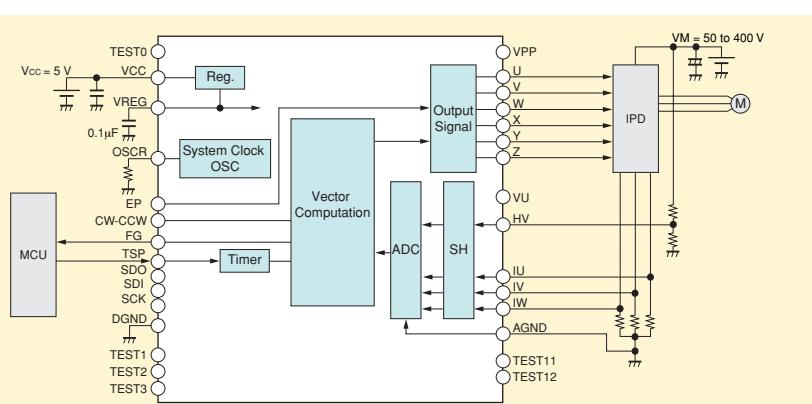
● Sine-Wave PWM Three-Phase Brushless DC Motor Controllers (TB6584FNG/AFNG)

- Sine-wave current drive
- Automatic lead angle correction
- On-chip oscillator (External resistors and capacitors required)
- On-chip power source for Hall sensors
- Programmable dead time
- Dual-phase modulation
- Package: SSOP30-P-300-0.65



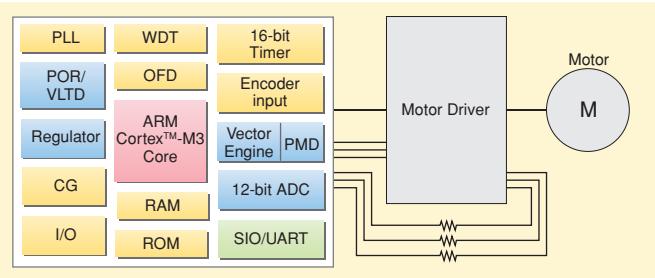
● Sensorless Sine-Wave PWM Three-Phase Brushless DC Motor Controller (TC7600FNG)

- Vector control
- Sensorless sine-wave control
- On-chip oscillator (External resistors required)
- RPM control
- Programmable dead time
- Package: SSOP30-P-300-0.65



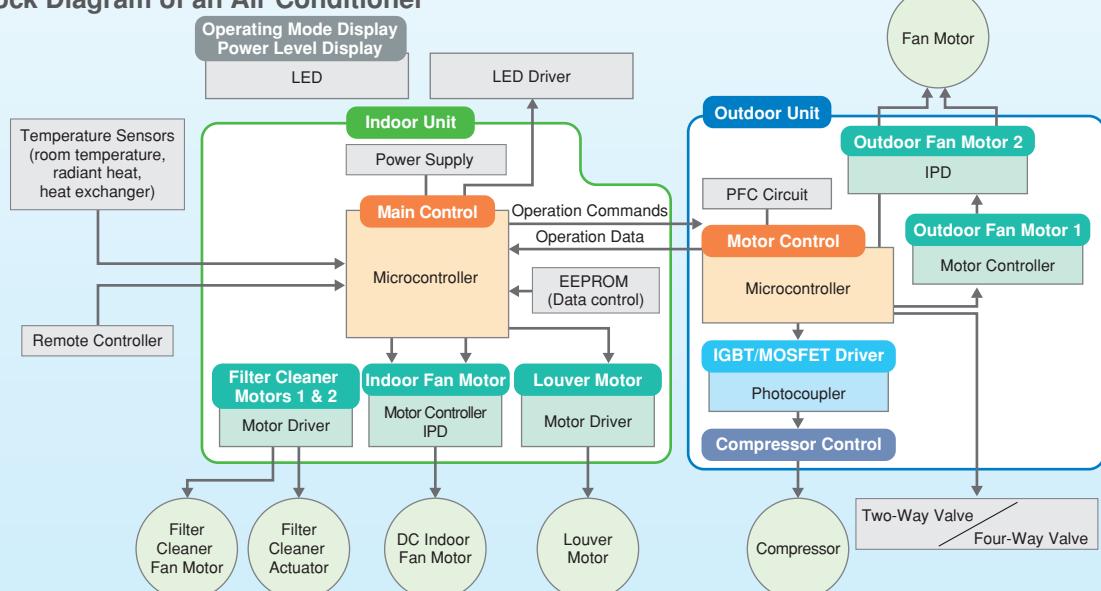
Microcontrollers with a Vector Engine (M370 Group)

- Operating voltage: 4.5 V to 5.5 V
- Maximum operating frequency: 80 MHz
- On-chip memory: Flash ROM: 128 KB/256 KB/512 KB
RAM: 6 KB to 32 KB
- Motor controller: 1 or 2 channels
- Encoder inputs: 1 or 2 channels
- 12-bit A/D converter: 6 to 22 channels
- 16-bit timer/counter: 8 channels



Motor Solution Example for Home Appliance and Consumer Electronics Applications

Block Diagram of an Air Conditioner



Product Lineup

Applications	Semiconductor	Recommended Devices	Features	End-Product Examples
Motor Control	Microcontrollers	TMPM370FY/TMPM374FW TMPM372FW**/TMPM373FW** TMPM376FD**/TMPM377FY**	Vector engine (VE) Multiple motors controllable with PMD	Refrigerators Air conditioners Automatic washing machines Dishwashers
Fan and Circulating Pumps	Brushless motor drivers	TB6588FG* TB6575FNG TB6585FG/FTG* TB6633FNG/AFNG* TC7600FNG*	Sensorless DC motor driver Quiet operation	Refrigerators Air conditioners Automatic washing machines Dishwashers Cloth driers
Ice Makers for Refrigerators	Brush motor drivers	TA7291P/FG/SG	Programmable output voltage	Refrigerators
Motor Dampers for Refrigerators	Stepping motor drivers	TB6674PG/FG/FAG	Two-phase stepping motor	Refrigerators (on-off valve)
Air Conditioners Filter Cleaner Motors (Actuators)	Micro-step driver	TB6608FNG	Two-phase stepping motor (bipolar type)	Air conditioners
Air Conditioners Filter Cleaner Motors (Fan)	Three-phase brushless motor drivers	TB6585FG/FTG*	Sine-wave-current PWM driver	Air conditioners
Air Conditioners Indoor Fan Motors	IPDs	TPD4131K/TPD4132K	Thin package High-voltage, high-current pins and control pins are isolated on the opposite sides of a package.	Air conditioners
Air Conditioners Outdoor Fan Motors	IPDs	TPD4123K/AK / TPD4134K/AK TPD4135K/AK	Thin package High-voltage, high-current pins and control pins are isolated on the opposite sides of a package.	Air conditioners
Compressor Control	IPDs	TPD4135K/AK	Single-chip inverter Low loss and low noise	Refrigerators
Compressor Drive Pulsator/Drum Drive	IGBT	GT30J324	Low loss and insulated package	Air conditioners Automatic washing machines
Circulating Pumps	IPDs	TPD4134K/AK	Thin package High-voltage, high-current pins and control pins are isolated on the opposite sides of a package.	Automatic washing machines Dishwashers Cloth driers
IGBT/MOSFET Drivers	Photocouplers	TLP155E/TLP701/TLP351	Direct IGBT/MOSFET drive	Refrigerators Air conditioners Automatic washing machines Dishwashers Cloth driers

*: New product **: Under development

Motor Solutions for Mobile and Small-Footprint Applications

MOTOR SOLUTIONS GUIDE

Toshiba offers motor solutions ideal for mobile and small-footprint applications that require low power consumption and small form factor.

Toshiba's Unique Motor Control Technologies

- **Reduced power consumption due to the use of a new process:**
Products with an LDMOS output stage featuring low power consumption
- **Significantly reduced power loss and heat dissipation from the output stage:** TB6614FNG: Output $R_{on} = 0.3 \Omega$ (typ.)
- **High-speed PWM control:** TB6614FNG: fPWM = Up to 400 kHz
- **Small packages:** Leadless QON and QFN packages
- **Ultrasonic-motor control and piezoelectric actuator support:** PPG outputs with 6-ns resolution.

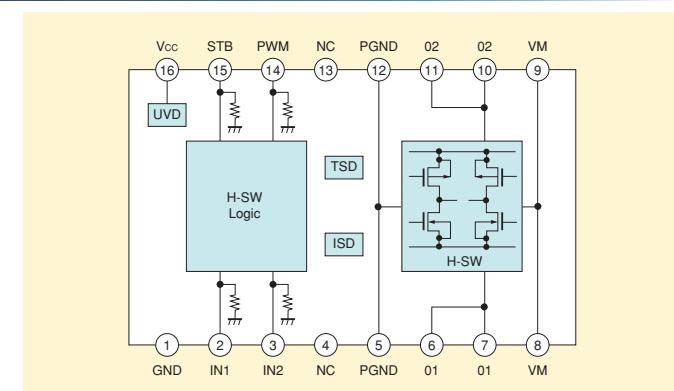
Product Overview

● DC Motor Driver for Low-Power Applications (TB6614FNG)

The TB6614FNG is a DC motor driver using low-ON-resistance LDMOS transistors at the output stage.

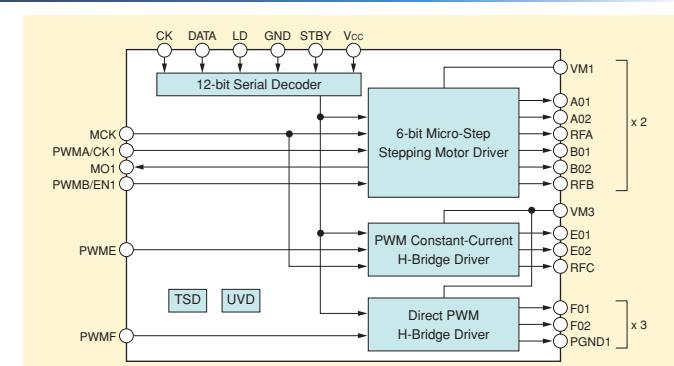
The IN1 and IN2 input terminals allow selection of one of the four modes: Forward, Reverse, Short Brake or Stop.

- Output current: $I_o = 1.2 \text{ A}$ (typ.), 3.2 A (repetitive pulse peak)
- Operating voltage: $V_{cc} = 2.7$ to 5.5 V
 $VM = 2.5$ to 13.5 V
- Output R_{on} : 0.3Ω typ. (high side + low side)
- Direct PWM, fPWM max = 400 kHz
- Standby function
- Thermal shutdown circuitry, overcurrent protection circuitry, undervoltage lockout circuitry
- Package: SSOP16-P-225-0.65

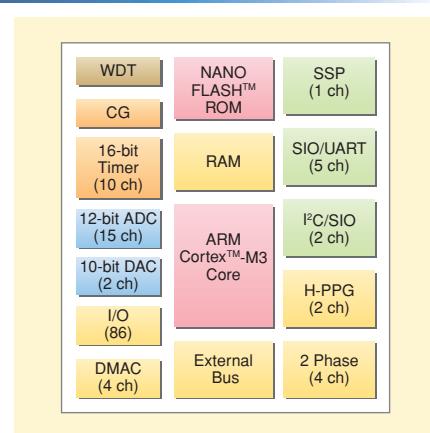


● 8-Channel Motor Driver for a Digital Still Camera (DSC) (TB6613FTG)

- Absolute maximum ratings: 6 V/0.8 A
- 8-channel single-chip driver (Independently controllable)
 - Channels A, B, C and D: 6-bit micro-step STM (Configurable to operate as four independent DCM drivers)
 - Channel E: PWM constant-current H-bridge driver
 - Channels F, G and H: Direct PWM H-bridge drivers
- 3-wire serial interface
- Standby function
- Thermal shutdown circuitry, undervoltage lockout circuitry
- Package: VQON44-P-0606-0.4



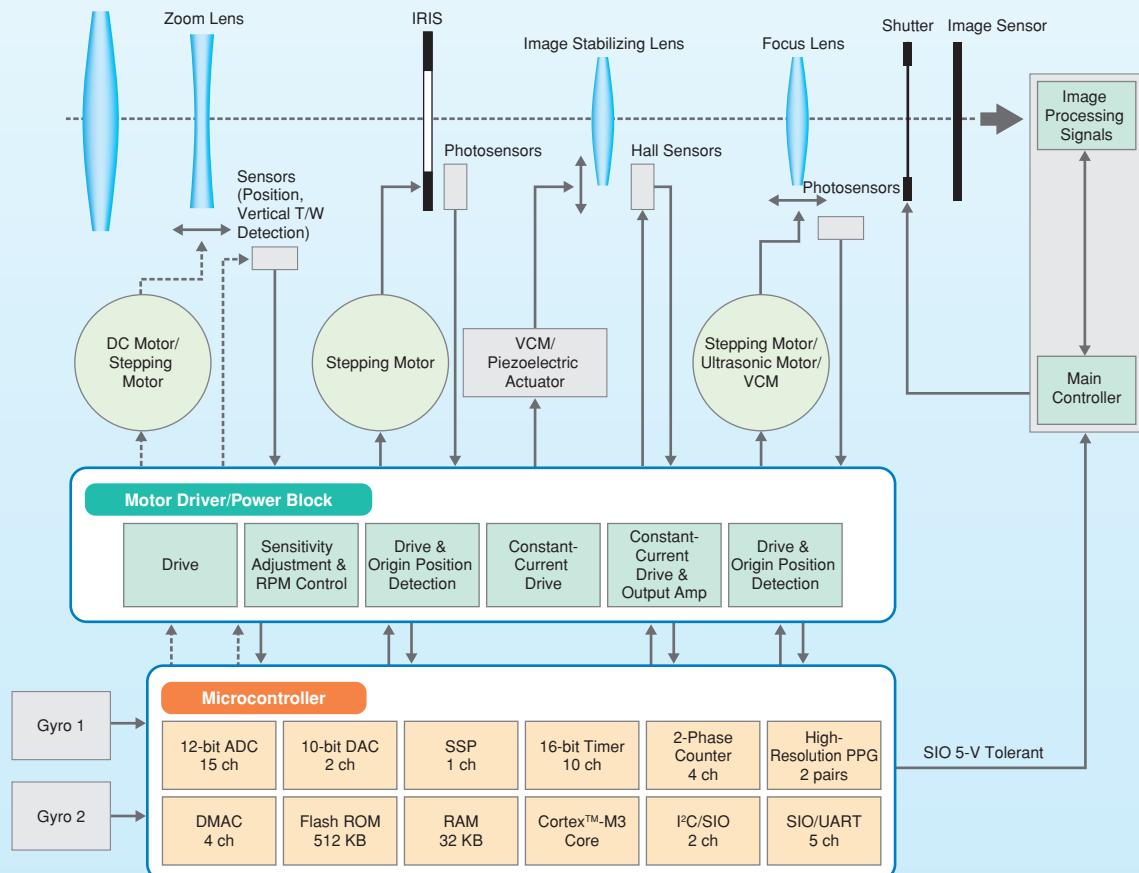
- Operating voltage: 2.7 to 3.6 V
- Maximum operating frequency: 54 MHz
- On-chip memory: Flash ROM: 512 KB/256 KB
RAM: 32 KB
- 12-bit AD converter: 15 channels
- 10-bit DA converter: 2 channels
- High-resolution PPG output: 2 channels (Resolution: 6 ns max)
- Two-phase pulse counter: 4 channels
- Serial interfaces: SIO/UART: 5 channels
 I^2C (100 kHz/400 kHz)/SIO: 2 channels
SSP: 1 channel
- Package: P-TFBGA113-0606-0.50AZ



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NANO FLASH is a registered trademark of Toshiba Corporation.

Motor Solution Example for Mobile and Small-Footprint Applications

Block Diagram of a Digital Still Camera



* VCM: Voice Coil Motor

Product Lineup

Applications	Semiconductor	Recommended Device	Features	End-Product Examples
Motor Control	Microcontrollers	TMPM341FDXBG TMPM341FYXBG**	ARM Cortex™-M3 core, 54 MHz (max), 12-bit ADC: 15 channels, 10-bit DAC: 2 channels, High-resolution PPG output (Resolution: 6 ns)	Digital still camera (DSLR) lens
Lens Drive Actuator Drive	Brush motor drivers Stepping motor drivers	TB6593FNG TB6614FNG TB6617FNG	Single-bridge	Digital still cameras (DSC, DSLR), small printers, lens control, security cameras, network cameras, small scanners
		TB6612FNG TB6552FNG/FLG/FTG*	Dual-bridge	
		TB6590FTG	Dual-bridge, small package: VQON16 (3 mm ²)	
		TB6607FLG	5 channels in 1 chip, Serial interface + 6-bit DAC	
		TB6596FLG TB6609FLG	6 channels in 1 chip, Serial interface + 6-bit DAC	
		TB6613FTG	8 channels in 1 chip, 6-bit micro-step control for two motors, serial interface	
		TB6608FNG	2W1-2-phase excitation, constant-current drive	

*: New Product **: Under development

Motor Solutions for Office and Industrial Equipment

MOTOR SOLUTIONS GUIDE

Toshiba offers motor solutions for office and industrial applications that require high current, quick control and high accuracy.

Toshiba's Unique Motor Control Technologies

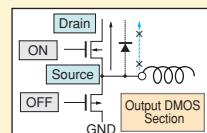
- **Low-Ron process:** Supports high-current, high-power outputs.
- **Synchronous rectification PWM control:**
Reduces power loss (heat dissipation) during PWM control.
- **High-accuracy micro-stepping:** Reduces the acoustic noise and vibration of a motor.

1) Low-Ron process (BiCD process)

- Low Ron (high side + low side): $0.6\ \Omega$
- High current drive: Up to 3.5 A

Example: TB6560AHQ

2) Synchronous rectification PWM control

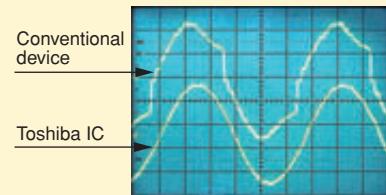


Conducting current on the reverse direction through the FETs eliminates a diode loss

3) High-accuracy micro-stepping

- High accuracy, low vibration, high-speed drive

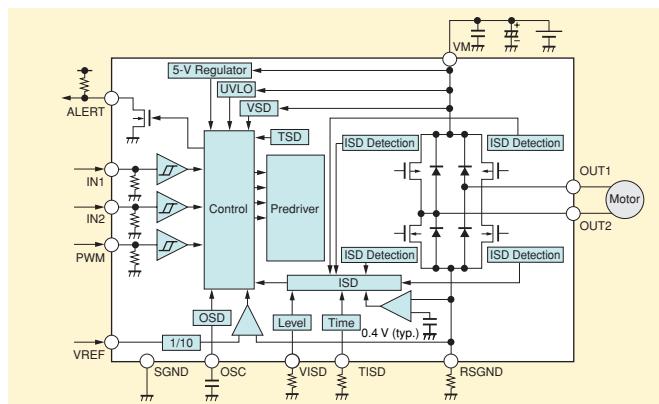
- Improved accuracy of motor drive signals due to the use of an on-chip 4-bit DAC
- Reduced current distortions thanks to the combined use of coil current decay modes



Product Overview

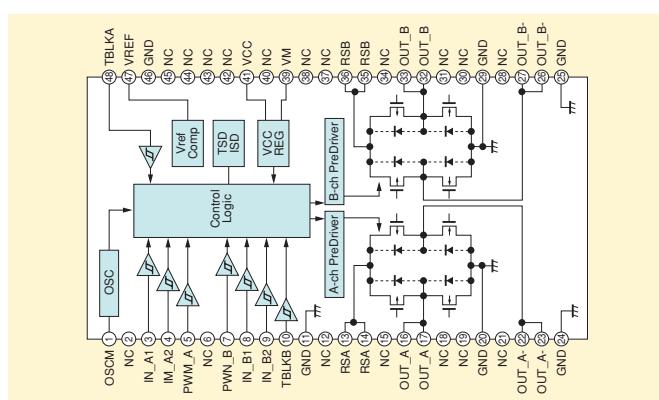
High-Current Motor Driver with Low Power Consumption (TB6569FG)

- Reduced power consumption due to the use of a BiCD process
- Output R_{on} : 0.55 Ω typ. (high side + low side)
- Constant-current PWM control
- Absolute maximum ratings: 50 V/4.0 A, 36 V/4.5 A
- Package: HSOP16-P-300-1.00



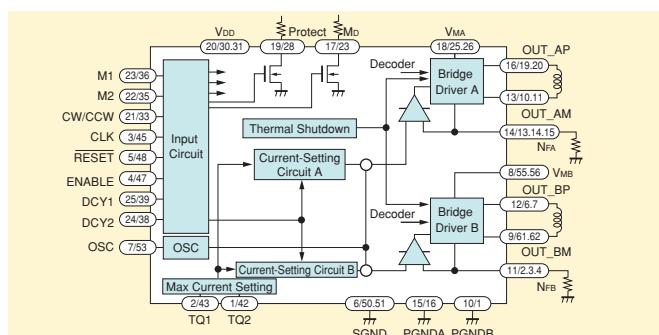
Constant-Current Motor Drivers (TB62216FNG/FTG/FG)

- 2-channel DC motor drivers (with a programmable digital blanking time)
- Reduced power consumption due to the use of a BiCD process
- Four selectable control modes (Forward, Reverse, Short Brake, Stop)
- Direct PWM and constant-current (current feedback) control
- Output R_{on} : $1.0\ \Omega$ (high side+ low side)
- Absolute maximum ratings: 40 V/2.5 A
- Packages: HTSSOP48-P-300-0.50
QFN48-P-0707-0.50
HSOP28-P-450-0.80



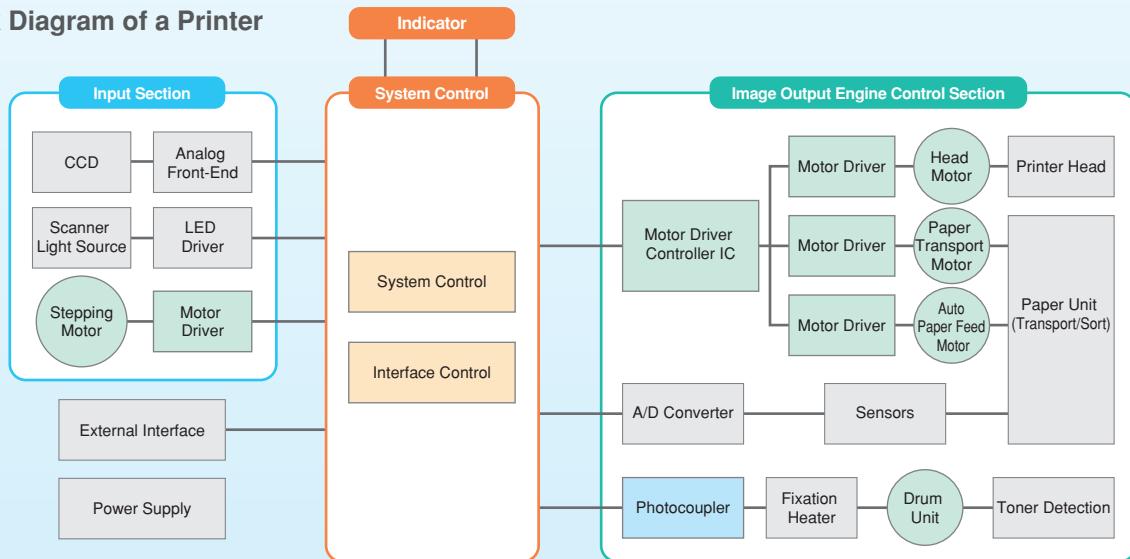
Micro-Step Motor Drivers (TB6560AHQ/AFG/AFTG)

- 4-bit (1/16) micro-stepping
- Clock input
- Absolute maximum ratings: 40 V/3.5 A (AHQ),
2.5 A (AFG), 2.5 A (AFTG)
- Packages: HZIP25-P-1.27
HQFP64-P-1010-0.50



Motor Solutions for Office and Industrial Equipment

Block Diagram of a Printer



Product Lineup

Applications	Semiconductor	Recommended Device	Features	End-Product Examples
Image Output Engine Control Section	Brush Motor Drivers	TA7291SG (J)/FG/P	Single full bridge, output voltage control	Plain paper copiers (PPCs), printers, scanners, fax machines, vending machines, ATMs, amusement equipment, card readers, bank note recognition machines, etc.
		TA8428K/FG TA8429HQ	Single full bridge	
		TB6549FG/PG/HQ TB6568KQ* TB6643KQ*	Single full bridge, direct PWM control	
		TB6559FG	Single full bridge, Constant-current PWM control/direct PWM control	
		TB6642FG*	Single full bridge, emergency output, Direct PWM control	
		TB6569FG*	Single full bridge, emergency output, Direct PWM control, Constant-current PWM control	
		TB6641FG*	Single full bridge, emergency output, Direct PWM control, constant-current PWM control, Reference voltage output	
		TB6561NG/FG	Dual full bridge	
Fans	Brushless Motor Drivers	TB6588FG	Sensorless control	Industrial fans
		TB6551FG		
		TB6572AFG TB6603FTG*	Sine-wave PWM controllers	
Image Output Engine Control Section, Input Section	Stepping Motor Drivers	TB6604FTG*	Sine-wave PWM controller, RPM control	Plain paper copiers (PPCs), printers, scanners, fax machines, vending machines, ATMs, amusement equipment, card readers, robots, bank note recognition machines, etc.
		TB6615PG	Controller	
		TB6560AHQ/AFG/AFTG* TB62209FG	Clock input, micro-stepping drive (4W1-2-phase excitation)	
		TB62211FNG* TB62214AFG*/AFTG*/AFNG*	Clock input, micro-stepping drive (W1-2-phase excitation)	
		TB62215AFG*/AFTG*/AFNG*	Pin-, functionally- and package-compatible version of TB62214A with low Ron	
		TB62210FNG* TB6562ANG/AFG TB62218AFG*/AFTG*/AFNG*	Phase inputs, micro-stepping drive (W1-2-phase excitation)	
		TB62213AFG*/AFTG*/AFNG*	Pin-, functionally- and package-compatible version of TB62218A with low Ron	
		TB62206FG TB62208FG/FTG/FNG*	Phase inputs, 1-2-phase excitation	
Heater Control	Stepping Motor Drivers/ Brush Motor Drivers	TB62212FTAG/FNG*	Phase inputs, 1-2-phase excitation, BiCD process, Four H-bridges Controls up to four brush DC motors or up to two stepping motors.	Multifunction printers
		TLP360J/TLP560J		

*: New product

Brush Motor Drivers

MOTOR SOLUTIONS GUIDE

Next-Generation Brush DC Motor Driver Series

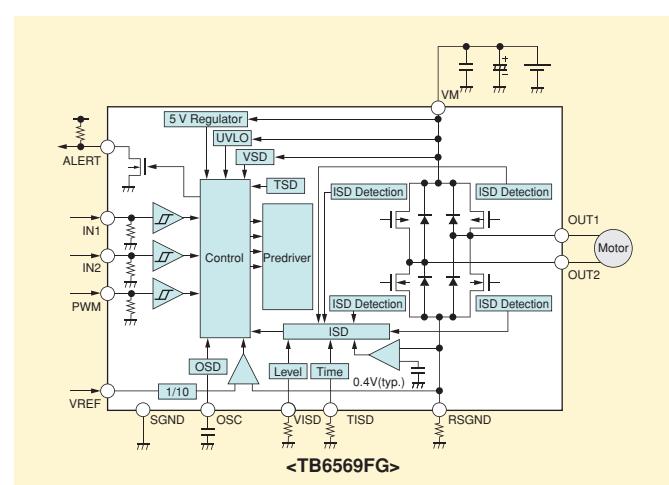
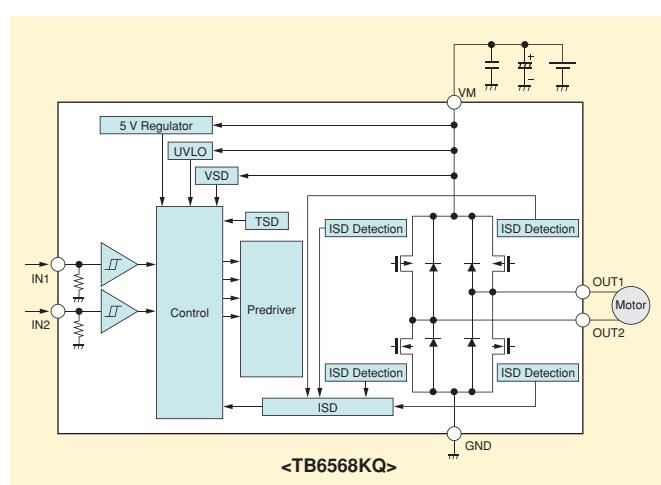
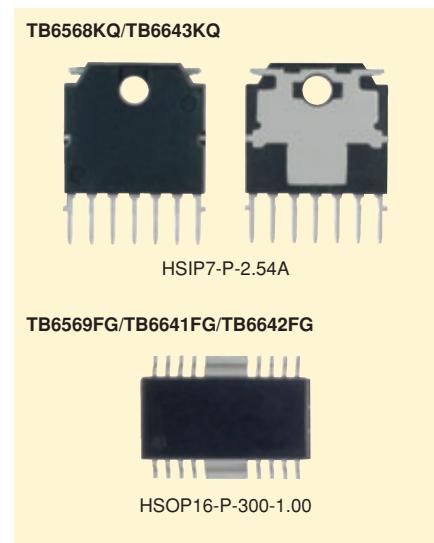
Toshiba offers a wide range of brush motor drivers to meet various supply voltage, output current and channel count requirements. They feature low power consumption due to the use of a BiCD process at the output stage that provides low on-resistance.

Ratings	15 V		25 V to 30 V			50 V			6 V to 15 V		40 V	
≥ 4.0 A			TA8429 HQ HZIP12	TB6549 HQ HZIP25	TB6569 FG HSOP16	TB6641 FG HSOP16	TB6642 FG HSOP16	TB6643 KQ HSIP7			TB62212 FTAG/FNG QFN48-P-0707-0.50/ HTSSOP48-P-300-0.50 Large Mode	
4.0 A to 3.0 A	TB6593 FNG SSOP20	TB6614 FNG SSOP16	TA7267 BP HSIP7	TA8428K TB6549 FG/PG HSOP20/ DIP16				TB6568 KQ HSIP7	TB6612 FNG SSOP24			
3.0 A to 2.0 A			TA7291 P HSIP10	TA8428 FG HSOP20		TB6617 FNG SSOP16	TB6559 FG HSOP16			TB62216 FTG/FNG/FG QFN48-P-0707-0.50/ HTSSOP48-P-300-0.50/ HSOP28-P-450-0.80	TB62212 FTAG/FNG QFN48-P-0707-0.50/ HTSSOP48-P-300-0.50 Small Mode	
≤ 1.5 A			TA7291 FG/SG HSOP16/ SIP9					TB6590 FTG VQON16	TB6552 FNG/FLG/ FTG SSOP16/ QON24/ QFN24	TB6561 FG/NG SSOP16/ SDIP24		
	1 Channel								2 Channels		4 Channels	

● TB6568KQ/TB6569FG/TB6641FG/TB6642FG/TB6643KQ 50 V Single-Channel DC Motor Drivers

Features

- Low power consumption thanks to low-Ron outputs: 0.55 Ω (high-side + low-side)
- High output current
3.0 A (TB6568KQ)
4.0 A/4.5 A (TB6569FG/TB6641FG/TB6642FG/TB6643KQ)
- Wide supply voltage range: 10 to 45 V
- Support for direct PWM drive
- Support for constant-current PWM control (TB6569FG/TB6641FG)
- Various abnormal condition detection
ISD (overcurrent protection), TSD (thermal shutdown), UVLO (undervoltage lockout),
VSD (overvoltage detection)
ISD/TSD latched/auto recovery selectable (TB6642FG)
Externally programmable ISD threshold (TB6569FG/TB6642FG)
- The on-chip high-accuracy voltage regulator eliminates the need for a logic power supply.
On-chip voltage regulator output pin (TB6641FG)



● **TB62216FNG/FTG/FG 40 V/2.5 A 2-Channel DC Motor Drivers (with Phase Inputs)**

Features

- 2-channel DC motor drivers with a maximum current rating of 2.5 A
- Four selectable control modes (Forward, Reverse, Short Brake, Stop)
- Direct PWM and constant-current (current feedback) control
- Programmable digital blanking time
- Power sequence-free thanks to the on-chip high-accuracy voltage regulator
- Low power consumption thanks to low-Ron outputs:
1.0 Ω (high-side + low-side)
- Packaging options that meet various pc board, application and assembly requirements



● **TB62212FTAG/FNG 40 V/2.0 A Configurable 4-Channel H-Bridges (40 V/1.5 A 2-Channel Stepping Motor Drivers)**

Features

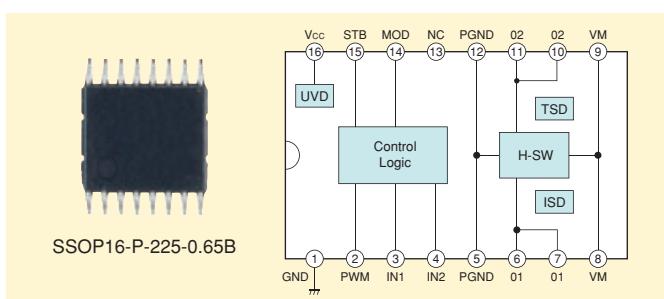
- 4-channel DC motor drivers with a maximum current rating of 2.0 A (Small Mode) or 4.0 A (Large Mode)
- H-bridges with 6 selectable operating modes
 - Two high-power DC motors: Maximum current rating = 4.0 A
 - Four low-power DC motors: Maximum current rating = 2.0 A
 - One high-power DC motor + one low-power stepping motor
 - Two low-power DC motor + one low-power stepping motor
 - Two low-power stepping motors: Maximum current rating = 1.5 A
 - One high-power stepping motor: Maximum current rating = 1.8 A

- Various shutdown circuits:
Overcurrent protection, thermal shutdown, power-on reset
- Output R_{on} : 2.2 Ω (high side + low side)
- Packages: QFN48-P-0707-0.50/HTSSOP48-P-300-0.50

● [TB6617FNG 50 V/2.0 A 1-Channel DC Motor Driver \(with Phase Inputs\)](#)

Features

- Rated at up to 50 V and operates with a wide range of supply voltage from 4.5 V to 45 V.
- Saves board space due to the use of a small SSOP16 package (with 0.65-mm lead pitch).
- Output R_{on} : 1.4 Ω (high-side + low-side)
- High-accuracy current control with a high-speed PWM ($f_{PWM\ max} = 350$ kHz)
- Capable of driving ceramic piezoelectric actuators.



Product Lineup

Part Number	Number of Circuits	Absolute Maximum Ratings		PWM Drive		Abnormality Detection		Packages
		Supply Voltage	Output Current	Direct	Constant-Current	TSD	ISD	
TA8428FG/K	1 ch	30 V	2.4 A/3.0 A	—	—	Auto	Auto	HSOP20-P-450-1.00/HSIP7-P-2.54
TA8429HQ	1 ch	30 V	4.5 A	—	—	Auto	Auto	HZIP12-P-1.78B
TB6549FG/PG/HQ	1 ch	30 V	3.5 A/3.5 A/ 4.5 A	Y	—	Auto	Auto	HSOP20-P-450-1.00/DIP16-P-300-2.54A/ HZIP25-P-1.00F
TB6617FNG	1 ch	50 V	2.0 A	Y	—	Auto	Auto	SSOP16-P-225-0.65B
TB6559FG	1 ch	50 V	2.5 A	Y	Y	Auto	Auto	HSOP16-P-300-1.00
TB6568KQ	1 ch	50 V	3.0 A	Y	—	Latched	Latched	HSIP7-P-2.54A
TB6643KQ*	1 ch	50 V	4.0 A/4.5 A	Y	—	Latched	Latched	HSIP7-P-2.54A
TB6569FG/TB6641FG*	1 ch	50 V	4.0 A/4.5 A	Y	Y	Latched	Latched	HSOP16-P-300-1.00
TB6642FG*	1 ch	50 V	4.0 A/4.5 A	Y	—	Auto/Latched	Auto/Latched	HSOP16-P-300-1.00
TB6561NG/FG	2 ch	40 V	1.5 A	Y	—	Auto	Auto	SDIP24-P-300-1.78/SSOP30-P-375-1.00
TB62212FTAG	2 ch/4 ch	40 V	4.0 A/2.0 A(DC) 1.8 A/1.5 A(ST)	Y	Y	Latched	Latched	QFN48-P-0707-0.50
TB62212FNG	2 ch/4 ch	40 V	4.0 A/2.0 A(DC) 1.8 A/1.5 A(ST)	Y	Y	Latched	Latched	HTSSOP48-P-300-0.50
TB62216FNG/FTG/FG*	2 ch	40 V	2.5 A	Y	Y	Latched	Latched	HTSSOP48-P-300-0.50/QFN48-P-0707-0.50/ HSOP28-P-450-0.80
TB6552FNG/FLG/FTG*	2 ch	15 V	1.0 A	Y	—	Auto	—	SSOP16-P-225-0.65B/QON24-P-0505-0.50/ WQFN16-3030-0.5-0.3
TB6590FTG	2 ch	6 V	0.5 A	Y	—	Auto	—	VQON16-P-0303-0.50
TB6593FNG	1 ch	15 V	3.2 A	Y	—	Auto	—	SSOP20-P-225-0.65A
TB6612FNG	2 ch	15 V	2.8 A	Y	—	Auto	—	SSOP24-P-300-0.65A
TB6614FNG	1 ch	15 V	3.2 A	Y	—	Auto	Auto	SSOP16-P-225-0.65B

Abbreviations: ISD: Overcurrent protection circuitry, TSD: Thermal shutdown circuitry, Auto: Automatic recovery, Latched: Latched recovery, DC: DC motor driver, ST: Stepping motor driver

*: New product

Stepping Motor Drivers

MOTOR SOLUTIONS GUIDE

Next-Generation Stepping Motor Driver Series

Toshiba offers an extensive product portfolio of stepping motor drivers with bipolar constant-current control fabricated using a BiCD process, which provides improved accuracy and high-current drive.

For each current rating, various packaging options are available to meet diverse pc board and assembly requirements.

Current Rating		0.4 A	0.8 A	1.0 A		1.5 A	1.8 A		2.0 A		2.5 to 3.5 A	
Interface		Phase	Clock	Phase	Clock	Phase	Phase	Clock	Phase	Clock	Phase	Clock
Through-Hole	DIP/SDIP	TB6674 PG Full step				TB6562 ANG 1/4 step						
	HZIP											TB6560 AHQ 1/16 step
Surface-Mount	QFN					TB62212 FTAG 1/2 step	TB62208 FTG 1/2 step		TB62218 AFTG 1/4 step	TB62214 AFTG 1/4 step	TB62213 AFTG 1/4 step	TB62215 AFTG 1/16 step
	SSOP/ HQFP	TB6674 FAG Full step	TB6608 FNG 1/8 step			TB6562 AFG 1/4 step						TB6560 AFG 1/16 step
	HSOP	TB6674 FG Full step				TB62206 FG 1/2 step	TB62208 FG 1/2 step	TB62209 FG 1/16 step	TB62218 AFG 1/4 step	TB62214 AFG 1/4 step	TB62213 AFG 1/4 step	TB62215 AFG 1/4 step
	HTSSOP			TB62210 FNG 1/4 step	TB62211 FNG 1/4 step	TB62212 FNG 1/2 step		TB62208 FNG 1/2 step	TB62218 AFNG 1/4 step	TB62214 AFNG 1/4 step	TB62213 AFNG 1/4 step	TB62215 AFNG 1/4 step

Quarter-Step Stepping Motor Drivers

Packaging Options

Toshiba offers packaging options that meet various pc board, application and assembly requirements.



HSOP28-P-450-0.80



QFN48-P-0707-0.50



HTSSOP48-P-300-0.50

Flow-solderable package

The 0.8-mm lead pitch of the HSOP28 makes it ideal for reflow soldering onto paper phenol boards and the like.

Space-saving package

The QFN48 is a small leadless package measuring approx. 7.0 X 7.0 mm. It is ideal for a high-density assembly onto glass-epoxy PCBs.

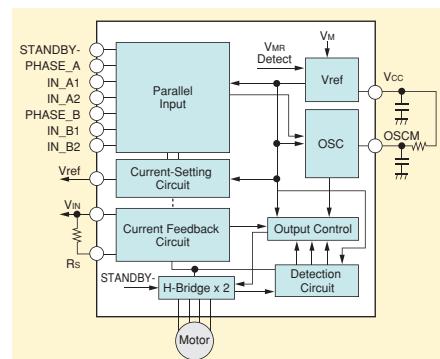
Standard thermally enhanced package

The HTSSOP48 is ideal for board designs where thermal performance is a critical factor.

● TB62210FNG, TB62218AFG/AFTG/AFNG and TB62213AFG/AFTG/AFNG 40 V Single-Channel Phase-In Stepping Motor Drivers

Features

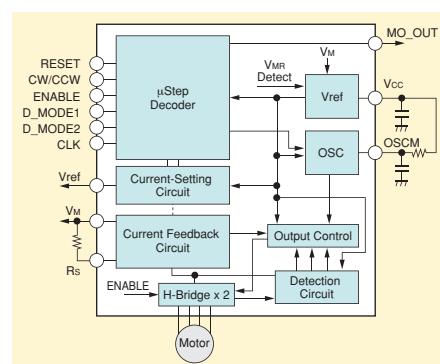
- Output current: 1.0 A (TB62210FNG)
2.0 A (TB62218AFG/AFTG/AFNG)
3.0 A (TB62213AFG/AFTG/AFNG)
- Interface: Phase inputs
- Fabricated using a low-Ron process (40 V 0.6 μ m BiCD process) to achieve high accuracy and high-current capacity.
- Micro-stepping (quarter-step) drive for vibration and acoustic noise reductions
- Mixed Decay mode for reducing current distortions at high RPMs
- Various shutdown circuits for safety precautions (TSD/ISD/POR*)
- * TSD: Thermal shutdown circuitry, ISD: Overcurrent protection circuitry, POR: Power-on reset circuitry
- The on-chip voltage regulator eliminates the need for a logic power supply (VDD).
- The charge pump-less design reduces the number of external components required.



● TB62211FNG, TB62214AFG/AFTG/AFNG and TB62215AFG/AFTG/AFNG 40 V Single-Channel Stepping Motor Drivers with a Clock Input

Features

- Output current: 1.0 A (TB62211FNG)
2.0 A (TB62214AFG/AFTG/AFNG)
3.0 A (TB62215AFG/AFTG/AFNG)
- Interface: Clock input supported by the on-chip micro-step decoder
- Fabricated using a low-Ron process (40 V 0.6 μ m BiCD process) to achieve high accuracy and high-current capacity.
- Micro-stepping (quarter-step) drive for vibration and acoustic noise reductions
- Mixed Decay mode for reducing current distortions at high RPMs
- Various shutdown circuits for safety precautions (TSD/ISD/POR*)
- The on-chip voltage regulator eliminates the need for a logic power supply (VDD).
- The charge pump-less design reduces the number of external components required.



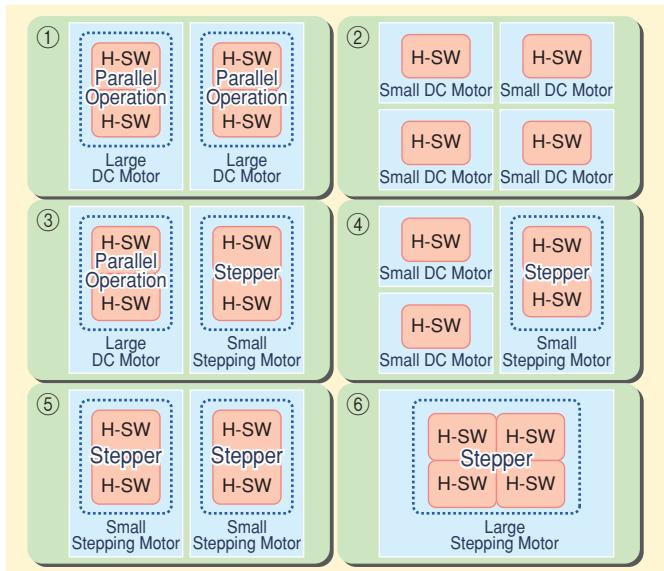
Half-Step Stepping Motor Drivers

● TB62212FTAG/FNG 40 V/2.0 A Configurable 4-Channel H-Bridges (40 V/1.5 A 2-Channel Stepping Motor Drivers)

The TB62212FTAG/FNG contain four channels of H-bridges, making it possible to drive up to two stepping motors or up to four brush DC motors simultaneously. They can also be configured as a dual brush DC motor driver with a maximum current rating of 4.0 A.

Features

- Supports full-step and half-step drives in Stepping mode.
- H-bridges with 6 selectable operating modes
 - ① Two high-power DC motors: Maximum current rating = 4.0 A
 - ② Four low-power DC motors: Maximum current rating = 2.0 A
 - ③ One high-power DC motor + one low-power stepping motor
 - ④ Two low-power DC motor + one low-power stepping motor
 - ⑤ Two low-power stepping motors: Maximum current rating = 1.5 A
 - ⑥ One high-power stepping motor: Maximum current rating = 1.8 A
- Various shutdown circuits: Overcurrent protection, thermal shutdown, power-on reset
- Output R_{on} : 2.2 Ω (high side + low side)
- Packages: QFN48-P-0707-0.50, HTSSOP48-P-300-0.50



Product Lineup

Part Number	Interface	Absolute Maximum Ratings		Stepping Mode	Detection Circuits			Packages
		Output Breakdown	Output Current		POR	ISD	TSD	
TB6674PG/FG/FAG	Phase	24 V	0.4 A/0.4 A/ 0.2 A	Full step	Y	Latched	Auto	DIP16-P-300-2.54A/HSOP16-P-300-1.00/ SSOP16-P-225-1.00A
TB62210FNG	Phase	40 V	1.0 A	1/4 step	Y	Latched	Latched	P-HTSSOP24-0508-0.65-001
TB6562ANG/AFG	Phase	40 V	1.5 A	1/4 step	—	Auto	Auto	SDIP24-P-300-1.78/SSOP30-P-375-1.00
TB62212FTAG/FNG	Phase	40 V	4.0 A/2.0 A (DC) 1.8 A/1.5 A (ST)	1/2 step	Y	Latched	Latched	QFN48-P-0707-0.50/HTSSOP48-P-300-0.50
TB62206FG	Phase	40 V	1.8 A	1/2 step	Y	Latched	Latched	HSOP20-P-450-1.00
TB62208FG/FTG/FNG	Phase	40 V	1.8 A	1/2 step	Y	Latched	Latched	HSOP28-P-450-0.80/QFN48-P-0707-0.50/ HTSSOP48-P-300-0.50
TB62218AFG/AFTG/ AFNG	Phase	40 V	2.0 A	1/4 step	Y	Latched	Latched	HSOP28-P-450-0.80/QFN48-P-0707-0.50/ HTSSOP48-P-300-0.50
TB62213AFG/AFTG/ AFNG	Phase	40 V	3.0 A	1/4 step	Y	Latched	Latched	HSOP28-P-450-0.80/QFN48-P-0707-0.50/ HTSSOP48-P-300-0.50
TB6608FNG	Clock	15 V	0.8 A	1/8 step	Y	—	Auto	SSOP20-P-225-0.65A
TB62211FNG	Clock	40 V	1.0 A	1/4 step	Y	Latched	Latched	P-HTSSOP24-0508-0.65-001
TB62209FG	Clock	40 V	1.8 A	1/16 step	Y	Latched	Latched	HSOP36-P-450-0.65
TB62214AFG/AFTG/ AFNG	Clock	40 V	2.0 A	1/4 step	Y	Latched	Latched	HSOP28-P-450-0.80/QFN48-P-0707-0.50/ HTSSOP48-P-300-0.50
TB62215AFG/AFTG/ AFNG	Clock	40 V	3.0 A	1/4 step	Y	Latched	Latched	HSOP28-P-450-0.80/QFN48-P-0707-0.50/ HTSSOP48-P-300-0.50
TB6560AHQ/AFG/ AFTG	Clock	40 V	3.5 A/2.5 A/ 2.5 A	1/16 step	—	—	Auto	HZIP25-P-1.27/HQFP64-P-1010-0.50/ QFN48-P-0707-0.50

Abbreviations: POR: Power-on reset, ISD: Overcurrent protection circuitry, TSD: Thermal shutdown circuitry, Auto: Automatic recovery, Latched: Latched recovery, DC: DC motor driver, ST: Stepping motor driver

● Transistor Array Series

Transistor arrays designed for stepping motor driving are available with a variety of functions, circuit counts, voltage and current ratings, packages and so on. Small, surface-mount SSOP packages help reduce the size of end products.

Product Lineup

Part Number	# of Circuits	Package	Absolute Maximum Ratings		Structure/Configuration	Remarks	
			Output Voltage	Output Current			
TD62064APG/BP1G	4	DIP16-P-300-2.54A	50 V/80 V	1.5 A/ch	Active-high transistor array	Unipolar constant-voltage drive	
TD62064AFG/BFG		HSOP16-P-300-1.00					
TD62308APG/BP1G		DIP16-P-300-2.54A	50 V/80 V	1.5 A/ch	Active-low transistor array		
TD62308AFG/BFG		HSOP16-P-300-1.00					
TD62003APG/TD62004APG	7	DIP16-P-300-2.54A	50 V	0.5 A/ch	Active-high transistor array	Unipolar constant-voltage drive	
TD62003AFG/TD62004AFG		SOP16-P-225-1.27					
TD62083APG/TD62084APG	8	DIP18-P-300-2.54D	50 V	0.5 A/ch	Active-high transistor array		
TD62083AFG/TD62084AFG		SOP18-P-375-1.27					
TD62083AFNG/TD62084AFNG		SSOP18-P-225-0.65					

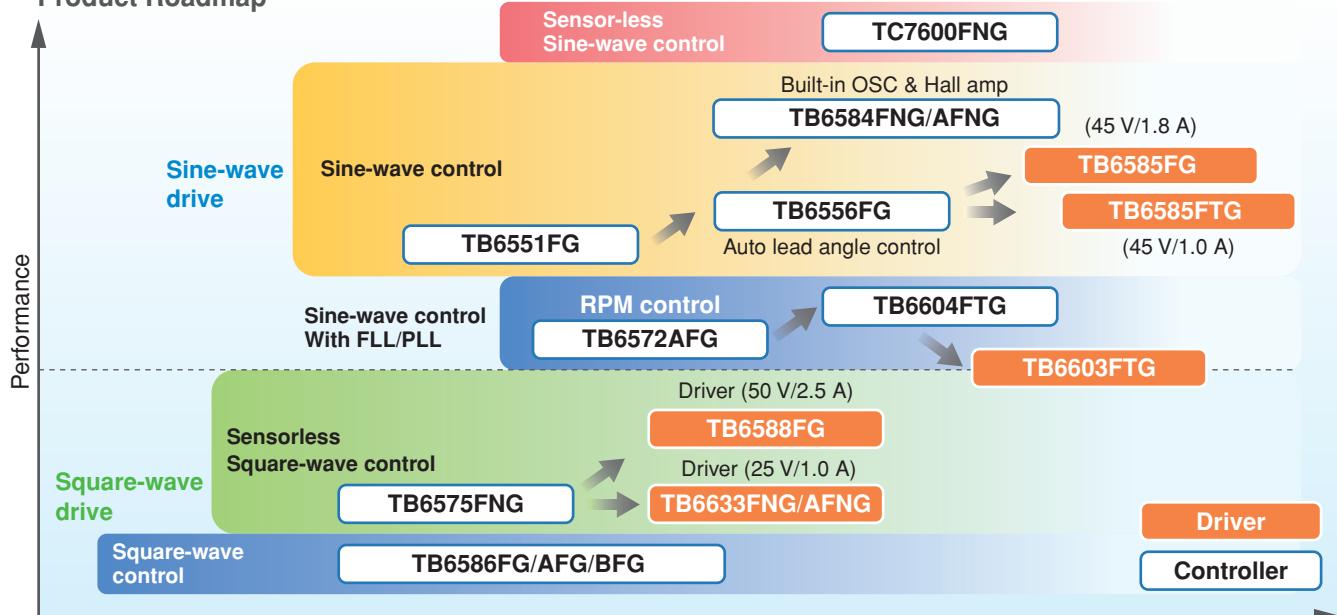
Brushless Motor Drivers

MOTOR SOLUTIONS GUIDE

Brushless Motor Controller and Driver Series

Leveraging sensorless drive and sine-wave drive technologies, Toshiba has been developing a broad array of brushless DC motor drivers ideal for applications that require low power consumption and silent operation.

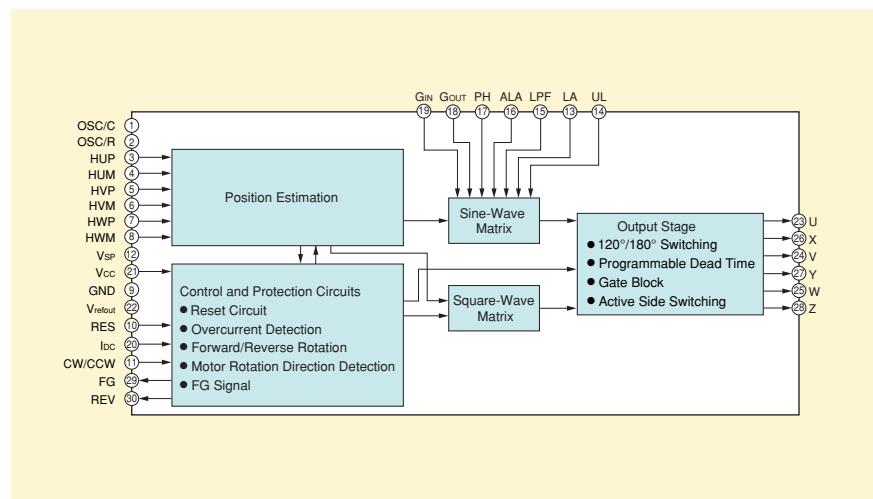
Product Roadmap



TB6584FNG/AFNG 16.5 V/2 mA Sine-Wave PWM Three-Phase Brushless DC Motor Controllers

Features

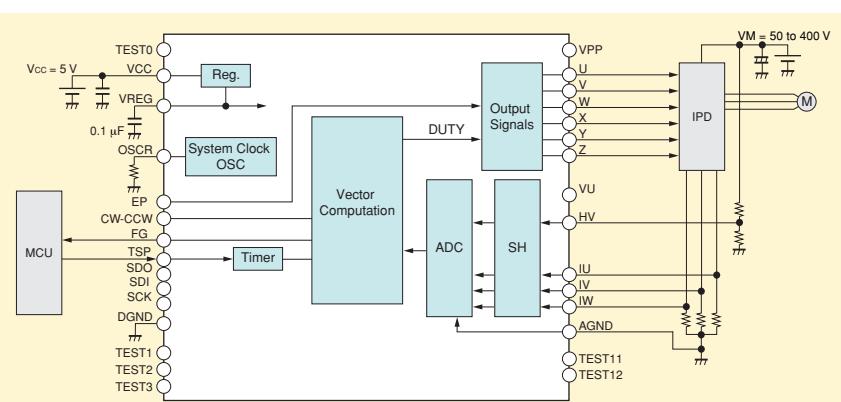
- Sine-wave drive helps to reduce acoustic noise significantly, compared to square-wave (120-degree) drive.
- The lead angle and PWM control capabilities help to improve efficiency and reduce power consumption.
- The lead angle is programmable between 0° and 58° in 32 discrete steps, making it possible to control a motor efficiently through appropriate output driver selection.
- Dead-time insertion is incorporated to prevent cross conduction of high-side and low-side drivers.
- Overcurrent protection, undervoltage lockout and reverse rotation detection
- Small package: SSOP30-P-300-0.65



TC7600FNG 5 V/2 mA Sensorless Sine-Wave PWM Three-Phase Brushless DC Motor Controller

Features

- Sine-wave drive can be used for sensorless control of three-phase brushless DC motors.
- Sine-wave drive helps to reduce acoustic noise and vibration significantly, compared to square-wave (120-degree) drive.
- Small package: SSOP30-P-300-0.65



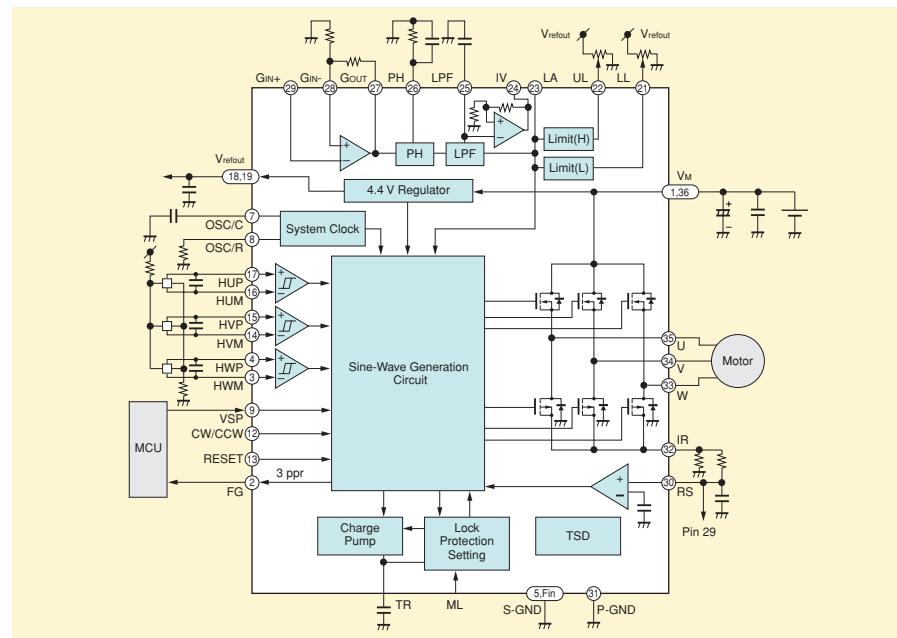
● TB6585FG/FTG 45 V/1.8 A/1.0 A Sine-Wave PWM Three-Phase Brushless DC Motor Drivers

Features

- Sine-wave drive helps to reduce acoustic noise and vibration significantly, compared to square-wave (120-degree) drive.
- Lead angle control helps to improve efficiency.
- The on-chip integration of output drivers reduces the number of external components required.

TB6585FG: 45 V/1.8 A
TB6585FTG: 45 V/1.0 A

- Output R_{on} : 0.7 Ω typ. (high side + low side)
- Small packages
TB6585FG: HSOP36-P-450-0.65
TB6585FTG: QFN48-P-0707-0.5



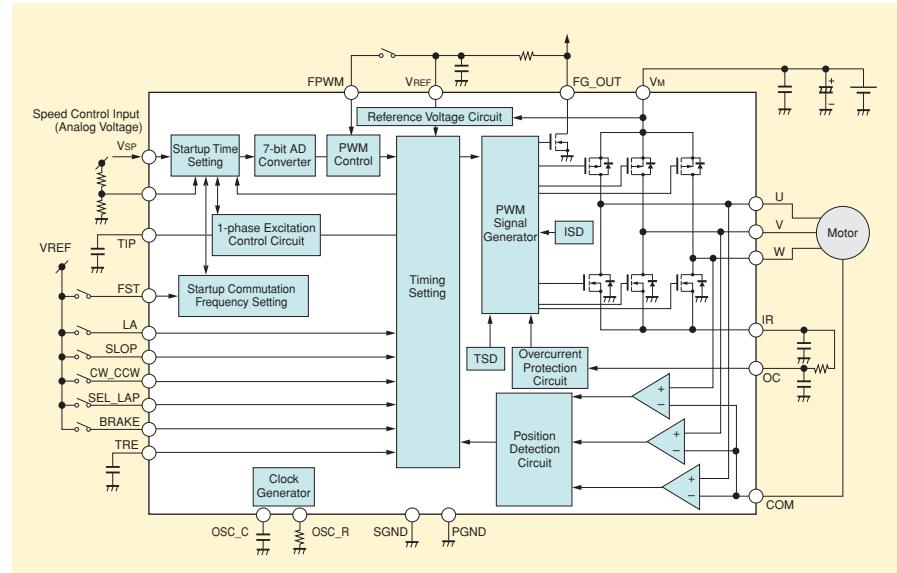
● TB6633FNG/AFNG 25 V/1.0 A Sensorless PWM Three-Phase Brushless DC Motor Drivers

Features

- Combines sensorless drive with PWM drive, facilitating the use of smaller motors (without Hall sensors) and reducing power consumption.
- Three-phase, full-wave sensorless drive eliminates the need for position sensors, reducing wires between a motor and a motor driver.
- The on-chip integration of output drivers reduces the number of external components required.

TB6633FNG/AFNG: 25 V/1.0 A

- The lap turn-on function provides a quiet motor drive.
- FG signal according to the rotation speed
TB6633FNG: 3 pulses per electrical degree
TB6633AFNG: 1 pulse per electrical degree
- Small package
SSOP24-P-300-0.65A



Product Lineup

Part Number	Function	Absolute Maximum Ratings		Commutation	Hall Input	Packages
		Supply Voltage	Output Current			
TB6551FG	Controller	12 V	2 mA	Sine-wave	Hall IC	SSOP24-P-300-1.00
TB6556FG	Controller	12 V	2 mA	Sine-wave	Hall IC	SSOP30-P-375-1.00
TB6586FG/AFG/BFG	Controller	18 V	35 mA	Square-wave (150°)	Hall IC/Hall element	SSOP24-P-300-1.00B
TB6585FG/FTG *	Driver	45 V	1.8 A/1.0 A	Sine-wave	Hall IC/Hall element	HSOP36-P-450-0.65/QFN48-P-0707-0.50
TB6584FNG/AFNG	Controller	18 V	2 mA	Sine-wave	Hall IC/Hall element	SSOP30-P-300-0.65
TB6572AFG	Pre-Driver	30 V	20 mA	Sine-wave	Hall element	QFP52-P-1010-0.65
TB6603FTG	Pre-Driver	30 V	20 mA	Sine-wave	Hall element	QFN36-P-0606-0.50
TB6604FTG	Pre-Driver	30 V	20 mA	Sine-wave	Hall element	QFN48-P-0707-0.50
TC7600FNG	Controller	5.5 V	2 mA	Sine-wave	Sensorless	SSOP30-P-300-0.65
TB6575FNG	Controller	5.5 V	20 mA	Square-wave (142°)	Sensorless	SSOP24-P-300-0.65A
TB6588FG	Driver	50 V	2.5 A	Square-wave (150°)	Sensorless	HSOP36-P-450-0.65
TB6633FNG/AFNG *	Driver	25 V	1.0 A	Square-wave (150°)	Sensorless	SSOP24-P-300-0.65A

*: New product

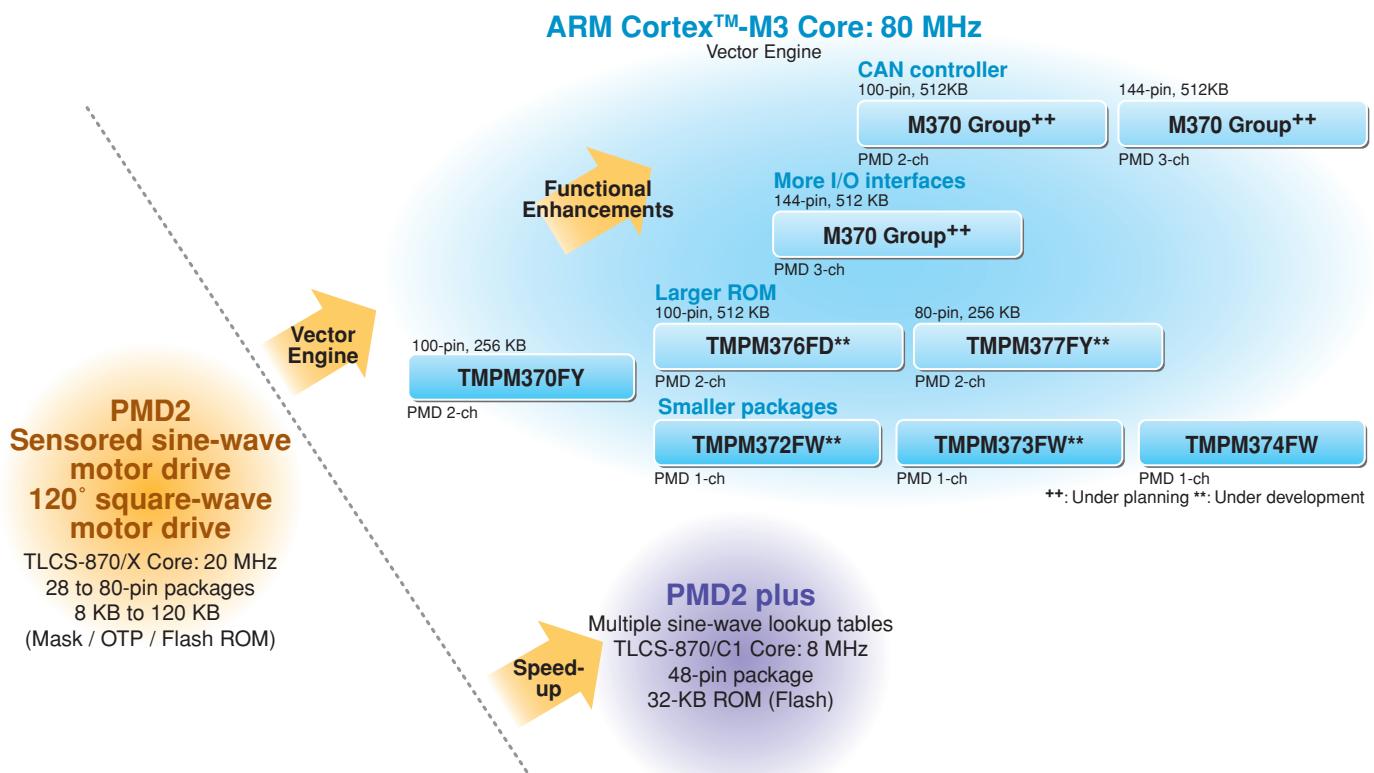
Microcontrollers

MOTOR SOLUTIONS GUIDE

Toshiba offers PMD microcontrollers that contain one or more programmable motor drivers (PMDs) specifically designed for inverter control of three-phase motors, reducing the CPU workload for motor control. There are two kinds of PMD microcontrollers: those with an ARM Cortex™-M3 core that features an integrated vector engine and those with an 8-bit TLCS-870/X or TLCS-870/C1 core that provides 180° commutation via interrupts raised every 60° electrical of rotation.

* ARM and Cortex are trademarks or registered trademarks of ARM Limited in the EU and other countries.

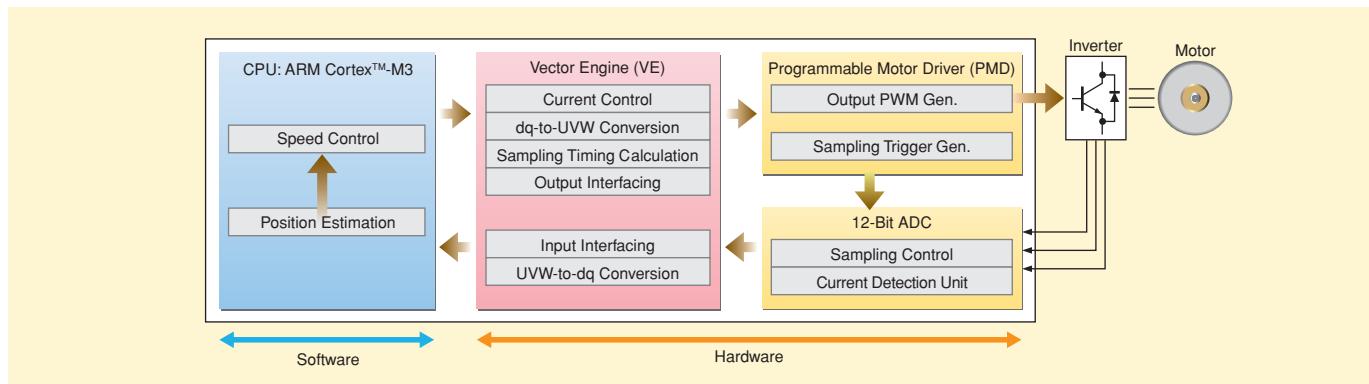
PMD Microcontroller Product Lineup



Vector Engine (VE)

The vector engine is a dedicated hardware unit that automatically performs basic vector control operations (such as coordinate transformations, phase transformations and sine/cosine calculations) and a PI algorithm for current control.

Block Diagram of a Motor Control System (Example)



The vector engine is a computation unit designed to perform various operations for motor vector control. It executes 1) routine operations, 2) peripheral interface operations, and 3) a scheduler that controls the sequence of these operations. Since the vector engine has the capability for performing basic vector control operations (such as coordinate transformations, phase transformations and sine/cosine calculations); a PI algorithm for current control; and PMD and high-speed ADC interface operations, it helps to reduce the software workload significantly. On the other hand, speed control and position estimation operations greatly depend on system configurations and the control methods used; thus, these operations can be freely implemented as software.

TX03 Series: M370 Group [New Products]

TMPPM372FWUG <Under development>/TMPPM373FWDUG <Under development>/ TMPPM374FWUG

PMD microcontrollers with a vector engine

High-efficiency motor control that reduces the CPU workload

ARM Cortex™ M3 Core

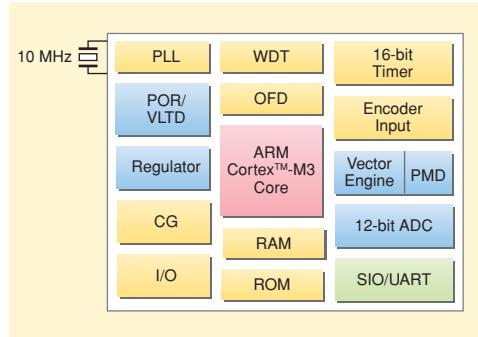
- Operating voltage: 4.5 V to 5.5 V (Single supply; on-chip voltage regulator)
- Maximum operating frequency: 80 MHz (Ta = -40 to 85°C)
32 MHz (Ta = -40 to 105°C)
- On-chip memory: flash ROM: 128 KB, RAM: 6 KB
- High-speed computation: Multiplier (1-7 cycles), divider (2-12 cycles)
- On-chip debug logic: JTAG/SWD/SWV
- Low-power: Clock gearing (Can be divided down to 1/2, 1/4, 1/8 and 1/16)
Operation modes (NORMAL/IDLE/STOP)

On-chip peripheral logic

- Next-generation Programmable Motor Driver (PMD): 1 channel
- Vector engine (VE): 1 unit
- Encoder inputs: 1 channel
- 12-bit A/D converter: conversion time: 2 μ s
- TMPPM372: 11 channels
- TMPPM373: 7 channels
- TMPPM374: 6 channels
- 16-bit timer/counter: 8 channels
(Free-run, output compare, PPG, input capture)
- TMPPM372: 7 inputs and 7 outputs
- TMPPM373: 5 inputs and 3 outputs
- TMPPM374: 4 inputs and 2 outputs
- Serial interface: SIO/UART: 4 channels
* M373/M374: SIO/UART: 3 channels
- Watchdog timer
- Power-on reset (POR)
- Voltage detection circuit (VLTD)
- Oscillation frequency detection (OFD)
- On-chip high-speed oscillator

Packages

- TMPPM372FWUG: LQFP64-P-1010-0.50E
- TMPPM373FWDUG: LQFP48-P-0707-0.50C
- TMPPM374FWUG: LQFP44-P-1010-0.80A



Product Lineup

Part Number	Maximum Operating Frequency (MHz)	ROM (KB)	Motor Controller (ch)	12-Bit A/D Converter (Conversion Time)	Encoder Input Logic (ch)	I/O Ports (ch)	Package
TMPPM370FYDFG	80	Flash 256	2	22 (2 μ s)	2	76	QFP100-P-1420-0.65Q
TMPPM370FYFG	80	Flash 256	2	22 (2 μ s)	2	76	LQFP100-P-1414-0.50H
TMPPM372FWUG **	80	Flash 128	1	11 (2 μ s)	1	53	LQFP64-P-1010-0.50E
TMPPM373FWDUG **	80	Flash 128	1	7 (2 μ s)	1	37	LQFP48-P-0707-0.50C
TMPPM374FWUG	80	Flash 128	1	6 (2 μ s)	1	33	LQFP44-P-1010-0.80A
TMPPM376FDDFG **	80	Flash 512	2	22 (2 μ s)	2	82	QFP100-P-1420-0.65Q
TMPPM376FDFG **	80	Flash 512	2	22 (2 μ s)	2	82	LQFP100-P-1414-0.50H
TMPPM377FYDFG **	80	Flash 256	2	11 (2 μ s)	2	63	LQFP80-P-1414-0.65
TMPPM377FYFG **	80	Flash 256	2	11 (2 μ s)	2	63	LQFP80-P-1212-0.50F

**: Under development

TLCS-870/X and TLCS-870/C1 Series

Product Lineup

Part Number	Maximum Operating Frequency (MHz)	ROM (KB)	Motor Controller (ch)	10-Bit A/D Converter (Conversion Time)	I/O Ports (ch)	Package
TMP88CH40MG	20	16	1	4 (15.6 μ s)	19	SOP28-P-450-1.27B
TMP88CH40NG	20	16	1	4 (15.6 μ s)	19	SDIP28-P-400-1.78
TMP88CH41NG	20	16	1	8 (15.6 μ s)	33	SDIP42-P-600-1.78
TMP88CH41UG	20	16	1	8 (15.6 μ s)	33	LQFP44-P-1010-0.80B
TMP88FH41UG	20	Flash 16	1	8 (15.6 μ s)	33	LQFP44-P-1010-0.80B
TMP88CS42FG	20	64	2	16 (15.6 μ s)	55	QFP64-P-1420-1.00A
TMP88CS42NG	20	64	2	16 (15.6 μ s)	55	SDIP64-P-750-1.78
TMP88CS43FG	20	64	2	16 (15.6 μ s)	71	QFP80-P-1420-0.80B
TMP88FW45AFG	20	Flash 120	2	16 (15.6 μ s)	71	QFP80-P-1420-0.80B
TMP88F846UG	20	Flash 8	1	8 (15.6 μ s)	33	QFP44-P-1010-0.80B
TMP89FM82DUG	8	Flash 32	1	8 (9.75 μ s)	39	LQFP48-P-0707-0.50D

Intelligent Power Devices (IPDs)

MOTOR SOLUTIONS GUIDE

Toshiba offers single-chip 250-V and 500-V motor drivers fabricated using its unique high-voltage Silicon-On-Insulator (SOI) IC process.

Single-Chip Inverters (IPDs): High-Voltage PWM Brushless DC Motor Drivers

Traditionally, a variable-voltage switching power supply was required to drive brushless DC motors. Toshiba's single-chip inverters, fabricated using a high-voltage monolithic process, eliminate the need for a buck converter, making it possible for the brushless DC motors to be directly powered from commercial mains. Single-chip inverters are available in the new DIP26 package, which exhibits improved physical and thermal characteristics compared to the conventional HZIP23 package.

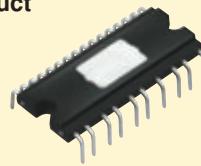
Features

- High withstand voltage due to the use of the SOI process and trench isolation structure
- Available with ratings from 250 V/1 A to 500 V/3 A
- Internal bootstrap power supply for the high-side gate drives

DIP26 Package

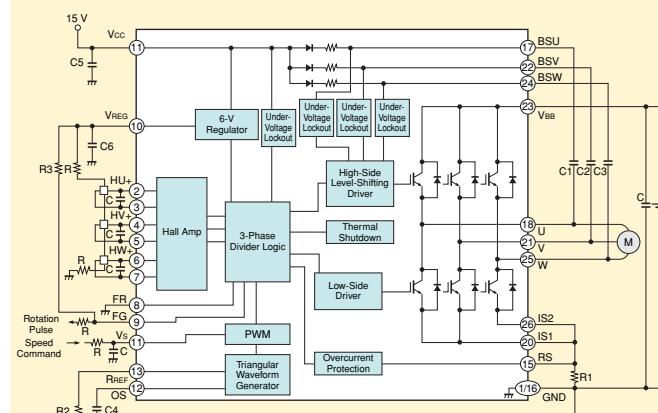
- Package body thickness: 3.8 mm max
- 16 control pins and 10 high-voltage pins are isolated on the opposite sides of the package.
(The complete isolation of these pins simplifies board trace routing.)
- Improved thermal resistance

New Product



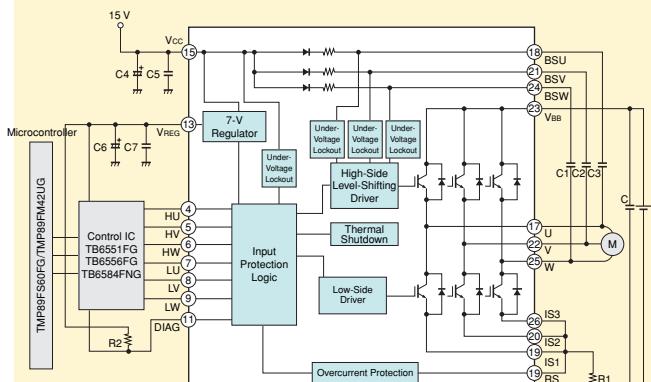
TPD4131K/TPD4132K Block Diagram

- Variable-speed brushless DC motor drive via the Hall amplifier or Hall IC inputs



TPD4123K/TPD4134K/TFD4135K Block Diagram

- Sine-wave drive in combination with a controller
- The TPD4123K, TPD4134K and TPD4135K are pin-compatible and interchangeable according to the motor ratings.



Product Lineup

Part Number	Ratings	Features							
		Hall-Effect Sensor Input	6 Inputs	Three-Phase Distribution	Level Shifter	Overcurrent Protection	Thermal Shutdown	Undervoltage Protection	
TPD4131K	250 V/1 A	Y	—	Y	Y	Y	Y	Y	
TPD4132K	500 V/1 A	Y	—	Y	Y	Y	Y	Y	
TPD4123K	500 V/1 A	—	Y	—	Y	Y	Y	Y	
TPD4123AK	500 V/1 A	—	Y	—	Y	—	Y	Y	
TPD4134K	500 V/2 A	—	Y	—	Y	Y	Y	Y	
TPD4134AK	500 V/2 A	—	Y	—	Y	—	Y	Y	
TPD4135K	500 V/3 A	—	Y	—	Y	Y	Y	Y	
TPD4135AK	500 V/3 A	—	Y	—	Y	—	Y	Y	

Photocouplers

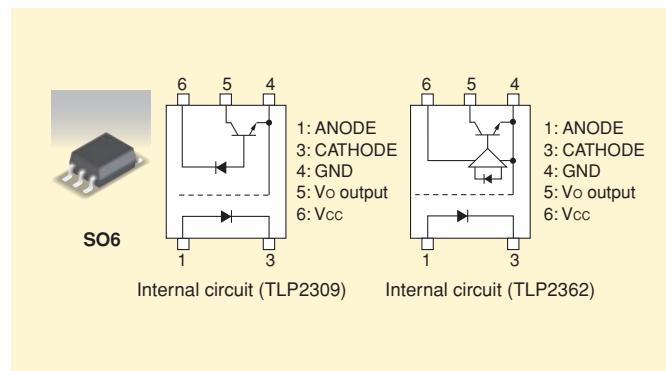
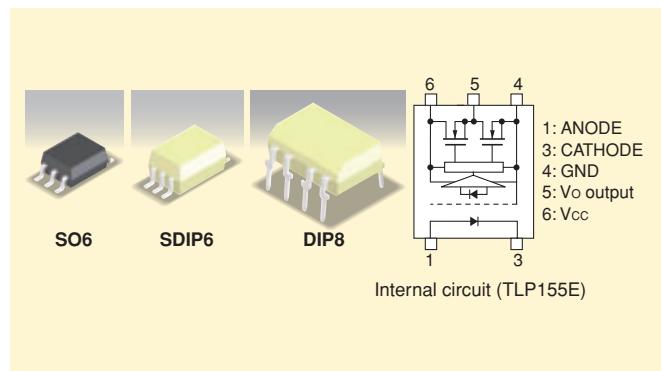
Toshiba is expanding its portfolio of photocouplers so that you can find solutions that best suit your needs. The new additions to our product portfolio include two photocouplers suitable for the gate drive of a power device, the TLP155E in the SO6 small, thin package and the TLP352 featuring high-speed operation and an extended operating temperature range, as well as two photocouplers ideal for high-speed communications, the TLP2309 and TLP2362 with mixed 3.3/5-V supply voltages.

IGBT/Power MOSFET Gate Driver Photocouplers

Characteristics	TLP155E	TLP705A	TLP352
Peak output current (max)	0.6 A	0.6 A	2.5 A
Supply voltage	10 to 30 V	10 to 30 V	15 to 30 V
Propagation delay time (max)	200 ns	200 ns	200 ns
Operating temperature range	−40 to 100°C	−40 to 100°C	−40 to 125°C
Supply current (max)	3 mA	3 mA	3 mA
Threshold input current (max)	7.5 mA	7.5 mA	7.5 mA
Common-mode transient immunity (min)	±15 kV/μs	±15 kV/μs	±15 kV/μs
Isolation voltage (min)	3750 Vrms	5000 Vrms	3750 Vrms
Package	SO6	SDIP6	DIP8

Photocouplers for High-Speed Communications

Characteristics	TLP2309	TLP2362
Data rate (typ.)	1 Mbps	10 Mbps
Supply voltage	2.7 to 20 V	2.7 to 5.5 V
Propagation delay time (max)	0.8 μs	60 ns
Operating temperature range	−40 to 110°C	−40 to 125°C
Current transfer ratio (min)	15%	—
Threshold input current (max)	—	5 mA
Common-mode transient immunity (min)	±15 kV/μs	±15 kV/μs
Isolation voltage (min)	3750 Vrms	3750 Vrms
Package	SO6	SO6



Toshiba America**Electronic Components, Inc.**

- Irvine, Headquarters
Tel: (949)623-2900 Fax: (949)474-1330
- Buffalo Grove (Chicago)
Tel: (847)484-2400 Fax: (847)541-7287
- Duluth/Atlanta
Tel: (770)931-3363 Fax: (770)931-7602
- El Paso
Tel: (915)771-8156
- Marlborough
Tel: (508)481-0034 Fax: (508)481-8828
- Parsippany
Tel: (973)541-4715 Fax: (973)541-4716
- San Jose
Tel: (408)526-2400 Fax: (408)526-2410
- Wixom (Detroit)
Tel: (248)347-2607 Fax: (248)347-2602
- Bloomington
Tel: (952)842-2400 Fax: (952)893-8031
- San Diego
Tel: (858)385-5900 Fax: (858)674-7606

Toshiba Electronics do Brasil Ltda.

Tel: (011)2539-6681 Fax: (011)2539-6675

Toshiba Electronics Europe GmbH

- Düsseldorf Head Office
Tel: (0211)5296-0 Fax: (0211)5296-400
- France Branch
Tel: (1)47282181
- Italy Branch
Tel: (039)68701 Fax: (039)6870205
- Spain Branch
Tel: (91)660-6798 Fax: (91)660-6799
- U.K. Branch
Tel: (0870)060-2370 Fax: (01252)53-0250
- Sweden Branch
Tel: (08)704-0900 Fax: (08)80-8459

Toshiba Electronics Asia (Singapore) Pte. Ltd.

Tel: (6278)5252 Fax: (6271)5155

Toshiba Electronics Service (Thailand) Co., Ltd.

Tel: (02)501-1635 Fax: (02)501-1638

Toshiba Electronics Trading (Malaysia) Sdn. Bhd.

- Kuala Lumpur Head Office
Tel: (03)5631-6311 Fax: (03)5631-6307
- Penang Office
Tel: (04)226-8523 Fax: (04)226-8515

Toshiba India Private Ltd.

Tel: (0124)499-6600 Fax: (0124)499-6611

Toshiba Electronics Asia, Ltd.

- Hong Kong Head Office
Tel: 2375-6111 Fax: 2375-0969
- Beijing Office
Tel: (010)6590-8796 Fax: (010)6590-8791
- Chengdu Office
Tel: (028)8675-1773 Fax: (028)8675-1065
- Qingdao Office
Tel: (532)8579-3328 Fax: (532)8579-3329

Toshiba Electronics (Shenzhen) Co.,Ltd.

Tel: (0755)2399-6897 Fax: (0755)2399-5573

Toshiba Electronics (Shanghai) Co., Ltd.

- Shanghai PUXI Branch
Tel: (021)6139-3888 Fax: (021)6190-8288
- Hangzhou Office
Tel: (0571)8717-5004 Fax: (0571)8717-5013
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Toshiba Electronics (Dalian) Co., Ltd.

Tel: (0411)8368-6882 Fax: (0411)8369-0822

Tsuring Xiamen Xiangyu Trading Co., Ltd.

Tel: (0592)226-1398 Fax: (0592)226-1399

Toshiba Electronics Korea Corporation

- Seoul Head Office
Tel: (02)3484-4334 Fax: (02)3484-4302
- Daegu Office
Tel: (053)428-7610 Fax: (053)428-7617

Toshiba Electronics Taiwan Corporation

- Taipei Head Office
Tel: (02)2508-9988 Fax: (02)2508-9999

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