

Motor Solutions Guide

Serving as the "Heart and Soul" of Motors

Toshiba offers an extensive portfolio of semiconductor devices for small to medium sized motor applications.

The concept of development is to have high efficiency.

Toshiba aims to reduce heat dissipation from semiconductor devices, improve motor drive performance, and reduce size of packages.

Toshiba's innovative technology brings life to the motors, and improves its performance up to its full potential.

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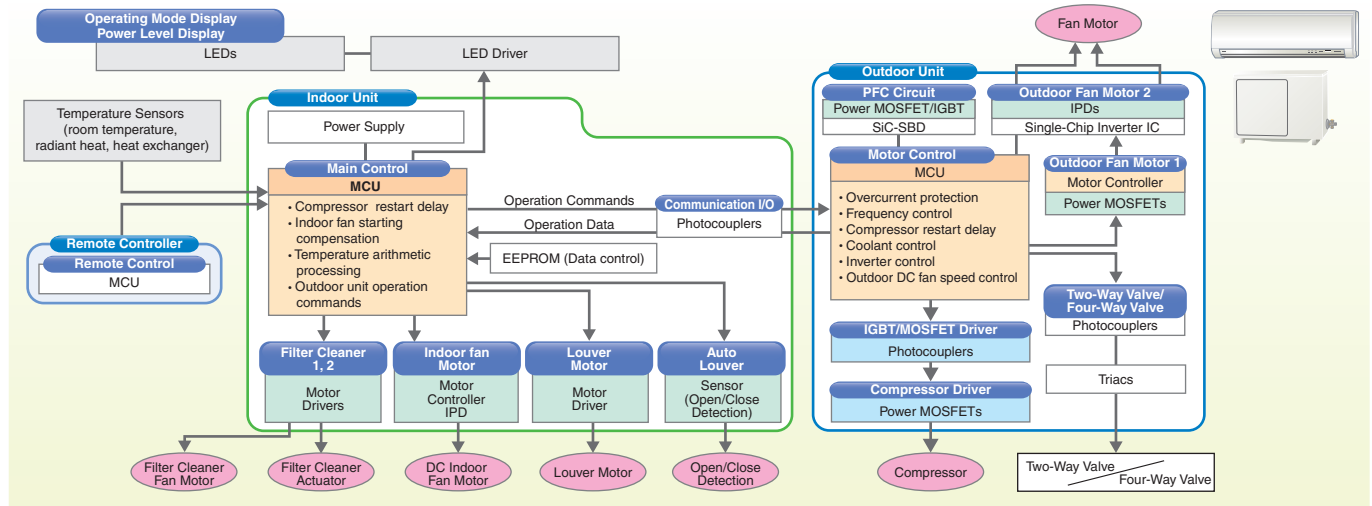
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Home Appliances and Consumer Electronics

Toshiba offers a suite of motor solutions suitable for DC inverter applications that require low power consumption and quiet motor control. Our product portfolio includes motor controllers, motor drivers, microcontrollers with an integrated vector engine, intelligent power devices (IPDs), IGBTs and photocouplers.

Application Example: Air Conditioner



Product Lineup

Applications (Air Conditioner)	Semiconductor	Recommended Devices	Features	End-Product Examples
Motor Control	Microcontrollers	TMPM370, TMPM372, TMPM373 TMPM374, TMPM375, TMPM376 TMPM470, TMPM475	Integrated motor control units (PMD, ADC, Vector Engine (VE)), single 5-V power supply	Refrigerators, air conditioners, automatic washing machines, dishwashers
Main Control	Microcontrollers	TMPM380, TMPM381**, TMPM383** TMPM384	Multipurpose timer for motor and IGBT control (TMPM380, TMPM384) Extensive memory options ROM(Flash): 64 KB to 512 KB RAM: 8 KB to 32 KB	
Compressor Drive	Power MOSFETs	TK16A60W5, TK20A60W5	DTMOSIV (HSD): With high-speed diodes	
PFC Circuitry for Air-Conditioner Outdoor Units	IGBTs	GT15J341, GT20J341, GT30J341	Low loss and low noise	
	IGBTs	GT30J122A, GT20J121	Low loss	
	Power MOSFETs	TK16A60W, TK20A60W, TK25A60X	DTMOSIV, DTMOSIV-H	
Indoor Fan Motor	SIC Schottky Barrier Diodes	TRS6E65C, TRS8E65C TRS6A65C, TRS8A65C	650-V V _{RRM} , maximum forward voltage (V _F) of 1.7 V	
	Motor Controllers/Drivers	TB67B000	Brushless DC motor driver; sine-wave current control	
		TB6584, TB6584A, TB6551 TB6631, TB6634	Brushless DC motor controller; sine-wave current control	
		TB6586, TB6586A, TB6586B	Brushless DC motor controller	
Outdoor Fan Motor	IPDs	TPD4151K, TPD4142K TPD4146K, TPD4152K/F**	High-voltage, high-current pins and control pins are placed on the opposite sides of a package to provide electrical isolation. 600-V IPDs housed in a small surface-mount package (TPD4152F)	
	Power MOSFETs	TK5P60W5, TK7P60W5, TK8P60W5	DTMOSIV (HSD): With high-speed diodes	
	Motor Controllers/Drivers	TB67B000	Brushless DC motor driver; sine-wave current control	
		TB6584, TB6584A, TB6551 TB6631, TB6634	Brushless DC motor controller; sine-wave current control	
Indoor Louver Motor	Motor Controllers/Drivers	TB6586, TB6586A, TB6586B	Brushless DC motor controller	
		TPD4123K/AK, TPD4144K/AK TPD4135K/AK, TPD4203F**, TPD4204F**	High-voltage, high-current pins and control pins are placed on the opposite sides of a package to provide electrical isolation. 600-V IPDs housed in a small surface-mount package (TPD4203F, TPD4204F)	
		TBD62003A	Transistor array	
		TB62210, TB62211, TC78S600 TB62261, TB62262, TB6608	Two-phase stepping motor driver	
Indoor Filter Cleaner Motor 1	Motor Controllers/Drivers	TC78H600, TC78H610, TB6552	Full-bridge driver for a brushed DC motor	
Indoor Filter Cleaner Motor 2	Motor Controllers/Drivers	TB6585, TB6585A, TC78B016**	Brushless DC motor driver; sine-wave current control	
IGBT/MOSFET Drivers for Air-Conditioner Outdoor Units	Photocouplers	TB6608, TC78S600	Stepping motor driver; 3-bit microstepping	
		TLP152, TLP155E TLP5214, TLP5751 TLP5752, TLP5754	Direct drive of an IGBT or a power MOSFET Peak output current: 0.6 A to 4.0 A Small low-cost SO6: 0.6-A output (TLP155E), 2.5-A output (TLP152) High isolation voltage: 5 kVrms Low-loss photocoupler in SO6L with a 1- to 4-A output (TLP5751), Photocoupler in SO16L with a 4-A output and Overcurrent protection (TLP5214)	Air conditioners, refrigerators

** : Under development

Toshiba's Unique Technologies

Motor drivers

- **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.

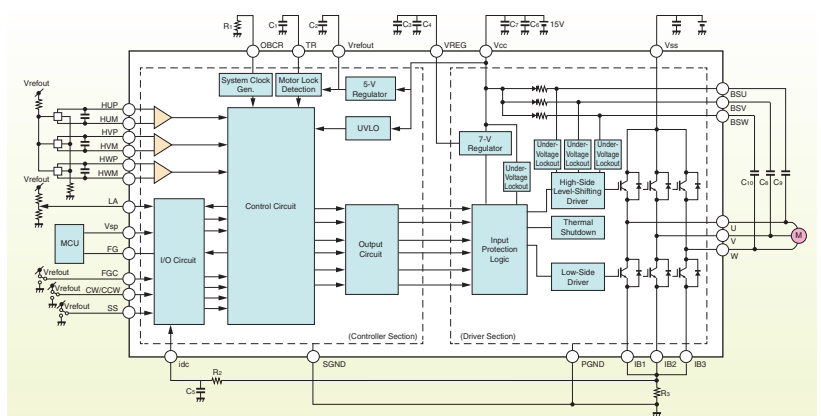
Microcontrollers

- **Vector control:** The hardware specifically designed for vector control enables sensorless sine-wave drive.

Product Overview

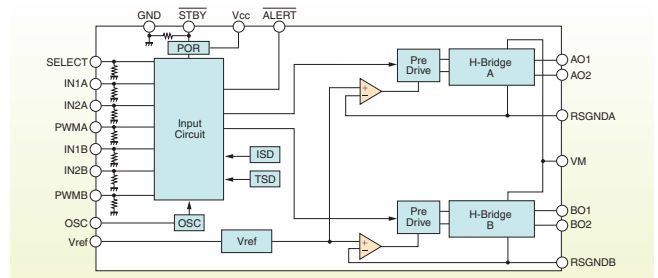
500-V Sine-Wave BLDC Motor Driver (TB67B000HG)

- High-voltage sine-wave driver (500 V/2.0 A, sine- and square-wave drive)
- Lead angle control (via an external input)
- On-chip power supply for Hall sensors and Hall ICs
- On-chip oscillator (external resistor required)
- Motor lock protection
- Current limiter
- Thermal shutdown (TSD)
- Through-hole package: HDIP30



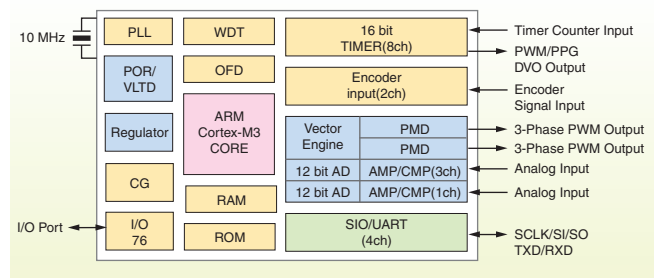
Two-Channel Brushed DC Motor Drivers (TC78H600FTG/FNG)

- Absolute maximum ratings: 18 V/1.0 A
- Supports direct and constant-current PWM
- Output Ron: 1.2 Ω typ. (high side + low side)
- Standby function
- Cross-conduction protection
- Small packages: WQFN24, SSOP20



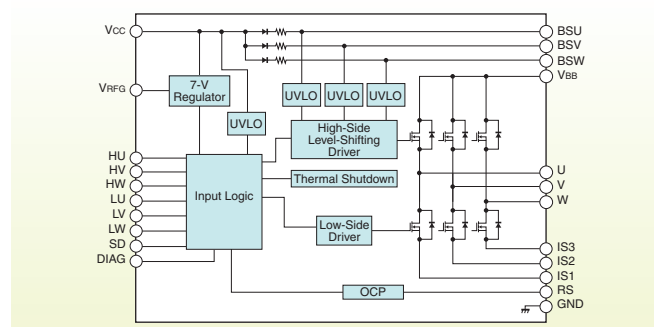
Microcontrollers with Vector Engine (TMPM370FYFG/FYDFG)

- Incorporates Toshiba's original Vector Engine (VE) that implements part of the motor vector control function in hardware
- High-performance ARM[®] Cortex[®]-M3 core with a clock rate of up to 80 MHz
- High-speed programming into Toshiba's original on-chip NANO FLASH[™] memory
- Various analog circuits (comparator, op-amp)
- 12-bit AD converter
- Compliant with the IEC 60730 standard of the International Electrotechnical Commission
- 5-V single power supply



600-V Withstand Voltage Intelligent Power Device (TPD4204F)

- 3-phase brushless DC motor driver
- Absolute maximum ratings: 600 V/2.5 A
- Low-loss type with integrated Toshiba MOSFET chip
- Various protection features: Undervoltage lockout (UVLO), thermal shutdown (TSD), overcurrent protection (OCP)
- Small surface-mount package: SOP30



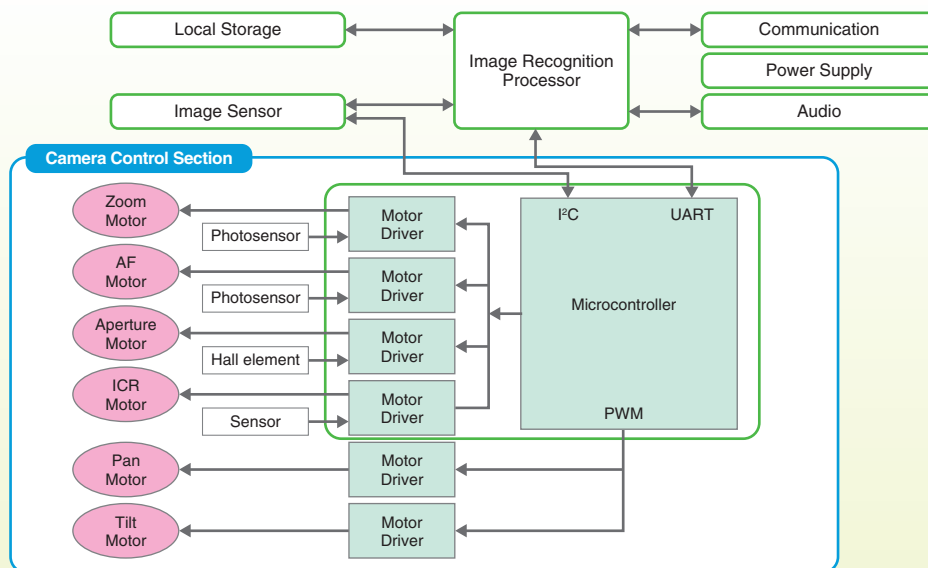
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Mobile and Compact Equipment

Toshiba offers a portfolio of semiconductor devices ideal for mobile and compact applications requiring low power consumption and small form factor.

Application Example: Surveillance Camera



Product Lineup

Applications	Semiconductor	Recommended Devices	Features	End-Product Examples
Motor Control	Microcontrollers	TMPM342 TMPM343	ARM Cortex-M3 core (50 MHz max) 12-bit AD converter, 10-bit DA converter High-resolution programmable pulse generator (PPG) with a 5-ns resolution 2-phase input pulse counter Programmable servo/sequence controller (PSC) Microstep control and H-switch driver Analog circuits for various sensors	Digital video cameras, digital still cameras, surveillance cameras, camera lenses
		TMPM440	ARM Cortex-M4F core (100 MHz max) 12-bit AD converter, 10-bit DA converter Improved performance thanks to multiple computing units (MAC, FPU, PSC)	Digital video cameras, digital single-lens reflex camera, surveillance cameras, home appliances, audio equipment, sensor applications, printers, communications equipment
Lens Drive Actuator Drive	Brush motor drivers/ Stepping motor drivers	TB6614	Single-bridge, absolute maximum ratings: 15 V/1.2 A	
		TB6552	Dual-bridge, absolute maximum ratings: 15 V/1.0 A	
		TB6612	Dual-bridge, absolute maximum ratings: 15 V/1.2 A	
		TB6613	8 channels, 6-bit microstepping, dual motor drive, serial interface	
		TB6608	8 microsteps, constant-current drive, absolute maximum ratings: 15 V/0.8 A	
		TC78S600	16 microsteps, constant-current drive, absolute maximum ratings: 18 V/1.0 A	
		TC78H600, TC78H610	Dual-bridge, absolute maximum ratings: 18 V/1.0 A	
Pan/Tilt Drive	Stepping motor drivers	TB62261, TB62262	4 microsteps, constant-current drive, absolute maximum ratings: 40 V/1.8 A (FTAG: 1.5 A)	Digital still cameras, surveillance cameras, network ip cameras, camera lenses, small scanners, mini printers
		TB67S213, TB67S215	4 microsteps, constant-current drive, absolute maximum ratings: 40 V/2.5 A	
		TB67S101A, TB67S102A	4 microsteps, constant-current drive, absolute maximum ratings: 50 V/4.0 A	
		TC78S600	16 microsteps, constant-current drive, absolute maximum ratings: 18 V/1.0 A	
		TB62269	16 microsteps, constant-current drive, absolute maximum ratings: 40 V/1.8 A	
		TB6560A	16 microsteps, constant-current drive, absolute maximum ratings: 40 V/2.5 A	
		TB67S269	16 microsteps, constant-current drive, absolute maximum ratings: 50 V/2.0 A	
		TB67S109A	16 microsteps, constant-current drive, absolute maximum ratings: 50 V/4.0 A	
		TB6600	16 microsteps, constant-current drive, absolute maximum ratings: 50 V/5.0 A	
		TB62212	4-channel H-bridges for driving two stepping motors	

Toshiba's Unique Technologies

Motor drivers

- Reduced power consumption due to the use of a new process technology:
Products with an LDMOS output stage featuring low power consumption
- Significantly reduced power loss and heat dissipation from the output stage: TB6600HG/FG: $R_{on} = 0.4 \Omega$ typ. (high side + low side)
- Reduced vibration due to the use of a high-resolution microstep sine-wave driver: Up to 64 microsteps (TB6613)
- Small packages: Available in leadless WQFN packages

Microcontrollers

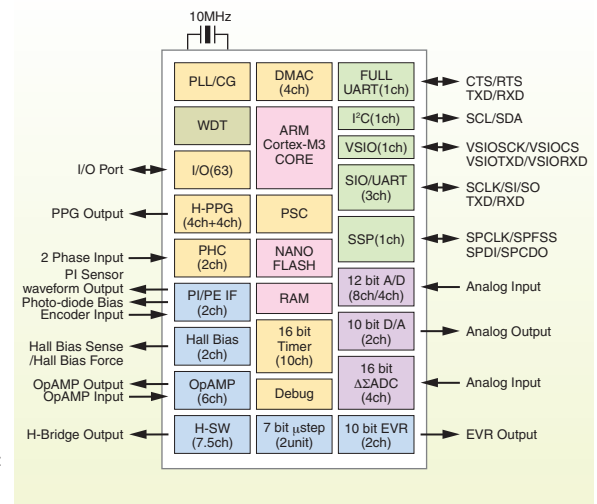
- Programmable servo/sequence controller (PSC): MCU with Toshiba's original coprocessor specifically designed for computing operations
- Ultrasonic-motor control and piezoelectric actuator support: PPG outputs with maximum resolution of 5 ns.

Product Overview

Motor Control Microcontroller (TPMP342FYXBG)

The TPMP342FYXBG incorporates analog circuits required for camera shake correction, lens control and overall system control. The high-performance ARM Cortex-M3 core provides high-speed computation. Additionally, a high-resolution programmable phase generator (PPG) enables smooth and quiet motor operation.

- ARM Cortex-M3 core
 - Supply voltage: 2.7 to 3.6 V (regulated on-chip)
 - Maximum operating frequency: 40 MHz
 - On-chip memory: 256-KB Flash ROM
32-KB SRAM
- Motor driver
 - Operating voltage: 2.5 V to 5.5 V max (with the driver on)
3.1 V to 3.5 V (peripheral analog blocks)
- On-chip peripherals
 - PSC: 2 KB (instruction) + 2 KB (data) per unit
 - 16-bit delta-sigma AD converter:
1 unit (4 differential channels)
 - 12-bit AD converters:
2 units (8 channels + 4 channels)
 - 10-bit DA converter: 2 channels
 - DMA controller: 4 channels
 - 16-bit timer:
8 high-speed channels + 10 channels
 - Two-phase input pulse counter:
2 channels
 - H-switch driver: 7.5 channels
(plus two 7-bit microstep controllers)
 - Hall Bias Control: 2 units
 - Op-amp: 6 channels
 - PI-PE interface: 2 channels
 - 10-bit electrical variable resistance (EVR):
2 units

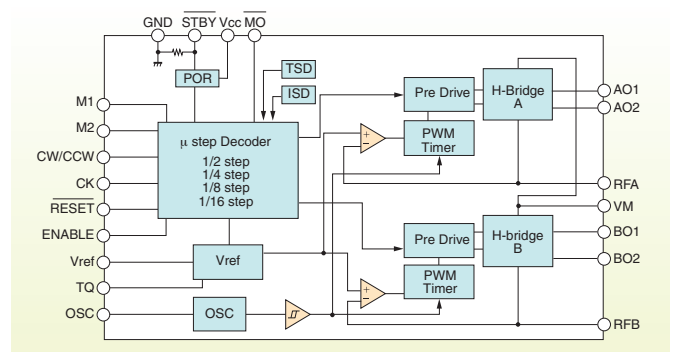


Abbreviations: PI: Photo Interrupter PE: Photo Encoder

Low-Voltage Stepping Motor Drivers (TC78S600FTG/FNG)

The TC78S600FTG/FNG supports half-, quarter-, 1/8- and 1/16-step motor drive modes, and forward/reverse direction control.

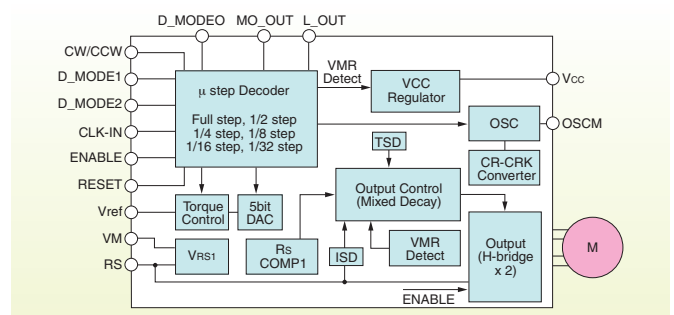
- Motor supply voltage (VM): 15 V max
- Control supply voltage (Vcc): 2.7 V to 5.5 V (operating range)
- Output current (Iout): 0.8 A max
- Output R_{on} : 1.2 Ω typ. (high side + low side)
- Microstep control circuit (with a clock input)
- Half-, quarter-, 1/8- and 1/16-step drive modes
- Internal pulldown resistors on input pins: 200 k Ω typ.
- Monitor output (MO) pin
- Overcurrent detection (ISD), thermal shutdown (TSD), undervoltage lockout (UVLO)
- Packages: WQFN24, SSOP20



PWM Bipolar Stepping Motor Driver (TB67S269FTG)

The TB67S269FTG is rated at 50 V/2.0 A. The internal voltage regulator allows control of a motor with a single VM power supply.

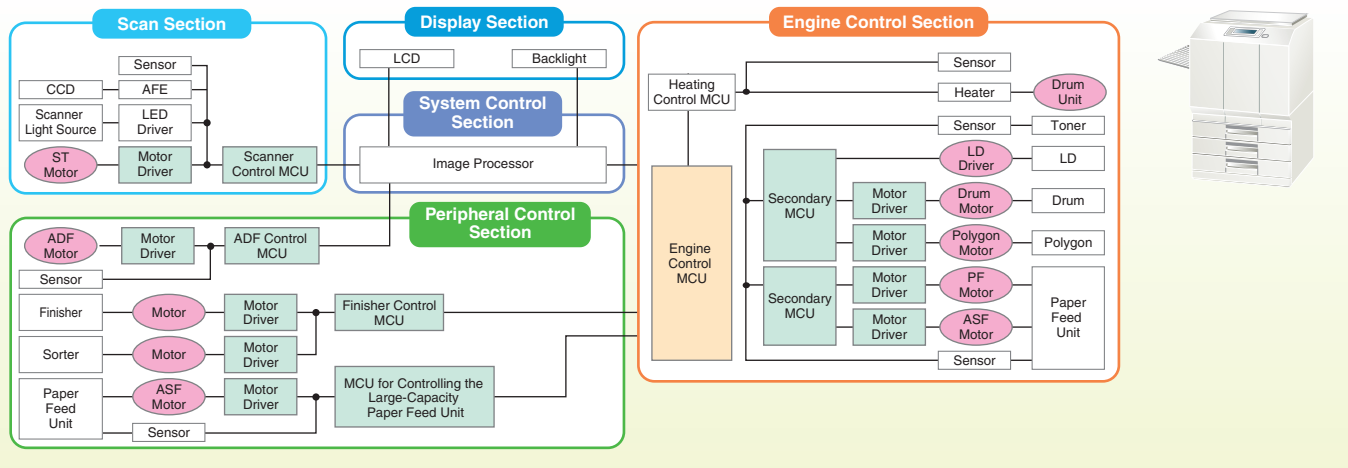
- Single-chip drive control of a bipolar stepping motor
- PWM constant-current drive
- Full-, half-, quarter-, 1/8-, 1/16- and 1/32-step drive modes
- Output R_{on} : 0.8 Ω typ. (high side + low side)
- Thermal shutdown (TSD), overcurrent detection (ISD), VM power-on reset (POR)
- Operates with only the VM power supply because of the on-chip Vcc regulator for internal circuitry
- Chopping frequency programmable via external resistor and capacitor
- High-efficiency constant-current control (Advanced Dynamic Mixed Decay)
- Package: WQFN48



Office Equipment

Toshiba offers various semiconductor devices for motor applications that embody its unique motor control technologies. These devices make it possible to optimize high-precision, high-speed motor control for office equipment applications.

Application Example: Printer



Product Lineup

Applications (MFP)	Semiconductor	Recommended Devices	Features	End-Product Examples
Engine Control Section	Microcontrollers	TMPM362	ARM Cortex-M3 core (64 MHz max), 18 serial channels, Sixteen 16-bit timer channels, Consumer Electronics Control (CEC) interface, remote control preprocessor	Multifunction printers, printers, audio-visual (AV) equipment, digital equipment, PC peripherals, industrial equipment, networking equipment, office equipment
		TMPM369	ARM Cortex-M3 core (80 MHz max), multipurpose timer suitable for various motor and IGBT control, USB, USB Embedded Host, dual AD converter, programmable motor driver (PMD), CAN, EtherMAC	
		TMPM461 TMPM462	ARM Cortex-M4F core (120 MHz max), multipurpose timer suitable for various motor and IGBT control, 3 DMA units, 20 serial channels, CEC interface, remote control preprocessor, large-capacity memory	
	Stepping Motor Drivers (Bipolar)	TB62211, TB62214A TB62215A, TB62262	Clock input, micro-stepping drive (1/4 step)	Plain paper copiers (PPCs), printers, fax machines, vending machines, ATMs, amusement equipment, card readers, bank note recognition machines, etc.
		TB67S102A	Clock input, micro-stepping drive (1/4 step), ADMD	
		TB62210, TB62218A TB62213A, TB62261	Phase inputs, micro-stepping drive (1/4 step)	
		TB67S101A, TB67S261	Phase inputs, micro-stepping drive (1/4 step), ADMD	
		TB62269	Clock input, micro-stepping drive (1/32 step)	
		TB67S109A, TB67S269	Clock input, micro-stepping drive (1/32 step), ADMD	
		TB67S141	Phase input interface, 84 V/3.0 A, micro-stepping drive (1/4 step)	
	Stepping Motor Drivers (Unipolar)	TB67S142	Clock input interface, 84 V/3.0 A, micro-stepping drive (1/4 step)	
		TB67S149	Clock input interface, 84 V/3.0 A, micro-stepping drive (1/32 step)	
	Stepping Motor Drivers/Brush Motor Drivers	TB62212	Phase inputs, micro-stepping drive (1/2 step), Four on-chip H-bridge channels allow control of either up to four brushed DC motors or up to two stepping motors.	
Scanner Peripheral Control Section	Microcontrollers	TMPM036, TMPM037	ARM Cortex-M0 core (20 MHz max), DMA (2 units in TMPM036, 1 unit in TMPM037), bit-banding	Multifunction printers, printers, audio-visual (AV) equipment, digital equipment, PC peripherals, industrial equipment, networking equipment, office equipment
		TMPM36B	ARM Cortex-M3 core (80 MHz max), multipurpose timer, suitable for various motor and IGBT control, PMD, 2 DMA units, remote control preprocessor	
		TMPM330	ARM Cortex-M3 core (40 MHz max), CEC interface, remote control preprocessor	
		TMPM361	ARM Cortex-M3 core (64 MHz max), CEC interface, remote control preprocessor, large-capacity memory	
		TMPM461 TMPM462	ARM Cortex-M4F core (120 MHz max), multipurpose timer, suitable for various motor and IGBT control, 3 DMA units, 20 serial channels, CEC interface, remote control preprocessor, large-capacity memory	
	Stepping Motor Drivers (Bipolar)	TB62211, TB62214A TB62215A, TB62262	Clock input, micro-stepping drive (1/4 step)	Plain paper copiers (PPCs), printers, fax machines, vending machines, ATMs, amusement equipment, card readers, bank note recognition machines, etc.
		TB67S102A	Clock input, micro-stepping drive (1/4 step), ADMD	
		TB62210, TB62218A TB62213A, TB62261	Phase inputs, micro-stepping drive (1/4 step)	
		TB67S101A, TB67S261	Phase inputs, micro-stepping drive (1/4 step), ADMD	
		TB62269	Clock input, micro-stepping drive (1/32 step)	
		TB67S109A, TB67S269	Clock input, micro-stepping drive (1/32 step), ADMD	
		TB67S141	Phase input interface, 84 V/3.0 A, micro-stepping drive (1/4 step)	
	Stepping Motor Drivers (Unipolar)	TB67S142	Clock input interface, 84 V/3.0 A, micro-stepping drive (1/4 step)	
		TB67S149	Clock input interface, 84 V/3.0 A, micro-stepping drive (1/32 step)	
	Brush Motor Drivers	TB6568, TB6643	Single full bridge, direct PWM control	
		TB6569, TB6641	Single full bridge, emergency output, Direct PWM control, Constant-current PWM control	
		TB67H303	Direct PWM control, Constant-current PWM control, Standby function	
		TB67H400A	Dual full bridge, Constant-current PWM control, Direct PWM control, Parallel control of two channels (Large mode)	

Toshiba's Unique Technologies

Motor drivers

- 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: TB67S269FTG: $R_{on} = 0.8 \Omega$ typ. (high side + low side)
- Reduced vibration due to the use of a high-resolution microstep sine-wave driver: TB67S269FTG: 32 microsteps
- Small packages: Leadless WQFN packages
- High-efficiency control of a high-rpm motor: Advanced Mixed Decay (ADMD) technology

Product Overview

50-V/2.0-A Bipolar Stepping Motor Drivers (TB67S261FTG, TB67S265FTG, TB67S269FTG)

- Full-, half-, quarter- and 1/8-step drive modes (TB67S269), 1/16-step drive mode (TB67S269), 1/32-step drive mode (TB67S269)
- Output R_{on} : 0.8Ω typ. (high side + low side)
- Thermal shutdown (TSD), overcurrent detection (ISD), VM power-on reset (POR)
- Supports a clock input and a phase-input interface
- Package: WQFN48

84-V/3.0-A Unipolar Stepping Motor Drivers (TB67S141FTG/HG/NG, TB67S142FTG/HG/NG, TB67S145FTG, TB67S149FTG/FG**/HG)

- Requires no current-sensing resistor
- Full-, half-, quarter- and 1/8-step drive modes (TB67S149), 1/16-step drive mode (TB67S149), 1/32-step drive mode (TB67S149)
- Output R_{on} : 0.25Ω typ.
- Thermal shutdown (TSD), overcurrent detection (ISD), VM power-on reset (POR)
- Supports a clock input and a phase-input interface
- Package: WQFN48, HSSOP28, HZIP25, SDIP24

50-V/4.0-A Two-Channel Brushed DC Motor Drivers (TB67H400AFTG/FNG/HG/NG)

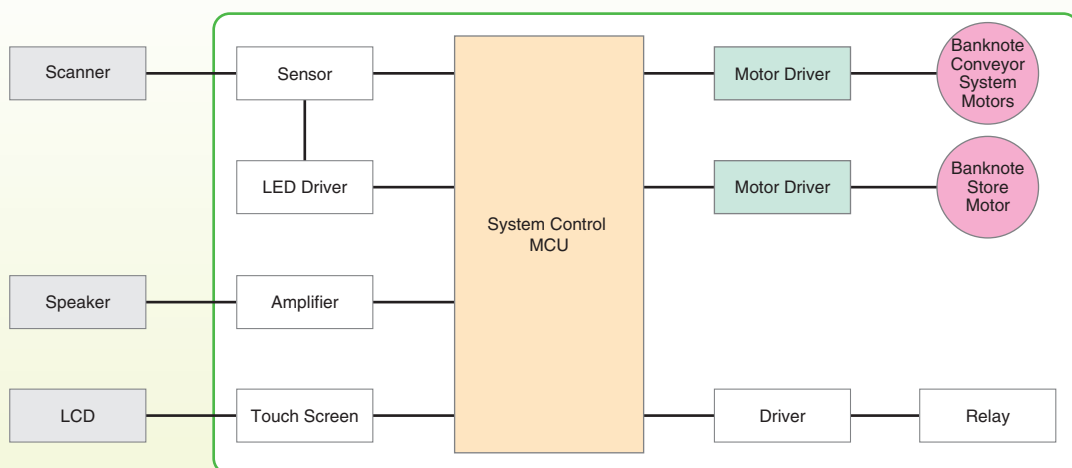
- Configurable as an 8.0-A single-channel motor driver in Large mode
- Output R_{on} : 0.49Ω typ. (high side + low side)
- Thermal shutdown (TSD), overcurrent detection (ISD), VM power-on reset (POR)
- Package: WQFN48, HTSSOP48, HSOP28, HZIP25, SDIP24

** : Under development

Industrial Applications

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

Application Example: Currency Counter



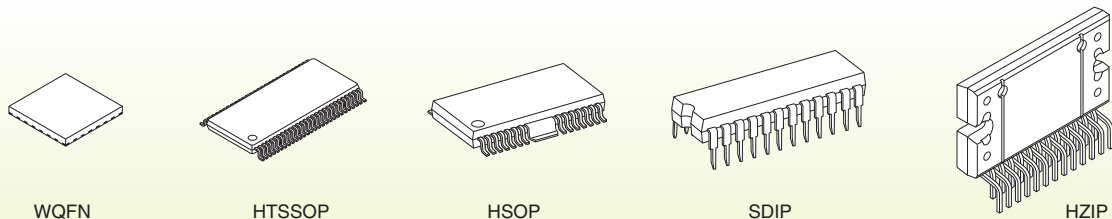
Product Lineup

Applications	Semiconductor	Recommended Devices	Features	End-Product Examples
Motor Controller	Stepping Motor Drivers (Unipolar)	TB67S141	Phase input interface, 84 V/3.0 A, 1/4 step	Currency counters, banking terminals, industrial weaving machines, sewing machines, embroidery machines, surface-mounting machines, POS systems, ticket-vending machines, amusement equipment
		TB67S142	Clock input interface, 84 V/3.0 A, 1/4 step	
		TB67S145	Serial input interface, 84 V/3.0 A, 1/2 step	
		TB67S149	Clock input interface, 84 V/3.0 A, 1/32 step	
		TB67S158	Various interface modes, 80 V/1.5 A, 2 channels, 1/2 step	
	Stepping Motor Drivers (Bipolar)	TB62261	Phase input interface, 40 V/1.8 A, 1/4 step	
		TB62262	Clock input interface, 40 V/1.8 A, 1/4 step	
		TB62269	Clock input interface, 40 V/1.8 A, 1/32 step	
		TB67S213	Phase input interface, 40 V/2.5 A, 1/4 step	
		TB67S215	Clock input interface, 40 V/2.5 A, 1/4 step	
		TB67S261	Phase input interface, 50 V/2.0 A, 1/4 step	
		TB67S265	Serial input interface, 50 V/2.0 A, 1/2 step	
		TB67S269	Clock input interface, 50 V/2.0 A, 1/32 step	
		TB67S101A	Phase input interface, 50 V/4.0 A, 1/4 step	
		TB67S102A	Clock input interface, 50 V/4.0 A, 1/4 step	
		TB67S103A	Serial input interface, 50 V/4.0 A, 1/32 step	
		TB67S105	Serial input interface, 50 V/3.0 A, 1/2 step	
		TB67S109A	Clock input interface, 50 V/4.0 A, 1/32 step	
		TB6600	Clock input interface, 50 V/5.0 A, 1/16 step	
	Brush Motor Drivers	TB67H301	40 V/3.0 A	General-purpose inverters, servo amplifiers, industrial sewing machines
		TB67H302	50 V/5.0 A, 2 ch	
		TB67H303	50 V/10 A	
		TB67H400A	50 V/4.0 A, 2 ch *In Large mode (single channel): 50 V/8.0 A	
		TB67H410	50 V/2.5 A, 2 ch *In Large mode (single channel): 50 V/5.0 A	
	Photocouplers	TLP5214, TLP5754	Direct drive of an IGBT or a power MOSFET Peak output current: 4.0 A, Isolation voltage: 5 kVrms Overcurrent protection (TLP5214), rail-to-rail output (TLP5754)	
		TLP2345, TLP2348	Direct IPM drive, Supply voltage: 4.5 V to 30 V High speed: 10 Mbps, Small SO6 package, active-high IPM input (TLP2345), active-low IPM input (TLP2348)	
		TLP2745, TLP2748	Direct IPM drive, Supply voltage: 4.5 V to 30 V, Isolation voltage: 5 kVrms, high speed: 10 Mbps, SO6L package with a creepage distance of 8 mm, active-high IPM input (TLP2745), active-low IPM input (TLP2748)	

Toshiba's Unique Technologies

Motor drivers

- Fabricated using a high-voltage and low on-resistance process: Rated at either 84 V or 50 V and provides high output current
- Synchronous rectification PWM control: Reduces power loss (heat dissipation) during PWM control.
- Various protection features help improve system safety: All motor drivers for industrial applications provide thermal shutdown (TSD), overcurrent detection (ISD) and VM power-on reset (POR).
- Available in multiple packages



Product Overview

84-V/3.0-A Unipolar Stepping Motor Drivers

(TB67S141FTG/HG/NG, TB67S142FTG/HG/NG, TB67S145FTG, TB67S149FTG/FG**/HG)

- Requires no current-sensing resistor
- Full-, half-, quarter- and 1/8-step drive modes (TB67S149), 1/16-step drive mode (TB67S149), 1/32-step drive mode (TB67S149)
- Output Ron: 0.25 Ω typ.
- Thermal shutdown (TSD), overcurrent detection (ISD), VM power-on reset (POR)
- Supports a clock input and a phase-input interface
- Packages: WQFN48, HSOP28, HZIP25, SDIP24

80-V/1.5-A Dual Unipolar Stepping Motor Drivers (TB67S158FTG/NG)

- Constant-voltage drive
- Output Ron: 0.5 Ω typ.
- Thermal shutdown (TSD), overcurrent detection (ISD), VM power-on reset (POR)
- Supports a clock input, a serial input and a parallel-input interface
- Packages: WQFN48, SDIP24

50-V/4.0-A Two-Phase Bipolar Stepping Motor Drivers

(TB67S101AFTG/FNG/NG, TB67S102AFTG/FNG, TB67S103AFTG, TB67S109AFTG/FNG, TB67S105FTG)

- High-efficiency constant-current control (Advanced Dynamic Mixed Decay)
- Full-, half-, quarter- and 1/8-step drive modes (TB67S109A), 1/16-step drive mode (TB67S109A), 1/32-step drive mode (TB67S109A)
- Output Ron: 0.49 Ω typ. (high side + low side)
- Thermal shutdown (TSD), overcurrent detection (ISD), VM power-on reset (POR)
- Supports a clock input, a serial input and a phase-input interface
- Packages: WQFN48, HTSSOP48, HSOP28, SDIP24

50-V/5.0-A Bipolar Stepping Motor Drivers (TB6600FG/HG)

- Full-, half-, quarter-, 1/8- and 1/16- step drive modes
- Output Ron: 0.4 Ω typ. (high side + low side)
- Thermal shutdown (TSD), overcurrent detection (ISD), VM power-on reset (POR)
- Supports a clock input interface
- Packages: HQFP64, HZIP25

50-V/10.0-A Large-Current Brushed DC Motor Driver (TB67H303HG)

- Output Ron: 0.2 Ω typ. (high side + low side)
- Thermal shutdown (TSD), overcurrent detection (ISD), VM power-on reset (POR)
- Package: HZIP25

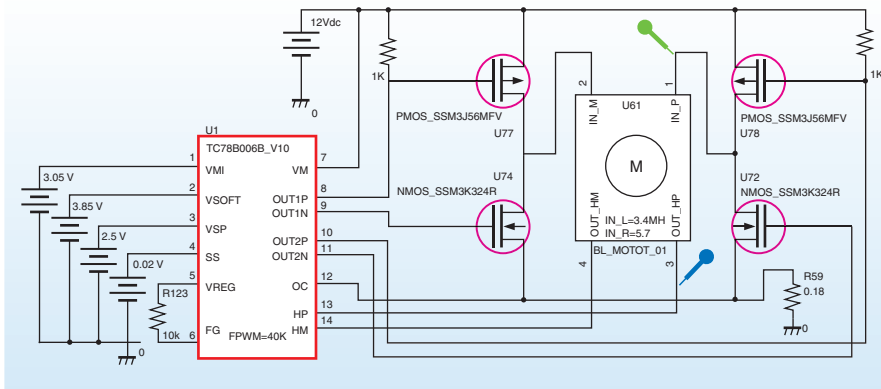
** : Under development

PSpice Models for Motor Driver ICs and MOSFETs

PSpice environment allows you to easily check input and output waveforms on a PC.

Toshiba offers PSpice® models for its motor driver ICs and output-stage MOSFETs.

● Typical Circuit Example



1. Early evaluation

→Allows you to check basic characteristics before obtaining ICs

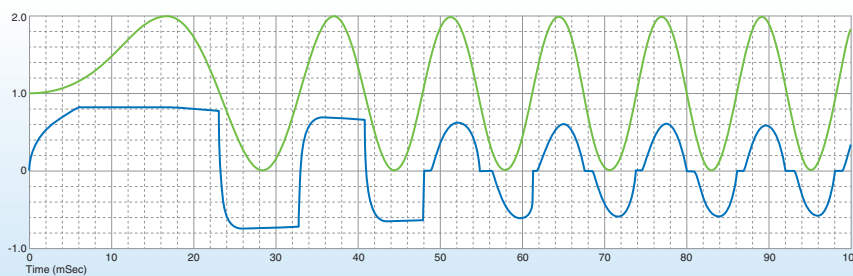
2. Saves time and labor

→Improves the efficiency of board development

3. Minimizes the number of prototypes

→Minimizes the bill of materials

● Example of a Simulation Result Waveform

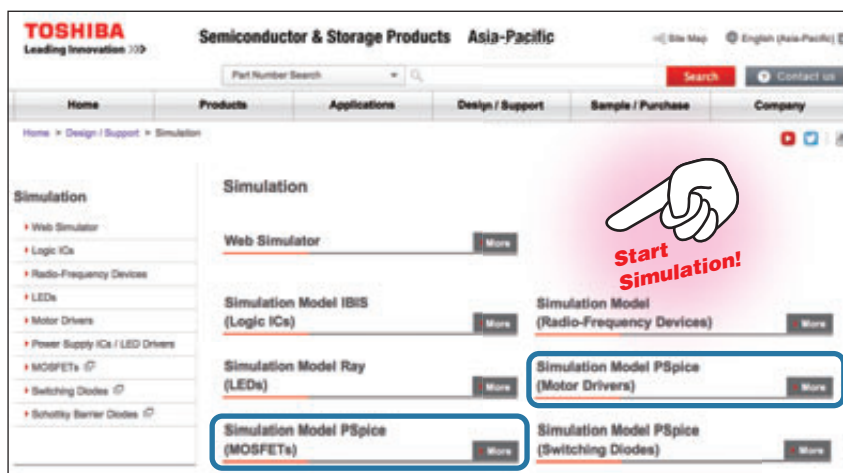


1-click simulation

Allows you to check the waveforms of basic operations without perusing datasheets

Obtaining PSpice models of motor drivers and MOSFETs

To download PSpice models, complete user registration at:
<http://toshiba.semicon-storage.com/ap-en/design-support/simulation.html>



Motor Drivers	
For stepping motors	
TB62214A	TB62218A
TB62216	TB67S109A
TB67S149	TB67S249
TB6600	TB67S158*
For brushless DC motors	
TC78B002	TC78B006
TC78B006B	TB67Z800
For brushed DC motors	
TB67H400A	TB67H303
TC78H610	

MOSFETs Recommended Devices for Home Appliance and Other Consumer Electronics Applications	
Outdoor Fan Motor	
TK5A60W5*	TK5P60W5*
TK7A60W5	TK7P60W5
TK8A60W5	TK8P60W5
Compressor Drive	
TK16A60W5	TK20A60W5

*: Being prepared for Web release

*PSpice is a registered trademark of Cadence Design Systems, Inc.

Motor Control Solutions

Toshiba's extensive portfolios of microcontroller units (MCUs), motor control drivers (MCDs), intelligent power devices (IPDs) provide optimal motor control solutions for diverse customer needs.

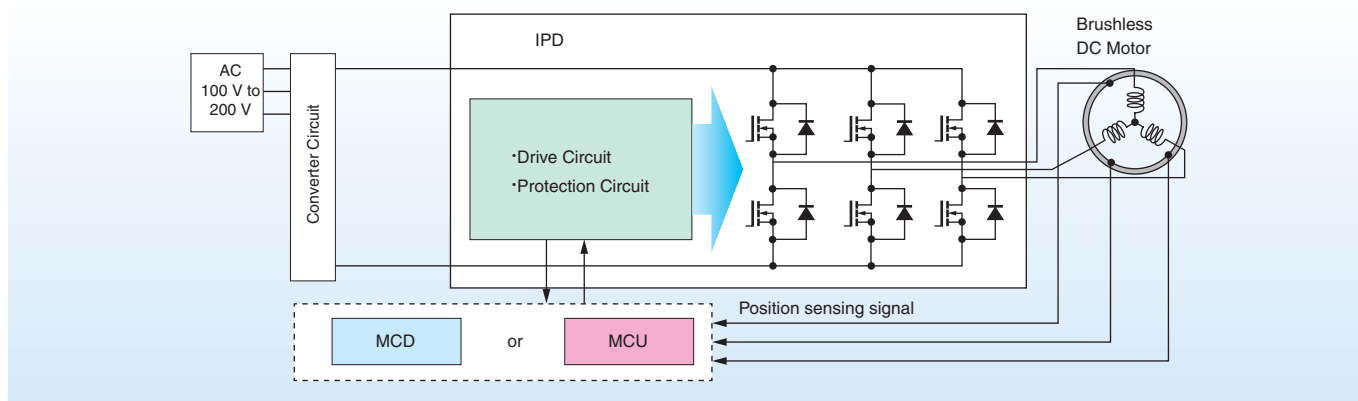
Drive and Control Solutions for 3-Phase Brushless DC Motors

1. Commutation mode: Selectable from square- and sine-wave commutation modes
 - 120-degree square-wave commutation: Suitable to make the system organization simple
 - 150-degree square-wave commutation: Provides quiet motor operation
 - Sine-wave commutation: Provides very quiet motor operation
2. Sensors:
 - Sensored: Incorporates a Hall IC or Hall elements to make it easy to respond to load variations
 - Sensorless: Suitable to make the system organization simple
3. Combination: Selectable from MCUs and MCDs:
 - MCUs: Finely adjustable under software control
 - MCDs: Requires no software development

1. Commutation Mode	2. Sensors	3. Combination			Examples of Product Combinations
		MCU	MCD	IPD	
Square-wave (120-degree commutation)	Hall IC / Hall Elements	—	—	Y	TPD4142K, TPD4152K/F, etc.
Square-wave (150-degree commutation)	Hall IC / Hall Elements	—	Y	Y	TB6586A + TPD4204F, etc.
	Sensorless	Y	—	Y	TMPM374 + TPD4204F, etc.
		—	Y	Y	TB6575 + TPD4204F, etc.
Sine-wave	Hall IC / Hall Elements	Y	—	Y	TMPM374 + TPD4204F, etc.
		—	Y	Y	TB67B000* TB6584 + TPD4204F, etc.
	Sensorless	Y	—	Y	TMPM375 + TPD4204F, etc.

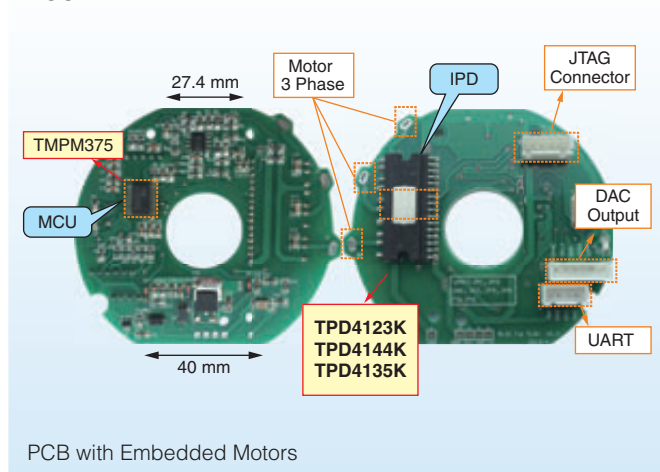
* Product that houses MCD and IPD chips in one package

General System Organization



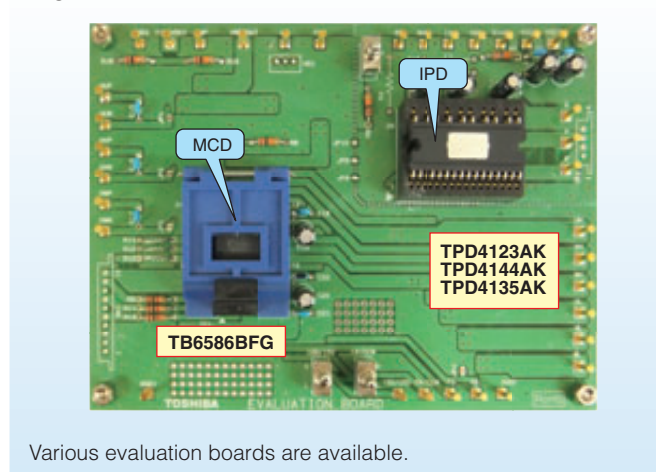
Board Assembly Example

MCU + IPD



Semiconductor Device Evaluation Board

MCD + IPD



Brushless Motor Drivers

Simply configurable auto lead angle control provides high efficiency.

Latest Motor Drive Technology – Intelligent Phase Control (InPAC)

InPAC is a high-performance analog IC technology developed by Toshiba.

InPAC senses the motor current and provides optimal phase control.

High efficiency

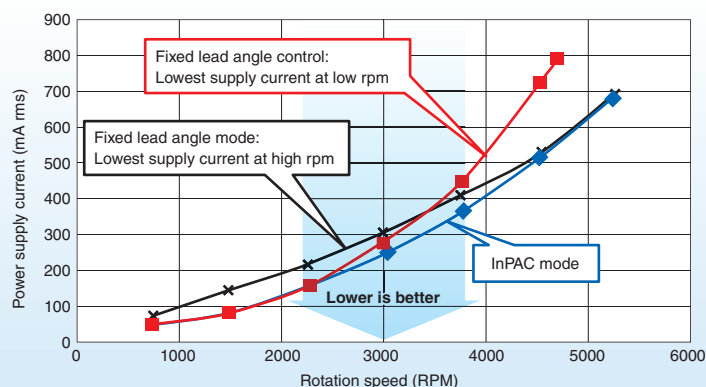
Maintains high efficiency regardless of a motor's rpm, load torque and supply voltage by adjusting motor current phases automatically

Simply configurable auto lead angle control

Reduces the number of external components necessary for lead angle control and eliminates the need for any programming according to the changing operating states of a motor

High efficiency: InPAC maintains the maximum efficiency regardless of the rpm of a motor.

Example: At 3,750 rpm, InPAC reduces supply current by approx. 10%, compared with the conventional fixed lead angle control (benchmarked by Toshiba).



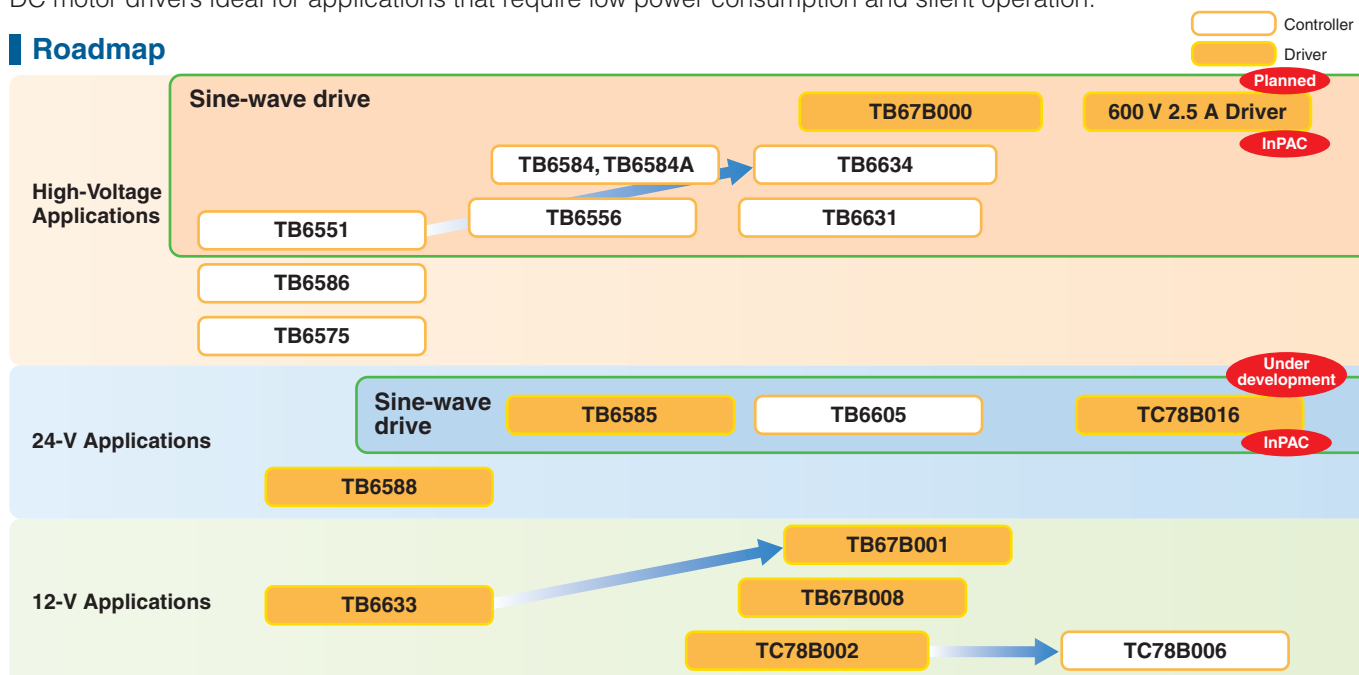
	Motor Efficiency	Ease of Programming	Support for Various Types of Motors	Part Count	Drawback
Fixed lead angle control	Poor	Poor	Poor	Moderate	Changes in the rpm of a motor make the adjustment point shift, making it impossible to achieve optimal efficiency. Lead angle must be adjusted for each type of motor.
Auto lead angle control using conventional technology	Moderate	Moderate	Moderate	Poor	
InPAC	Excellent	Excellent	Excellent	Excellent	–

Quiet and high-efficiency motor control using original high-performance motor drive technology

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.

Roadmap



Brushed Motor Drivers

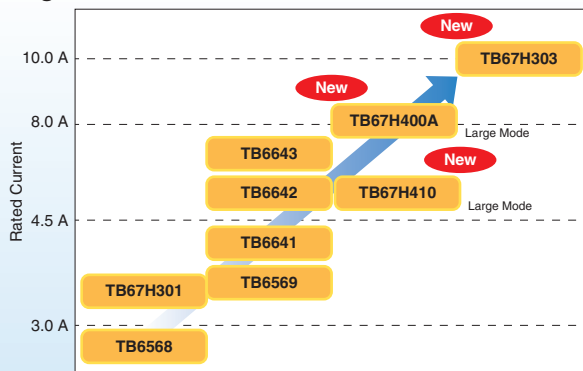
Brushed motor drivers designed for various applications, featuring high-current drive, multi-channel drive, etc.

Brushed DC Motor Driver Series

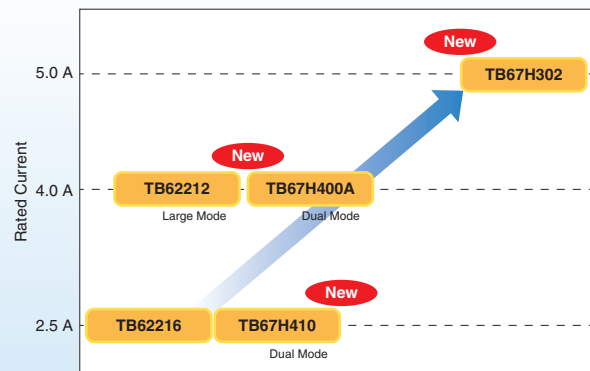
Toshiba offers brushed motor drivers fabricated using a BiCD process that exhibits low output R_{on} and thus helps reduce power consumption. Toshiba's product portfolio contains a wide range of brushed motor drivers with extensive supply voltage, output current and channel count options. Toshiba's product offerings include motor drivers that consist of multiple H-bridges that can be combined in a flexible manner according to the types of motors driven (stepping motors and brushed DC motors) and the required current capabilities.

Roadmap

Single-Channel Motor Drivers



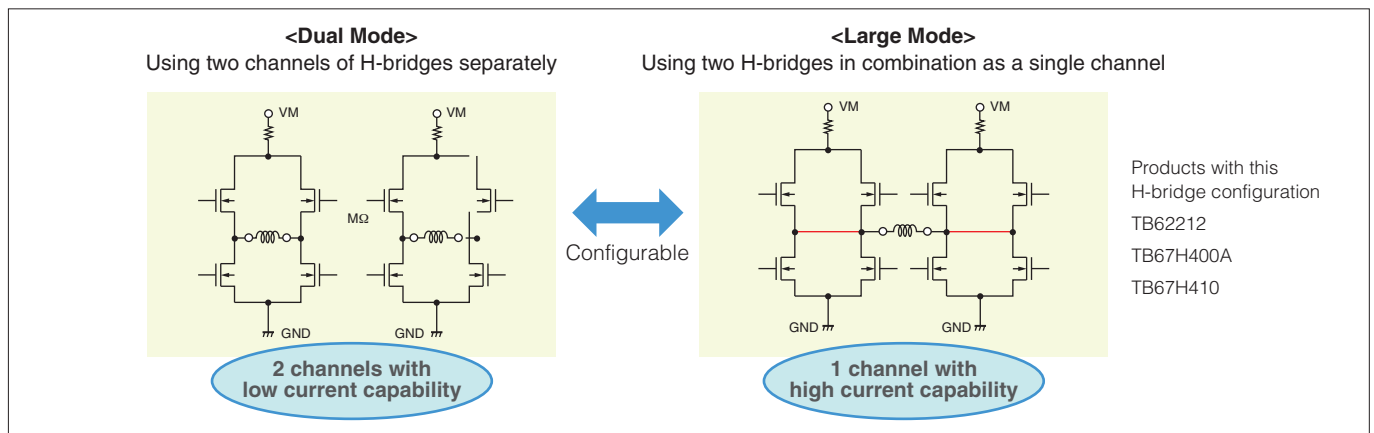
Dual-Channel Motor Drivers



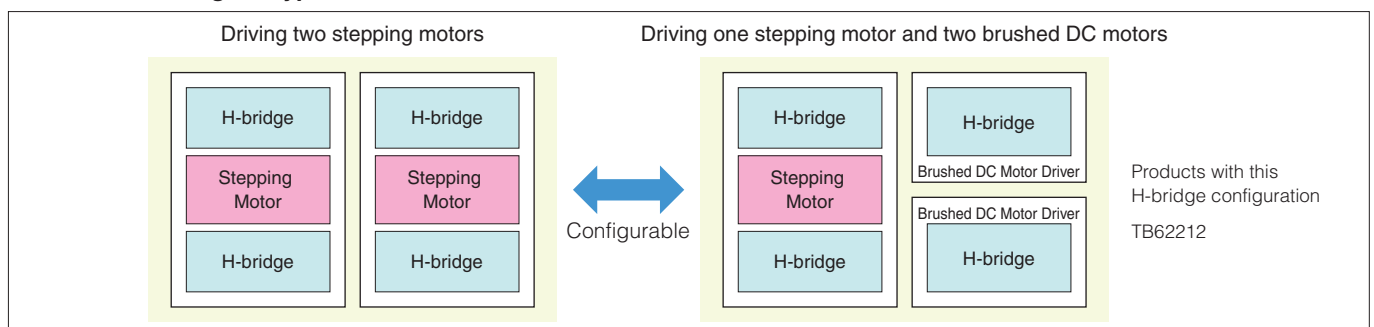
Configurable Motor Drivers

The on-chip H-bridges can be configured according to the types of motors driven (stepping motors and brushed DC motors) and the required current capabilities to suit the needs of various motor applications.

Case 1: Switching between different current capabilities



Case 2: Selecting the types of motors to be driven





Brushed DC Motor Driver (TB67H303HG)

The TB67H303HG is a high-efficiency brushed DC motor driver for use with a PWM drive. Incorporating low on-resistance DMOS output drivers, the TB67H303HG can drive a motor rated at up to 50 V/10.0 A.

- Forward, reverse, short-circuit brake and stop; standby mode
- Low output Ron: 0.2 Ω typ. (high side + low side)
- Supply voltage (Vcc) = 50 V, output current (Iout) = 10.0 A (absolute maximum ratings, peak)
- Various fault detection features: Thermal shutdown (TSD), undervoltage lockout (UVLO), overcurrent detection (ISD)
- Package: HZIP25

PWM Chopper-Type Brushed DC Motor Drivers (TB67H400AFTG/FNG/HG/NG)

Incorporating two channels of output drivers, the TB67H400A can drive up to two brushed DC motors. It can also be configured into an 8.0-A single-channel motor driver in Large mode. The TB67H400A is rated at 50 V, and 4.0 A (per channel in dual-channel mode) or 8.0 A (in single-channel Large mode).

- Low output Ron: 0.49 Ω typ. (high side + low side)
- Four operating modes: forward, reverse, short-circuit brake, stop (off)
- Various fault detection features: Thermal shutdown (TSD), overcurrent detection (ISD), VM power-on reset (POR)
- Packages: WQFN48, HTSSOP48, HZIP25, SDIP24

PWM Chopper-Type Brushed DC Motor Drivers (TB67H410FTG/NG)

Incorporating two channels of output drivers, the TB67H410 can drive up to two brushed DC motors. It can also be configured into an 5.0-A single-channel motor driver in Large mode. The TB67H410 is rated at 50 V, and 2.5 A (per channel in dual-channel mode) or 5.0 A (in single-channel Large mode).

- Low output Ron: 0.8 Ω typ. (high side + low side)
- Four operating modes: forward, reverse, short-circuit brake, stop (off)
- Various fault detection features: Thermal shutdown (TSD), overcurrent detection (ISD), VM power-on reset (POR)
- Packages: WQFN48, SDIP24

Product Lineup

Part Number	Absolute Maximum Ratings		Output Ron (H + L) (Ω)	# Circuits (ch)	Constant- Current PWM Control	Detection Circuits		Packages
	Supply Voltage (V)	Output Current (A)				ISD	TSD	
TB6568KQ	50	3.0	0.55	1	—	Y (Latch)	Y (Latch)	HSIP7
TB6643KQ	50	4.5	0.55	1	—	Y (Latch)	Y (Latch)	HSIP7
TB6559FG	50	2.5	1.3	1	Y	Y (Auto)	Y (Auto)	HSOP16
TB6617FNG	50	2.0	1.4	1	—	Y (Auto)	Y (Auto)	SSOP16
TB6569FTG/FG	50	4.5	0.55	1	Y	Y (Latch)	Y (Latch)	VQFN32/HSOP16
TB6641FTG/FG	50	4.5	0.55	1	Y	Y (Latch)	Y (Latch)	VQFN32/HSOP16
TB6642FTG/FG	50	4.5	0.55	1	—	Y (Latch/Auto)	Y (Latch/Auto)	VQFN32/HSOP16
TB6640FTG/AFTG	40	3.0	1.0	1	Y	Y (Latch/Auto)	Y (Latch/Auto)	WQFN48
TB67H301FTG	40	3.0	1.0	1	Y	Y (Latch/Auto)	Y (Latch/Auto)	WQFN24
TB67H303HG	50	10	0.2	1	Y	Y (Latch)	Y (Latch)	HZIP25
TB6561NG/FG	40	1.5	1.5	2	—	Y (Auto)	Y (Auto)	SDIP24/SSOP30
TB62216FTG/FNG/FG	40	2.5	1.0	2	Y	Y (Latch)	Y (Latch)	QFN48/HTSSOP48/HSOP28
TB62212FTAG/FNG	40	4.0(2ch) 2.0(4ch)	2.2	2 4	Y	Y (Latch)	Y (Latch)	QFN48/HTSSOP48
TB67H302HG	50	5.0	0.4	2	Y	Y (Latch)	Y (Latch)	HZIP25
TB67H400AFTG/FNG/ HG/NG	50	8.0(1ch) 4.0(2ch)	0.49	1 2	Y	Y (Latch)	Y (Latch)	WQFN48/HTSSOP48/ HZIP25/SDIP24
TB6552FTG/FNG	15	1.0	1.5	2	—	—	Y (Auto)	WQFN16/SSOP16
TB6593FNG	15	3.2	0.35	1	—	—	Y (Auto)	SSOP20
TB6612FNG	15	3.2	0.5	2	—	—	Y (Auto)	SSOP24
TB6614FNG	15	3.2	0.3	1	—	Y (Auto)	Y (Auto)	SSOP16
TC78H600FTG/FNG	18	1.0	1.2	2	Y	Y (Latch)	Y (Auto)	WQFN24/SSOP20
TC78H610FNG	18	1.0	1.2	2	—	Y (Latch)	Y (Auto)	SSOP16
TB67H410FTG/NG	50	5.0(1ch) 2.5(2ch)	0.8	2	Y	Y (Latch)	Y (Latch)	WQFN48/SDIP24

Stepping Motor Drivers

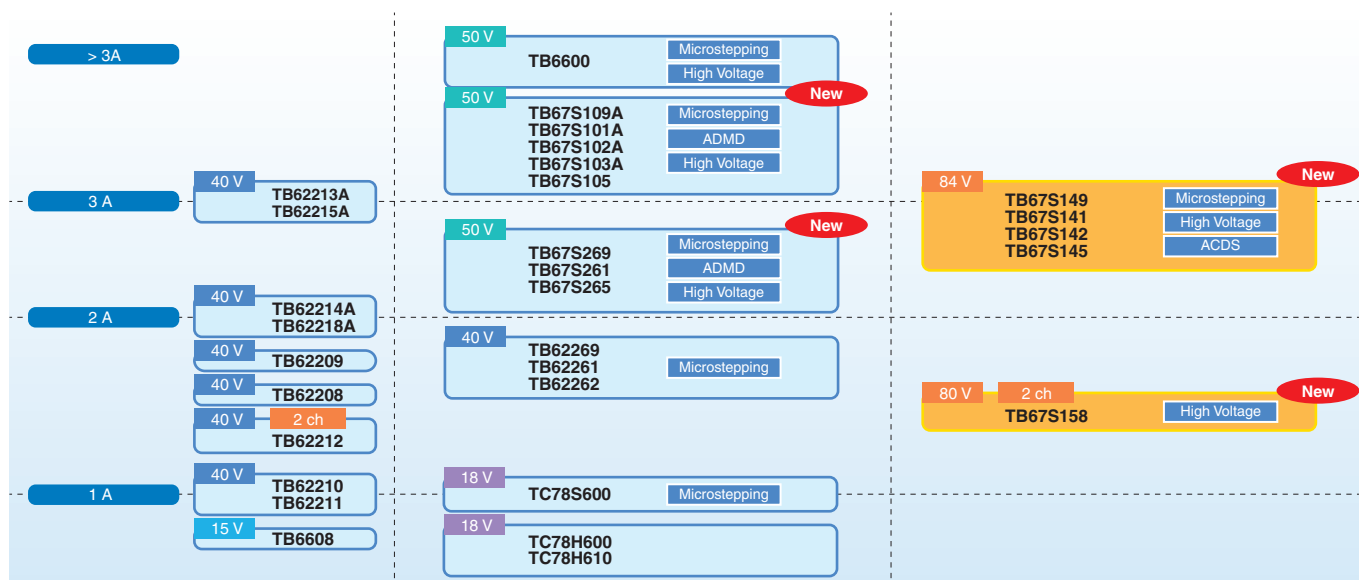
Complete portfolio of stepping motor drivers for various motors and applications

Stepping Motor Driver Series

Toshiba offers an extensive lineup of stepping motor drivers fabricated using a BiCD process that provides high accuracy and high-current capability. Toshiba's stepping motor drivers are available in bipolar and unipolar configurations.

Roadmap

■ Bipolar
■ Unipolar

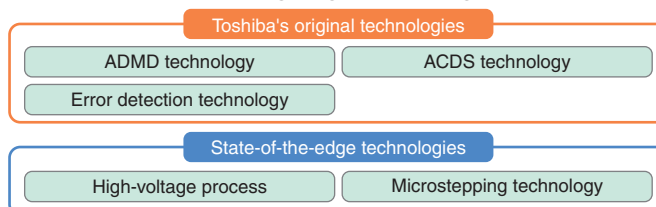


Features of Toshiba's Stepping Motor Drivers

Extensive product lineup



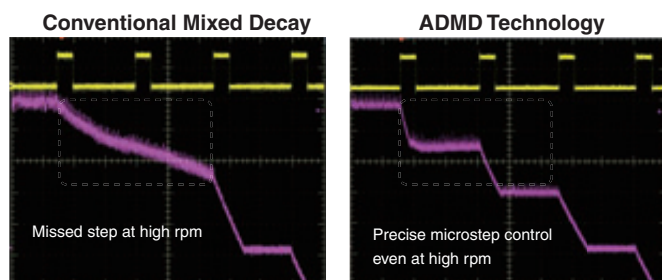
Solutions for customers' needs and issues based on leading-edge technologies



Toshiba's Original Technologies

1. Advanced Dynamic Mixed Decay (ADMD) Technology

Toshiba's original ADMD technology tracks input current more closely than the conventional mixed-decay mode, making highly efficient motor control possible at high rpm.



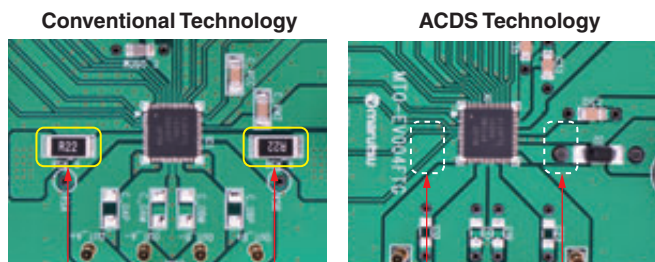
Products incorporating the ADMD technology:

- TB67S101A •TB67S109A
- TB67S102A •TB67S261
- TB67S103A •TB67S265
- TB67S105 •TB67S269

2. Advanced Current Detect System (ACDS) Technology

Toshiba's original ACDS technology enables motor drive with highly accurate constant current without requiring external current-sensing resistors.

The reduced part count also helps reduce the board area and the bill-of-material (BOM) cost.



Two resistors with high electrical ratings are necessary.

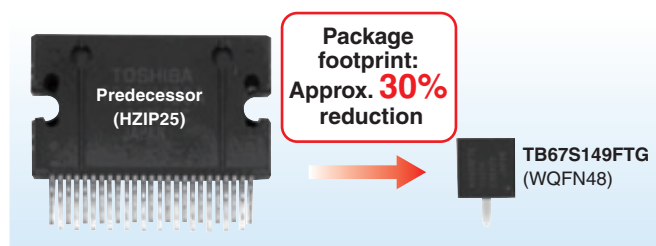
No external resistor is required.

Products incorporating the ACDS technology

- TB67S141 •TB67S145
- TB67S142 •TB67S149

3. High-Voltage Analog Process Technology

Fabricated using a state-of-the-art high-voltage analog process (130-nm BiCD process), Toshiba's stepping motor drivers combine low-voltage control circuitry with high-voltage DMOS output drivers on the same monolithic structure. Consequently, high-voltage motor drivers rated at 84 V can be housed in the small WQFN48 (7 mm × 7 mm) package, which helps reduce the solution size.



4. Package Lineup

Toshiba's stepping motor drivers are available in various package styles, including small surface-mount and through-hole packages, that are suitable for diverse printed circuit boards, assembly methods and system applications.

● Product Lineup (Bipolar)

Part Number	Interface	Absolute Maximum Ratings		Stepping Mode	Detection Circuits			Packages
		Output Breakdown (V)	Output Current (A)		POR	ISD	TSD	
TB62211FNG	Clock input	40	1.0	1/4 step	○	○	○	HTSSOP24
TB62262FTAG/FTG	Clock input	40	1.5(FTAG) 1.8(FTG)	1/4 step	○	○	○	WQFN36/WQFN48
TB62209FG	Clock input	40	1.8	1/16 step	○	○	○	HSOP36
TB62269FTG	Clock input	40	1.8	1/32 step	○	○	○	WQFN48
TB67S269FTG	Clock input	50	2.0	1/32 step	○	○	○	WQFN48
TB62214AFTG/FNG/FG	Clock input	40	2.0	1/4 step	○	○	○	QFN48/HTSSOP48/HSOP28
TB67S215FTAG	Clock input	40	2.5	1/4 step	○	○	○	WQFN36
TB62215AFTG/FNG/FG/HQ	Clock input	40	3.0	1/4 step	○	○	○	QFN48/HTSSOP48/HSOP28/HZIP25
TB6560AFTG/FG/HQ	Clock input	40	2.5(FTG/FG) 3.5(HQ)	1/16 step	—	—	○	QFN48/HQFP64/HZIP25
TB67S102AFTG/FNG	Clock input	50	4.0	1/4 step	○	○	○	WQFN48/HTSSOP48
TB67S103AFTG	Serial + clock input	50	4.0	1/32 step	○	○	○	WQFN48
TB67S109AFTG/FNG	Clock input	50	4.0	1/32 step	○	○	○	WQFN48/HTSSOP48
TB6600FG/HG	Clock input	50	4.5(FG) 5.0(HG)	1/16 step	○	○	○	HQFP64/HZIP25
TB6608FNG	Clock input	15	0.8	1/8 step	○	—	○	SSOP20
TC78S600FTG/FNG	Clock input	18	1.0	1/16 step	○	○	○	WQFN24/SSOP20
TB6674PG/FG/FAG	Phase input	24	0.4(PG/FG) 0.2(FAG)	Full step	○	○	○	DIP16/HSOP16/SSOP16
TB62210FNG	Phase input	40	1.0	1/4 step	○	○	○	HTSSOP24
TB6562ANG/AFG	Phase input	40	1.5	1/4 step	—	○	○	SDIP24/SSOP30
TB62206FG	Phase input	40	1.8	1/2 step	○	○	○	HSOP20
TB62208FTG/FNG/FG	Phase input	40	1.8	1/4 step	○	○	○	QFN48/HTSSOP48/HSOP28
TB62261FTAG/FTG	Phase input	40	1.5(FTAG) 1.8(FTG)	1/4 step	○	○	○	WQFN36/WQFN48
TB67S261FTG	Phase input	40	2.0	1/4 step	○	○	○	WQFN48
TB62218AFTG/FNG/FG	Phase input	40	2.0	1/4 step	○	○	○	QFN48/HTSSOP48/HSOP28
TB67S213FTAG	Phase input	40	2.5	1/4 step	○	○	○	WQFN36
TB62213AFTG/FNG/FG/HQ	Phase input	40	3.0	1/4 step	○	○	○	QFN48/HTSSOP48/HSOP28/HZIP25
TB67S101AFTG/FNG/NG	Phase input	50	4.0	1/4 step	○	○	○	WQFN48/HTSSOP48/SDIP24
TB67S105FTG	Serial input	50	3.0	1/2 step	○	○	○	WQFN48
TB67S265FTG	Serial input	50	2.0	1/2 step	○	○	○	WQFN48
TC78H600FNG	Phase input	18	1.0	1/2 step	○	○	○	SSOP20
TC78H610FNG	Phase input	18	1.0	1/2 step	○	○	○	SSOP16
TB62212FTAG/FNG	Phase input	40	1.5 × 2 ch	1/2 step	○	○	○	QFN48/HTSSOP48

● Product Lineup (Unipolar)

Part Number	Interface	Absolute Maximum Ratings		Stepping Mode	Detection Circuits			Packages
		Output Breakdown (V)	Output Current (A)		POR	ISD	TSD	
TB67S141FTG/HG/NG	Phase input	84	3.0	1/4 step	○	○	○	WQFN48/HZIP25/SDIP24
TB67S142FTG/HG/NG	Clock input	84	3.0	1/4 step	○	○	○	WQFN48/HZIP25/SDIP24
TB67S145FTG	Serial input	84	3.0	1/2 step	○	○	○	WQFN48
TB67S149FTG/FG**/HG	Clock input	84	3.0	1/32 step	○	○	○	WQFN48/HSSOP28/HZIP25
TB67S158FTG/NG	Clock input Parallel input Serial input	80	1.5 × 2 ch	1/2 step	○	○	○	WQFN48/SDIP24

Abbreviations: POR: Power-on reset, ISD: Overcurrent detection, TSD: Thermal shutdown

** : Under development

Transistor Arrays

The DMOS FET^{*1} output stage realizes high-efficiency drive.

Transistor arrays designed for stepping motor driving applications are available with a variety of functions, circuit counts and current ratings, packages and so on.

Features

- High-efficiency motor drive

The new TBD62003A series of transistor arrays provides an approximately 40% reduction^{*2} in power loss, compared to the conventional TD62003A series.

- High-voltage and high-current drive

Toshiba also offers transistor arrays whose output stage has absolute maximum ratings of 50 V and 1.5 A.

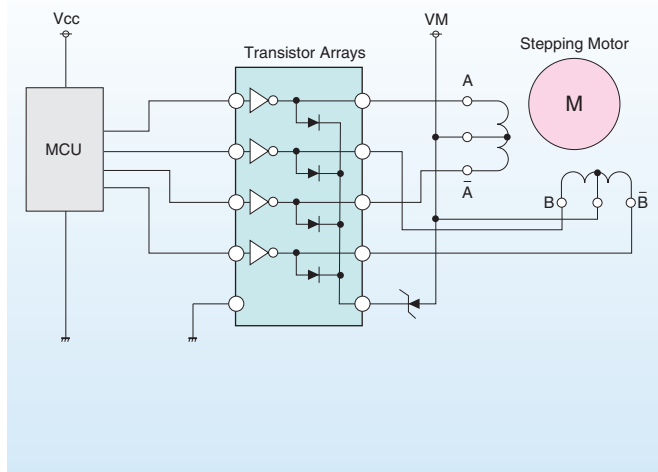
- Devices and packaging options that meet customers' specific needs

Transistor arrays are available in DIP packages, surface-mount SOP and SOL packages, and space-saving SSOP packages (with a 0.65-mm lead pitch).

Product Lineup

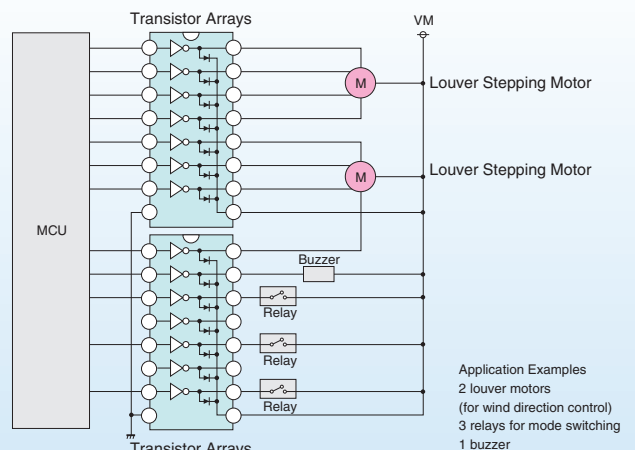
Output Configuration	# Channels	Output Current (A)	Output Voltage (V)	Common Diode	Active Input Level	Part Number	Packages	Predecessor
Sink	4	1.5	50	Y (inductive load-compatible)	H	Under development	DIP16/SOP16	TD62064APG/FG
		1.5	50	Y (inductive load-compatible)	L	Under development	DIP16/SOP16	TD62308APG/FG
	7	0.5	50	Y (inductive load-compatible)	H	TBD62003A PG/FG/FNG/FWG	DIP16/SOP16 SSOP16/SOL16	TD62003APG/FG ULN2003APG/FWG
		0.5	50	Y (inductive load-compatible)	H	TBD62004A PG/FG/FNG/FWG	DIP16/SOP16 SSOP16/SOL16	TD62004APG/FG ULN2004APG/FWG
		0.3	50	–	H	TBD62502A PG/FG/FNG/FWG	DIP16/SOP16 SSOP16/SOL16	TD62502APG/FG/FNG
		0.3	50	–	H	TBD62503A PG/FG/FNG/FWG	DIP16/SOP16 SSOP16/SOL16	TD62503APG/FG/FNG
	8	0.5	50	Y (inductive load-compatible)	H	TBD62083A PG/FG/FNG/FWG	DIP18/SOP18 SSOP18/SOL18	TD62083APG/FG/FNG ULN2803APG/FWG
		0.5	50	Y (inductive load-compatible)	H	TBD62084A PG/FG/FNG/FWG	DIP18/SOP18 SSOP18/SOL18	TD62084APG/FG/FNG ULN2804APG/FWG
Source		0.5	50	Y (inductive load-compatible)	H	TBD62783A PG/FG/FNG/FWG	DIP18/SOP18 SSOP18/SOL18	TD62783APG/FG/FNG TD62783AFWG

Motor Drive Application Example



Application

Air conditioner



Application Examples
2 louver motors
(for wind direction control)
3 relays for mode switching
1 buzzer

*1 DMOS FET: Double-Diffused MOSFET

*2: At Ta = 25°C and Iout = 200 mA

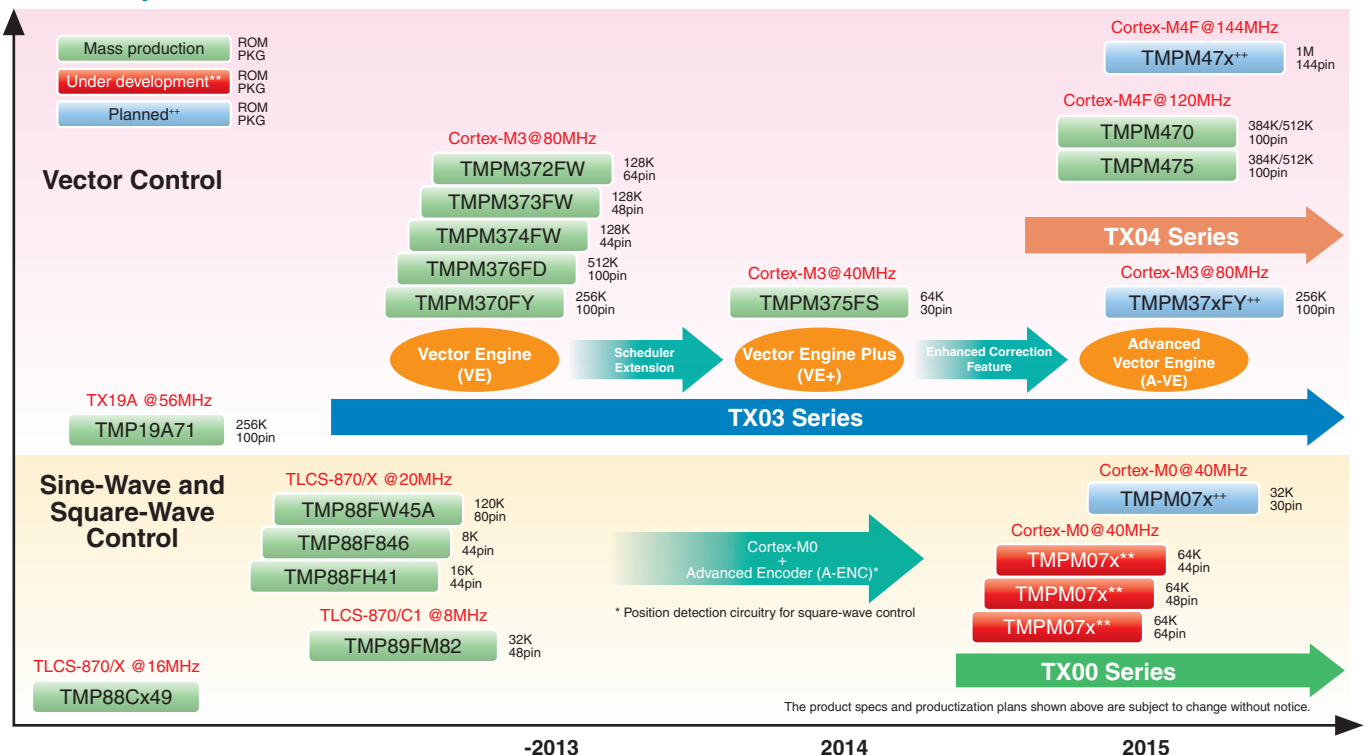
Wide spectrum of motor control MCUs

Microcontrollers Designed for Motor Applications

Toshiba's product portfolio includes 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 several kinds of PMD microcontrollers: those with an ARM Cortex-M3 core that feature an integrated Vector Engine (VE), those with an ARM Cortex-M4F core that provide an Advanced Vector Engine (A-VE), and those with an 8-bit TLCS-870/X or TLCS-870/C1 core that provide sine-wave commutation via interrupts raised every 60° electrical rotation.

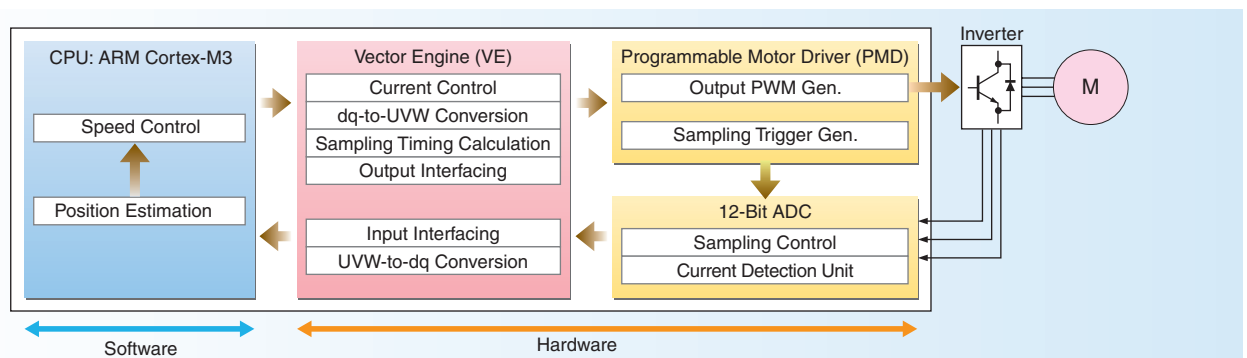
Roadmap



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.

MCUs with a Vector Engine for High-Precision Brushless DC Motor Control

Microcontroller with Vector Engine (M370/M470 Group)

Features

- Toshiba's original Vector Engine (VE)
 - High-speed processing using dedicated hardware
- Supports a commonly used single 5-V power supply
 - Allows the reuse of the conventional platform

Specification Overview

- High-performance Cortex-M3 core with a clock rate of up to 80 MHz (M370 Group)
 - Cortex-M4F core with a clock rate of up to 120 MHz (M470 Group)
- Integrated motor control circuitry
 - Vector Engine (VE)
 - AD converter
 - Programmable Motor Driver(PMD)
- Available in various packages (SSOP30, LQFP44, LQFP48, LQFP64, LQFP100, QFP100)

TMPM475

with Advanced Vector Engine (A-VE)

- High-performance and low-power-consumption Cortex-M4F core with a maximum clock rate of 120 MHz
- Motor control circuits (A-VE, ADC, PMD)
- High-speed flash memory programming
- CAN controller

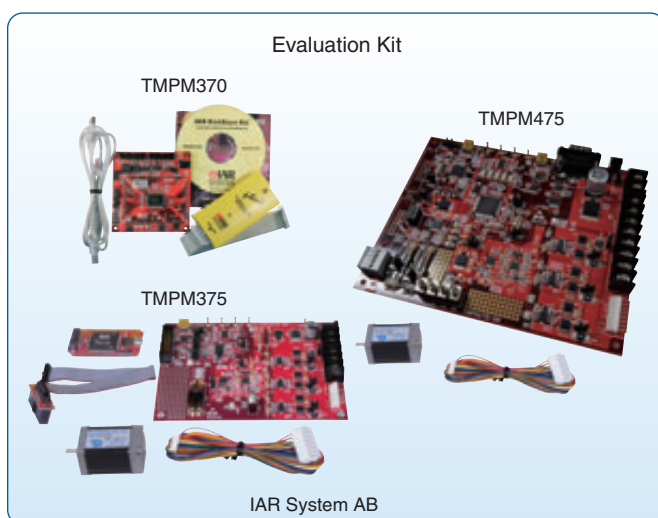
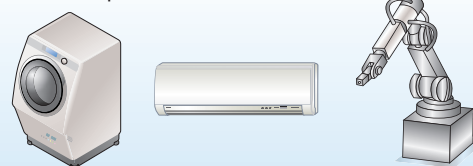
Cortex-M4F Core

- Single-precision floating-point unit (FPU)
- Operating voltage: 4.5 to 5.5 V (single power supply, on-chip voltage regulator)
- Maximum operating frequency: 120 MHz
- On-chip memory: Flash ROM: 256 KB/384 KB/512 KB
 - SRAM: 18 KB/34 KB
- Debug units: JTAG/SWD/SWV 4-bit-wide trace
- Low power consumption:
 - Clock gear (1/2, 1/4, 1/8 and 1/16 frequency division)
 - Standby modes (IDLE/STOP)
- On-chip high-speed oscillator: 10 MHz

Peripheral Units

- Advanced Vector Engine (A-VE): 2 channels
- PMD: 2 channels
- 12-bit AD converter: 2 units (with a conversion time of 1 μ s)
- Advanced Encoder (A-ENC): 2 channels
- 16-bit timer: 10 channels
- UART/SIO: 4 channels
- I²C/SIO: 1 channel
- DMA: 32 channels (1 unit)
- CAN 2.0B controller: 1 unit
- Watchdog timer (WDT): 1 channel
- Oscillation frequency detection (OFD) circuit: 1 channel
- Power-on reset (POR)
- Voltage detection (VLTD) circuit

Application Examples



Product Lineup

Part Number	Maximum Operating Frequency (MHz)	ROM(Flash) (KB)	Motor Controller (ch)	12-Bit AD Converter (Conversion Time)	Encoder Input Logic (ch)	CAN (ch)	I/O Ports (ch)	Package
TMPM370FYDFG	80	256	2	22 (2 μ s)	2		76	QFP100
TMPM370FYFG	80	256	2	22 (2 μ s)	2		76	LQFP100
TMPM372FWUG	80	128	1	11 (2 μ s)	1		53	LQFP64
TMPM373FWDUG	80	128	1	7 (2 μ s)	1		37	LQFP44
TMPM374FWUG	80	128	1	6 (2 μ s)	1		33	LQFP44
TMPM376FDDFG	80	512	2	22 (2 μ s)	2		82	QFP100
TMPM376FDFG	80	512	2	22 (2 μ s)	2		82	LQFP100
TMPM375FSDMG	40	64	1	4 (2 μ s)	1		21	SSOP30
TMPM470FYFG	120	256	2	23 (1 μ s)	2		79	LQFP100
TMPM470FZFG	120	384	2	23 (1 μ s)	2		79	LQFP100
TMPM470FDFG	120	512	2	23 (1 μ s)	2		79	LQFP100
TMPM475FYFG	120	256	2	23 (1 μ s)	2	1	79	LQFP100
TMPM475FZFG	120	384	2	23 (1 μ s)	2	1	79	LQFP100
TMPM475FDFG	120	512	2	23 (1 μ s)	2	1	79	LQFP100

MCUs with a Programmable Servo/Sequence Controller (PSC) ideal for high-precision motor control applications

Microcontrollers with PSC (M340/M440 Group)

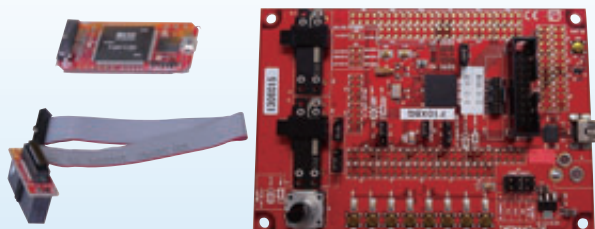
Features

- Incorporates a Programmable Servo/Sequence Controller (PSC) that acts as a sub-processor to an Cortex-M3/M4 core based MCU
- Runs computational tasks in parallel at high speed
- Reduces overall power consumption by offloading the CPU from motor servo routines and sequencing operations

Specification Overview

- High-performance Cortex-M3 core with a clock rate of up to 54 MHz (M340 Group)
Cortex-M4F core with a clock rate of up to 100 MHz (M440 Group)
- High-resolution PPG (programmable phase difference of up to $\pm 90^\circ$)
- High-speed 12-bit AD converter and 10-bit DA converters
- Housed in a small fine-pitch BGA packages

Evaluation Kit



IAR System AB

TMPM440FEXBG/F10XBG with High-Speed “NANO FLASH™-100”

- Cortex-M4F core with a clock rate of up to 100 MHz and zero-wait flash access
- Low power consumption due to parallel operation of FPU and PSC
- Various analog functions
(Three 12-bit AD converters, two 10-bit DA converters)

Cortex-M4F Core

- Operating voltage: 2.7 to 3.6 V (regulated by the on-chip DC-DC converter)
- Maximum operating frequency: 100 MHz
- On-chip ROM: 1024 KB/768 KB
- On-chip RAM: 80 KB
- Debug units: JTAG/SWD/SWV, 4-bit-wide trace

Peripheral Units

- One PSC unit with 16-KB SRAM
- External bus interface
- 12-bit AD converter
- 10-bit DA converter
- 32-bit and 16-bit timers
PPG, HS PPG, 2-phase input pulse counter
- Real-time clock (RTC), timebase timer (TBT), watchdog timer (WDT)
- Serial interfaces: SIO/UART, Enhanced SIO (ESIO), I²C
- Key scan matrix: 8 inputs and 8 outputs

Application Examples



Product Lineup

Part Number	Maximum Operating Frequency (MHz)	ROM(Flash) (KB)	SRAM (KB)	PSC (ch)	PPG (ch)	PHC (ch)	I/O Ports (ch)	Package
TMPM342FYXBG	40	256	36	1	8	2	63	VFBGA142
TMPM343FDXBG	50	512	80	4	16	3	59	VFBGA162
TMPM343F10XBG		1024	96					
TMPM440FEXBG	100	768	80	1	4	PHC: 2 EPH: 1	228	VFBGA289
TMPM440F10XBG		1024						

Motor Drivers (Intelligent Power Devices)

Toshiba offers high-voltage brushless DC motor drivers fabricated with its proprietary high-voltage silicon-on-insulator (SOI) process.

Intelligent Power Devices (IPDs): High-Voltage PWM Brushless Motor Drivers

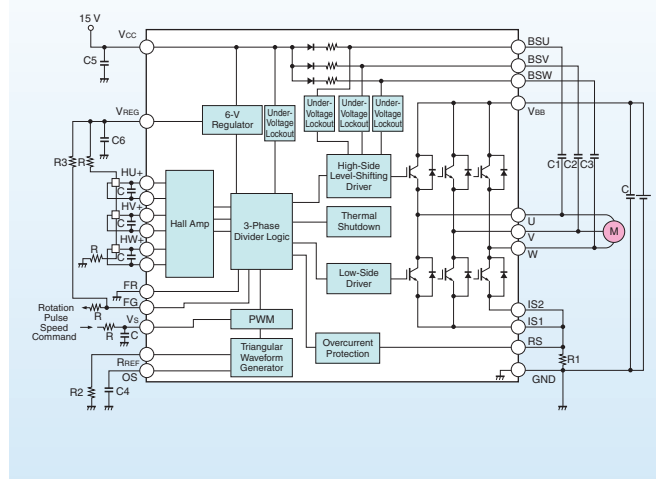
Features

- High withstand voltage due to the use of the SOI process and trench isolation structure
- Available with ratings from 250 V to 600 V and 0.7 A to 3.0 A
- Internal bootstrap power supply for the high-side gate drives

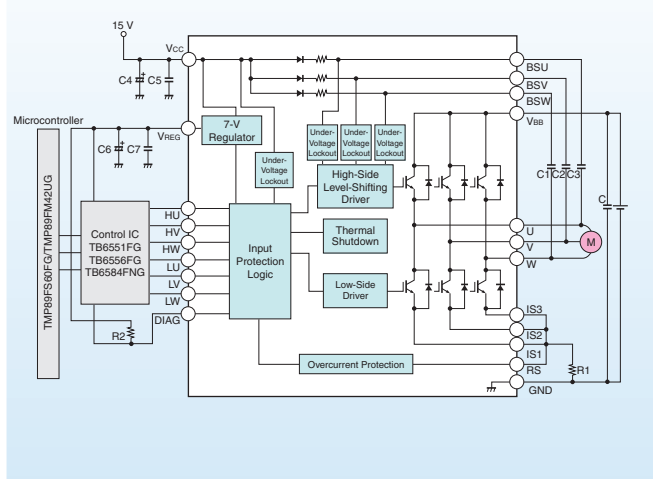
Packages

- **DIP26**
Control and high-voltage pins are placed on the opposite sides of a small DIP package with a body thickness of 3.6 mm.
- **HSSOP31/SOP30**
Control and high-voltage pins are placed on the opposite sides of a surface-mount package with a body thickness of 2.0 mm.

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



- 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

- **120-Degree Commutation**

Part Number	Ratings	PKG	Features			
			Three-Phase Distribution PWM Circuit	Overcurrent Protection	Thermal Shutdown	Undervoltage Protection
TPD4151K	250V/1A	DIP26	Y	Y	Y	Y
TPD4142K	500V/1A	DIP26	Y	Y	Y	Y
TPD4142K/46K	500V/1A	DIP26	Y	Y	Y	Y
TPD4152K/F**	600V/0.7A	DIP26/HSSOP31	Y	Y	Y	Y

- **180-Degree Commutation** (used in tandem with a driver IC)

Part Number	Ratings	PKG	Features			
			Three-Phase Distribution PWM Circuit	Overcurrent Protection	Thermal Shutdown	Undervoltage Protection
TPD4123K	500V/1A	DIP26		Y	Y	Y
TPD4123AK	500V/1A	DIP26			Y	Y
TPD4144K	500V/2A	DIP26		Y	Y	Y
TPD4144AK	500V/2A	DIP26			Y	Y
TPD4135K	500V/3A	DIP26		Y	Y	Y
TPD4135AK	500V/3A	DIP26			Y	Y
TPD4203F**	600V/1.5A	SOP30		Y	Y	Y
TPD4204F**	600V/2.5A	SOP30		Y	Y	Y

** : Under development

New Products

- Has a withstand voltage of 600 V (up from 500 V)
- Further reduction in power loss (TPD4204F using MOSFETs at the output stage)
- Newly developed small surface-mount package

● 120-Degree Commutation

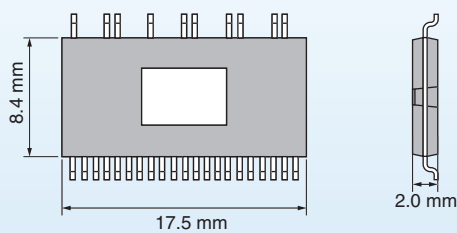
Part Number: TPD4152K (Package: DIP26)

TPD4152F (Package: HSSOP31)

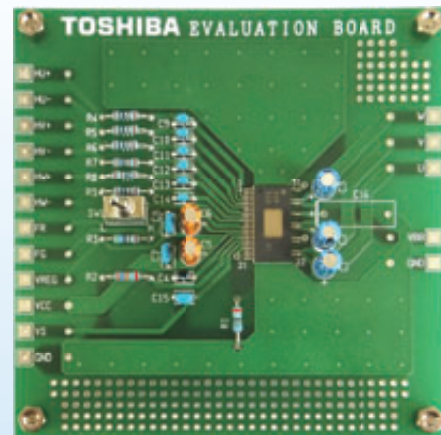
Ratings: 600 V/0.7 A

Output stage: IGBTs

Package: HSSOP31



Evaluation Board



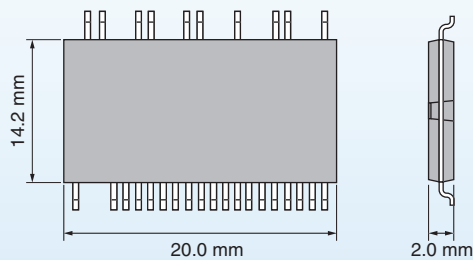
● 180-Degree Commutation (used in tandem with a driver IC)

Part Number: TPD4204F (Package: SOP30)

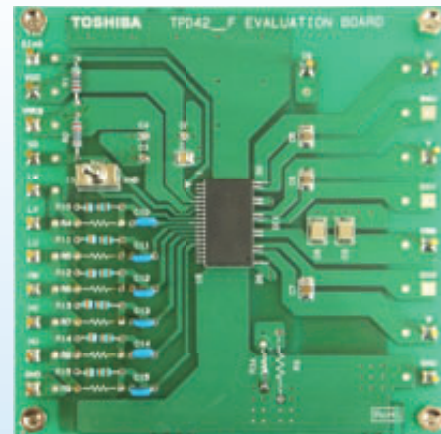
Ratings: 600 V/2.5 A

Output stage: MOSFETs

Package: SOP30



Evaluation Board



MOSFETs and Schottky Barrier Diodes

High-Voltage MOSFETs (DTMOSIV Super-Junction MOSFET Series)

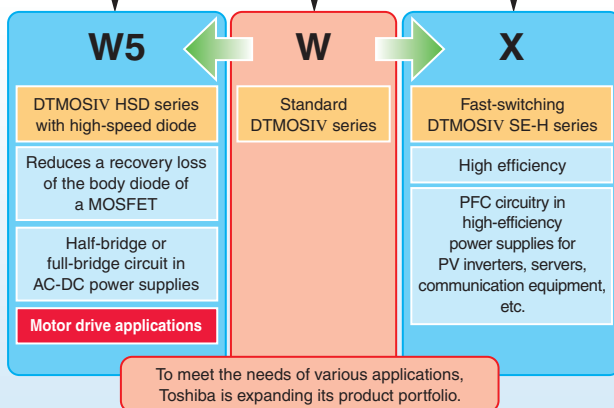
Fabricated with a single-epitaxial process, the DTMOSIV series provides a 30% reduction in R_{onA} compared to its preceding series and thus helps reduce system power consumption.

Features of the DTMOSIV Series

- Exhibits a 30% reduction in R_{onA} , than the preceding series and thus helps improve the performance and reduce the size of a system
- Reduces an increase in on-resistance in the high-temperature region by approx. 20% due to the use of a single-epitaxial process and thus contributes to improving efficiency

DTMOSIV Lineup

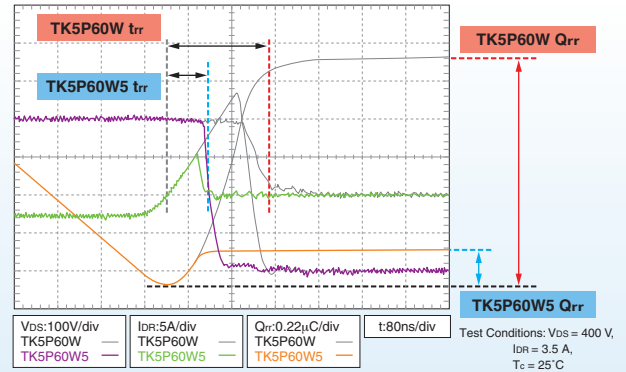
Representative Part: TK31N60



Features of the DTMOSIV HSD series suitable for driver applications for compressors and fan motors

The DTMOSIV HSD series provides a recovery time approximately 70% shorter than the standard DTMOSIV series and thus helps reduce recovery loss due to the parasitic diode.

Reverse Recovery Waveform of the Parasitic Diode



Comparisons of Representative Parts

DTMOSIV	Standard Series	HSD Series
Part Number	TK5P60W	TK5P60W5
Package	DPAK	DPAK
Ratings	600 V / 5.4 A	600 V / 4.5 A
On-resistance (max)	0.90 Ω	0.99 Ω
Recovery time (trr)	200 ns	65 ns

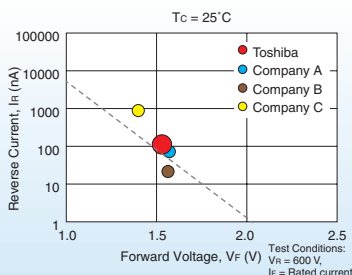
SiC Schottky Barrier Diodes

Helps reduce the energy consumption and improve the power efficiency of high power equipment

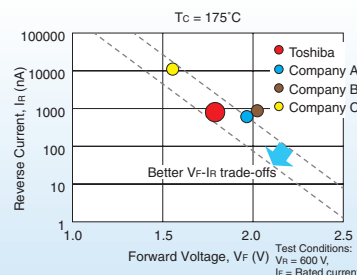
Feature 1: Outstanding V_F - I_R trade-offs at high temperatures

There is a trade-off between the forward voltage (V_F) and reverse current (I_R) of an SBD. Toshiba is focusing to improve the V_F - I_R trade-off by optimizing the device structure. Our SiC SBDs exhibit low loss even in the high-temperature region and thus help reduce power loss.

V_F - I_R Trade-offs at $T_c = 25^\circ\text{C}$



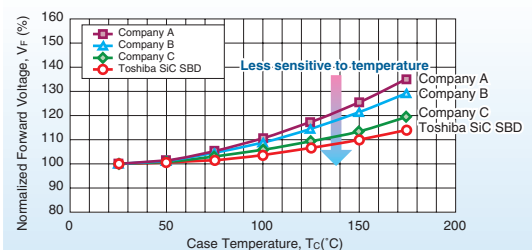
V_F - I_R Trade-offs at $T_c = 175^\circ\text{C}$







Feature 2: Low V_F temperature coefficient

Toshiba's SiC SBDs have low dependence on forward voltage, V_F , making it possible to reduce conduction loss in the high-temperature region.

Forward Voltage (V_F) vs. Temperature



Product Lineup

Absolute Maximum Ratings		Electrical Characteristics (Ta=25°C)					TO-220-2L	TO-220F-2L	TO-247	TO-3P(N)
VRRM (V)	IF(A)	VF(V)			IR(μA)		 Cathode Anode	 Cathode Anode	 Anode Anode Cathode	 Anode Anode Cathode
		Typ.	Max	@ IF(A)	Max	@ VR(V)				
650	6	1.5	1.7	6	90	650	TRS6E65C	TRS6A65C		
	8	1.5	1.7	8	90	650	TRS8E65C	TRS8A65C		
	10	1.5	1.7	10	90	650	TRS10E65C	TRS10A65C		
	12	1.54	1.7	12	90	650	TRS12E65C	TRS12A65C	TRS12N65D	
	16	1.5	1.7	16	90	650		TRS16A65C	TRS16N65D	
	20	1.5	1.7	20	90	650			TRS20N65D	
	24	1.5	1.7	24	90	650			TRS24N65D	
1200	20	1.5	1.7	20	100	1200				TRS20J120C

Photocouplers

Toshiba provides a total photocoupler solution for inverter systems with low power consumption and thin packaging.

High-Performance IC-Output Photocoupler Series

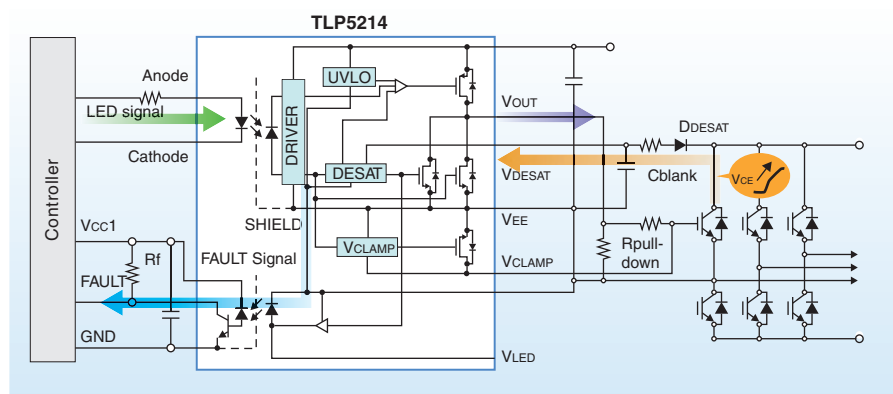
Toshiba offers a smart IGBT gate driver with protection features and a high-precision optically isolated isolation amplifier fabricated with the latest 0.13- μm BiCD process.

IGBT/MOSFET-Drive Photocoupler with Overcurrent Protection (TLP5214)

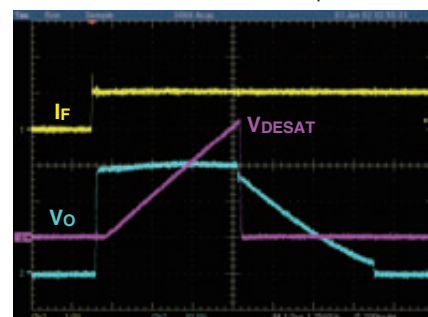
The TLP5214 monitors the saturation voltage, $V_{CE(sat)}$, of an IGBT and shuts down its output when $V_{CE(sat)}$ exceeds 6.5 V typical in the event of an overcurrent condition.

Additionally, the TLP5214 is housed in the thin SO16L package and provides active mirror clamping, rail-to-rail output and other features, reducing the number of external components compared with that previously required. This helps reduce bill-of-material (BOM) costs and board size. Despite the low-profile package, the TLP5214 provides a clearance distance of 8 mm and guarantees an isolation voltage of up to 5 kVrms, making it suitable for applications requiring higher insulation performance.

- VCE(sat) detection and shutdown protect an IGBT/MOSFET in the event of overcurrent.
- The FAULT signal is fed back to the controller at high speed.
- Active mirror clamping prevents IGBT/MOSFET failures due to mirror current.
- A rail-to-rail output reduces power loss.
- Maximum output peak current: 4.0 A
- Propagation delay (tpHL / tpLH): 150 ns max



Soft Shutdown Waveform Example



Conditions:
 $I_F = 10 \text{ mA}$, $V_{CC} = 30 \text{ V}$, $R_G = 10 \text{ }\Omega$, $C_G = 25 \text{ nF}$, $T_a = 25^\circ\text{C}$
 $I_F: 10 \text{ mA/div}$, $V_O: 10 \text{ V/div}$, $V_{DESAT}: 2 \text{ V/div}$, $1 \text{ }\mu\text{s/div}$

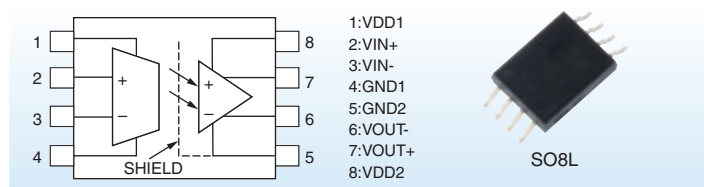
High-Precision Isolation Amplifier with a High-Performance $\Delta\Sigma$ AD Converter (TLP7820)

Typical AC servo inverters for industrial applications require feedback of the motor current. Therefore, the signal lines of a CPU or an MPU that control inverter circuitry at low voltage must be isolated from the current lines of a three-phase motor that operate at high voltage.

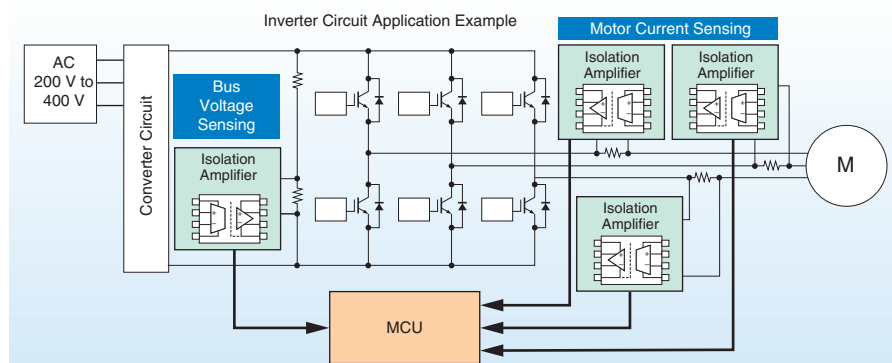
Toshiba's optically isolated isolation amplifier, the TLP7820, provides a solution for this requirement. The TLP7820 has an analog-output delta-sigma AD converter.

Features

- Exhibits primary-side current consumption of only 9 mA typical and thus helps to reduce the size of power supplies
- Unique test mode that makes it possible to monitor internal characteristics
- Housed in the thin SO8L package and thus can be soldered on the backside of a PCB



Package	SO8L
Product height (max)	2.3 mm
Operating temperature	-40 to 105°C
Input voltage range	±200 mV
Gain	8.2(typ.)
Gain error (Ta = 25°C)	±0.5/±1/±3%
Primary-side current consumption	12 mA(max)
Input offset voltage	0.9 mV(typ.)
Isolation voltage	5000 Vrms



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