

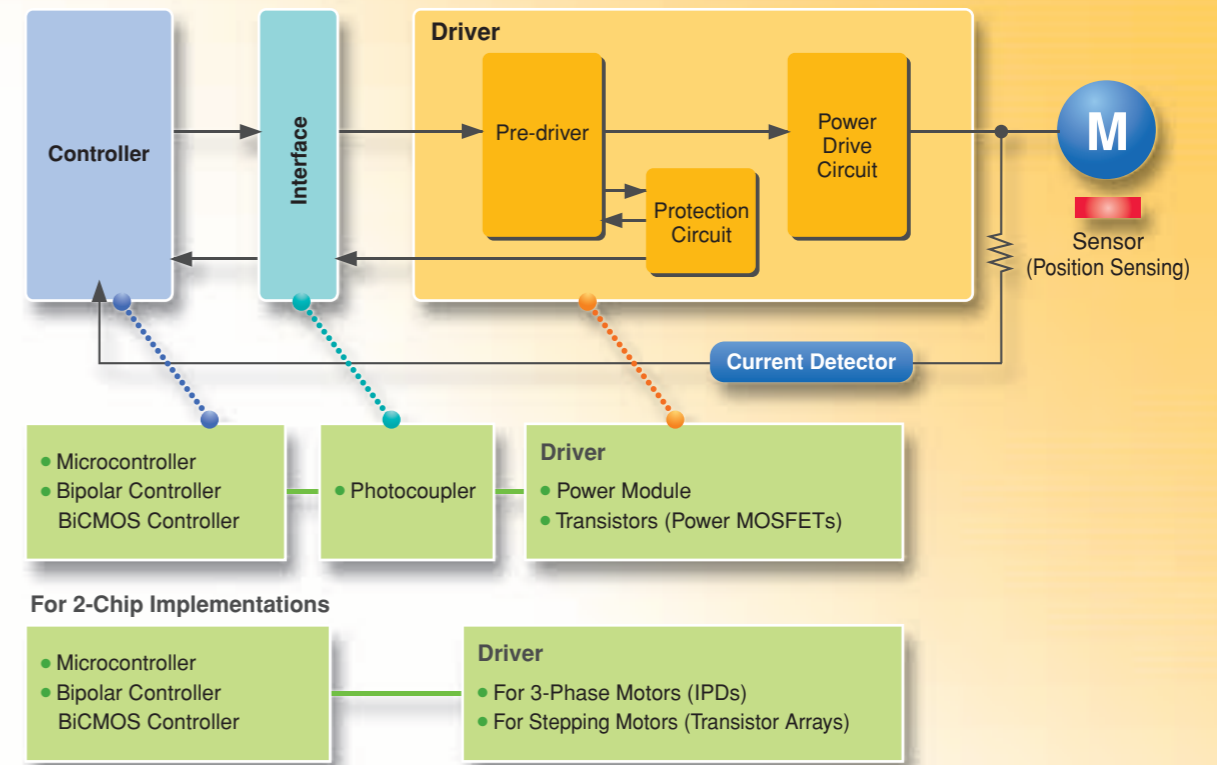
SYSTEM CATALOG

# Motor Solutions Guide

Datasheet.Live

# Toshiba's Semiconductors for Motor Control

Many of the digital mobile handsets, small office equipment and toy robots are battery-powered, and the controllers for small motors and actuators in these applications are required to consume little power. Toshiba is committed to the development of next-generation general-purpose motor drivers featuring low power consumption, low noise, quick response and accurate control by leveraging proprietary manufacturing and circuit technologies.



## Packaging Options for Motor Drivers and Microcontrollers

**Microcontrollers**

- QFP100
- LQFP44
- LQFP100
- LQFP48

**Motor Drivers for Battery-Powered Appliances**

- SSOP16
- VQON44
- SSOP20
- QON36
- SSOP24
- QON48
- WCSP6

**Motor Drivers for Office and Industrial Equipment**

- HZIP25
- HSIP10
- HZIP12
- HSIP7
- SIP9
- HQFP64
- HSOP20
- HSOP16
- SSOP10
- QFN36
- QFN48

**Motor Drivers for Home Appliances**

- DIP16
- SSOP24
- DIP20
- SSOP30
- QFP52
- HSOP36
- DIP26

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The above package photos are not actual size.

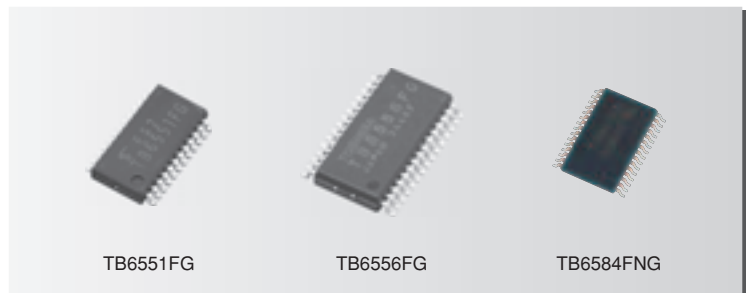
Toshiba offers a range of motor drivers ideal for inverter-powered equipment requiring low-power and quiet motor control. Toshiba designs and fabricates these motor drivers using proprietary technologies.

### Sine-Wave PWM Motor Drive Solutions

#### TB6551FG/TB6556FG/TB6584FNG

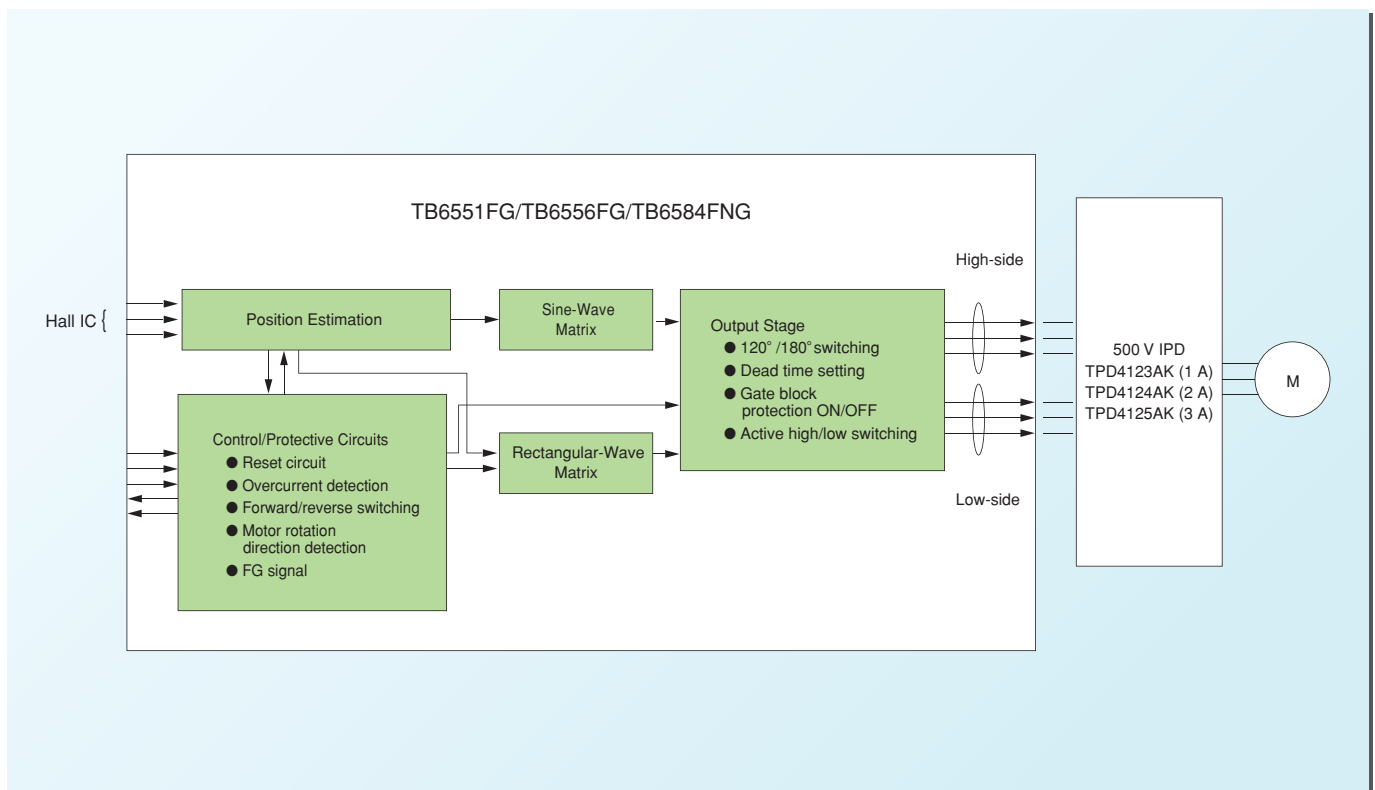
The TB6551FG, TB6556FG and TB6584FNG are three-phase brushless DC motor controllers that generate a full sine-wave PWM output.

These motor controllers, are specifically designed to reduce motor noise and vibration by controlling the motor drive current with a sine wave. With lead angle control and PWM control, they provide high efficiency and low power dissipation. The TB6556FG and TB6584FNG feature on-chip auto lead angle control.



#### Features

- A true sine-wave output provides a significant reduction in acoustic noise compared to the conventional 120° commutation.
- Integrated lead angle control between 0° and 58° in 32 separate steps. This permits a wide range of motor applications through a choice of a suitable output driver.
- The phase outputs can be configured as either active-high or active-low.
- The dead-time function prevents cross conduction.
- Overcurrent protection: Forces the output signals to the inactive state to protect the output drivers if they exceed the rated voltage (V<sub>dc</sub> = 0.5 V typ.)
- Undervoltage protection and motor rotational direction detection





## Product Lines

Part Number	Motor Type	Absolute Maximum Ratings		Characteristics	Application
		Output Breakdown	Output Current		
<b>TB6575FNG</b>	Brushless motors	5.5 V	20 mA	PWM sensorless controller	Air conditioners (indoor fans), washing machines, cloth drier fans, dish washer pumps
<b>TB6588FG*</b>		50 V	2.5 A	PWM sensorless driver	Washing machines, cloth drier fans
<b>TB6586FG/AFG/BFG</b>		18 V	2 mA	PWM controller with a turn-on angle of 150 degrees	Air conditioners (outdoor and indoor fans), kitchen fans, massage machines, water heaters, dish washer pumps
<b>TB6551FG</b>		12 V	2 mA	Sine-wave PWM controller	
<b>TB6556FG</b>		12 V	2 mA	Sine-wave PWM controller, Auto lead angle control	
<b>TB6584FNG*</b>		18 V	2 mA	Sine-wave PWM controller, Auto lead angle control	
<b>TB6585FG*</b>		45 V	1.8 A	Sine-wave PWM controller	
<b>TA7291P/FG/SG</b>		Brush motors	25 V	2 A (1.2 A)	Vref function

\*: New product

# Motor Drivers for Battery-Powered Appliances

## MOTOR SOLUTIONS GUIDE

Toshiba offers a range of motor drivers for portable applications that are fabricated using a new process featuring low power dissipation. These motor drivers use LDMOS transistors at the output stage to slash power loss and are available in compact leadless QON and QFN packages.

### DC Motor Drivers

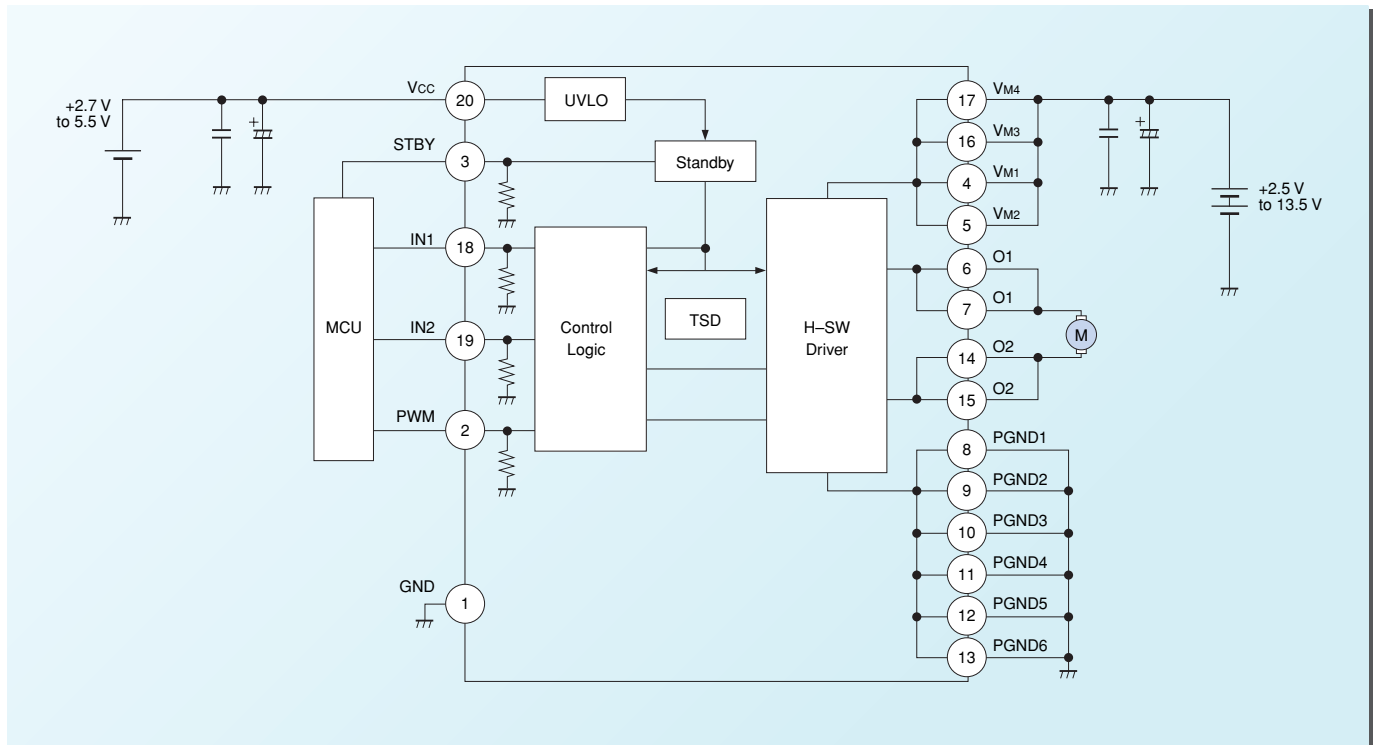
#### TB6593FNG

The TB6593FNG is a DC motor driver IC using low-ON-resistance LDMOS transistors at the output stage. The IN1 and IN2 input terminals allow selection of one of the four modes: Forward, Reverse, Short Brake or Stop.

#### Features

- Power supply voltage:  $V_M = 15\text{ V}$  (max)
- Output current:  $I_{OUT} = 1.2\text{ A}$  (typ.)/ $3.2\text{ A}$  (peak)
- $R_{ON}$ :  $0.35\ \Omega$  (high side + low side/typ. @  $V_M \geq 5\text{ V}$ )
- Direct PWM control
- Standby (power-saving) function
- Forward, reverse, short brake and stop modes
- Thermal shutdown circuitry, undervoltage lockout
- Small surface-mount package (SSOP20 with a 0.65-mm lead pitch)

A dual-channel motor driver, TB6612, is also available.



## 8-Channel Motor Driver IC for a Digital Still Camera (DSC)

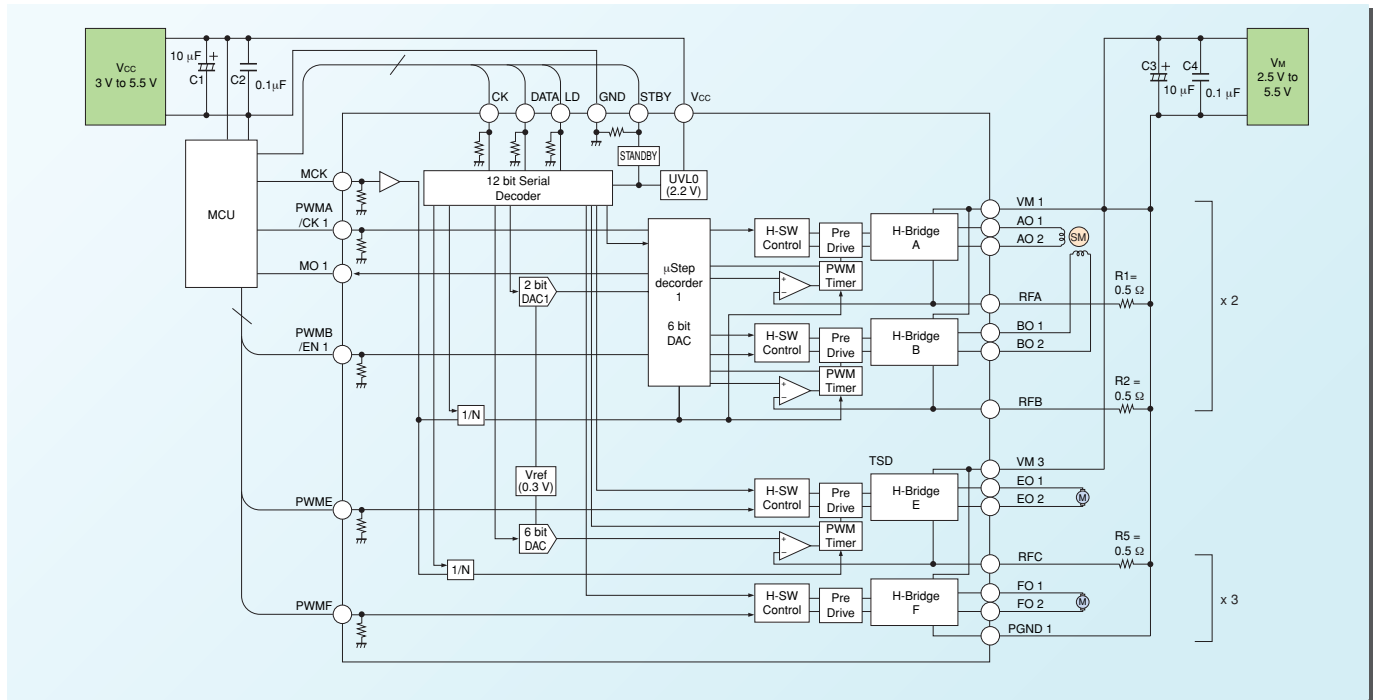
### TB6613FTG

The TB6613FTG is a DC motor driver IC using low-ON-resistance LDMOS transistors at the output stage.

It incorporates five channels of constant-current H-bridge drivers for PWM chopping current control, four of which can be used to control up to two microstepping motors. This makes the TB6613FTG an ideal solution for various lens actuators of digital cameras and the like. Each driver is individually programmable through a three-wire serial interface, which minimizes the number of interconnections between the controller and the TB6613FTG.

### Features

- 8-ch bridge driver:
  - 3-ch full-bridge driver + 5-ch constant-current bridge driver (four of which can control up to two microstepping motors with either a 6-bit or 1-bit DAC)
- Absolute maximum ratings: 6 V/ 0.8 A
- Power supply voltage:  $V_{CC} = 3.0$  to  $5.5$  V  
 $V_M = 2.5$  to  $5.5$  V
- Ron:  $1.5 \Omega$
- Direct PWM control
- PWM constant-current chopper drive
- Standby function
- Thermal shutdown circuitry
- Package: VQON44



### Product Offerings

Part Number	Motor Type	Absolute Maximum Ratings		Characteristics	Application
		Output Breakdown	Output Current		
TB6552FNG/FLG	Brush motors/ Stepping motors	15 V	1.0 A	Dual bridge	Toys, robots, digital still cameras
TB6596FLG		6 V	0.8 A	6-ch, serial interface + 6-bit DAC	Digital still cameras, robots
TB6607FLG		6 V	0.8 A	5-ch, serial interface + 6-bit DAC	
TB6609FLG		15 V	0.8 A	6-ch, serial interface + 6-bit DAC	
TB6613FTG*		6 V	0.8 A	8-ch, two 6-bit microstepping drivers, serial and parallel control	
TB6593FNG		15 V	3.2 A	Single bridge	Digital still cameras, small printers, toys
TB6612FNG		15 V	2.8 A	Dual bridge	Network cameras, small printers, small scanners
TB6608FNG		15 V	0.8 A	2W 1-2-phase, constant current control	
TB6590FTG*		6 V	0.5 A	Dual bridge, small VQON16 package (3 mm x 3 mm)	
TB6614FNG**		15 V	3.2 A	Single bridge ( $f_{PWM} \leq 350$ kHz, $R_{on} = 0.3 \Omega$ )	
TB6617FNG**		40 V	2.0 A	Single bridge ( $f_{PWM} \leq 350$ kHz)	Digital still cameras, small printers, toys
TC7650WLG**		Voice coil motors	5.5 V	100 mA	10-bit DAC, I <sup>2</sup> C interface

\*: New product \*\*: Under development

# Motor Drivers for Office and Industrial Equipment

## MOTOR SOLUTIONS GUIDE

Toshiba offers a range of motor drivers for various types of motors that are designed to meet the large-current, quick-control and high-precision needs of office and industrial applications. These motor drivers leverage Toshiba's proprietary technologies such as a 40-V BiCD process and thermally enhanced packages.

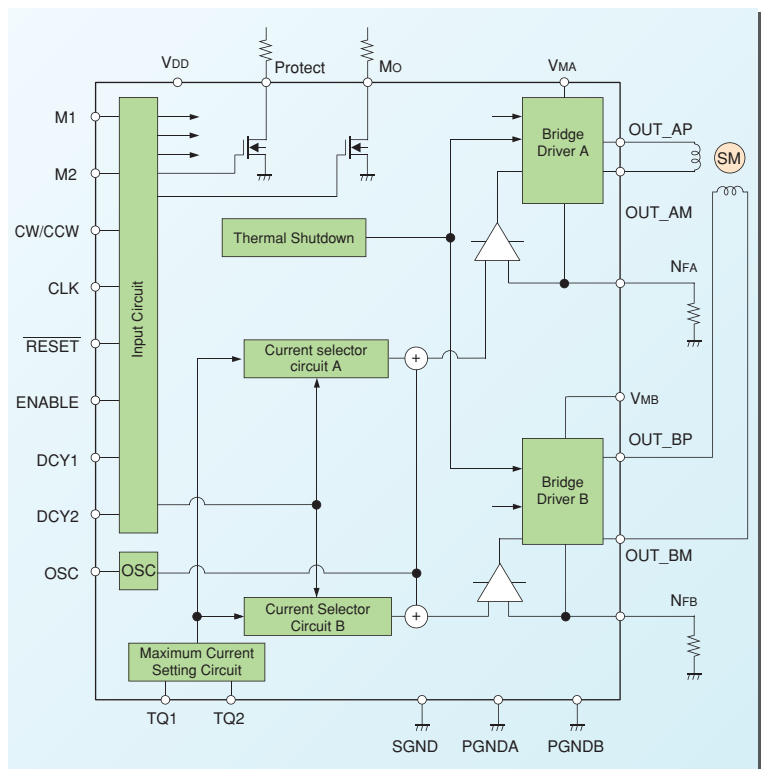
### Constant-Current Chopper Stepping Motor Driver with a Micro-Step Output

#### TB6560AHQ/AFG

The TB6560AHQ/AFG is a bipolar dual-phase stepping motor driver. Fabricated with the BiCD process, the TB6560AHQ/AFG provides large current and low ON-resistance.

#### Features

- Low RON (high side + low side): 0.6  $\Omega$  (typ.)
- 2-phase to 4W1-2-phase excitation
- Selectable current decay modes for improved micro-stepping
- High-speed PWM chopping at 100 kHz or higher
- The CLK input allows MCU-less motor control
- Ratings: 40 V/3.5 A (AHQ), 40 V/2.5 A (AFG)
- Wide supply voltage range: 4.5 to 34 V
- Packages: HZIP25 (AHQ), THQFP64 (AFG)



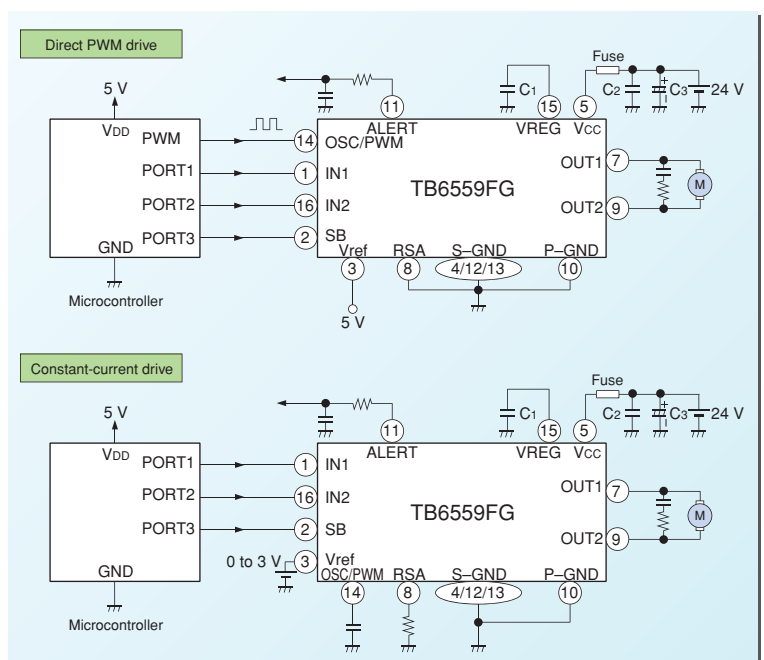
### Full-Bridge DC Motor Driver

#### TB6559FG

The TB6559FG is a full-bridge DC motor driver using complementary MOS transistors at the output stage: P-channel transistors on the high side and N-channel transistors on the low side. This eliminates the need for an external charge pump. The TB6559FG offers high thermal efficiency, thanks to selectable constant-current and direct PWM control. The IN1 and IN2 input terminals allow selection of one of the four modes: Forward, Reverse, Short Brake or Stop.

#### Features

- Power supply voltage: 50 V (max.)
- Output current: 2.5 A (max.)
- Ron: 1.3 $\Omega$  typ. (high side + low side)
- Selectable from constant-current and direct PWM control
- Standby function
- Forward, reverse, short brake and stop modes
- Overcurrent protection circuitry
- Thermal shutdown (TSD) circuitry



## Product Offerings

Part Number	Motor Type	Absolute Maximum Ratings		Characteristics	Application	
		Output Breakdown	Output Current			
<b>TA7291SG (J)/FG</b>	Brush motors	25 V	1.2 A	Single bridge, output voltage controllable	Plain paper copiers (PPCs), printers, fax machines, vending machines, automatic teller machines (ATMs), amusement equipment, card readers, currency counters, etc.	
<b>TA7291P</b>		25 V	2.0 A	Single bridge, output voltage controllable		
<b>TA8428K</b>		30 V	3.0 A	Single bridge		
<b>TA8428FG</b>		30 V	2.5 A	Single bridge		
<b>TA8429HQ</b>		30 V	4.5 A	Single bridge		
<b>TB6549FG/PG</b>		30 V	3.5 A	BiCD process, direct PWM control		
<b>TB6549HQ</b>		30 V	4.5 A	BiCD process, direct PWM control		
<b>TB6561NG/FG</b>		40 V	1.5A	BiCD process, dual bridge		
<b>TB6559FG</b>		50 V	2.5 A	Constant-current PWM control / direct PWM control, BiCD process		
<b>TB6568KQ**</b>		50 V	3.0 A	Full-bridge driver, BiCD process		
<b>TB6569FG**</b>		50 V	4.5 A	Full-bridge driver, abnormal condition output Constant-current PWM control, BiCD process		Plain paper copiers
<b>TB6551FG</b>		Brushless motors	12 V	2 mA		Sine-wave PWM controller
<b>TB6588FG*</b>	50 V		2.5 A	Sensorless control		
<b>TB6572AFG</b>	30 V		20 mA	Sine-wave PWM controller	Office printers	
<b>TB6615PG</b>	Stepping motors	7 V	0.4 A	Controller	Plain paper copiers (PPCs), scanners, sewing machines, fax machines, printers, robots, card readers, etc.	
<b>TB6560AHQ/AFG</b>		40 V	3.5 A/2.5 A	Micro-step drive (4W1-2-phase)		
<b>TB62206FG</b>		40 V	1.6 A	1-2 phase, BiCD process		
<b>TB62209FG</b>		40 V	1.8 A	Micro-step drive, BiCD process		
<b>TB6562ANG/AFG</b>		40 V	1.5 A	W1-2 phase (1/4 step), BiCD process		
<b>TB62212FTAG/ TB62212FNG**</b>	Stepping motors /Brush motors	40 V	1.5 A/1.8 A 2.0 A/4.0 A	1-2-phase, 4-channel H-bridges Can control up to four DC brush motors.	Plain paper copiers (PPCs), printers, etc.	
<b>TB62214FG*/FTG*/FNG**</b>	Stepping motors	40 V	2.0 A	Clock input, W1-2-phase (1/4 step), BiCD process		
<b>TB62218FG*/FTG*/FNG**</b>		40 V	2.0 A	W1-2 phase (1/4 step), BiCD process, Phase inputs		

\*: New product \*\*: Under development

## Automotive Actuator Applications

Part Number	Motor Type	Absolute Maximum Ratings		Characteristics	Application
		Output Breakdown	Output Current		
<b>TB9056FNG</b>	Brush motors	–	0.3 A	LIN interface; single bridge driver, extended temperature range	Pumps
<b>TB9061FNG**</b>	Brushless motors	–	0.02 A	PWM sensorless controller, extended temperature range	
<b>TB9067FNG</b>		–	0.25 A	PWM motor controller, extended temperature range	

\*\*: Under development



### Full-Bridge DC Motor Driver IC

#### TB6568KQ/TB6569FG (Under development)

The TB6568KQ and TB6569FG are DC motor drivers with MOS output transistors. The low-RDS(ON) LDMOS output transistors and the PWM drive method improve thermal efficiency.

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

Housed in the HSIP7 package, the TB6568KQ is pin-compatible with the TA8428K and allows easy control of a DC motor.

The TB6569FG is offered in the HSOP16 package, a thermally enhanced surface-mount package. The TB6569FG provides an abnormal condition output, constant-current PWM control and an externally programmable overcurrent protection.

#### Features

##### (TB6568KQ/TB6569FG)

- Overcurrent protection circuitry
- Overvoltage protection circuitry
- Undervoltage lockout circuitry
- Thermal shutdown circuitry
- Cross conduction protection
- Low Ron: 0.7 Ω typ. (high side + low side)\*
- PWM control
- Operating voltage range: 10 to 48 V\*

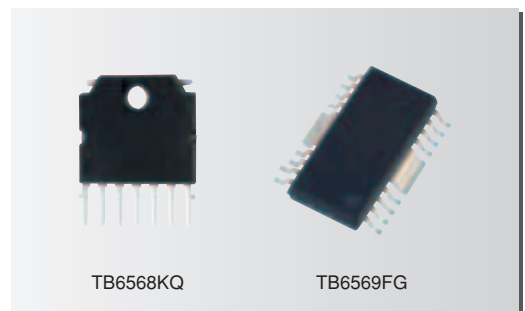
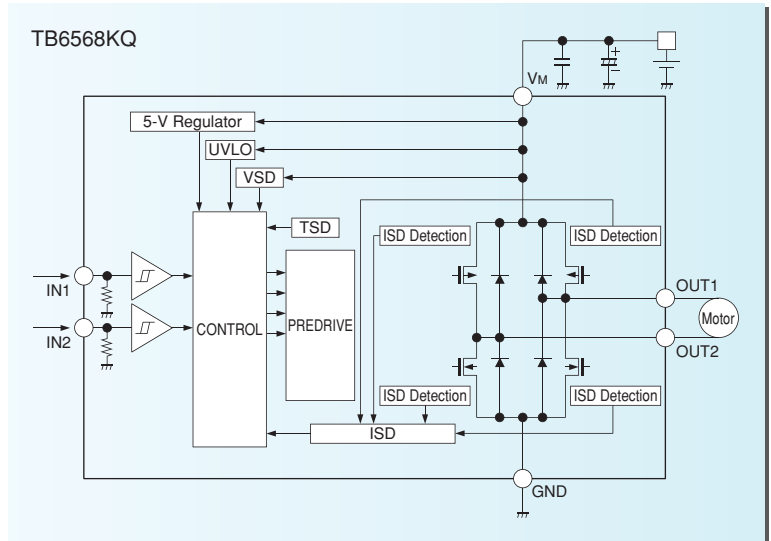
##### (TB6568KQ)

- HSIP7 package

- Pin-compatible with TA8428K
- Rated absolute maximum output current: 3 A\*

##### (TB6569FG)

- HSOP16 package
- Abnormal condition output
- Constant-current PWM control
- Overcurrent protection control circuitry
- Rated absolute maximum output current: 4.5 A\*



\* Design target

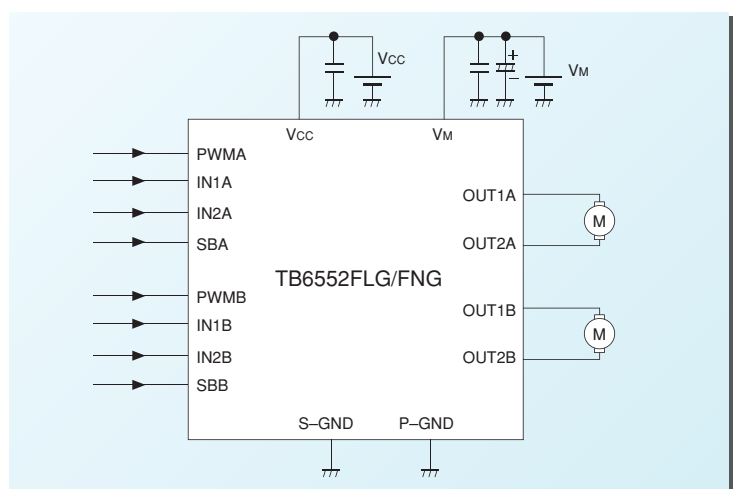
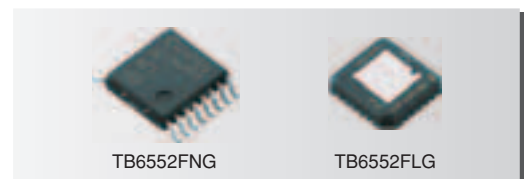
### Dual-Bridge DC Motor Driver

#### TB6552FLG/FNG

The TB6552FLG/FNG is a dual-bridge DC motor driver with low-RDS(ON) LDMOS output transistors. The IN1 and IN2 input terminals allow selection of one of the four modes: Forward, Reverse, Short Brake or Stop. The PWM drive method improves thermal efficiency.

#### Features

- Dual-bridge driver
- Absolute maximum ratings: 15 V/1 A (TB6552FLG/FNG)
- Power supply voltage: Vcc = 2.7 to 5.5 V, Vm = 2.5 to 13.5 V (TB6552FLG/FNG)
- Ron: 1.5 Ω typ. (high side + low side, Vm = 5 V)
- Forward, reverse, short brake and stop modes
- Direct PWM control
- Standby function
- Thermal shutdown circuitry
- Packages: QON24 (TB6552FLG), SSOP16 (TB6552FNG)



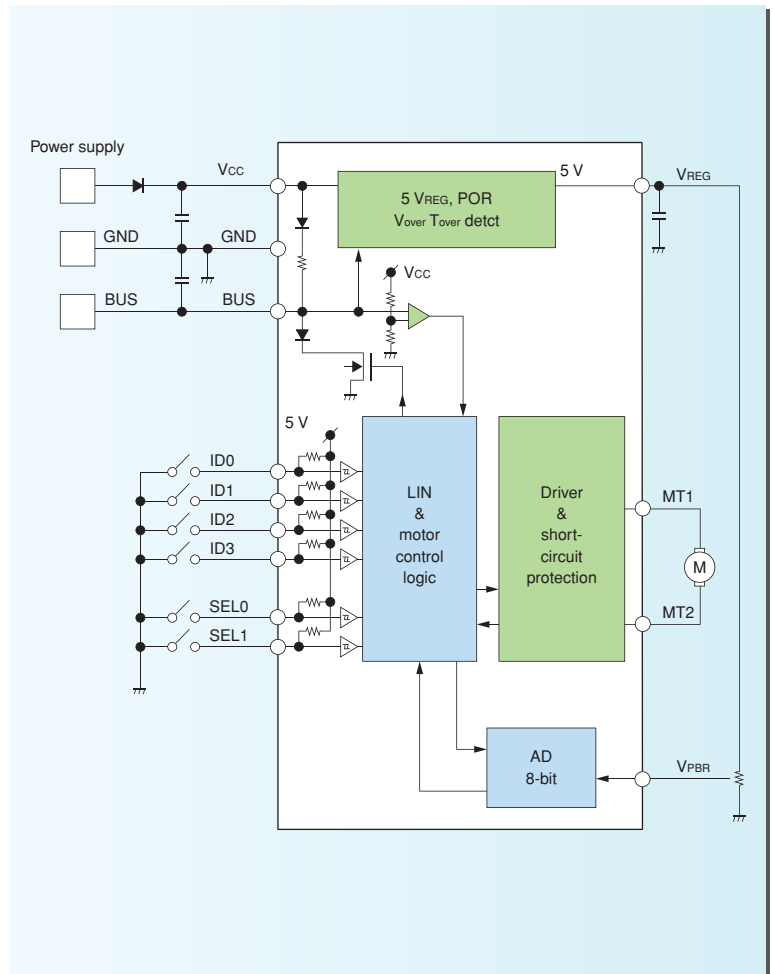
## Full-Bridge DC Motor Driver with LIN Interface

### TB9056FNG

The TB9056FNG is a full-bridge DC motor driver. Fabricated with a low-ON-resistance MOS process, the TB9056FNG offers a LIN interface for communication and allows selection of one of the four modes, Forward, Reverse, Short Brake or Stop. The TB9056FNG helps save energy with a standby leakage current of less than 10  $\mu$ A.

#### Features

- Full-bridge driver
- Operating voltage range: 7 to 18 V
- Rated absolute output current: 300 mA
- LIN interface (V1.3)
- Output  $R_{ON}$
- Overcurrent protection, overvoltage protection, thermal shutdown
- Standby leakage,  $I_{leak} = 10 \mu\text{A}$  (max)
- Extended temperature range: -40 to 85°C
- Package: SSOP24 (0.65-mm lead pitch)



## Features of Low-Withstand-Voltage (60/30 V) Intelligent Power Devices (IPDs)

### High-Side Power Switches < TPD1038F, TPD1042F >

#### Features

- High-side switch that allows grounding of an electrical load
- Overtemperature and load shorting protection
- Package: Surface-mount SOP8
- Direct driving of an electrical load from a microcontroller
- Diagnostic circuit that allows diagnosis results to be driven to the outside world while the protection circuit is active



### 2-ch High-Side N-ch Power MOSFET Gate Driver < TPD7101F >

#### Features

- Power MOSFET protection and diagnostic circuits
- Package: Surface-mount SSOP24
- Overcurrent detection level set by an external resistor



### Power MOSFET Gate Driver for 3-Phase (H-Bridge) Motors < TPD7210F >

#### Features

- Charge pump
- Supply voltage diagnostic circuitry
- Small surface-mount package: SSOP24

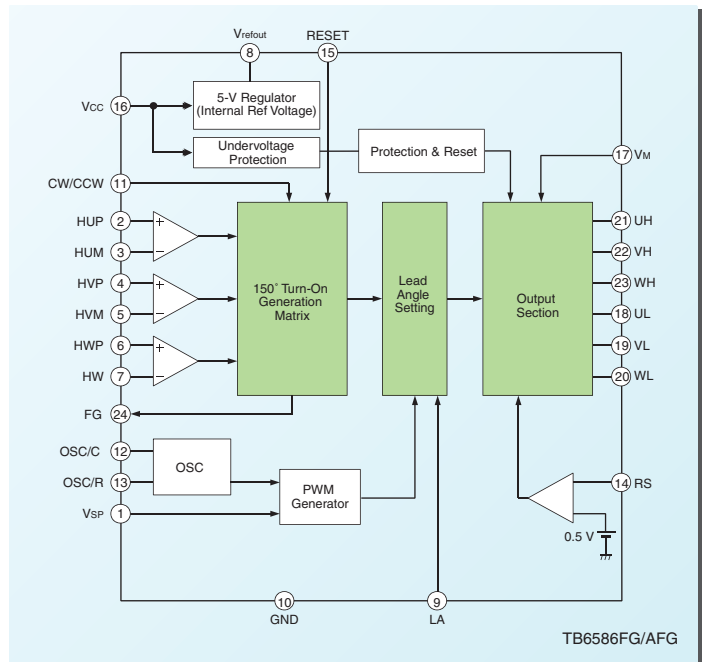
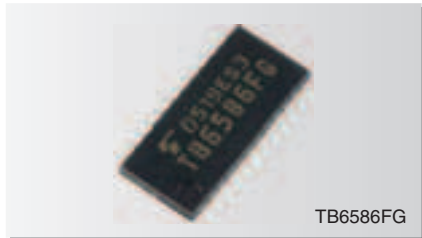
### 3-Phase Brushless DC Motor Controller with 150° Commutation and Lead Angle Control

#### TB6586FG/AFG/BFG

The TB6586FG/AFG/BFG motor controller IC has 150° commutation and provides auto lead angle control that determines the optimal turn-on point, enabling highly efficient driving of three-phase brushless motors.

#### Features

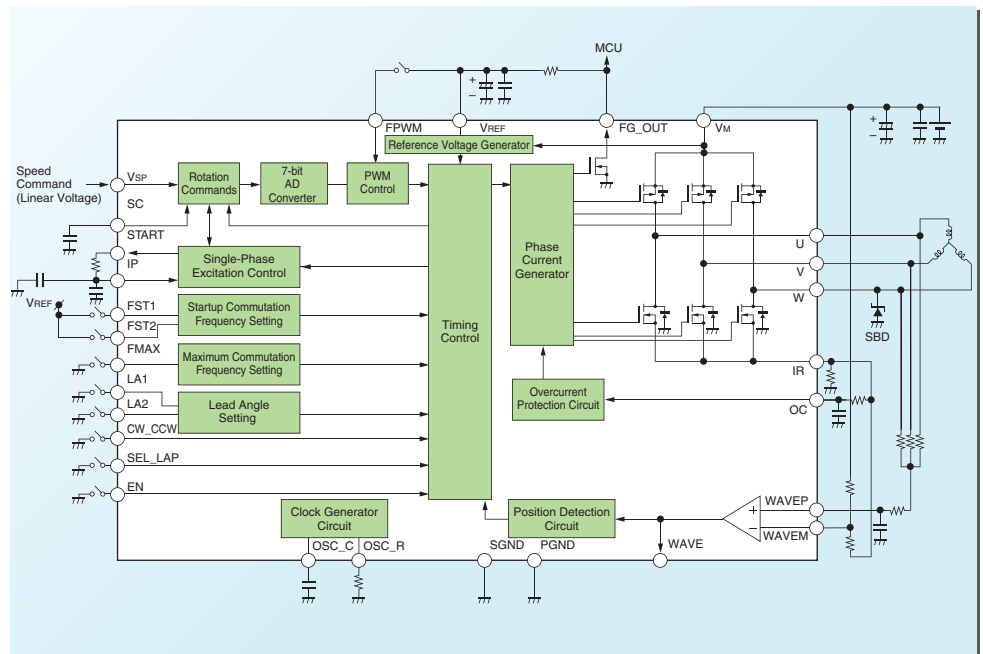
- High-side drivers are controlled with internally generated PWM signals with 150° commutation.
- Integrated bootstrap circuitry
- Auto lead angle control between 0° and 28° in 16 separate steps
- The reference clock is sourced from an external RC network.
- Overcurrent protection, reverse rotation detection, undervoltage lockout



### 3-Phase Full-Wave Sensorless Brushless Motor Driver

#### TB6588FG

The TB6588FG incorporates the driver stage on the same chip, reducing the number of external components required and thus improving board utilization. The TB6588FG combines sensorless operation with hardware-based PWM motor control. It facilitates the use of smaller motors (without Hall sensors) and contributes to a reduction in power dissipation. The lap turn-on function for smooth phase current switching provides a quiet motor drive.



#### Features

- Three-phase, full-wave sensorless operation eliminates the need for Hall sensor feedback for motor position sensing. Only three wires are required for motor control circuitry and a motor.
- The rotation speed can be controlled with a linear voltage input.
- Four selectable lead angle settings according to the H or L level (0, 7.5, 15 or 30 degrees).
- The lap turn-on function for smooth phase current switching provides a quiet motor drive.
- An overcurrent protection circuit limits the PWM duty cycle when an overcurrent signal is detected.
- Single power supply:  $V_m = 7$  to 42 V (Rated absolute maximum voltage = 50 V)
- Output current:  $I_{out} = 1.5$  A (Rated absolute maximum current = 2.5 A)
- Incorporates an output driver and thus saves board space.

### Next-Generation Stepping Motor Series

#### Two-phase bipolar stepping motor drivers fabricated using the BiCD process

- Charge pump-less and logic voltage regulator-less
- Overcurrent detection, thermal shutdown and power-on reset
- Mixed decay mode with improved constant-current accuracy

### 4-in-1 Stepping/DC Motor Driver

#### TB62212FTAG/(FNG)

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

#### Features

- H-bridges configurable into six different modes
  1. Two large DC motors:  $I_{OUT} = 4.0\text{ A}$
  2. Four small DC motors:  $I_{OUT} = 2.0\text{ A}$
  3. One large DC motor plus one small stepping motor
  4. Two small DC motors plus one small stepping motor
  5. Two small stepping motors:  $I_{OUT} = 1.5\text{ A}$
  6. One large stepping motor:  $I_{OUT} = 1.8\text{ A}$
- 2-phase and 1-2-phase support in Stepping Motor mode
- Packages: QFN48, thermally enhanced SOP package

### Stepping Motor Driver with a Clock-In Decoder and W1-2-Phase Excitation Support

#### TB62214FG/FTG/(FNG) (Under development)

Fabricated on the BiCD process, the TB62214FG/FTG/FNG features maximum ratings of 40 V and 2.0 A and contains a clock-in decoder. The TB62214FG/FTG/FNG incorporates a voltage regulator for logic power supply, allowing single voltage ( $V_M$ ) operation.

#### Features

- Integrated clock-in decoder for motor control via a clock input
- Supports 2-phase, 1-2-phase and W1-2-phase excitation modes.
- Packages: QFN48, HSOP28, thermally enhanced SOP package

### Stepping Motor Driver with W1-2-Phase Excitation Support

#### TB62218FG/FTG/(FNG) (Under development)

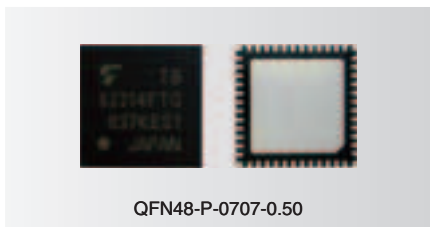
Fabricated on the BiCD process, the TB62218FG/FTG/FNG features maximum ratings of 40 V and 2.0 A. The TB62218FG/FTG/FNG is controlled via phase inputs and incorporates a voltage regulator for logic power supply, allowing single voltage ( $V_M$ ) operation.

#### Features

- Programmable into 2-phase, 1-2-phase and W1-2-phase modes via a three-wire serial interface
- Packages: QFN48, HSOP28, thermally enhanced SOP package

#### ► Packaging

Small footprint



Suitable for flow soldering



Package that is thermally enhanced and easy to mount onto a PCB





# Transistor Arrays and Linear Motor Drivers

## MOTOR SOLUTIONS GUIDE

### Transistor Arrays

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

Package	# of Circuits	Package	Absolute Maximum Ratings		Structure/Configuration	Remarks
			Output Voltage	Output Current		
TD62064APG	4	DIP16-P-300-2.54A	50	1.5	Active-high transistor array	Unipolar constant-voltage drive
TD62064AFG		HSOP16-P-300-1.00				
TD62308APG		DIP16-P-300-2.54A			Active-low transistor array	
TD62308AFG		HSOP16-P-300-1.00				
TD62003,004APG	7	DIP16-P-300-2.54A		0.5	Active-high transistor array	
TD62003,004AFG		SOP16-P-225-1.27				
TD62083,084APG	8	DIP18-P-300-2.54D				
TD62083,084AFG		SOP18-P-375-1.27				
TD62083,084AFNG		SSOP18-P-225-0.65				

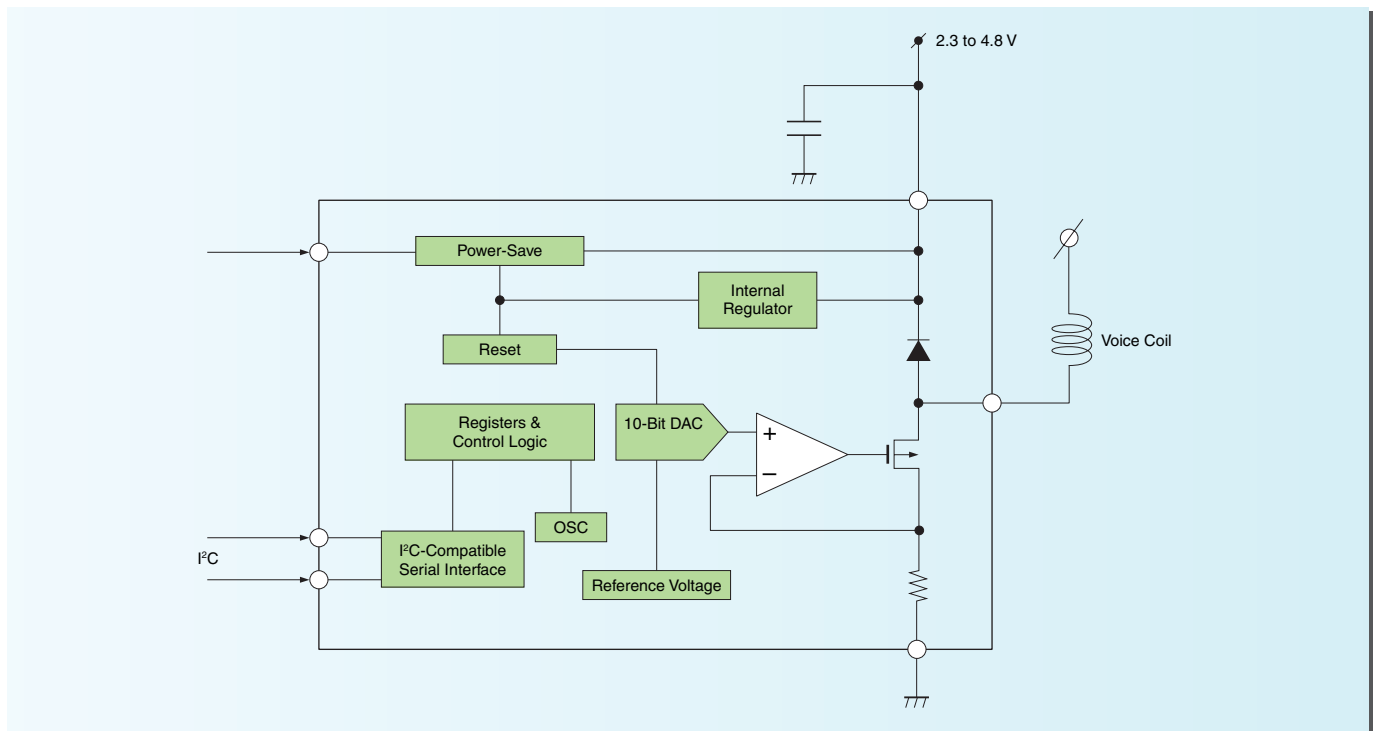
### Linear Motor Drivers

#### TC7650WLG VCM Driver for Camera Modules (Under development)

Controls a 100-mA linear constant-current driver with an integrated 10-bit DAC.  
Uses an I<sup>2</sup>C-compatible two-wire serial interface.

#### Features

- 2.3- to 4.8-V single power supply
- 100-mA current sink
- 2-wire serial interface (I<sup>2</sup>C-compatible)
- 10-bit DAC
- On-chip reset circuit
- Power-save mode
- Slope control
- Small WCSP package



## Mixed DMOS Process (BiCD)

Toshiba's motor drivers are fabricated using the BiCD process, which combines the accuracy, high speed and high-current capability.

### BiCD (Bi ipolar + C CMOS + D DMOS )

- ▶ **B**ipolar: Analog Circuit
- ▶ **C**MOS: High Speed Logic
- ▶ **D**MOS: High Voltage & Current Drive

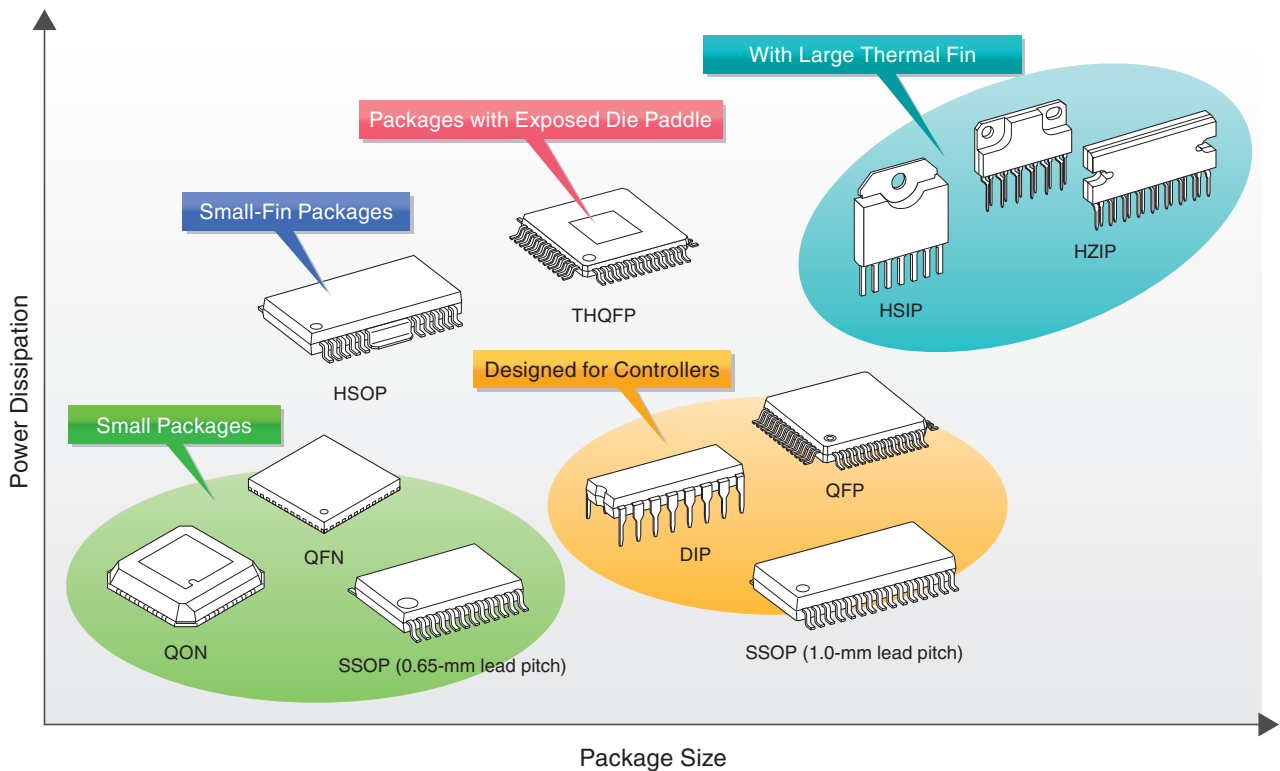
High-accuracy  
analog circuitry  
Bipolar

High-speed  
logic  
CMOS

High-current  
output  
DMOS

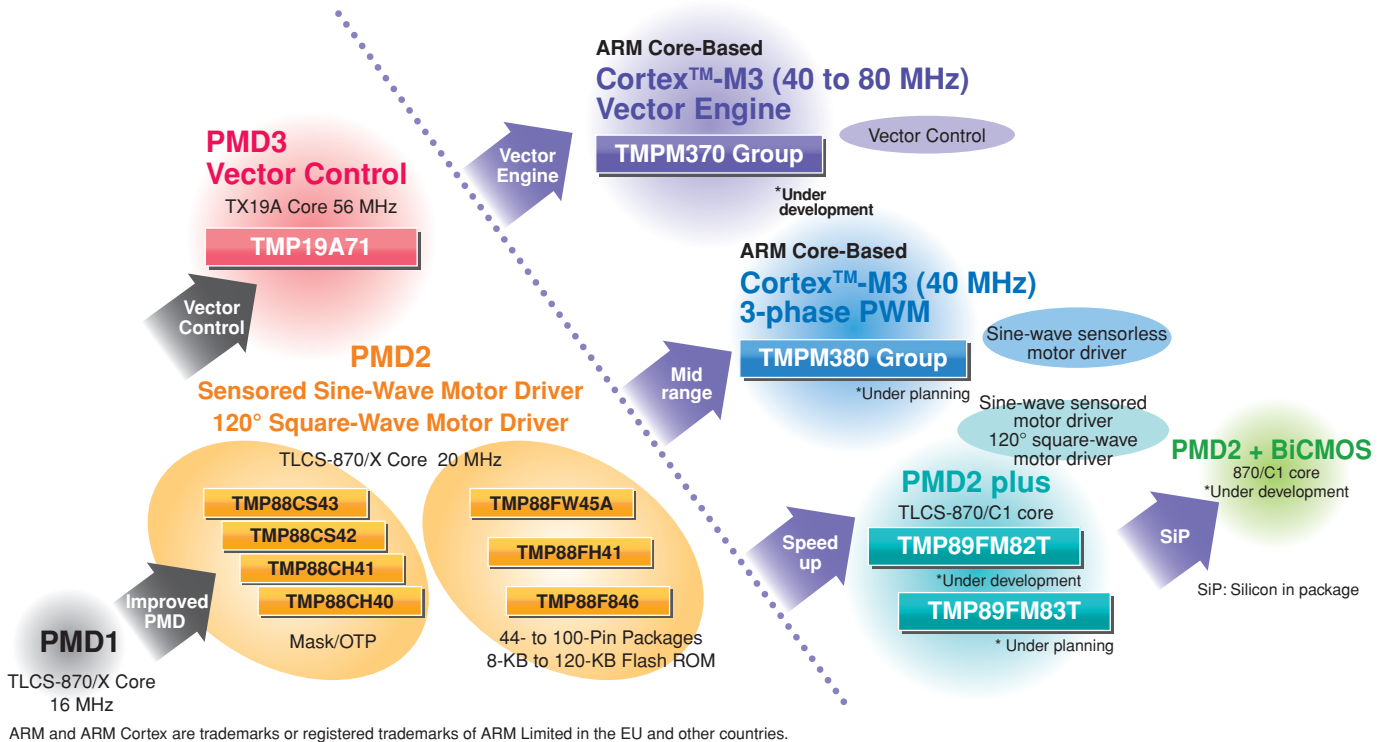
## Wide Variety of Packaging Options

Toshiba offers a broad range of package from small packages for mobile devices to packages with a thermal fin that support large current.



Toshiba offers a range of microcontrollers that incorporate a programmable motor driver (PMD) featuring inverter control of three-phase motors.

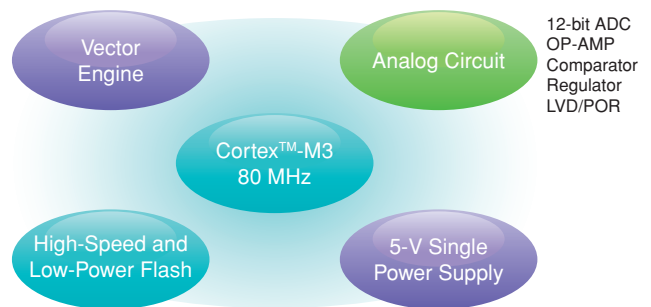
### Toshiba PMD Microcontroller Roadmap



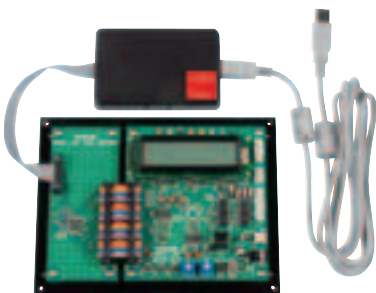
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#### Vector Engine (VE)

The Vector Engine (VE) is built-in hardware for handling routine computations such as coordinate translation, reducing the software processing time of a servo loop to approximately 7.5  $\mu$ s at 80 MHz. The VE provides 100-MHz-class performance at an 80-MHz CPU frequency. Additionally, it allows vector control of two motors at 40 MHz, which helps reduce noise and power consumption.



### Starter Kit with TMP89FM82TDUG

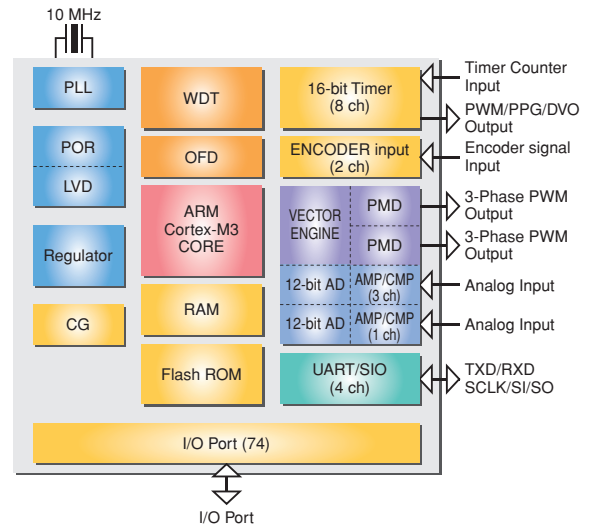


- Portable: 155 mm x 110 mm x 30 mm
- The microcontroller is exchangeable, being mounted on a separate board from the main circuit board.
- Supports an on-chip debug emulator (OCDE).
- Control from a PC is possible by connecting via a USB cable. (User-created application software is required.)
- Sample codes for three motor drive techniques (sensorless square-wave, sensed square-wave and sensed sine-wave control)
- Shows the target and current rotation speeds on a monochrome LCD (16 characters x 2 lines).

## Cortex™-M3 Core and Vector Motor Control Engine

### TMPM370FYFG/TMPM370FYDFG (Under development)

- ARM Cortex™-M3 CPU core
  - ▶ Operating voltage: I/O = 4.5 to 5.5 V
  - ▶ Maximum operating frequency: 80 MHz (derived by multiplying a 10-MHz clock by a factor of 8 with on-chip PLL)
  - ▶ On-chip memory: 256-KB flash ROM, 10-KB RAM
  - ▶ High-speed computation: Multiplier (1-7 cycles), divider (2-12 cycles)
  - ▶ On-chip debug logic: EJTAG or 2-wire SWD (Serial Wire Debug) interface
  - ▶ Low-power: Clock gearing (f/2, f/4 or f/8), standby mode (NORMAL/STOP)
- On-chip peripherals
  - ▶ Next-generation PMDs (motor control timers): 2 channels
    - Vector Engine: 1 channel
    - Encoder inputs: 2 channels
    - Comparator for emergency stop
  - ▶ 12-bit AD converter: 2- $\mu$ s conversion time, 13-channel and 12-channel ADCs (with three channels sharing the same pins)
  - ▶ 16-bit timer/counter: 8 channels (free-run, compare output, PPG, input capture)
  - ▶ Serial interface: 4 UART/SIO channels
  - ▶ Watchdog timer      ▶ Power-on reset
  - ▶ Low voltage detection      ▶ Oscillation frequency detection (OFD)
- Packages
  - ▶ 100-pin LQFP (14 x 14 mm, 0.5-mm lead pitch)
  - ▶ 100-pin QFP (14 x 20 mm, 0.65-mm lead pitch)

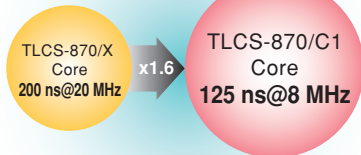


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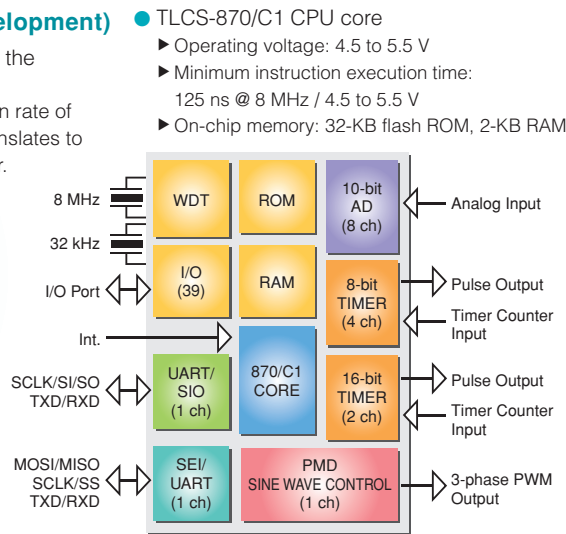
## TLCS-870/C1 Core and Sensored Sine-Wave/120° Square-Wave Motor Controller

### TMP89FM82TDUG (Under development)

- Improved instruction throughput due to the TLCS-870/C1 core
- The TLCS-870/C1 core provides an execution rate of one instruction per machine cycle, which translates to 1.6 times the performance of its predecessor.



- On-chip debug features
- The on-chip debug features simplify the evaluation of motor software.



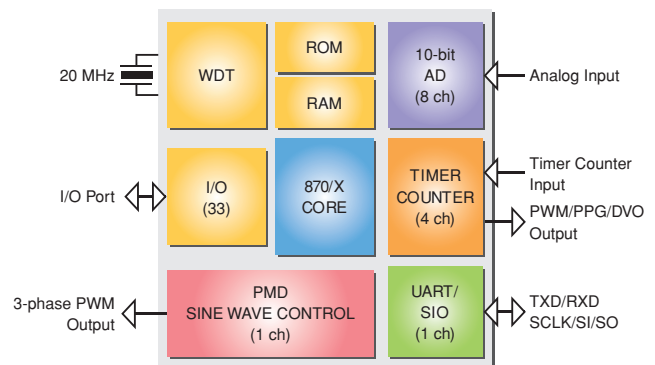
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- On-chip peripherals
  - ▶ Programmable Motor Driver: 1 channel
    - PWM resolution: 42 ns
    - Dead time counter resolution: 83 ns
    - Sine-wave control
    - Sensorless and sensored DC motor control
    - Inverter AC motor control
    - Overload protection
    - Automatic commutation; real-time position sensing
  - ▶ 10-bit AD converters: 8 channels
  - ▶ 8-bit timers: 4 channels
  - ▶ 16-bit timers: 2 channels
  - ▶ UART/SIO: 1 channel
  - ▶ SEI/UART: 1 channel
  - ▶ Power-on reset circuit
  - ▶ Low voltage detection
  - ▶ Extended operating temperature range: Ta = -40 to 125°C
  - ▶ Automotive-qualified
  - ▶ ISO/TS16949-compliant
- Package
  - ▶ 48-pin LQFP (7 x 7 mm, 0.5-mm lead pitch)

## TLCS-870/X Core and Sensored Sine-Wave/120° Square-Wave Motor Controller

### TMP88FH41UG

- TLCS-870/X CPU core
  - ▶ Operating voltage: 4.5 to 5.5 V
  - ▶ Minimum instruction execution time: 200 ns @ 20 MHz / 4.5 to 5.5 V
  - ▶ On-chip memory: 16-KB flash ROM, 512-byte RAM
- On-chip peripherals
  - ▶ Programmable Motor Driver: 1 channel
    - Sine-wave motor driver (sine-wave data table in RAM)
    - Rotor position sensing      · Motor control timer and capture
    - Overload protection      · Automatic commutation and automatic position sensing start
  - ▶ 10-bit AD converter: 8 channels
  - ▶ 8-bit timer/counter: 2 channels
  - ▶ 16-bit timer/counter: 2 channels
  - ▶ UART/SIO: 1 channel
- Package
  - ▶ 44-pin LQFP (10 x 10 mm, 0.8-mm lead pitch)



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# IPDs, Power Drivers and Interface ICs

## MOTOR SOLUTIONS GUIDE

### 250/500-V Brushless DC Motor Drivers Fabricated Using a Silicon-On-Insulator (SOI) Process

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

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

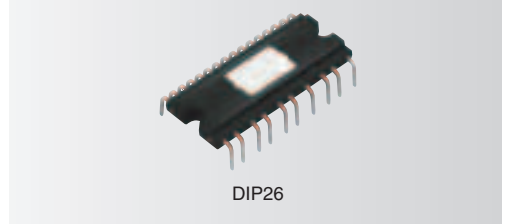
- Features**
- High withstand voltage due to the use of the SOI process and trench isolation structure
  - Available with ratings from 250 V/1A to 500 V/3A
  - Internal bootstrap power supply for the high-side gate drives

#### IPDs in the New DIP26 Package

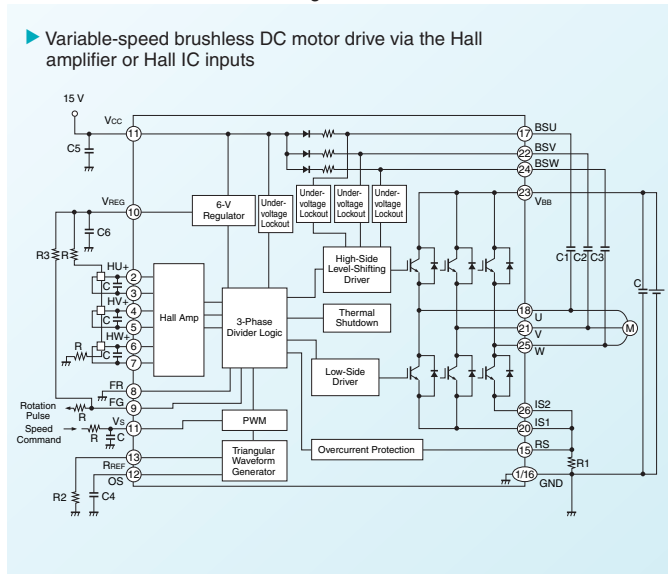
**Features**

- Package: 26-pin DIP (NEW-DIP)
- Package body thickness: 3.8 mm max
- 16 control pins and 10 high-voltage pins are isolated on the opposite sides of the package.  
(This simplifies board trace routing.)
- Improved thermal resistance
  - Example  
TPD4125K/AK Rth (j-c): IGBT section = 3.1°C/W; FRD section = 4.8°C/W

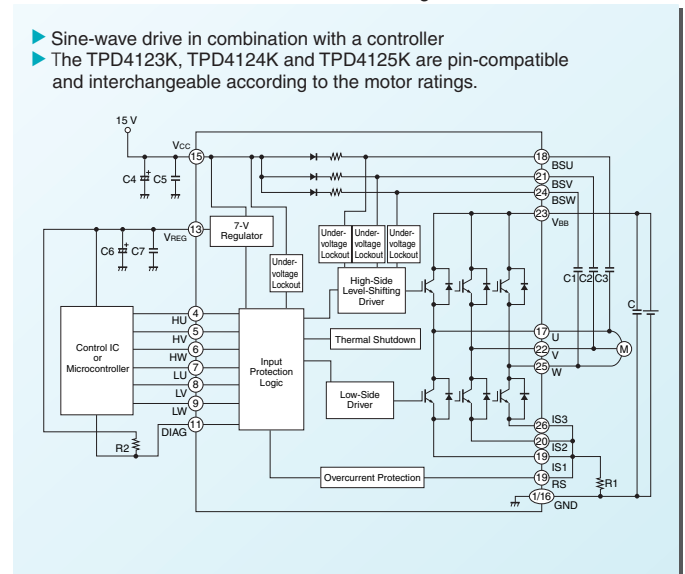
New Product



<TPD4121K/TPD4122K Block Diagram>



<TPD4123K/TPD4124K/TPD4125K Block Diagram>



#### Product Offerings

Part Number	Rating	Features						
		Hall-Effect Sensor Input	6 Inputs	Three-Phase Distribution	Level Shifter	Overcurrent Protection	Thermal Shutdown	Undervoltage Protection
TPD4121K	250 V/1 A	○	—	○	○	○	○	○
TPD4122K	500 V/1 A	○	—	○	○	○	○	○
TPD4123K	500 V/1 A	—	○	—	○	○	○	○
TPD4123AK	500 V/1 A	—	○	—	○	—	○	○
TPD4124K	500 V/2 A	—	○	—	○	○	○	○
TPD4124AK	500 V/2 A	—	○	—	○	—	○	○
TPD4125K	500 V/3 A	—	○	—	○	○	○	○
TPD4125AK	500 V/3 A	—	○	—	○	—	○	○

## Power Drivers

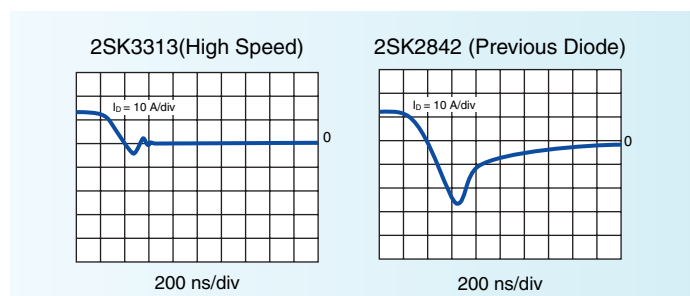
Power MOSFETs with integrated a high-speed diode: Achieves a higher parasitic-diode speed by using lifetime control ( $t_{rr} \approx 100$  ns)

### Product Offerings

Part Number	Absolute Maximum Rating			Package	$R_{DS(ON)}$ Max( $\Omega$ )			$t_{rTyp.}(ns)$
	$V_{bss}(V)$	$I_b(A)$	$P_D(W)$			$V_{GS}(V)$	$I_b(A)$	
2SK3316	500	5	35	TO-220NIS	1.8	10	2.5	60
2SK3868	500	5	35	TO-220SIS	1.7	10	2.5	150
2SK3417	500	5	50	TO-220FL/SM	1.8	10	2.5	60
2SK4042	500	8	40	TO-220SIS	0.97	10	4	185
2SK3313	500	12	40	TO-220NIS	0.62	10	6	90
2SK3314	500	15	150	TO-3P(N)	0.49	10	7	105
2SK3131	500	50	250	TO-3P(L)	0.11	10	25	105
2SK3936	500	23	150	TO-3P(N)	0.25	10	11.5	380
2SK3947	600	6	40	TO-220SIS	1.4	10	3	150
2SK4015	600	10	45	TO-220SIS	0.86	10	5	170
2SK4016	600	13	50	TO-220SIS	0.50	10	6.5	160
2SK3906	600	20	150	TO-3P(N)	0.33	10	10	400

### Characteristics of High-Speed Diode Series

Faster parasitic diode

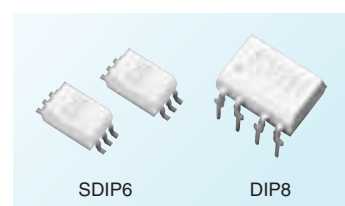


## IGBT/MOSFET Gate Driver Photocouplers

Fabricated using the Bi-CMOS process, the TLP700, TLP701, TLP705, TLP351 and TLP350 offer the industry's lowest power consumption. These photocouplers are designed for direct drive of medium-power IGBTs or power MOSFETs.

Optimized to deliver a dramatic reduction in supply current, the TLP700, TLP701, TLP705, TLP351 and TLP350 generate less heat, extending the maximum operating temperature to 100°C.

The TLP700, TLP701 and TLP705 are housed in a 6-pin SDIP package. While meeting the reinforced insulation requirements of international safety standards, the 6-pin SDIP package occupies approximately 50% less board space than the 8-pin DIP package.



Characteristics	TLP700	TLP701	TLP705	TLP351	TLP350
Peak output current $I_{OPH}/I_{OPL}$ (max)( $T_a = 25^\circ C$ )	$\pm 2.0$ A*	$\pm 0.6$ A	$\pm 0.45$ A	$\pm 0.6$ A	$\pm 2.5$ A*
Supply voltage $V_{CC}$ ( $T_a = -40$ to $100^\circ C$ )	15 to 30 V	10 to 30 V	10 to 20 V	10 to 30 V	15 to 30 V
Supply current $I_{CCH}/I_{CCL}$ (max)( $T_a = -40$ to $100^\circ C$ )	2 mA	2 mA	3 mA	2 mA	2 mA
Propagation delay time $t_{pHL}/t_{pLH}$ (max)( $T_a = -40$ to $100^\circ C$ )	0.5 $\mu s$	0.7 $\mu s$	0.2 $\mu s$	0.7 $\mu s$	0.5 $\mu s$
Operating temperature range $T_{opr}$ ( $^\circ C$ )	-40 to $100^\circ C$	-40 to $100^\circ C$	-40 to $100^\circ C$	-40 to $100^\circ C$	-40 to $100^\circ C$
Threshold input current $I_{FLH}$ (max)( $T_a = -40$ to $100^\circ C$ )	5 mA	5 mA	8 mA	5 mA	5 mA
Common-mode transient immunity $CMH/CM_L$ (min) ( $T_a = 25^\circ C$ )	$\pm 10$ kV/ $\mu s$	$\pm 10$ kV/ $\mu s$	$\pm 10$ kV/ $\mu s$	$\pm 10$ kV/ $\mu s$	$\pm 15$ kV/ $\mu s$
Isolation voltage $BV_s$ (min) ( $T_a = 25^\circ C$ )	5000 Vrms			3750 Vrms	
Packaging	SDIP6 pin			DIP8 pin	
Pin Configuration					

\*:  $T_a = -40$  to  $100^\circ C$

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