

TOSHIBA

Leading Innovation >>>

2008-9

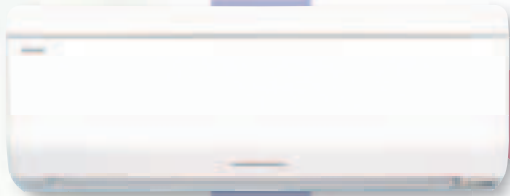
SYSTEM CATALOG

Home Appliances

Datasheet.Global

s e m i c o n d u c t o r

<http://www.semicon.toshiba.co.jp/eng>



Air Conditioners



Induction Rice Cookers



Dishwashers



Refrigerators



Automatic Washing Machines

C O N T E N T S

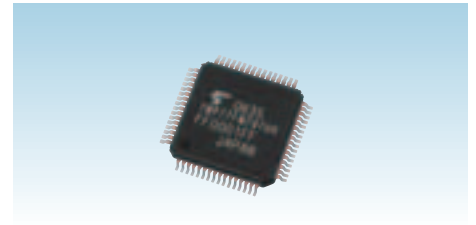
Characteristics of Motor Control Devices.....	3
Overview of Toshiba's Semiconductor Devices for Home Appliances.....	4 to 5
Features of Toshiba's Motor Control Microcontrollers.....	6
TLCS-870/C1 Microcontroller Series	
Designed for Home Appliance Applications.....	7
Roadmap for Toshiba's IPD Motor Controllers.....	8
Roadmap for Sine-Wave Motor Driver ICs.....	8
Block Diagram Examples for Home Appliances Using Toshiba's Recommended Semiconductor Devices.....	9 to 14
Microcontrollers.....	15 to 16
Microcontrollers for Home Appliances.....	17
Motor Drivers.....	18 to 19
Peripheral ICs and Sensors.....	19
Discrete Devices for Inverter Home Applications.....	20
Output Interfaces.....	21
Power Drivers.....	21 to 22
Semiconductor Devices for Power Supplies.....	23 to 25
LED Lamps.....	26
General-Purpose Discrete Devices.....	27

Characteristics of Motor Control Devices

Optimal choices of motor control devices are important for the success of electric home appliances. You can find motor control devices ideal for your applications in Toshiba's product portfolio: intelligent power devices (IPDs) that provide control over a motor via microcontroller signals; motor driver ICs; and microcontrollers capable of generating a variety of motor control sequences.

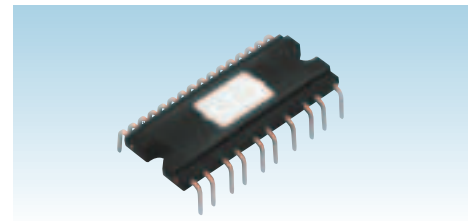
■ Microcontrollers designed for motor control

- No external component is required for motor control. Applications can be executed at the same time.
- Available with a wide range of I/O counts and ROM sizes optimized for particular applications.
- 8-bit to 32-bit CPUs suitable for various motor control requirements
- Supports complicated motor control such as abrupt acceleration, constant-speed control and braking.
- Use of a Flash ROM allows motor control parameters to be changed and their history to be saved.



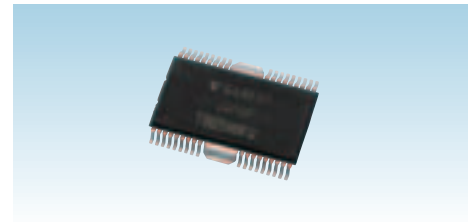
■ IPD drivers

- Capable of operating from commercial power supply, eliminating the need for a buck converter.
- Capable of controlling a motor in tandem with a microcontroller.
- New packages help simplify pc board traces.
- Available with a wide range of electrical ratings for brushless dc motors.

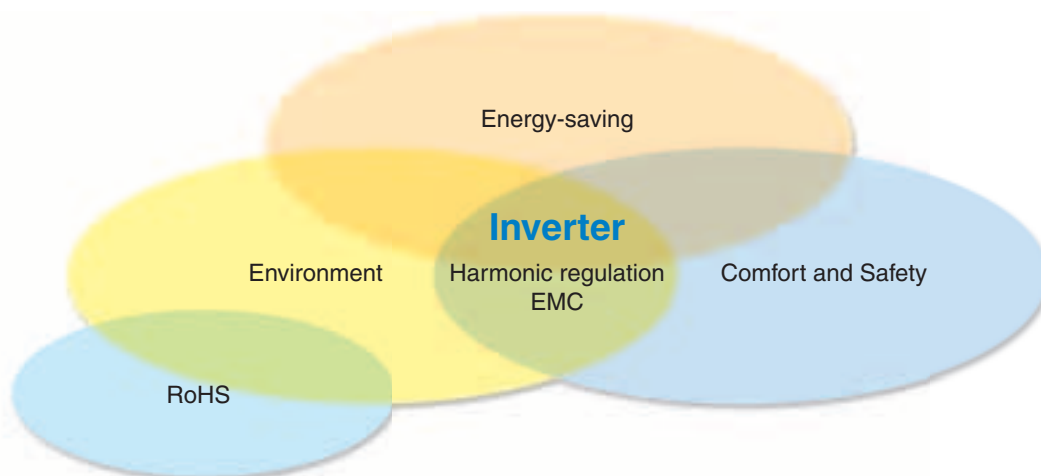


■ Motor control drivers

- Provides easy motor control. Capable of controlling a motor in tandem with a microcontroller.
- Purely hardware motor control eliminates the need for software development, reducing time-to-market.
- Motor controllers and drivers are available for brushless and brushed dc motors, and stepping motors.



Market and Technology Trends of Inverter Home Appliances



Enabling Technologies

Energy-saving: Vector control

DSPs and RISC microcontrollers with vector control capability → **TMP77CM70T/TMP19A71**

Harmonic reduction: Partial sliding-mode (SM) control

PFC circuit plus control device (microcontroller) → **GT30J121** + diode bridge

Overview of Toshiba's Semiconductor Devices for Home Appliances

Single-Chip Inverter ICs (IPDs) for Brushless DC Motors

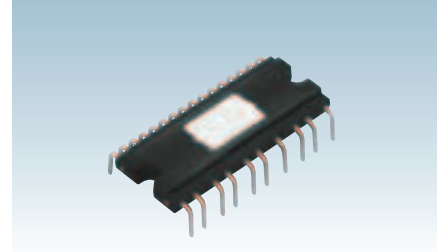
Available in the DIP26 Package

Package Features

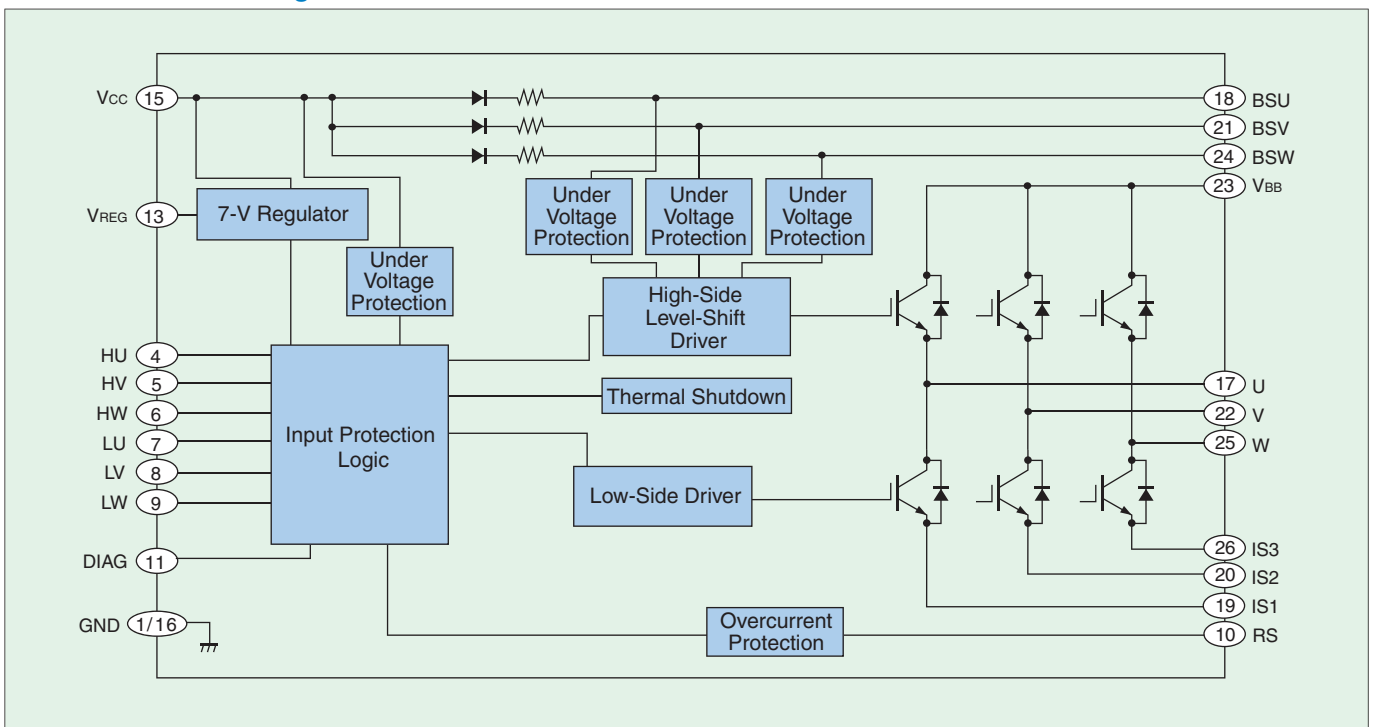
- 3.6-mm body thickness
- Control and high-voltage pins are completely isolated.
- Wide lead pitches
(High-voltage pins: 3.8 mm; control pins: 2.0 mm)

Device Features

- The bootstrap operation eliminates the need for a power supply for high-side drivers.
- Built-in bootstrap diodes
- Overcurrent protection, thermal shutdown and undervoltage protection



TPD4125K Block Diagram



Discrete IGBTs for Induction Cookers and Microwave Ovens

- Reduced turn-on and switching losses thanks to the leading-edge microfabrication technology
- Integrates IGBT and fast recovery diode (FRD) chips in a single package

Circuit Types and Recommended Products

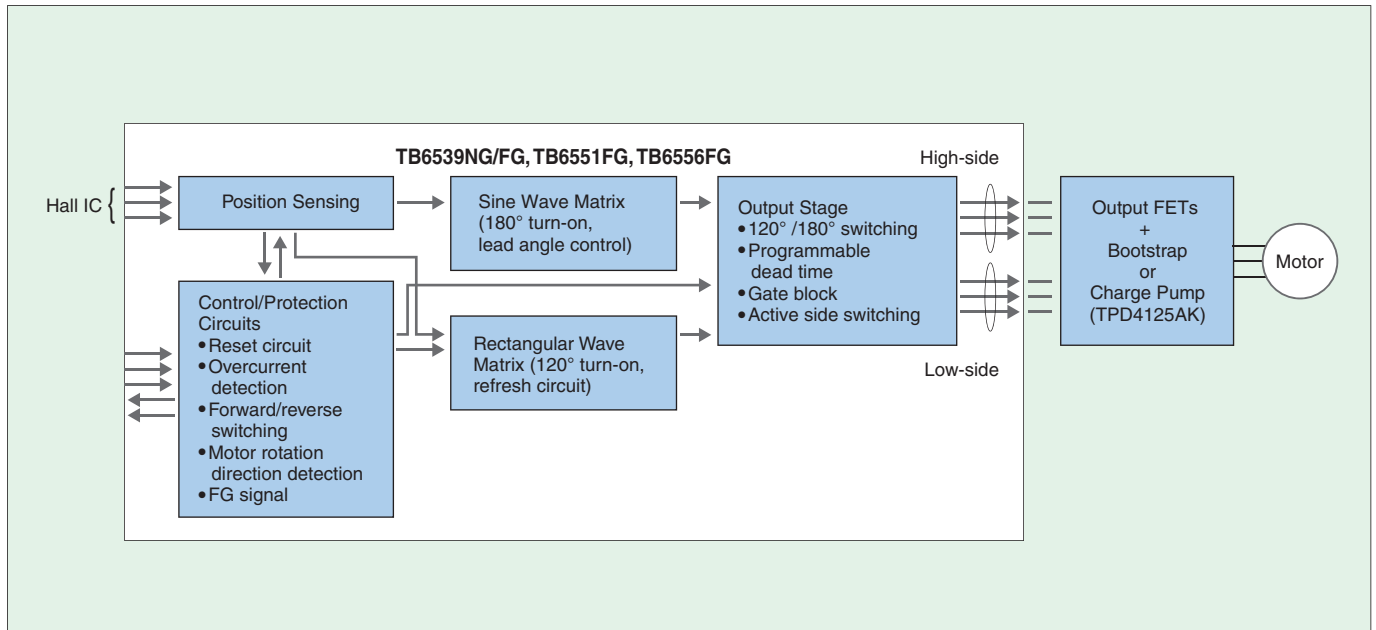
Input		Internal Circuit Diagram	IGBT	
AC Line	Power Consumption		Ratings	Part Number
100 V	Up to 1600 W		$V_{CES} = 900$ to 1000 V $I_C = 50$ A	GT50M322 GT50N322A
			$V_{CES} = 1200$ V $I_C = 40$ A	GT40Q321
220 V	Up to 3000 W		$V_{CES} = 600$ V $I_C = 35$ to 60 A	GT35J321* GT40J321 GT40J322 GT50J328 GT60J323 GT60J323H

*: Insulated package

Motor Controllers

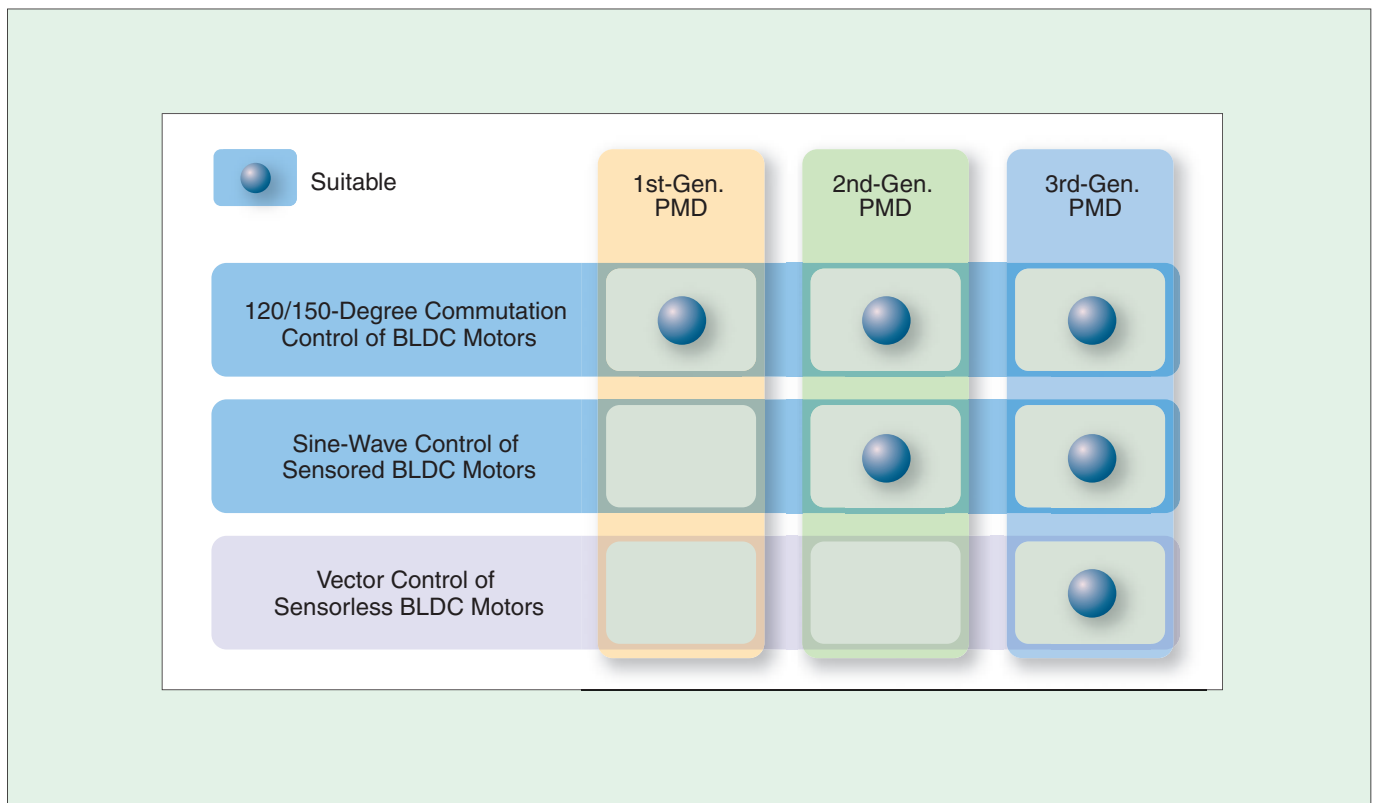
■ Sine-Wave PWM Motor Controllers

The TB6539NG/FG, TB6551FG and TB6556FG use a sine wave to control the motor drive current. This helps to reduce the noise and vibration emitted by the motor. The TB6556FG also features auto lead angle control.



Toshiba Microcontrollers for Motor Control

Toshiba's microcontrollers with a motor control circuit support inverter control of 3-phase DC and AC motors. Motor drive signals are coordinated with feedback signals from the motor, thus controlling the motor with less load imposed on the CPU. The product offerings include a variety of microcontrollers supporting 120-degree commutation and vector control.



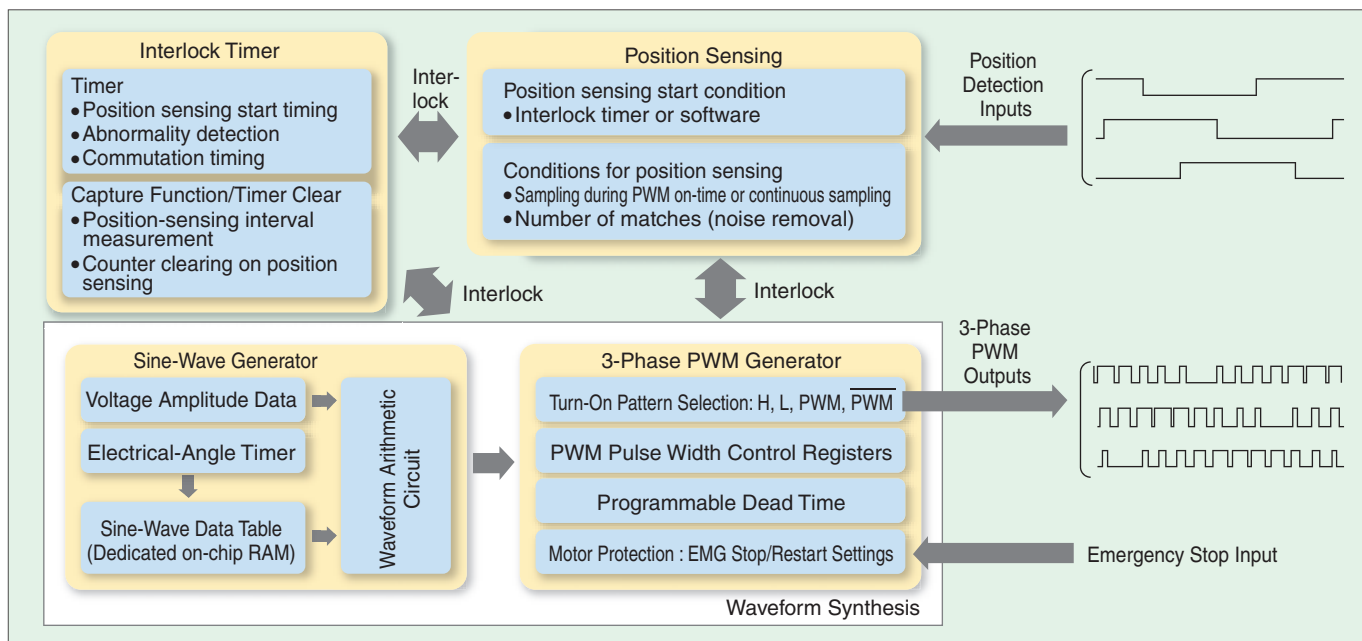
Features of Toshiba's Motor Control Microcontrollers

Second-Generation PMDs

■ Features

The second-generation PMDs incorporate a three-phase PWM generator, a position sensing circuit, interlock timers and protection circuits. These hardware units enable inverter motor control using eight-bit microcontrollers. The integrated sine-wave generator allows sine-wave output with no additional burden on software, enabling motor noise reduction for washing machines and such. With the sine-wave generator, the PMD can also easily support AC inverters.

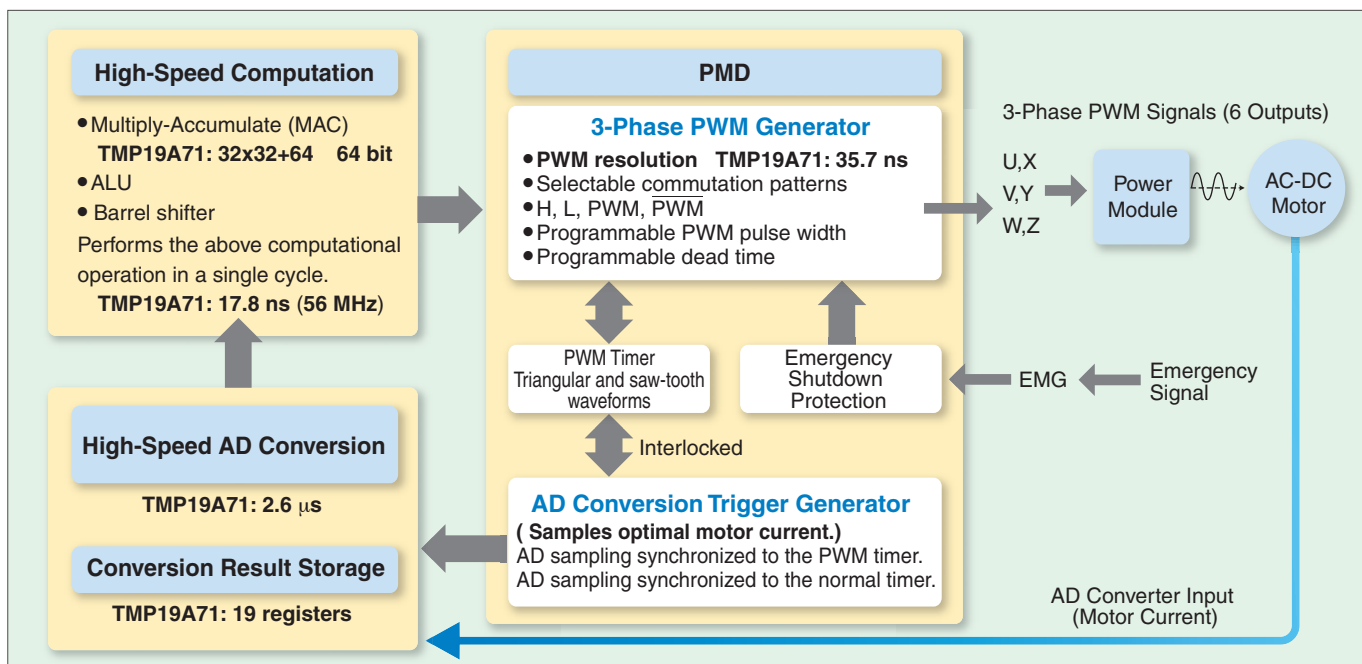
■ Microcontrollers for Motor Control (870/X, 870/C1 Series)



Third-Generation PMDs

■ Features

In today's home appliance industry where the drive to achieve ever higher performance such as energy savings is advancing, an increasing number of motor control systems use vector control that enables high-speed and high-precision control of motor currents. To meet this demand, Toshiba has developed the third-generation PMD containing a three-phase PWM generator, a PWM-synchronized high-speed AD converter and a high-speed multiply-accumulate (MAC) unit.



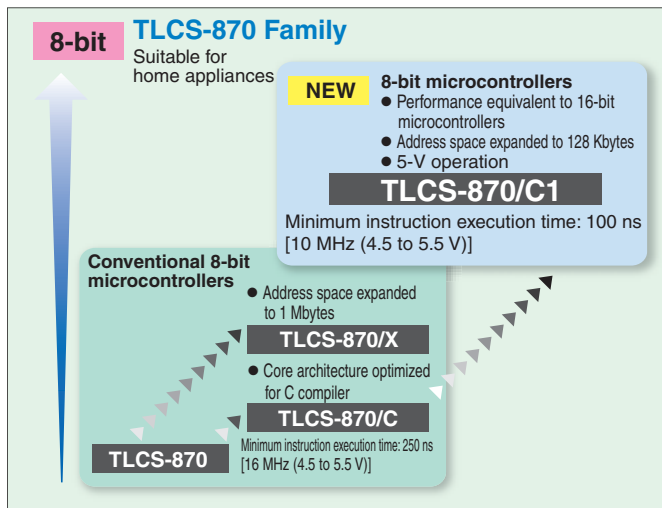
TLCS-870/C1 Microcontroller Series

Designed for Home Appliance Applications

Performance equivalent to 16-bit microcontrollers and a maximum memory address space of 128 Kbytes

Toshiba offers TLCS-870/C1 Series of 8-bit microcontrollers that deliver performance equivalent to 16-bit microcontrollers. The TLCS-870/C1 Series achieves high-speed processing capability at low internal clock frequencies by executing each instruction in one clock cycle. Toshiba's proprietary memory segmentation method allows addressing of up to 128 Kbytes of memory.

8-Bit Microcontroller Cores



TLCS-870/C1 Series Development System

- **Toshiba Integrated Development Environment (TIDE)**
- **Emulators**
 - In-circuit emulator
Compact, low-cost, yet highly functional in-circuit emulator Supports on-chip debug emulation.
 - On-chip debug emulator
Business-card-sized compact emulator No need for power supply (USB bus powered)



Microcontroller Product Offerings

TMP89FM42UG, TMP89FH42UG

44-pin high-performance general-purpose microcontroller housed in a small package

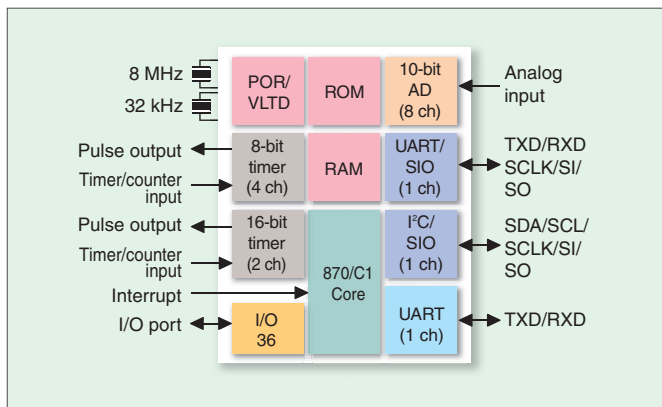
■ TLCS-870/C1 Core

- Operating voltage: 4.5 to 5.5 V at 8 MHz; 2.7 to 5.5 V at 4.2 MHz
- Clock gearing: 1/4, 1/2, 1/1

■ Peripheral Functions

- 32-KB or 16-KB flash ROM and 3-KB RAM
 - Constant-voltage detection circuit (Two voltage levels detectable; reset or interrupt selectable)
 - Power-on reset circuit (Threshold voltage: 2.4 V \pm 0.2 V)
 - 8-bit timer/counter: 4 channels (Resolution: 125 ns at 8 MHz)
 - 16-bit timer/counter: 2 channels (Resolution: 250 ns at 8 MHz)
 - UART/SIO*: 2 channels (UART: 128 Kbps, SIO: 4 Mbps at 8 MHz)
 - UART: 1 channel
 - I²C/SIO*: 1 channel (I²C: 381 Kbps, SIO: 4 Mbps at 8 MHz)
 - 10-bit AD converter: 8 channels
 - Built-in pull-up resistors
 - On-chip debug function
- * Up to 2 SIO channels can be used simultaneously.

■ Packaging: LQFP44 (10 x 10 mm)



TMP89FM42LUG, TMP89FH42LUG

High-performance 8-bit microcontrollers in a small package with a flash ROM erasable and programmable at a low voltage

■ TLCS-870/C1 Core

- Operating voltage: 2.7 to 3.6 V at 4.2 MHz; 2.2 to 3.6 V at 2 MHz
- Erase/program voltage: 3.0 to 3.6 V at 4.2 MHz

■ Peripheral Functions

- Same as TMP89FM42.

■ Packaging: LQFP44 (10 x 10 mm)

TMP89FM43LQG

High-performance 8-bit microcontroller in an ultra-small package with a flash ROM erasable and programmable at a low voltage

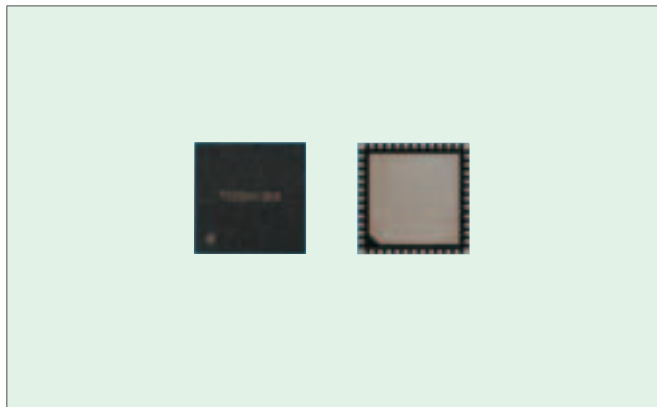
■ TLCS-870/C1 Core

- Operating voltage: 2.7 to 3.6 V at 4.2 MHz; 2.2 to 3.6 V at 2 MHz
- Erase/program voltage: 3.0 to 3.6 V at 4.2 MHz

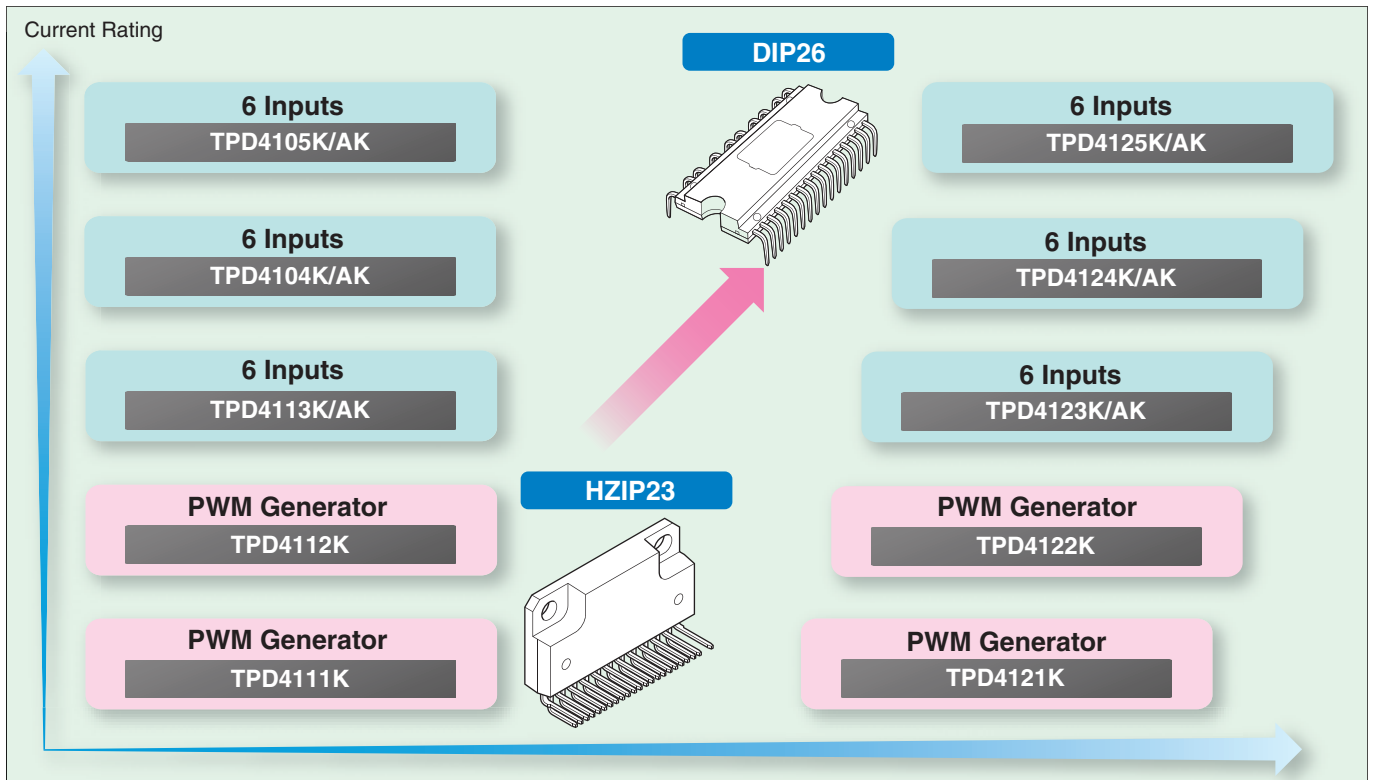
■ Peripheral Functions

- Same as TMP89FM42.

■ Packaging: VQON44 (5.3 x 5.3 mm)

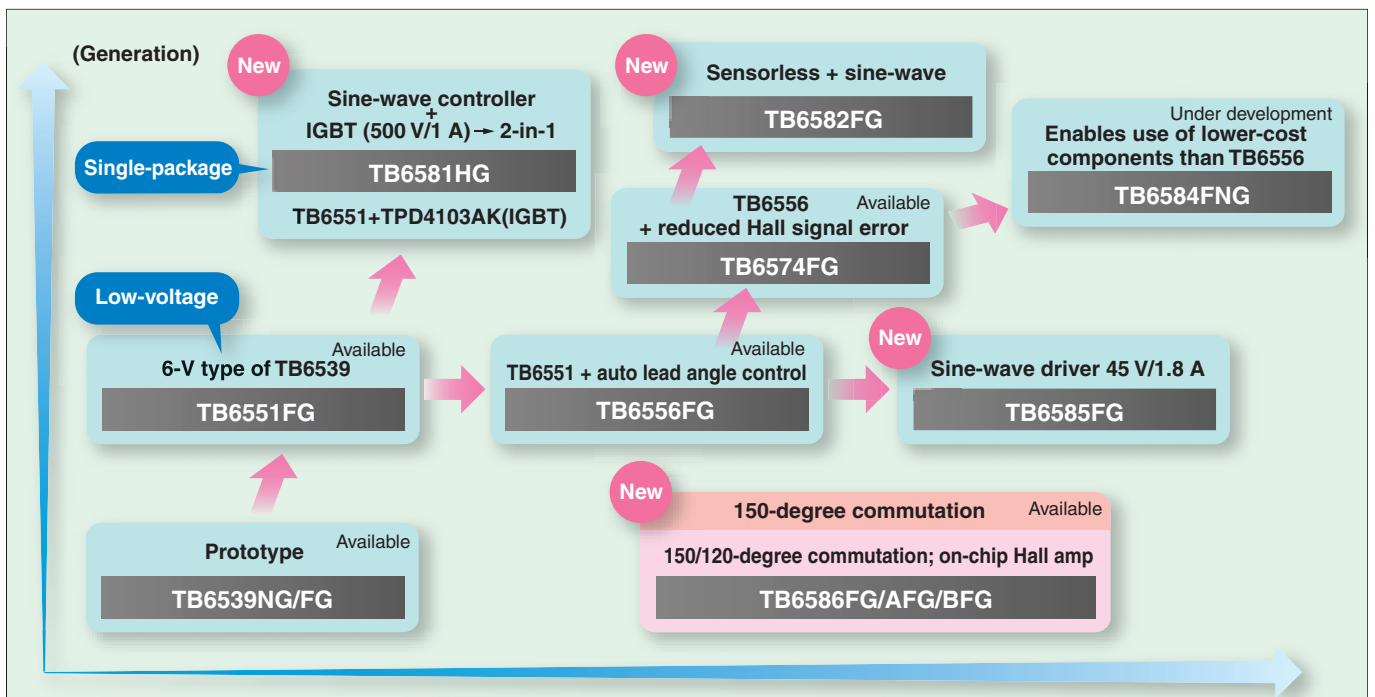


Roadmap for Toshiba's IPD Motor Controllers



Roadmap for Sine-Wave Motor Driver ICs

Toshiba offers a line of three-phase brushless motor drivers that generate a sine wave by hardware.



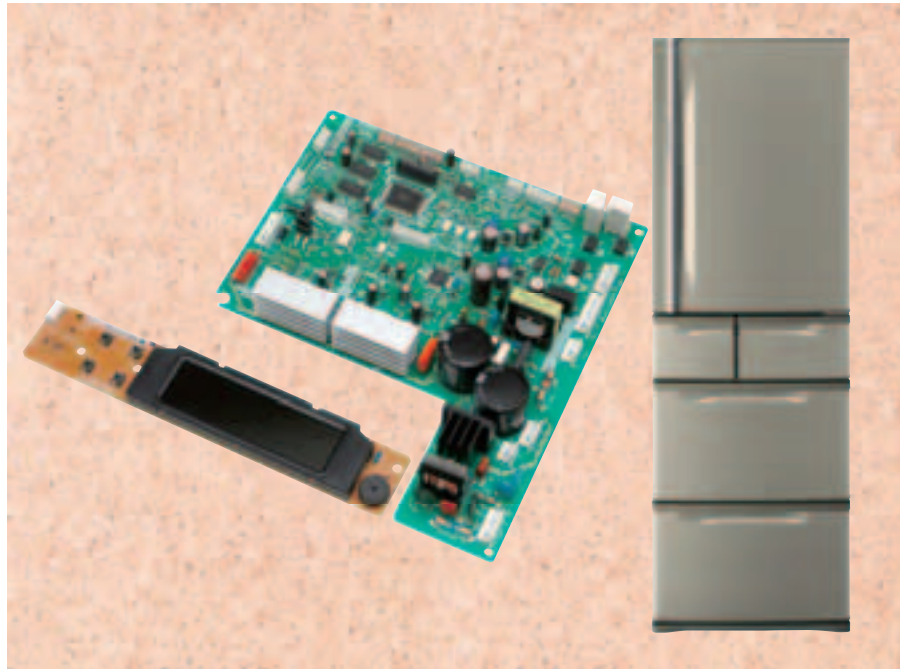
Block Diagram Examples for Home Appliances Using Toshiba's Recommended Semiconductor Devices

Refrigerators

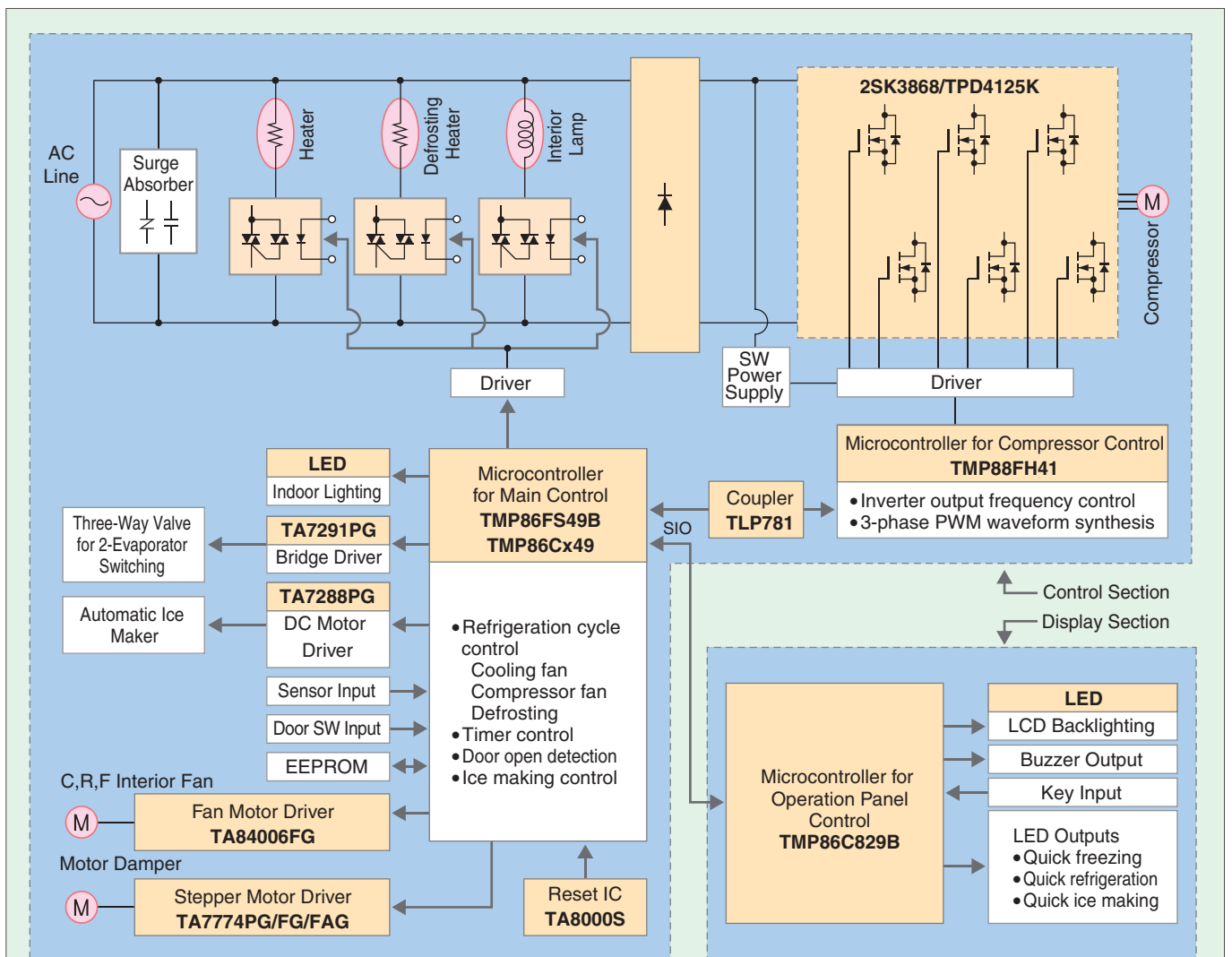
Refrigerators are quite similar to air conditioners, in terms of the purpose their inverter compressor motors serve. However, refrigerators use high-performance microcontrollers and sensors to control internal temperature and humidity. The use of inverter technology helps achieve higher efficiency (energy conservation), lower vibration and lower noise levels.

Benefits of Electronic Design

- Higher efficiency through inverter control
- Temperature control
- Defrosting timer and automatic defrost detection
- Reduced board size for greater interior space
- Individual compartment temperature settings, enabling optimal food storage
- LCD display of operating status



Block Diagram Example

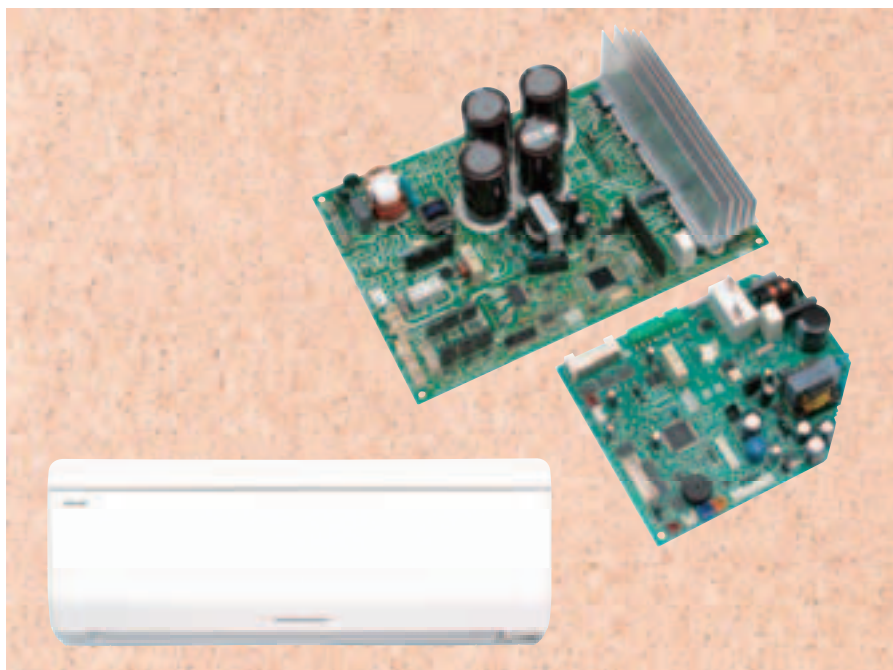


Note: This block diagram serves only as an application example and may not be identical to the specifications of products and boards shown in the photographs.

Block Diagram Examples for Home Appliances Using Toshiba's Recommended Semiconductor Devices

Air Conditioners

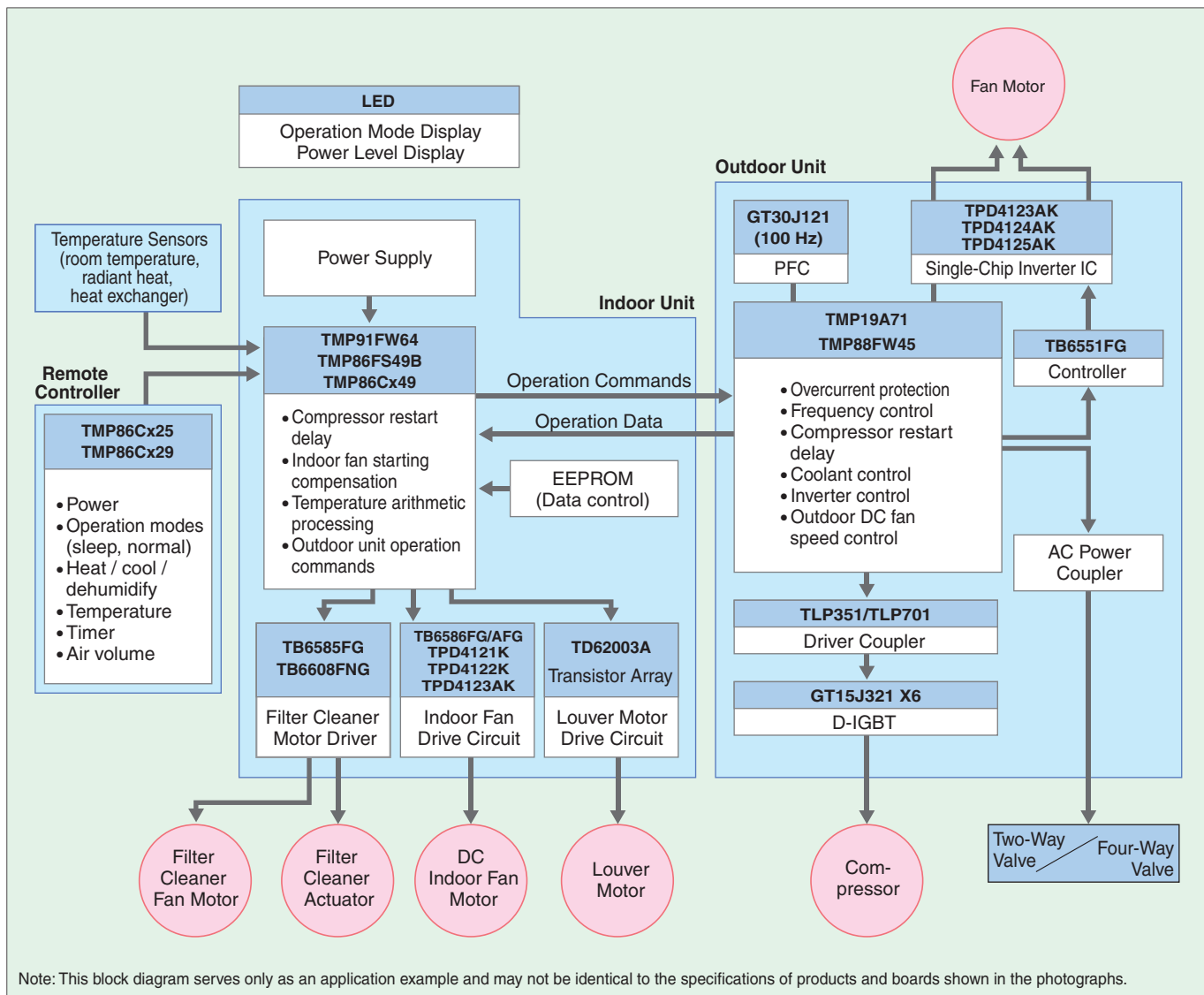
Inverter air conditioners utilize an inverter circuit to drive a compressor motor. For motor control, various semiconductor devices are used, such as microcontrollers, insulated gate bipolar transistors (IGBTs) and photocouplers. Microcontrollers provide overall system control, pulse-width-modulation (PWM) generation and system protection functions. IGBTs and photocouplers reside in the inverter driver circuit and its interface, respectively.



Benefits of Electronic Design

- Higher efficiency through inverter control
- Remote control of air flow directions
- Smaller and slimmer products
- Energy savings through use of DC motors
- Automatic filter cleaning

Block Diagram Example



Note: This block diagram serves only as an application example and may not be identical to the specifications of products and boards shown in the photographs.

Block Diagram Examples for Home Appliances Using Toshiba's Recommended Semiconductor Devices

Automatic Washing Machines (Washer-Dryer Combos)

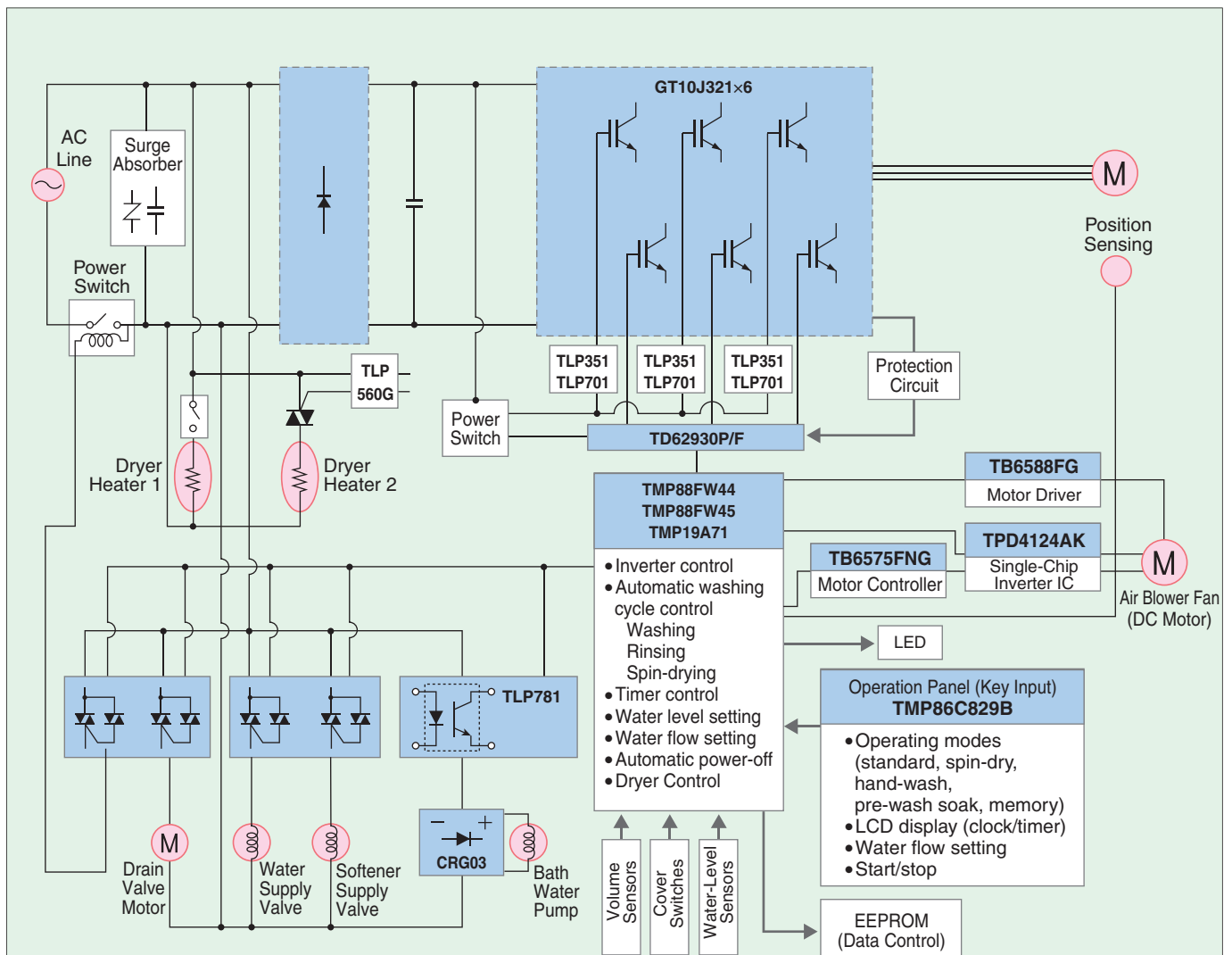
Direct-drive (DD) inverter motors are well suited as the main motor of washing machines. The DD inverter motor helps reduce wash/spin noise and vibration. Use of an inverter motor enables a washing machine to adjust the amount of water to suit the washload. IGBT modules are used for motor drive, and microcontrollers for overall control.

Benefits of Electronic Design

- Energy and water savings plus quiet operation through inverter control
- Integration of washer and dryer functions
- Automatic control of water flow and washing time, according to the type of fabric and washload



Block Diagram Example



Note: This block diagram serves only as an application example and may not be identical to the specifications of products and boards shown in the photographs.

Block Diagram Examples for Home Appliances Using Toshiba's Recommended Semiconductor Devices

Dishwashers

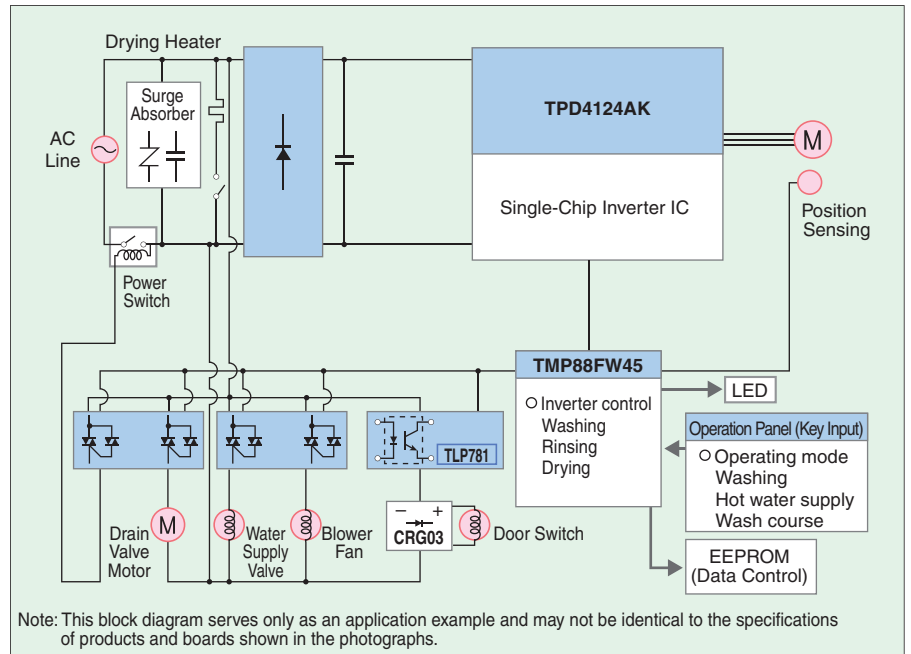
An inverter motor gives a powerful water jet, low vibration and low noise. IGBTs are used for motor drive and microcontrollers for overall control.

Benefits of Electronic Design

- For example, in Japan, electricity costs only two-thirds of town gas that would be consumed for hand-washing.



Block Diagram Example



Block Diagram Examples for Home Appliances Using Toshiba's Recommended Semiconductor Devices

Induction Rice Cookers

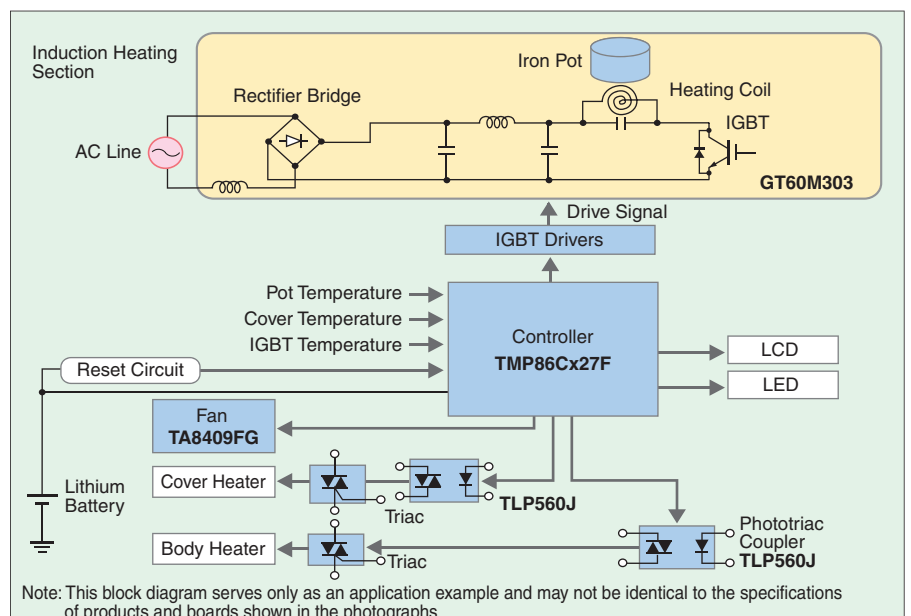
Induction rice cookers use a type of pot specifically designed for induction heating. This allows for quick, yet perfect boiling at high temperatures. IGBTs are used for the induction-heating system. In addition, phototriac couplers are used for the side heater, microcontrollers for overall control, and transistors for driving cooling fans.

Benefits of Electronic Design

- Programmable cook-end time



Block Diagram Example



Block Diagram Examples for Home Appliances Using Toshiba's Recommended Semiconductor Devices

Induction Cooktops

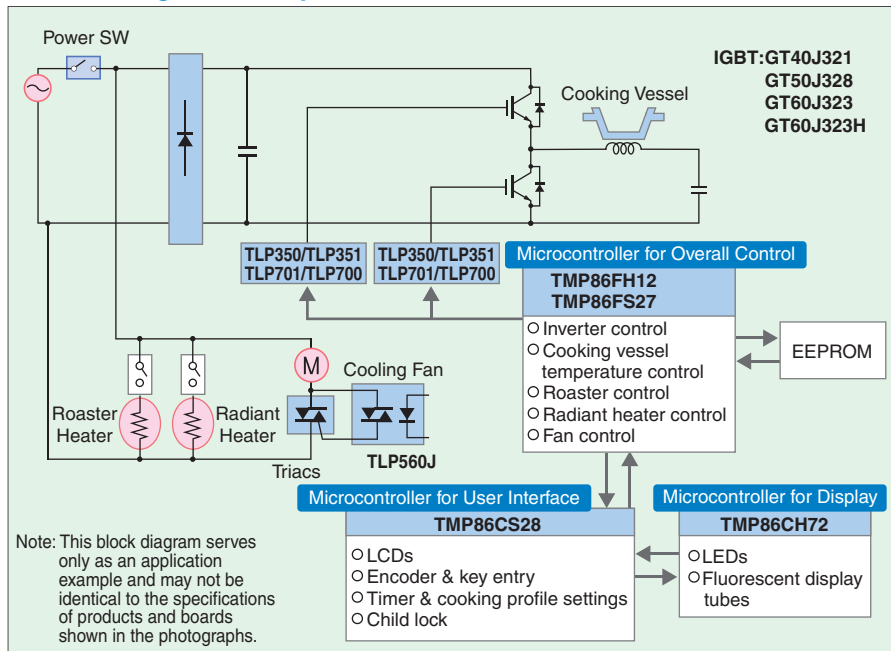
Induction cooktops supply energy directly to the cooking vessel by the magnetic field. Generally, induction cooktops can be used to roast and grill. The heat level can be adjusted from very high to low (simmering) for good cooking. IGBTs are used for induction heaters; microcontrollers for temperature control; and phototriac couplers for cooling fans for control circuitry, etc.

Benefits of Electronic Design

- Safer than traditional stoves because there are no open flames
- Heats cooking vessels evenly and are energy-efficient
- Memory settings for heat levels and cooking times



Block Diagram Example



Block Diagram Examples for Home Appliances Using Toshiba's Recommended Semiconductor Devices

Microwave Ovens

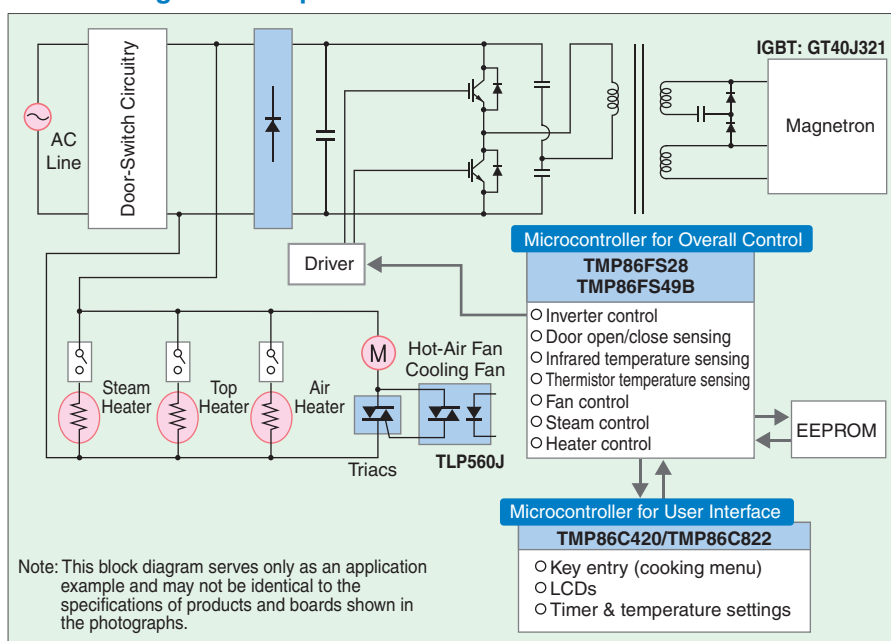
Microwave ovens employ microwave radiation to cook or heat food by moving water, fat and sugar molecules. Recently, superheated steam ovens got much public fanfare. Since they remove excess fat and salt from food, they are popular as a healthier way of cooking. IGBTs are used for driving magnetrons; microcontrollers for controlling the amount of heating; and photocouplers for driving fan motors.

Benefits of Electronic Design

- Inverter control of the heating power
- Automatic cooking with food temperature sensing
- Selectable cooking modes



Block Diagram Example



Block Diagram Examples for Home Appliances Using Toshiba's Recommended Semiconductor Devices

Water Heaters

Water heaters are broadly categorized into gas, electric and solar-powered heaters. Almost the same kinds of semiconductor devices are used in all of them. Hot water is circulated to bathrooms, floor heating systems and so on. The water is adjusted to a temperature specified via a remote controller (PLC communication) by mixing hot and cold water at a mixing valve.

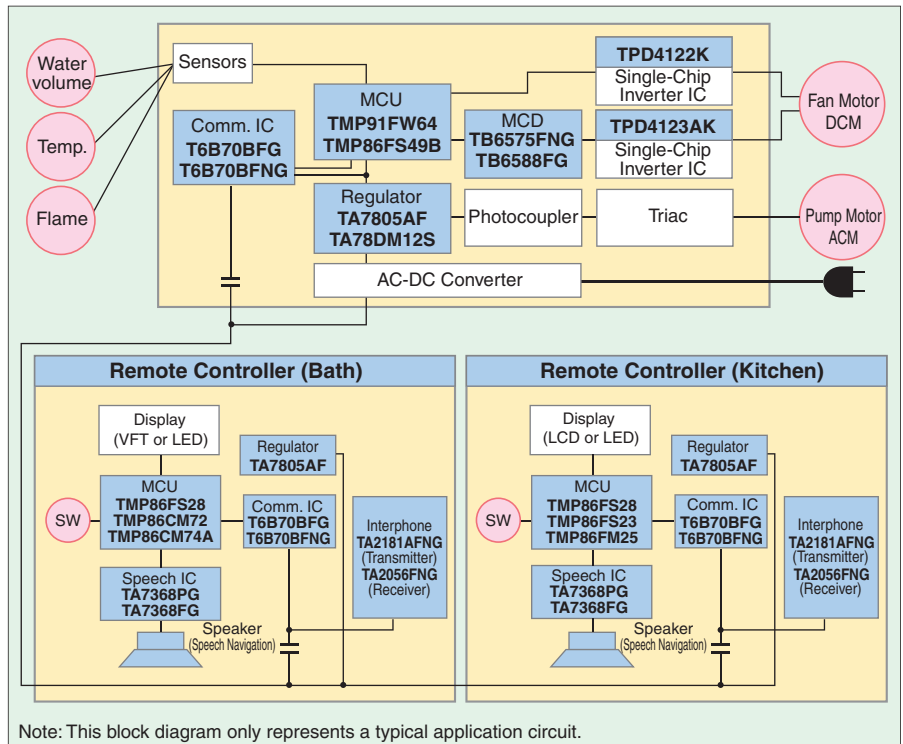
Microcontrollers are used for control of the heater and remote controller; and triacs for the PLC communications IC and pump motors.

PLC: Power-Line-Communication

Benefits of Electronic Design

- Remote control
- Water temperatures can be separately set for the bath, kitchen and so on.
- Automatic bathtub filling, heating and topping-up

Block Diagram Example



Block Diagram Examples for Home Appliances Using Toshiba's Recommended Semiconductor Devices

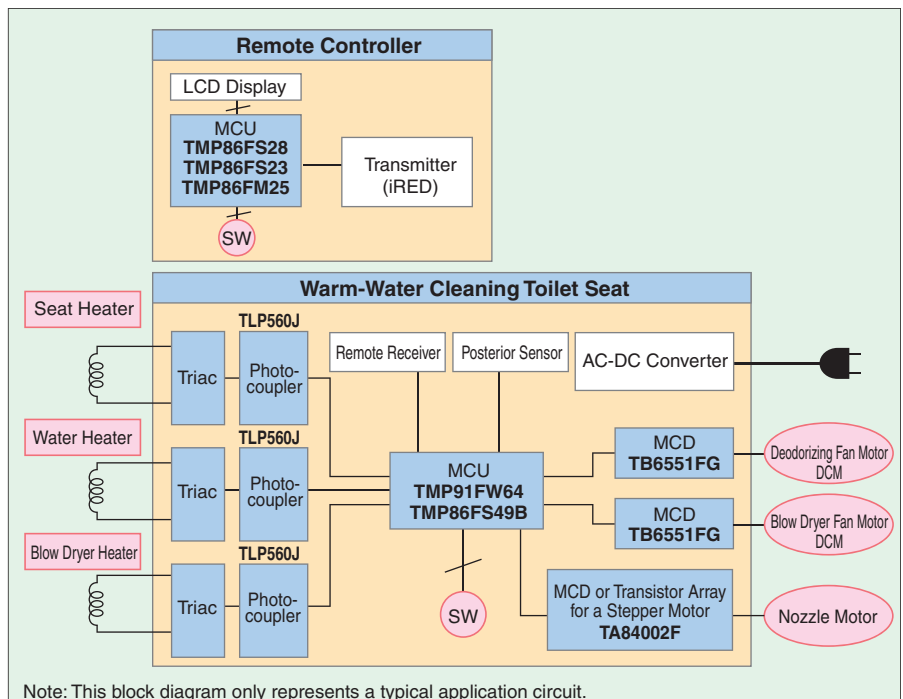
Bidet Toilets (Warm-Water Cleaning Toilet Seats)

The most basic feature of a bidet toilet is that a jet of water cleanses a user of a bidet toilet. The nozzle is also self-cleaning. The advanced features include massage options, which provide a vibrating and pulsating jet of water.

Benefits of Electronic Design

- Automatic cleansing of a toilet bowl after use
- Automatic lid opening and closing
- Automatic air deodorizing

Block Diagram Example



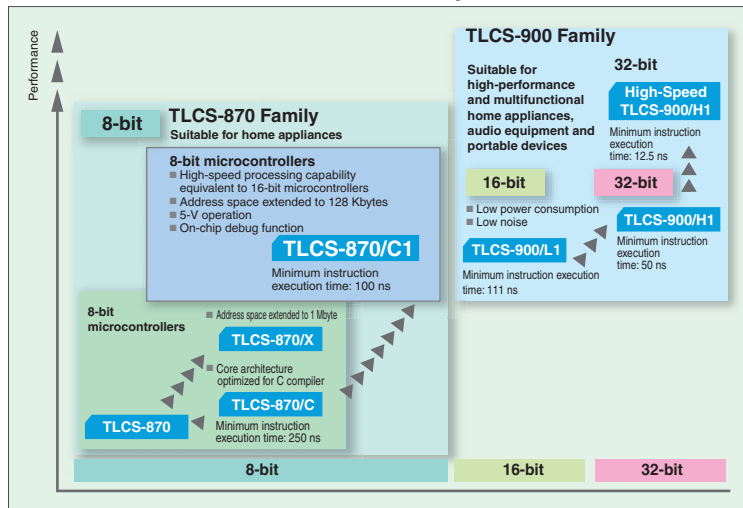
Microcontrollers

8-Bit Microcontrollers TLCS-870/C1 Series

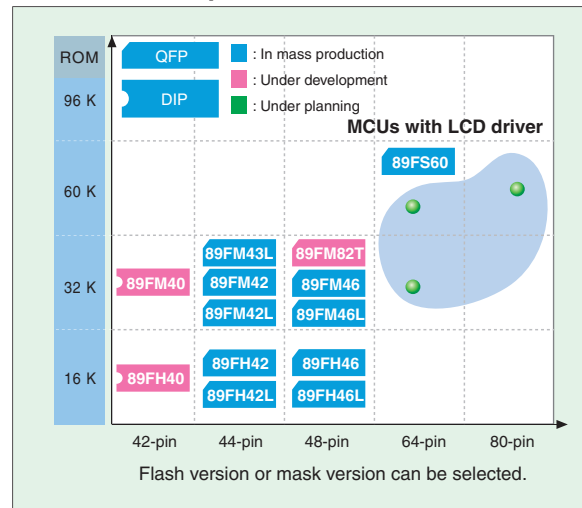
Realizing processing capability equivalent to 16-bit microcontrollers and memory address space extendable up to 128 Kbytes

Toshiba has newly developed TLCS-870/C1 Series of 8-bit microcontrollers that deliver high-speed processing capability equivalent to 16-bit microcontrollers. The TLCS-870/C1 Series achieves high-speed processing capability at low internal clock frequencies by operating one instruction cycle in a single clock cycle. Toshiba's proprietary memory segment method allows addressing up to 128 Kbytes of memory address space.

Toshiba Microcontroller Core Lineup



Series Road Map



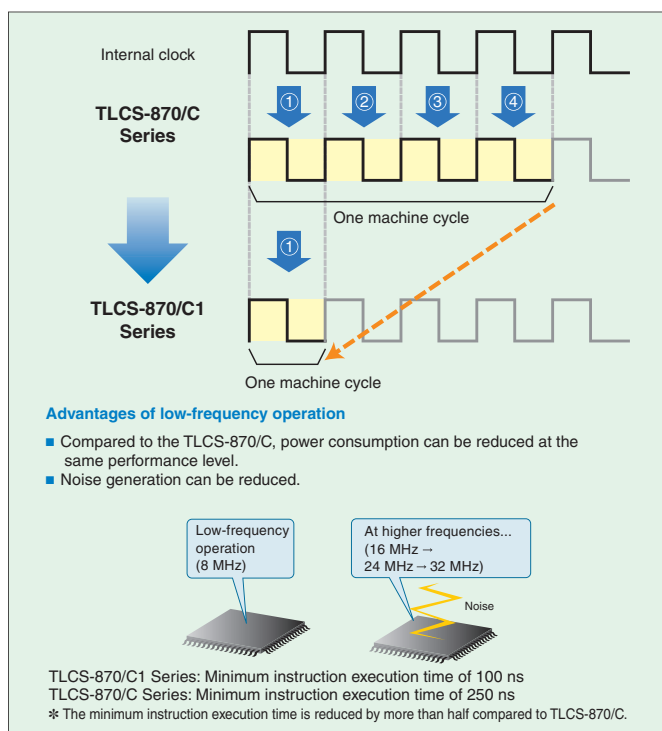
Features of TLCS-870/C1 Series

The new 8-bit CPU core delivering high-speed processing capability and memory address space extension, while offering instruction code compatibility with TLCS-870/C

High-speed processing at a low clock frequency

One instruction cycle operated in a single clock cycle

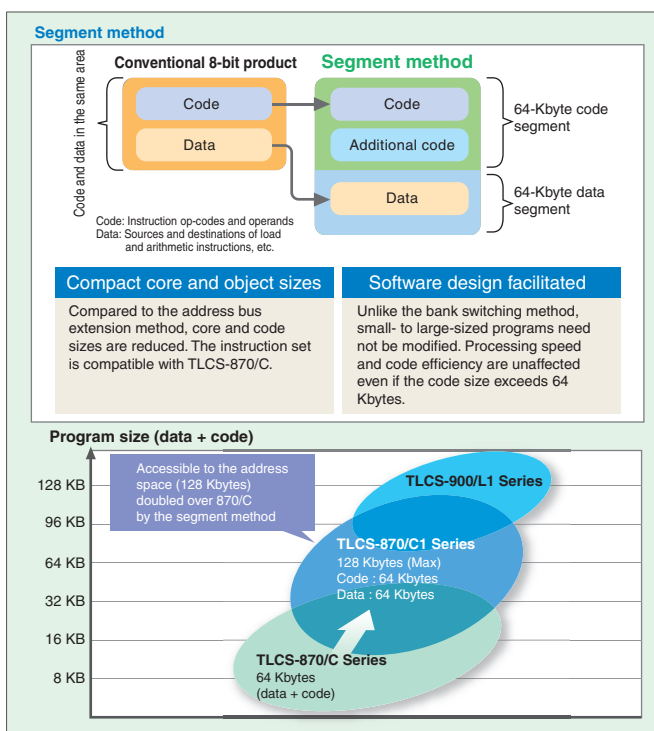
The core architecture is configured to reduce the number of clock cycles required to complete one machine cycle to a single clock cycle. This achieves processing performance four times that of TLCS-870/C Series at the same internal clock frequency.



Address space extendable to 128 Kbytes

Toshiba's proprietary memory management method (segment method) **NEW**

Toshiba's proprietary memory segment method manages instruction codes and data independently in separate memory address spaces. This new method enables memory address space extension without affecting processing speed or code efficiency for small- to large-sized programs exceeding 64 Kbytes.



Microcontrollers

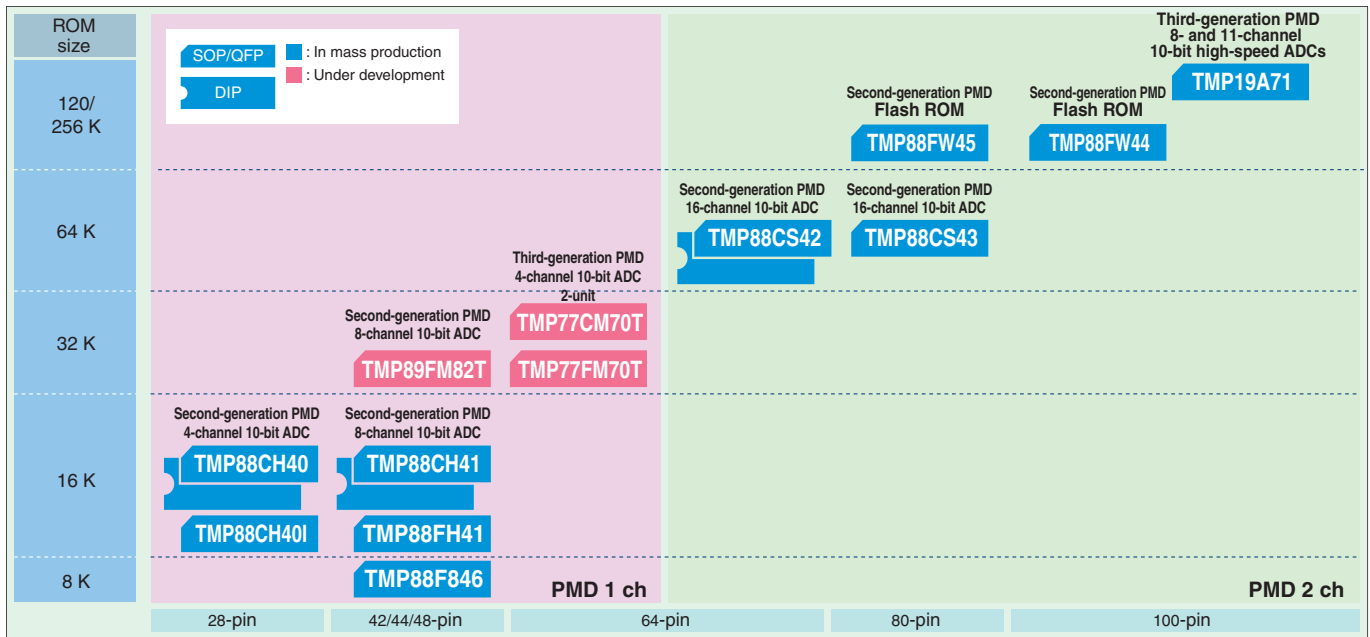
Microcontrollers with motor control circuit (PMD)

These microcontrollers with a motor control circuit incorporate an inverter control function for 3-phase DC and AC motors. The motor control circuit supports hardware configuration where motor drive signals are linked with feedback signals from the motor, thus controlling the motor with less load imposed on the CPU. The lineup includes a variety of microcontrollers supporting 120-degree commutation and vector control.

Main functions

- Sine wave drive
- Rotor position detection function
- Motor control timer and timer capture
- PWM waveform generation function
- Overload protection function
- Abnormality protection function
- Automatic commutation start and automatic position detection start
- AD converter trigger generation function

Microcontrollers with motor control circuit (PMD)



* PMD: Programmable Motor Driver

Product lineup

Series Name	Part Number	Flash	ROM (bytes)	RAM (bytes)	I/O	PMD (channel)	Additional Functions	Supply Voltage (V)	Version with OTP/Flash	Package	
870/X	TMP88F846UG	●	8 K		33	1	<ul style="list-style-type: none"> ● Power-on-reset circuit ● Voltage detector circuit ● Built-in oscillator (20 MHz) ● 10-bit AD converter ● UART/SIO 	4.5 to 5.5	–	LQFP44 (10 x 10 mm)	
	TMP88CH40NG/MG			512	19		<ul style="list-style-type: none"> ● 10-bit AD converter ● UART/SIO 		TMP88PH40NG/MG	SDIP28/SOP28	
	TMP88CH40IMG								TMP88PH40MG	SOP28	
	TMP88CH41NG/UG		16 K						TMP88PH41NG/UG	SDIP42/LQFP44 (10 x 10 mm)	
	TMP88FH41UG	●				33	<ul style="list-style-type: none"> ● Power-on-reset circuit ● Voltage detector circuit ● 10-bit AD converter ● UART/SIO 	–	–	LQFP44 (10 x 10 mm)	
	TMP88CS42NG/FG			64 K	2 K	55	2	<ul style="list-style-type: none"> ● 10-bit AD converter ● UART ● SIO ● PWM 	4.5 to 5.5	TMP88PS42NG/FG	SDIP64/QFP64 (14 x 20 mm)
	TMP88CS43FG				71	TMP88PS43FG				QFP80 (14 x 20 mm)	
		TMP88FW44FG	●	120 K	4 K	91	2	<ul style="list-style-type: none"> ● 10-bit AD converter ● UART ● SIO ● PWM 	4.5 to 5.5	–	–
	TMP88FW45FG	●	120 K	4 K	71	2	<ul style="list-style-type: none"> ● 10-bit AD converter ● UART ● SIO ● PWM 	4.5 to 5.5	–	–	QFP80 (14 x 20 mm)
870/C1	TMP89FM82TDUG☆	●	32 K	2 K	39	1	<ul style="list-style-type: none"> ● 10-bit AD converter ● UART ● SIO ● SEI 	4.5 to 5.5	–	–	LQFP48 (7 x 7 mm)
770	TMP77CM70TUG☆		32 K	1 K	18	1	<ul style="list-style-type: none"> ● 10-bit AD converter ● UART/SIO 	Internal: 3.0 to 3.6 I/O: 4.5 to 5.5	TMP77FM70TUG☆	LQFP64 (10 x 10 mm)	
TX19A	TMP19A71CYUG/FG		256 K	10 K	75	2	<ul style="list-style-type: none"> ● 10-bit AD converter ● UART/SIO ● PWM ● Encoder input 	3.0 to 3.6	TMP19A71FYUG/FG	LQFP100 (14 x 14 mm)/ QFP100 (14 x 20 mm)	

* Some of the flash memories use the SuperFlash® technology under the license of Silicon Storage Technology, Inc. SuperFlash® is a registered trademark of Silicon Storage Technology, Inc. ☆: Under development

Microcontrollers for Home Appliances

Product Offerings

The following tables show microcontrollers suitable for home appliances. In addition to those listed below, Toshiba offers a wide range of microcontrollers with a variety of on-chip peripherals. For details, please refer to the *Microcomputer Product Guide*.

Note: "x" in part numbers indicates the ROM size: 4 for 4 Kbytes, 8 for 8 Kbytes, C for 12 Kbytes, H for 16 Kbytes, K for 24 Kbytes, M for 32 Kbytes, P for 48 Kbytes, S for 60 or 64 Kbytes and W for 128 Kbytes.

General-Purpose Microcontrollers

	Part Number	ROM/RAM (Bytes)	Features	Number of I/O Ports	Power Supply Voltage (V)	Operating Temperature (°C)	Package
870/C Core	TMP86F409 TMP86F809 TMP86FH09A	4 K/512, 8 K/512, 16 K/512	Flash ROM; UART x 1 ch; SEI x 1 ch; 10-bit AD x 6 ch; 8-bit timer x 2 ch; 16-bit timer x 1 ch; key-on wakeup	26	2.7 to 5.5	-40 to 85	SDIP32
	TMP86FH92/93	16 K/256	Flash ROM; UART x 2 ch; SEI; I ² C; 10-bit AD x 6 ch; 8-bit timer x 2 ch; 16-bit timer x 1 ch; LVD/POR	24/26			SSOP30/ SDIP32
	TMP86Cx46/47	8 K/512 16 K/512 32 K/1 K	SIO; UART; 10-bit AD x 8 ch; 16-bit timer x 1 ch; 8-bit timer x 2 ch; high-current ports x 19 pins	33/35	1.8 to 5.5		SDIP42/ LQFP44
	TMP86FH46A/47A	16 K (Flash)/512			2.7 to 5.5		
	TMP86Cx49	16 K/512 32 K/1 K 60 K/2 K	HSIO x 2 ch; UART x 2 ch; I ² C x 1 ch; 10-bit AD x 16 ch; 16-bit timer x 2 ch; 8-bit timer x 4 ch	56	1.8 to 5.5		LQFP64/ QFP64
	TMP86FS49B	60 K (Flash)/2 K			2.7 to 5.5		
870/C1 Core	TMP89FM43LQG	16 K/2 K 32 K/2 K	Flash ROM; UART/SIO x 1 ch; UART x 1 ch; SIO x 1 ch; 10-bit AD x 8 ch; 16-bit timer x 2 ch; 8-bit timer x 4 ch; high-current ports	36	2.2 to 3.6	VQON44	
	TMP89Fx42			38	2.7 to 5.5	LQFP44	
	TMP89Fx46			40		LQFP48	
	TMP89Fx60	60 K/3 K	Flash ROM; UART/SIO x 1 ch; UART x 1 ch; SIO x 1 ch; 10-bit AD x 8 ch; 16-bit timer x 2 ch; 8-bit timer x 4 ch; high-current ports	56		QFP64/ LQFP64	
900/L1 Core	TMP91FW64	128 K/8 K	UART/SIO x 3 ch; I ² C x 2 ch, 10-bit AD x 16 ch; 8-bit timer x 6 ch; 16-bit timer x 5 ch; 32-kHz timer for software RTC; ROM patch x 6 banks; Flash ROM	83	4.5 to 5.5	QFP100/ LQFP100	
	TMP91FU62	96 K/4 K	Flash ROM; 16-bit 900/L1 core; UART/SEI x 3 ch; I ² C x 1 ch; 10-bit AD x 16 ch; 8-bit timer x 4 ch; 16-bit timer x 4 ch; 32-bit timer for software RTC; ROM patch	71		QFP80/ LQFP80	

Microcontrollers with an LCD Driver

	Part Number	ROM/RAM (Bytes)	Features	Number of I/O Ports	Power Supply Voltage (V)	Operating Temperature (°C)	Package
	TMP86Cx29B	8 K/512 16 K/1.5 K 32 K/1.5 K	LCD driver (32 to 8 segment pins & 4 common pins); SIO; UART; 10-bit AD x 8 ch; 18-bit timer x 1 ch; 8-bit timer x 4 ch; high-current ports x 4 pins	39	1.8 to 5.5	-40 to 85	QFP64/ LQFP64
	TMP86FM29	32 K/1.5 K			1.8 to 3.6		
	TMP86Cx27	32 K/1 K 48 K/1 K	LCD driver (40 to 8 segment pins & 4 common pins); IGBT control timer x 1 ch; SIO; UART; 10-bit AD x 8 ch; 8-bit timer x 2 ch; high-current ports x 8 pins	55	2.7 to 5.5	-40 to 85	QFP80
	TMP86FS27	60 K (Flash)/1 K					
	TMP86CS28	60 K/2 K	LCD driver (40 to 1 segment pins & 4 common pins); UART/SIO x 1 ch; UART x 1 ch; 8-bit timer x 4 ch; 16-bit timer x 2 ch; 10-bit AD x 8 ch	62		-40 to 85	QFP80/ LQFP80
	TMP86FS28	60 K (Flash)/2 K					
	TMP86Cx25	32 K/2 K 60 K/2 K	LCD driver (60 segment pins & 4, 8 or 16 common pins); UART/SIO x 1 ch; SIO; 8-bit AD x 8 ch; 18-bit timer x 1 ch; 8-bit timer x 4 ch; high-current ports x 4 pins	42	1.8 to 5.5	-40 to 85	QFP100
	TMP86FM25	32 K (Flash)/2 K			1.8 to 3.6		

Microcontrollers for Static Inverters

	Part Number	ROM/RAM (Bytes)	Features	Number of I/O Ports	Power Supply Voltage (V)	Operating Temperature (°C)	Package
	TMP86CH12	16 K/512	UART x 1 ch; SIO x 1 ch; 10-bit AD x 8 ch; IGBT timer x 1 ch; 16-bit timer x 1 ch; 8-bit timer x 2 ch	22	2.7 to 5.5	-40 to 85	SSOP30
	TMP86FH12	16 K (Flash)/512					
	TMP86Cx27	32 K/1 K 48 K/2 K	40 to 8 x 4 com; UART x 1 ch; SIO x 1 ch; 10-bit AD x 8 ch; IGBT timer x 1 ch; 8-bit timer x 2 ch	55			QFP80

Motor Drivers for Home Appliances

Motors are commonly used in home appliances. Traditional AC motors are being replaced by DC motors, which are favorable in terms of control characteristics and efficiencies. Toshiba offers various motor controllers and drivers for brushed DC motors, 3-phase brushless motors, stepper motors and solenoids.

For details, please refer to the *Toshiba Semiconductor System Catalog for Motors and Mechatronics*.

Applications		Part Number	Features	
Refrigerators	Cooling fans	TA7262FG	3-phase brushless motor driver; 25 V/1.5 A	
		TA8492PG	3-phase brushless motor driver; 25 V/1.5 A; shrink version of TA7262P	
		TB6537PG/FG	3-phase PWM sensorless motor controller; 5.5 V/20 mA	
		TB6548FG+TA84005FG	3-phase PWM sensorless motor controller/driver; 25 V/1.0 A	
		▲TB6575FNG	3-phase PWM sensorless motor controller; 5.5 V/20 mA	
	Automatic ice makers	TA7291P/FG/SG	Bridge motor driver; 25 V/2 A (1.2 A)	
		TA8409FG/SG	Bridge motor driver; 25 V/1 A	
	Switching valves	TA7774PG/FG/FAG	Stepper motor driver; 17 V/0.4 A	
	Air Conditioners	Indoor fans	TB6520PG+TA8483CP	3-phase sensorless motor controller/driver; 35 V/2.0 A
TB6539NG/FG			Sine-wave PWM motor controller; 18 V/20 mA	
TB6551FG			Sine-wave PWM motor controller; 12 V/2 mA	
▲TB6556FG			Sine-wave PWM motor controller with an auto lead angle control function; 12 V/2 mA	
▲TB6586FG/AFG			PWM motor controller for 150° commutation; 16.5 V/3 mA	
▲TB6582FG			Sensorless sine-wave PWM motor controller; 16.5 V/2 mA	
☆TB6584FNG			Sine-wave PWM motor controller with an auto lead angle control function; 16.5 V/2 mA	
Outdoor fans		TB6539NG/FG	Sine-wave PWM motor controller; 18 V/20 mA	
		TB6551FG	Sine-wave PWM motor controller; 12 V/2 mA	
		▲TB6556FG	Sine-wave PWM motor controller with an auto lead angle control function; 12 V/2 mA	
		▲TB6581HG	Sine-wave PWM motor driver; 500 V/1.0 A	
		▲TB6582FG	Sensorless sine-wave PWM motor controller; 16.5 V/2 mA	
		☆TB6584FNG	Sine-wave PWM motor controller with an auto lead angle control function; 16.5 V/2 mA	
Louvers		TA84002FG	2-phase bipolar stepper motor driver; 35 V/1 A	
Filter cleaning		Actuator	▲TB6608FNG	2-phase bipolar microstepping motor driver; 15 V/0.8 A
		Fan	▲TB6585FG	Sine-wave PWM motor driver; 45 V/1.8 A
Dishwashers		Pumps	▲TB6575FNG	3-phase PWM sensorless motor controller; 5.5 V/20 mA
Washing Machines	Drying fans	▲TB6575FNG	3-phase PWM sensorless motor controller; 5.5 V/20 mA	
		▲TB6588FG	3-phase PWM sensorless motor driver; 50 V/2.5 A	
Ventilators	Fan	▲TB6585FG	Sine-wave PWM motor driver; 45 V/1.8 A	

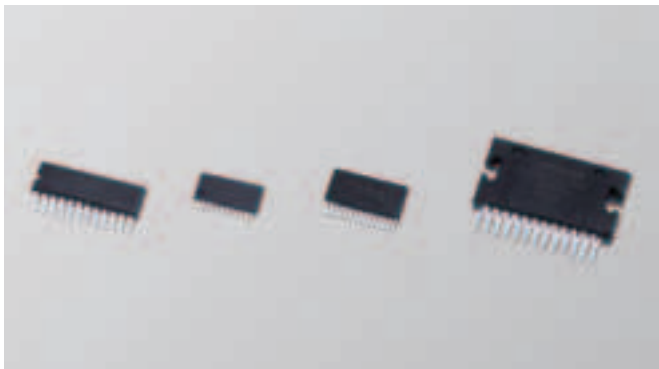
▲: New product ☆: Under development

3-Phase Full-Wave Sine-Wave PWM Brushless Motor Controllers

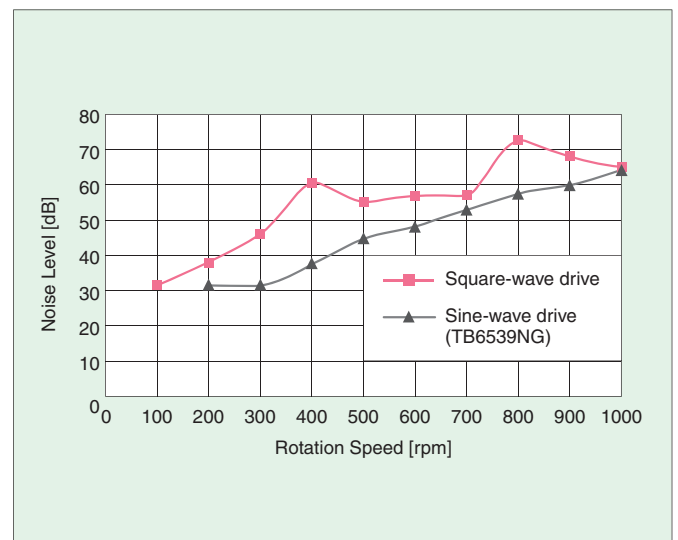
Overview

The TB6539NG/FG, TB6551FG, TB6556FG and TB6581HG are 3-phase, full-wave brushless motor controllers.

Sine-wave drive provides quiet motor operation. In addition, the use of lead angle and PWM control enables high-efficiency drive.



TB6539NG noise test result (Presented only as a guide)



Motor Driver IPDs

Part Number	Ratings	Functions							Package
		Hall Sensor Inputs	6 Inputs	3-Phase Distribution/PWM Circuit	Level-Shift Drivers	Overcurrent Protection	Thermal Shutdown	Undervoltage Protection	
TPD4121K	250 V/1 A	Y	-	Y	Y	Y	Y	Y	DIP26
TPD4122K	500 V/1 A	Y	-	Y	Y	Y	Y	Y	DIP26
TPD4123K	500 V/1 A	-	Y	-	Y	Y	Y	Y	DIP26
TPD4123AK	500 V/1 A	-	Y	-	Y	-	Y	Y	DIP26
TPD4124K	500 V/2 A	-	Y	-	Y	Y	Y	Y	DIP26
TPD4124AK	500 V/2 A	-	Y	-	Y	-	Y	Y	DIP26
TPD4125K	500 V/3 A	-	Y	-	Y	Y	Y	Y	DIP26
TPD4125AK	500 V/3 A	-	Y	-	Y	-	Y	Y	DIP26
TPD4111K	250 V/1 A	Y	-	Y	Y	Y	Y	Y	HZIP23
TPD4112K	500 V/1 A	Y	-	Y	Y	Y	Y	Y	HZIP23
TPD4113K	500 V/1 A	-	Y	-	Y	Y	Y	Y	HZIP23
TPD4113AK	500 V/1 A	-	Y	-	Y	-	Y	Y	HZIP23
TPD4110AK	500 V/2 A	-	Y	-	Y	-	Y	Y	HZIP23
TPD4104K	500 V/2 A	-	Y	-	Y	Y	Y	Y	HZIP23
TPD4104AK	500 V/2 A	-	Y	-	Y	-	Y	Y	HZIP23
TPD4105K	500 V/3 A	-	Y	-	Y	Y	Y	Y	HZIP23
TPD4105AK	500 V/3 A	-	Y	-	Y	-	Y	Y	HZIP23

Peripheral ICs and Sensors

Toshiba offers a complete line of peripheral ICs for various home appliances.

Communication ICs for Water Heaters

Part Number	Package	Application Examples	Operating Voltage (V)	Features
T6B70BFG	SOP16	Water heaters	4.5 to 5.5	Communications between water heater and control unit DC power line carrier communications Pseudo-sine-wave generation Detection of an external carrier signal
T6B70BFNG	SSOP16	Water heaters	4.5 to 5.5	Smaller package version of T6B70BFG

Magnetic Sensors with a Digital Output

Part Number	Polarity	Output Configuration	Package	Application Examples	Magnetic Flux Density B _{ON} / B _{OFF} (Typ.)	Features
TCS10SPU	S	Push-pull	UFV	Appliances with doors or lids such as refrigerators and washing machines	1.8 mT / 0.8 mT	Highly sensitive (Magnetic flux density B _{ON} = 1.8 mT typ.) Low current consumption (5.5 μA typ. @ V _{CC} = 2.5 V, TCS10SPU)
TCS10SLU		Open-drain				
TCS11SLU		Inverted output; open-drain				
TCS10NPU	N	Push-pull				
TCS10NLU		Open-drain				
TCS11NLU		Inverted output; open-drain				
TCS10DPU	S and N	Push-pull				
TCS10DLU		Open-drain				
TCS11DLU		Inverted output; open-drain				

Discrete Devices for Inverter Home Applications

Power Drivers

Inverter Output IGBTs

Discrete IGBTs for inverters with built-in emitter-to-collector free-wheel diode

Part Number	I _c (A)	V _{CE(S)} (V)	V _{CE(sat)} (Max)	(V)	Package
				I _c (A)	
GT10J321	10	600	2.45	10	TO-220NIS
GT15J321	15	600	2.45	15	TO-220NIS
GT20J321	20	600	2.45	20	TO-220NIS

Power MOSFETs for Inverters

- Carrier lifetime control for improving intrinsic diode speed (HSD Series: $t_{rr} \approx 100$ ns, conventional series: $t_{rr} \approx 500$ ns)
- Improved trade-offs between ON resistance and leakage current, thanks to design optimization

Part Number	Ratings		Characteristics		Package
	V _{DSS} (V)	I _D (A)	R _{DS(ON)} (Ω) Max	t _{rr} (ns) Typ.	
2SK3868	500	5	1.7	150	TO-220SIS
2SK3313	500	12	0.62	90	TO-220NIS
2SK3314	500	15	0.49	105	TO-3P(N)
2SK3936	500	23	0.25	380	TO-3P(N)
2SK3131	500	50	0.11	105	TO-3P(L)
2SK3947	600	6	1.4	150	TO-220SIS
2SK4015	600	10	0.86	170	TO-220SIS
2SK4016	600	13	0.50	160	TO-220SIS
2SK3906	600	20	0.33	400	TO-3P(N)

Photocouplers

Photocouplers (Transistor Output)

Part Number	Features	Current Transfer Ratio (%)	V _{CEO} (V)	Isolation Voltage (@ 1 minute)(Vrms)
TLP781	4-pin DIP	See right-side table.	80	5000
TLP181	6-pin MFSOP	See right-side table.	80	3750

Current Transfer Ratio(%)			
Rank	Min	Max	@ I _F , V _{CE}
-	50	600	5 mA, 5 V
Y	50	150	
GR	100	300	
BL	200	600	
GB	100		
YH	75	150	
GRL	100	200	
GRH	150	300	
BLL	200	400	

Photocouplers (IC Output)

Part Number	Features	Propagation Delay Time (Max)	Peak output current (Max)	I _{FHL} (Max)	V _{CC} (V)	Isolation Voltage (@ 1 minute)(Vrms)
TLP701	6-pin SDIP, Direct drive of a small-power IGBT/MOSFET	0.7	±0.6 A	5	10 to 30	5000
TLP351	8-pin DIP, Direct drive of a small-power IGBT/MOSFET	0.7	±0.6 A	5	10 to 30	3750
TLP700	6-pin SDIP, Direct drive of a medium-power IGBT/MOSFET	0.5	±2.0 A	5	15 to 30	5000
TLP350	8-pin DIP, Direct drive of a medium-power IGBT/MOSFET	0.5	±2.5 A	5	15 to 30	3750

Photocouplers (Triac Output)

Part Number	Features	Peak Off-State Voltage (V)	On-State Current (A)	Peak Nonrepetitive Surge Current (A)	Max. Trigger LED Current (mA)	Isolation Voltage (@ 1 minute)(Vrms)
TLP560J	6-pin DIP	600	0.1	1.2	10 or 7	2500
TLP561J	6-pin DIP, Zero cross	600	0.1	1.2	10 or 7	2500
TLP360J	4-pin DIP	600	0.1	1.2	10 or 7	5000
TLP361J	4-pin DIP, Zero cross	600	0.1	1.2	10 or 7	5000
TLP666L(S)	6-pin DIP, Zero cross	800	0.1	1.2	10	5000
TLP669L(S)	6-pin DIP, Zero cross	800	0.1	1.2	10 or 5	5000

Output Interfaces

Transistor Arrays

Toshiba's transistor arrays have a proven track record as drivers of inductive loads (relays, solenoids and stepper motors), capacitive loads, LED lamps and so on. Transistor arrays are available with various functions, voltage and current ratings, packages and so on for a wide range of applications. Small surface-mount packages help reduce system size and weight.

Applications	Function	Recommended Parts	
Air conditioners	Stepper motors	TD62003APG/AFG	TD62004APG/AFG
	Relays	TD62083APG/AFG/AFNG	TD62084APG/AFG/AFNG
	LEDs	TD62308APG/AFG	
	IGBT gate drivers	TD62930FG	
Oil fan heaters	Level shifters	TD62503, 504FG/FNG	
	Triac couplers	TD62783, 784AFG/AFNG	TD62083, 084AFG/AFNG
Bidet toilets	Stepper motors	TD62308AFG	TD62064APG/AFG
		TD62308BFG	TD62064BFG
Washing machines	LEDs	TD62783APG/AFG/AFNG	TD62083APG/AFG/AFNG
	Level shifters	TD62503, 504PG/FG/FNG	
	IGBT gate drivers	TD62930FG	
Cloth dryers	Triac couplers	TD62783, 784AFG/AFNG	TD62083, 084AFG/AFNG
Refrigerators	Triac couplers	TD62783, 784APG/AFG/AFNG	TD62083, 084APG/AFG/AFNG
Vacuum cleaners	Triac couplers	TD62783, 784AFG/AFNG	TD62083, 084AFG/AFNG
Water heaters	Relays	TD62387AFG/AFNG	TD62083AFG/AFNG
	Sensor drivers	TD62783, 784AFG/AFNG	TD62785FG
Microwave ovens	Lamps, LEDs	TD62003, 004APG/AFG	
	Triac couplers	TD62783, 784AFG/AFNG	TD62083, 084AFG/AFNG

Power Drivers

IGBTs for Induction Cookers and Microwave Ovens

	AC Input Voltage (V)	Part Number	V _{CE(S)} (V)	I _C (A)	FRD	V _{CE(sat)} Typ. (V)	t _r Typ. (μs)	Package
Voltage Resonance	100 V	GT50M322	900	50	Y	2.1	0.25	TO-3P(N)
		GT50N322A	1000	50	Y	2.2	0.10	TO-3P(N)
	220 V	GT40Q321	1200	42	Y	2.8	0.41	TO-3P(N)
Current Resonance	220 V	GT35J321	600	37	Y	1.9	0.19	TO-3P(N)IS
		GT40J321	600	40	Y	2.1	0.15	TO-3P(N)
		GT40J322	600	40	Y	2.0	0.24	TO-3P(N)
		GT50J328	600	50	Y	2.0	0.10	TO-3P(N)
		GT60J323	600	60	Y	1.9	0.16	TO-3P(LH)
		GT60J323H	600	60	Y	2.1	0.12	TO-3P(LH)

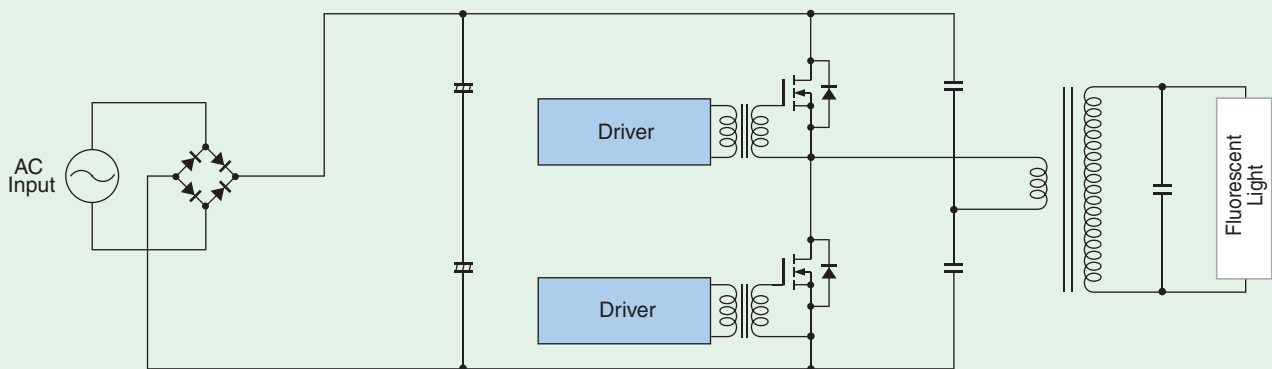
Fast-Switching IGBTs for Power Factor Correction (PFC)

Part Number	V _{CES} (V)	I _c (A)	P _c (W)	V _{CE(sat)} Max	(V)	t _r (ns) Typ.	FRD	Package
					I _c (A)			
GT20J321	600	20	45	2.45	20	40	Y	TO-220NIS
GT30J121		30	170		30	50	-	TO-3P(N)
GT30J324		30	170		30	50	Y	TO-3P(N)
GT50J325		50	240		50	50	Y	TO-3P(LH)
GT50J121		50	240		50	50	-	TO-3P(LH)

Power MOSFETs for Inverter Lighting Applications

Input	Fluorescent Light	Peak Drain Current I _{DP} (A) (Intended only as a guide)	Part Number
AC 100 V	Bulb-shaped fluorescent lamp	0.7 A	2SK3462, 2SJ610, 2SK3342, 2SJ512
	32 W	1.2 A	2SK3563, 2SK4103
	32 W + 40 W	2.6 A	2SK3563, 2SK4103
	32 W x 3 lights	3.5 A	2SK3561, 2SK3568, TK8A50D, TK12A50D
	32 W x 4 lights	4.6 A	2SK3934, TK15A50D
AC 200 V	32 W	0.7 A	2SK3767, 2SK4002
	32 W + 40 W	1.3 A	
	32 W x 3 lights	1.8 A	2SK3567, 2SK4003

< Circuit Example >



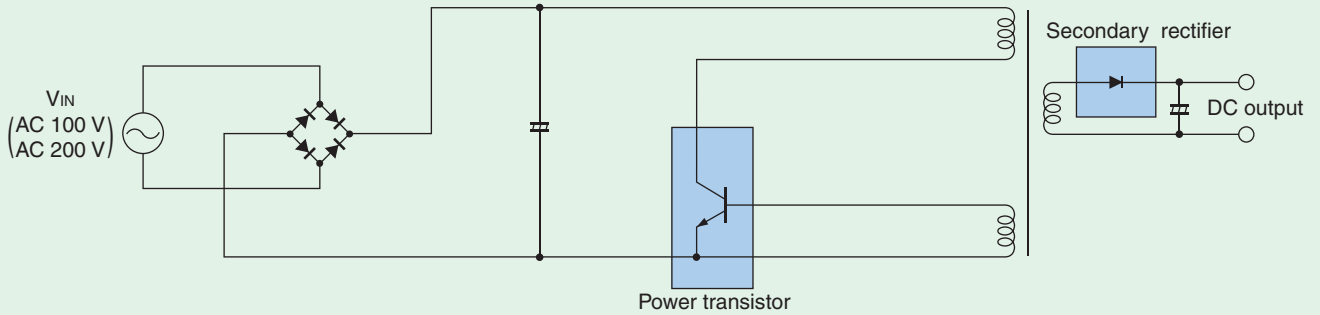
Power MOSFETs for Air-Conditioner Outdoor-Unit Fan Motor Drive

Part Number	I _D (A)	V _{DSS} (V)	R _{DS(ON)} Max(W)	Remarks	Package
2SK3313	12	500	0.62	High-speed diode	TO-220NIS
2SK3868	5	500	1.7	High-speed diode	TO-220SIS
2SK3947	6	600	1.4	High-speed diode	TO-220SIS
2SK4015	10	600	0.86	High-speed diode	TO-220SIS
2SK4016	13	600	0.50	High-speed diode	TO-220SIS

Semiconductor Devices for Power Supplies

Self-Excited RCC Single Flyback Power Supply

< Application Circuit Example >



Secondary Rectifiers

High-Efficiency Diodes (HEDs)

			Package	Reverse Recovery Time (Max)	Peak Repetitive Reverse Voltage				
					200 V	300 V	400 V	600 V	
Average Forward Current	Single	1 A	S-FLAT	35 ns	CRH01	-	-	-	
			M-FLAT		CMH04	-	CMH05A	-	
				2 A	50 ns	-	-	CMH05	-
			35 ns		CMH07	-	CMH08A	-	
		3 A	L-FLAT	50 ns	-	-	CMH08	-	
				35 ns	CLH01	CLH02	CLH03	-	
			M-FLAT	50 ns	-	-	CMH02A	-	
				35 ns	CMH01	-	CMH02	-	
			5 A	L-FLAT	35 ns	CLH05	CLH06	CLH07	-
				TO-220NIS #	50 ns	5DLZ47A	-	5GLZ47A	5JLZ47A
Average Rectified Output Current	Center-Tapped	5 A	TO-220SM	35 ns	U5DL2C48A	U5FL2C48A	-	-	
			TO-220NIS		5DL2CZ47A	5FL2CZ47A	5GL2CZ47A	-	
		10 A	TO-220SM	50 ns	-	-	-	5JL2CZ47	
				35 ns	U10DL2C48A	U10FL2C48A	-	U10JL2C48A	
			TO-220NIS	50 ns	10DL2CZ47A	10FL2CZ47A	10GL2CZ47A	10JL2CZ47A	
				35 ns	-	-	-	10JL2CZ47	
		16 A	TO-220NIS	35 ns	16DL2CZ47A	16FL2CZ47A	-	-	
			TO-3P(N)		16DL2C41A	16FL2C41A	-	-	
		20 A	TO-220SM	35 ns	U20DL2C48A	U20FL2C48A	U20GL2C48A	U20JL2C48A	
			TO-220NIS		20DL2CZ47A	20FL2CZ47A	-	-	
			TO-3P(N)		20DL2C41A	20FL2C41A	20GL2C41A	20JL2C41A	
			TO-3P(N)IS		20DL2CZ51A	20FL2CZ51A	-	-	
			TO-3P(N)	50 ns	-	-	-	20JL2C41	
				TO-3P(N)IS	50 ns	-	-	-	20JL2CZ51
		30 A	TO-3P(N)	50 ns	-	-	-	30JL2C41	

#: No center lead

Semiconductor Devices for Power Supplies

■ Shunt Regulators

Part Number	Absolute Maximum Ratings		Reference Voltage		Package	Comment
	V _{KA} (V)	I _K (mA)	Typ. (V)	Accuracy (%)		
TA76431S	37	150	2.495	±2.2	LSTM	
TA76431F/FR	37	150	2.495	±2.2	PW-Mini	F/FR: Pin order reversed
TA76L431FB	20	50	2.495	±1	S-Mini	
TA764L431S	20	50	2.49	±1	LSTM	
TA76L431FT	20	50	2.49	±1	UFV	
TA76432S	20	20	1.26	±1.4	LSTM	
TA76432F/FR	20	20	1.26	±1.4	PW-Mini	F/FR: Pin order reversed
TA76432FC	20	20	1.26	±1.4	SMV	
TA76432FT	20	20	1.26	±1.4	UFV	
TA76432AS	20	20	1.26	±1	LSTM	
TA76432AF/AFR	20	20	1.26	±1	PW-Mini	F/FR: Pin order reversed
TA76432AFT	20	20	1.26	±1	UFV	
TA76433FC	15	20	1.26	±1.4	SMV	Independent K-Vcc

■ Series Regulators

Part Number	Polarity	Absolute Maximum Ratings		Features				Fixed/ Variable	Output Voltage (V)	Package
		Output Current (mA)	Input Voltage (V)	LDO	3-Terminal	ON/OFF	Tracking			
TA48xxBF	+	1000	16	Y	Y			F	1.5/ 1.8/ 2.5/ 3.3/ 5/ 8/ 9	New PW-Mold
TA48SxxAF	+	1000	16	Y		Y		F	1.5/ 1.8/ 2.5/ 3.3/ 5/ 9	New PW-Mold 5-pin
TA48S00AF	+	1000	16	Y		Y		V	1.5 to 9	New PW-Mold 5-pin
TA4800AF	+	1000	16	Y				V	1.5 to 9	New PW-Mold 5-pin
TA48MxxF	+	500	29	Y	Y			F	2.5/ 3/ 3.3/ 3.45/ 4/ 5	PW-Mold
TA48LSxxF	+	300	14	Y		Y		F	1.5/ 1.8/ 2.5/ 3.3/ 5	PS-8
TA48LS00F	+	300	14	Y		Y		V	1.5 to 5	PS-8
TA48LxxF	+	150	16	Y	Y			F	1.8/ 2/ 2.5/ 3/ 3.3/ 5	PW-Mini
TA58MxxF	+	500	29 60 (Pulse)	Y	Y			F	5/ 6/ 8/ 9/ 10/ 12/ 15	New PW-Mold
TA58MxxS	+	500	29 60 (Pulse)	Y	Y			F	5/ 6/ 8/ 9/ 10/ 12/ 15	TO-220NIS
TA58MSxxF	+	500	29 60 (Pulse)	Y		Y		F	3.3/ 5/ 6/ 8/ 9/ 12	New PW-Mold 5-pin
TA58MS00F	+	500	29 60 (Pulse)	Y		Y		V	2.475 to 24	New PW-Mold 5-pin
TA58LxxF	+	250	29 60 (Pulse)	Y	Y			F	5/ 6/ 8/ 9/ 10/ 12/ 15	New PW-Mold
TA58LxxS	+	250	29 60 (Pulse)	Y	Y			F	5/ 6/ 8/ 9/ 10/ 12/ 15	TO-220NIS
TA58LT00F	+	150	38 60 (Pulse)	Y				V	2.5 to 13.4 (Tracking)	New PW-Mold 5-pin
TA58ST00F	+	50	38 60 (Pulse)	Y		Y	Y	V	2.5 to 13.4 (Tracking)	SOP-8
TA78DSxxF	+	30	29 60 (Pulse)	Y	Y	Y	Y	F	5/ 6/ 8/ 9/ 10/ 12/ 15	PW-Mini
TA78DSxxBP	+	30	29 60 (Pulse)	Y	Y			F	5/ 6/ 8/ 9/ 10/ 12/ 15	LSTM
TA78xxAF	+	1000	20		Y			F	3.3/ 4/ 5/ 7/ 8/ 9	New PW-Mold
TA78xxF	+	1000	35/40		Y			F	5/ 5.7/ 6/ 7/ 8/ 9/ 10/ 12/ 15/ 18/ 20/ 24	PW-Mold
TA78xxSB	+	1000	35/40		Y			F	5/ 5.7/ 6/ 7/ 8/ 9/ 10/ 12/ 15/ 18/ 20/ 24	TPL
TA78MxxF	+	500	35/40		Y			F	5/ 6/ 8/ 9/ 10/ 12/ 15/ 18/ 20/ 24	PW-Mold
TA78MxxSB	+	500	35/40		Y			F	5/ 6/ 8/ 9/ 10/ 12/ 15/ 18/ 20/ 24	TPL
TA78LxxF	+	150	35/40		Y			F	5/ 6/ 7/ 8/ 9/ 10/ 12/ 15/ 18/ 20/ 24	PW-Mini
TA78LxxPF	+	150	35/40		Y			F	5/ 6/ 7/ 8/ 9/ 10/ 12/ 15	PS-8
TA78LxxAP	+	150	35/40		Y			F	5/ 6/ 7/ 7.5/ 8/ 9/ 10/ 12/ 13.2/ 15/ 18/ 20/ 24	LSTM
TA78LxxS	+	100	35		Y			F	5/ 7/ 8/ 9/ 10/ 12/ 15	TO-92
TA79xxSB	-	1000	-35/-40		Y			F	-5/ -6/ -7/ -8/ -9/ -10/ -12/-15/ -18/ -20/ -24	TPL
TA79LxxF	-	150	-35/-40		Y			F	-5/ -6/ -8/ -9/ -10/ -12/-15/ -18/ -20/ -24	PW-Mini
TA79LxxP	-	150	-35/-40		Y			F	-5/ -6/ -8/ -9/ -10/ -12/-15/ -18/ -20/ -24	LSTM

DC-DC Converter ICs

Part Number	Type	Input Voltage Range (V)	Output Voltage Typ. (V)	Output Current Max (A)	Oscillation Frequency Typ. (kHz)	Package
TB7100F	Buck	3.0 to 5.5	Variable	0.7	550	PS-8
TB7101F(T5L1.2,F)	Buck	2.7 to 5.5	1.2	1.0	1000	
TB7101F(T5L1.5,F)	Buck	2.7 to 5.5	1.5			
TB7101F(T5L1.8,F)	Buck	2.8 to 5.5	1.8			
TB7101F(T5L2.5,F)	Buck	3.5 to 5.5	2.5			
TB7101F(T5L3.3,F)	Buck	4.3 to 5.5	3.3			
TB7101AF(T5L1.2,F)	Buck	2.7 to 5.5	1.2	1.0	1000	
TB7101AF(T5L1.5,F)	Buck	2.7 to 5.5	1.5			
TB7101AF(T5L1.8,F)	Buck	2.8 to 5.5	1.8			
TB7101AF(T5L2.5,F)	Buck	3.5 to 5.5	2.5			
TB7101AF(T5L3.3,F)	Buck	4.3 to 5.5	3.3			
TB7102F	Buck	2.7 to 5.5	Variable	1.0	1000	
TB7102AF	Buck	2.7 to 5.5	Variable	1.0	1000	
TCV7100F	Buck	2.7 to 5.5	Variable	2.5	800	
TCV7101F	Buck	2.7 to 5.5	Variable	3.8	600	
TC7704FNG	Buck	2.7 to 5.5	Variable	1.0	3000	SSOP16
TCV7102F☆	Buck	2.7 to 5.5	Variable	3.0	1500	SOP Advance
TCV7103F☆	Buck	2.7 to 5.5	Variable	5.0	1500	SOP Advance

☆: Under development

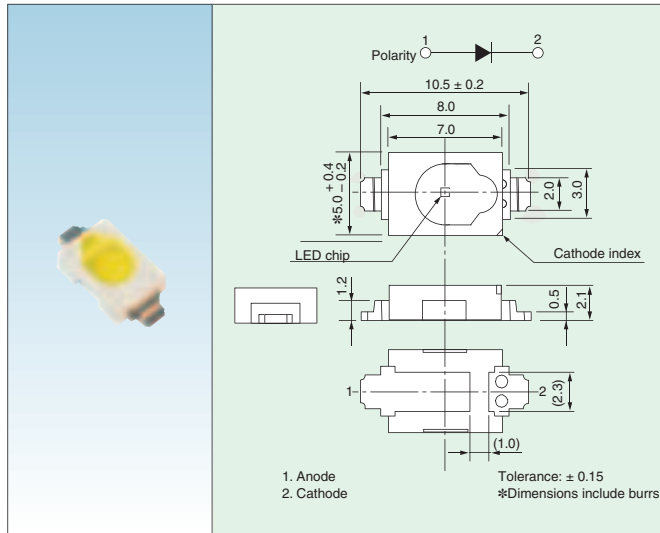
MOSFETs for Power Supplies

Part Number	Ratings		Characteristics				Package	
	V _{DSS} (V)	I _D (A)	V _{th} (V)	R _{Ds(ON)} Max (Ω)	Q _g Typ. (nC)	t _{rr} Typ. (ns)		
2SK3757	450	2	2.0 to 4.0	2.45	9	1000	TO-220SIS	
2SK3766			3.5 to 4.5	2.45	8	1000		
2SK3869		10	2.0 to 4.0	0.68	28	1000		
2SK3935								17
2SK3563	500	5	2.0 to 4.0	1.5	16	1400		
TK8A50D		8		0.85	16	1200		
TK12A50D		12		0.52	25	1300		
2SK4012		13		0.4	50	1000		
TK15A50D		15		0.3	40	1300		
2SK3767		600		2	2.0 to 4.0	5		9
2SK3567	3.5		2.2	16		1400		
TK6A60D	6		1.25	16		1000		
2SK3667	7.5		1.0	33		1200		
TK10A60D	10		0.75	25		1300		
TK12A60U	12		3.0 to 5.0	0.4		14		380
TK13A60D	13		2.0 to 4.0	0.43		40		1050
2SK4013	800		6	2.0 to 4.0		1.7	35	1200
TK15A60U	600	15	3.0 to 5.0	0.3	17	530		
TK20A60U		20		0.19	27	450		
2SK3566	900	2.5	2.0 to 4.0	6.4	12	720		
2SK3564		3		4.3	17	850		
2SK3798		4		3.5	26	1100		
2SK3565		5		2.5	28	900		
2SK3742			4.0 to 5.0	2.5	25	900		
2SK4014		6	2.0 to 4.0	2	45	1100		
2SK3799		8		1.3	60	1700		

LED Lamps

LED Lamps for Lighting Applications

TL12W01-D



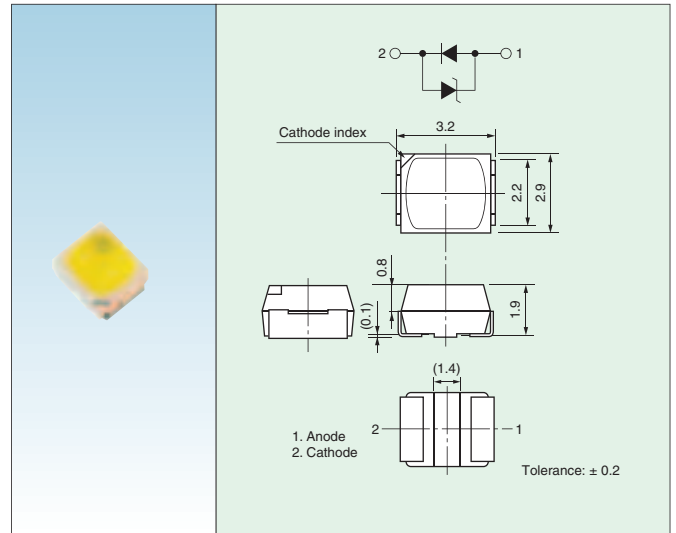
■ Features

- Package dimensions: 10.5 (L) x 5.0 (W) x 2.1 (H) mm
- Applications: Light sources for lighting equipment

■ Optical and Electrical Characteristics (I_F = 250 mA, T_a = 25°C)

Part Number	Typical Luminous Flux F _{lm}	Typical Chromaticity Coordinates		Typical Forward Voltage V _F (V)
		C _x	C _y	
TL12W01-D(T30)	40	0.32	0.31	3.4

TLWK1100C



■ Features

- PLCC package: 3.2 (L) x 2.9 (W) x 1.9 (H) mm
- Two luminous intensity bins available
- Applications: Light sources for LCD backlighting, lighting equipment, etc.

■ Optical and Electrical Characteristics (I_F = 20 mA, T_a = 25°C)

Part Number	Typical Luminous Intensity I _v (mcd)	Typical Chromaticity Coordinates		Typical Forward Voltage V _F (V)
		C _x	C _y	
TLWK1100C(T11)	1700	0.31	0.3	3.2

LED Lamps for Indicator and Display Applications

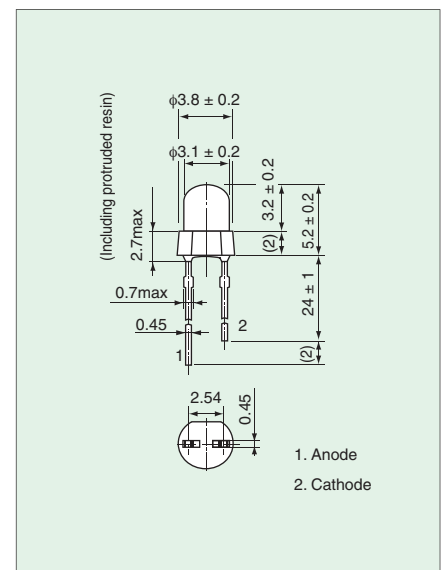
■ Features

- Designed for flush mounting
- Transparent, colored, and colored diffusion lens types

■ Product Offerings

Color	Part Number	Lens	I _F Absolute Maximum Rating (mA)	Typical Characteristics @ I _F = 20 mA, T _a = 25°C			
				Luminous Intensity (mcd)	λ _d (nm)	V _F (V)	Viewing Angle (°)
Red	TLRME68TG(F)	Transparent colorless	50	330	626	2.0	80
	TLRME68CG(F)	Transparent red	50	260	626	1.9	80
	TLRME68DG(F)	Red diffused	50	140	626	1.9	100
Yellow	TLYE68TG(F)	Transparent colorless	50	340	587	2.0	80
	TLYE68CG(F)	Transparent yellow	50	300	587	2.0	80
	TLYE68DG(F)	Yellow diffused	50	150	587	2.0	100
Green	TLGE68TG(F)	Transparent colorless	50	155	571	2.0	80
	TLGE68CG(F)	Transparent green	50	110	571	2.0	80
	TLGE68DG(F)	Green diffused	50	45	571	2.0	100
Fresh green	TFLFGE68CG(F)	Transparent green	50	70	565	2.0	80
	TFLFGE68DG(F)	Green diffused	50	30	565	2.0	100

■ Package Dimensions



General-Purpose Discrete Devices

Low-Saturation-Voltage Transistors

Ic(A)	V _{CE0} = 10 V		V _{CE0} = 15 V	V _{CE0} = 20 V		V _{CE0} = 30 V	
	PNP	NPN	PNP	PNP	NPN	PNP + NPN	NPN
1	-	-	③TPC6D02@2	-	-	⑧HN4B101J	-
1.5	①2SA2058	-	-	①2SA2065 ⑥2SA2069	①2SC5784 ⑥2SC5819 ②TPC6503	-	-
2	⑥2SA2066 ②TPC6602	①2SC5755 ⑥2SC5785 ②TPC6501 ④TPCP8504	-	-	-	③TPC6902@1 ⑤TPCP8902@1	-
2.5	-	-	-	①2SA2061 ⑥2SA2059 ②TPC6603 ⑤TPCP8F01@3	-	-	-
3	-	-	-	-	-	-	①2SC5976 * ⑤TPCP8H02@4*
3.5	-	-	-	-	①2SC5738	-	-
4	-	⑥2SC5713	-	④TPCP8601	⑥2SC5714 ⑥2SC6125 *	-	①2SC5906 *
5	-	-	-	-	-	-	①2SC6062 *
	V _{CE0} = 50 V			V _{CE0} = 80 V			
	PNP	PNP + NPN	NPN	PNP	NPN		
1	⑥2SA2070	③TPC6901A@1 ⑤TPCP8901@1	③TPC6701 ⑥2SC5810	-	-		
1.5	-	-	-	-	-		
2	①2SA2056 ⑥2SA2060 ②TPC6601	-	⑤TPCP8701	⑥2SA2206	-		
2.5	④TPCP8602	-	①2SC5692 ①2SC6033 *	-	⑥2SC6124		
3	-	-	⑥2SC5712 ⑥2SC6126 * ②TPC6502 ④TPCP8505	-	⑦2SC6076		
3.5	-	-	-	-	-		
4	-	-	①2SC5703	-	-		
5	-	-	⑤TPCP8H01@4 * ⑦2SC5886A	-	-		

Package①TSM, ②VS-6, ③VS-6 (2in1), ④PS-8, ⑤PS-8 (2in1), ⑥PW-Mini, ⑦PW-Mold, ⑧SMV
 *: Ultra-high speed ☆: Under development @1: NPN + PNP, @2: PNP + SBD, @3: PNP + S-MOS, @4: NPN + S-MOS

General-Purpose Rectifiers (Power Rectification Diodes)

Average Forward Current	Package	Peak Repetitive Reverse Voltage			
		100 V	400 V	600 V	800 V
0.3 A	VS-6	-	TPC6K01	-	-
0.5 A	HM-FLAT	-	HMG01	-	-
0.7 A	S-FLAT	CRG01	CRG02	-	-
		-	CRG07	-	-
1 A	M-FLAT	-	CRG03	CRG04	CRG05
		-	CMC01	-	-
2 A		-	CMC02	-	-
3 A	L-FLAT	-	CMG02	CMG03	-
10 A	TO-220SM	-	CLG05	-	U10LC48

Very-Fast Reverse Recovery Diodes

Average Forward Current	Package	Reverse Recovery Time (Max)	Peak Repetitive Reverse Voltage		
			400 V	600 V	800 V
0.2 A	S-FLAT	100 ns	-	-	CRF04
		100 ns	-	-	CRF02
0.5 A	M-FLAT	100 ns	-	-	CMF03
0.7 A	S-FLAT	100 ns	-	CRF03	-
1 A	M-FLAT	100 ns	-	CMF02	-
2 A		100 ns	-	CMF01	-
5 A	TO-220NIS	100 ns	5GUZ47	5JUZ47	-

Zener Diodes

P	Prsm (W) ◆	Zener Voltage Range (V)	Part Number	Package
0.7 W	50	6.2 to 9.1	CRY62	S-FLAT(SMD)
		10 to 47	CRZ10	
1.0 W	90	18 to 51	CMZB18	M-FLAT(SMD)
2.0 W	180	12 to 53	CMZ12	M-FLAT(SMD)

◆: Recommendation at $t_w = 1$ ms; square pulse

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