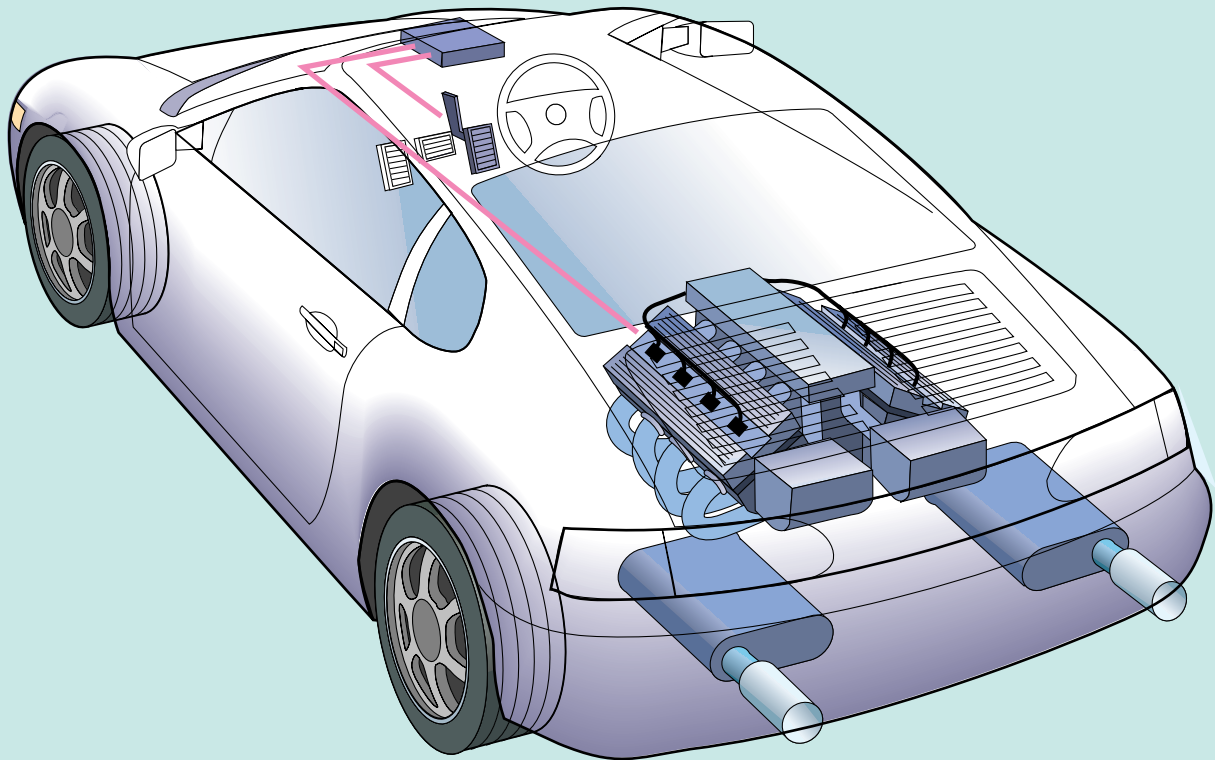# TOSHIBA

SYSTEM CATALOG

FOR
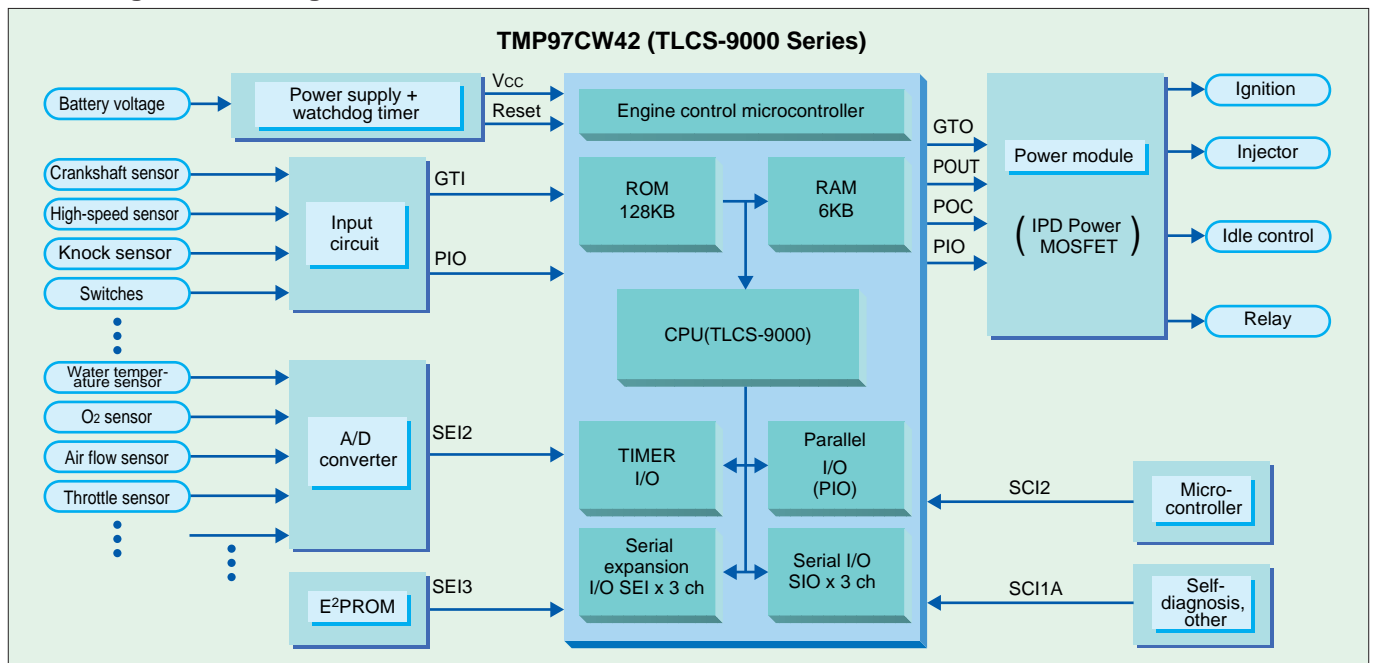# AUTOMOBILES

Engine Control Unit

Engine Control Unit System Trends

Engine and transmission control systems will be required to be equipped with more advanced functions in response to stricter emission and fuel consumption regulations.
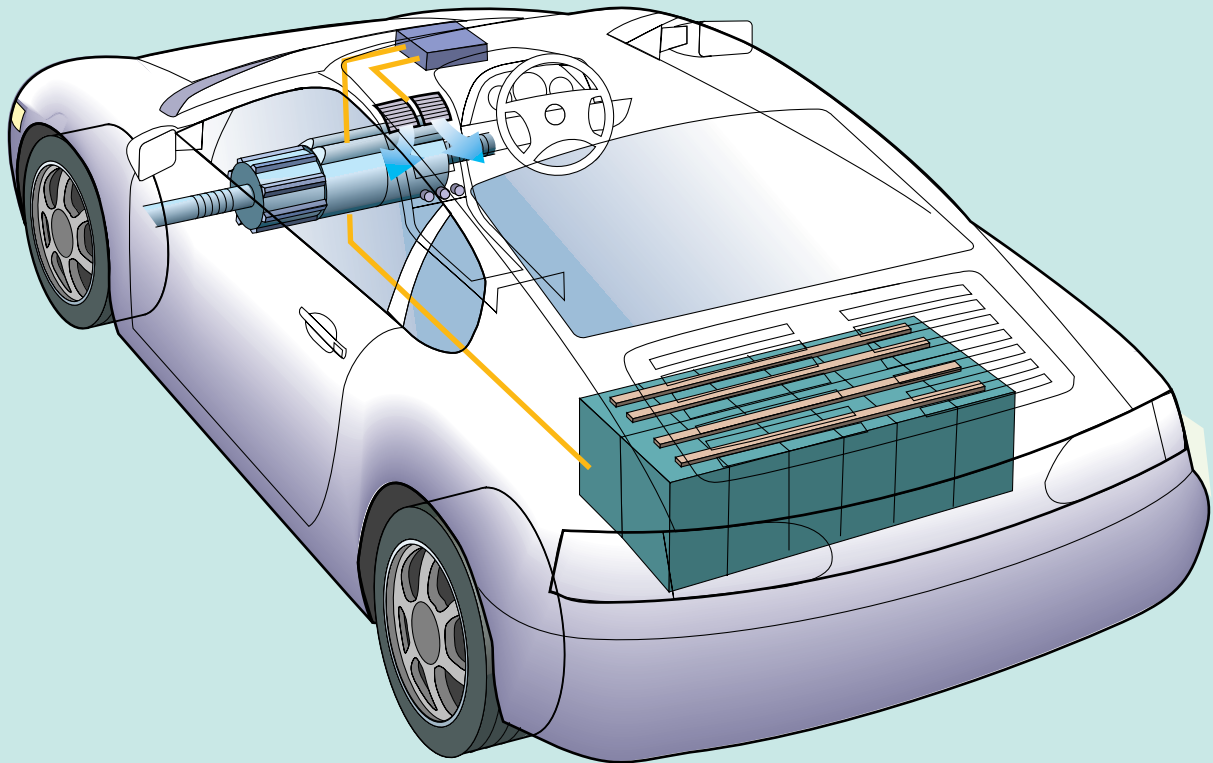
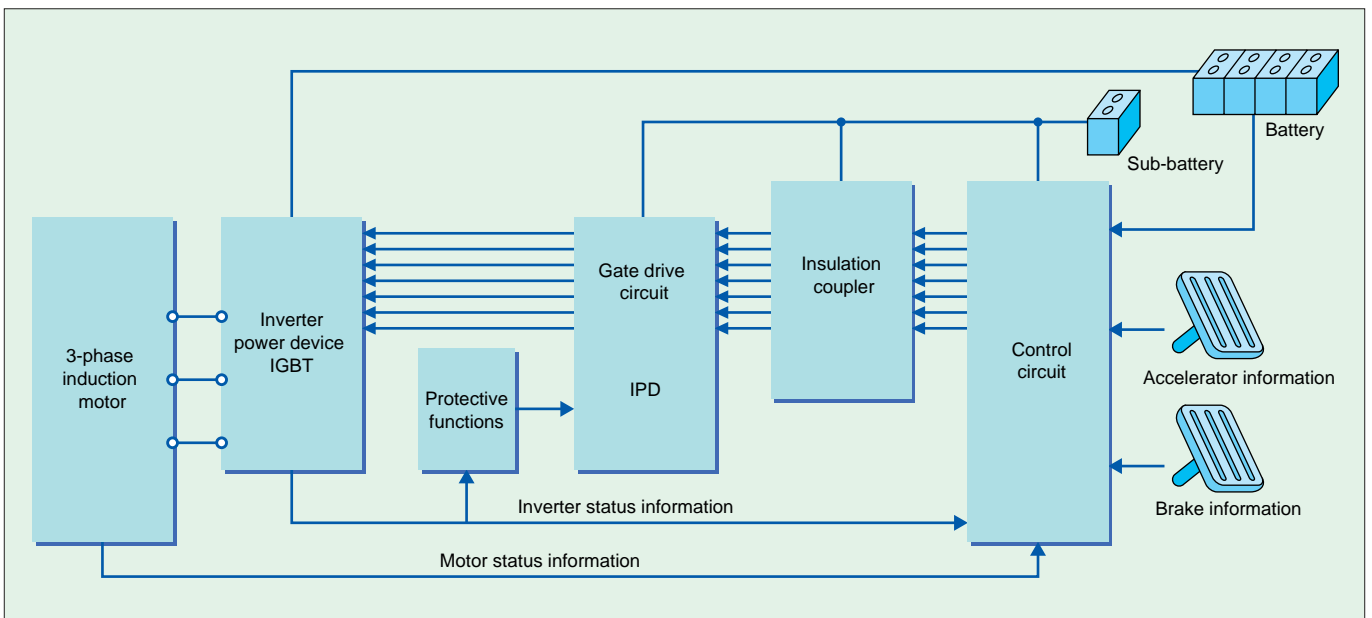| System Trend	Semiconductor Product Trend (Microcontrollers)
Higher precision	● Higher precision and increased memory capacity of 16-bit microcontrollers and timer I/O
Increased complexity	● More advanced functions and greater intelligence of I/O accompanying increased number of functions being controlled

Block Diagram of an Engine Control Unit

TMP97CW42 (TLCS-9000 Series)

Battery voltage → Power supply + watchdog timer → Vcc / Reset → Engine control microcontroller

Crankshaft sensor, High-speed sensor, Knock sensor, Switches → Input circuit → GTI / PIO

Water temperature sensor, O$_2$ sensor, Air flow sensor, Throttle sensor → A/D converter → SEI2

E^{2}PROM → SEI3

ROM 128KB, RAM 6KB

CPU(TLCS-9000)

TIMER I/O, Parallel I/O (PIO)

Serial expansion I/O SEI x 3 ch, Serial I/O SIO x 3 ch

GTO, POUT, POC, PIO → Power module (IPD Power MOSFET) → Ignition, Injector, Idle control, Relay

SCI2 → Micro-controller

SCI1A → Self-diagnosis, other

4

EV Motor Drive Systems


EV Motor Drive System Trends

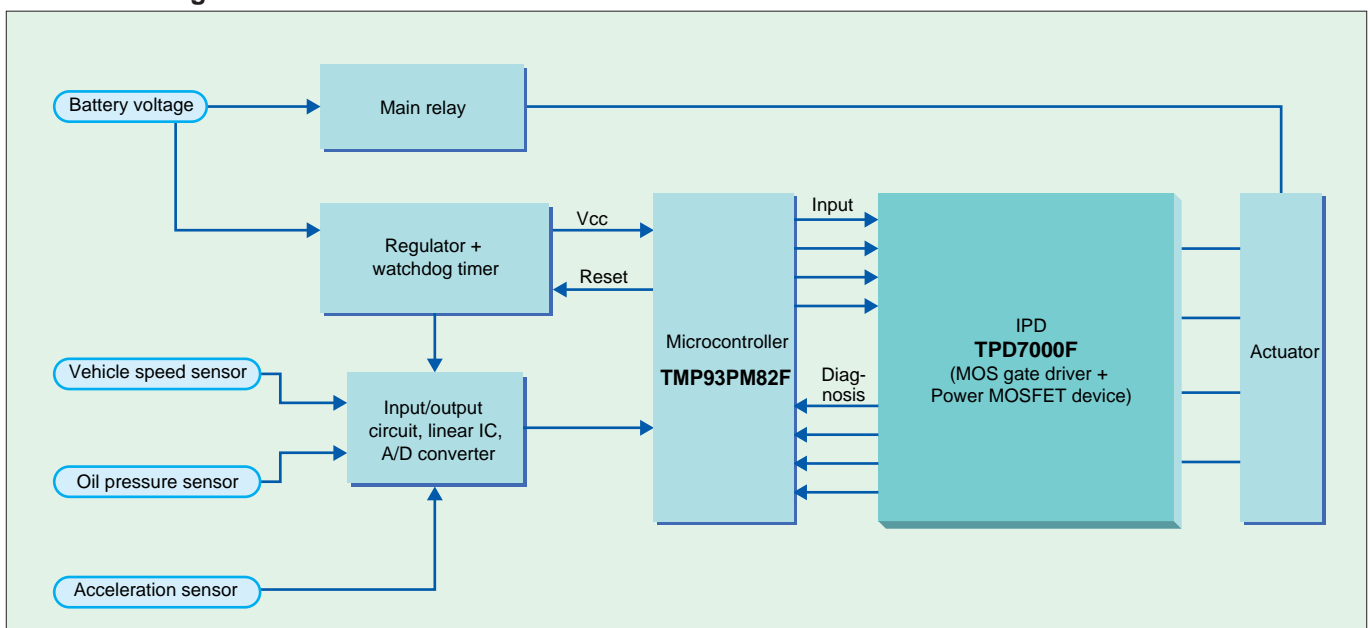| System Trend	Semiconductor Product Trend
Increased capacity and reduced size	● Inhibition of heat generation by reducing loss of IGBT chip ● Inhibition of heat generation by using soft recovery of FWD chips ● Increased heat radiation by using an insulator with high thermal conductivity
Increased functions	● Use of IPM with built-in drive circuit
Increased reliability	● Use of IPM with built-in protective circuit

Block Diagram of an EV Motor Drive System

ABS, Airbag Systems and Vehicle Navigation Systems
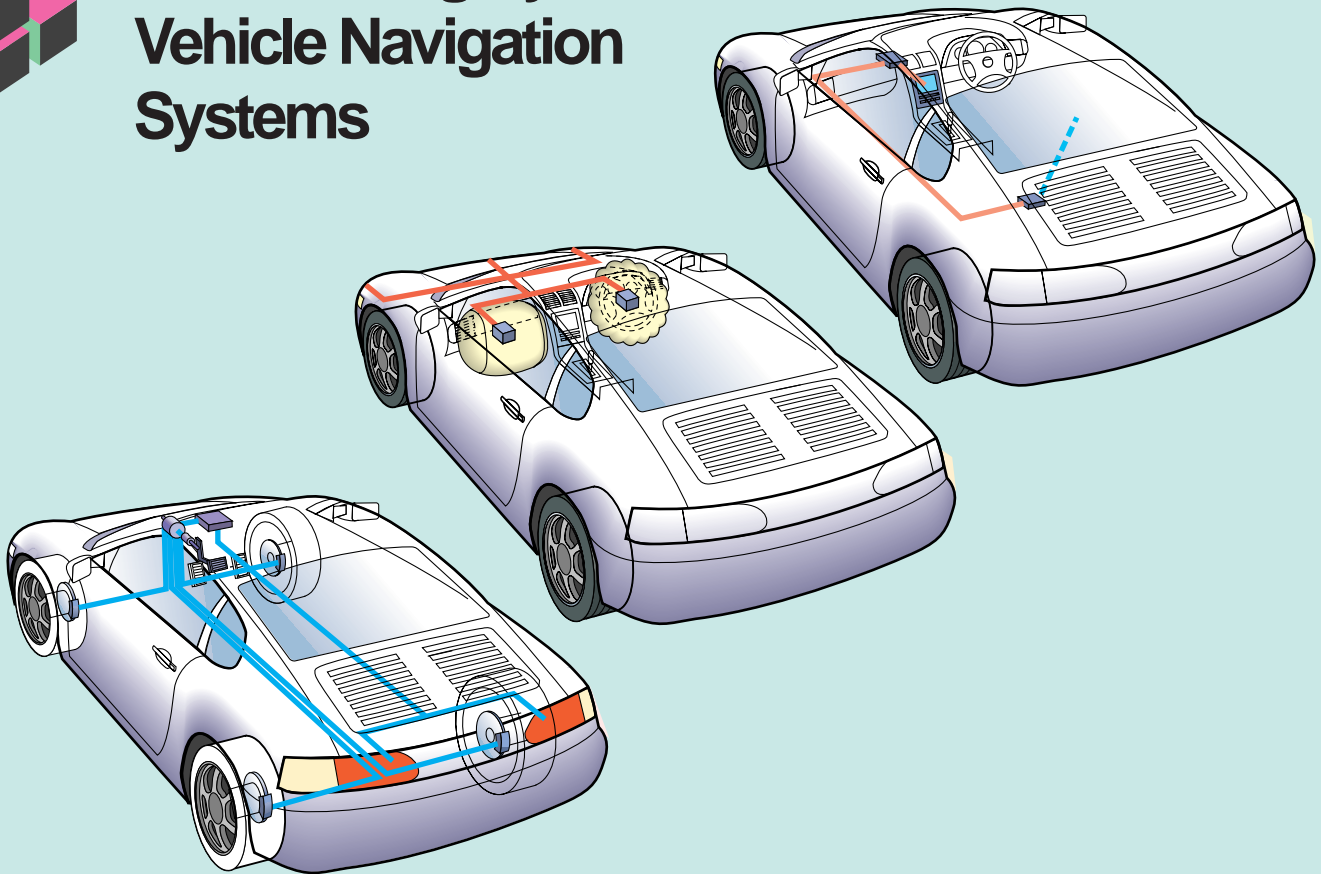
ABS System Trends

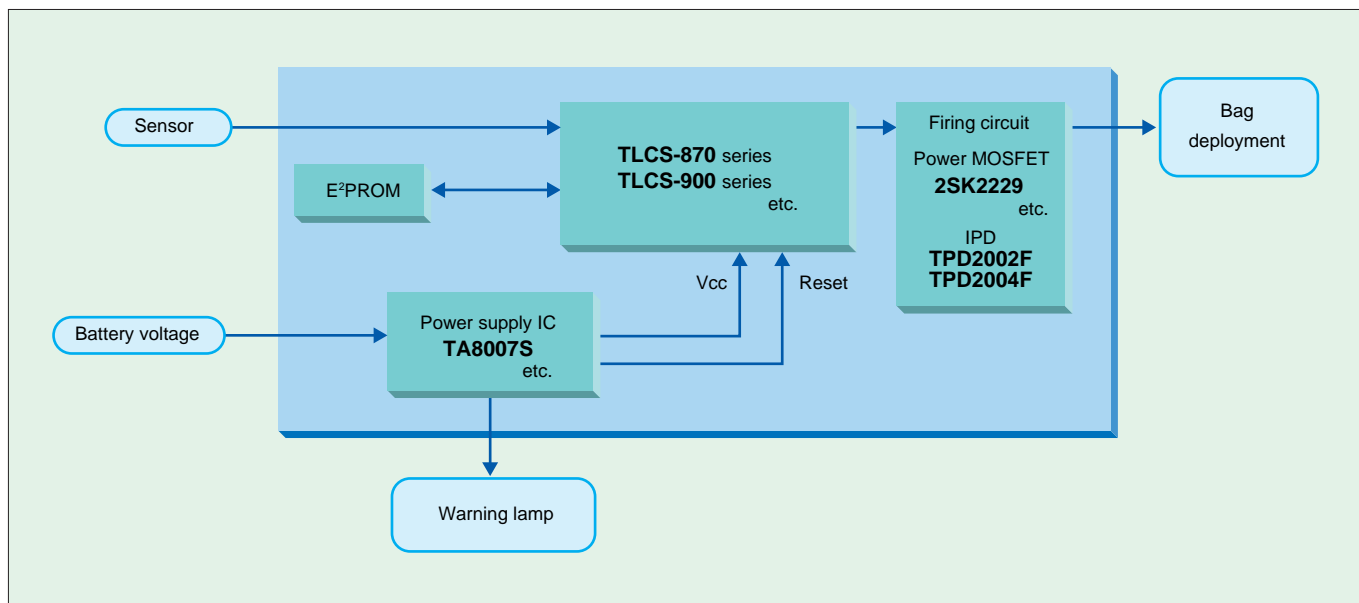| System Trend	Semiconductor Product Trend (Power Devices)
Lower cost	IPDs — More refined, lower loss (no heat sink necessary), multiple outputs Power MOSFET devices — More refined, lower loss (no heat sink necessary), more compact packages
Reduced size and weight	IPDs — Control circuit and power MOSFET device integrated on a single chip, lower loss (no heat sink necessary) Power MOSFET devices — Lower loss (no heat sink necessary), more compact packages
Increased reliability	IPDs — Protective functions during abnormal loads, built-in diagnostic circuit

ABS Block Diagram

Airbag System Trends

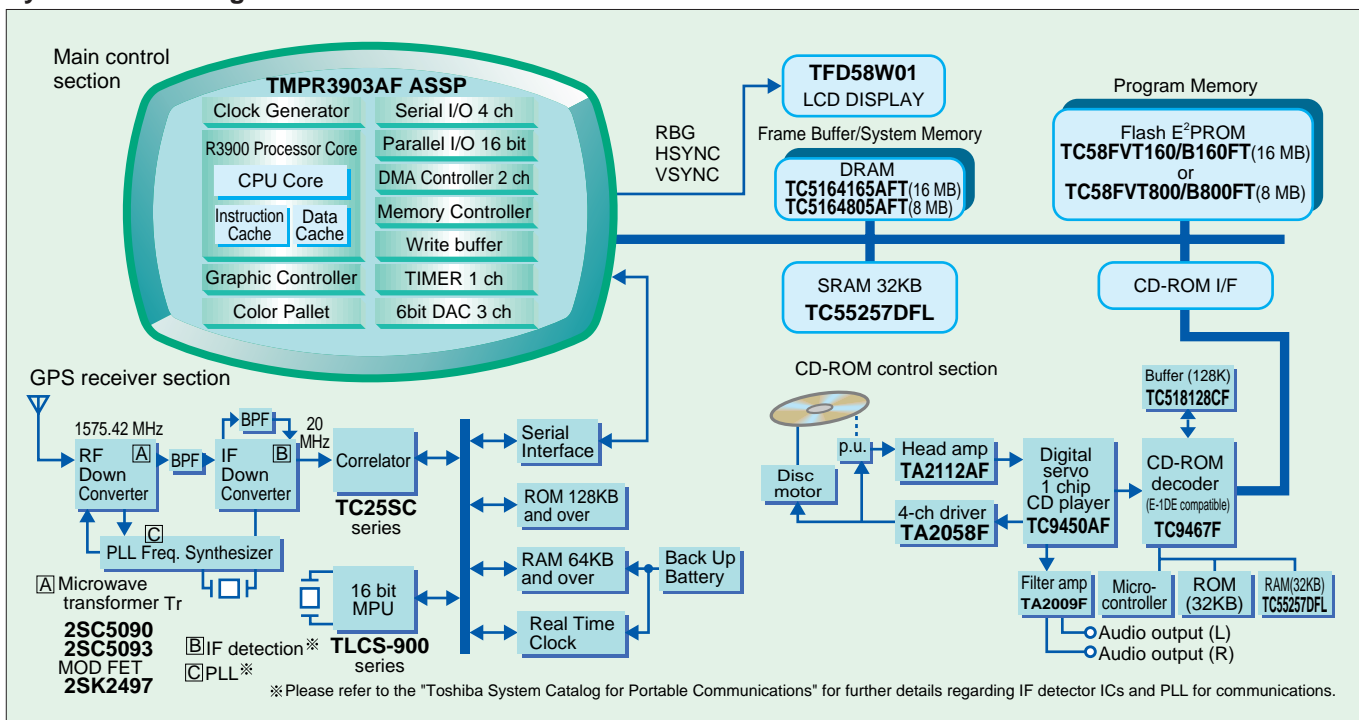| System Trend	Semiconductor Product Trend (Power MOSFET)
Lower cost	● More refined, lower loss (no heat sink necessary), more compact package
Reduced size and weight	● Lower loss (smaller heat sink), more compact package

System Block Diagram

Sensor

E²PROM

TLCS-870 series
TLCS-900 series
etc.

Vcc   Reset

Firing circuit
Power MOSFET
2SK2229
etc.

IPD
TPD2002F
TPD2004F

Bag deployment

Battery voltage

Power supply IC
TA8007S
etc.

Warning lamp


Vehicle Navigation System Trends

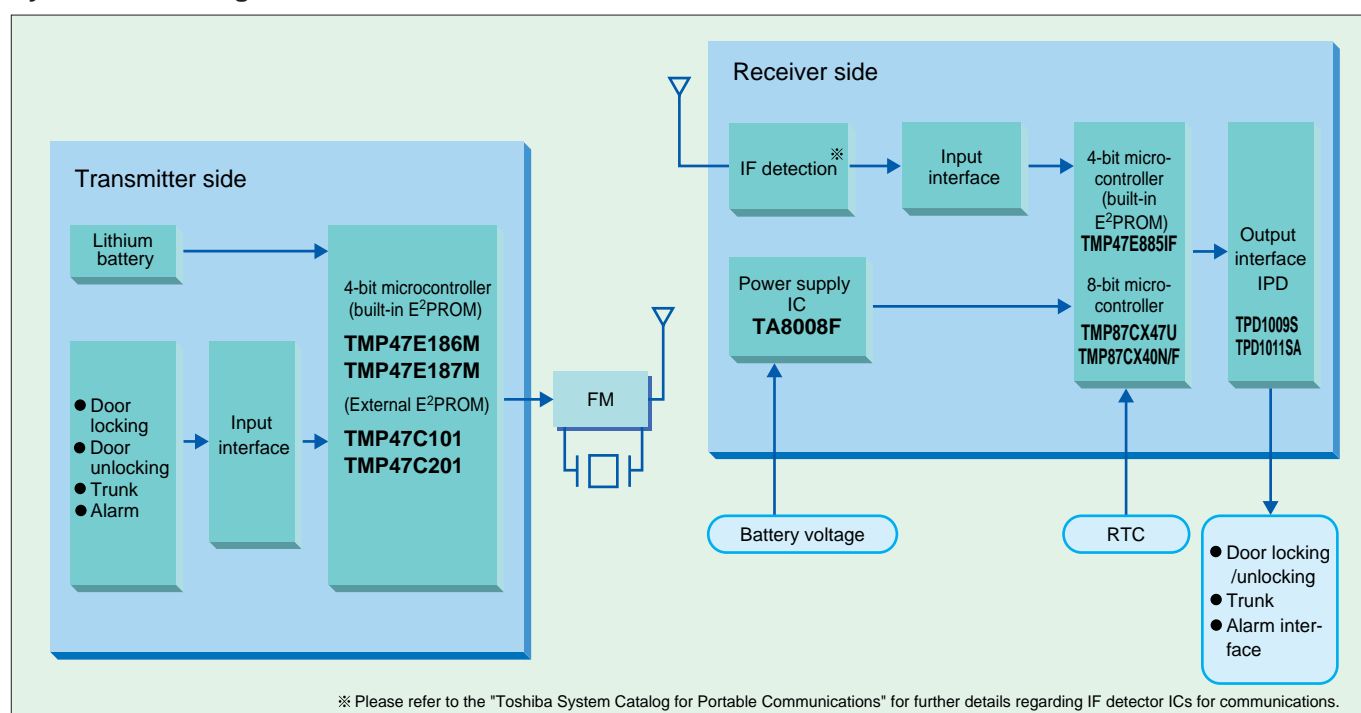| System Trend	Semiconductor Product Trend
Car multi-media applications	● Increased processing speed of main controller (32-bit RISC core, high-speed image processing ASIC) ● IC for CD-ROM (20 times speed to 24 times speed), IC for DVD-ROM

System Block Diagram

Main control section

TMPR3903AF ASSP

Clock Generator	Serial I/O 4 ch
R3900 Processor Core	Parallel I/O 16 bit
CPU Core	DMA Controller 2 ch
Instruction Cache / Data Cache	Memory Controller
	Write buffer
Graphic Controller	TIMER 1 ch
Color Pallet	6bit DAC 3 ch

TFD58W01
LCD DISPLAY

RBG
HSYNC
VSYNC

Frame Buffer/System Memory

DRAM
TC5164165AFT(16 MB)
TC5164805AFT(8 MB)

SRAM 32KB
TC55257DFL

Program Memory

Flash E²PROM
TC58FVT160/B160FT(16 MB)
or
TC58FVT800/B800FT(8 MB)

CD-ROM I/F

GPS receiver section

1575.42 MHz

RF Down Converter A BPF

BPF
IF Down Converter B 20 MHz

Correlator

TC25SC series

PLL Freq. Synthesizer C

Serial Interface

ROM 128KB and over

RAM 64KB and over

Real Time Clock

Back Up Battery

16 bit MPU

TLCS-900 series

A Microwave transformer Tr
2SC5090
2SC5093
MOD FET
2SK2497

B IF detection ※
C PLL ※

CD-ROM control section

Disc motor

p.u.

Head amp
TA2112AF

4-ch driver
TA2058F

Digital servo 1 chip CD player
TC9450AF

Buffer (128K)
TC518128CF

CD-ROM decoder
(E-1DE compatible)
TC9467F

Filter amp
TA2009F

Micro-controller

ROM (32KB)

RAM(32KB)
TC55257DFL

Audio output (L)
Audio output (R)

※Please refer to the "Toshiba System Catalog for Portable Communications" for further details regarding IF detector ICs and PLL for communications.

Key-less Entry Systems, Automobile Air-conditioning Systems and Electric Power Steering Control Units
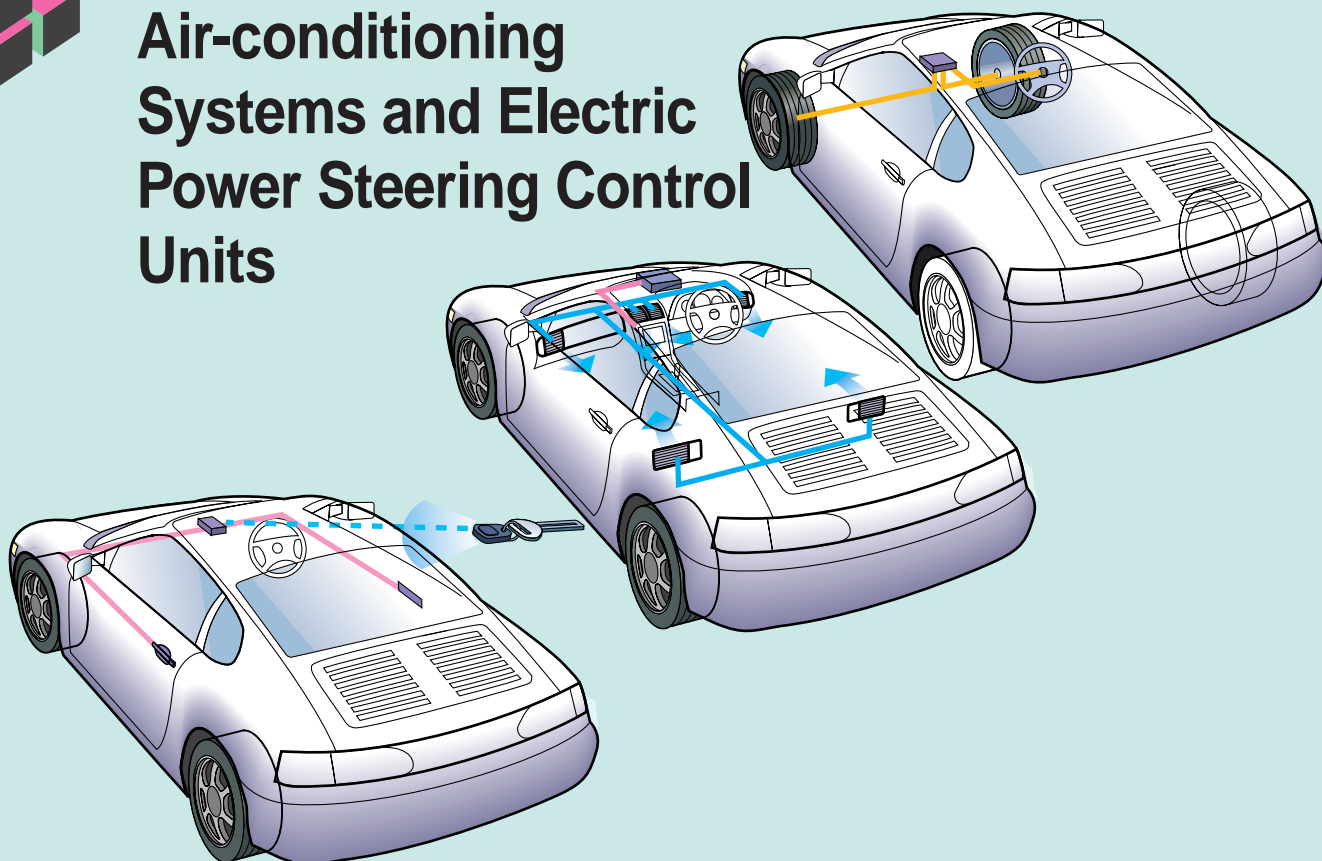
Key-less Entry System Trends

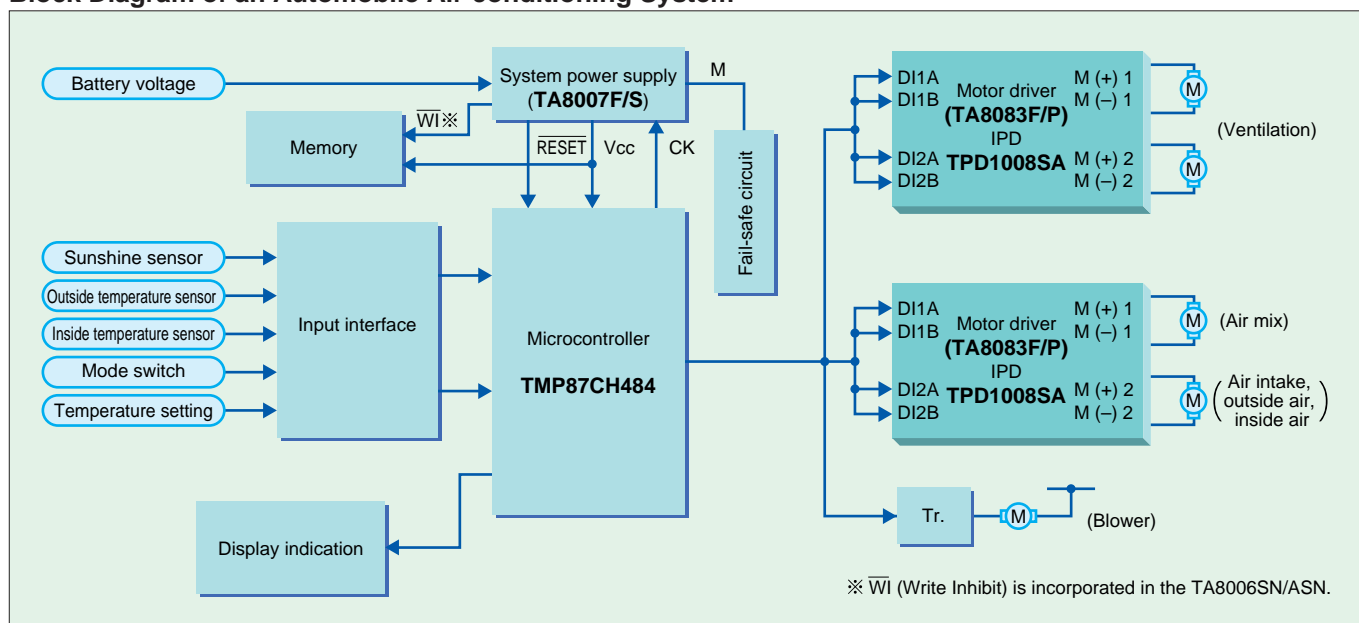| System Trend	Semiconductor Product Trend (Microcontrollers)
Reduced size	● Smaller package ● Lower power consumption

System Block Diagram

Receiver side

Transmitter side

Lithium battery

4-bit microcontroller (built-in E^{2}PROM)
TMP47E186M
TMP47E187M
(External E^{2}PROM)
TMP47C101
TMP47C201

● Door locking
● Door unlocking
● Trunk
● Alarm

Input interface

FM

IF detection ※

Input interface

4-bit micro-controller (built-in E^{2}PROM)
TMP47E885IF

8-bit micro-controller
TMP87CX47U
TMP87CX40N/F

Power supply IC
TA8008F

Output interface IPD
TPD1009S
TPD1011SA

Battery voltage

RTC

● Door locking /unlocking
● Trunk
● Alarm inter-face

※ Please refer to the "Toshiba System Catalog for Portable Communications" for further details regarding IF detector ICs for communications.

8

Automobile Air-conditioning System Trends

| System Trends	Semiconductor Product Trends (Driver ICs)
Advanced functions	● Detailed setting control ● Built-in self-diagnostic functions
Reduced energy consumption	● Built-in low standby mode
Reduced cost and size	● 2-circuit built-in motor driver ● Compact package (surface mounting)

Block Diagram of an Automobile Air-conditioning System

※ $\overline{\text{WI}}$ (Write Inhibit) is incorporated in the TA8006SN/ASN.

Electric Power Steering Control Unit Trends

System Trend	Semiconductor Product Trend (Microcontrollers)
High performance	● Low voltage operation

System Block Diagram
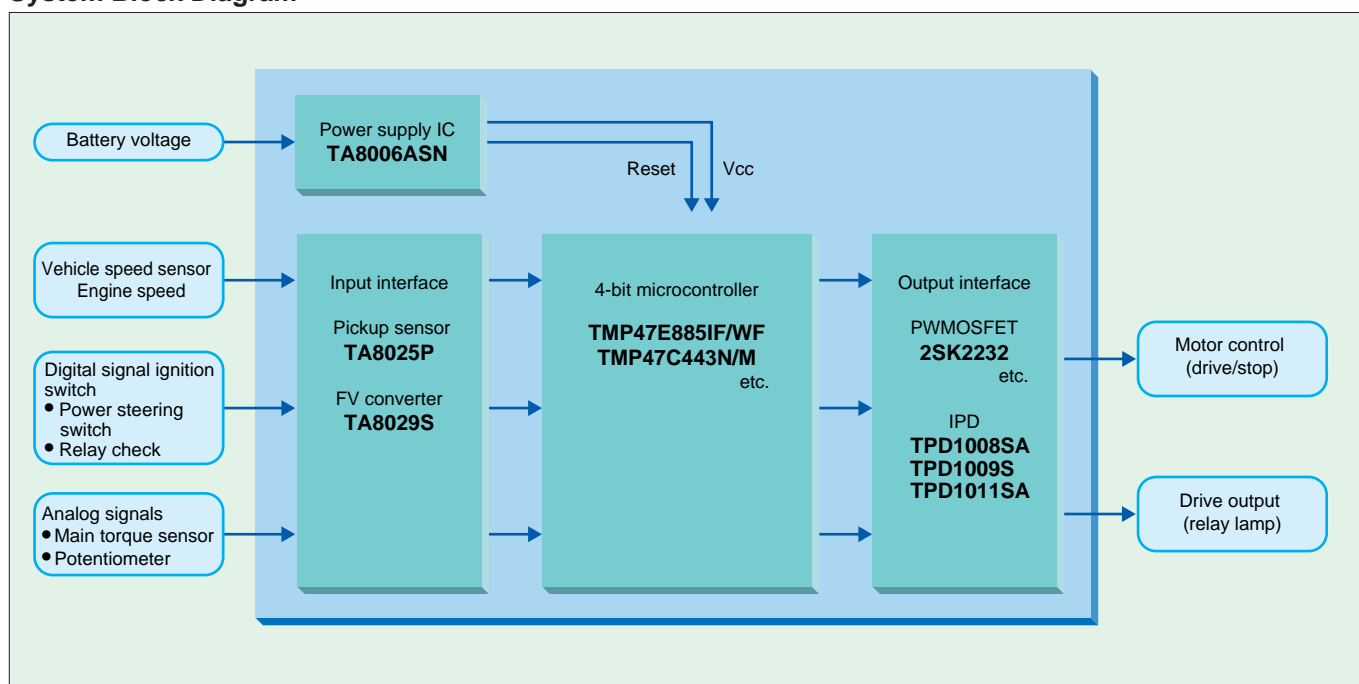
4-bit Microcontrollers

TLCS-47E Series

Features

- 4-bit microcontrollers
- ROM size: 1K to 4K, RAM size: 64 to 256 nibbles
- Instructions: 90
- Minimum instruction execution time: 1.3 µs (operating at 6.0 MHz)
- 5 interrupt factors (2 external, 3 internal) 6 interrupt factors (2 external, 4 internal)
- I/O ports: 11 to 23
- Hold function

Broad Temperature Range

Device	Function	ROM (bytes)	RAM (bytes)	I/O ports	Min. instruction execution time (µs)	Operating voltage (V)	Operating temper-ature (˚C)	Package	OTP version
+ TMP47E186M/187M (Note 2)	E²PROM16 bytes, SPI	1K	64	11	1.3	2.0 to 5.5 (Note 1)	−40 to 85	SOP16	TMP47P186M/187M (Note 2)
TMP47C241IN/IM	A/D converter, LED driver	2K	128	21		2.7 to 6.0		SDIP28 SOP28	TMP47P241VN/VM
TMP47C241WN							−40 to 110		

＋: Covered by U.S. Patent No. 4,382,279 owned by BULL CP8.

Note 1: During CR oscillation
(2.7 to 5.5 V when oscillator connected)
Note 2: 186: CR oscillation version
187: Oscillator version

Please refer to Toshiba's List of Microcomputer Products for information on other TLCS-47E standard products.

> **About OTP products:**
> OTP products will be supported for system development and assessment.

TLCS-470 Series

Features

- 4-bit microcontrollers
- ROM size: 4K to 8K, RAM size: 256 to 1024 nibbles
- Instructions: 92
- Minimum instruction execution time: 1.3 µs (operating at 6.0 MHz)
- 6 interrupt factors (2 external, 4 internal) I/O ports: 28 to 56
- Hold function
- Dual clock system

Broad Temperature Range

Device	Function	ROM (bytes)	RAM (bytes)	I/O ports	Min. instruction execution time (µs)	Operating voltage (V)	Operating temper-ature (˚C)	Package	OTP version
+TMP47E885IF	E²PROM (64 bytes), PWM, UART, A/D converter, 16-bit timer/counter, input capture, output compare	8K	512	36	1.3	4.5 to 5.5	−40 to 85	QFP44	TMP47P885F
+TMP47E885WF							−40 to 110		

＋: Covered by U.S. Patent No. 4,382,279 owned by BULL CP8.

Please refer to Toshiba's List of Microcomputer Products for information on other TLCS-470 standard products.

> **About OTP products:**
> OTP products will be supported for system development and assessment.

Please refer to Toshiba's List of Microcomputer Products for information on other TLCS-47/470A standard products.
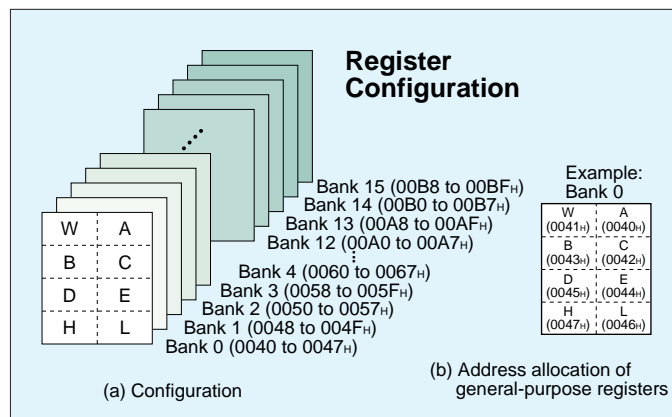
8-bit Microcontrollers

TLCS-870 Series

Features
- Original architecture
- ROM size: 8K to 60K bytes
  RAM size: 256 to 2K bytes
- Instructions: 412 instructions of 129 types
- Minimum instruction execution time: 0.5 μs
  (operating at 8.0 MHz)
  - Multiplication instructions (8 bits x 8 bits)
  - Division instructions (16 bits ÷ 8 bits)
  - Various bit operating instructions
  - 16-bit data operating instructions
  - 1-byte jump/call instructions
- Maximum of 15 interrupt factors
  High-speed task switching by register bank switching
- Dual clock system capable of switching between
  high-speed and low power consumption operation
- General-purpose register bank
  8-bit registers x 8 x max. of 16 banks
- I/O ports: 35 to 90
- Various standby modes

- Multi-function timer/counter
  16-bit timer/counter: 1 to 2 ch
  8-bit timer/counter: 2 to 4 ch
  Time-based timer: 1 ch
  Watchdog timer: 1 ch
- Divider output function

Register Configuration

Bank 15 (00B8 to 00BF$_H$)
Bank 14 (00B0 to 00B7$_H$)
Bank 13 (00A8 to 00AF$_H$)
Bank 12 (00A0 to 00A7$_H$)
Bank 4 (0060 to 0067$_H$)
Bank 3 (0058 to 005F$_H$)
Bank 2 (0050 to 0057$_H$)
Bank 1 (0048 to 004F$_H$)
Bank 0 (0040 to 0047$_H$)

(a) Configuration

Example: Bank 0

W (0041$_H$)	A (0040$_H$)
B (0043$_H$)	C (0042$_H$)
D (0045$_H$)	E (0044$_H$)
H (0047$_H$)	L (0046$_H$)

(b) Address allocation of general-purpose registers

Broad Temperature Range

Device	Functions	ROM (bytes)	RAM (bytes)	I/O ports	Min. instruction execution time (μs)	Power supply voltage (V)	Operating temperature (°C)	OTP version	Package
TMP87CH48IU	LED driver 10-bit A/D converter x 16 ch Timer/counter x 4 ch Watchdog timer Time-based timer UART x 1 ch Clock-synchronized SIO or I^{2}C x 1 ch	16K	512	56	0.50/122 0.95/122	4.5 to 5.5 2.7 to 5.5	−40 to 85	**TMP87PH48U**	μQFP64

Please contact our sales or supervisory technical division when considering the I/W version for consultation regarding product details. OTP products are not compatible with the I/W version.

Please refer to Toshiba's List of Microcomputer Products for information on other TLCS-870 series standard products.

About OTP products: OTP products will be supported for system development and assessment.

TMP68HC11 Series

The TMP68HC11 series consist of a lineup of 8-bit single-chip CMOS microcontrollers with various highly functional peripheral devices integrated onto a single chip. These microcontrollers are fully compatible with Motorola's 68HC11 [mask set ID: C11W (68HC11A)/C27B (68HC11E)].

Device	ROM (bytes)	E^{2}PROM (bytes)	RAM (bytes)	Timer I/O Capture	Timer I/O Compare	8-bit event counter	SCI	SPI	ADC	Operating temperature (°C)	Package
T5B74-OR/WT (TMP68HC11AOR/WT)	—	—	256	16 bits x 3	16 bits x 5	○	○	○	8 bits x 8 ch	−40 to 85/105 [*1]	QFJ52
+ T5B74-1R/WT (TMP68HC11A1R/WT)	—	512	256	16 bits x 3	16 bits x 5	○	○	○	8 bits x 8 ch	−40 to 85/105 [*1]	QFJ52
+ T5B74-XXXX-R/WT (TMP68HC11A8R/WT) XXXX:ROM CODE	8K	512	256	16 bits x 3	16 bits x 5	○	○	○	8 bits x 8 ch	−40 to 85/105 [*1]	QFJ52
T5B75-OR/WT (TMP68HC11EOR/WT)	—	—	512	16 bits x 3 or x 4	16 bits x 5 or x 4	○	○	○	8 bits x 8 ch	−40 to 85/105 [*1]	QFJ52
+ T5B75-1R/WT (TMP68HC11E1R/WT)	—	512	512	16 bits x 3 or x 4	16 bits x 5 or x 4	○	○	○	8 bits x 8 ch	−40 to 85/105 [*1]	QFJ52
+ T5B75-XXXX-R/WT (TMP68HC11E9R/WT) XXXX:ROM CODE	12K	512	512	16 bits x 3 or x 4	16 bits x 5 or x 4	○	○	○	8 bits x 8 ch	−40 to 85/105 [*1]	QFJ52

+: Covered by U.S. Patent No. 4,382,279 owned by BULL CP8.
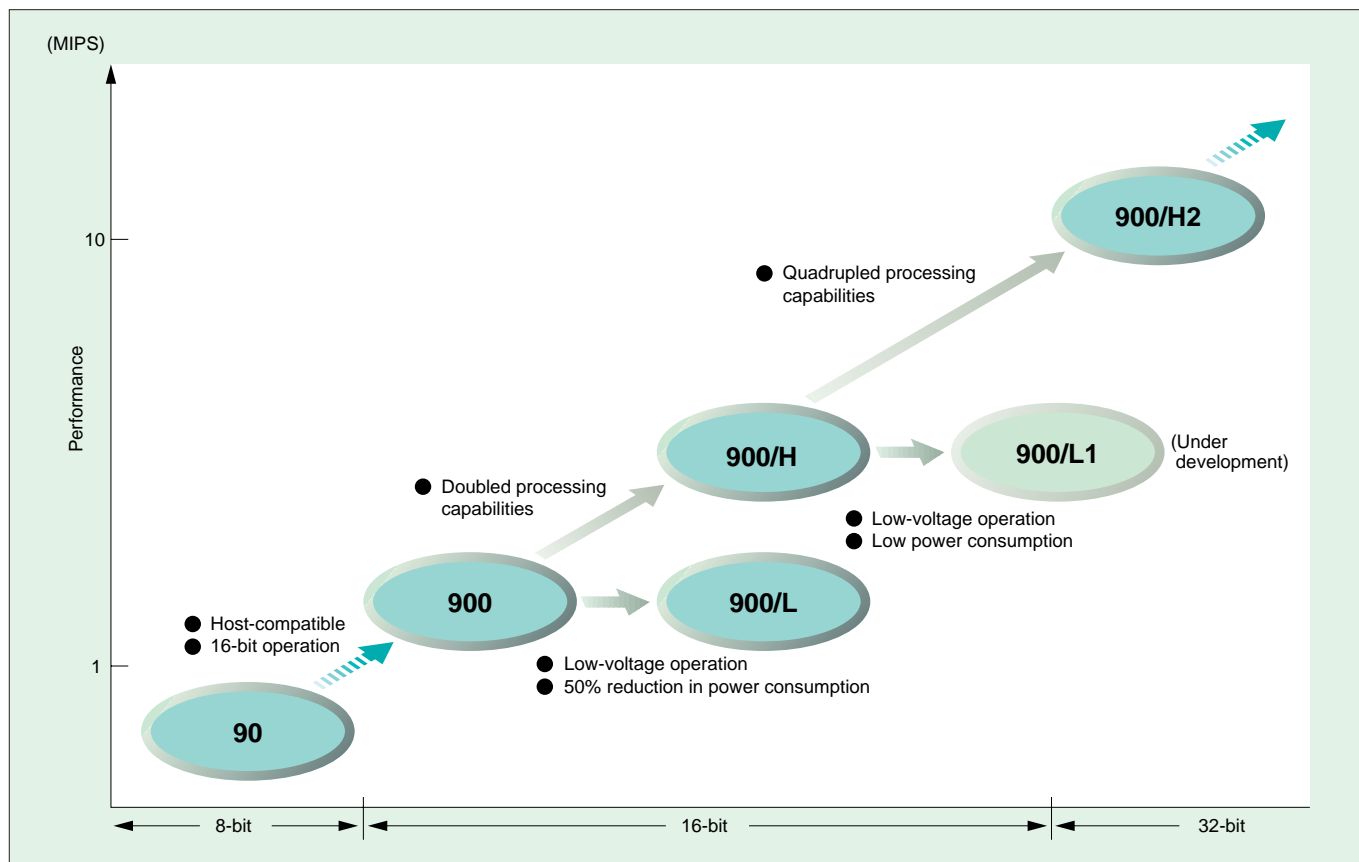
*1: Type no. suffixes: −40 to 85°C/QFJ52 = RT
−40 to 105°C/QFJ52 = WT

11

16/32-bit Microcontrollers

900 Family

These 16/32-bit microcontrollers were designed to realize improved C language code efficiency.

Core Deployment Corresponding to the Application

Core Features

Item	900,900/L Series	900/H Series	900/H2 Series
Max. operating frequency (@ input frequency)	10 MHz(@20 MHz)	12.5 MHz(@25 MHz)	20 MHz(@10 MHz)
Min. instruction execution time	200ns	160ns	50ns
Address space	Max. 16M bytes of linear address space for both program and data		
Data transfer rate (micro DMA)	1.6 μs	0.64 μs	0.25 μs
32-bit length data processing instructions	Transfer, arithmetic processing, logic processing, shift instructions		
Bit processing instructions	Transfer, logic processing, test, set, reset, search		
Multiplication instruction execution time (16 x 16→32)	2.6 μs	960ns	600ns
Dynamic bus sizing	8/16 bits		8/16/32 bits

Device	Functions	ROM (bytes)	RAM (bytes)	I/O ports	Min. instruction execution time (ns)	Operating voltage (V)	Operating temperature (˚C)	Package
★TMP95FW86F	SIC/UART x 1 (UART x 2) 16-bit timer x 3 16-bit compare x 10 to 14 16-bit capture x 2 to 6 PWM: 8 bits x 3 10-bit A/D converter x 12	128K (Note)	4K	77	200	Vcc = 5 V Vpp = 12 V	−40 to 85	QFP100
☆TMP93CM82F	SCI x 1, SCI/UART x 1, UART x 2 18-bit timer x 1 16-bit compare x 8 (output) 16-bit capture x 6 (input) 10-bit A/D converter x 8	MASK 32K	2K	44	250	Vcc = 5 V	−40 to 110	QFP80
☆TMP93PM82F		OTP 32K						

☆ : Under development ★ : Samples currently being shipped   Note: Flash E^{2}PROM (USP 4, 382, 279 owned by BULLCP8)

Please refer to Toshiba's List of Microcomputer Products for information on other standard products of the TLCS-900, 900/L and 900/H series.

16-bit Microcontrollers

TLCS-9000 Sereies

CPU Features

[1] High-speed processing machine comparable to RISC
- Register-to-register operations:
  1 clock (50 ns @20 MHz).........20 MIPS peak
- 16-bit multiplication: 7 clocks (350 ns @20 MHz)

[2] Register bank machine
- 256 banks max.
- Overlap window possible

[3] Powerful instruction set
- Instruction crossing: Addressing, register and data processing widths (8, 16 and 32 bits) can be combined as desired
- Three operand instructions (ADD3, SUB3)
- Bit field instructions (data transfer of 1 to 16 bits in length)
- Product sum instructions (with or without code)
- Table jump instruction TJP: PC ← PC + (mem)

Register Configuration
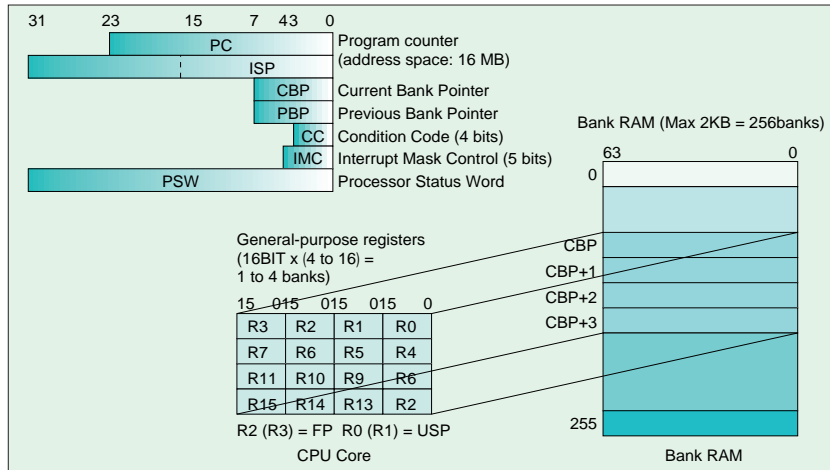
Development Tools

C Compiler for TLCS-9000

■ C Language Dramatically Enhances Development Efficiency of TLCS-9000 Series

C language was developed for the purpose of structural programming, and allows description relatively close to that of assembly language. In addition, it is also extremely effective for improving program development efficiency.

■ Language Specifications

The language specifications of the TLCS-9000 compiler comply with ANSI standards. They provide functions that are suited for the development of microcontroller application systems, and generate ROM-convertible objects.

■ Features
- Compact object generation as a result of exhaustive optimization

- Absolute addresses can be designated for each section
- Easy linking with programs created with an assembler
- Designation of interrupt processing functions: Interrupt processing statement
- Control of internal I/O: Supports header files for internal I/O control.
  The compiles of the manufacturers indicated below are also supported.
  - Microtech Research Corp., U.S.A.
  - Gaio Technology Corp.

In-circuit Emulator

The in-circuit emulator for the TLCS-9000 is supported by the manufacturers indicated below.
- Yokogawa Digital Computer Co., Ltd.
  AD200B-S560S+PT451
- Hewlett-Packard Japan, Ltd. HP64770B

List of Products

Device	Enhanced timer function versions		Built-in A/D converter versions	
	TMP97CU42AF	**TMP97CW42AF**	**TMP97CS44AF**	**★ TMP97CU44AF**
Functions	Timer : 24 bits x 1 ch Timer output : 24 ch Timer input : 8 ch Serial : 7 ch DMAC : 6 ch Memory controller : 4 ch		Timer : 24 bits x 1 ch Timer output : 16 ch Timer input : 8 ch Serial : 4 ch DMAC : 4 ch Memory controller : 4 ch A/D converter : 10 bits x 16 ch	
Built-in ROM (bytes)	96K	128K	64K	96K
Built-in RAM (bytes)	5.25K	6K	3.5K	5.25K
I/O ports	98		95	
Min. instruction execution time	62.5 @16 MHz	50 @20 MHz	62.5 @16 MHz	
Operating temperature (˚C)	−40 to 110			
Package	QFP120			
Write-once PROM version	**TMP97PU42AF**	**TMP97PW42AF**	**TMP97PU44AF**	

★ : Samples currently being shipped

32-bit RISC Processors

TMPR3903AF

The TMPR3903AF is a 32-bit, high-performance RISC ASSP that operates around the R3900 core and integrates a graphic control function, memory controller and other components suitable for building a car navigation system onto a single chip.
Use of the TMPR3903AF facilitates the creation of car navigation systems featuring reduced size, lower costs and faster speed.
In addition, as a result of being provided with a built-in graphic control function, it can also be applied to PDA, electronic instrument, Karaoke and FA display panels requiring compact size and color display functions.

Features

■ CPU Core

The TMPR3903AF uses the R3900 32-bit CPU core. Toshiba has improved this core for embedded applications with the MIPS R3000A.

● Originally developed by Toshiba based on the R3000A architecture.
● Achieves low-voltage operation, low power consumption and high-speed processing for embedded applications.
● Additional functions:
  • Loaded with instruction/data Cache (4KB/1KB)
  • Cache-lock function
  • High-speed addition and multiplication instructions for DSP functions (1 clock)
  • Branch-likely instruction
  • Non-maskable interrupts
● Operating frequency: 40 MHz (10 MHz external)
● Package: 208-pin PQFP (QFP208-P-2828-0.50)
● Power supply voltage: 3.3 V ± 0.3 V
● Max. power consumption: 800 mW
● Operating temperature: –40 to 85°C

■ Graphic Control Function

● Supports frame-buffer structure with DRAM
  • Unified memory architecture
  • Generation of RAS/CAS signals
  • Reading of display data by high-speed hyperpage mode
  • Built-in 32-bit buffer
● Four-layer overlay processing by hardware
  • Layer A   : 16 colors selectable from 65,536 colors or natural drawing (16 bits/pixel)
  • Layers B-D: 16 colors selectable from 65,536 colors (including 1 transmission color) (Colors can be set independently for layers A-D)
● Generation of synchronous signals for display (HSYNC, VSYNC/CSYNC)
● Built-in color palette and video DAC (3 channels)
● Drawing functions can be provided with software. Basic routine library (drawing commands) provided.
● Display sync signals (HSYNC, VSYNC) can be input from the outside.

Block Diagram
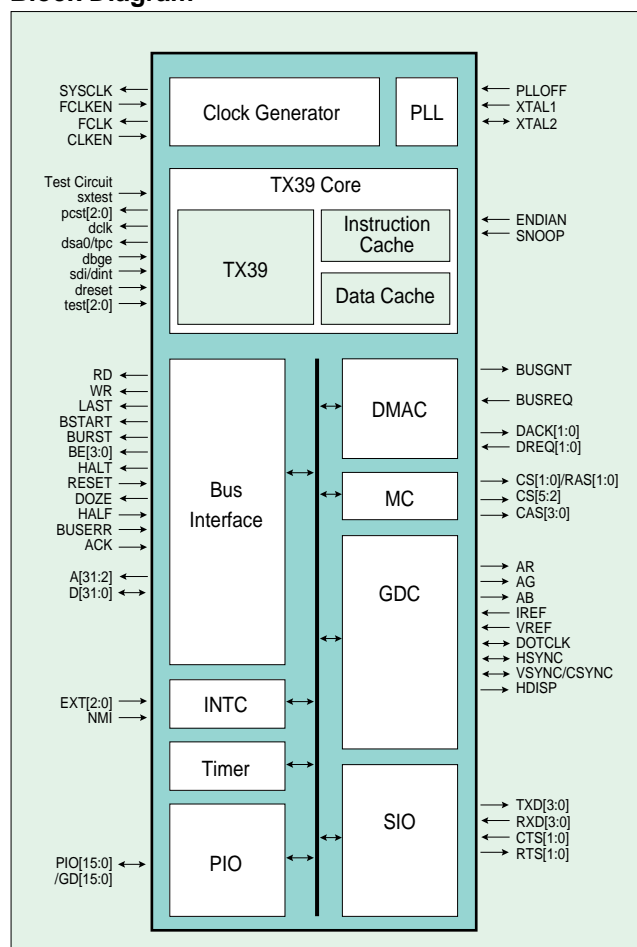
■ Peripheral Controllers

● Memory controller (MC)
  • Chip select signal: 6 outputs
● DMA controller (DMAC)
  • 2 independent channels
  • Dual address mode
● Interrupt controller (INTC)
  • Internal: 9 factors; external: 3 factors
  • Non-maskable interrupt
● Timer/counter (TIMER)
  • 24-bit up-counter, 3 channels
  • Supports watchdog timer mode
● Serial I/O (SIO)
  • 4-channel UART
  • Also used as digital RGB output

14

Vehicle-use MOS/Bipolar LSIs

Toshiba offers a complete lineup of MOS and bipolar LSIs, designed and developed for high reliability, for use in automobiles to accommodate a wide range of needs.

MOS IC/LSI

Device	Function	Features	Operating voltage (V)	Operating temperature (˚C)	Package
TC9538N/U	Car clock	Digital car clock with built-in VFD driver (variable dimming)	3.5 to 6.0	−40 to 85	SDIP42 μFP44

Bipolar ICs/LSIs

Device	Function	Features	Operating voltage (V)	Operating temperature (˚C)	Package
TD6330BP	Stepping motor driver	4-phase stepping motor driver (application example: odometer)	6 to 16		DIP16
TA8020S/AS	Lamp broken wire sensor	Lamp broken wire detection IC, 2 circuits built in	8 to 16	−40 to 85	SIP9
TA8021S		Lamp broken wire detection IC, 3 circuits built in			
TD6336P	Output expansion interface	Serial input, 8-stage parallel output/serial output	4 to 6	−40 to 105	DIP16/HSOP20
TD6337P	VFD driver	Serial input, 10-stage parallel output/serial output	4 to 6	−40 to 85	DIP18
TD6338P		Serial input, 10-stage parallel output/serial output			
TD6347S/F	Timer	Built-in power on reset, 3 inputs, open collector output	5 to 16	−40 to 85	SIP9/SSOP10
TA8025P/F	Pickup sensor interface	Automatic Vth control	4.5 to 16	−40 to 105	DIP8/SOP8
TA8026P/AP	Flasher controller	Built-in reference voltage for lamp current correction, lamp broken wire detection function	8 to 16	−40 to 110	DIP8
TA8028S	Duty controller	Analog input	8 to 16	−40 to 85	SIP7
TA8029S	FV converter	Built-in comparator (2 circuits), built-in shunt regulator	5 to 16		SIP9

TA8025F Application Circuit Example

$$K = \frac{R_3}{R_2 + R_3}$$
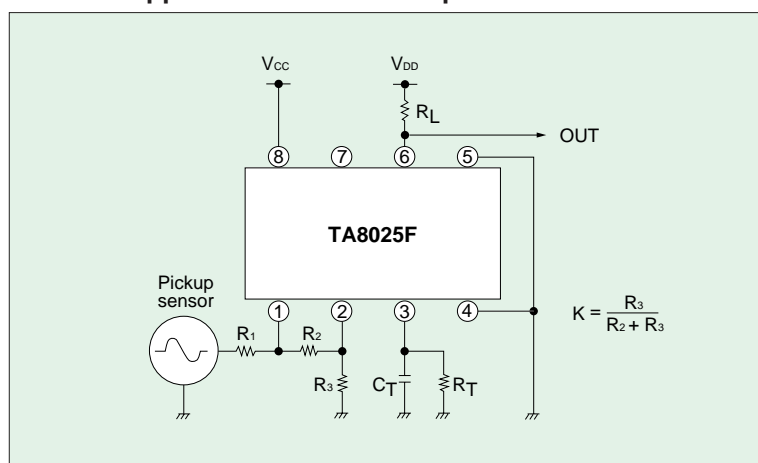
System Power Supplies

TA7900S Series

Members of the TA7900S series feature silicon monolithic bipolar linear integrated circuits designed for use in vehicle-use microcontrollers and equipped with numerous functions including a built-in system reset function.
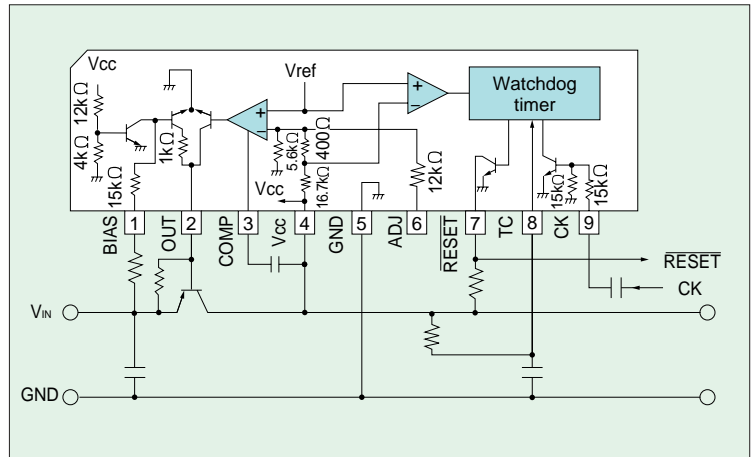
Features
- Built-in high-precision output power: 5 ± 0.25 V
- Equipped with output voltage adjustment terminals
- Built-in power on reset and low voltage reset functions (V_{REG} x 92%)
- Built-in watchdog timer
- Operating temperature range: −40 to 85°C
- Operating voltage range: Max. 40 V

TA7900S Block Diagram
Example of Pin Arrangement and Application Circuit

System Power Supply ICs

Device	Output transformer Tr.	Max. input voltage (V)	Output voltage (V)	Reset functions				Protective functions		Power supply monitor voltage (% x Vreg)	Max. standby current (mA)	Operating temperature range (°C)	Package
				Watchdog Timer	Power On Reset	Write Inhibit	CPU Monitor	Over-current	Over-voltage				
TA7900S/F	External	40	5.0 ± 0.25	○	○	—	—	—	—	92	6.5	−40 to 85	SIP9/SOP14
TA7900S-H/F-H	External	40	5.0 ± 0.5	○	○	—	—	—	—	92	6.5	−40 to 105	SIP9/SOP14
TA7900S-D/F-D			5.0 ± 0.10									−40 to 85	SIP9/SOP14
TA8000S/F	External	80	5.0 ± 0.25	○	○	—	—	—	—	85	6.5	−40 to 85	SIP9/SOP14
TA8000S-H/F-H	External	80	5.0 ± 0.5	○	○	—	—	—	—	85	6.5	−40 to 105	SIP9/SOP14
TA8000S-D/F-D			5.0 ± 0.10									−40 to 85	SIP9/SOP14
TA8001S	Internal 10 mA	30	5.0 ± 0.5	—	○	—	—	—	—	92	0.3	−40 to 85	SIP7
TA8002S	External	40	5.0 ± 0.5										
TA8002AS	External	40	5.0 ± 0.25										
TA8005S/F	External	60	5.0 ± 0.25	○	○	—	—	—	—	85	1.4	−40 to 85	SIP9/SOP14
TA8006SN	External	60	5.0 ± 0.15	○	○	○	—	○ Ext.R	○ 43 V	84/92	0.7	−40 to 105	SSIP12
TA8006ASN	External	60	5.0 ± 0.15	○	○	○	—	○ Ext.R	○ 43 V	88/96	0.7	−40 to 105	SSIP12
TA8007S	External	60	5.0 ± 0.25	○	○	—	○	—	○ 40 V	92	1.2	−40 to 105	SIP9/SSOP16
TA8007F	External	60	5.0 ± 0.15	○	○	—	○	—	○ 40 V	92	1.2	−40 to 105	SIP9/SSOP16
TA8007AS	External	60	5.0 ± 0.25	○	○	—	○	—	○ 40 V	88	1.2	−40 to 105	SIP9/SSOP16
TA8008F	External	60	5.0 ± 0.15	○	○	—	—	○ 600 mA	—	92	0.95	−40 to 105	SSOP16
TA8030S/F	—	7	—	○	○	○	—	—	—	85/92	4.5	−40 to 85	SIP7/SOP8
TA8041HA	Internal 250 mA (main) Internal 100 mA (sub)	60	5.0 ± 0.15 x 2	○	○	○	—	○ 500 mA	—	84/92 88/96	1.0	−40 to 105	HZIP12
☆**TA8042F**※1	Internal 100 mA	60	5.0 ± 0.15	○	○	—	—	○ 200 mA	—	92	1.2	−40 to 105	HSOP20
☆**TA8044F**※2	External External	60	3.4 ± 0.15 5.1 +0.15,-0.18	○	○	—	—	400 mA Ext.R	—	93	0.8	−40 to 125	SSOP16
TA8045BF	Internal 50 mA	60	5.0 ± 0.15	○	○	—	—	○ 100 mA	○ 28 V	92	0.4	−40 to 105	SSOP16

☆ : Under development 　※1: ES NOW 　※2 : ES 98. 3Q

IGBT Modules

IGBT Modules

Either 600 V-resistant or 1200 V-resistant series can be selected according to the application. In particular, Toshiba has released third-generation products for the 600 V-resistant series that offer the following features:
- High-speed switching (t_f = 0.2 μs typ.) and low saturation voltage ($V_{CE(sat)}$ = 2.1 V typ.); and,
- Full square, reverse bias safe operating area (RBSOA).

Device	V_{CES} (V)	I_C (A)	$V_{CE(sat)}$ (max.)		Switching time		
			(V)	I_C (A)	ton (typ.) (μs)	toff (typ.) (μs)	tf (typ.) (μs)
MG100J2YS50	600	100	2.7	100	0.4	0.5	0.3
MG100J6ES50	600	100	2.7	100	0.4	0.5	0.3
MG150J2YS50	600	150	2.7	150	0.4	0.5	0.3
MG200J2YS50	600	200	2.7	200	0.4	0.5	0.3
MG300J2YS50	600	300	2.7	300	0.4	0.5	0.3
MG400J1US51	600	400	2.7	400	0.4	0.5	0.3
MG400J2YS50	600	400	2.7	400	0.4	0.5	0.3
MG600J1US51	600	600	2.7	600	0.4	0.5	0.3
MG800J1US51	600	800	2.7	800	0.4	0.5	0.3
MG100Q2YS50	1200	100	3.6	100	0.2	0.6	0.3
MG150Q2YS50	1200	150	3.6	150	0.2	0.6	0.3
MG200Q1US51	1200	200	3.6	200	0.2	0.6	0.3
MG200Q2YS50	1200	200	3.6	200	0.2	0.6	0.3
MG300Q1US51	1200	300	3.6	300	0.2	0.6	0.3
MG300Q2YS50	1200	300	3.6	300	0.2	0.6	0.3
MG400Q1US51	1200	400	3.6	400	0.2	0.6	0.3
MG600Q1US51	1200	600	3.6	600	0.2	0.6	0.3

Note: Modules rated below the rated current of 100 A are also available.

Intelligent Power Modules (IPM)

An output switching device, its drive circuit and protective circuits are contained within a single package, offering the following characteristics:
- High reliability : Self-protection from overcurrent and overheating; and
- High efficiency: Greater ease of automation of assembly as a result of having more peripheral circuits and components built in.

Device	V_{CES} (V)	I_C (A)	Device	V_{CES} (V)	I_C (A)
MIG200J201H	600	200	MIG150Q201H	1200	150
MIG300J101H	600	300			
MIG400J101H	600	400	MIG200Q101H	1200	200
			MIG300Q101H	1200	300

Note: Modules rated below the rated current of 100 A are also available.

Power Drivers

Actuator Drivers

These driver ICs can be controlled by TTL-compatible input, and contain built-in overvoltage, overcurrent and over-heating protective functions.

High-side/Low-side Drivers

Function		Device	Max. voltage (V)	Output current (A)	Standby current (mA)	Self-diagnostic function	Protective functions				Package
							Overcurrent detection		Overheating detection (°C)	Overvoltage detection (V)	
							Current (A)	Function			
High-side driver	2 circuits	☆TA8061H	60	1.5	0.5	Short/open	3.0	Latch	150	27.5	HZIP12
High-side driver	2 circuits	TA8062S	50	0.3	5.0	——	0.55	Limiter		30	SIP7
	2 circuits	☆TA8062AS		0.3	0.1	——	0.55	Limiter		30	SIP7
	4 circuits	☆TA8063F	60	0.5 x 4	0.1	Short	1.0	Switching		30	HSOP20
Low-side driver	2 circuits	TA8066AS	50	0.3	0.1	——	0.55	Limiter	150	30	SIP7
	4 circuits	TA8069F	60	0.5 x 4	0.1	Short	1.0	Switching		30	HSOP20

☆ : Under development   ES Now

TA8069F Block Diagram
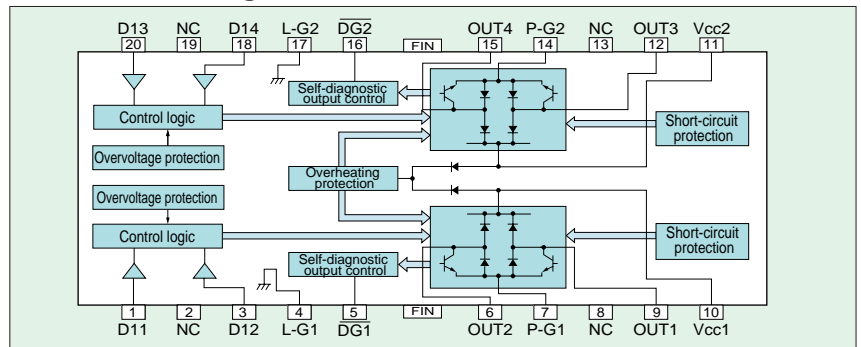
Motor Drivers

These drivers are direct-driving bidirectional DC motors. Forward, reverse, stop and brake modes are available depending on the combination of inputs, and various protective functions (overvoltage, overcurrent and overheating) are built in.

H Switch Motor Drivers

Function		Device	Max. voltage (V)	Output current (A)	Max. standby current (mA)	Self-diagnostic function	Protective functions				Package
							Overcurrent detection		Overheating detection (°C)	Overvoltage detection (V)	
							Current (A)	Function			
H switch motor driver	1 circuit	TA8050P	60	1.5	15.0	——	3.0	Switching	150	27.5	HSIP7
		TA8050AK		1.5	0.1	——	3.3	Switching		30.0	HSIP7(BS)
		TA8051P		3.0	0.1	——	5.0	Switching		27.5	HZIP12
		TA8052S	50	0.3	5.0	——	0.55	Limiter		30.0	SIP7
		TA8052AS		0.3	0.1	——	0.55	Limiter		30.0	SIP7
		TA8053H	60	3.0	0.1	Short	5.0	Switching		29.0	HZIP12
		TA8080K		1.0	15.0	——	2.0	Switching		30.0	HSIP7
		TA8081P		0.7	0.1	Short	1.5	Switching		30.0	DIP16
	2 circuits	TA8082H		1.5 X 2	0.1	Short/open	3.0	Switching		32.5	HZIP15
		TA8083P/F		0.5 X 2	0.1	Short	1.0	Switching		30.0	DIP16/HSOP20
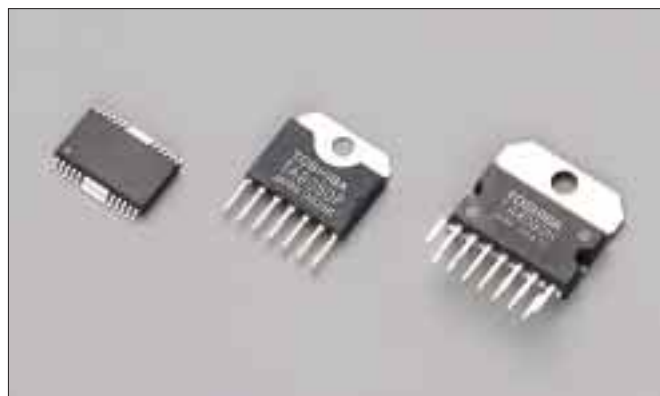
TA8050P Block Diagram

18
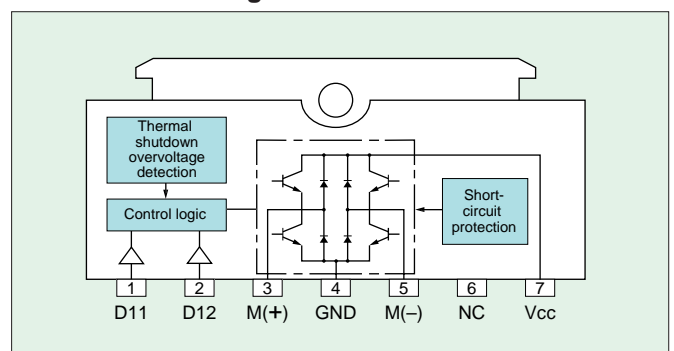
ASIC

What features and functions a new product should have, and what additional functions and new ideas can be incorporated are factors provided by ASICs that are indispensable in the diverse development of new products. In particular, as the current life cycle of products is becoming shorter and shorter, competitive strength in the marketplace depends upon how fast a new product can be developed with higher added value. Toshiba's gate-array and cell-based ICs respond to the growing need for ASICs in a flexible and developer-friendly manner.

Gate Array and Cell-based ICs

Series name	TC140G series	TC160G series	TC25SC series
Process technology	1.0 μm	0.8 μm	0.8 μm
	HC^{2}MOS silicon gates, 2-layer metal wiring		
Delay time (internal gate, typical)	0.4 ns	0.3 ns	0.33 ns
Number of gates	1K to 68K	4K to 210K	700K to 100K
The TC140G series/TC160G series consist of gate array ICs, while the TC25SC series consists of cell-based ICs. Highly functional cells such as RAM and ROM can be loaded onto these gate array and cell-based ICs.			

Wide Variety of Package Variations

Toshiba offers a wide variety of packages, from 16-pin DIP to 160-pin QPF-P, to respond to a diverse range of ASIC needs.

Mounting method \ Material	Plastic
Lead-inserted type	16-, 18-, 24-, 28-, 40-, 42- and 48-pin DIP
	42- and 64-pin SDIP
Surface-mounted type	100-, 120-, 144- and 160-pin QPF-P

Fully Customized ICs/LSIs

The field of applications for vehicle-use onboard electronic systems is continuously expanding, and the need is growing for multiple functions, high-precision and high-density mounting. Although Toshiba provides a complete lineup of standard vehicle-use semiconductor devices to accommodate these needs, Toshiba also recommends fully customized and semi-customized products to facilitate more appropriate designs and greater task dedication.

Flow of Development Work
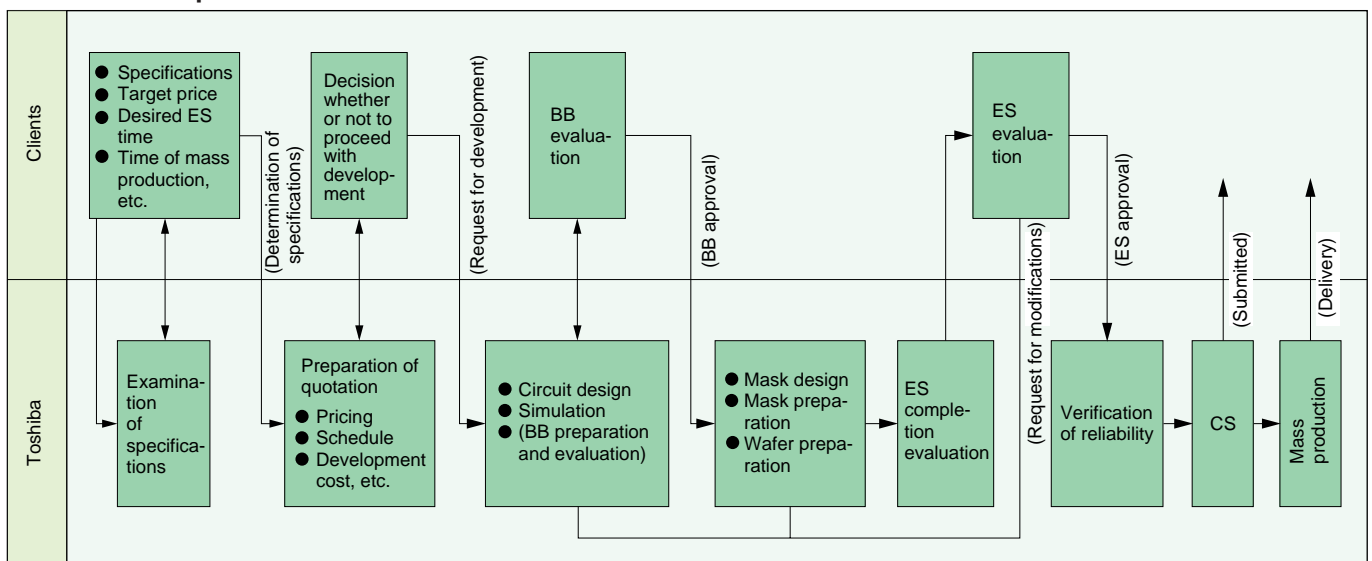
Toshiba's Production Process
CMOS, bipolar, bipolar + I^{2}L, BiCMOS, hybrid IC, multi-chip package IC (MCP)
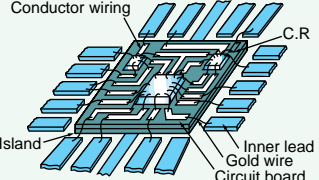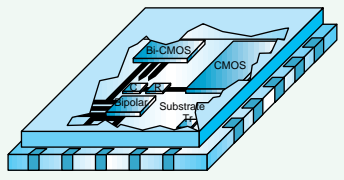
19

MCP (Multi-Chip Packages)
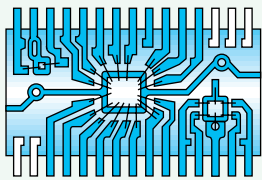
> **Multi-chip packages are the fruit of new integration technology, which enables integration of multiple semiconductor chips with existing envelopes into a single package.**

Multi-chip packages consist of a multiple number of LSIs and individual semiconductor devices loaded onto a lead frame. The devices are connected with bonding wires via the lead frame or a circuit board, and contained in a standard LSI package by transfer molding. As a result, the level of reliability of the sealed package is comparable to that of conventional monolithic ICs.

Since this technology can utilize existing LS assembly and testing processes without requiring any modifications, it enables production at a lower cost than hybrid ICs. What is more, since it allows the use of existing LSIs and discrete semiconductor devices, reliable ICs can be provided at minimal development risk.

Multi-Chip Technology

Toshiba's multi-chip technology can be broadly divided into general type, high-density type and Micro Assembly System Technology (MAST).

Type	Multi-chip package		MAST
Concept	General type	High-density type	Chips are loaded onto a circuit board, producing an LCC-type package with one side that is resin-sealed
	Simple integration of multiple chips into a single package	Interconnection of chips by loading a circuit board onto a lead frame island	
Surface mounting area	☆	☆☆	
No. of parts	☆	☆☆	
Configuration		Conductor wiring / C.R / Island / Inner lead / Gold wire / Circuit board	Bi-CMOS / CMOS / Bipolar / Substrate

Example of Multi-Chip Mounting

Toshiba's multi-chip technology enables high-density mounting as illustrated below.

Multi-chip package — Mold — MAST
Mounting substrate
Frame — Substrate — Substrate
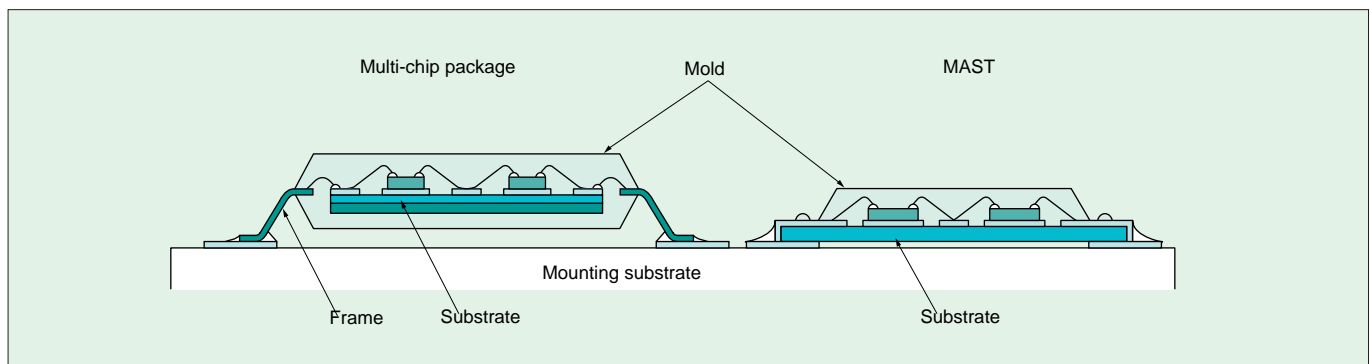
Features of Multi-Chip Packages

Toshiba's multi-chip technology offers the features described below.

Features / Benefits

Integration of different processes in a single package →
● High performance (high frequency, low noise, large current, etc.)
● Systemization (microcontroller, driver, etc.)

Utilization of existing chip packages →
● QTAT, reliable operation
● High reliability

Integration of multiple chips in a single package →
● Significant improvement of space factor
● Significant reduction in the number of parts

Power MOSFET Devices

L²-π-MOSV

This ultra-low on resistance series realizes high-density integration of 4.4 Mcells/inch^2 through the use of Toshiba's original microtechnology.

Lineup

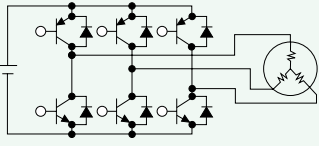| Device	Max. rating			Package	RDS (ON) max. (Ω)	
	V_{DSS} (V)	I_D (A)	P_D (W)		VGS = 10 V	VGS = 4 V
2SK2614	50	20	40	DP	0.046	0.08
2SK2507	50	25	25	TO-220(NIS)	0.046	0.08
2SK2886	50	45	40	TO-220(NIS)	0.02	0.036
2SK2550 Note 1	50	45	100	TO-3P(N)	0.03	——
2SK2551 Note 1	50	50	150	TO-3P(N)	0.011	——
2SK2745	50	50	150	TO-3P(N)	0.0095	0.016
2SK2615	60	2	1.5	PW MINI	0.3	0.44
2SK2229	60	5	1.3	TPS	0.16	0.30
2SK2741	60	5	2.5	SP	0.16	0.30
2SK2231	60	5	20	PW MOLD	0.16	0.30
2SK2782	60	20	40	DP	0.055	0.09
2SK2232	60	25	35	TO-220(NIS)	0.046	0.08
2SK2311	60	25	40	TO-220FL/SM	0.046	0.08
2SK2385	60	36	40	TO-220(NIS)	0.030	0.055
2SK2233	60	45	100	TO-3P(N)	0.030	0.055
2SK2266	60	45	65	TO-220FL/SM	0.030	0.055
2SK2398 Note 1	60	45	125	TO-3P(N)	0.030	——
2SK2312	60	45	45	TO-220(NIS)	0.017	0.025
2SK2376	60	45	100	TO-220FL/SM	0.017	0.025
2SK2173	60	50	125	TO-3P(N)	0.017	0.025
2SK2445 Note 1	60	50	150	TO-3P(N)	0.018	——
2SK2313	60	60	150	TO-3P(N)	0.011	0.015
2SK2267	60	60	150	TO-3P(L)	0.011	0.015
2SK2200	100	3	1.3	TPS	0.35	0.45
2SK2201	100	3	20	PW MOLD	0.35	0.45
2SK2399	100	5	20	PW MOLD	0.23	0.30
2SK2400	100	5	1.3	TPS	0.23	0.30
2SK2391	100	20	35	TO-220(NIS)	0.085	0.13
2SK2314	100	27	50	TO-220AB	0.085	0.13
2SK2789	100	27	60	TO-220FL/SM	0.085	0.13
2SJ360	−60	−1	0.5	PW MINI	0.73	1.2
2SJ377	−60	−5	20	PW MOLD	0.19	0.28
2SJ378	−60	−5	1.3	TPS	0.19	0.28
2SJ438	−60	−5	25	TO-220(NIS)	0.19	0.28
2SJ349	−60	−20	35	TO-220(NIS)	0.045	0.090
2SJ401	−60	−20	100	TO-220FL/SM	0.045	0.090
2SJ334	−60	−30	45	TO-220(NIS)	0.038	0.060
2SJ402	−60	−30	100	TO-220FL/SM	0.038	0.060
2SJ380	−100	−12	35	TO-220(NIS)	0.21	0.32
2SJ412	−100	−16	60	TO-220FL/SM	0.21	0.32
2SJ464	−100	−18	45	TO-220(NIS)	0.09	0.12

Note 1: 10 V drive type

Power Modules

These multi-chip modules consist of a multiple number of transistors, MOSFET devices, diodes or other discrete chips loaded on a frame.
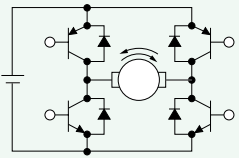
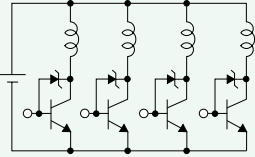**Power Transisters and MOSFET Modules**

	S-10	S-12	F-12
Package			

3-phase Hall Motors (3-phase Bridge Drivers)

Basic corresponding block	Classification	Device	Package	Rating V	Rating A	Configuration	Remarks
	MOSFET	MP6403	S-12	±60	±5	P x 3 + N x 3	
		MP6801	F-12	±60	±10	P x 3 + N x 3	

DC Brush Motors (H-bridge Drivers)

	MOSFET	MP4207	S-10	±60	±5	P x 2 + N x 2	
	Darlington	MP4005	S-10	±80	±4	P x 2 + N x 2	
		MP4503	F-12	±80	±4	P x 2 + N x 2	

2-phase Stepping Motors, General-purpose Solenoids (with Built-in Zener Diode between C-B, 4 In1)

	MOSFET	MP4208	S-10	−60	−5	P x 4	Without Zener diodes between D–G
	Darlington with Zener diodes	MP4101	S-10	60 ± 10	4	N x 4	
		MP4020	S-10	60 ± 10	5	N x 4	Large energy resistance
		MP4021	S-10	100 ± 15	2	N x 4	
		MP4024	S-10	100 ± 15	3	N x 4	Built-in bias resistance

2-phase Stepping Motors, General-purpose Solenoids (with Built-in Flyback Voltage Absorption Diodes, 4 In 1)

	MOSFET	MP4403	S-12	120	5	N x 4	
		MP4703	F-12	120	5	N x 4	
	Darlington	MP4303	S-12	100	2	N x 4	
	High-β	MP4304	S-12	80	3	N x 4	Low $V_{CE(sat)}$

Rectifiers

Diodes

Switching Diodes (S-MINI)

	VR = 80 V, IO = 100 mA	Circuit examples
Anode common	**1SS181**	
Cathode common	**1SS184**	
Series	**1SS226**	
Single	**1SS187, 1SS190, 1SS193, 1SS196**	

S-MINI

Zener Diodes

P (W)	Package	Device	Remarks
0.2	S-MINI	**02CZ2.0 to 47**	For hybrid ICs

Thyristors

Rectifiers

Application example	Rated current (A)	Withstand voltage (V)		
		400	600	1000
Power supply rectification, harness and flywheel	1.0	**U1GC44**	**U1JC44**	
		S5688G	**S5688J**	**S5688N**
	1.2	**1S1887A**	**1S1888A**	
Converter output rectification	0.5	**U05GH44**	**U05JH44**	
		TVR5G	**TVR5J**	
	1.0	**1GH45**	**1JH45**	
	3.0	**3GH45**	**3JH45**	
Flywheel	1.0	**1G4B42**	**1J4B42**	
	5.0	**5GL2CZ47A**	**5JLZ47**	
Battery reverse connection protection	1.5	**1R5GZ41**	**1R5JZ41**	
	2.0	**U2GC44**	**U2JC44**	
	3.0	**3GZ41**	**3JZ41**	

Zener Diodes

Application example	Rated power (W)	Withstand energy* (W)	Device
Surge absorption	1.0	230	U1ZB6.8 series
		320	1ZB6.8 series
	1.5	800	2Z12 series
	2.0	600	U2Z12 series
	3.0	1000	3Z12 series
	5.0	6000	U5ZA27, U5ZA27C

∗ Limit value for square wave (tw = 1 ms)

Thyristors

Application example	Rated current (A)	Withstand voltage (V)		
		400	600	800
CDI and DC switches	3.0	**SF3G48**	**SF3J48**	
		SF3GZ47	**SF3JZ47**	
	5.0	**SF5G42**	**SF5J42**	
Disk charge head lamp				**S6992**

Regulator and CDI Ignition Diagram for 2-wheel Vehicles
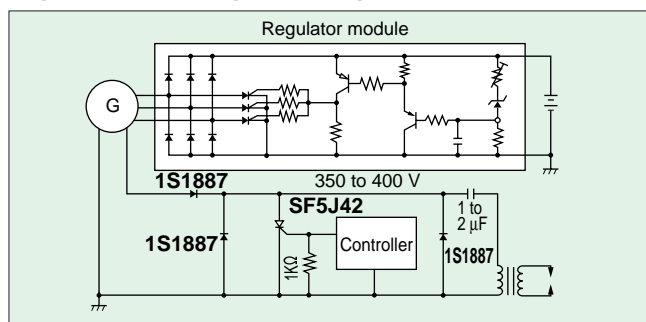
CDI Ignition Diagram for 4-wheel Vehicles

Other Circuits

23
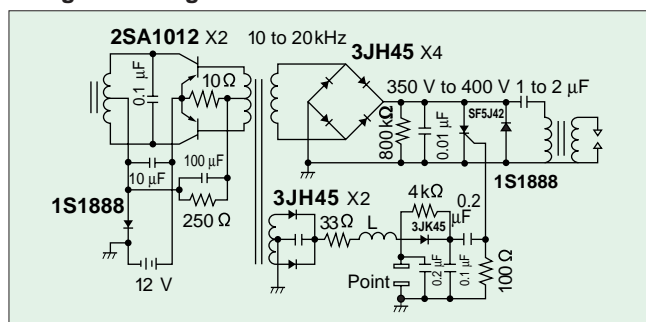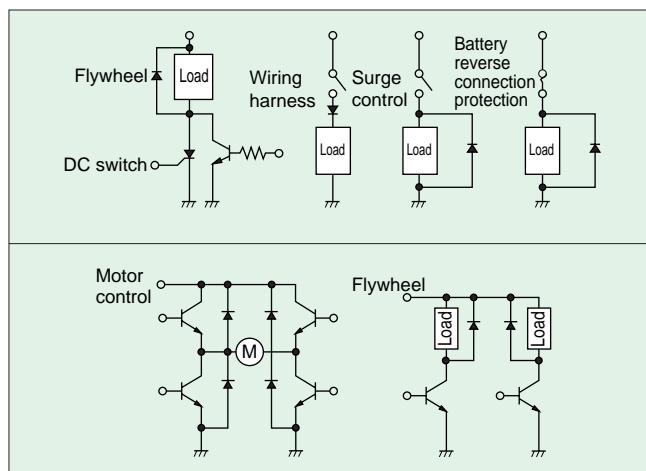
LED Lamps

TOSBRIGHT® – High Brightness LED Lamp Series

Many types of LED lamps are used in illumination applications both on the outside and inside of vehicles by taking advantage of their ease of design, low power consumption and high reliability.
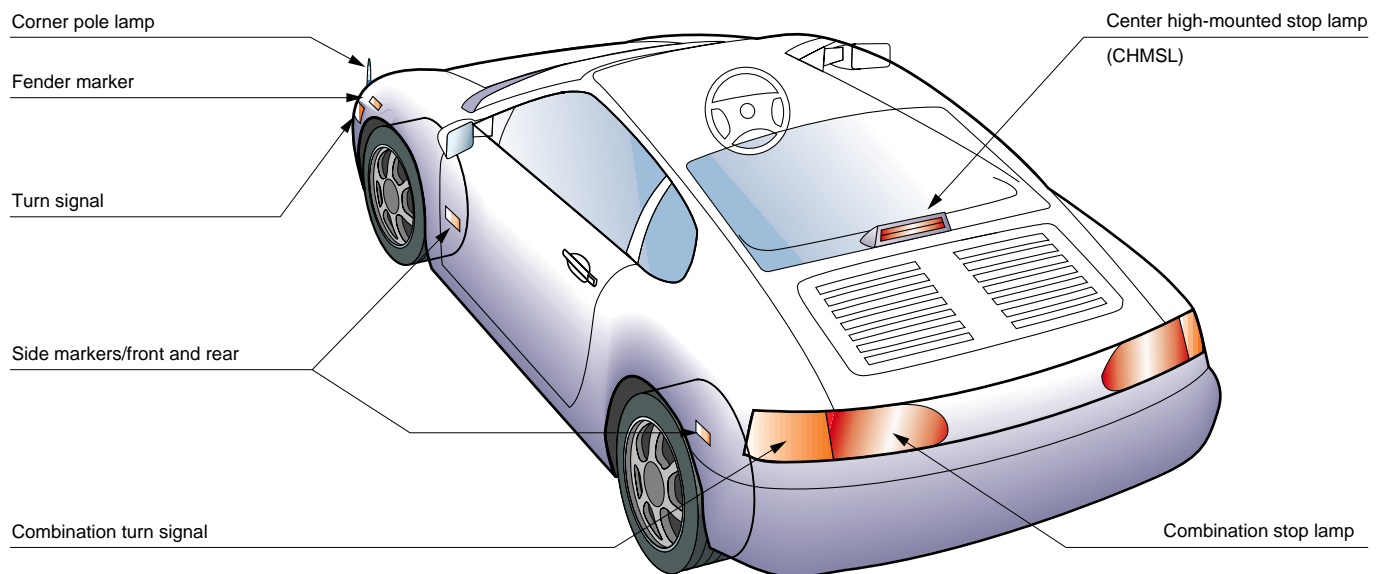They also offer outstanding space efficiency from the viewpoint of maintenance.

Features
- Standard products are available that offer high reliability (weather resistance).
  T_{stg} = –40 to 120˚C T_{opr} = –30 to 85˚C
- Rapid response
- New lineup for the TLGE and TLPGE series. Realizes even higher brightness for green LED lamps.
- InGaAlP LEDs achieve higher levels of brightness for red, orange, yellow, green and bright green lamps, making it possible to switch from bulbs to LED lamps.

Exterior Use

Corner pole lamp

Fender marker

Turn signal

Side markers/front and rear

Combination turn signal

Center high-mounted stop lamp (CHMSL)

Combination stop lamp

ø5 mm Diameter Type

Appear-ance	Device	Typical characteristics						
		Typ. luminosity (mcd)	Emission wavelength λp (nm)	Directionality (˚)	Operating temperature (˚C)	Luminescent material	Response time *(ns)	Recommended applications
A	**TLSH156P**	1000	623	30	–30 to 85	InGaAlP	60	** CHMSL Rear combination lamps
B	**TLSH157P**	2300	623	22	–30 to 85	InGaAlP	60	
C	**TLPGE183P**	1200	562	7	–30 to 85	InGaAlP	60	Corner pole lamps Fender markers
C	**TLGE183P**	4500	574	7	–30 to 85	InGaAlP	60	
B	**TLRH157P**	1600	644	22	–30 to 85	InGaAlP	60	Side markers Turn signals Rear combination lamps
B	**TLOH157P**	2000	612	22	–30 to 85	InGaAlP	60	
A	**TLYH156P**	1200	590	30	–30 to 85	InGaAlP	60	
B	**TLYH157P**	2300	590	22	–30 to 85	InGaAlP	60	

Preliminary discussions regarding compatibility of specifications are required
in the case of using LED lamps in automotive applications.
Please contact our sales representative when considering such applications.

* Response time: Standard rise time
** CHMSL: Center high-mounted stop lamp
Measurement conditions: Ta = 25˚C, IF = 20 mA

Backlighting Illumination

Appear-ance	Device	Typical characteristics						Recommended applications
		Typ. brightness (mcd)	Emission wavelength λp (nm)	Directionality (°)	Operating temperature Topr (°C)	Luminescent material	Dimensions (mm)	
D	**TLGD233P**	250	567	——	−20 to 75	GaP	□ 2.5 x 5	Heater controls Power windows
E	**TLYH262**	300	590	70	−30 to 85	InGaAlP	ϕ3.1	Instrument panel Monitor backlighting
E	**TLRH262**	220	644	70	−30 to 85	InGaAlP	ϕ3.1	
E	**TLOH262**	260	612	70	−30 to 85	InGaAlP	ϕ3.1	
E	TLGE262	150	547	65	−30 to 85	InGaAlP	ϕ3.1	
E	TLPEG262	45	562	65	−30 to 85	InGaAlP	ϕ3.1	
F	**TLSH180P**	8000	623	8	−30 to 85	InGaAlP	ϕ5	Meter needles
F	**TLOH180P**	7000	612	8	−30 to 85	InGaAlP	ϕ5	

TOSBRIGHT is a registered trademark of Toshiba Corp.

Appearance

A   B   C   D   E   F
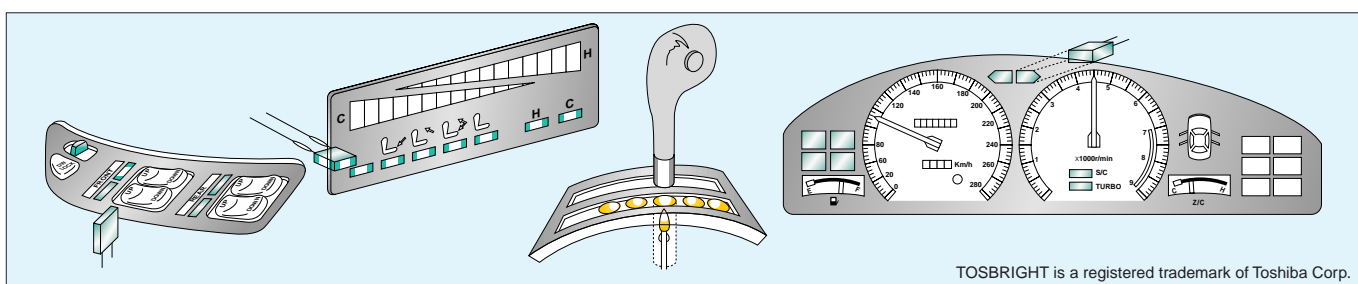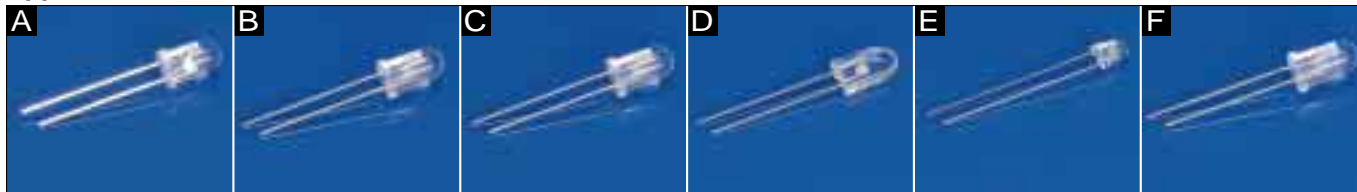
Photocouplers

● Toshiba offers a lineup of TLP559/TLP114A photocouplers that are suitable for driving IPM/IGM intelligent power module interfaces.

Example of Application Circuit Configuration
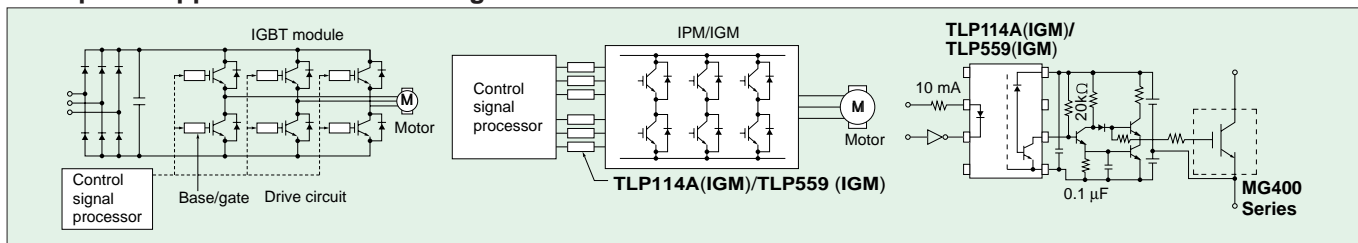
Device	Pin configuration	Features	Response time (typ.)	Output current	$I_{F\ (IN)}$	V_{CC}	Isolation voltage (for 1 minute)
TLP114A (IGM)	1 ☐ ☐ 8 2 ☐ ☐ 7 3 ☐ ☐ 6 4 ☐ ☐ 5	5-pin mini flat	$|t_{PLH} - t_{PHL}| \leq 0.7\ \mu s$ 0.45 μs	25%(min.) to 75% (max.)	16 mA	30 V (max.)	3750 Vrms
TLP559 (IGM)		Without base connection Shielded high CMR		Current transfer ratio			2500 Vrms

Photocouplers are intended for use in general electronic equipment (such as office equipment, communication equipment, measuring instruments and home appliances).
Please contact our sales representative when exceptionally high levels of quality and reliability are required for vehicle use.

Optical Transmission Device: TOSLINK ®

Accompanying the dramatic improvements in the performance of audio systems and vehicle navigation systems achieved in recent years, there has been an increase in signal capacity and the number of cables.
This has resulted, however, in problems relating to signal noise and increased vehicle weight.
Signal transmission by means of optical cables provides an effective way of eliminating EMI noise from system signals and reducing cable weight.

Features of TOSLINK

● TTL interface, +5 V power supply
● The transmitting unit contains a built-in transmission circuit that drives the LED using a differential circuit.
● The receiving unit contains a built-in waveform shaping circuit that uses an ATC (Automatic Threshold Control) circuit.

Features of Optical Fiber

● Not affected by noise and does not generate noise.
● Narrow core and light weight.

Applications

● Audio systems
● Navigation systems

Configuration of Optical Module
Example of an optical receiving module (resin molded package)

- Receptacle
- Transparent resin mold
- Receiving IC
- PIN-PD
- Receiving unit

Connection method

Transmitting module **TOTX193**
Fixed to printed circuit board
TTL input
+5 V
GND
Fixed to printed circuit board

Optical fiber with optical connectors

(bottom view)

Receiving module **TORX193**
GND
TTL output
+5 V
GND
GND
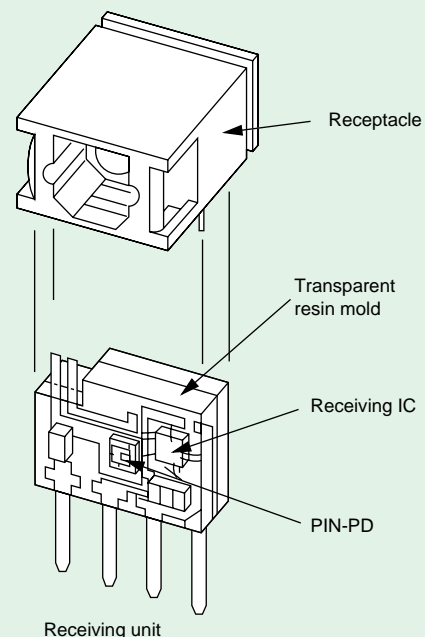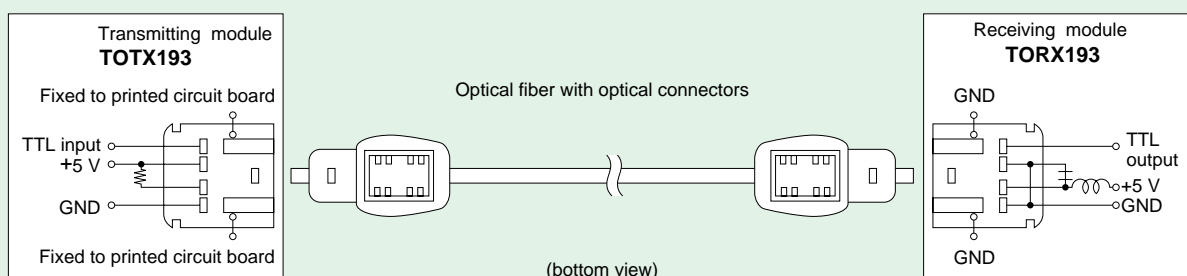
(Ta=25℃)

Product description / Item	Optical unit **TOTU180A** **TORU180**	Optical unit **TOTU193** **TORU193**	Optical module **TOTX193** **TORX193**
Shape			
Optical unit structure	Ceramic package	Resin package	
Type	Simplex		
Data rate	DC to 6 Mb/s (NRZ)		
Transmission distance	up to 40 m	up to 10 m	
Pulse width distortion	±55ns	±25ns	
Operating temperature	−40 to 85℃		
Applicable optical connector	—	—	JIS F05 type
Applicable optical fiber	APF (980 μm/1000 μm)		APF (980 μm/1000 μm)

Notes: 1) TOSLINK is a trademark of Toshiba Corp.
2) Do not use these products in applications in which their misoperation or malfunction can lead to loss of human life, injury or property damage.

APF: All Plastic Fiber

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