TOSHIBA
Leading Innovation >>>

Motor Solutions Guide

SEMICONDUCTOR & STORAGE PRODUCTS

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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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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
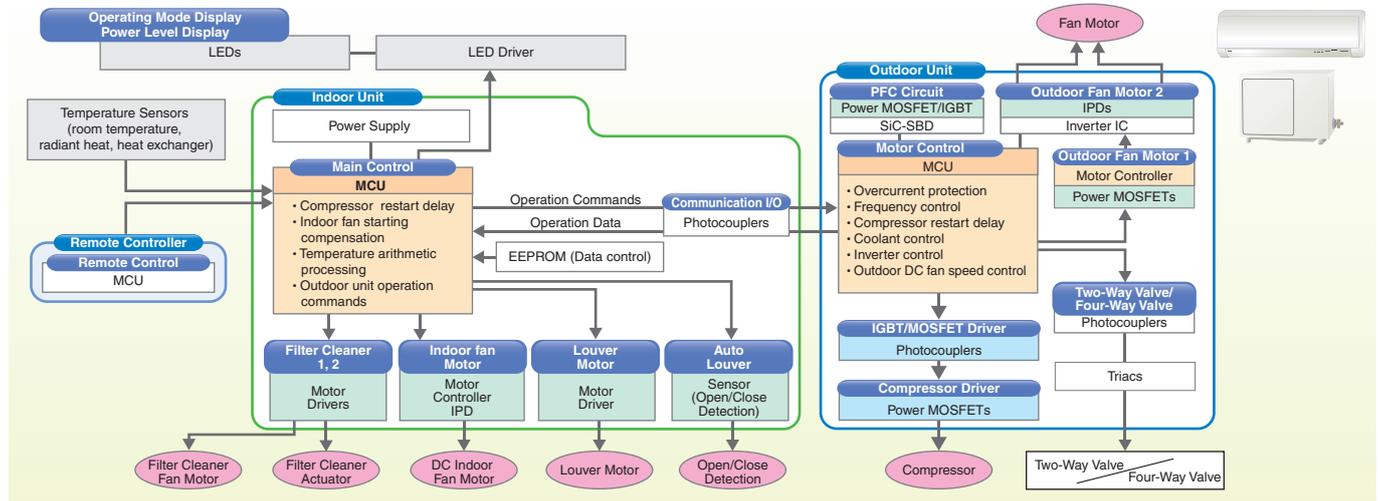

Product Lineup

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	
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	
	IGBTs	**GT15J341, GT20J341, GT30J341**	Low loss and low noise	
PFC Circuitry for Air-Conditioner Outdoor Units	IGBTs	**GT30J122A, GT20J121**	Low loss	
	Power MOSFETs	**TK16A60W, TK20A60W, TK25A60X**	DTMOSIV, DTMOSIV-H	
	SiC Schottky Barrier Diodes	**TRS6E65C, TRS8E65C TRS6A65C, TRS8A65C**	650-V V_{RRM}, maximum forward voltage (V_F) of 1.7 V	
Indoor Fan Motor	Motor Controllers/Drivers	**TB67B000**	Brushless DC motor driver; sine-wave current control	Refrigerators, air conditioners, automatic washing machines, dishwashers
		TB6584, TB6584A, TB6551, TB6631 TB6634	Brushless DC motor controller; sine-wave current control	
		TB6586, TB6586A, TB6586B	Brushless DC motor controller	
	IPDs	**TPD4152K*, TPD4152F*, 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 (TPD4152F/TPD4204F)	
Outdoor Fan Motor	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	
		TB6586, TB6586A, TB6586B	Brushless DC motor controller	
	IPDs	**TPD4152K*, TPD4152F*, 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 (TPD4152F/TPD4204F)	
Indoor Louver Motor	Motor Controllers/Drivers	**TBD62003A**	Transistor array	
		TB62210, TB62211, TC78S600 TB62261, TB62262, TB6608	Two-phase stepping motor driver	
		TC78H600, TC78H610, TB6552 TB78H620*	Full-bridge driver for a brushed DC motor	
Indoor Filter Cleaner Motor 1	Motor Controllers/Drivers	**TB6585, TB6585A, TC78B016***	Brushless DC motor driver; sine-wave current control	
Indoor Filter Cleaner Motor 2	Motor Controllers/Drivers	**TB6608, TC78S600**	Stepping motor driver; 3-bit microstepping	
IGBT/MOSFET Drivers for Air-Conditioner Outdoor Units	Photocouplers	**TLP152, TLP155E TLP5214, TLP5751 TLP5752, TLP5754 TLP5771, TLP5772, TLP5774**	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 (TLP575x), Photocoupler in SO16L with a 4-A output and Overcurrent protection (TLP5214) Low loss, low input current, SO6L, 1 to 4 outputs (TLP577x)	Air conditioners, refrigerators

*: New product

Product Overview

Sine-Wave, PWM-Drive 3-Phase BLDC Motor Driver with InPAC (TC78B016FTG)

- Absolute maximum ratings: 40 V/3.0 A
- Three-phase full-wave drive / sine-wave PWM drive
- Integrated Intelligent Phase Control (InPAC)
- Integrated Hall amplifier (Both Hall elements and Hall ICs are supported.)
- Motor lock protection
- Supply voltage supervisor, overcurrent detection (ISD), thermal shutdown (TSD), undervoltage lockout (UVLO), integrated current limiting circuit (external resistor required)
- Small package: WQFN36
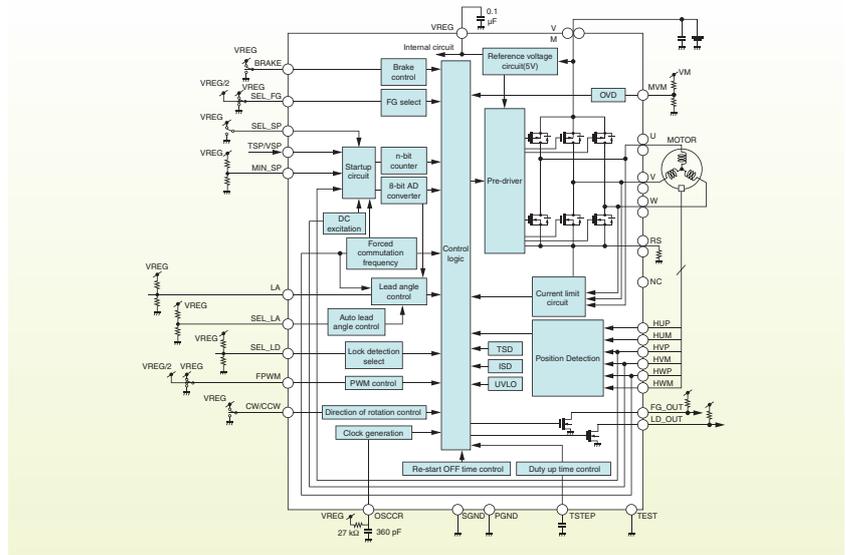
500-V Sine-Wave BLDC Motor Driver (TB67B000HG)

- 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
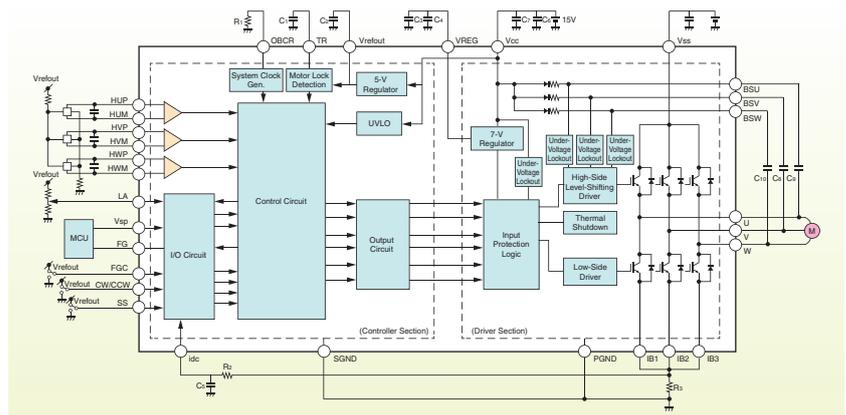
Microcontrollers with Vector Engine (TMPM370FYFG/FYDFG)

- 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
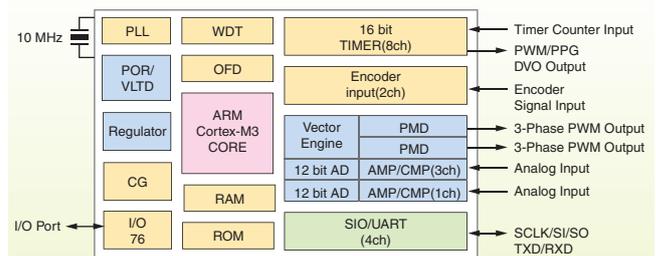
600-V Withstand Voltage Intelligent Power Device (TPD4204F)

- 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)
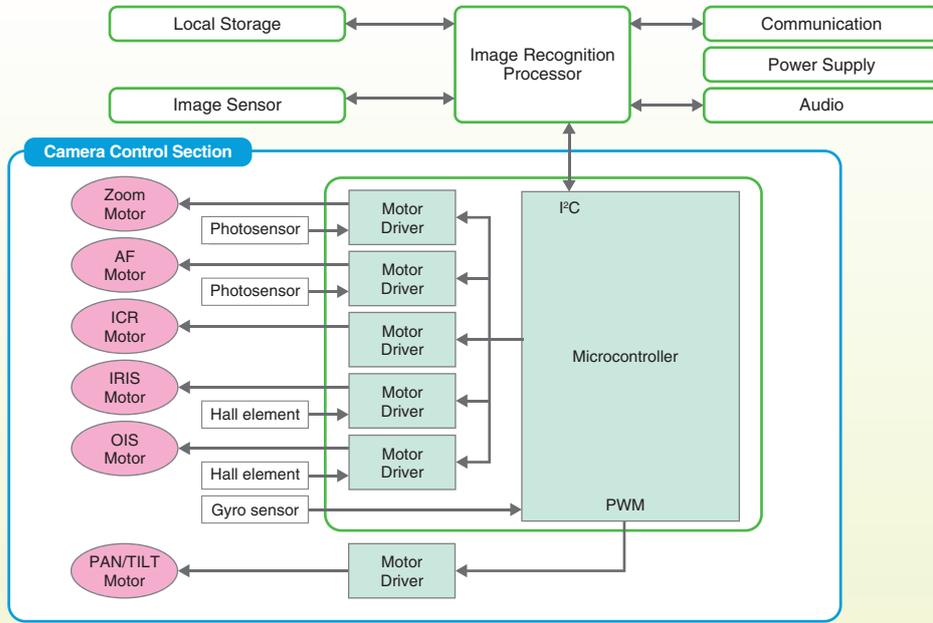- Small surface-mount package: SOP30
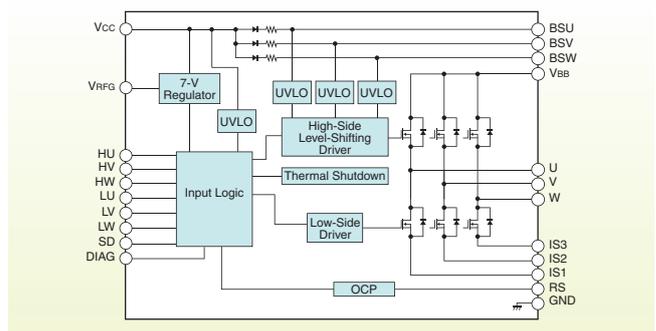
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Compact Equipment

Toshiba offers a portfolio of semiconductor devices ideal for 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	Digital still cameras, surveillance cameras, network ip cameras, camera lenses, small scanners, mini printers
		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	Constant-current drive, dual-bridge, absolute maximum ratings: 18 V/1.0 A	
		TC78H610, TC78H620*	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)	
		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	32 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	32 microsteps, constant-current drive, absolute maximum ratings: 50 V/2.0 A	
		TB67S109A	32 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	
		TC78S121*, **TC78S122***	4-channel H-bridges for driving two stepping motors	

*: New product

Product Overview

MCUs with a Programmable Servo/Sequence Controller (PSC) suitable for high-precision motor control applications (TMPM343FDXBG/10XBG)

The TMPM343FDXBG and TMPM310XBG incorporate a programmable serve/sequence controller (PSC) required for camera shake compensation, auto-focus tracking for video, lens control and overall system control, as well as motor controller/drivers and analog circuitry. The high-performance ARM Cortex-M3 core provides high-speed computation.

Additionally, a micro-step driver and a high-resolution programmable phase generator (PPG) enable smooth and quiet motor operation.

- ● ARM Cortex-M3 core
  - ・Supply voltage: 2.7 to 3.6 V (regulated on-chip)
  - ・Maximum operating frequency: 50 MHz
  - ・On-chip memory: Flash ROM 512 KB/1 MB
    - SRAM FD: 48 KB + 32 KB (PSC)
    - F10: 64 KB + 32 KB (PSC)
- ● Motor driver
  - ・Operating voltage: 2.5 V to 5.5 V (with the driver on)
    - 2.7 V to 3.6 V (peripheral analog blocks)
- ● On-chip peripherals
  - ・PSC: 4 units
  - ・12-bit AD converters (for MR sensors): 3 unit (8 channels + 4 channels x 2)
  - ・16 bit HS PWM (high-resolution PPG output): 8 channels (4 channels + 4 channels)
  - ・16-bit timer: 16 channels (free-running, compare output, PPG output)
  - ・Two-phase input pulse counter: 3 channels (for MR sensors)
  - ・Serial interfaces: 32-bit TSPI: 4 channels, UART: 1 channel, I²C: 1 channel
  - ・DMAC: 3 units
  - ・Hall Bias Control: 2 channels
  - ・10-bit DAC: 6 channels
  - ・Op-amp: 10 channels (incl. VCA 4 channels)
  - ・Photo interrupter/ encoder interface: 4 channels (two-phase 2 units)
  - ・7-bit micro-step controllers: 3 units (with the MO function)
  - ・H-SW driver: 8 channels
- ● Package: VFBGA162 (7 x 7 mm, 0.5 mm pich)
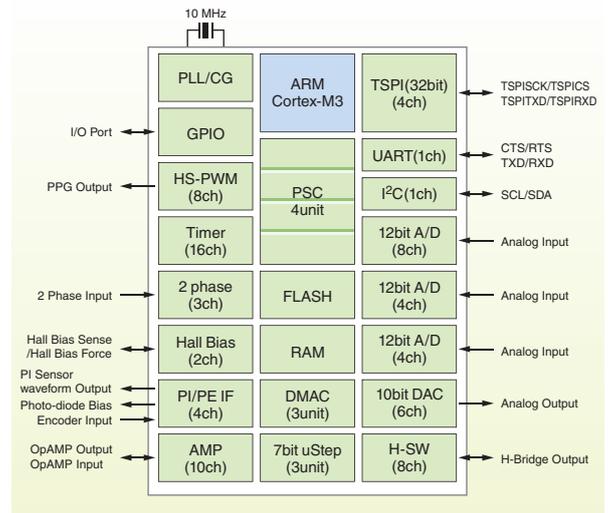
PWM Chopper-Type Dual Stepping Motor Driver (TC78S121FNG/FTG, TC78S122FNG/FTG)

- ● Controls up to two bipolar stepping motors
- ● Absolute maximum ratings: 40 V/2.0 A@Normal mode
- ● Output Ron: 0.6 Ω typ. (high side + low side)
  Exhibits an on-resistance of 0.3 Ω when two high-side switches are connected in parallel in Large mode
- ● Thermal shutdown (TSD), overcurrent detection (ISD), power-on reset (POR)
- ● Two devices provide clock- and phase-input interfaces for stepping motor applications.
- ● Operates a single power supply without the need for an external logic power supply (5 V)
- ● Small packages: HTSSOP48/QFN48
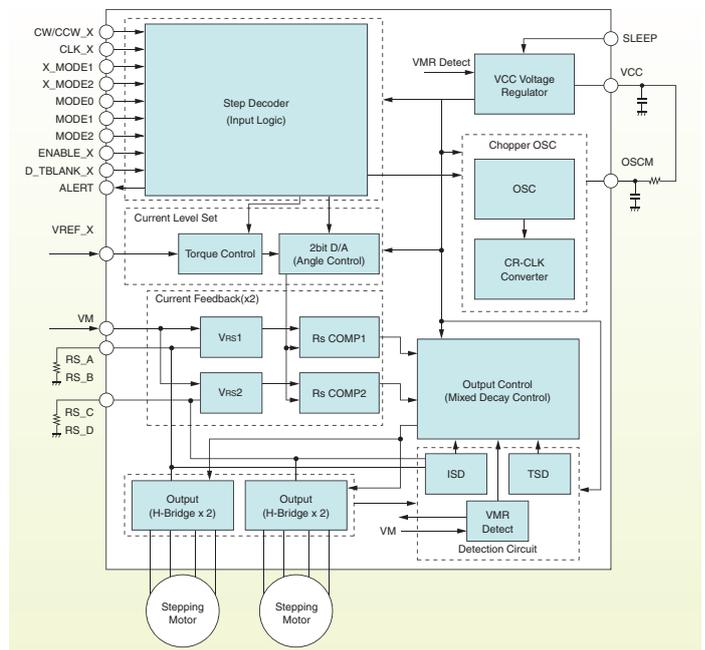
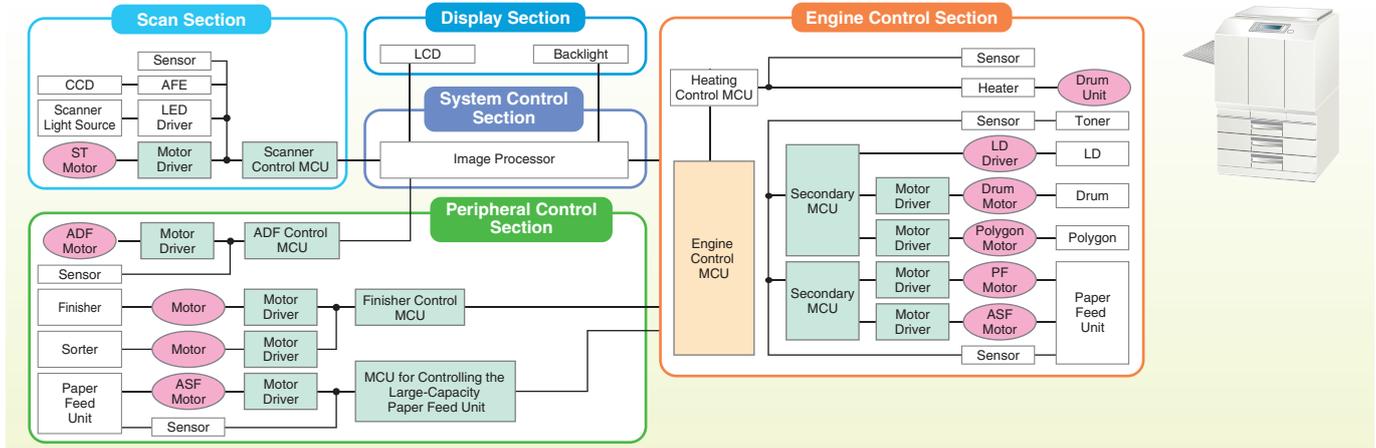### Low-Voltage Two-Channel Brushed DC Motor Driver (TC78H620FNG)

- ● Absolute maximum ratings: 18 V/1.0 A
- ● Output Ron: 1.2 Ω typ. (high side + low side)
- ● Cross-conduction protection
- ● Thermal shutdown (TSD), overcurrent detection (ISD), power-on reset (POR)
- ● Small package: SSOP16
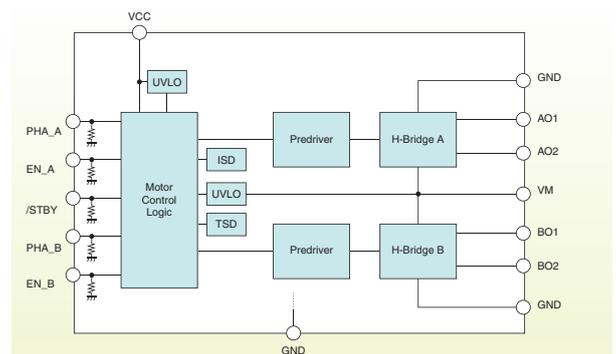
Office Equipment

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	
		TB67S289**	Clock input, 50 V/3.0 A, micro-stepping drive (1/32 step), AGC	
		TB67S508**	Clock and phase inputs, 40 V/3.0 A, micro-stepping drive (1/4 step), ACDS, ADMD	
	Stepping Motor Drivers (Unipolar)	TB67S141	Phase input interface, 84 V/3.0 A, micro-stepping drive(1/4 step)	
		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)	
		TB67S179*	Clock input, 80 V/1.5 A, micro-stepping drive (1/32 step)	
	Stepping Motor Drivers/ Brush Motor Drivers	TC78S121, TC78S122*	Phase inputs (TC78S121), Clock input (TC78S122), micro-stepping drive (1/4 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	
		TMPM46B	ARM Cortex-M4F core (120 MHz max), Integrated SLC NAND Flash controller, security feature, large-capacity memory (Flash 1 MB/RAM 514 KB)	
		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	
		TB67S289**	Clock input, 50 V/3.0 A, micro-stepping drive (1/32 step), AGC	
		TB67S508**	Clock and phase inputs, 40 V/3.0 A, micro-stepping drive (1/4 step), ACDS, ADMD	
	Stepping Motor Drivers (Unipolar)	TB67S141	Phase input interface, 84 V/3.0 A, micro-stepping drive(1/4 step)	
		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)	
		TB67S179*	Clock input, 80 V/1.5 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	50 V/10.0 A, Direct PWM control, Constant-current PWM control, Standby function	
		TB67H400A	50 V/2.5 A, dual-bridge, Large mode	
		TB67H410	50 V/2.5 A, dual-bridge, Large mode	

*: New product
**: Under development

Product Overview

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

- Full-, half- and quarter-drive modes (except TB67S265), 1/8-step drive mode (only TB67S269), 1/16-step drive mode (only TB67S269), 1/32-step drive mode (only TB67S269)
- Output Ron: 0.8 Ω 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-drive modes (except TB67S145), 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, HSSOP28, HZIP25, SDIP24

80-V/1.5-A Unipolar Stepping Motor Driver (TB67S179FTG)

- Absolute maximum ratings: 80 V/1.5 A
- The integrated ACDS eliminates the need for current-sensing resistors.
- Micro-step (1/32-step) control
- Output Ron: 0.5 Ω typ.
- Supports a clock input interface
- Thermal shutdown (TSD), overcurrent detection (ISD), power-on reset (POR)
- Small package: VQFN48
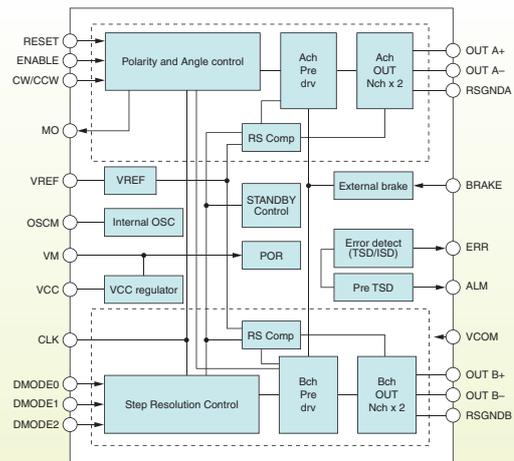
50-V/2.5-A Two-Channel Brushed DC Motor Drivers (TB67H410FTG/NG)

- Absolute maximum ratings: 50 V/2.5 A
- Configurable as a 5.0-A single-channel brushed DC motor driver in Large mode
- Output Ron: 0.8 Ω typ. (high side + low side)
- Thermal shutdown (TSD), overcurrent detection (ISD), power-on reset (POR)
- Packages: VQFN48/SDIP24
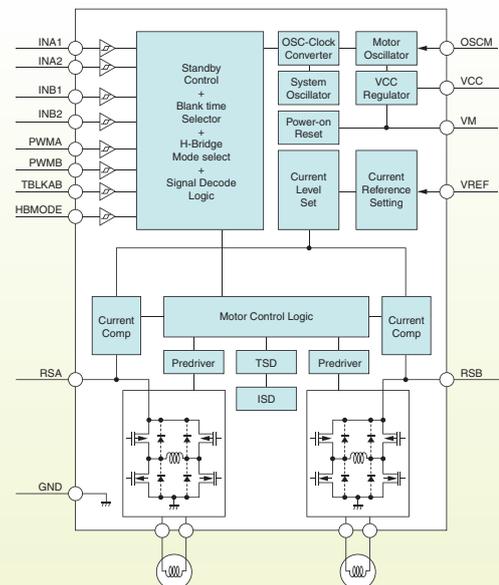
Industrial Applications

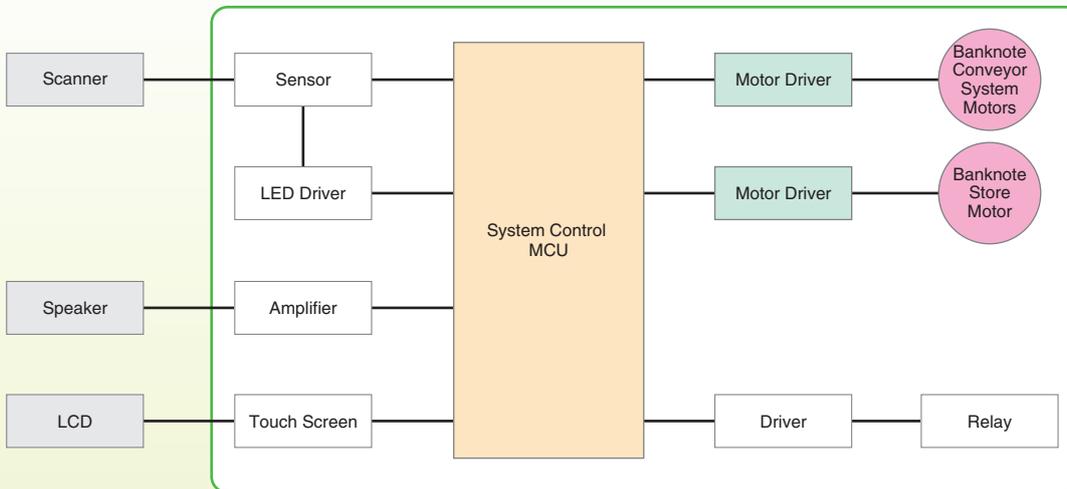Toshiba offers motor solutions for industrial applications that require high current, quick control and high accuracy.

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	
		TB67S179*	Clock input interface, 80 V, 1.5 A, 1/32 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	
		TB67S209*	Clock input interface, 50 V/4.0 A, micro-stepping drive (1/32 step)	
		TB67S289**	Clock input interface, 50 V/3.0 A, micro-stepping drive (1/32 step), AGC	
		TB67S508**	Clock and phase inputs, 40 V/3.0 A, micro-stepping drive (1/4 step), ACDS, ADMD	
	Brush Motor Drivers	TB67H301	40 V/3.0 A	
		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)	General-purpose inverters, servo amplifiers, industrial sewing machines
		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)	
		TLP7820, TLP7830	Motor phase current sensing, bus voltage sensing, 5-kVrms isolation voltage, SO8L package with 8-mm creepage distance, analog output (TLP7820), digital output (TLP7830)	

*: New product
**: Under development

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- and quarter-drive modes (except TB67S145), 1/8-step drive mode (only TB67S149), 1/16-step drive mode (only TB67S149), 1/32-step drive mode (only 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- and quarter-step drive modes (except TB67S105), 1/8-step drive mode (TB67S103A, TB67S109A), 1/16-step drive mode (TB67S103A, TB67S109A), 1/32-step drive mode (TB67S103A, TB67S109A)
- Output Ron: 0.49 Ω typ. (high side + low side) * TB67S105: 0.6 Ω typical
- 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, HZIP25, 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)
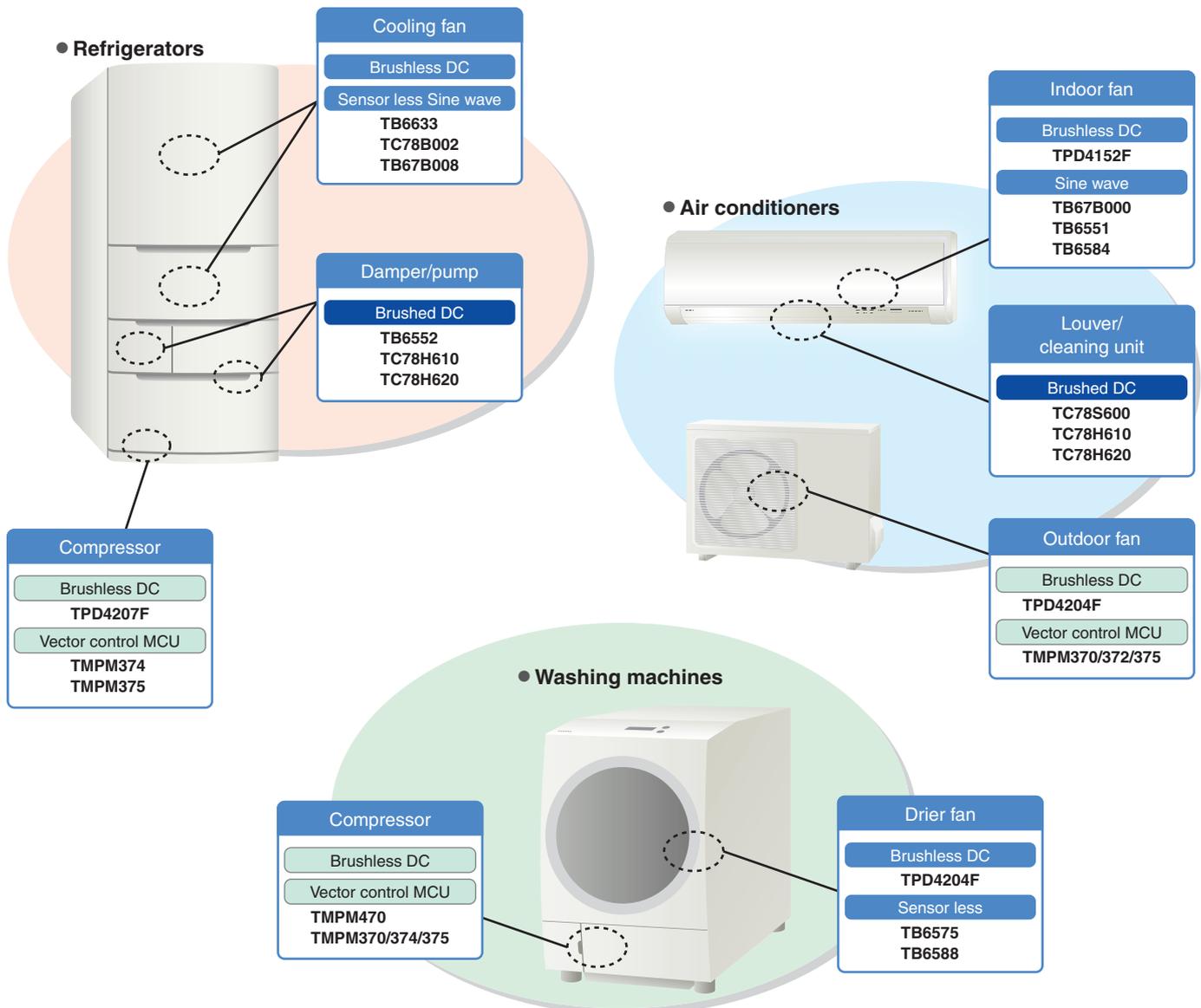- Package: HZIP25

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

Toshiba's unique motor drive technology provides high efficiency and
quiet motor operation.

● **Refrigerators**

Cooling fan
Brushless DC
Sensor less Sine wave
TB6633
TC78B002
TB67B008

Damper/pump
Brushed DC
TB6552
TC78H610
TC78H620

Compressor
Brushless DC
TPD4207F
Vector control MCU
TMPM374
TMPM375

● **Air conditioners**

Indoor fan
Brushless DC
TPD4152F
Sine wave
TB67B000
TB6551
TB6584

**Louver/
cleaning unit**
Brushed DC
TC78S600
TC78H610
TC78H620

Outdoor fan
Brushless DC
TPD4204F
Vector control MCU
TMPM370/372/375

● **Washing machines**

Compressor
Brushless DC
Vector control MCU
TMPM470
TMPM370/374/375

Drier fan
Brushless DC
TPD4204F
Sensor less
TB6575
TB6588

Example of Three-Phase BLDC Motor Control Using Toshiba's Semiconductor Devices

1
- High-efficiency model using lead angle control
  ⇒ InPAC helps improve efficiency without the need for tuning.
- Sine-wave output or sensorless motor drive models are also available.

For low-voltage motors
(rated at up to 50 V and 1 to 5 A)

Low-Voltage Motor

2
- High-performance vector control model

Microcontrollers Designed for Motor Applications

PMD (ch)	Vector Control	Part Number
1	VE+	TMPM37AFSQG
	VE	TMPM375FSDMG
		TMPM372FWUG
		TMPM373FWDUG
		TMPM374FWUG
		TMPM370FYDFG
		TMPM370FYFG
		TMPM376FDDFG
		TMPM376FDFG
2	A-VE	TMPM470FDFG
		TMPM470FYFG
		TMPM470FZFG
		TMPM475FDFG
		TMPM475FYFG
		TMPM475FZFG

MCDs (Drivers)

Output (V)	Current (A)	Part Number	Output Waveform	Lead Angle Control	Sensing
25	1	TB6633FNG/AFNG	Square-wave	External input	Sensorless
	3	TB67B001FTG/AFTG		Auto	
		TB67B008FNG/AFNG/BFNG/CFNG			
		TB67B008FTG/AFTG/BFTG/CFTG			
36		TC78B015BFTG/CFTG**			
40		TC78B016FTG	Sine-wave	InPAC	Hall sensors
45	1.8	TB6585FG/AFTG		Auto	
50	2.5	TB6588FG	Square-wave	External input	Sensorless

For high-voltage motors
(rated at 250 to 600 V and 0.7 to 5 A)

High-Voltage Motor

IPDs (180-Degree Commutation)

Output (V)	Current (A)	Part Number
500	1	TPD4123AK
		TPD4123K
	2	TPD4144AK
		TPD4144K
	2.5	TPD4206F
	3	TPD4135AK
		TPD4135K
600	2.5	TPD4204F
	5	TPD4207F

3
- High-efficiency model using lead angle control
- Sine-wave output or sensorless motor drive models are also available.

MCDs (Controllers)

Output (V)	Current (A)	Part Number	Output Waveform	Lead Angle Control	Sensing
5.5		TB6575FNG	Square-wave	External input	Sensorless
12	Depends on output circuitry	TB6551FAG	Sine-wave		Hall sensors
		TB6556FG		Auto	
18		TB6584FNG/AFNG			
		TB6586FG/AFG/BFG	Square-wave	External input	
		TB6631FNG	Sine-wave	Auto	
		TB6634FNG			
30		TB6603FTG	Sine-wave	External input	
		TB6604FTG		Auto	
		TB6605FTG			

4
- High-voltage IPDs

High-Voltage Motor

IPDs (120-Degree Commutation)

Output (V)	Current (A)	Part Number	Output Waveform
250	1	TPD4151K	Square-wave
500		TPD4142K	
		TPD4146K	
600	0.7	TPD4152F	Square-wave
		TPD4152K	

5
- High-voltage MCDs

High-Voltage Motor

MCDs (Drivers)

Output (V)	Current (A)	Part Number	Output Waveform
500	2	TB67B000HG	Sine-wave Square-wave

**: Under development

13

Brushless Motor Drivers

Simply configurable auto lead angle control provides high efficiency.

Latest Motor Drive Technology – Intelligent Phase Control (InPAC)

InPAC is the state-of-the-art motor control technology developed by Toshiba.
It delivers high efficiency by automatically optimizing motor current and voltage phases.
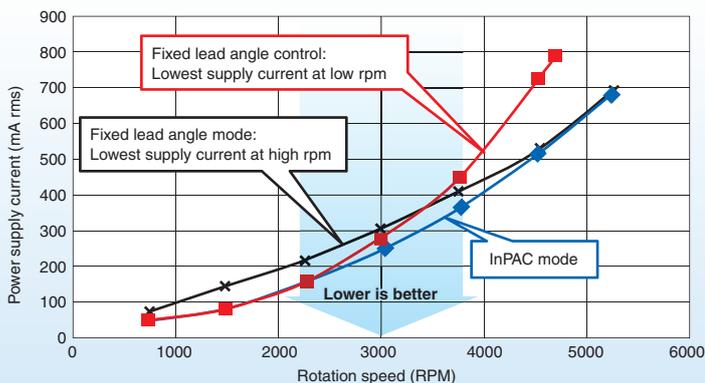
High efficiency

Maintains high efficiency regardless of the motor rpm, load torque and supply voltage by automatically optimizing motor current and voltage phases

Simply configurable auto lead angle control

Reduces the number of external components necessary for lead angle control and eliminates the need for setup and tuning according to the operating state 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).


Lead Angle Control	Efficiency	Effort Required for Tuning
Conventional technology	Low: Except for the target rpm	High: Tunable only for a specific rpm
InPAC	High: Automatically configured for the best setup	Low: No tuning required

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.
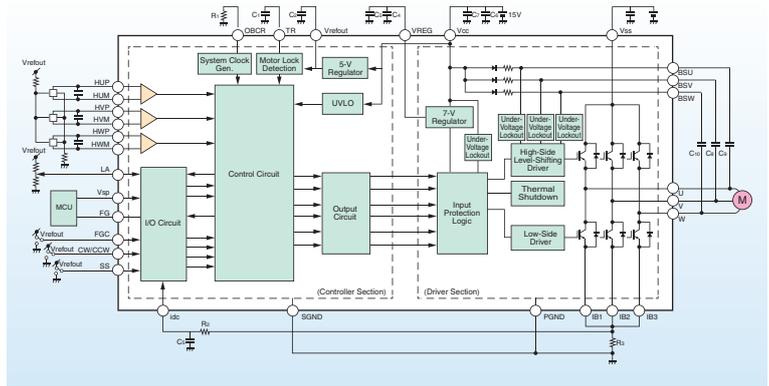
Product Lines

14
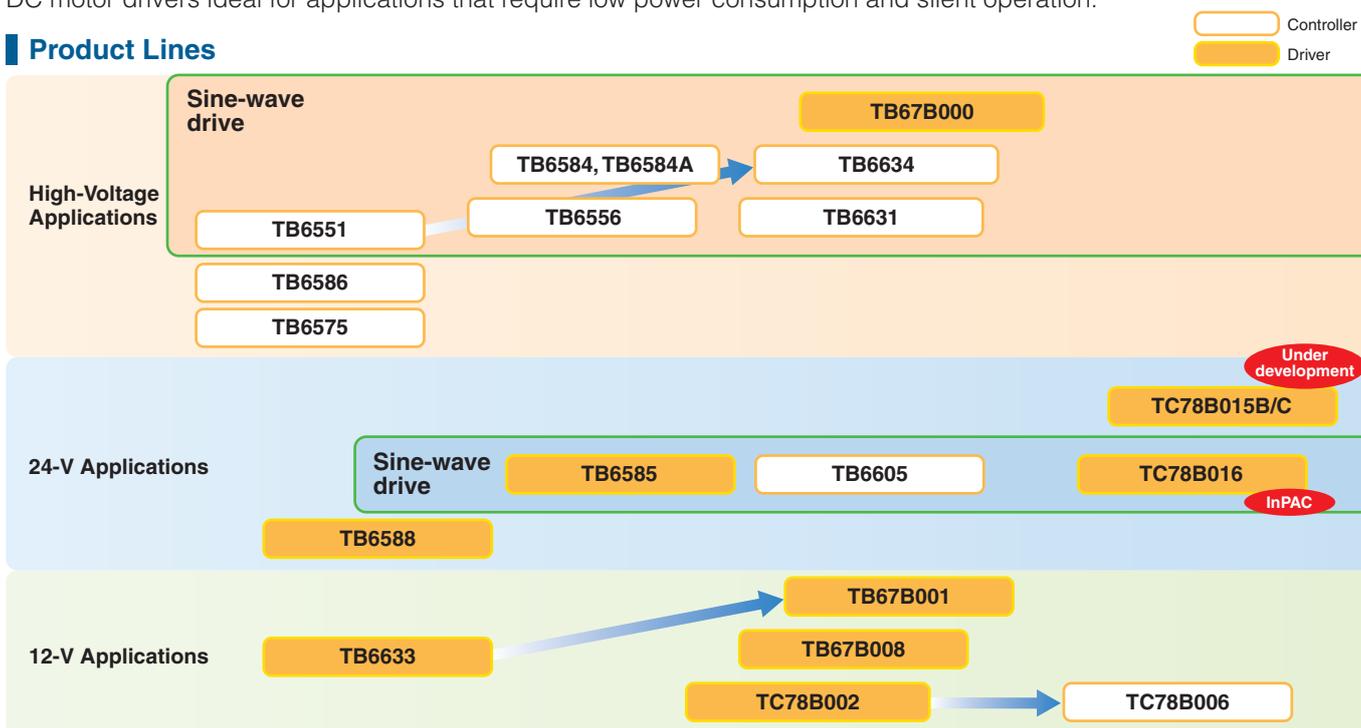
Product Overview

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

- High-voltage sine-wave driver(Absolute Maximum Ratings: 500 V/2.0 A, sine- and square-wave drive)
- Lead angle control(via an external input)
- Motor speed control via an analog voltage input
- On-chip power supply for Hall sensors and Hall ICs
- Motor lock protection
- Through-hole package: HDIP30

Sine-Wave, PWM-Drive 3-Phase BLDC Motor Driver with InPAC (TC78B016FTG)

- Absolute maximum ratings: 40 V/3.0 A
- Three-phase full-wave drive / sine-wave PWM drive
- Integrated Intelligent Phase Control (InPAC)
- Integrated Hall amplifier (Both Hall elements and Hall ICs are supported.)
- Motor lock protection
- Supply voltage supervisor, overcurrent detection (ISD), thermal shutdown (TSD), undervoltage lockout (UVLO), integrated current limiting circuit (external resistor required)
- Small package: WQFN36
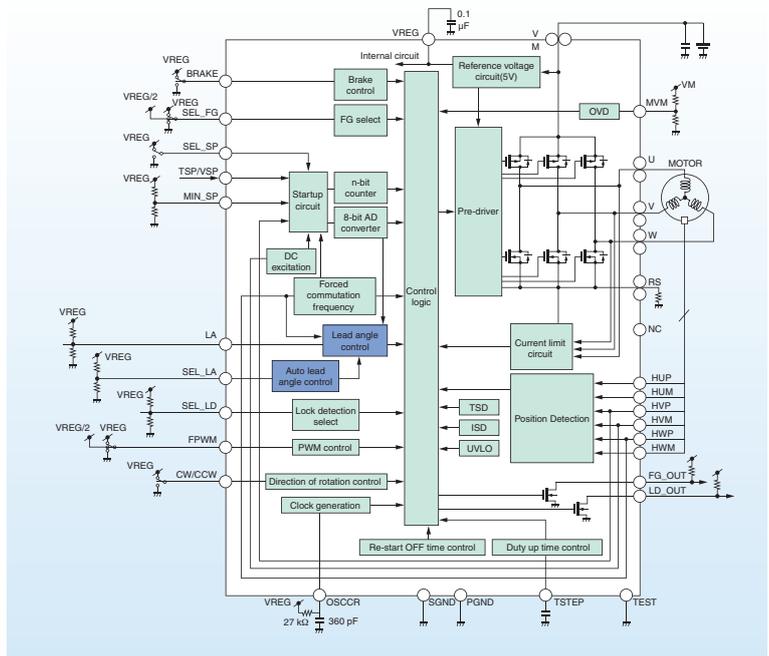
Single-Phase Pseudo-Sine-Wave BLDC Motor Driver (TC78B002FTG/FNG)

- Ideal for use with a 12-V power supply (Absolute maximum rating: 18 V/1.5 A)
- Capable of driving a BLDC motor with a sine wave by shaping the commutation waveform
- Motor speed control via an analog voltage input
- On-chip 5-V regulator
- Motor lock protection
- Small packages: WQFN16, SSOP16

● Product Lineup

Part Number	Phases		Type			Maximum Ratings		Sensor type		Commutation		Lead Angle Control				Package
	3-Phase	1-Phase	Con-troller	Pre Driver	Driver	Voltage (V)	Current (A)	Sensor-less	Hall Sensor Inputs	Square	Sine	External Input	Auto (current FB)	Auto (rpm FB)	Auto (InPAC)	
TB6551FAG	●		●			12	0.002		●		●	●				SSOP24
TB6556FG	●		●			12	0.002		●	●	●	●	●			SSOP30
TB6575FNG	●		●			5.5	0.02	●		●		●				SSOP24
TB6584FNG/AFNG	●		●			18	0.002		●	●	●	●	●			SSOP30
TB6585FG/AFTG	●				●	45	1.8		●	●	●	●				HSOP36/QFN48
TB6586FG/AFG/BFG	●		●			18	0.002		●	●		●				SSOP24
TB6588FG	●				●	50	2.5	●		●		●				HSOP36
TB6603FTG	●			●		30	0.02		●	●	●	●				QFN36
TB6604FTG	●			●		30	0.02		●	●		●	●			QFN48
TB6605FTG	●			●		30	0.02		●	●	●	●		●		QFN36
TB6631FNG	●		●			18	0.002		●	●		●		●		SSOP30
TB6633FNG/AFNG	●				●	25	1.0	●		●		●				SSOP24
TB6634FNG	●		●			18	0.002		●	●	●	●	●			SSOP30
TB67B000HG	●				●	500	2.0		●	●	●	●				HDIP30
TB67B001FTG/AFTG	●				●	25	3.0	●		●		●		●		QFN36
TB67B008FNG/AFNG/BFNG/CFNG	●				●	25	3.0	●		●		●		●		SSOP24
TB67B008FTG/AFTG/BFTG/CFTG	●				●	25	3.0	●		●		●		●		QFN24
TB67Z800FTG	●				●	25	3.0									QFN36
TC78B002FTG/FNG		●			●	18	1.5		●	●		●				QFN16/SSOP16
TC78B006FNG/AFNG/BFNG/CFNG		●		●		40	0.02		●	●	●					SSOP16
TC78B006FTG/AFTG/BFTG/CFTG		●		●		40	0.02		●	●	●					QFN16
TC78B016FTG *	●				●	40	3.0		●	●	●	●		●	●	QFN36
TC78B015BFTG/CFTG **	●				●	36	3.0		●	●		●		●		QFN36

*: New product
**: Under development

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BLDC Motor Drivers (High-Voltage)

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 5.0 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.
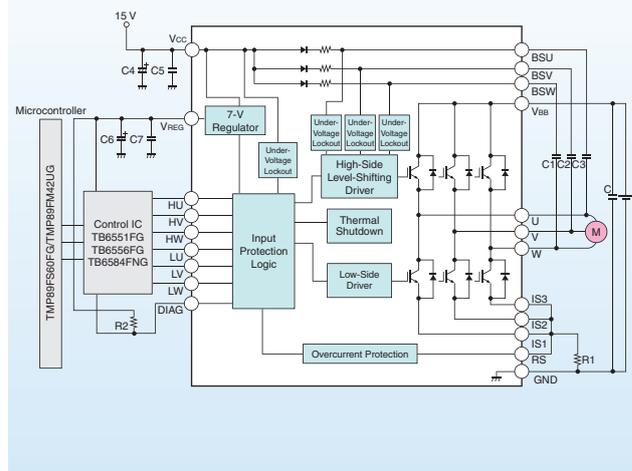
■ 120-Degree Commutation

- Variable-speed brushless motor drive via the Hall sensor or Hall IC inputs
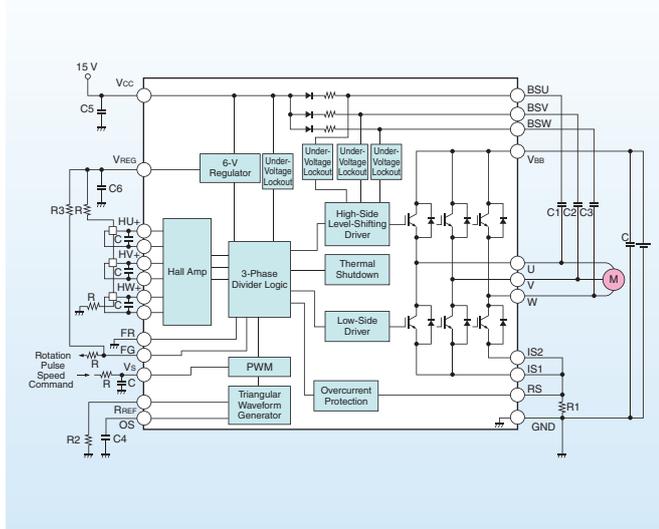
■ 180-Degree Commutation

- 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	Package	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	Package	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
TPD4204F*	600V/2.5A	SOP30	Y	Y	Y	Y
TPD4206F*	500V/2.5A	SOP30	Y	Y	Y	Y
TPD4207F*	600V/5A	SOP30	Y	Y	Y	Y

*: New product

Photocouplers

Toshiba's extensive portfolio of high-performance IC and other types of photocouplers provides total solutions for inverter systems.

### 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.

- $V_{CE(sat)}$ 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

SO16L

TLP5214
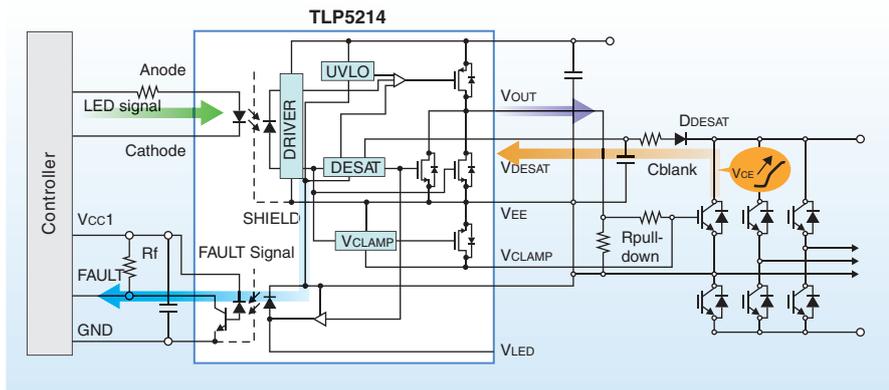
Soft Shutdown Waveform Example
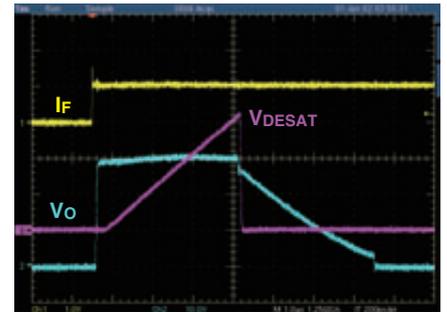
Conditions:
I_F = 10 mA, V_{CC} = 30 V, R_G = 10 Ω, C_G = 25 nF, Ta = 25°C
I_F: 10 mA/div, V_O: 10 V/div, V_{DESAT}: 2 V/div, 1 μs/div

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

1:VDD1
2:VIN+
3:VIN-
4:GND1
5:GND2
6:VOUT-
7:VOUT+
8:VDD2
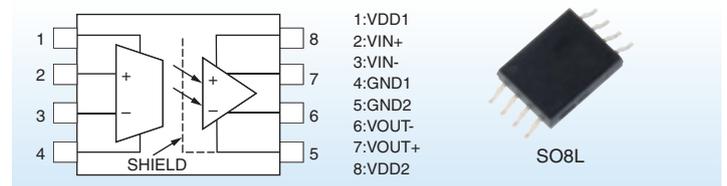
SO8L

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

Inverter Circuit Application Example
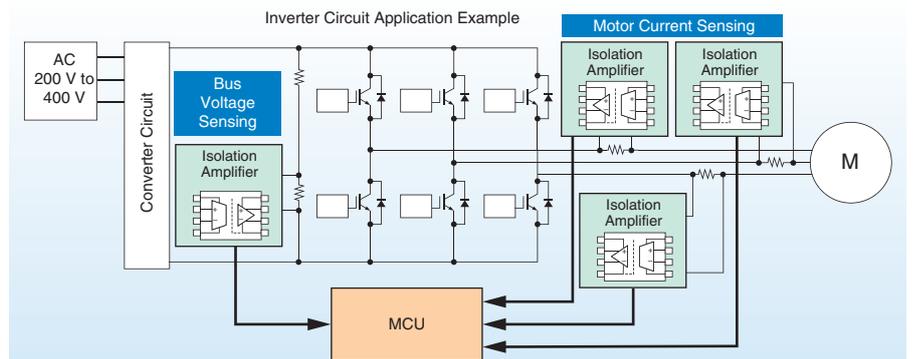
Microcontrollers

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.
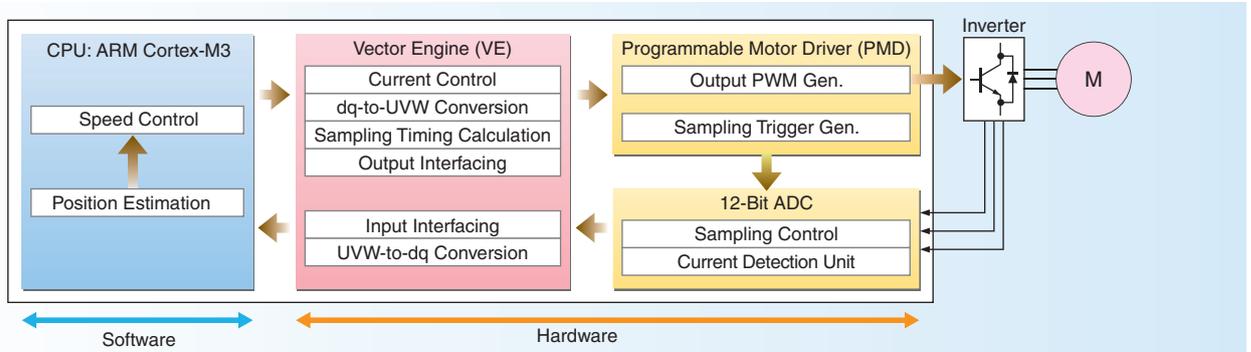
Roadmap
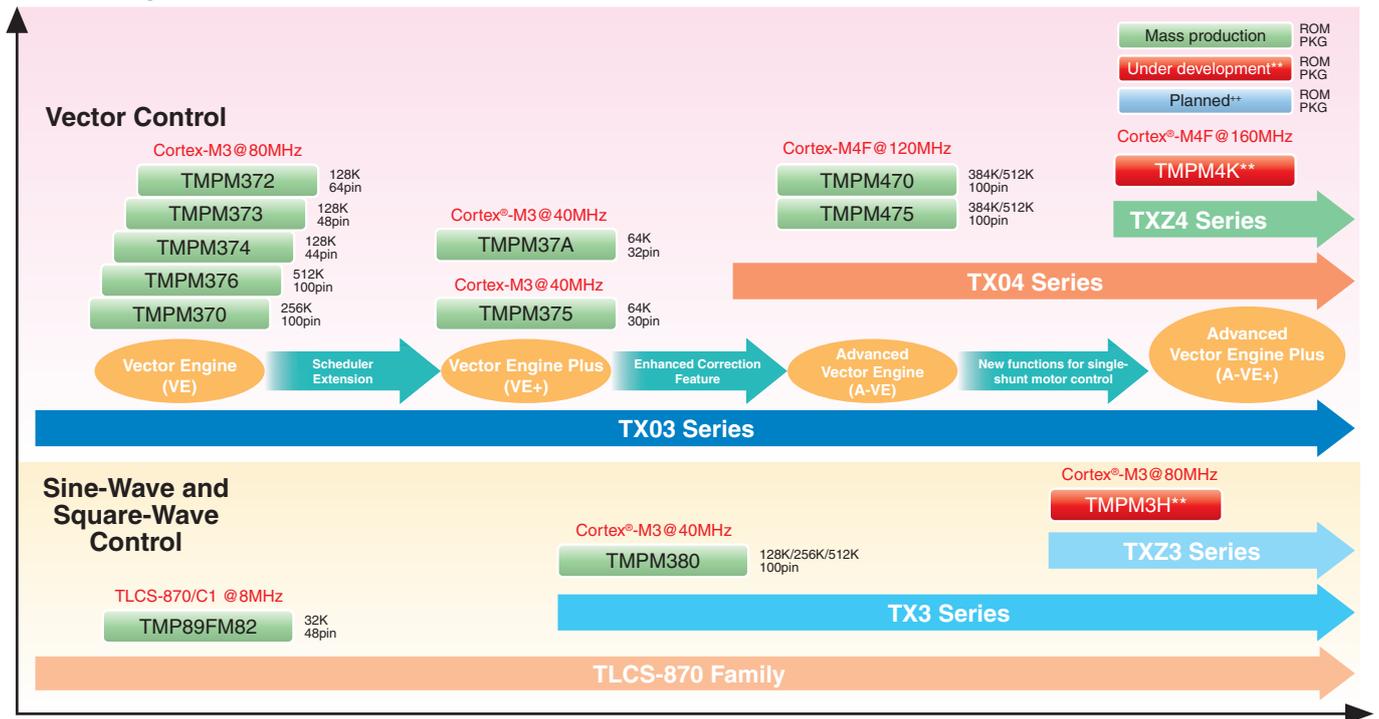
**: Under development

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.

For details, visit our website.
Vector Engine https://toshiba.semicon-storage.com/ap-en/product/microcomputer/lineup/arm-micon/tx03-series/function/vector-engine.html

New Products: TXZ Family

TXZ3 Series M3H Group MCUs with ARM® Cortex®-M3 Core

Extensive lineup of standard MCUs featuring low power consumption and high functionality

Features

- High-performance ARM Cortex-M3 core with a clock rate of up to 80 MHz
  ARM Cortex-M core recognized as a de facto global standard.
- Extensive memory and packaging options
  The TXZ family is offered with a wide range of memory and packaging options to simplify your selection process.
- General-purpose microcontrollers suitable for a variety of applications
  Suitable for motor control, commercial and industrial applications.
  Incorporates AD converter, DA converter, UART, timer, I²C controller, SPI/SIO and motor controller blocks.

ARM Cortex-M3	MPU	WDT	ADC
Code Flash 32KB-2MB	RTC	RMC	DAC
Data Flash 8-32KB	A-ENC	Timer	UART
SRAM 6-128K	PMD	SPI/SIO	I²C

Application examples

General commercial and industrial equipment

Note: This table includes microcontrollers being planned and developed and is therefore subject to change without notice.
For details, visit our website.
https://toshiba.semicon-storage.com/ap-en/product/microcomputer/lineup/arm-micon/txz3-series.html

TXZ4 Series M4K Group MCUs with ARM® Cortex®-M4 Core

Motor control MCUs incorporating all functions and peripherals necessary for motor control

Features

- High-performance ARM Cortex-M4F core with a maximum clock rate of 160 MHz
  ARM Cortex-M core recognized as a de facto global standard.
- Advanced motor control engine and high-precision analog circuitry
  Advanced Vector Engine Plus (A-VE+)/Advanced Encoder Input Circuit (A-ENC),
  High-speed 12-bit AD converter, op-amp.
- Safety functions (IEC 60730), dynamic RAM analysis
  IEC 60730-compliant ROM, RAM, AD and clock tests.
  Non-Break Debug (NBD) interface for dynamic RAM analysis using RAMScope.

ARM Cortex-M4F		WDT	12bit ADC
Code Flash 64KB-128KB	MPU	POR	A-VE+
IOSC	A-ENC	Timer	OP-AMP
SRAM 18-26K	A-PMD	OFD	NBD I/F

Application examples

General applications with motors
(air conditioners, washing machines, refrigerators, power-assisted bicycles, etc.)
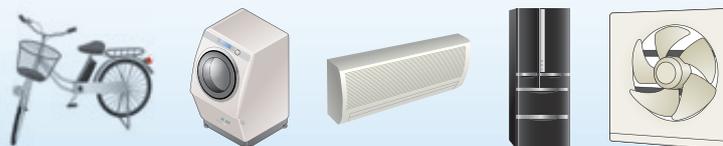
Note: This table includes microcontrollers being planned and developed and is therefore subject to change without notice.
For details, visit our website.
https://toshiba.semicon-storage.com/ap-en/product/microcomputer/lineup/arm-micon/txz4-series.html

Microcontrollers

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, VQFN32, LQFP44, LQFP48, LQFP64, LQFP100, QFP100)

Evaluation Kit

TMPM370   TMPM375

IAR System AB

TMPM37A   TMPM475

ESP Co., Ltd.

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 μs)
- 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
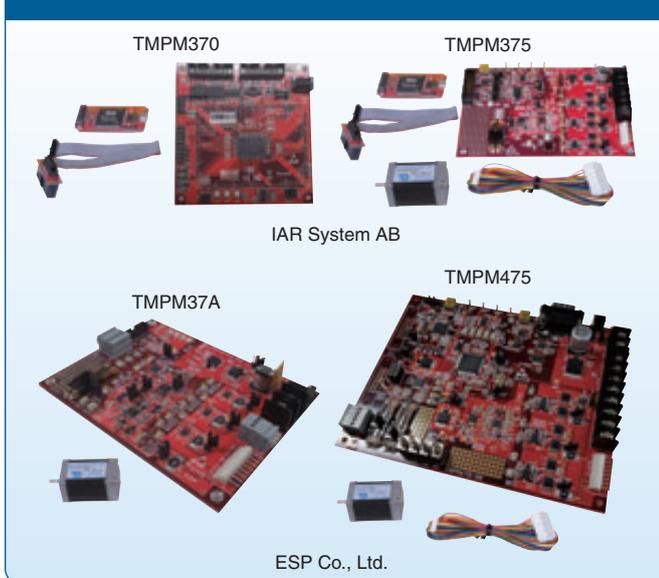
● Product Lineup

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 μs)	2		76	QFP100
TMPM370FYFG	80	256	2	22 (2 μs)	2		76	LQFP100
TMPM372FWUG	80	128	1	11 (2 μs)	1		53	LQFP64
TMPM373FWDUG	80	128	1	7 (2 μs)	1		37	LQFP48
TMPM374FWUG	80	128	1	6 (2 μs)	1		33	LQFP44
TMPM376FDDFG	80	512	2	22 (2 μs)	2		82	QFP100
TMPM376FDFG	80	512	2	22 (2 μs)	2		82	LQFP100
TMPM375FSDMG	40	64	1	4 (2 μs)	1		21	SSOP30
TMPM37AFSQG	40	64	1	5 (2 μs)			13	VQFN32
TMPM470FYFG	120	256	2	23 (1 μs)	2		79	LQFP100
TMPM470FZFG	120	384	2	23 (1 μs)	2		79	LQFP100
TMPM470FDFG	120	512	2	23 (1 μs)	2		79	LQFP100
TMPM475FYFG	120	256	2	23 (1 μs)	2	1	79	LQFP100
TMPM475FZFG	120	384	2	23 (1 μs)	2	1	79	LQFP100
TMPM475FDFG	120	512	2	23 (1 μs)	2	1	79	LQFP100

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

Microcontrollers with PSC (M340/M440 Group)

Features

- Incorporates a Programmable Servo/Sequence Controller (PSC)[*1] 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 ±90°)
- High-speed 12-bit AD converter and 10-bit DA converters
- Housed in a small fine-pitch BGA packages

Evaluation Kit

TMPM440

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
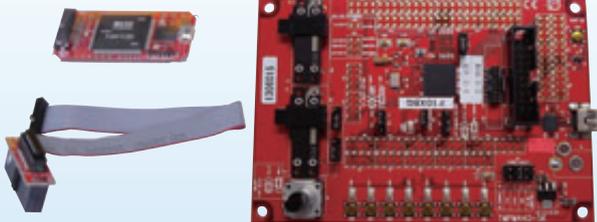
● Product Lineup

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						

(*1) For details of the PSC, visit our website at:
https://toshiba.semicon-storage.com/ap-en/product/microcomputer/lineup/arm-micon/tx03-series/function/psc.html
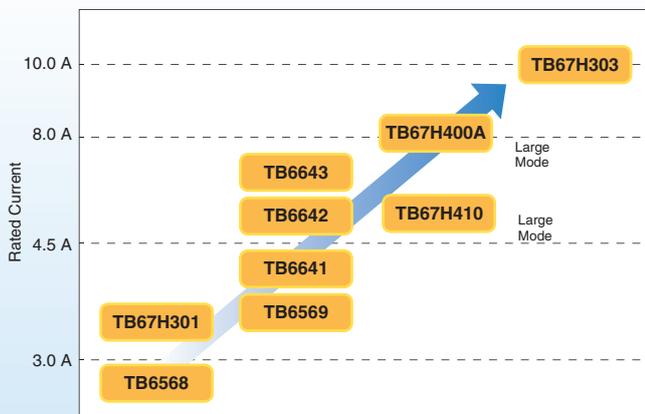
Brushed Motor Drivers

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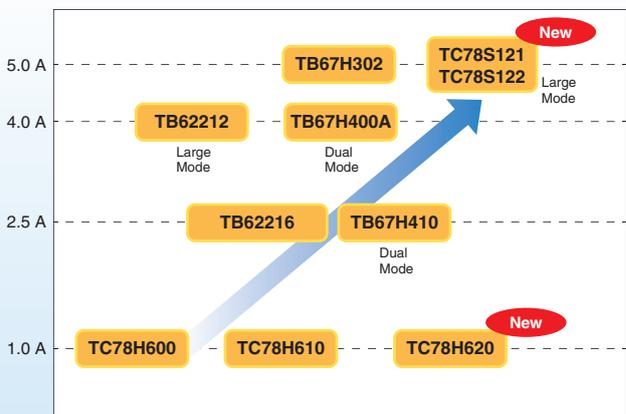
Brushed DC Motor Driver Series

Toshiba offers brushed motor drivers fabricated using a BiCD process that exhibits low output Ron 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.
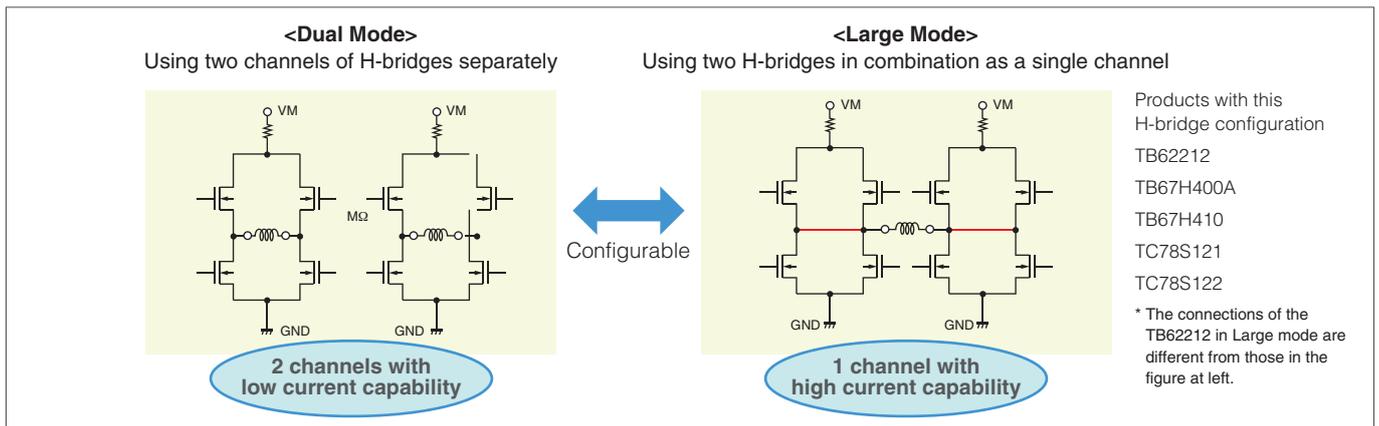
Product Lines

● **Single-Channel Motor Drivers**

Rated Current	
10.0 A	TB67H303
8.0 A	TB67H400A — Large Mode
	TB6643
	TB6642 / TB67H410 — Large Mode
4.5 A	TB6641
	TB67H301 / TB6569
3.0 A	TB6568

● **Dual-Channel Motor Drivers**

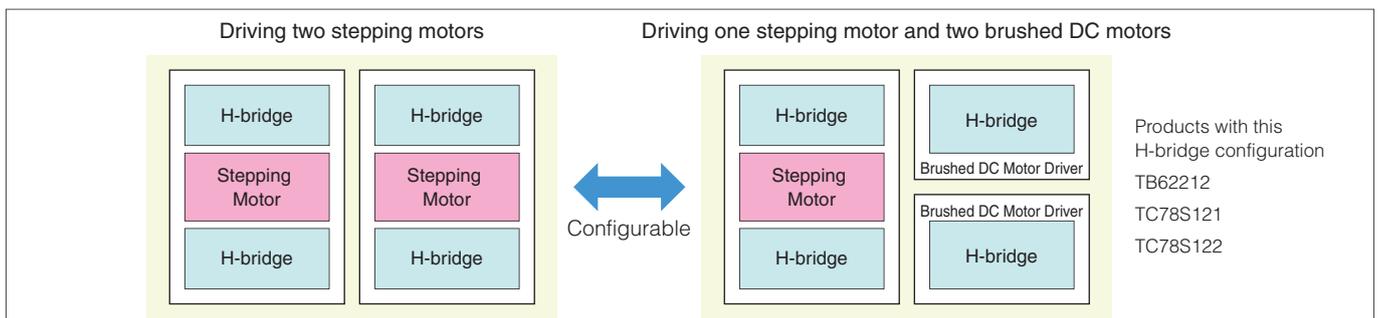| Rated Current	
5.0 A	TB67H302 / TC78S121 TC78S122 (New) Large Mode
4.0 A	TB62212 (Large Mode) / TB67H400A (Dual Mode)
2.5 A	TB62216 / TB67H410 (Dual Mode)
1.0 A	TC78H600 / TC78H610 / TC78H620 (New)

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**

<Dual Mode>
Using two channels of H-bridges separately

<Large Mode>
Using two H-bridges in combination as a single channel

Configurable

VM · VM · MΩ · GND · GND

VM · VM · GND · GND

2 channels with low current capability

1 channel with high current capability

Products with this H-bridge configuration

TB62212
TB67H400A
TB67H410
TC78S121
TC78S122

* The connections of the TB62212 in Large mode are different from those in the figure at left.

● **Case 2: Selecting the types of motors to be driven**

Driving two stepping motors

H-bridge	H-bridge
Stepping Motor	Stepping Motor
H-bridge	H-bridge

Configurable

Driving one stepping motor and two brushed DC motors

H-bridge	H-bridge
Stepping Motor	Brushed DC Motor Driver
H-bridge	Brushed DC Motor Driver / H-bridge

Products with this H-bridge configuration

TB62212
TC78S121
TC78S122

PWM Chopper-Type Dual Stepping Motor Driver (TC78S121FNG/FTG, TC78S122FNG/FTG)

- Controls up to two bipolar stepping motors
- Absolute maximum ratings: 40 V/1.5 A@Normal mode
- Low output Ron: 0.6 Ω typ. (high side + low side)
  Exhibits an on-resistance of 0.3 Ω when two high-side switches are connected in parallel in Large mode
- Overcurrent detection (ISD), thermal shutdown (TSD), power-on reset (POR)
- Operates a single power supply without the need for an external logic power supply (5 V)
- Small packages: HTSSOP48/QFN48

Low-Voltage Two-Channel Brushed DC Motor Driver (TC78H620FNG)

- Absolute maximum ratings: 18 V/1.0 A
- Low output Ron: 1.2 Ω typ. (high side + low side)
- Motor lock protection
- Small package: SSOP16

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), power-on reset (POR)
- Packages: WQFN48, SDIP24

● Product Lineup

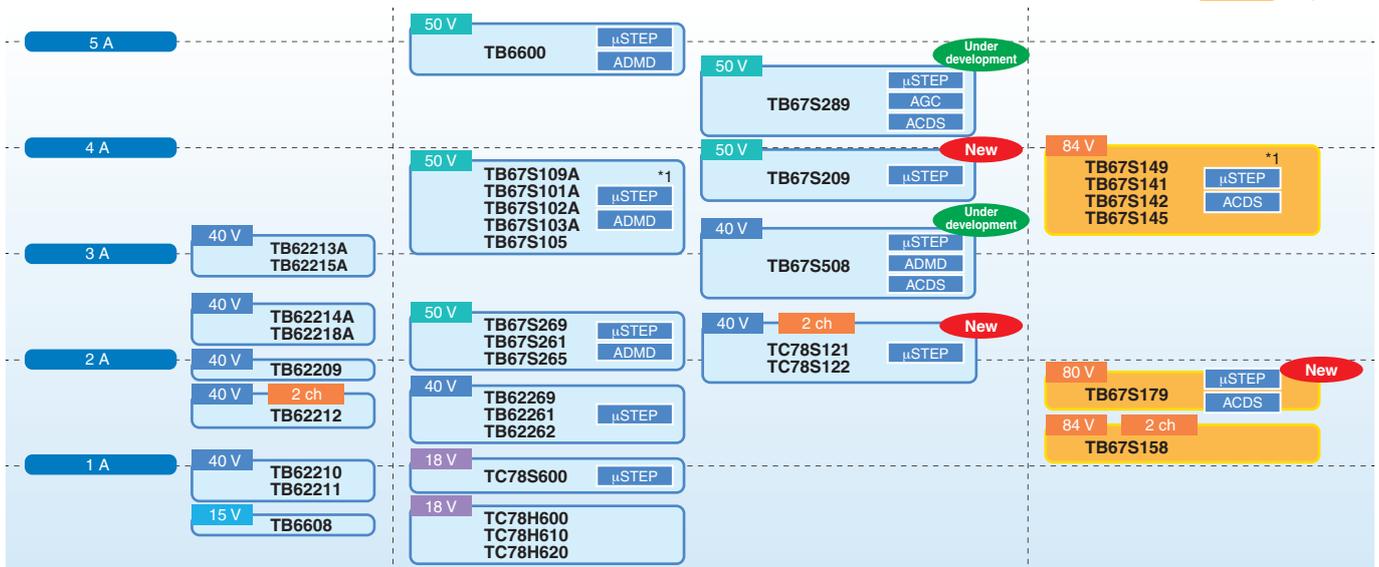| Part Number	Large Mode	Absolute Maximum Ratings		Output Ron (H + L) (Ω)	# Circuits (ch)	Constant-Current PWM Control	Protection			Packages
		Supply Voltage (V)	Output Current (A)				UVLO	ISD	TSD	
TB62212FTAG/FNG	●	40	4.0	1.1	2	●	●	●	●	QFN48/HTSSOP48
			2.0	2.2	4					
TB62216FTG/FNG/FG		40	2.5	1.0	2	●	●	●	●	QFN48/HTSSOP48/HSOP28
TB6549FG/PG/HQ		30	3.5/4.5(HQ)	1.0	1			●	●	HSOP20/DIP16/HZIP25
TB6552FTG/FNG		15	1.0	1.5	2				●	QFN16/SSOP16
TB6559FG		50	2.5	1.3	1	●		●	●	HSOP16
TB6561NG/FG		40	1.5	1.5	2			●	●	SDIP24/SSOP30
TB6568KQ		50	3.0	0.55	1		●	●	●	HSIP7
TB6569FG		50	4.5	0.55	1	●	●	●	●	HSOP16
TB6569FTG		50	4.5	0.55	1	●	●	●	●	QFN32
TB6593FNG		15	3.2	0.35	1		●		●	SSOP20
TB6612FNG		15	3.2	0.5	2		●		●	SSOP24
TB6613FTG		6	0.8	1.5	8	●	●		●	QON44
TB6614FNG		15	3.2	0.3	1		●	●	●	SSOP16
TB6640FTG/AFTG		40	3.0	1.0	1	●	●	●	●	QFN48
TB6641FG/FTG		50	4.5	0.55	1	●	●	●	●	HSOP16/QFN32
TB6642FG/FTG		50	4.5	0.55	1	●	●	●	●	HSOP16/QFN32
TB6643KQ		50	4.5	0.55	1	●	●	●	●	HSIP7
TB67H301FTG		40	3.0	1.0	1	●	●	●	●	QFN24
TB67H302HG		50	5.0	0.4	2	●	●	●	●	HZIP25
TB67H303HG		50	10.0	0.2	1	●	●	●	●	HZIP25
TB67H400AFTG/FNG/HG/NG	●	50	8.0	0.25	1	●	●	●	●	QFN48/HTSSOP48/HZIP25/SDIP24
			4.0	0.49	2					
TB67H410FTG/NG	●	50	5.0	0.4	1	●	●	●	●	QFN48/SDIP24
			2.5	0.8	2					
TC78H600FTG/FNG		18	1.0	1.2	2	●	●	●	●	QFN24/SSOP20
TC78H610FNG		18	1.0	1.2	2		●	●	●	SSOP16
TC78H620FNG		18	1.0	1.2	2		●	●	●	SSOP16
TC78S121FTG/FNG *	●	40	5.0	0.3	2	●	●	●	●	QFN48/HTSSOP48
			3.5	0.6	4					
TC78S122FTG/FNG *	●	40	5.0	0.3	2	●	●	●	●	QFN48/HTSSOP48
			3.5	0.6	4					

*: New product

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.
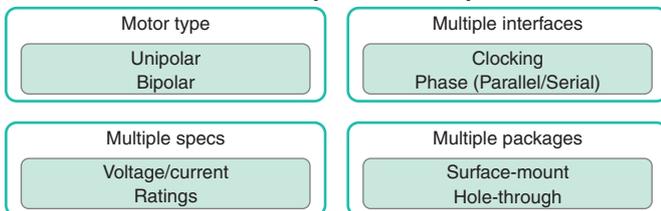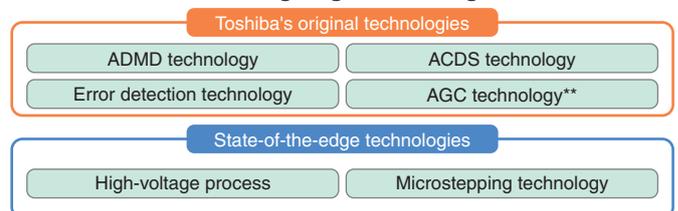
Product Lines

Bipolar
Unipolar

5 A	50 V **TB6600** μSTEP / ADMD			
		50 V **TB67S289** μSTEP / AGC / ACDS — Under development		
4 A		50 V **TB67S209** μSTEP — New	84 V **TB67S149 TB67S141 TB67S142 TB67S145** μSTEP / ACDS *1	
	50 V **TB67S109A TB67S101A TB67S102A TB67S103A TB67S105** *1 μSTEP / ADMD			
3 A	40 V **TB62213A TB62215A**	40 V **TB67S508** μSTEP / ADMD / ACDS — Under development		
	40 V **TB62214A TB62218A**	50 V **TB67S269 TB67S261 TB67S265** μSTEP / ADMD		
2 A	40 V **TB62209**	40 V **TC78S121 TC78S122** 2 ch / μSTEP — New	80 V **TB67S179** μSTEP / ACDS — New	
	40 V **TB62212** 2 ch	40 V **TB62269 TB62261 TB62262** μSTEP	84 V **TB67S158** 2 ch	
1 A	40 V **TB62210 TB62211**	18 V **TC78S600** μSTEP		
	15 V **TB6608**	18 V **TC78H600 TC78H610 TC78H620**		

*1: The TB67S105 and TB67S145 do not support micro-stepping.

Features of Toshiba's Stepping Motor Drivers

Extensive product lineup

Motor type	Multiple interfaces
Unipolar / Bipolar	Clocking / Phase (Parallel/Serial)

Multiple specs	Multiple packages
Voltage/current Ratings	Surface-mount Hole-through

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

Toshiba's original technologies

ADMD technology	ACDS technology
Error detection technology	AGC technology**

State-of-the-edge technologies

High-voltage process	Microstepping technology

**: Under development

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.

Conventional Mixed Decay — Missed step at high rpm
ADMD Technology — Precise microstep control even at high rpm

Products incorporating the ADMD technology:
·TB67S101A ·TB67S261
·TB67S102A ·TB67S265
·TB67S103A ·TB67S269
·TB67S109A ·TB67S508**
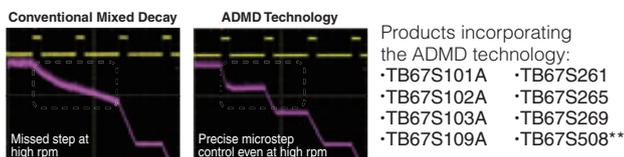
2. Advanced Current Detect System (ACDS) Technology

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.
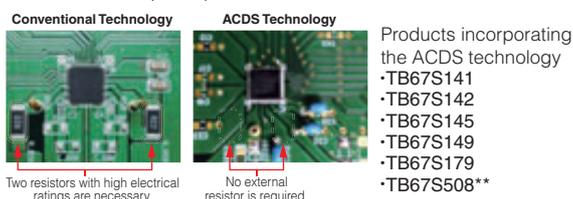
Conventional Technology — Two resistors with high electrical ratings are necessary.
ACDS Technology — No external resistor is required.

Products incorporating the ACDS technology
·TB67S141
·TB67S142
·TB67S145
·TB67S149
·TB67S179
·TB67S508**

3. Active Gain Control (AGC) Technology**

AGC is Toshiba's unique stepping motor technology to automatically optimize the drive current in real time according to load torques. It helps reduce unnecessary current and drastically cut power consumption and heat generation.

Up to 30% reduction in motor drive current

AGC OFF
AGC ON
+100%
0%
−100%
AGC:ON AGC:OFF
Current boost when needed.

Current reduce Current boost

Products incorporating the AGC technology **TB67S289****
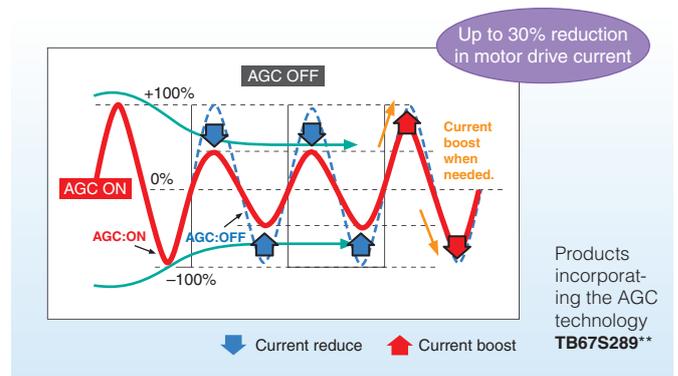
**: Under development

● Product Lineup (Bipolar)

Part Number	Clock	Phase	Serial	Voltage (V)	Current (A)	Constant Current Cont.	Full	Half	1/4	1/8	1/16	1/32	DC-DC Converter	UVLO	ISD	TSD	Package
TB62206FG		●		40	1.8	●	●	●						●	●	●	HSOP20
TB62208FTG/FNG/FG		●		40	1.8	●	●	●						●	●	●	QFN48/HTSSOP48/HSOP28
TB62209FG	●			40	1.8	●	●	●	●	●	●			●	●	●	HSOP36
TB62210FNG		●		40	1.0	●	●	●	●					●	●	●	HTSSOP24
TB62211FNG	●			40	1.0	●	●	●	●					●	●	●	HTSSOP24
TB62212FTAG/FNG		●		40	1.5 x 2 ch	●	●	●						●	●	●	QFN48/HTSSOP48
TB62213AFTG/FNG/FG/HQ		●		40	3.0	●	●	●						●	●	●	QFN48/HTSSOP48/HSOP28/HZIP25
TB62214AFTG/FNG/FG	●			40	2.0	●	●	●						●	●	●	QFN48/HTSSOP48/HSOP28
TB62215AFTG/FNG/FG	●			40	3.0	●	●	●						●	●	●	QFN48/HTSSOP48/HSOP28/HSIP25
TB62217AFG			●	50	1.3 x 2 ch	●	●	●	●	●	●		3ch	●	●	●	HQFP64
TB62218AFTG/FNG/FG		●		40	2.0	●	●	●						●	●	●	QFN48/HTSSOP48/HSOP28
TB62237BFG			●	40	1.3 x 2 ch	●	●	●	●	●	●		3ch	●	●	●	HQFP64
TB62247AFG			●	40	1.3 x 2 ch	●	●	●	●	●	●		3ch	●	●	●	HQFP64
TB62261FTG/FTAG		●		40	1.8 (FTG)/1.5 (FTAG)	●	●	●	●					●	●	●	QFN48/QFN36
TB62262FTG/FTAG	●			40	1.8 (FTG)/1.5 (FTAG)	●	●	●	●					●	●	●	QFN48/QFN36
TB62269FTG/FTAG *	●			40	1.8	●	●	●	●	●	●	●		●	●	●	QFN48/QFN32
TB6560AFTG/FG/HQ	●			40	2.5/3.5 (HQ)	●	●	●		●	●					●	QFN48/HQFP64/HZIP25
TB6562ANG/AFG		●		40	1.5	●	●	●	●							●	SDIP24/SSOP30
TB6600FG/HG	●			50	4.5 (FG)/5.0 (HG)	●	●	●		●	●			●	●	●	HQFP64/ HZIP25
TB6608FNG	●			15	0.8	●	●	●	●	●				●		●	SSOP20
TB6674PG/FG/FAG		●		24	0.4/0.2 (FAG)		●							●	●	●	DIP16/HSOP16/SSOP16
TB67S101AFTG/FNG/NG		●		50	4.0	●	●	●	●					●	●	●	QFN48/HTSSOP48/SDIP24
TB67S102AFTG/FNG	●			50	4.0	●	●	●						●	●	●	QFN48/HTSSOP48
TB67S103AFTG	●		●	50	4.0	●	●	●	●	●	●			●	●	●	QFN48
TB67S105FTG			●	50	3.0	●	●	●						●	●	●	QFN48
TB67S109AFTG/FNG	●			50	4.0	●	●	●	●	●	●			●	●	●	QFN48/HTSSOP48
TB67S213FTAG		●		40	2.5	●	●	●						●	●	●	QFN36
TB67S215FTAG	●			40	2.5	●	●	●						●	●	●	QFN36
TC78S600FTG/FNG	●			18	1.0	●	●	●	●	●				●	●	●	QFN24/SSOP20
TB6613FTG	●		●	6	0.8	●	half-step and 1/64-step							●		●	QON44
TB67S261FTG		●		50	2.0	●	●	●	●					●	●	●	QFN48
TB67S265FTG			●	50	2.0	●	●	●						●	●	●	QFN48
TB67S269FTG	●			50	2.0	●	●	●	●	●	●	●		●	●	●	QFN48
TC78S121FTG/FNG *		●		40	2.0 x 2 ch	●	●	●						●	●	●	QFN48/HTSSOP48
TC78S122FTG/FNG *	●			40	2.0 x 2 ch	●	●	●						●	●	●	QFN48/HTSSOP48
TB67S209FTG *	●			50	4.0	●	●	●	●	●	●			●	●	●	QFN48
TB67S289FTG **	●			50	3.0	●	●	●	●	●	●			●	●	●	QFN48
TB67S508FTG **	●	●		40	3.0	●	●	●	●					●	●	●	QFN36

● Product Lineup (Unipolar)

Part Number	Clock	Phase	Serial	Voltage (V)	Current (A)	Constant Current Cont.	Full	Half	1/4	1/8	1/16	1/32	DC-DC Converter	UVLO	ISD	TSD	Package
TB6615PG	●			28	0.4		●	●									DIP16
TB67S141FTG/NG/HG		●		84	3.0	●	●	●	●					●	●	●	QFN48/SDIP24/HZIP25
TB67S142FTG/NG/HG	●			84	3.0	●	●	●	●					●	●	●	QFN48/SDIP24/HZIP25
TB67S145FTG			●	84	3.0	●	●	●						●	●	●	QFN48
TB67S149FTG/FG/HG	●			84	3.0	●	●	●	●	●	●	●		●	●	●	QFN48/HSSOP28/HZIP25
TB67S158FTG/NG	● (FTG)	●	●	80	1.5 × 2 ch		●	●						●	●	●	QFN48/SDIP24
TB67S179FTG *	●			80	1.5	●	●	●	●	●	●	●		●	●	●	QFN48

UVLO: Undervoltage Lockout, ISD: Overcurrent detection, TSD: Thermal shutdown

*: New product **: Under development

Transistor Arrays

Toshiba is migrating to transistor arrays consisting of MOSFETs instead of bipolar transistors.

ULN/TD62xxx Series
Bipolar transistors in the output stage

TBD62xxxA Series
DMOS FET in the output stage
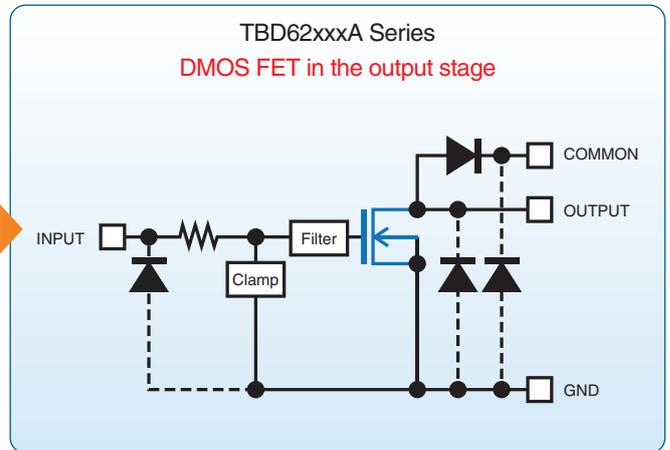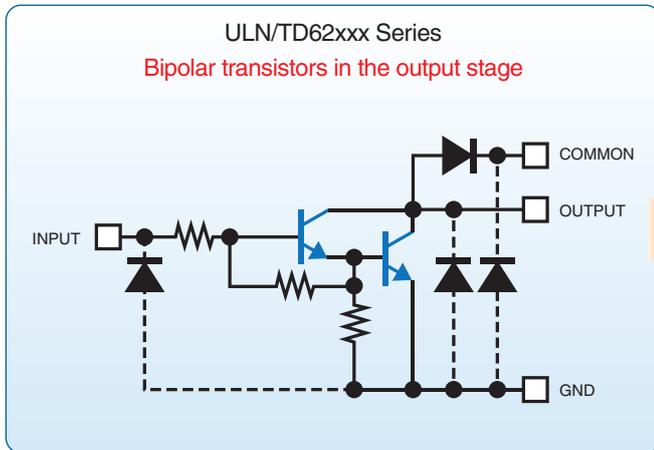
DMOS FET: Double-Diffused MOSFET

The DMOS FET output stage realizes high-efficiency drive.

Conventionally, the TD62xxx bipolar transistor array series has been widely used to drive motors, relays, LEDs and other devices. As a successor to the TD62xxx series, Toshiba has begun the mass production of the next-generation high-efficiency TBD62xxxA series with a DMOS FET output.

The TBD62xxxA series is available with a wide range of options, including functionality, channel count, current and packaging.

Features

- High-voltage analog process

  Fabricated with the latest high-voltage analog process (BiCD 130 nm)

- High-voltage and high-current drive

  Two devices with the absolute maximum ratings of 50 V/1.5 A are available.

  The TBD62xxxA series is available in surface-mount SSOP packages (with a lead pitch of 1.0 mm) in addition to conventional HSOP packages with a thermal fin.

- High-efficiency motor drive

  The new TBD62003A series of transistor arrays provides an approximately 40% reduction[1] in power loss, compared to the conventional TD62003A series.

- Devices and packaging options that meet customers' specific needs

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

Package type: DIP

Package type: SOP

Package type: SOL

New package type: SSOP

Package type: SSOP

*1: At Ta = 25°C and I_{OUT} = 200 mA

● Major Applications

The TBD62xxxA series is ideal for inductive load (e.g., stepper motor, relay, and solenoid), LED drive and level-shift applications in amusement equipment (pachinko and slot machines), home appliances (air conditioners and refrigerators), and industrial equipment (automatic vending machines, ATM and other currency machines, office equipment and factory equipment).

● Motor Drive Application Example

● Application

Air conditioner

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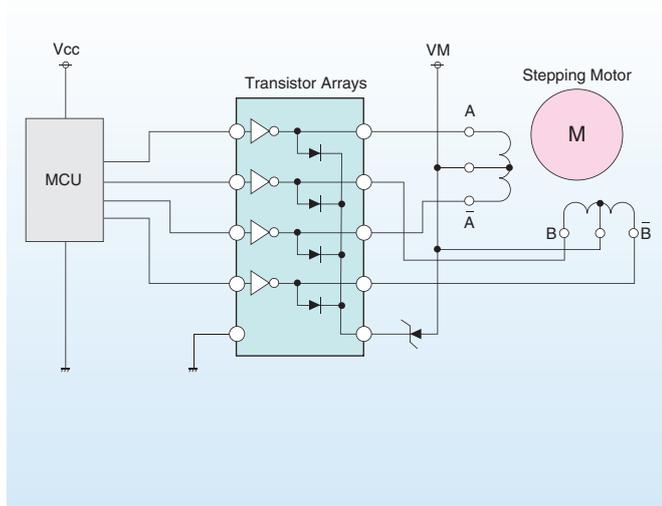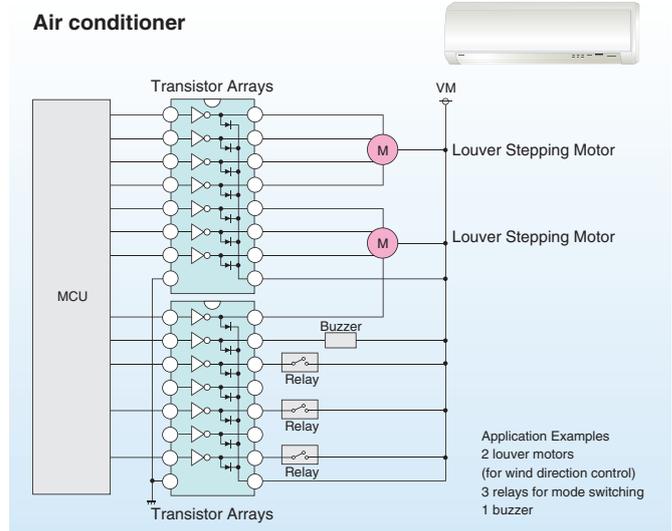
● Product Lineup

Part Number	Package Type	Output Configuration	# Channels	Output Current (A)	Output Voltage (V)	Common Diode	Active Input Level	Packages	Predecessor
TBD62064A	PG		4	1.5	50	Y (inductive load-compatible)	H	DIP16	**TD62064APG**
	FG							HSOP16	**TD62064AFG**
	FAG							SSOL24	None
TBD62308A	PG			1.5	50	Y (inductive load-compatible)	L	DIP16	**TD62308APG**
	FG							HSOP16	**TD62308AFG**
	FAG							SSOP24	None
TBD62003A	PG	Sink	7	0.5	50	Y (inductive load-compatible)	H	DIP16	**TD62003APG, ULN2003APG**
	FG							SOP16	**TD62003AFG**
	FNG							SSOP16	None
	FWG							SOL16	**ULN2003AFWG**
TBD62004A	PG			0.5	50	Y (inductive load-compatible)	H	DIP16	**TD62004APG, ULN2004APG**
	FG							SOP16	**TD62004AFG**
	FNG							SSOP16	None
	FWG							SOL16	**ULN2004AFWG**
TBD62502A	PG			0.5	50	–	H	DIP16	**TD62502PG**
	FG							SOP16	**TD62502FG**
	FNG							SSOP16	**TD62502FNG**
	FWG							SOL16	None
TBD62503A	PG			0.5	50	–	H	DIP16	**TD62503PG**
	FG							SOP16	**TD62503FG**
	FNG							SSOP16	**TD62503FNG**
	FWG							SOL16	None
TBD62083A	PG		8	0.5	50	Y (inductive load-compatible)	H	DIP18	**TD62083APG, ULN2803APG**
	FG							SOP18	**TD62083AFG**
	FNG							SSOP18	**TD62083AFNG**
	FWG							SOL18	**ULN2803AFWG**
TBD62084A	PG			0.5	50	Y (inductive load-compatible)	H	DIP18	**TD62084APG, ULN2804APG**
	FG							SOP18	**TD62084AFG**
	FNG							SSOP18	**TD62084AFNG**
	FWG							SOL18	**ULN2804AFWG**
TBD62783A	PG	Source	8	−0.5	50	Y (inductive load-compatible)	H	DIP18	**TD62783APG**
	FG							SOP18	**TD62783AFG**
	FNG							SSOP18	**TD62783AFNG**
	FWG							SOL18	**TD62783AFWG**

■For detailed specifications of the new transistor array series, visit our website at:
https://toshiba.semicon-storage.com/ap-en/product/linear/transistor-array.html

MOSFETs

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

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

Features of the DTMOSIV Series

● **30% lower RonA than the previous series**

Due to reduced RonA, the DTMOS IV series helps improve power efficiency.
This makes it possible to house more chips in a single package, contributing to reducing the size of motor applications.
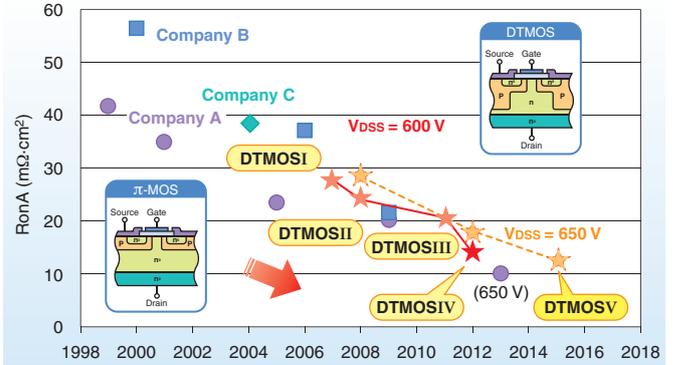
● **Coss loss: Eoss reduction**

The reduced Eoss helps improve efficiency at light load.

Eoss—VDS Curve

Test Conditions: $V_{DS} = 0$ to 400 V, $V_{GS} = 0$, $T_a = 25°C$
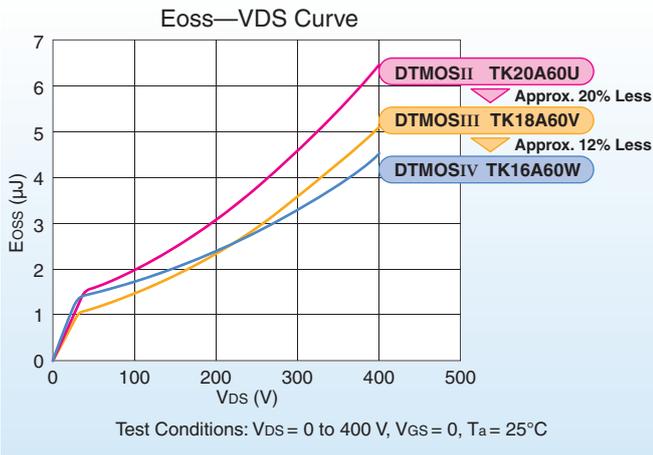
● **The use of a single-epitaxial process helps reduce on-resistance and therefore temperature increase.**

The reduction in temperature increase in the high-temperature region contributes to improving efficiency.

Tch: Channel temperature (°C)
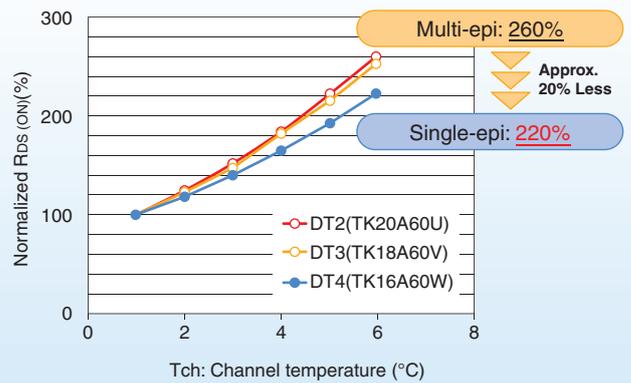
DTMOSIV Lineup

Toshiba will continually expand its product portfolio according to customer needs.

Representative Part: TK31N60☐

W5	W	X
DTMOSIV HSD series with high-speed diode	Standard DTMOSIV series	Fast-switching DTMOSIV SE-H series
Reduces a recovery loss of the body diode of a MOSFET		High efficiency
Half-bridge or full-bridge circuit in AC-DC power supplies		PFC circuitry in high-efficiency power supplies for PV inverters, servers, communication equipment, etc.
Motor drive applications		

To meet the needs of various applications, Toshiba is expanding its product portfolio.

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

| VDS:100V/div TK5P60W — TK5P60W5 — | IDR:5A/div TK5P60W — TK5P60W5 — | Qrr:0.22μC/div TK5P60W — TK5P60W5 — | t:80ns/div | Test Conditions: $V_{DS} = 400$ V, $I_{DR} = 3.5$ A, $T_c = 25°C$ |
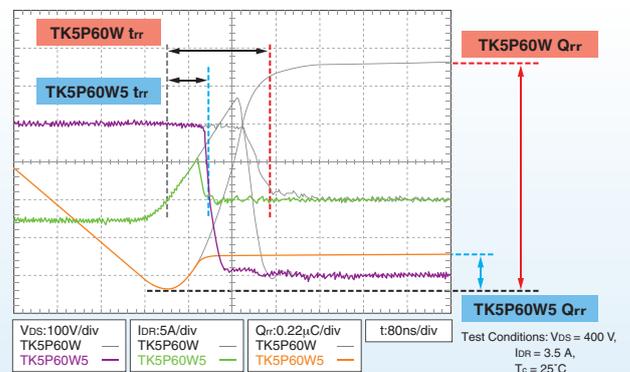
Comparisons of Representative Parts

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

Toshiba offers an extensive portfolio of small, high-efficiency diodes, including SiC Schottky barrier diodes (SBDs) featuring high-speed operation and low forward loss.

The use of the Junction Barrier Schottky (JBS) structure reduces leakage current compared to the typical SBD structure, making it possible to realize stable operation even at high voltage and high current.

▌ Features of the Second-Generation Products (Compared to the First-Generation Products)

● 70% higher allowable peak forward surge current (I_{FSM})

● 30% lower switching loss

● **70% higher allowable peak forward surge current (I_{FSM})**

Current density (A/cm²) vs Forward Voltage V_F (V)

Second generation / First generation

Generates less heat at the same current level

● **30% lower switching loss (examples of 650-V and 10-A diodes)**

Switching Loss (P_{Qc} - V_R)

f = 100 kHz

Switching Loss P_{Qc} (W) vs Reverse Voltage V_R (V)

First generation / Second generation
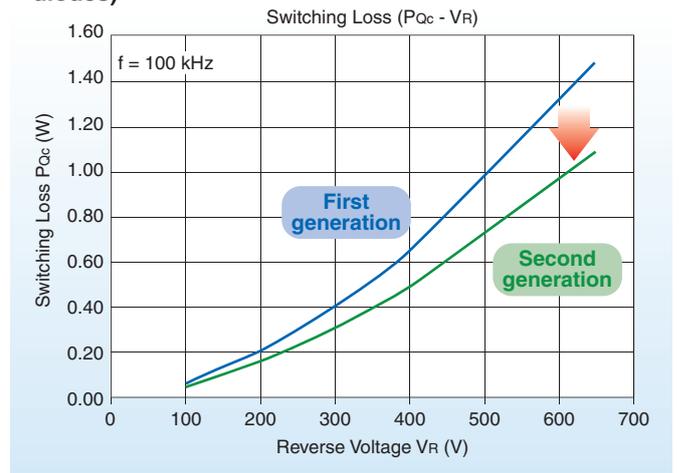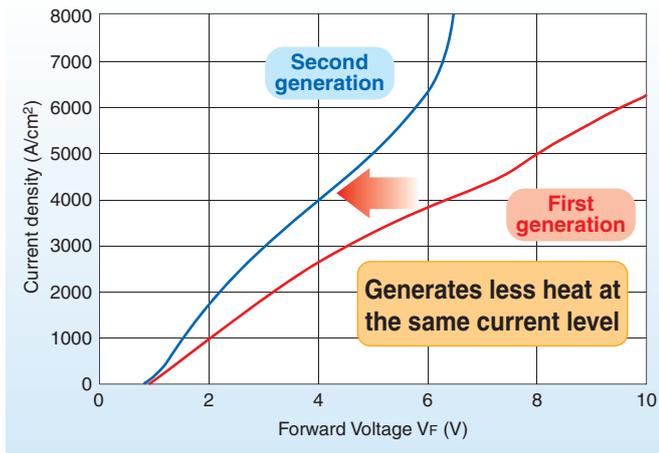
● Product Lineup

Unit: mm

Absolute Maximum Ratings		Electrical Characteristics (Ta=25°C)				Package		
V_{RRM} (V)	I_F(DC) (A)	V_F @I_F(DC) (V)		Cj @650 V 1 MHz (pF)	I_R @V_{RRM} (µA)	DPAK	TO-220-2L	TO-220F-2L Insulated Type
		Typ.	Max	Typ.	Max			
650	2	(1.45)	(1.6)	(8)	(20)	TRS2P65F**	TRS2E65F**	
	3	(1.45)	(1.6)	(13)	(20)	TRS3P65F**	TRS3E65F**	
	4	1.45	1.6	16	20	TRS4P65F**	TRS4E65F	TRS4A65F
	6	1.45	1.6	22	30	TRS6P65F**	TRS6E65F	TRS6A65F
	8	1.45	1.6	28	40	TRS8P65F**	TRS8E65F	TRS8A65F
	10	1.45	1.6	36	50	TRS10P65F**	TRS10E65F	TRS10A65F
1200	5	(1.45)	(1.6)	(25)	(25)		TRS5E120F**	
	10	(1.45)	(1.6)	(44)	(50)		TRS10E120F**	

Figures in parentheses are provisional.
**: Under development

Support Tools for Semiconductor Devices for Motor Applications

PSpice Models for Motor ICs and MOSFETs

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

- Models that closely represent actual devices
- Allows you to easily simulate circuit operations when a motor changes its rpm, rotational direction, commutation mode, etc.
- Single-click simulation: You can obtain typical application circuits simply by downloading and uncompressing a model file.

● **Typical Circuit Example**
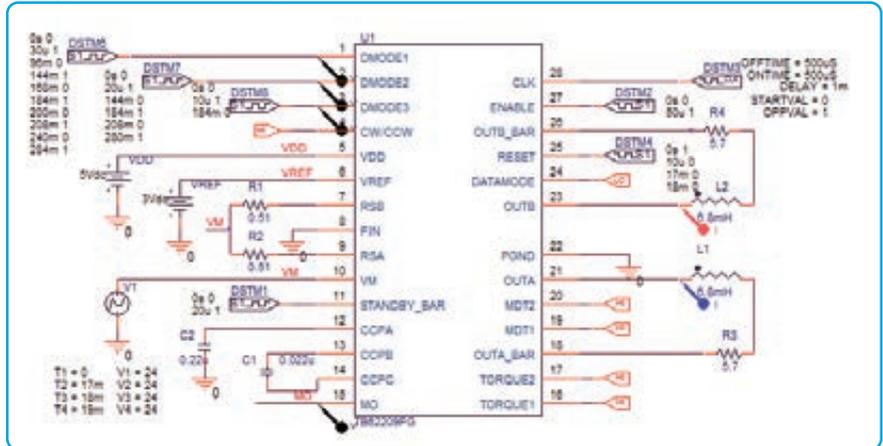
● **Example of an output current waveform**

Enlarged View
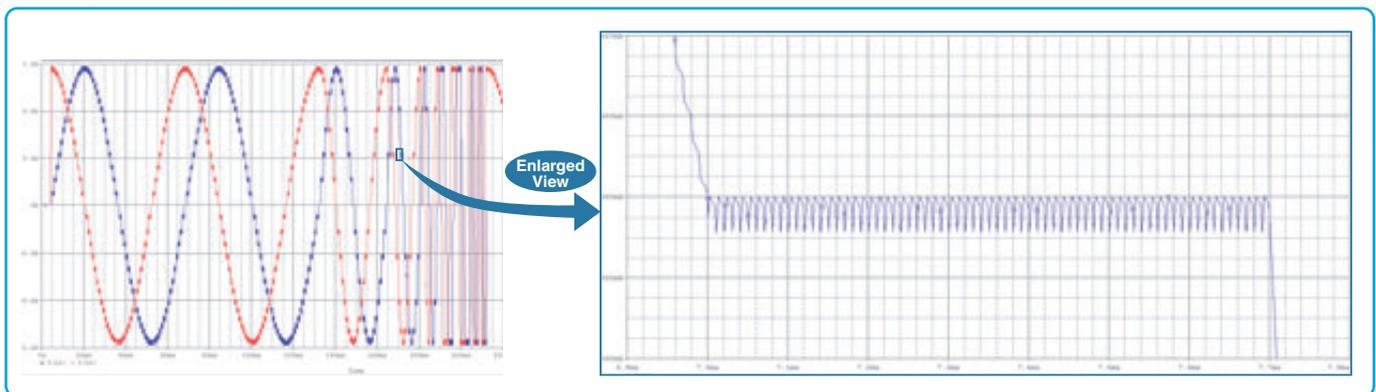
Obtaining PSpice models of motor drivers and MOSFETs

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

Start Simulation!

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

Motor Drivers	
For stepping motors	
TB62214A	TB62218A
TB67S109A	TB6600
TB67S149	TB67S249
TB67S158	TB78S122
For brushless DC motors	
TC78B002	TC78B006
TB6585	TC78B016✳
For brushed DC motors	
TB67H400A	TB67H303
TC78H620	TB6569
TB6552	TB67H301✳

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

Motor Driver Evaluation Boards, Sample MCU Software, and MCU Evaluation Boards

For details of Motor Driver evaluation boards, visit the following website at:
http://www.marutsu.com/search?q=MOTORDRIVER1602

Stepping motor driver/TB67S149FTG
Evaluation Board
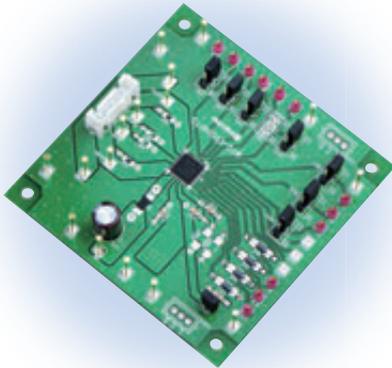
Stepping motor driver/TB67S101AFTG
Evaluation Board
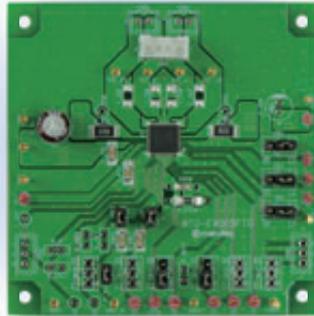
Brushed DC motor driver/TB67H400AHG
Evaluation Board
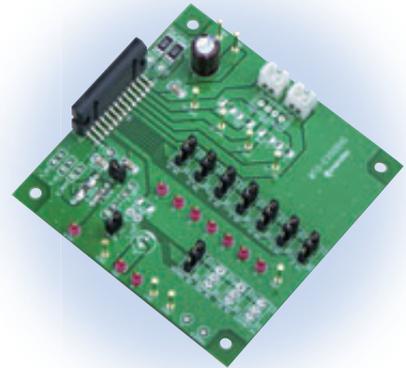
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Sample programs are available at
https://toshiba.semicon-storage.com/ap-en/product/microcomputer/designsupport/applicationnote-read-me.html
Sample programs for motor control are available among those for the M370 Group of the TX03 Series.

TX03 Series M370 Group

Login / Register

Sample Program/Function		Description	Product Name						
			TMPM 370	TMPM 372	TMPM 373	TMPM 374	TMPM 375	TMPM 376	TMPM 37A
Motor Control Circuit	PMD	This example demonstrates the phase outputs.	√	√	√	√	√	√	√

For details of MCU evaluation boards, visit our website at:
https://toshiba.semicon-storage.com/ap-en/product/microcomputer/designsupport/reference-model.html

TMPM370

TMPM375

TMPM37A

TMPM475

IAR System AB

ESP Co., Ltd.

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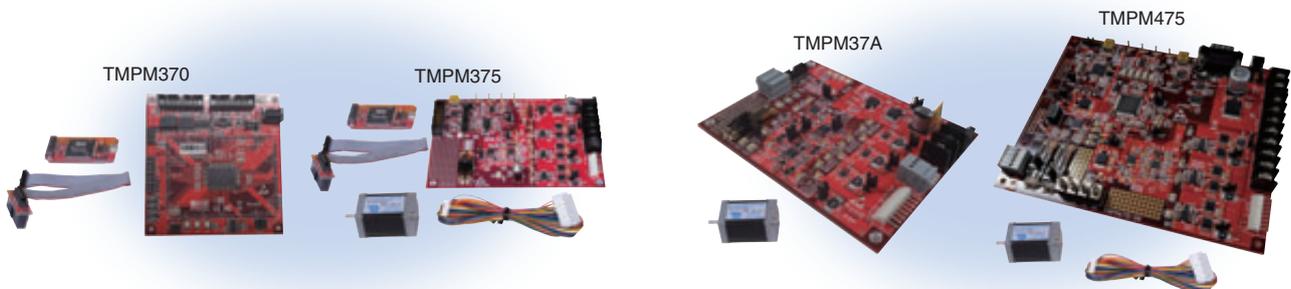
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