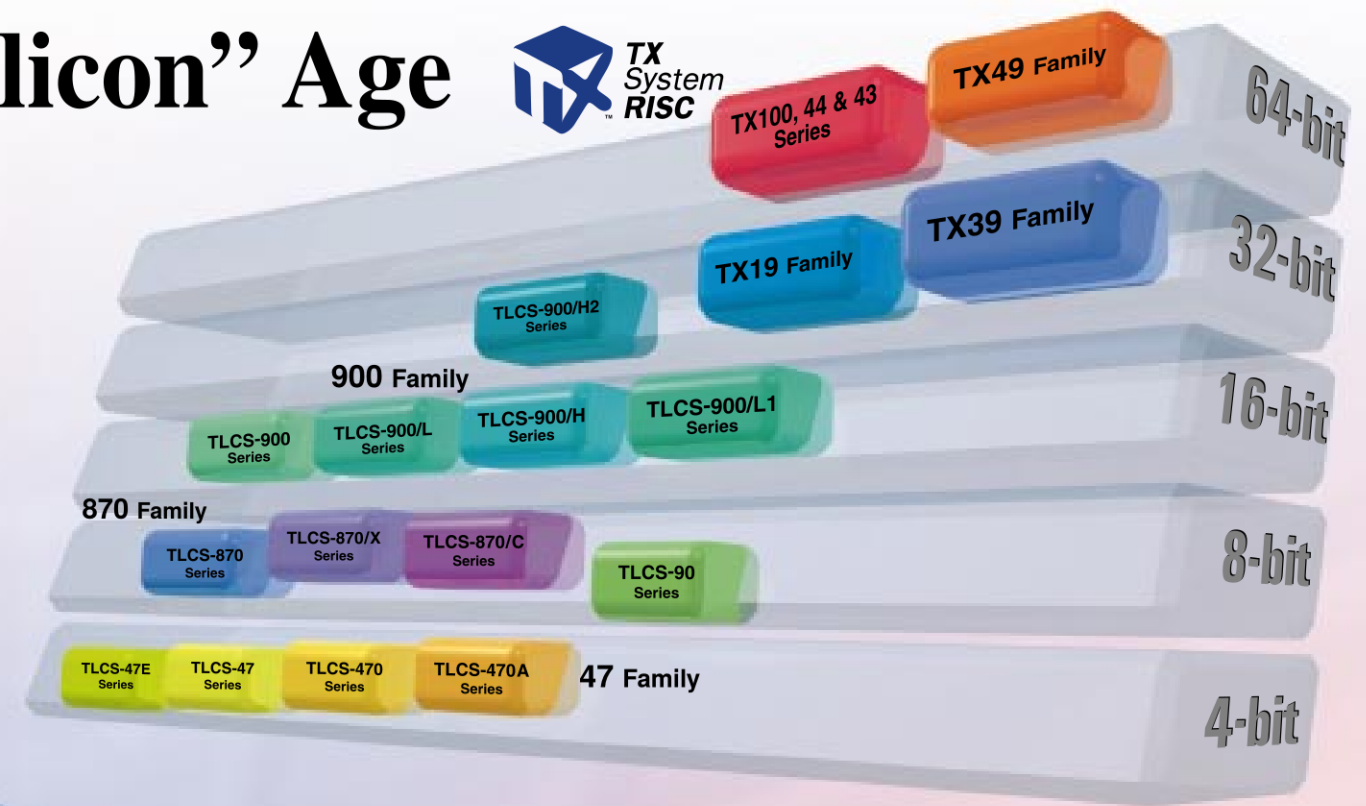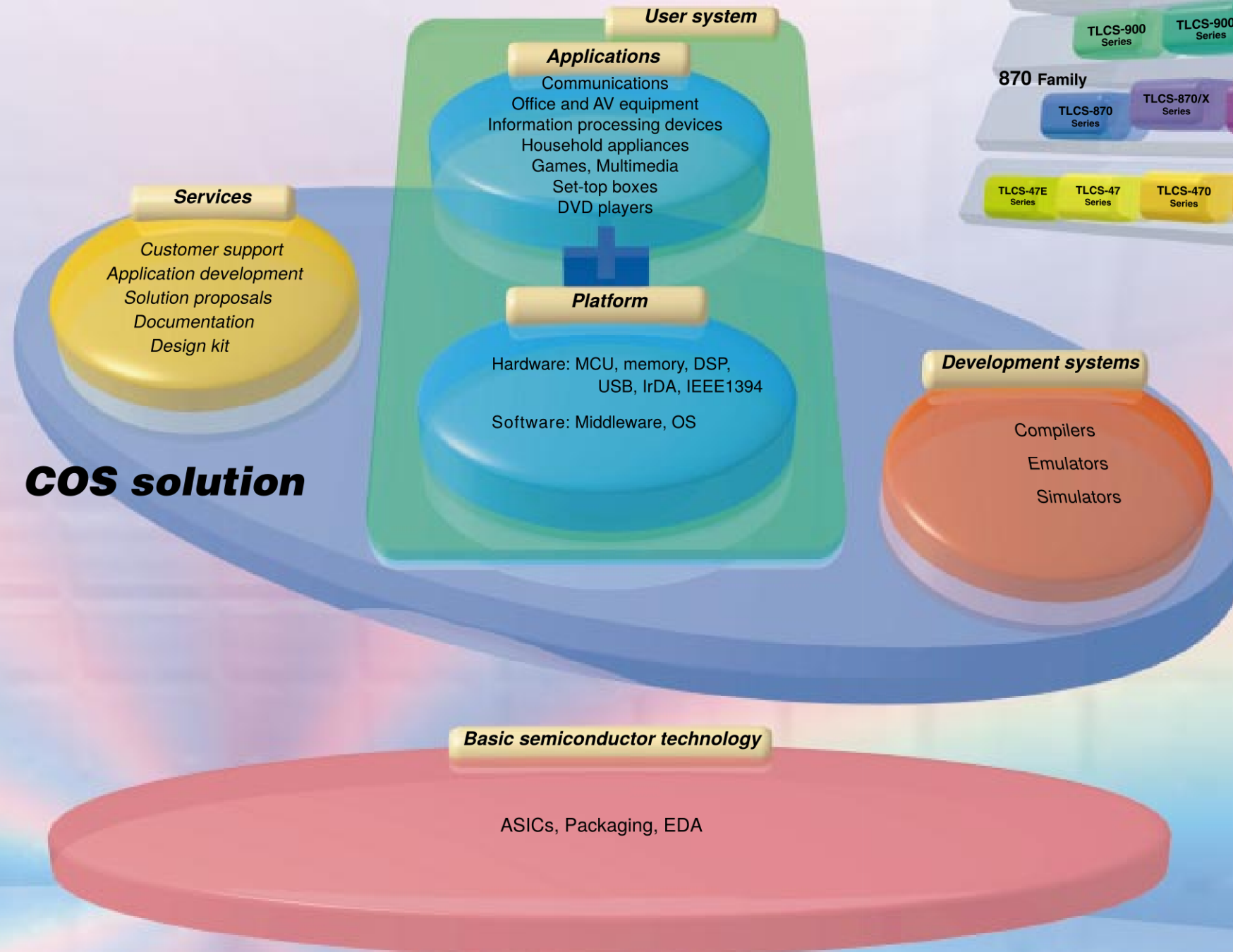# TOSHIBA

Microcomputer

PRODUCT GUIDE

The Dawn of the "Computer-on-Silicon" Age

TX System RISC

Applications continue to diversify, and devices are becoming more highly integrated. To ensure that your product will be brought to market on time, Toshiba offers a "computer-on-silicon" (COS) solution that combines computer and silicon technologies.

The COS solution is not simply a combination of hardware components plus a basic software library. Rather, COS provides you with total support including extensive services and a line of development systems. This means that you can devote all your efforts to developing your application.

64-bit

TX100, 44 & 43 Series

TX49 Family

32-bit

TX19 Family

TX39 Family

TLCS-900/H2 Series

16-bit

900 Family

TLCS-900 Series

TLCS-900/L Series

TLCS-900/H Series

TLCS-900/L1 Series

870 Family

TLCS-870 Series

TLCS-870/X Series

TLCS-870/C Series

TLCS-90 Series

8-bit

TLCS-47E Series

TLCS-47 Series

TLCS-470 Series

TLCS-470A Series

47 Family

4-bit

User system

Applications

Communications
Office and AV equipment
Information processing devices
Household appliances
Games, Multimedia
Set-top boxes
DVD players

Platform

Hardware: MCU, memory, DSP,
USB, IrDA, IEEE1394

Software: Middleware, OS

Services

Customer support
Application development
Solution proposals
Documentation
Design kit

COS solution

Development systems

Compilers

Emulators

Simulators

Basic semiconductor technology

ASICs, Packaging, EDA

C O N T E N T S

To meet diverse customer needs, Toshiba provides a wide range of CISC and RISC microcomputers. The product line includes 32-bit and 64-bit TX System RISCs and also features 4-bit to 32-bit original Toshiba microcontrollers. This wide selection allows you to find the best product for your application.

Microcomputers of the COS age – Proposal for a new COS solution from Toshiba.

TX
System
RISC

RISC stands for **r**educed **i**nstruction **s**et **c**omputer. By limiting the computer instruction set used, this architecture enables instructions to be executed at high speed. Compared to the conventional **CISC** (complex instruction set computer), its simplified circuit structure offers attractive features such as increased execution speed and reduced power consumption.

Since we introduced the RISC processor technology (pioneered by the MIPS Group in the U.S.A.) into our product line, we at Toshiba have marketed various RISC products, including the **TX39** Family of embedded 32-bit processors, the **TX43** Series of 64-bit processors for office equipment, and the **TX44**/**TX100** Series of 64-bit processors for high-end workstations. More recently, the **TX19** Family of processors, with part of the instruction set compressed to 16 bits, and the **TX49** Family of 64-bit processors for embedded use have been added to the product line.

■TX System RISC road map

TX19 Family

TX System RISC
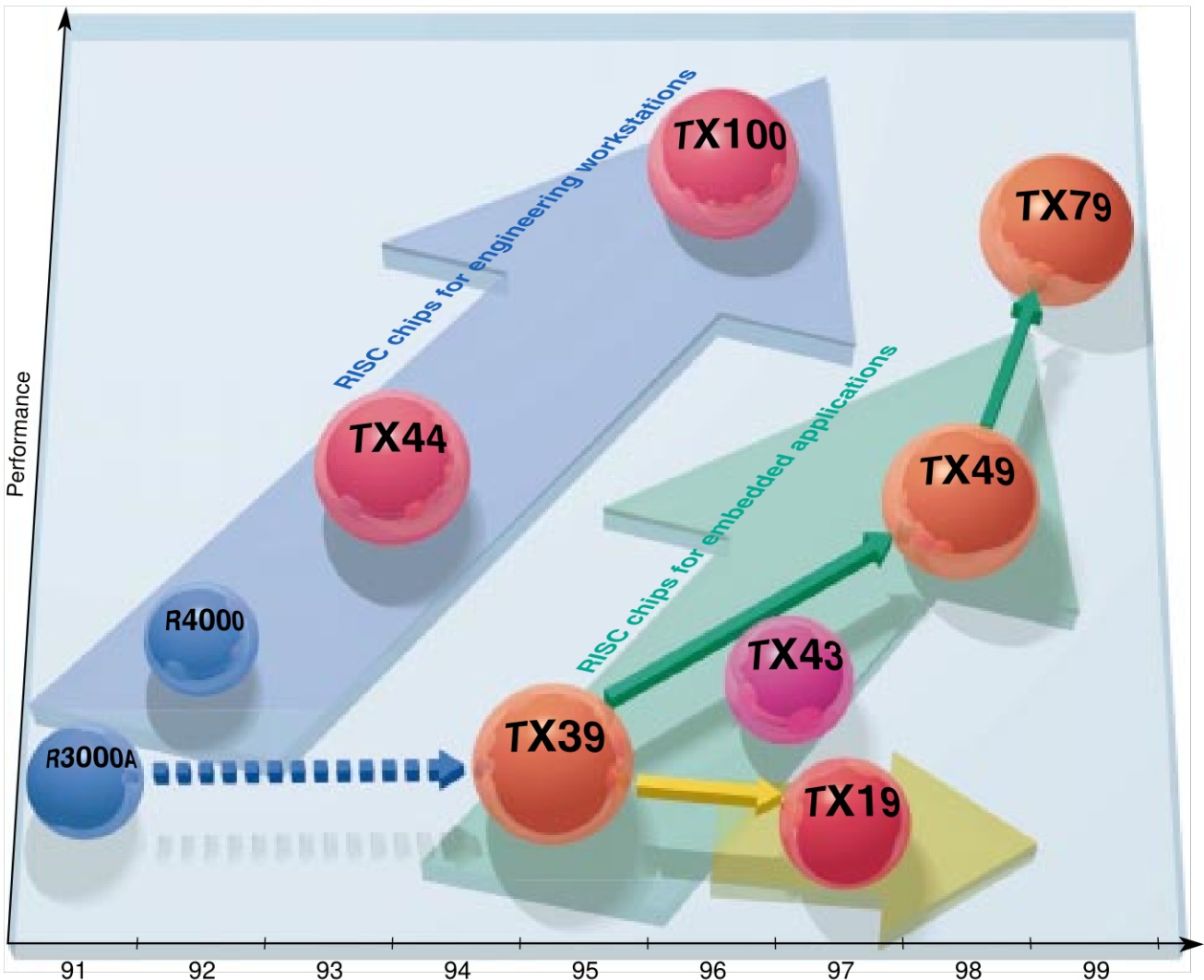
The **TX19** Family of RISC microprocessors for embedded-system use is derived from the **TX39** Family that was developed by Toshiba based on the R3000A architecture designed by the MIPS Group in the U.S.A. The **TX19** Family features the MIPS16™ ASE (Application Specific Extension), a highly efficient instruction set from the MIPS Group. The result is a new Toshiba 32-bit RISC processor family.

Future development of the **TX19** Family will focus on products built around the **TX19** processor core; peripheral functions will be incorporated. The **TX19** processor core will also be made available as a CPU core for ASIC (application-specific IC) microcomputers. Hence, the **TX19** Family will offer you the resources necessary to create a system using a single chip.

High-performance RISC technology

- R3000A architecture
- Processing performance: **21 MIPS**
  (when operating at 20 MHz)
  (Dhrystone 2.1)
- Built-in cache and high-speed memory
- Non-blocking load function
  The instructions which follow the instruction currently being executed are executed while the cache is being refilled.
- DSP function
  A 32-bit multiply/add operation takes four clock cycles to execute.

Functions suitable for embedded applications

- Code size reduction based on 16-bit codes
  Object code-compatible with MIPS16™ ASE
- Increased real-time capability
  Faster interrupt response
  Instruction/Data cache lock function

Low power consumption

- Design optimized using low power consumption libraries
- Low power consumption modes
  Clock gear
  Dual clock
  Various standby modes

Useful as CPU core for gate arrays/cell-based ICs

- TC240 process technology
- Compact core
- Based on Virtual Socket Interface (VSI)
- Complete development environment

Superior **Code** efficiency

Cool CPU core

Compact CPU core

CPU core ideal for embedded use **TX19**

Fast **Interrupt** response

Embedded **Flash E²PROM**
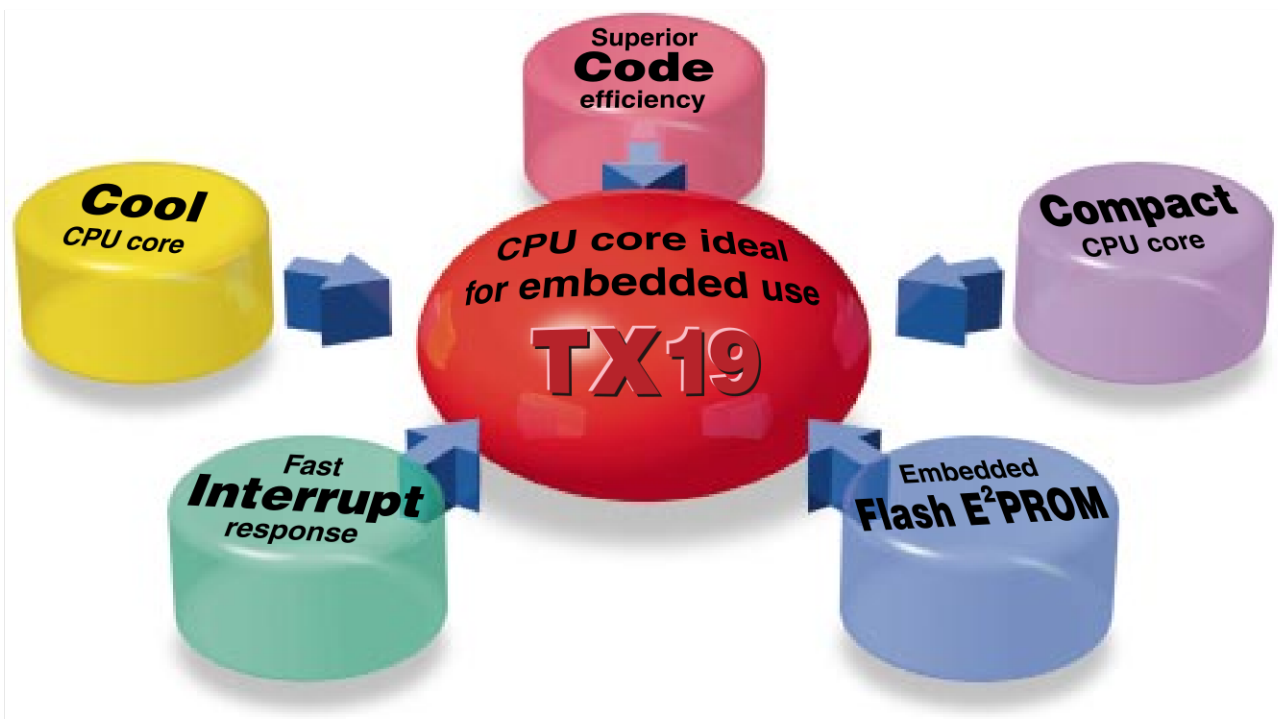
✽ R3000A and MIPS16 are trademarks of MIPS Technologies, Inc.

Core simultaneously realizes low power dissipation and high performance.

- **Low power dissipation**
  - ■ Design optimized for low power dissipation
  - ■ Clock gear
  - ■ Standby modes

- **Low operating voltage**
- **2.7-V operation possible**

Twin 16-/32-bit instruction sets improve code efficiency and computing performance.

32-bit instruction codes

Switch using a single instruction

16-bit instruction codes

- **Better computing performance**
- **Object code-compatible with TX39**
- **Support for multiply/add operations and coprocessor instructions**
- **Increased code efficiency**
- **Support for PC-relative instructions**

■ Main applications

■ Portable devices: PCI, personal organizers, digital cellular 'phones
■ PC peripherals: HDDs, DVD-ROM, printers
■ Home electronics: DVD players, DVCs, DSCs

NEW PRODUCTS

NEW

Built-in peripheral functions

TMP1904AF*

✽ Under development

■ *32-bit general-purpose RISC microprocessor with peripheral functions*

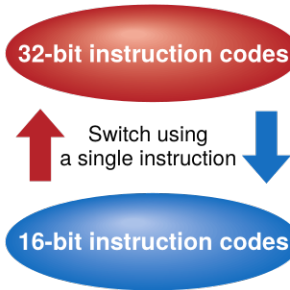The **TMP1904AF** is a 32-bit RISC microprocessor built around the **TX19** processor core and incorporating peripheral circuits such as a memory controller, DMAC, UART and timer – all highly suitable for general-purpose use.

This microprocessor can be used for a wide range of applications, from portable information equipment to copiers and other office equipment.

- Instruction cache: 4 Kbytes built in
- Data cache: 1 Kbyte built in
- SRAM/ROM controller: 16-bit bus width can also be set.
    Page Mode Read supported
- DRAM controller: 16-bit bus width can also be set.
    Fast Page Mode, Hyper Page Mode
- DMA controller: 2 channels
    Memory-to-memory transfer, memory-to-I/O transfer
- Interrupt controller: 6 external sources
- Timer: 3 channels
- UART: 2 channels
- PIO: 8 bits × 3 ports
- Maximum operating frequency: 20 MHz
- Supply voltage: 2.7 V to 3.6 V
- Package: 160-pin QFP

DRAM Controller	TX19 Processor Core	
SRAM/ROM Controller	CPU	
3-Ch Timer	Data Cache	Instruction Cache
Interrupt Controller	DSU*	
2-Ch UART	2-Ch DMAC	
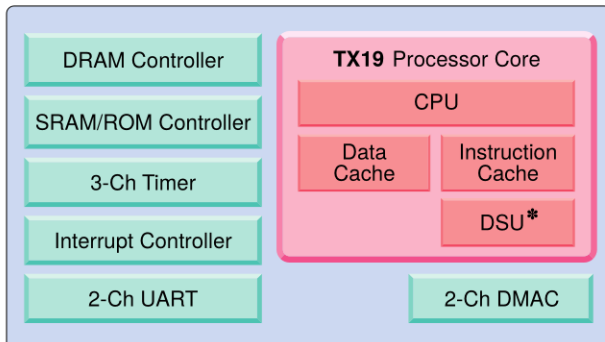
✽DSU: debug support unit

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32-Bit TX System RISC

TX39 Family

The **TX39** Family of embedded-use RISC microprocessors was developed by Toshiba based on the R3000A architecture designed by the MIPS Group, a division of Silicon Graphics, Inc. It is an original Toshiba 32-bit processor family. Using the **TX39** or the high-speed **TX39/H** as the CPU core for gate arrays and cell-based ICs, you can accomplish greater integration in your system.

High-performance RISC technology

- R3000A architecture
- **TX39/H** processing performance: **74 MIPS**
  (when operating at 20 MHz)
  TX39 processing performance: **52 MIPS**
  (when operating at 20 MHz)
  (Dhrystone 2.1)
- Built-in cache memory
- Non-blocking load function
  The instructions which follow the instruction currently being executed are executed while the cache is being refilled.
- DSP function
  A 32-bit multiply/add operation takes only a single clock cycle to execute.

Low power consumption

- Low power consumption modes
- Clock stop function

Functions suitable for embedded applications

- Reduced code size and improved performance
  Use of **branch-likely** instructions
  Hardware interlock function
- Increased real-time capability
  Cache lock function
- Real-time debugger system connection
  Real-time debugging is possible while cache is on.

Useful as CPU core for gate arrays/cell-based ICs

- **TX39/H**: **TC220** process technology
- **TX39**: **TC200** process technology
- Complete development environment

NEW PRODUCTS

General-purpose MPU

TMPR3901AF-70

■ *32-bit general-purpose RISC microprocessor based on the TX39/H core*

The **TMPR3901AF** is built around the **TX39/H** high-speed core and incorporates peripheral circuits such as a clock generator and a write buffer.

As well as being used as a general-purpose MPU, this microprocessor can also be used to evaluate performance or create function prototypes when ASICs using the **TX39/H** core are being developed.

- Instruction cache: 4 Kbytes built in
- Data cache: 1 Kbyte built in
- Clock generator with ×8 PLL
- 4-stage write buffer
- Half-Speed Bus Mode
  System bus frequency is halved.
- Low power consumption modes
  Doze/Halt Mode to reduce power consumption when idle
  RF function to reduce operating frequency
- Built-in debug support unit
- Maximum operating frequency: 70 MHz
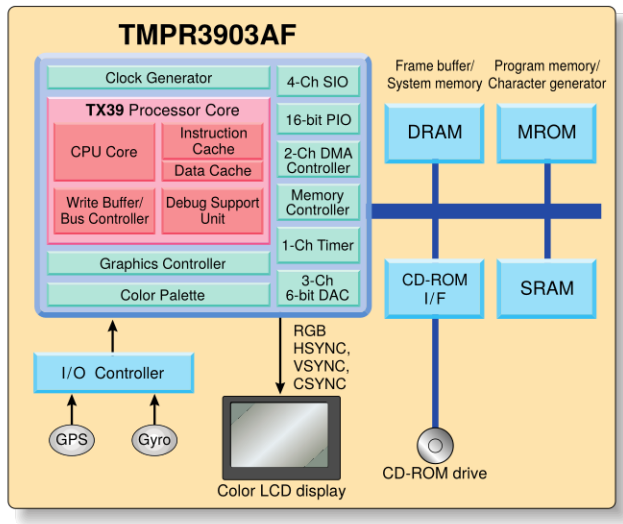- Supply voltage: 3.3 V
- Package: 160-pin QFP

NEW PRODUCTS

TMPR3903AF

■ 32-bit RISC microprocessor with graphics controller

The **TMPR3903AF** is a 32-bit RISC microprocessor, incorporating graphics control and other functions suitable for car navigation systems, portable information terminals and other systems that require color displays.

In addition, this microprocessor contains a memory controller, DMA controller, SIO, PIO and other peripheral circuits all encapsulated together in a 208-pin QFP package.

TMPR3903AF

Clock Generator	4-Ch SIO
TX39 Processor Core	16-bit PIO
Instruction Cache	2-Ch DMA Controller
CPU Core	Data Cache
Write Buffer/ Bus Controller	Debug Support Unit
Memory Controller	
	1-Ch Timer
Graphics Controller	
Color Palette	3-Ch 6-bit DAC

Frame buffer/ System memory — DRAM

Program memory/ Character generator — MROM

CD-ROM I/F — SRAM

I/O Controller

RGB HSYNC, VSYNC, CSYNC

GPS Gyro

Color LCD display

CD-ROM drive

- ● Instruction cache: 4 Kbytes built in
- ● Data cache: 1 Kbyte built in
- ● Clock generator with ×4 PLL
- ● 4-stage write buffer
- ● Half-Speed Mode
    System bus frequency is halved.
- ● Built-in debug support unit
- ● Graphics control functions
    - ■ Frame buffer configured using DRAM
    - ■ Fast Page Mode/Hyper Page Mode
    - ■ 4-plane superimposition performed by hardware
    - ■ Display synchronization signals
        HSYNC, VSYNC and CSYNC are generated.
    - ■ Built-in color palette and 3-ch video DAC
- ● DMA controller: 2 channels
- ● Interrupt controller: 3 external sources
- ● SIO: 4 channels; PIO: 16 bits
- ● Timer (free-running counter)
- ● Maximum operating frequency: 50 MHz
- ● Operating temperature range: –40° to 85℃
- ● Supply voltage: 3.3 V
- ● Package: 208-pin QFP

TMPR3904AF-66

■ 32-bit general-purpose RISC microprocessors with peripheral functions

The **TMPR3904AF** is a 32-bit RISC microprocessor built around the **TX39/H** high-speed processor core and incorporating peripheral circuits such as a memory controller, DMA controller, UART and timer – all highly suitable for general-purpose use.

DRAM Controller	**TX39/H** Processor Core
ROM Controller	CPU
3-Ch Timer	Data Cache / Instruction Cache
Interrupt Controller	Debug Support Unit
2-Ch UART	2-Ch DMAC / 2-Ch DMAC
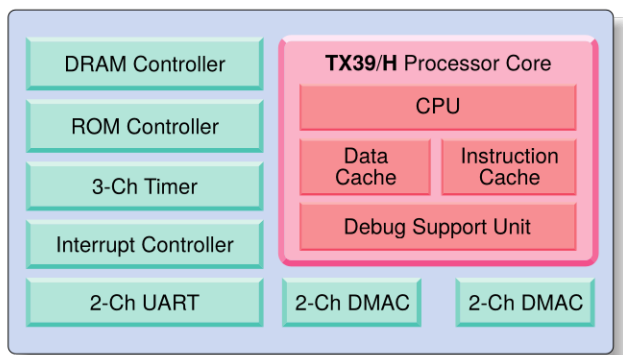
- ● Instruction cache: 4 Kbytes built in
- ● Data cache: 1 Kbyte built in
- ● ROM controller: 16-bit bus width can also be set.
    Page Mode Read supported
- ● DRAM controller: 16-bit bus width can also be set.
    Fast Page Mode, Hyper Page Mode
- ● DMA controller: 4 channels
    Memory-to-memory transfer, memory-to-I/O transfer
- ● Interrupt controller: 8 external sources
- ● Timer: 3 channels
- ● UART: 2 channels
- ● PIO: 8 bits × 3 ports
- ● Maximum operating frequency: 66 MHz
- ● Supply voltage: 3.3 V
- ● Package: 208-pin QFP

NEW PRODUCTS

TMPR3907F

■ *32-bit RISC microprocessor with PCI controller*

The **TMPR3907F** is a 32-bit RISC microprocessor built around the **TX39/H** processor core. It incorporates a PCI controller and other peripheral circuits such as a memory controller, UART and timer.

Using the **TX39/H** high-speed core, this microprocessor operates at 66 MHz, with the PCI bus operating at 33 MHz.
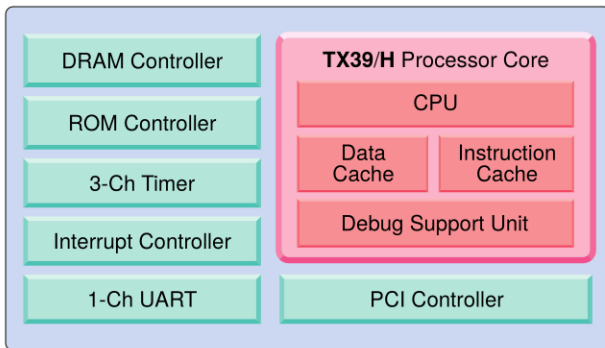
● Instruction cache: 4 Kbytes built in
● Data cache: 1 Kbyte built in
● PCI controller: 3 slots supported
● ROM controller: interleaved operation also possible
● DRAM controller
● Interrupt controller: 3 external sources
● Timer: 3 channels
● UART: 1 channel
● Maximum operating frequency: 66 MHz
● Supply voltage: 3.3 V
● Package: 208-pin QFP

TMPR3912U

■ *32-bit RISC microprocessor with peripheral functions for portable information equipment*

The **TMPR3912U** is an application-specific standard product (ASSP) built around the **TX39/H** processor core and incorporating the peripheral functions required for portable information communicators (PICs) on a single chip. In addition, this microprocessor has an enhanced power management function, making it ideal for PICs. All told, the **TMPR3912U** helps you minimize the size, reduce the cost, and increase the functionality of your portable information terminal system.
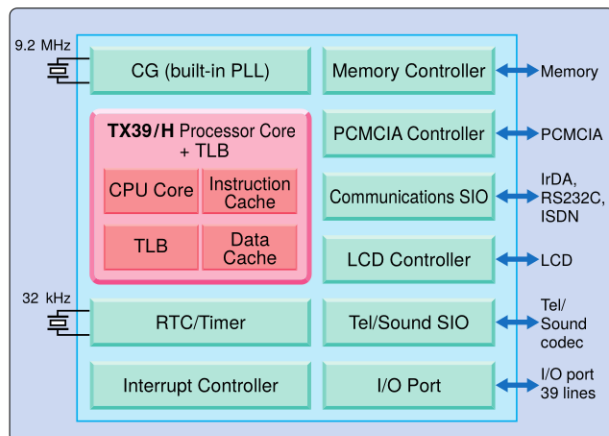
● Instruction cache: 4 Kbytes built in
● Data cache: 1 Kbyte built in
● Memory management unit (TLB):
    32-entry, 4-Kbyte pages
● Memory controller: supports DRAM (EDO),
    SDRAM, SRAM, ROM and flash memory.
● Communications interface: supports RS232C,
    IrDA (rev 1.0) and ISDN.
● PCMCIA interface
● LCD interface: supports monochrome and color.
    1024 × 1024 pixels maximum
● Timer: 2 channels (RTC and/or watchdog timer)
● I/O port: 39 bits
● Low power consumption modes: Doze/Sleep
● Maximum operating frequency: 75 MHz
● Supply voltage: 3.3 V
● Package: 208-pin LQFP (1.4 mm thick)

NEW PRODUCTS

Built-in peripheral functions

TMPR3922U*/AU*

✻ Under development

■ 32-bit RISC microprocessor with peripheral functions for high performance

The **TMPR3922U** is an application-specific standard product (ASSP) built around the **TX3920** processor core and incorporating the peripheral functions required for portable information communicators (PICs) on a single chip. In addition, this microprocessor has an enhanced power management function, making it ideal for PICs.

All told, the **TMPR3922U** helps you minimize the size, reduce the cost, and increase the functionality of your portable information terminal system or multimedia device.
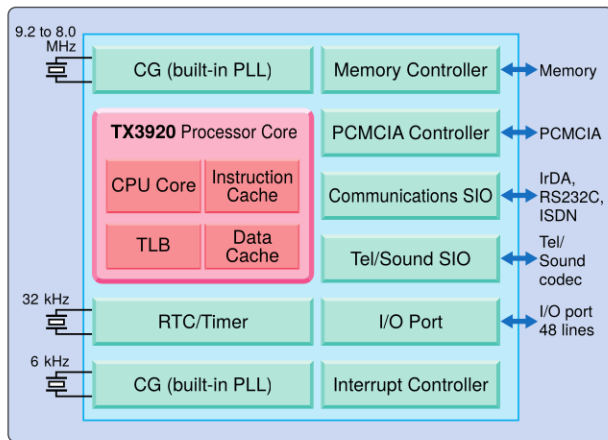
- Instruction cache: 16 Kbytes built in (2-way set-associative)
- Data cache: 8 Kbytes built in (2-way set-associative)
- Memory management unit (TLB): 64-entry 4-Kbyte/16-Kbyte/64-Kbyte/256-Kbyte/1-Mbyte/ 4-Mbyte pages
- Memory controller: supports DRAM (EDO), SDRAM, SRAM, ROM and flash memory.
- Communications interface: supports RS232C, IrDA (rev 1.1) and ISDN.
- PCMCIA interface
- Timer: 2 channels, watchdog timer
- RTC
- I/O port: 48 pins
- Low power dissipation modes: Sleep (only RTC operates.) Doze (device operates at low frequency.)
- Maximum operating frequency: 148 MHz / 129 MHz
- I/O supply voltage: 3.3 V
- Internal supply voltage: 2.5 V
- Package: 208-pin LQFP (1.4 mm thick)

■ Advanced PIC system solution

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64-Bit TX System RISC

TX49 Family

TX System RISC
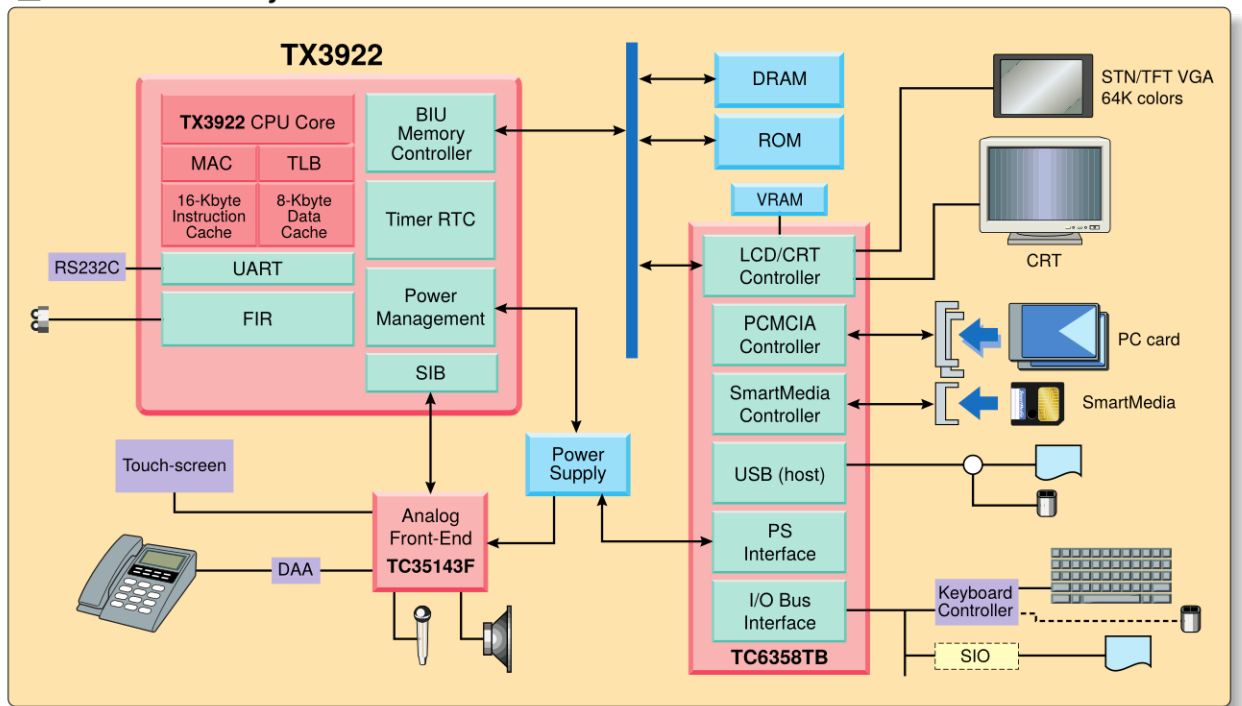
The **TX49** Family of RISC microprocessors for embedded use is an original Toshiba 64-bit processor family and is based on the RISC architecture designed by the MIPS Group in the U.S.A. The **TX49** Family processors can also be used as ASSPs or as the CPU core for gate arrays and cell-based ICs, allowing you to attain a higher level of integration in your system than has ever been possible before.

64-bit RISC architecture

- 64-bit operation
- Thirty-two 64-bit general-purpose registers
- Optimized 5-stage pipelining
- Upward-compatible instruction set including MIPS I, MIPS II and MIPS III instruction set architectures (ISAs)
  - Multiply/add instructions and debugging instructions added
- Built-in 48 double-entry TLB

Built-in high-capacity primary cache

- Instruction cache: 8/16/32 KB (selectable)
  - 4-way set-associative
  - Supports lock function.
- Data cache: 8/16/32 KB (selectable)
  - 4-way set-associative
  - Supports lock function.
  - Write-back/write-through (every page)
  - Supports snoop function.

Numerous optional functions

- Debug support unit
  - Supports EJTAG.
- Single- or double-precision floating-point unit

Low power consumption design

- Low power consumption modes (Doze/Halt)
- Supply voltage: 3.3 V

■TX49 processor block diagram

Integer Arithmetic Unit	System Control Coprocessor	Floating-Point Coprocessor (optional)
64-Bit General-purpose Register / Integer Data Path / Multiply/add Arithmetic Unit / Pipeline Control	Coprocessor Register / Memory Management Unit (MMU) 48 Double-Entry TLB / Exception Handling Unit	32-Bit Single-/Double-Precision Floating-Point General-Purpose Register / Floating-Point Data Path

8-/16-/32-KB Instruction Cache (4-way set-associative) — Cache Controller — 8-/16-/32-KB Data Cache (4-way set-associative) — Write Buffer

NEW PRODUCTS

General-purpose MPU

TMPR4901F-133*

✻ Under development

■ *64-bit general-purpose RISC microprocessor based on the TX49 processor core*

The **TMPR4901F** is the first product in the **TX49** Family. Built around the **TX49** processor core, it incorporates a clock generator and a debug support unit.

This microprocessor is not just a general-purpose MPU, it can also be used to verify functions and evaluate device performance during the development of ASICs which feature the **TX49** processor core.

- TX49 processor core
- Instruction cache: 16 Kbytes built in
- Data cache: 16 Kbytes built in
- Separate 36-bit address bus and 64-bit data bus
- Clock generator with ×16 PLL
- Low power consumption modes (Doze/Halt)
- Built-in debug support unit
- Maximum Internal operating frequency: 133 MHz
- Maximum external operating frequency: 66 MHz
- Supply voltage: 3.3 V
- Package: 208-pin QFP

■ TMPR4901F block diagram
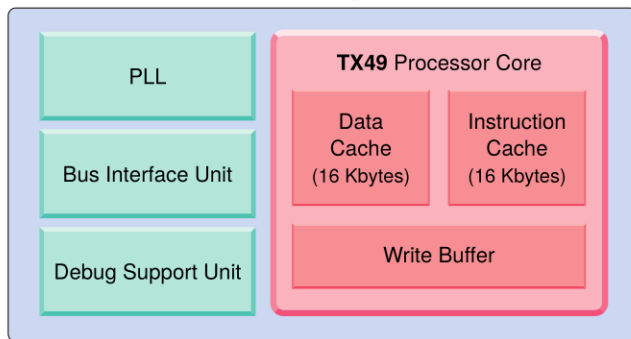
PLL	**TX49** Processor Core	
	Data Cache (16 Kbytes)	Instruction Cache (16 Kbytes)
Bus Interface Unit		
Debug Support Unit	Write Buffer	

■ System block diagram

TMPR4901F

64-bit data bus →

36-bit address bus →

Memory Controller

ROM   DRAM   I/O Controller

■ Target applications

Office equipment

Laserprinters

Digital PPCs

Home electronics

DVD players

Game machines

Network equipment & peripherals

Networks

Set-top boxes

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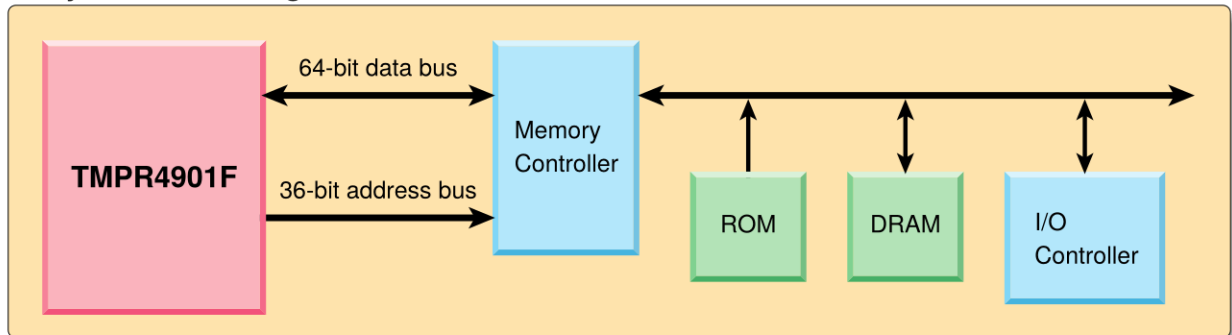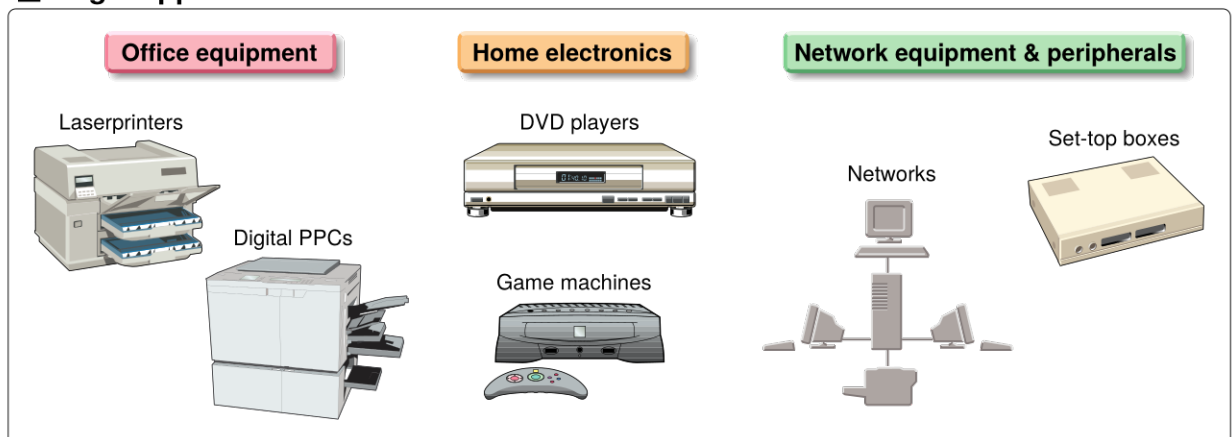
NEW PRODUCTS

General-purpose MPU

TMPR4951F-133*

✽ Under development

■ *64-bit general-purpose RISC microprocessor based on the TX49 processor core*

Built around the **TX49** processor core, the **TMPR4951F** incorporates a SysAD bus interface function. This microprocessor is not just a general-purpose MPU, it can also be used as a base for future products incorporating a SysAD bus interface function. The device is also pin-compatible with our existing **TC86R4300** microprocessor. The high-capacity 4-way set-associative caches enable the device to meet demands for improved performance and high-speed processing.

- ● 64-bit **TX49** core
- ● Instruction cache: 16 Kbytes built in
- ● Data cache: 16 Kbytes built in
- ● 32-bit system interface (SysAD bus interface)
- ● Support for JTAG
- ● Supply voltage: 3.3 V
- ● Maximum internal operating frequency: 133 MHz
- ● Maximum external operating frequency: 66 MHz
- ● Power dissipation : 1.2 W (at 133 MHz)
- ● Package: 120-pin QFP

■ TMPR4951F block diagram
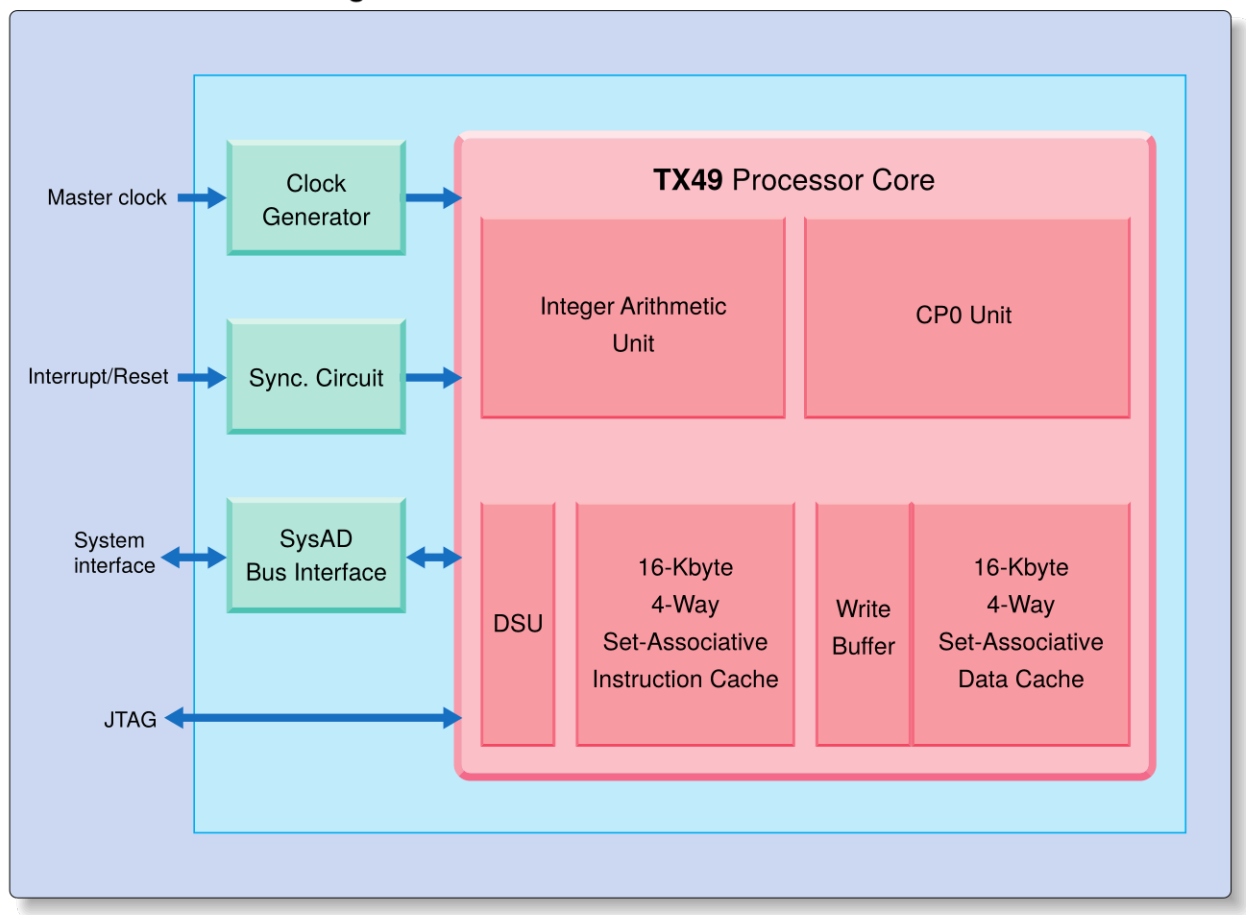
TX100 Series

64-bit superscalar RISC processors for workstations and servers

- Compatible with the R10000 RISC processors available from MIPS Technologies, Inc.
- 64-bit superscalar architecture
- Capable of operating at 200 MHz
- Built-in 32-Kbyte instruction and data caches

Product No.	Internal Frequency	Supply Voltage	Package	Features
TC86R10000	200 MHz	3.3 V	LGA 599	Superscalar architecture Built-in primary cache memory (64 KB) Built-in secondary cache memory controller

64-Bit TX System RISC

TX44 Series

The **TX44** Series is comprised of 64-bit RISC microprocessors that are compatible with the R4000/R4400 microprocessors from MIPS Technologies, Inc. The microprocessors in this series are suited to a wide variety of applications, ranging from personal computers to high-end workstations. In addition to the internal operating frequency of 200 MHz, 8-stage super-pipeline and 32 Kbytes of primary cache memory, the microprocessors in this series contain an FPU based on the ANSI/IEEE-754-1985 standard, enhancing their integer and floating-point arithmetic capability.

- Integer arithmetic performance: 141 SPECint92 (at 200 MHz)
- Floating-point arithmetic performance: 143 SPECfp92 (at 200 MHz)
- 8-stage super-pipeline
- Built-in secondary cache memory controller
- Multiprocessing capability
- Package: 447-pin PGA

Product No.	Internal Frequency	Supply Voltage	Operating Temperature Range	Package
TC86R4400-200(L)	200 MHz	3.3 V	0˚ to 70˚C	PGA447
TC86R4400-200(SB)	200 MHz	3.3 V	0˚ to 85˚C	PGA447
TC86R4400-150(S)	150 MHz	3.3 V	0˚ to 85˚C	PGA447

64-Bit TX System RISC

TX43 Series

Product No.	Internal Frequency	Supply Voltage	Operating Temperature Range	Package
TC86R4300F-100	100 MHz	3.3 V	0˚ to 85˚C	QFP120

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Small package general-purpose microcontrollers

In addition to the SOP and SSOP, Toshiba offer a line-up of 10 mm × 10 mm 44-pin and 64-pin miniflat packages. Some products incorporate functions such as a built-in 8-bit AD converter.

Applications

- Home electronics
- Audio
- Remote control
- Game machines
- Portable devices
- VCRs
- Telephones
- Battery chargers

Low-pin-count, small-ROM, general-purpose microcontrollers

	In mass production						
Under development							
32 KB							TMP87CM48 / TMP87CM41
24 KB							TMP87CK41
16 KB					TMP86CH06		TMP87CH48 / TMP87CH41
12 KB							TMP87CC41
8 KB			TMP87C808	TMP87C809			TMP87C807 / TMP87C847	TMP87C841
4 KB			TMP87C405A / TMP87C408	TMP87C409 / TMP47C443	TMP47E487 / TMP47E486	TMP47C408D / TMP47C443D	TMP87C447
2 KB		TMP47C201	TMP47C206 / TMP47C202	TMP47C203	TMP47C241	TMP47C243	TMP47C243D
1 KB	TMP47C101	TMP47E186 / TMP47E187	TMP47C102		TMP47C103		
	SOP					SSOP	µQFP
	16-pin	20-pin	28-pin			30-pin	44-pin / 64-pin

● 8-bit microcontrollers (870 Series, 870/C Series)

Series Name	Product No.	ROM (bytes)	RAM (bytes)	I/O	Small Package	Additional Functions	Version with Built-in OTP
870	TMP87C405AM	4K	256	22	SOP28	● Clock gear	TMP87P808M
	TMP87C408M	4K				● 8-bit AD converter: 6 channels ● Clock gear ● 8-bit SIO: 1 channel	
	TMP87C808M	8K					
	TMP87C408LM	4K					TMP87P808LM
	TMP87C808LM	8K					
	TMP87C409M	4K				● 10-bit AD converter: 8 channels ● 8-bit SIO/I²C bus: 1 channel (selectable by software)	TMP87P809M
	TMP87C809M	8K					
	TMP87C408DM	4K			SSOP30	● 8-bit AD converter: 6 channels ● 8-bit SIO: 1 channel	TMP87P808M
	TMP87C807U	8K	512	37	µQFP44 (10 × 10 mm)	● 8-bit SIO: 1 channel, high-speed serial output	TMP87PH47U
	TMP87C447U	4K				● 8-bit AD converter: 8 channels ● 8-bit SIO: 1 channel, high-speed serial output ● 16-bit timer/counter: 2 channels 8-bit timer/counter: 2 channels	
	TMP87C847U	8K					
	TMP87CH47U	16K					
	TMP87C847LU	8K					TMP87PH47LU
	TMP87CH47LU	16K					
	TMP87C841U	8K	256	56	µQFP64 (10 × 10 mm)	● 10-bit AD converter: 16 channels ● 8-bit SIO: 2 channels ● 16-bit timer/counter: 2 channels 8-bit timer/counter: 2 channels	TMP87PM41U
	TMP87CC41U	12K	512				
	TMP87CH41U	16K					
	TMP87CK41U	24K	1K				
	TMP87CM41U	32K					
	TMP87CH48U	16K	512			● 10-bit AD converter: 16 channels ● UART ● I²C bus	TMP87PH48U
	✱TMP87CM48U	32K	1K				TMP87PM48U
870/C	✱TMP86CH06U	16K	512	35	µQFP44 (10 × 10 mm)	● UART: 2 channels ● SIO: 1 channel (switchable)	✱TMP86PH06U

†For details of the products listed above, please refer to the **870 Series** Selection Guide on pages 36 and 37, or the **870/C Series** Selection Guide on page 38.   ✱ Under development

● 4-bit microcontrollers (47E Series)

Series Name	Product No.	ROM (bytes)	RAM (nibbles)	I/O	Small Package	Additional Functions	Version with Built-in OTP
47E	TMP47C101M	1K	64	11	SOP16	● High-current output port: 4 pins	TMP47P201VP
	TMP47C201M	2K	128				
	TMP47E186M	1K	64			● 16-byte E²PROM built in	TMP47P186M
	TMP47E187M						TMP47P187M
	TMP47C102M	1K	64	15	SOP20	● High-current output port: 4 pins	TMP47P202VM
	TMP47C202M	2K	128				
	TMP47C206M					● Pulse output: buzzer drive, remote transmission	TMP47P206VM
	TMP47C103M	1K	64	23		● High-current output port: 8 pins ● 8-bit SIO: 1 channel	TMP47P403VM
	TMP47C203M	2K	128				
	TMP47C241M	2K	128	21	SOP28	● 8-bit AD converter: 4 channels ● 4-bit SIO: 1 channel	TMP47P241VM
	TMP47C241IM						
	TMP47C241WM						
	TMP47C243M	2K		23		● 8-bit AD converter: 8 channels ● 8-bit SIO: 1 channel ● Pulse output: buzzer drive, remote transmission	TMP47P443VM
	TMP47C443M	4K	256				
	TMP47E486M	4K	256	21		● 64-byte E²PROM built in	✱TMP47W486M
	TMP47E487M						✱TMP47W487M
	TMP47C243DM	2K	128	23	SSOP30	● 8-bit AD converter: 8 channels ● 8-bit SIO: 1 channel ● Pulse output: buzzer drive, remote transmission	TMP47P443VDM
	TMP47443DM	4K	256				

†For details of the products listed above, please refer to the **47 Family** Selection Guide on pages 44 and 45.   ✱ Under development

CISC APPLICATIONS
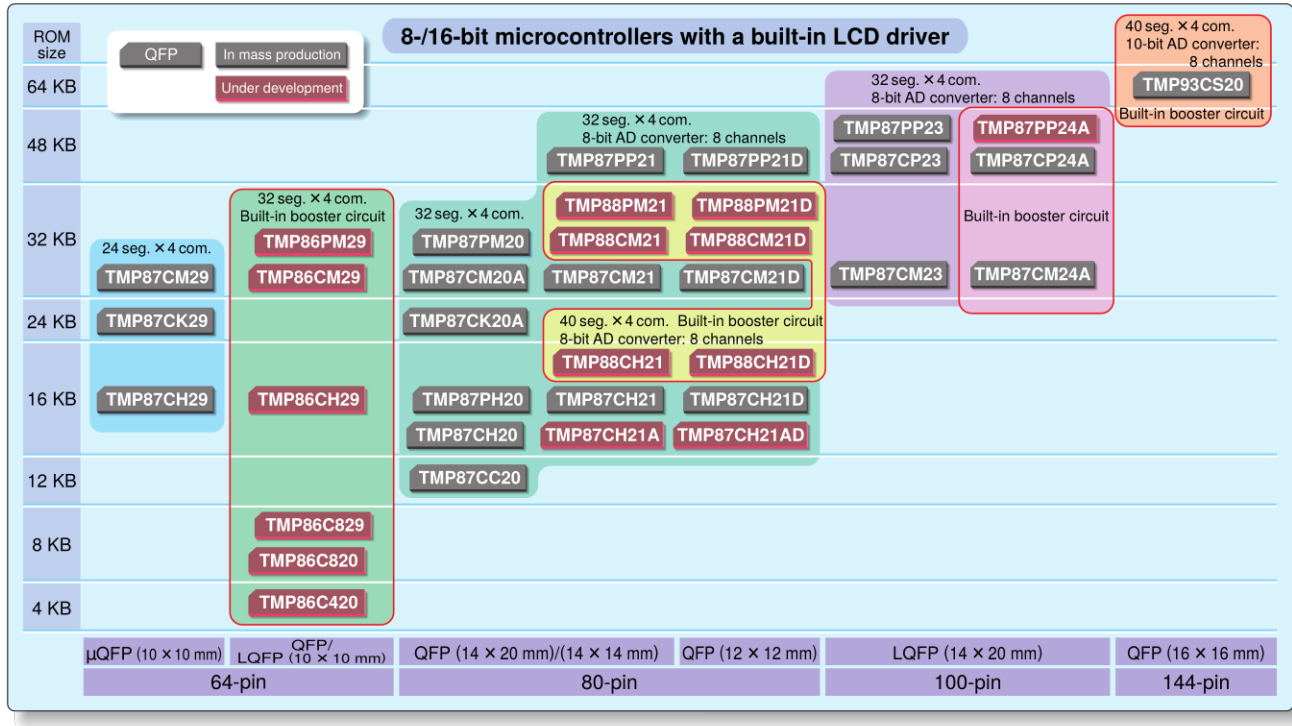
Microcontrollers with built-in LCD driver

The following microcontrollers contain LCD driver circuitry which incorporates a voltage booster, enabling it to continue to drive the LCD, even at a low operating voltage, and to dissipate little power during operation.

Applications
- Home electronics
- Audio
- Remote control
- Telephones
- Game machines

8-/16-bit microcontrollers with a built-in LCD driver

ROM size	QFP — In mass production / Under development				
64 KB				32 seg. × 4 com. 8-bit AD converter: 8 channels	40 seg. × 4 com. 10-bit AD converter: 8 channels **TMP93CS20** Built-in booster circuit
48 KB		32 seg. × 4 com. 8-bit AD converter: 8 channels **TMP87PP21** **TMP87PP21D**	**TMP87PP23** **TMP87CP23**	**TMP87PP24A** **TMP87CP24A**	
32 KB	32 seg. × 4 com. Built-in booster circuit **TMP86PM29** / 24 seg. × 4 com. **TMP87CM29** **TMP86CM29**	32 seg. × 4 com. **TMP87PM20** **TMP87CM20A**	**TMP88PM21** **TMP88PM21D** **TMP88CM21** **TMP88CM21D** **TMP87CM21** **TMP87CM21D**	Built-in booster circuit **TMP87CM23** **TMP87CM24A**	
24 KB	**TMP87CK29**	**TMP87CK20A**	40 seg. × 4 com. Built-in booster circuit 8-bit AD converter: 8 channels **TMP88CH21** **TMP88CH21D**		
16 KB	**TMP87CH29** **TMP86CH29**	**TMP87PH20** **TMP87CH20**	**TMP87CH21** **TMP87CH21D** **TMP87CH21A** **TMP87CH21AD**		
12 KB		**TMP87CC20**			
8 KB	**TMP86C829** **TMP86C820**				
4 KB	**TMP86C420**				
	µQFP (10 × 10 mm) / QFP/LQFP (10 × 10 mm) **64-pin**	QFP (14 × 20 mm)/(14 × 14 mm) / QFP (12 × 12 mm) **80-pin**		LQFP (14 × 20 mm) **100-pin**	QFP (16 × 16 mm) **144-pin**

● 16-bit microcontroller (900/L Series)

Series Name	Product No.	ROM (bytes)	RAM (bytes)	I/O	LCD Driver	Additional Functions	Supply Voltage (V)	Version with Built-in OTP	Package
900/L	TMP93CS20F	64K	2K	88	40 seg. × 4 com. (built-in booster circuit)	● Serial interface: 3 channels ● 10-bit AD converter: 8 channels ● 16-bit timer/counter: 4 channels 8-bit timer/counter: 4 channels	5 ±10% 3 ±10%	●	QFP144 (16 × 16 mm)

†For details of the products listed above, please refer to the **900 Family** Selection Guide on page 29.

● 8-bit microcontrollers (870 Series, 870/X Series, 870/C Series)

Series Name	Product No.	ROM (bytes)	RAM (bytes)	I/O	LCD Driver	Additional Functions	Supply Voltage (V)	Version with Built-in OTP	Packages
870	TMP87CC20F	12K	512	45	32 seg. × 4 com.	● 8-bit SIO: 1 channel ● 16-bit timer/counter: 1 channel 8-bit timer/counter: 4 channels	4.5 to 6.0 2.7 to 6.0	●	QFP80
	TMP87CH20F	16K	512						
	TMP87CK20AF	24K	1K					●	
	TMP87CM20AF	32K						●	
	TMP87CH21F/DF	16K	1K	52		● 8-bit AD converter: 8 channels ● 8-bit SIO: 2 channels ● 16-bit timer/counter: 2 channels 8-bit timer/counter: 2 channels	4.5 to 5.5 2.7 to 5.5	●	QFP80/ QFP80 (12 × 12 mm)
	✽TMP87CH21AF/ADF							●	
	TMP87CM21F/DF	32K							
	TMP87CM23F	32K	1K	70	40 seg. × 4 com.			●	QFP100
	TMP87CP23F	48K	2K					●	
	TMP87CM24AF	32K	2K	69	40 seg. × 4 com. (built-in booster circuit)		4.5 to 5.5 2.2 to 5.5	●	
	TMP87CP24AF	48K						●	
	TMP87CH29N/U	16K	1K	43	24 seg. × 4 com.	● 8-bit AD converter: 5 channels ● UART: 1 channel ● 16-bit timer/counter: 1 channel 8-bit timer/counter: 4 channels	4.5 to 5.5 2.7 to 5.5	●	SDIP64/ µQFP64 (10 × 10 mm)
	TMP87CK29N/U	24K						●	
	TMP87CM29N/U	32K							
870/X	✽TMP88CH21F/DF	16K	512	47	40 seg. × 4 com.	● 8-bit AD converter: 8 channels ● 8-bit SIO/UART: 1 channel ● 16-bit timer/counter: 2 channels 8-bit timer/counter: 2 channels	4.5 to 5.5 2.7 to 4.5	●	QFP80/ LQFP80 (12 × 12 mm)
	✽TMP88CM21F/DF	32K	1K						
870/C	✽TMP86C420U/F	4K	256	39	32 seg. × 4 com. (built-in booster circuit)	● 8-bit AD converter: 8 channels ● 8-bit SIO: 1 channel ● 18-bit timer/counter: 1 channel 8-bit timer/counter: 2 channels ● 10-bit AD converter: 8 channels ● 8-bit SIO/UART: 1 channel ● 16-bit timer/counter: 1 channel 8-bit timer/counter: 4 channels	1.8 to 5.5	●	µQFP64 (10 × 10 mm)/ LQFP64
	✽TMP88C820U/F	8K							
	✽TMP86C829U/F	8K	512						
	✽TMP86CH29U/F	16K	1.5K						
	✽TMP86CM29U/F	32K							

†For details of the products listed above, please refer to the **870 Series** Selection Guide on pages 36 and 37, the **870/C Series** Selection Guide on page 38, or the **870/X Series** Selection Guide on page 39. ✽ Under development

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4-bit microcontrollers with built-in LCD driver

ROM size					
16 KB				TMP47C1620 (32 seg. × 4 com.)	
12 KB				TMP47C1220	
8 KB		TMP47C823 (24 seg. × 4 com.)	TMP47C820	TMP47C855 / TMP47C847 (8-bit AD converter: 8 channels)	TMP47C858 (44 seg. × 10 com.)
6 KB		TMP47C623	TMP47C620	TMP47C655 / TMP47C647 (8-bit AD converter: 8 channels)	
4 KB	TMP47C422 (20 seg. × 4 com. 8-bit AD converter: 4 channels)	TMP47C446 / TMP47C423 / TMP47C421	TMP47C456		
2 KB	TMP47C222	TMP47C221			
	QFP/SDIP 42-/44-pin	QFP 64-pin	QFP 80-pin		100-pin

Legend: QFP, DIP, In mass production

● 4-bit microcontroller (47 Family)

Series Name	Product No.	ROM (bytes)	RAM (nibbles)	I/O	LCD Driver	Additional Functions	Supply Voltage (V)	Version with Built-in OTP	Packages
47E	TMP47C222N/F	2K	192	22	20 seg. × 4 com.	•8-bit AD converter: 4 channels •8-bit SIO: 1 channel •Pulse output: remote control transmission carrier	2.5 to 5.5	●	SDIP42/ QFP44
	TMP47C422N/F	4K	256					●	
47	TMP47C221ADF	2K	192	28	24 seg. × 4 com.	•4-bit SIO: 1 channel •12-bit timer/counter: 2 channels	4.5 to 6.0	●	QFP64
	TMP47C421ADF	4K	256	28		•4-bit SIO: 1 channel •Pulse output		—	
	TMP47C423ADF	4K	256					—	
	TMP47C446ADF	4K	256	24		•16-bit high-speed event counter: 1 channel		●	
	TMP47C456ADF		768	34		•DTMF generator	2.7 to 6.0	—	
470	TMP47C620DF	6K	384	36	32 seg. × 4 com.	•8-bit SIO: 1 channel •Pulse output •8-bit high-speed event counter: 2 channels	4.5 to 6.0	●	QFP80
	TMP47C820DF	8K	512					●	
	TMP47C647F	6K	384	35		•8-bit AD converter: 8 channels •8-bit SIO: 1 channel •Pulse output		●	
	TMP47C847F	8K	512					●	
	TMP47C655F	6K	896	36		•DTMF generator •8-bit SIO: 1 channel	2.2 to 6.0	●	
	TMP47C855F	8K	1024					●	
	TMP47C858F		512		44 seg. × 10 com.	•DTMF generator	2.7 to 6.0	—	QFP100
470A	TMP47C623F	6K	384	32 to 28	24 seg. × 4 com.	•8-bit SIO: 1 channel •Pulse output •16-bit high-speed event counter: 1 channel	4.5 to 6.0	●	QFP64
	TMP47C823F	8K	512					●	
	TMP47C1220F	12K	768	36	32 seg. × 4 com.	•8-bit SIO: 1 channel •Pulse output •8-bit high-speed event counter: 2 channels	4.5 to 6.0	●	QFP80
	TMP47C1620F	16K	768					●	

†For details of the products listed above, please refer to the **47 Family** Selection Guide on pages 45 and 46.
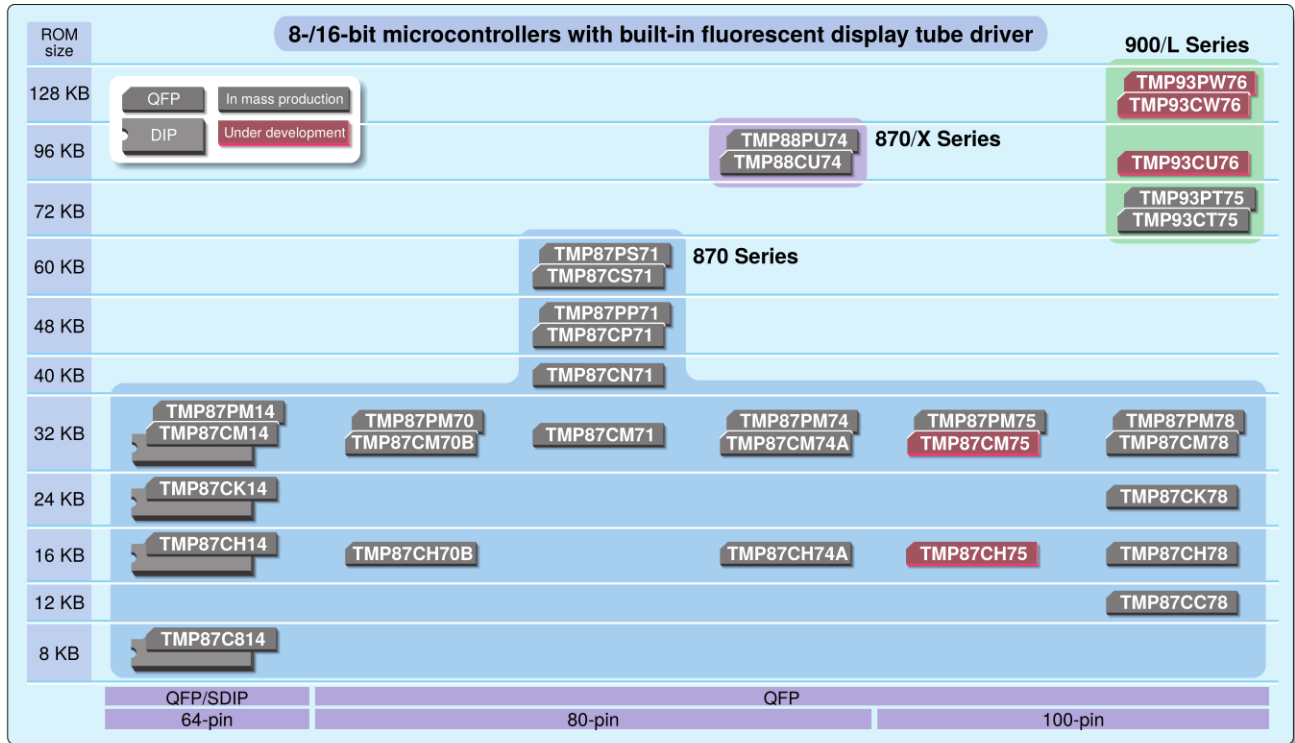
CISC APPLICATIONS

Microcontrollers with built-in fluorescent display tube drivers

The following microcontrollers incorporate a display circuit with high breakdown voltage output which can automatically transfer display data to a port so as to drive a fluorescent display tube directly. In addition to existing products, such as a VFT driver circuit which can display digits on a segmented display, Toshiba offer a line-up of products which support automatic display to universal grid display tubes.

Applications
- Home electronics
- Audio
- VCRs

8-/16-bit microcontrollers with built-in fluorescent display tube driver

Legend: QFP — In mass production; DIP — Under development

900/L Series

ROM size			
128 KB			TMP93PW76 / TMP93CW76
96 KB	TMP88PU74 / TMP88CU74 (870/X Series)		TMP93CU76
72 KB			TMP93PT75 / TMP93CT75
60 KB	TMP87PS71 / TMP87CS71 (870 Series)		
48 KB	TMP87PP71 / TMP87CP71		
40 KB	TMP87CN71		
32 KB	TMP87PM14 / TMP87CM14 · TMP87PM70 / TMP87CM70B · TMP87CM71 · TMP87PM74 / TMP87CM74A · TMP87PM75 / TMP87CM75 · TMP87PM78 / TMP87CM78		
24 KB	TMP87CK14	TMP87CK78	
16 KB	TMP87CH14 · TMP87CH70B · TMP87CH74A · TMP87CH75 · TMP87CH78		
12 KB		TMP87CC78	
8 KB	TMP87C814		

QFP/SDIP 64-pin	QFP 80-pin	QFP 100-pin

● 16-bit microcontroller (900/L Series)

Series Name	Product No.	ROM (bytes)	RAM (bytes)	I/O	VFT Driver	Additional Functions	Version with Built-in OTP	Package
900/L	TMP93CT75F	72K	1.8K	85	14 seg. × 10 dig. (maximum breakdown voltage: 40 V)	● Serial interface: 1 channel; I²C bus: 2 channels ● 8-bit AD converter: 10 channels ● 14-bit PWM timer: 3 channels ● VCR servo controller	●	QFP100 (14 × 20 mm)
	✻TMP93CU76F	96K	2.5K	85		● Serial interface: 1 channel; I²C bus: 2 channels (including FIFO) ● 8-bit AD converter: 10 channels ● 14-bit PWM timer: 3 channels ● VCR servo controller	●	
	✻TMP93CW76F	128K						

† For details of the products listed above, please refer to the **900 Family** Selection Guide on page 29. ✻ Under development

● 8-bit microcontrollers (870 Series, 870/X Series)

Series Name	Product No.	ROM (bytes)	RAM (bytes)	I/O	VFT Driver	Additional Functions	Version with Built-in OTP	Packages
870	TMP87C814N/F	8K	512	55	Maximum breakdown voltage: 40 V on each of 24 pins	● 8-bit AD converter: 8 channels ● 8-bit SIO: 1 channel ● 16-bit timer/counter: 2 channels 8-bit timer/counter: 2 channels	●	SDIP64/ QFP64
	TMP87CH14N/F	16K					●	
	TMP87CK14N/F	24K	1K				●	
	TMP87CM14N/F	32K					●	
	TMP87CH70BF	16K	512	73	Maximum breakdown voltage: 40 V on each of 32 pins	● AD converter input: 6 channels ● 8-bit SIO: 1 channel ● High-speed serial output	●	
	TMP87CM70BF	32K					●	
	TMP87CM71F	32K	1.5K	73	16 seg. × 16 dig.	● AD converter input: 6 channels ● 8-bit SIO: 1 channel ● High-speed serial output	●	QFP80
	TMP87CN71F	40K					●	
	TMP87CP71F	48K					●	
	TMP87CS71F	60K	2K				●	
	TMP87CH74AF	16K	512	71	Maximum breakdown voltage: 40 V on each of 37 pins Programmable grid scan output	● 8-bit AD converter: 12 channels ● 8-bit SIO: 2 channels ● 16-bit timer/counter: 2 channels, 8-bit timer/counter: 2 channels	●	
	TMP87CM74AF	32K	1K				●	
	✻TMP87CH75F	16K	512		Maximum breakdown voltage: 40 V on each of 51 pins Programmable grid scan output	● 8-bit AD converter: 16 channels ● 8-bit SIO: 2 channels ● 16-bit timer/counter: 2 channels, 8-bit timer/counter: 2 channels	●	
	✻TMP87CM75F	32K	1K				●	
	TMP87CC78F	12K	512	89	Maximum breakdown voltage: 40 V on each of 50 pins	● 8-bit AD converter: 8 channels ● UART: 2 channels ● 16-bit timer/counter: 1 channel 8-bit timer/counter: 4 channels	●	QFP100
	TMP87CH78F	16K					●	
	TMP87CK78F	24K	1K				●	
	TMP87CM78F	32K					●	
870/X	TMP88CU74F	96K	2K	71	Maximum breakdown voltage: 40 V on each of 37 pins Programmable grid scan output	● 8-bit SIO: 1 channel ● 16-bit timer/counter: 2 channels	●	QFP80

† For details of the products listed above, please refer to the **870 Series** Selection Guide on pages 36 and 37, or the **870/X Series** Selection Guide on page 39. ✻ Under development

4-bit microcontrollers with built-in fluorescent display tube drivers

ROM size		
16 KB	QFP · DIP — In mass production	**470A Series** — 8-bit AD converter: 8 channels — TMP47C1670
12 KB		8-bit AD converter: 8 channels — TMP47C1270
8 KB	**470 Series**	8-bit AD converter: 8 channels — TMP47C862, TMP47C870
6 KB		A8-bit AD converter: 8 channels — TMP47C662, TMP47C670
4 KB	**47 Series** — 8-bit AD converter: 4 channels — TMP47C410, TMP47C441, TMP47C412	8-bit AD converter: 4 channels — TMP47C415, TMP47C416
2 KB	TMP47C210, TMP47C212	8-bit AD converter: 4 channels — TMP47C215, TMP47C216

QFP/SDIP	QFP
42-/44-pin	64-pin

● 4-bit microcontroller (47 Family)

Series Name	Product No.	ROM (bytes)	RAM (nibbles)	I/O	VFT Driver	Additional Functions	Version with Built-in OTP	Packages
47	TMP47C210AN/AF	2K	128	36	Maximum breakdown voltage: 42 V on each of 20 pins	●4-bit SIO: 1 channel ●12-bit timer/counter: 2 channels	●	SDIP42/QFP44
	TMP47C410AN/AF	4K	256	36			●	
	TMP47C212AN	2K	128	35			−	SDIP42
	TMP47C412AN	4K	256	35			−	
	TMP47C441AN/AF	4K		34	Maximum breakdown voltage: 42 V on each of 16 pins	●8-bit AD converter: 4 channels ●4-bit SIO: 1 channel	●	SDIP42/QFP44
470	TMP47C215N	2K	128	36	High breakdown voltage output: 23 pins	●8-bit AD converter: 4 channels ●8-bit SIO: 1 channel	●	SDIP42
	TMP47C415N	4K	256	36			●	
	TMP47C216F	2K	128	38	High breakdown voltage output: 24 pins		●	QFP44
	TMP47C416F	4K	256	38			●	
	TMP47C662AN	6K	384	55	Maximum breakdown voltage: 42 V on each of 27 pins	●8-bit AD converter: 8 channels ●8-bit SIO: 1 channel ●Remote control signal preprocessing capability ●Pulse output	●	SDIP64
	TMP47C862AN	8K	512	55			●	
	TMP47C670N	6K	384	53	Maximum breakdown voltage: 42 V on each of 28 pins	●8-bit AD converter: 8 channels ●8-bit SIO: 1 channel ●Remote control signal preprocessing capability ●Pulse output	●	SDIP64
	TMP47C870N	8K	512	53			●	
470A	TMP47C1270AN	12K	768	53	12 seg. × 16 dig. to 16 seg. × 12 dig.		●	
	TMP47C1670AN	16K					●	

†For details of the products listed above, please refer to the **47 Family** Selection Guide on pages 45 and 46.

CISC APPLICATIONS

Single-chip TV microcontrollers

These single-chip 8-bit microcontrollers for TV incorporate an on-screen display circuit, which can be used to display characters and symbols on screen, and a peripheral circuit for controlling station selection. The devices are optimized for digital tuning system applications. The product line-up features devices with ROM sizes ranging from 12 Kbytes to 60 Kbytes (in the case of the **870 Series**).

Main Functions

- **Advanced 8-bit core (870 Series)**
- **High ROM and RAM capacity**
- **High-speed operation, low power dissipation**
- **Serial interface: I²C bus**

8-bit TV microcontrollers with a built-in OSD circuit

OSD for U.S. broadcast subtitles (32-digit × 8-line)
8-bit AD converter: 6 channels
I²C bus interface: 2 channels
14-bit PWM: 1 channel
7-bit PWM: 9 channels

OSD (24-digit × 12-line)
8-bit AD converter: 6 channels
I²C bus interface: 2 channels
14-bit PWM: 1 channel
7-bit PWM: 9 channels

ROM size	TMPxxxxxx — QFP / DIP — In mass production / Under development					
60 KB	A8700PS / A8700CS	A8700PS		87PS38 / 87CS38	87PS39 / 87CS39	
48 KB	A8700CP		OSD (24-digit × 12-line) 8-bit AD converter input: 4 channels I²C bus interface: 1 channel 14-bit PWM: 1 channel 7-bit PWM: 9 channels	87CP38	87CP39	
32 KB	87PM34A / 87CM34B	A8700CM	A8701CM	87PM36 / 87CM36	87CM38	87CM39
24 KB	87CK34B	A8700CK	A8701CK	87CK36	87CK38	OSD (24-digit × 12-line) 8-bit AD converter: 8 channels I²C bus interface: 2 channels 14-bit PWM: 1 channel 7-bit PWM: 9 channels
16 KB	87CH31 / 87CH34B	A8700CH	A8701CH	87CH36	87CH38	
12 KB	87CC31					

OSD (24-digit × 4-line)
8-bit AD converter input: 4 channels
14-bit PWM: 1 channel
7-bit PWM: 9 channels

OSD for U.S. broadcast sub-titles (32-digit × 8-line)
8-bit AD converter input: 4 channels
I²C bus interface: 2 channels
14-bit PWM: 1 channel
7-bit PWM: 9 channels

OSD for U.S. broadcast sub-titles (32-digit × 8-line)
8-bit AD converter: 6 channels
I²C bus interface: 2 channels

OSD (24-digit × 8-line)
8-bit AD converter: 6 channels
I²C bus interface: 2 channels
14-bit PWM: 1 channel
7-bit PWM: 9 channels

SDIP/QFP (14 × 14mm)	SDIP
42/44-pin	64-pin

● 8-bit microcontrollers (870 Series)

Series Name	Product No.	ROM (bytes)	RAM (bytes)	I/O	On-Screen Display	Additional Functions	Version with Built-in OTP
870	TMPA8700CHN/F	16K	1K	33	For U.S. broadcast sub-titles 32-digit × 8-line display	● 8-bit AD converter: 6 channels ● I²C bus interface: 2 channels ● 14-bit PWM: 1 channel ● 7-bit PWM: 9 channels	TMPA8700PSN/F
	TMPA8700CKN/F	24K					
	TMPA8700CMN/F	32K					
	TMPA8700CPN/F	48K	2K				
	TMPA8700CSN/F	60K					
	TMPA8701CHN/F	16K	768			● 8-bit AD converter: 6 channels ● I²C bus interface: 2 channels	
	TMPA8701CKN/F	24K					
	TMPA8701CMN/F	32K					
	TMP87CC31N	12K	256	34	24-digit × 4-line display	● 6-bit AD converter input: 4 channels ● 14-bit PWM: 1 channel ● 7-bit PWM: 9 channels	TMP87PM36N
	TMP87CH31N	16K					
	TMP87CH34BN	16K	1K	33	For U.S. broadcast sub-titles 32-digit × 8-line display	● 6-bit AD converter input: 4 channels ● I²C bus interface: 2 channels ● 14-bit PWM: 1 channel ● 7-bit PWM: 9 channels	TMP87PM34AN
	TMP87CK34BN	24K					
	TMP87CM34BN	32K					
	TMP87CH36N	16K		34	24-digit × 12-line display	● 6-bit AD converter input: 4 channels ● I²C bus interface: 1 channels ● 14-bit PWM: 1 channel ● 7-bit PWM: 9 channels	TMP87PM36N
	TMP87CK36N	24K					
	TMP87CM36N	32K					
	TMP87CH38N/F	16K	512	33	24-digit × 8-line display	● 8-bit AD converter: 6 channels ● I²C bus interface: 2 channels ● 14-bit PWM: 1 channel ● 7-bit PWM: 9 channels	TMP87PS38N/F
	TMP87CK38N/F	24K					
	TMP87CM38N/F✽	32K	1K		24-digit × 12-line display		
	TMP87CP38N/F✽	48K	2K				
	TMP87CS38N/F✽	60K					
	TMP87CM39N	32K	1K	55	24-digit × 12-line display	● 8-bit AD converter: 8 channels ● I²C bus interface: 2 channels ● 14-bit PWM: 1 channel ● 7-bit PWM: 9 channels	TMP87PS39N
	TMP87CP39N	48K	2K				
	TMP87CS39N	60K					

†For details of the products listed above, please refer to the **870 Series** Selection Guide on pages 36 and 37.   ✽ Under development

Microcontrollers with built-in AD converter

8-bit microcontrollers with built-in AD converter

Legend: TMPxxxxxx — QFP / DIP, In mass production

ROM size	SOP/SDIP 28-pin	SDIP 42-pin	µQFP (10 × 10mm) 44-pin	QFP/SDIP 64-pin	µQFP/QFP SDIP 64-pin	QFP 80-pin	QFP 100-pin
60 KB						87PS64 / 87CS64	
48 KB							87CP64
32 KB		87PM43 / 87CM43		87PM40A / 87CM40A, 87PM41 / 87CM41		87PM53 / 87CM53	87CM64
24 KB		87CK43		87CK40, 87CK41			
16 KB		87PH46 / 87CH46, 87PH47 / 87CH47, 87PH47L / 87CH47L		87PH40A / 87CH40, 87CH41			
12 KB				87CC40, 87CC41			
8 KB	87P808 / 87C808, 87P808L / 87C808L	87P844 / 87C844, 87C846, 87C847		87C840, 87C841			
4 KB	87C408 / 87C408L (1.8-V, 4.2-MHz version)	87C444, 87C446, 87C447					

Notes:
- 8-bit AD converter: 6 channels, I²C bus interface
- 8-bit AD converter: 8 channels
- 10-bit AD converter: 16 channels
- 8-bit AD converter: 8 channels
- 8-bit AD converter: 16 channels
- 8-bit AD converter: 6 channels
- (1.8-V, 4.2-MHz version)
- 8-bit AD converter: 4 channels / 8-bit DA converter: 8 channels / I²C bus interface

4-bit microcontrollers with built-in AD converter

Legend: TMPxxxxxx — Built-in OTP / Mask ROM

ROM size	28-pin	42-pin (QFP-44)				64-pin			80-pin
16 KB								47P1660V / 47C1660 (8-bit SIO)	
12 KB							47C1260		
8 KB			47P840V / 47C840 (8-bit SIO)			47P862 / 47C862A (8-bit SIO VFT)	47P860 / 47C860	47P847 / 47C847 (8-bit SIO LCD)	
6 KB			47C640			47C662A	47C660	47C647	
4 KB		47P443V / 47C443 (8-bit SIO), 47P422V / 47C422 (8-bit SIO LCD), 47P441A / 47C441 (8-bit SIO VFT), 47P440V / 47C440B (4-bit SIO)				47P446V / 47C446A (4-bit SIO LCD)			
2 KB	47P241V / 47C241 (8-bit SIO), 47C243, 47C222								

23

16-Bit and 32-Bit Microcontrollers

900 Family

16-bit and 32-bit microcontrollers developed for C language code efficiency

The **900** Family is made up of highly functional microcontrollers combining the best of Toshiba technologies.

The microcontrollers in this family are available as the processor core for a wide variety of applications, including office equipment, such as printers and fax machines, complex electronic household appliances, such as VCRs and video cameras, cellular 'phones and other information-based equipment.

■ Core expansion keeping pace with applications

[MIPS]

- 900/H2
- Processing capability quadrupled
- 900/H → 900/L1
- Low-voltage operation
- Low power consumption
- Low noise
- Processing capability doubled
- 900 → 900/L
- Upward-compatible
- 16-bit implementation
- Low-voltage operation
- Power consumption halved
- 90

8-bit   16-bit   32-bit
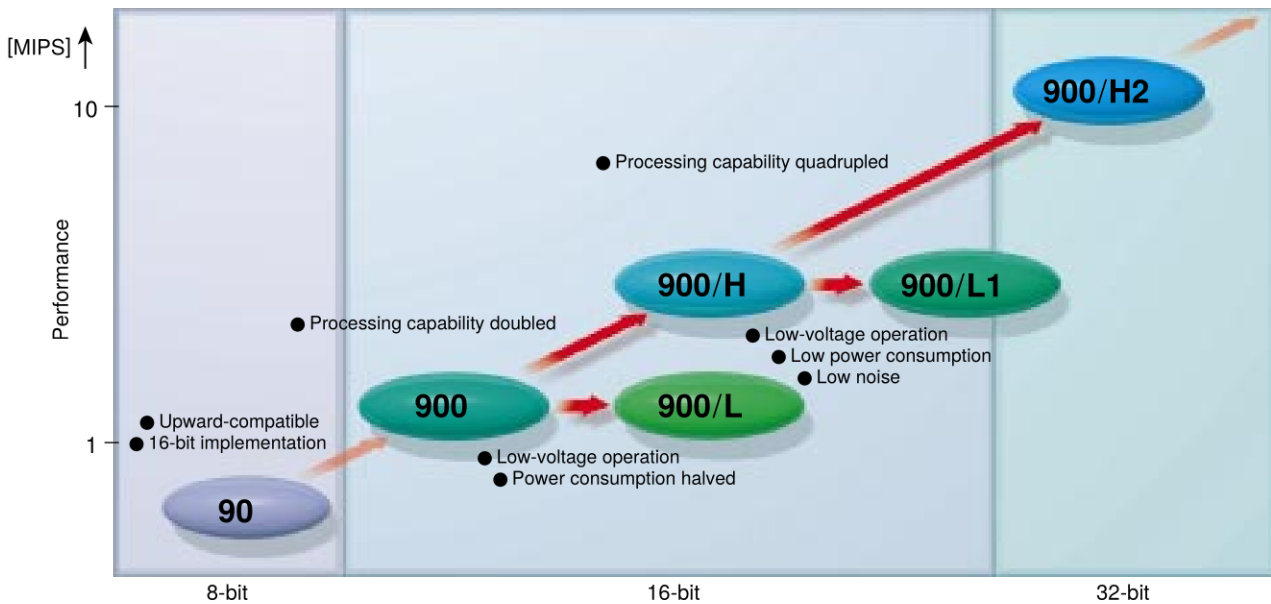
■ Processor core features

	900/H2 Series	**900/H** & **900/L1** Series	**900** & **900/L** Series
Maximum operating frequency (@input frequency)	20 MHz (@10 MHz)	12.5 MHz (@25 MHz)	10 MHz (@20 MHz)
Minimum instruction execution time	50 ns	160 ns	200 ns
Address space	16 Mbytes of linear address space (for program and data)		
Data transfer rate (micro DMA)	0.25 µs	0.64 µs	1.6 µs
32-bit data-processing instructions	Transfer, arithmetic/logic operations and shift instructions		
Bit-processing instructions	Transfer, logic operations, test, set, reset and search		
Multiplication instruction execution time (16-bit operands, 32-bit result)	600 ns	960 ns	2.6 µs
Dynamic bus sizing	8-/16-/32-bit	8-/16-bit	
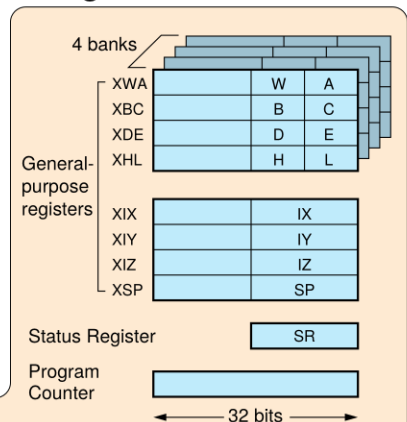
■ Main applications

Office equipment

Printers   Fax machines

Home electronics

Digital video cameras

DVD players

Portable devices

PICs

Cellular 'phones e.g. PHS

■ Register model

4 banks

General-purpose registers

XWA	W	A
XBC	B	C
XDE	D	E
XHL	H	L

XIX	IX
XIY	IY
XIZ	IZ
XSP	SP

Status Register   SR

Program Counter

← 32 bits →

- **32-bit wide general-purpose registers**
  Can be used for address calculations.
  Code size reduction is possible.

- **Numerous general-purpose registers**
  Flexible code generation by compiler.
  Code size reduction is possible.

- **Register bank method**
  Ideal for real-time processing.

900 Family
900/L Series

*Low power consumption design ideal
for high-performance portable equipment*

- Low-voltage operation
  - Operating supply voltage: 4.5 V to 5.5 V @20 MHz
    2.7 V to 5.5 V @12.5 MHz
- Designed for low power consumption

■ Comparison of power consumption levels

Icc [mA]

900 Series (TMP96CM40F)

$\frac{1}{2}$

900/L Series (TMP93CM40F)

(5 V, 20 MHz, 25°C)   (5 V, 20 MHz, 25°C)   (3 V, 12.5 MHz, 25°C)

- Power consumption is almost halved due to the improved design of the clock buffer and various other factors.

Digital movie cameras

Portable MD players

Cellular 'phones

■ Four standby modes

[mA] Operating current (Icc)

⟨TMP93CM40F⟩ (Vcc = 3 V, Ta = 25°C)

NORMAL
RUN
IDLE2
IDLE1
STOP

Operating frequency (fc) [MHz]
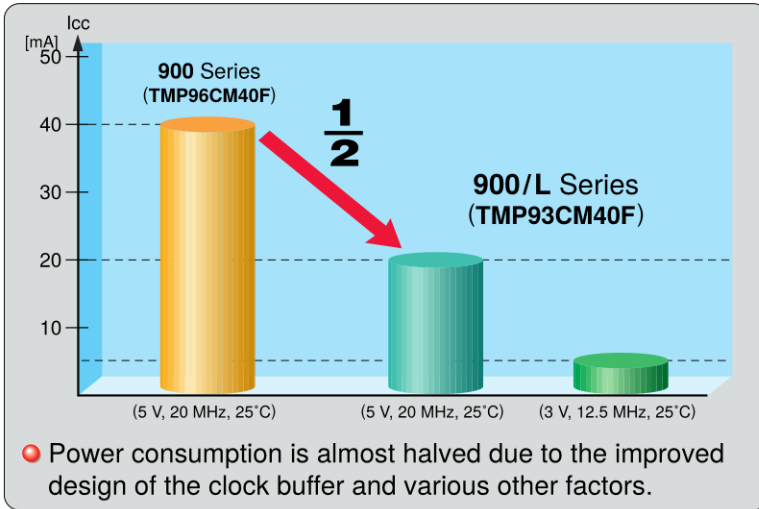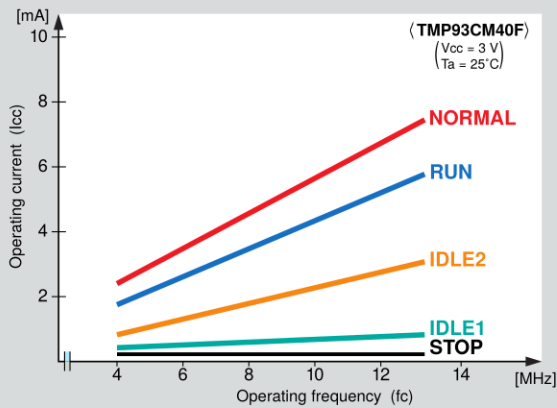
Operation Mode	CPU	AD	Peripheral I/O (other than AD)	Oscillator Circuit
NORMAL	●	●	●	●
RUN	—	●	●	●
IDLE2	—	—	●	●
IDLE1	—	—	—	●
STOP	—	—	—	—

● : Operating   — : Operation halted

■ Clock gear function

[mA] Operating current (Icc)

⟨TMP93CM40F⟩ (Vcc = 3 V, Ta = 25°C)

Gear ratio

1/1
1/2
1/4
1/8
1/16

Operating frequency (fc) [MHz]

■ Dual clock function

[µA] Current consumption

Operating current when device is operating at low frequency

[TMP93CM40F]
(3 V, 32 kHz, 25°C)

NORMAL   RUN   IDLE2   IDLE1
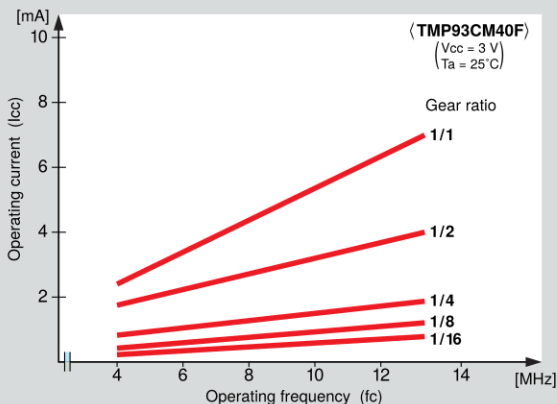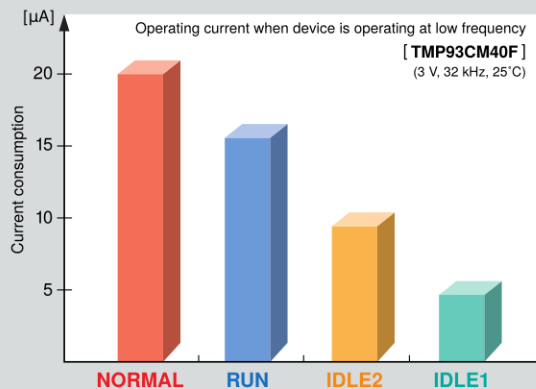
900 Family

900/H Series

High-performance devices ideally suited to high-end office equipment

- Processing capability doubled (relative to the 900 Series)
- Applications
  - Serial printers
  - Electronic musical instruments
  - CD-ROM drives
  - HDDs

■ Block diagram of serial printer

```
        Host Computer
              ↓
        Interface          Paper sensor      LED indicator    Operation switch
              ↓                  ↓                 ↑                 ↓
   ┌─────────────────────────────────────────────────────────────────────┐
   │                      900/H Series  MCU                               │
   └─────────────────────────────────────────────────────────────────────┘
   Address bus ↓   ↕ Data bus      ↑                 ↓                 ↓
        Memory          Carriage Detection     Gate Array        Motor Driver
                                                    ↓
                                               Head Driver
                             Head  ←──────────────────────────────────
```
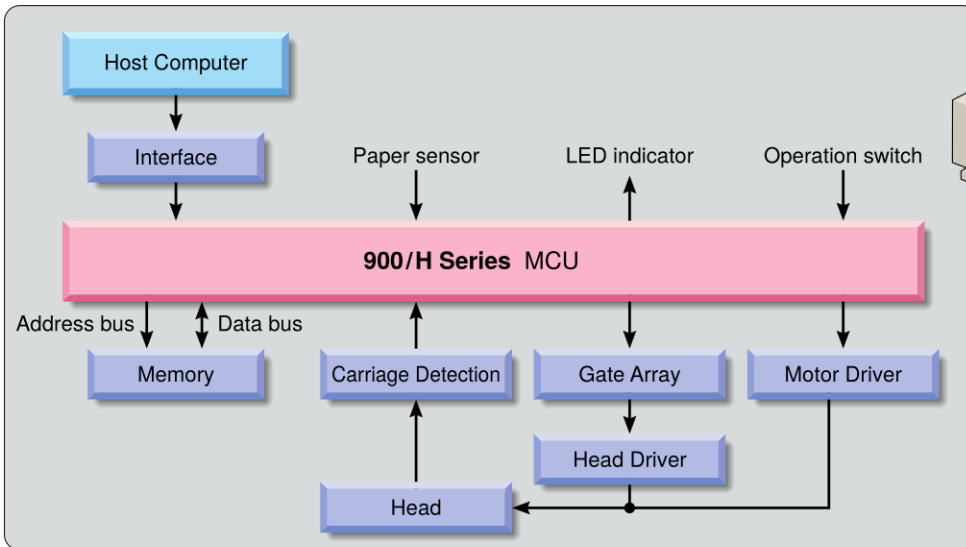
■ Full DRAM control functions

(a) 2-CAS method, 16-bit DRAM

TMP95C063F

Address →
Data ↔
RAS
UCAS
LCAS
RD
WE

16-Bit DRAM
(2-CAS method)

(b) 2-WE method, 16-bit DRAM

TMP95C061BF
TMP95C063F

Address →
Data ↔
RAS
CAS
UW (HWR)
LW (WR)
RD

16-Bit DRAM
(2-WE method)

(c) 8-bit DRAM

TMP95C061BF
TMP95C063F

Address →
Data ↔
RAS
CAS
RD
WE (WR)

8-Bit DRAM
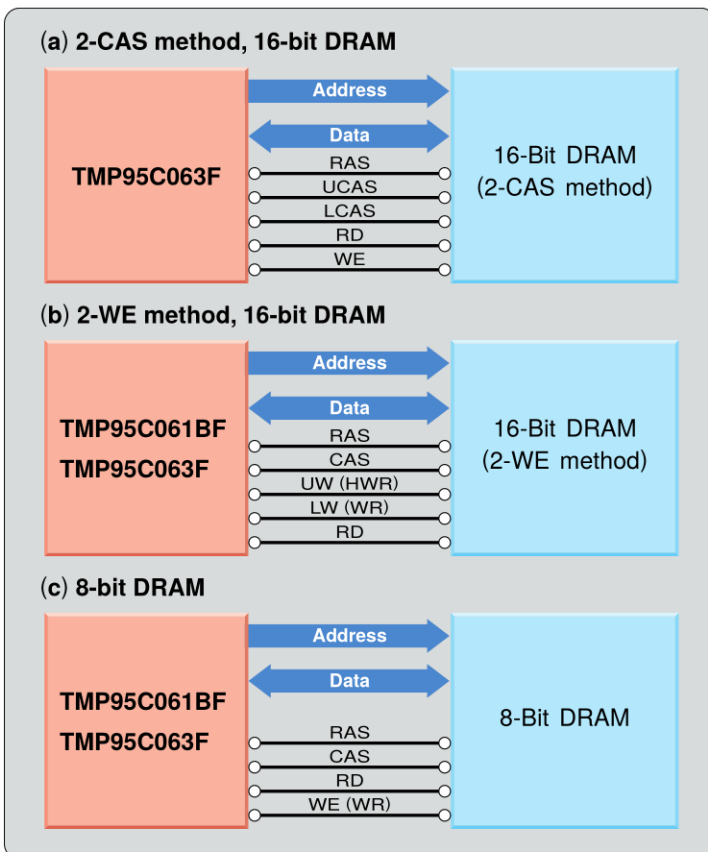
- Devices can be connected directly to various types of DRAM.

- Since memory is refreshed asynchronously from CPU operation, access to other resources is not degraded.

CD-ROM drives

Electronic musical instruments
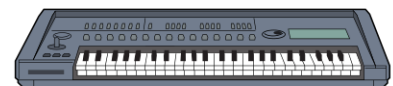
900 Family
900/L1 Series

Next-generation 16-bit microprocessors
offering both high performance and low-power operation

- Low-voltage operation: 1.8 V to 5.5 V
- Low power consumption: 3.0 mA (when operating at 3 V and 16 MHz)
- Low noise (EMC register)
  - EMI: reduced by 30%
  - EMS: noise filter, protection register

Portable communications

DSCs

DVCs

■ Low power consumption design

Icc
[mA]

Conditions: 3 V, 16 MHz, 25°C

19 mA
900/H
0.6 μm

Approx. **1/3**

Approx. **1/2**

6 mA
900/L1
0.6 μm

3 mA
900/L1
0.4 μm

20 —
15 —
10 —
5 —

95CW64 or equivalent   **91CW12**   **91CW12**
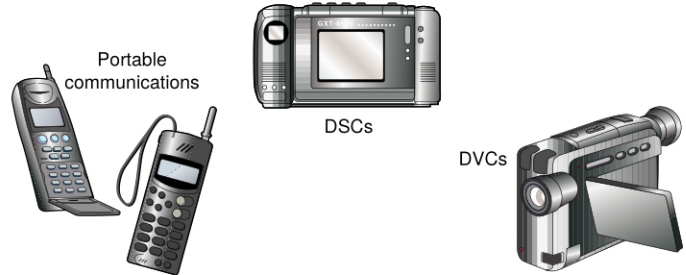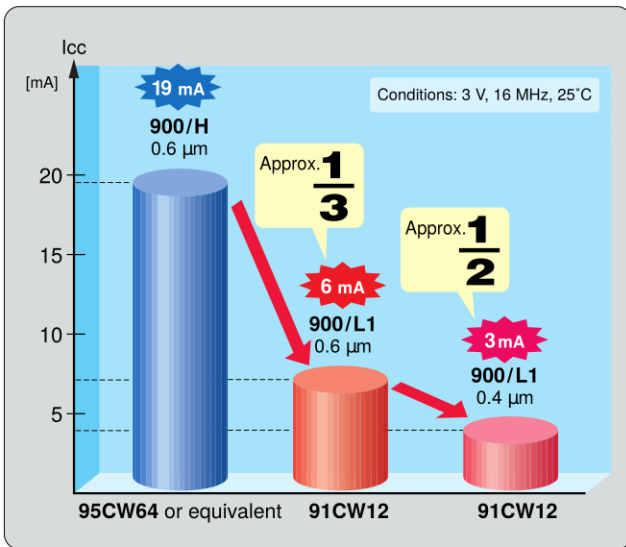
■ Typical techniques for low power consumption design

Reduced power consumption for ROM and RAM

Conventional   **900/L1**

Decoder   Decoder

Decoder   Decoder

Precharge signal   Precharge signal

Gated clock system

Gated Clock Control

Clock   Clock stopped

H
L   SIO

L   Timer

H
L   INTC

■ Core expansion plan

[MIPS]

Performance

10 —

1 —

Advanced version

High-speed core

900/H → **900/L1** → **ASIC microcomputer**

ASIC-ready

900/L

Low-voltage operation
Reduced power consumption
Reduced noise level
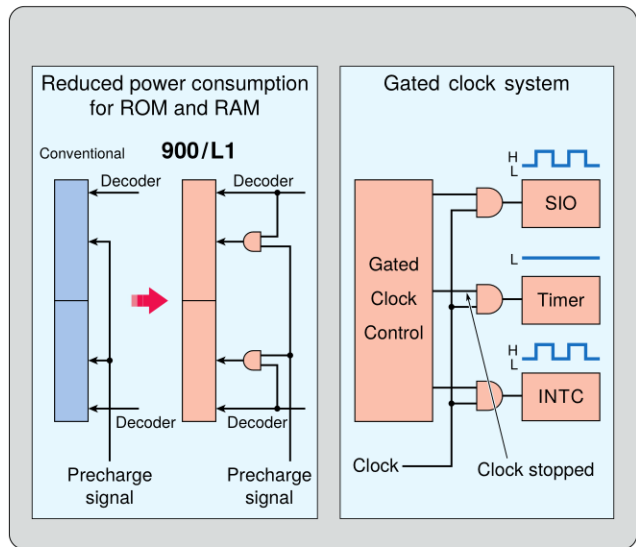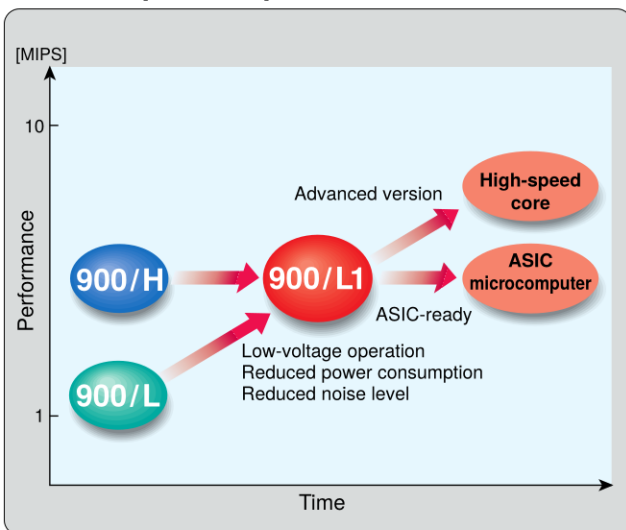
Time

■ Comparison of core performance (with 900/L)

900/L1

900/L

0.0   0.5   1.0   1.5   2.0
Performance

(Unit: Toshiba MCU MIPS)

27
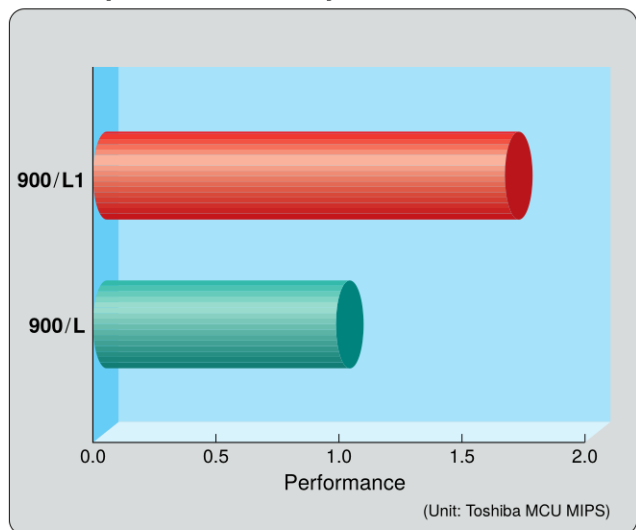
900 Family
900/H2 Series
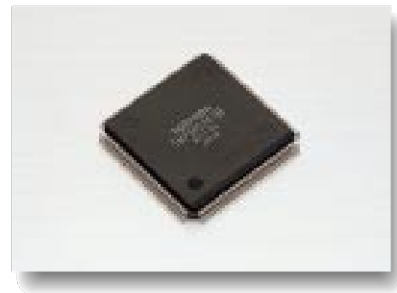
*High-performance microcontrollers
incorporating a 32-bit CPU core*

● Approximately 4 times the processing performance of conventional products (e. g. the 900/H Series)

■ Comparison of instruction execution times

Instruction	Operand Size		
	8-bit	16-bit	32-bit
● Data transfer 1 LD reg, reg	160 ← Conventional products 50 ← 900/H2 Series	160 ← Conventional products 50 ← 900/H2 Series	160 ← Conventional products 50 ← 900/H2 Series
● Data transfer 2 LD reg, mem	320 100	320 100	480 100
● Arithmetic operation ADD reg, imm	240 50	320 50	480 50
● Bit manipulation SET imm, reg	240 50	240 50	
● Branching JR disp8	400 100		Unit: ns

● Enhanced high-speed data transfer function (micro DMA)

900/**H2** Series microcontrollers come with a high-speed data transfer function, equivalent to that of a DMAC (direct memory access controller), as standard.

■ Function and performance comparison

Parameter	**900** Series **900**/**L** Series	**900**/**H** Series **900**/**L1** Series	**900**/**H2** Series
Number of channels	4 channels	4 channels	8 channels
Minimum transfer time	1600 ns (2 bytes)	640 ns (2 bytes)	250 ns (4 bytes)
Initiated by	Interrupt	Interrupt and software trigger	Interrupt and software trigger
Continuous Transfer Mode	NA	NA	Available

● Diverse memory types fully utilized

The **900**/**H2** Series architecture allows various kinds of external memory chip to be connected directly to the CPU core without the need for an external circuit. Furthermore, the internal memory is connected to the CPU core via a 32-bit data bus and the internal RAM can be accessed in a single clock cycle.
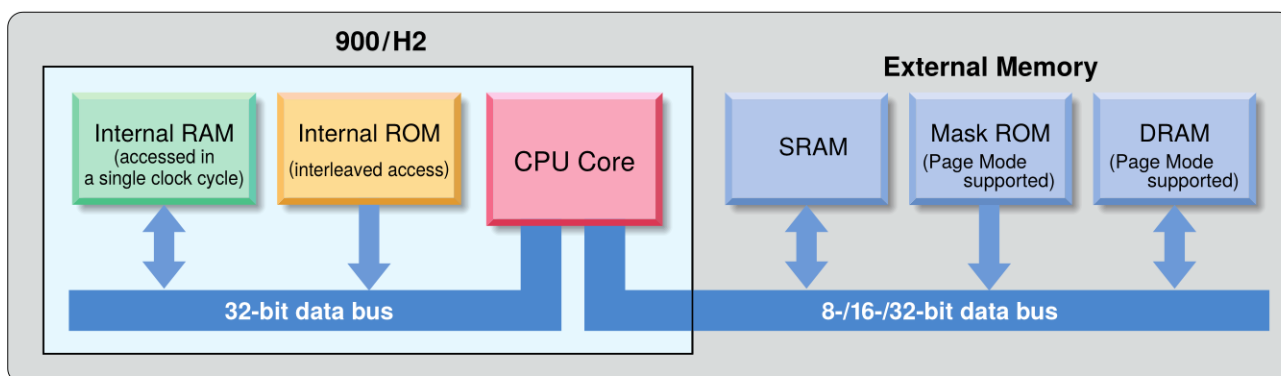
900/H2

Internal RAM (accessed in a single clock cycle)

Internal ROM (interleaved access)

CPU Core

32-bit data bus

External Memory

SRAM

Mask ROM (Page Mode supported)

DRAM (Page Mode supported)

8-/16-/32-bit data bus

900 Family Selection Guide

Column legend for the middle fields (left to right): CAN, SEI, SIO/UART, Synchronous SIO, I²C Bus/SIO, DRAM Controller, AD Converter (6-bit channels / 8-bit channels / 10-bit channels), 8-Bit DA Converter, LCD Driver, VFT Driver, Timer/Counter (8-bit channels / 16-bit channels), Clock timer, Timebase Counter, Pattern Generator, Stepping Motor Controller, 8-bit PWM Timer, 14-bit PWM Timer, CS/Wait Controller, VCR Servo Controller, Watchdog Timer, Dual Clock, Clock Gear, I/O Port, Operating Temperature (°C), Version with Built-in OTP, Packages (mm).

Minimum Instruction Execution Time columns: 5 V ±10% / 3 V ±10% (ns).

900 Series

ROM	RAM	Product No.	5V	3V	CAN	SEI	SIO/UART	Sync SIO	I²C Bus/SIO	DRAM	AD 6-bit	AD 8-bit	AD 10-bit	8-Bit DA	LCD	VFT	Timer 8-bit	Timer 16-bit	Clock timer	Timebase	Pattern Gen	Stepping	8-bit PWM	14-bit PWM	CS/Wait	VCR	Watchdog	Dual Clock	Clock Gear	I/O	Op Temp	OTP Version	Package
NA	NA	TMP96C041BF	200 (Note 2)	–	–	–	2	–	–	–	–	–	4	–	–	–	2	2	–	–	2	–	2	–	3	–	●	–	–	47	–40 to 85	–	QFP80 (14×20)
NA	NA	TMP96C031ZF	200 (Note 2)	–	–	–	2	–	–	1	4	–	–	–	–	–	4	1	–	–	2	–	–	–	4	–	●	–	–	37	–40 to 85	–	QFP64 (14×20)
NA	1K	TMP96C141BF	200 (Note 2)	–	–	–	2	–	–	–	–	–	4	–	–	–	2	2	–	–	2	–	2	–	3	–	●	–	–	47	–40 to 85	–	QFP80 (14×20)
32K	1K	TMP96CM40F	200 (Note 2)	–	–	–	2	–	–	–	–	–	4	–	–	–	2	2	–	–	2	–	2	–	3	–	●	–	–	65	–40 to 85	TMP96PM40F	QFP80 (14×20)

900/L Series

ROM	RAM	Product No.	5V	3V	CAN	SEI	SIO/UART	Sync SIO	I²C Bus/SIO	DRAM	AD 6-bit	AD 8-bit	AD 10-bit	8-Bit DA	LCD	VFT	Timer 8-bit	Timer 16-bit	Clock timer	Timebase	Pattern Gen	Stepping	8-bit PWM	14-bit PWM	CS/Wait	VCR	Watchdog	Dual Clock	Clock Gear	I/O	Op Temp	OTP Version	Package
NA	2K	TMP93CS41F/DF	–	–	–	–	2	–	–	–	–	–	8	–	–	–	2	2	–	–	2	–	2	–	3	–	●	●	●	61	–40 to 85	–	QFP100 (14×14)
NA	2K	TMP93CS45F	320	–	–	–	2	–	1	–	–	–	8	–	–	–	4	2	–	–	–	–	–	–	–	–	●	●	●	44	–40 to 85	–	QFP80 (12×12)
NA	4K	TMP93CW41DF	–	–	–	–	2	–	–	–	–	–	8	–	–	–	2	2	–	–	2	–	2	–	3	–	●	●	●	61	–40 to 85	–	QFP100 (14×14)
NA	8K	TMP93C071F	–	–	–	–	1	2	1	–	–	16	–	–	–	–	1	5	●	●	–	–	–	3	3	●	●	●	–	69	–20 to 70	–	QFP120 (28×28)
8K	1K	TMP93C852F	–	–	–	–	–	6	–	–	–	–	–	–	–	–	–	–	–	–	–	4	–	–	3	–	●	–	●	88	–40 to 85	–	QFP160 (28×28)
32K	2K	TMP93CM40F	200	400	–	–	2	–	–	–	–	–	8	–	–	–	2	2	–	–	2	–	2	–	3	–	●	●	●	79	–40 to 85	TMP93PS40F/DF	QFP100 (14×14)
64K	2K	TMP93CS20F	200	–	–	–	2	–	1	–	–	–	8	–	●	–	4	4	●	–	–	–	–	–	–	–	●	●	●	88	–40 to 85	TMP93PW20AF	QFP144 (16×16)
64K	2K	TMP93CS32F	320	–	–	–	2	–	1	–	–	–	6	–	–	–	4	2	–	–	–	–	–	–	–	–	●	–	●	49	–40 to 85	TMP93PW32F	QFP64 (14×14)
64K	2K	TMP93CS40F/DF	200	–	–	–	2	–	–	–	–	–	8	–	–	–	2	2	–	–	2	–	2	–	3	–	●	●	●	79	–40 to 85	TMP93PS40F/DF	QFP100 (14×14)
64K	2K	TMP93CS42AF	–	–	–	–	2	–	–	–	–	–	5	–	–	–	2	2	–	–	–	–	2	–	3	–	●	–	●	80	–40 to 85	TMP93PS42AF	QFP100 (14×14)
64K	2K	TMP93CS44F	320	–	–	–	2	–	1	–	–	–	8	–	–	–	4	2	–	–	–	–	–	–	–	–	●	●	●	62	–40 to 85	TMP93PS44F	QFP80 (12×12)
72K	1.8K	TMP93CT75F	250	–	–	–	–	–	–	1	–	–	10	–	–	●	1	5	●	●	–	–	–	–	3	–	●	●	●	85	–10 to 70	TMP93PT75F	QFP100 (14×20)
96K	3K	TMP93CU44DF	200	320	–	–	2	–	1	–	–	–	8	–	–	–	4	2	–	–	–	–	–	–	–	–	●	●	●	62	–40 to 85	✱TMP93PW44DF TMP93PW44ADF	QFP80 (14×20)
128K	2.5K	✱TMP93CW76F	250	–	–	–	–	–	1	1	–	–	10	–	–	●	1	5	●	●	–	–	–	–	3	–	●	●	●	85	–20 to 70	✱TMP93PW76F	QFP100 (14×20)
128K	4K	TMP93CW40DF	200	320	–	–	2	–	–	–	–	–	8	–	–	–	2	2	–	–	2	–	2	–	3	–	●	●	●	79	–40 to 85	TMP93PW40DF	QFP100 (14×14)
128K	4K	TMP93CW46AF	200	320	–	–	5	–	–	–	–	–	8	–	–	–	2	2	–	–	–	–	2	–	3	–	●	●	●	79	–40 to 85	TMP93PW46AF	QFP100 (14×14)
128K	4K	TMP93CW44DF	200	–	–	–	2	–	1	–	–	–	8	–	–	–	4	2	–	–	–	–	–	–	–	–	●	●	●	62	–40 to 85	✱TMP93PW44DF TMP93PW44ADF	QFP80 (14×20)

900/H Series

ROM	RAM	Product No.	5V	3V	CAN	SEI	SIO/UART	Sync SIO	I²C Bus/SIO	DRAM	AD 6-bit	AD 8-bit	AD 10-bit	8-Bit DA	LCD	VFT	Timer 8-bit	Timer 16-bit	Clock timer	Timebase	Pattern Gen	Stepping	8-bit PWM	14-bit PWM	CS/Wait	VCR	Watchdog	Dual Clock	Clock Gear	I/O	Op Temp	OTP Version	Package
NA	NA	TMP95C001F	320	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4	–	–	–	–	0	–20 to 70	–	QFP64 (14×14)
NA	NA	TMP95C061BF	–	–	–	–	2	–	–	1	–	4	–	–	–	–	4	2	–	–	2	–	–	–	4	–	●	–	–	56	–20 to 70	–	QFP100 (14×14)
NA	NA	TMP95C063F	160	–	–	–	2	–	–	2	–	–	8	2	–	–	8	2	–	–	2	–	–	–	4	–	●	–	–	91	–20 to 70	–	QFP144 (20×20)
NA	NA	TMP95C265F	400	–	–	–	3	–	–	–	–	–	8	2	–	–	8	2	–	–	2	–	–	–	4	–	●	–	–	55	–20 to 70	–	QFP100 (14×14)
64K	2K	✱TMP95CS54F	167	–	1	1	–	–	–	–	–	–	8	–	–	–	8	2	–	–	2	–	–	–	4	–	●	–	–	81	–40 to 85	TMP95PS54F	QFP100 (14×14)
64K	2K	TMP95CS64F	400	–	–	–	3	–	–	–	–	–	8	2	–	–	8	2	–	–	2	–	–	–	4	–	●	–	–	81	–40 to 85	TMP95PW64F	QFP100 (14×14)
128K	4K	TMP95CW64F	160	400	–	–	3	–	–	–	–	–	8	2	–	–	8	2	–	–	2	–	–	–	4	–	●	–	–	81	–20 to 70	TMP95PW64F	QFP100 (14×14)
256K	8K	✱TMP95FY64F	–	–	–	–	3	–	–	–	–	–	8	2	–	–	8	2	–	–	2	–	–	–	4	–	●	–	–	81	–20 to 70	–	QFP100 (14×14)

900/L1 Series

ROM	RAM	Product No.	5V	3V	CAN	SEI	SIO/UART	Sync SIO	I²C Bus/SIO	DRAM	AD 6-bit	AD 8-bit	AD 10-bit	8-Bit DA	LCD	VFT	Timer 8-bit	Timer 16-bit	Clock timer	Timebase	Pattern Gen	Stepping	8-bit PWM	14-bit PWM	CS/Wait	VCR	Watchdog	Dual Clock	Clock Gear	I/O	Op Temp	OTP Version	Package
96K	3K	TMP91CU10F	–	296	–	–	3	–	–	–	–	–	8	–	–	–	8	2	–	–	–	–	–	–	3	–	●	●	●	80	–40 to 85	TMP91PW10F	QFP100 (14×14)
128K	4K	TMP91CW11F	160	320	–	–	3	2	1	–	–	–	8	–	–	–	2	2	●	–	–	–	2	–	3	–	●	●	●	79	–40 to 85	TMP91PW11F	QFP100 (14×14)
128K	4K	TMP91CW12F	250	–	–	–	2	–	1	–	–	–	8	–	–	–	8	2	–	–	–	–	–	–	4	–	●	●	●	81	–40 to 85	TMP91PW12F	QFP100 (14×14)
128K	4K	✱TMP91CW12AF	–	150	–	–	2	–	1	–	–	–	8	–	–	–	8	2	●	–	–	–	–	–	4	–	●	●	●	81	–40 to 85	–	QFP100 (14×14)

900/H2 Series

ROM	RAM	Product No.	5V	3V	CAN	SEI	SIO/UART	Sync SIO	I²C Bus/SIO	DRAM	AD 6-bit	AD 8-bit	AD 10-bit	8-Bit DA	LCD	VFT	Timer 8-bit	Timer 16-bit	Clock timer	Timebase	Pattern Gen	Stepping	8-bit PWM	14-bit PWM	CS/Wait	VCR	Watchdog	Dual Clock	Clock Gear	I/O	Op Temp	OTP Version	Package
NA	2K	TMP94C241BF	50	–	–	–	–	2	–	–	2	–	8	2	–	–	4	4	–	–	–	–	–	–	6	6	●	–	–	64	–20 to 70	–	QFP160 (28×28)

✱ Under development

Note 1: The suffix F in a product number denotes a quad flat package (QFP).

Note 2: Guaranteed minimum instruction execution time is 200 ns when device is operating at temperatures of –20° to 70°C, or 250 ns when device is operating at temperatures of –40° to 85°C.

NEW PRODUCTS

900/L1 Series product with ultra-low power consumption and low noise

TMP91CW12F/PW12F

■ Low-voltage operation, low power consumption and low-noise technology combined into one device

The **TMP91CW12F**/**PW12F** are new products, capable of operating at voltages of as low as 2.7 V. They feature low power consumption (1/3 that of conventional Toshiba products) and low-noise operation. The ground pin is positioned so as to minimize noise and the devices include a PLL circuit, a noise filter and an EMC register. They also contain both a 16-bit and an 8-bit timer/counter, a serial interface, a 10-bit AD converter and a timer, making them ideal for battery-powered portable equipment such as PDAs, portable 'phones, digital cameras and other highly functional devices.

- Internal ROM
  TMP91CW12F: mask ROM, 128 Kbytes
  TMP91PW12F: EPROM, 128 Kbytes
- Internal RAM
  TMP91CW12F: 4 Kbytes
  TMP91PW12F: 4 Kbytes
- Timer
- Programmable Idle Mode
  Clock to any peripheral can be stopped to achieve low-power operation.
- 16-bit timer/counter: 2 channels
- 8-bit timer/counter: 8 channels
- SIO/UART: 2 channels
- I^{2}C bus/SIO: 1 channel
- 10-bit AD converter: 8 channels
- 100-pin miniflat package
  (14 mm × 14 mm, 0.5-mm pitch, 1.4 mm thick)

Low-noise 900/L Series microcontrollers with I^{2}C bus interface

TMP93CU44DF/CW44DF/PW44DF* ＊Under development

■ Multi-function, high-capacity, low-noise, low-voltage, low power dissipation 16-bit microcontrollers

The **TMP93CU44DF**/**CW44DF**/**PW44DF** are low-voltage, low power dissipation 16-bit microcontrollers based on the 900/H CPU and incorporating an I^{2}C bus interface and a high-capacity memory. To reduce unnecessary radiated noise and to enable low-noise operation, a decoupling capacitor has been incorporated and the number of wiring harnesses has been optimized. With lower noise levels than existing products, these microcontrollers are suitable for a wider range of applications.
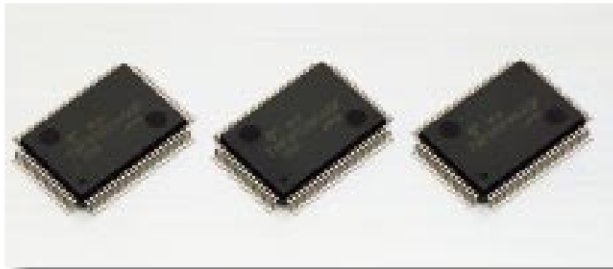
- Internal ROM
  TMP93CU44DF: mask ROM, 96 Kbytes
  TMP93CW44DF: mask ROM, 128 Kbytes
  TMP93PW44DF: OTP ROM, 128 Kbytes
- Internal RAM
  TMP93CU44DF 3 Kbytes
  TMP93CW44DF/**PW44DF**: 4 Kbytes
- I2C bus/SIO: 1 channel
- SIO/UART: 2 channels
- 10-bit AD converter: 8 channels
- High-current output port: 8 pins
- Clock gear/Dual clock function
- Watchdog timer
- 16-bit timer/counter: 2 channels
- 8-bit timer/counter: 4 channels
- 80-pin miniflat package
  (14 mm × 20 mm, 0.8-mm pitch, 2.7 mm thick)

NEW PRODUCTS

900/H Series devices with built-in CAN controller

TMP95CS54F/PS54F

■ 16-bit microcontrollers with built-in CAN controller

The **TMP95CS54F/PS54F** are 16-bit microcontrollers based on the **900**/**H** CPU. They are the first ever microcontrollers to incorporate the controller area network (CAN) communications protocol, the standard European protocol for vehicle LANs. The CAN has a maximum transfer rate of 1 Mbps.

The **TMP95CS54F/PS54F** also offer enhanced communications functions in the shape of a built-in serial expansion interface (SEI) for synchronous serial communications.

The **TMP95PS54F** version incorporates an OTP ROM.

- ● Internal ROM
  TMP95CS54F: mask ROM, 64 Kbytes
  TMP95PS54F: OTP ROM, 64 Kbytes
- ● Internal RAM: 2 Kbytes
- ● CAN controller: 1 channel
  supports protocol 2.0B
  (standard and extended formats)
  16 mailboxes built in
- ● SEI: 1 channel
- ● 16-bit timer/counter: 2 channels
- ● 8-bit timer/counter: 8 channels
- ● SIO/UART: 2 channels
- ● 10-bit AD converter: 8 channels
- ● Operating voltage: 4.7 V to 5.3 V
- ● Operating temperature: –40°C to +85°C
- ● 100-pin miniflat package
  (14 mm × 14 mm, 0.5-mm pitch, 1.4 mm thick)

900/H Series with flash E^{2}PROM

TMP95FY64F*

✳ Under development

■ 16-bit microcontrollers with built-in flash E^{2}PROM

The **TMP95FY64F** is a 16-bit microcontroller based on the **900**/**H** CPU and incorporating a single 5-V flash memory.

This microcontroller incorporates all of the **900 Family's** standard functions. It is easy to reprogram the microcontroller without removing it from the PCB on which it is mounted.
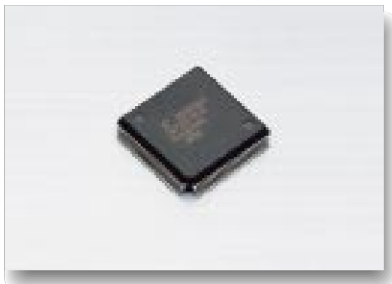
- ● Internal ROM: flash E^{2}PROM, 256 Kbytes
- ● Internal RAM: 8 Kbytes
- ● CS/Wait controller: 4 blocks
- ● SIO/UART: 3 channels
- ● 10-bit AD converter: 8 channels
- ● 16-bit timer/counter: 2 channels
- ● 8-bit timer/counter: 8 channels
- ● 8-bit DA converter: 2 channels
- ● 100-pin miniflat package
  (14 mm × 14 mm, 0.5-mm pitch, 2.7 mm thick)

8-Bit Microcontrollers

90Series

8-bit microcontrollers suitable for control of office equipment systems and for consumer and industrial electronics

The **90** Series is made up of 8-bit microcontrollers suitable for use in various control applications.

- Microcontrollers with up to 60 Kbytes of ROM or no ROM are available.
- Microcontrollers with up to 4 Kbytes of RAM or no RAM are available.
- Minimum instruction execution time: 250 ns (at 16 MHz)
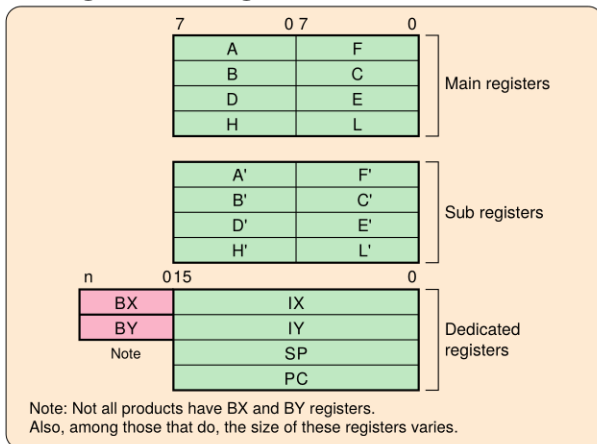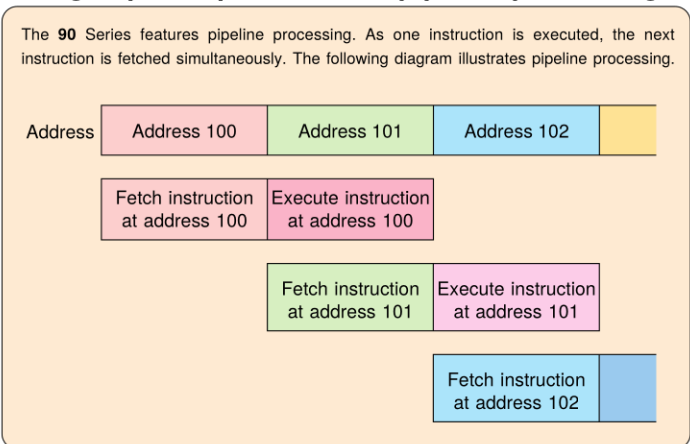- Memory or I/O can be added externally: maximum of 8 Mbytes program/data area
- Enhanced instructions: multiplication and division instructions, 16-bit arithmetic instructions, bit-manipulation instructions
- Variety of interrupt types: vector to automatically handle internal and external interrupts, micro DMA function
- Standby modes

■ Register configuration

7	0 7	0	
A		F	
B		C	Main registers
D		E	
H		L	

A'		F'	
B'		C'	Sub registers
D'		E'	
H'		L'	

n	0 15	0	
BX		IX	
BY		IY	Dedicated registers
Note		SP	
		PC	

Note: Not all products have BX and BY registers.
Also, among those that do, the size of these registers varies.

■ High-speed operation with pipeline processing

The **90** Series features pipeline processing. As one instruction is executed, the next instruction is fetched simultaneously. The following diagram illustrates pipeline processing.

Address	Address 100	Address 101	Address 102	
	Fetch instruction at address 100	Execute instruction at address 100		
		Fetch instruction at address 101	Execute instruction at address 101	
			Fetch instruction at address 102	

■ Applications

- Office equipment
  - Printers
  - Fax machines
  - CD-ROM drives
  - Copy machines
- VCRs
- Electronic instruments
- Game devices
- Industrial cameras

90 Series

- Industrial equipment
  - Controllers
  - Measuring tools
  - Scanners
  - Card readers

■ Product line

Memory options

- 60-KB ROM 2-KB RAM
- 32-KB ROM 1-KB RAM
- 16-KB ROM 512-byte RAM
- 8-KB ROM 256-byte RAM

Package:
- 100-pin
- 80-pin
- 64-pin
- 44-pin
- 40-pin

90 Series

Built-in I/O options

- DAC: 8-bit voltage/current output
- ADC: 8-bit sequential/half flash
- 4-phase stepping motor control
- Serial: UART Serial: synchronizing
- Real-time pulse parallel port
- 8-bit PWM 16-bit PWM
- Micro DMA
- 8-bit timer 16-bit timer
- On-screen display
- MMU
- *TPH I/F RTC

*TPH: thermal printer head

▶ 90 Series Selection Guide

ROM (bytes)	RAM (bytes)	Product No.	Minimum Instruction Execution Time (ns)	Serial Interface: Synchronous	Serial Interface: Asynchronous	Serial Interface: Synchronous/Asynchronous	I²C Bus Channels	8-Bit AD Converter Channels	Flash AD Converter Channels	8-Bit DA Converter Channels	Timer/Counter: 8-bit channels	Timer/Counter: 16-bit channels	Watchdog Timer	High-speed PWM	Timebase Counter	Timing Pulse Generator	Stepping Motor Controller	VCR Servo Controller	OSD	MMU	DRAM Controller	High-Speed DMA	Slave Bus Interface	Thermal Print Head Controller	Real-Time Clock	Dual Clock	Power Supply Voltage (V)	Operating Temperature (°C)	Version with Built-in OTP	Packages
0K	NA	TMP90C051F				2					4		●				●		●	●	●				●	●	4.5 to 5.5	−20 to 70	−	QFP80
	NA	TMP90C041AN/AF				1		6			4	1	●				●										4.5 to 5.5	−20 to 70	−	SDIP64, QFP64
	128	TMP90C401N/F	320 (Note)			1					4																4.5 to 5.5	−20 to 70	−	SDIP64, QFP64
	256	TMP90C801N/F	320 (Note)			1					4																4.5 to 5.5	−20 to 70	−	SDIP64, QFP64
		TMP90C803AP/AM	320 (Note)			1					4		●														4.5 to 5.5	−20 to 70	−	DIP40, SOP40
		TMP90C841AN/AF	320 (Note)			1		6			4	1	●				●										4.5 to 5.5	−20 to 70	−	SDIP64, QFP64
		TMP90C845AN/AF	250			1		4			4	1	●				●	●									4.5 to 5.5	−20 to 70	−	SDIP64, QFP64
	512	TMP90CH03P/M	250			1					4		●														4.5 to 5.5	−20 to 70	−	DIP40, SOP40
		TMP91C641N/F	320 (Note)			1		6			4	1	●				●										4.5 to 5.5	−20 to 70	−	SDIP64, QFP64
		TMP90CH45N/F	250			1		4			4	1	●				●	●									4.5 to 5.5	−20 to 70	−	SDIP64, QFP64
		TMP90C141N/F	320			1		8			4	1	●														4.5 to 5.5	−20 to 70	−	SDIP64, QFP64
	1K	TMP90CM37F/T	250	1	1	1		8		2	4	1	●		●	●									●		4.5 to 5.5	−20 to 70	−	MFP80, PLCC84
		TMP90CM39F/T	250	1		1		8			4	1	●			●									●		4.5 to 5.5	−20 to 70	−	MFP80, PLCC84
	2K	TMP90CS37F/T	250	1	1	1		8		2	4	1	●		●	●									●		4.5 to 5.5	−20 to 70	−	MFP80, PLCC84
		TMP90CS39F/T	250	1		1		8			4	1	●			●									●		4.5 to 5.5	−20 to 70	−	MFP80, PLCC84
	4K	TMP90C441N/F	250			1		6			4	1	●				●										4.5 to 5.5	−20 to 70	−	SDIP64, QFP64
4K	128	TMP90C400N/F	320 (Note)			1					4																4.5 to 5.5	−20 to 70	TMP90P800N/F	SDIP64, QFP64
8K	256	TMP90C800N/F	320 (Note)			1					4																4.5 to 5.5	−20 to 70	TMP90P800N/F	SDIP64, QFP64
		TMP90C802AP/AM	320 (Note)			1					4		●														4.5 to 5.5	−20 to 70	TMP90P802AP/AM	DIP40, SOP40
		TMP90C840AN/AF	320 (Note)			1		6			4	1	●				●										4.5 to 5.5	−20 to 70	TMP91P640N/F	SDIP64, QFP64
		TMP90C844AN/AF	250			1		4			4	1	●				●							●				4.5 to 5.5	−20 to 70	TMP90PH44N/F	SDIP64, QFP64
	512	TMP90C848F	400		1					16	4	1	●	8												●	4.5 to 5.5	−20 to 70	TMP90PH48F	QFP80
16K	320	TMP91C642AN/AF	400	2				12			4		●	3	●	●	●										4.5 to 5.5	−20 to 70	TMP91P642N/F	SDIP64, QFP64
	512	TMP90CH02P/M	250			1					4		●														4.5 to 5.5	−20 to 70	TMP90PH02P/M	DIP40, SOP40
		TMP91C640N/F	320 (Note)			1		6			4	1	●				●										4.5 to 5.5	−20 to 70	TMP91P640N/F	SDIP64, QFP64
		TMP90CH44N/F	250			1		4			4	1	●				●							●				4.5 to 5.5	−20 to 70	TMP90PH44N/F	SDIP64, QFP64
	640	TMP90CH42DF	320	2				6			3		●	3	●	●	●										4.5 to 5.5	−20 to 70	TMP90PM42DF	QFP100
24K	640	TMP90CK42DF	320	2				6			3		●	3	●	●	●										4.5 to 5.5	−20 to 70	TMP90PM42DF	QFP100
		TMP90CK76DF		2				12			4		●	3	●	●	●								●	●	4.5 to 5.5	−20 to 70	TMP90PS74DF	QFP100
32K	1K	TMP90CM36F/T	250	1	1	1		8		2	4	1	●		●	●									●		4.5 to 5.5	−20 to 70	TMP90PM36F/T	MFP80, PLCC84
		TMP90CM38F/T	250	1		1		8			4	1	●			●									●		4.5 to 5.5	−20 to 70	TMP90PM38F/T	MFP80, PLCC84
		TMP90CM40AN/AF	320 (Note)			1		6			4	1	●				●										4.5 to 5.5	−20 to 70	TMP90PM40E/N/F	SDIP64, QFP64
40K	768	TMP90CN72EDF		2				12			4		●	3	●	●		●	●							●	●	4.5 to 5.5	−20 to 70	TMP90PS74DF	QFP100
60K	1K	TMP90CS74EDF		2			1	12			4		●	3	●	●		●	●							●	●	4.5 to 5.5	−20 to 70	TMP90PS74DF	QFP100
	2K	TMP90CS36F/T	250	1	1	1		8		2	4	1	●		●	●									●		4.5 to 5.5	−20 to 70	TMP90PS36F	MFP80, PLCC84
		TMP90CS38F/T	250	1		1		8			4	1	●			●									●		4.5 to 5.5	−20 to 70	TMP90PS38F	MFP80, PLCC84

Note: Guaranteed minimum instruction execution time is 320 ns when device is operating at temperatures of −20˚ to 70˚C, and 400 ns when device is operating at temperatures of −40˚ to 85˚C.

Product number suffixes   N: Plastic shrink dual in-line package (SDIP)   F: Plastic quad flat package (QFP)   P: Plastic standard dual in-line package (DIP)
M: Plastic small-outline package (SOP)   T: Plastic leaded chip carrier (PLCC)   E: Ceramic standard dual in-line package (SDIC)
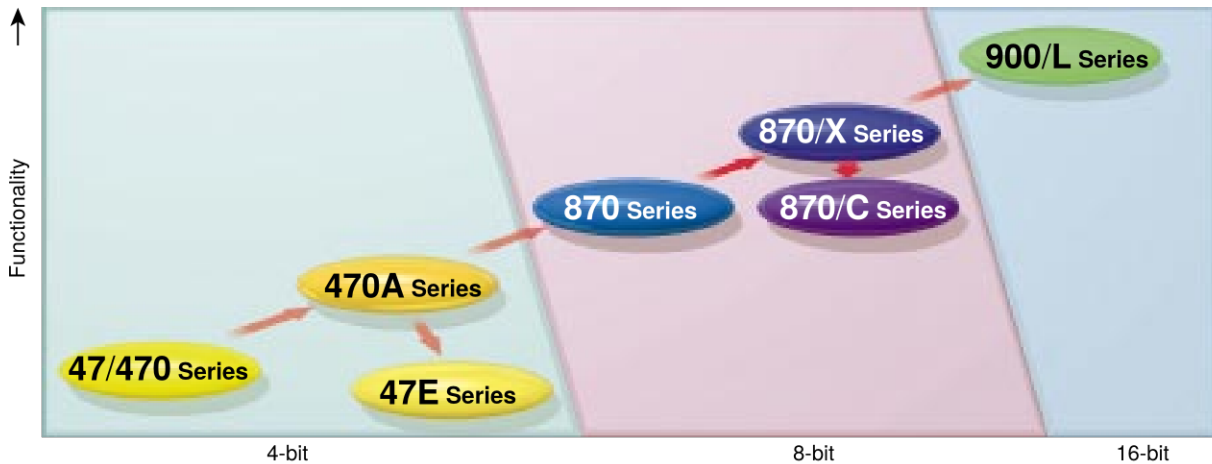
8-Bit Microcontrollers
870 Family

8-bit microcontrollers suitable for a wide range of consumer electronic appliances such as TVs, VCRs and telephones
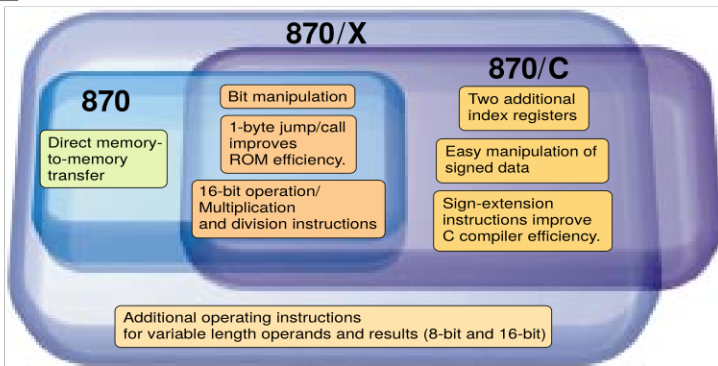
The **870** Family is made up of microcontrollers which are suitable for consumer electronic equipment such as TVs, audio equipment and telephones. Every device in this family has an AD converter, LCD drive circuit, UART and on-screen display circuit. However, each device also has unique features particularly suiting it to certain well-defined applications and operating conditions. For example, the **870** Family product line includes devices with low-voltage, low power consumption and low-noise operation features, and these are suited to a wide range of portable equipment.

In addition to the popular **870** Series, Toshiba have recently introduced the **870/X** Series with improved functionality. To round out the **870** Family, Toshiba are currently developing the **870/C** Series for small-scale applications.

■ Application core development
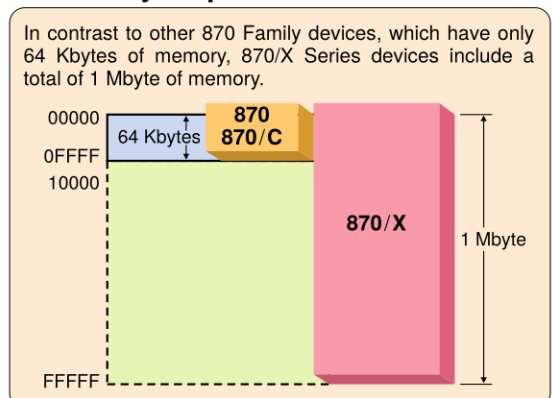

■ Instruction set features

■ Register configuration (870 and 870/X)

Note: [ ] **870/X** only

■ Comparative performance

■ Memory map

In contrast to other 870 Family devices, which have only 64 Kbytes of memory, 870/X Series devices include a total of 1 Mbyte of memory.
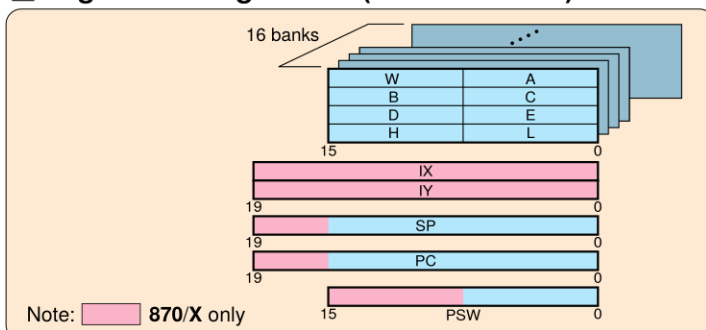
870 Series

● 64 Kbytes of memory space
- ■ From 4 Kbytes to 60 Kbytes of ROM
- ■ From 256 bytes to 2 Kbytes of RAM

● Architecture suitable for real-time control
- ■ 0.5 μs per instruction cycle at 8 MHz
- ■ High-speed task switching
  High-speed Interrupt Register save/restore using register bank switching
- ■ Up to 15 interrupt vectors

● Low-voltage, high-speed operation; low power consumption
- ■ Wide operating voltage range: 2.7 V to 5.5 V or 2.7 V to 6.0 V (standard type)
- ■ 1.8 V / 0.95 μs at 4.2 MHz (low-voltage type)
- ■ Clock gear
  Low power consumption modes attained by switching the speed of the system clock.
- ■ Low-voltage AD conversion
- ■ Dual clock system
  Main clock for high-speed operation (8 MHz)
  and sub-clock for low power consumption (32.8 kHz); 5 different low power consumption modes

● Instruction set for embedded controller: 412 instructions
- ■ 1-byte jump/call instructions, direct memory-to-memory transfer instructions and
  arithmetic instructions to improve memory efficiency
- ■ Variety of bit-manipulation instructions
- ■ 16-bit transfer/calculation instructions
- ■ Multiplication and division instructions

● One-time PROM product versions
- ■ One-time PROM product versions with features
  compatible with mask ROM products

● Small package
- ■ Microflat package/Miniflat package

● Well-developed support environment
- ■ Assembler
- ■ High-level languages (C compiler, C-Like compiler)
- ■ High-level language debugger
- ■ Real-time emulator: RTE Model 10

■ Register configuration
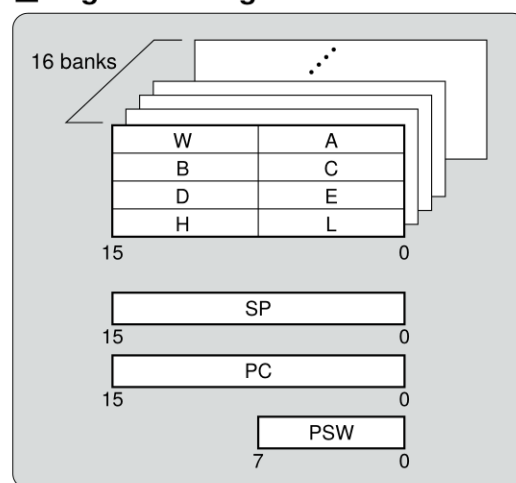
16 banks

W	A
B	C
D	E
H	L

15   0

| SP |
15   0

| PC |
15   0

| PSW |
7   0

◨ Wide temperature range performance
Special products with a guaranteed operating temperature range of from –40° to 85°C can also be supplied.
If you are interested in using them, please contact your nearest Toshiba office or authorized Toshiba dealer.

ROM (bytes)	RAM (bytes)	Product No.	Min. Instruction Execution Time (µs)	LED	LCD	VFT	SIO Ch	UART Ch	I²C Bus Ch (Note 2)	High-Speed Serial Output	AD 8-bit ch	AD 10-bit ch	AD Conversion Input	DA Converter Ch	Timer 18-bit ch	Timer 16-bit ch	Timer 8-bit ch	Remote Control Pulse Detector	Watchdog Timer	OSD	Dual Clock	Clock Gear	No. of I/O Ports	Power Supply Voltage (V)	Operating Temp (°C)	Version with Built-in OTP	Packages
4K	256	✳TMP87C405AM/AN	0.50 / 0.95	6													2		●			●		4.5 to 5.5 / 2.7 to 5.5	−30 to 70	TMP87P808M/N	SOP28/ SDIP28
	256	TMP87C408M/N/DM	0.95	6			1				6						2		●			●	22	4.5 to 5.5 / 2.7 to 5.5	−30 to 70	TMP87P808M/N	SSOP30/ SOP28/ SDIP28
	256	TMP87C408LM/LN	0.95	6			1				6						2		●			●	22	1.8 to 4.0	−30 to 70	TMP87P808LM/LN	SSOP30/ SOP28/ SDIP28
	256	TMP87C409M/N	0.50 / 0.95	6					1		8					1	2		●					4.5 to 5.5 / 2.2 to 5.5	−30 to 70	✳TMP87P809M/N	SSOP30/ SOP28/ SDIP28
	256	TMP87C444N	0.50			1	1				4			8			2		●				34	4.5 to 5.5	−30 to 70	TMP87P844N	SDIP42
	512	TMP87C446N	0.50/122 / 0.95/122	8			1		●		8					2	2		●		●		35	4.5 to 5.5 / 2.7 to 5.5	−30 to 70	TMP87PH46N	SDIP42
	512	TMP87C447U	0.50/122 / 0.95/122	8			1		●		8					2	2		●		●		37	4.5 to 5.5 / 2.7 to 5.5	−30 to 70	TMP87PH47U	µQFP44 (10×10 mm)
8K	256	TMP87C800N/F/DF	0.50/122 / 0.95/122	8			2									2	2		●		●		58	4.5 to 6.0 / 2.7 to 6.0	−30 to 70	TMP87PH00N/F/DF	SDIP64/ QFP64/ LQFP64
	256	TMP87C807U	0.50/122 / 0.95/122	8			1		●							2	2		●		●		37	4.5 to 5.5 / 2.7 to 5.5	−30 to 70	TMP87PH47U	µQFP44 (10×10 mm)
	256	TMP87C808M/N	0.50 / 0.95	6			1				6						2		●			●		4.5 to 5.5 / 2.7 to 5.5	−30 to 70	TMP87P808M/N	SOP28/ SDIP28
	256	TMP87C808LM/LN	0.95	6			1				6						2		●			●	22	1.8 to 4.0	−30 to 70	TMP87P808LM/LN	SOP28/ SDIP28
	256	TMP87C809M/N	0.50 / 0.95	6					1		8					1	2		●					4.5 to 5.5 / 2.2 to 5.5	−30 to 70	✳TMP87P809M/N	SOP28/ SDIP28
	256	TMP87C840N/F	0.50/122 / 0.95/122	8			2				8					2	2		●		●		56	4.5 to 6.0 / 2.7 to 6.0	−30 to 70	TMP87PH40AN/AF	SDIP64/ QFP64
	256	TMP87C841N/F/U	0.50/122 / 0.95/122	8			2					16				2	2		●		●		56	4.5 to 5.5 / 2.7 to 5.5	−40 to 85	TMP87PM41N/F/U	SDIP64/ QFP64/ µQFP64 (10×10 mm)
	256	TMP87C844N	0.50			1	1				4			8			2		●				34	4.5 to 5.5	−30 to 70	TMP87P844N	SDIP42
	512	TMP87C814N/F	0.50/122 / 0.95/122		16	1					8					2	2		●		●		55	4.5 to 5.5 / 2.7 to 5.5	−30 to 70	TMP87PM14N/F	SDIP64/ QFP64
	512	TMP87C846N	0.50/122 / 0.95/122	8			1		●		8					2	2		●		●		35	4.5 to 5.5 / 2.7 to 5.5	−30 to 70	TMP87PH46N	SDIP42
	512	TMP87C847U	0.50/122 / 0.95/122	8			1		●		8					2	2		●		●		37	4.5 to 5.5 / 2.7 to 5.5	−30 to 70	TMP87PH47U	µQFP44 (10×10 mm)
	512	TMP87C847LU	0.95/122	8			1		●		8					2	2		●		●		37	1.8 to 4.0	−30 to 70	TMP87PH47LU	µQFP44 (10×10 mm)
12K	256	TMP87CC31N	0.50	4								4				2	2	●	●		●		34	4.5 to 5.5	−30 to 70	TMP87PM36N	SDIP42
	512	TMP87CC20F	0.50/122 / 0.95/122	2	32		1									1	4		●		●		45	4.5 to 6.0 / 2.7 to 6.0	−30 to 70	TMP87PH20F	QFP80
	512	TMP87CC40N/F	0.50/122 / 0.95/122	8			2				8					2	2		●		●		56	4.5 to 6.0 / 2.7 to 6.0	−30 to 70	TMP87PH40AN/AF	SDIP64/ QFP64
	512	TMP87CC41N/F/U	0.50/122 / 0.95/122	8			2					16				2	2		●		●		56	4.5 to 5.5 / 2.7 to 5.5	−40 to 85	TMP87PM41N/F/U	SDIP64/ QFP64/ µQFP64 (10×10 mm)
	512	TMP87CC78F	0.50/122 / 0.95/122			40	2				8					2	2		●		●		89	4.5 to 5.5 / 2.7 to 5.5	−30 to 70	TMP87PM78F	QFP100
16K	256	TMP87CH00N/F/DF	0.50/122 / 0.95/122	8			2				8					2	2		●		●		58	4.5 to 6.0 / 2.7 to 6.0	−30 to 70	TMP87PH00N/F/DF	SDIP64/ QFP64/ LQFP64
	256	TMP87CH00LF	0.50/122 / 0.95/122	4			2									2	2		●		●		58	4.5 to 5.5 / 1.8 to 5.5	−30 to 70	TMP87PH00LF	QFP64
	256	TMP87CH31N	0.50	4								4				2	2	●	●		●		34	4.5 to 5.5	−30 to 70	TMP87PM36N	SDIP42
	512	TMP87CH14N/F	0.50/122 / 0.95/122		16	1					8					2	2		●		●		55	4.5 to 5.5 / 2.7 to 5.5	−30 to 70	TMP87PM14N/F	SDIP64/ QFP64
	512	TMP87CH20F	0.50/122 / 0.95/122	2	32		1									1	4		●		●		45	4.5 to 6.0 / 2.7 to 6.0	−30 to 70	TMP87PH20F	QFP80
	512	TMP87CH38N/F	0.50	4					2		6					2	2	●	●		●		33	4.5 to 5.5	−30 to 70	TMP87PS38N/F	SDIP42/ QFP44
	512	TMP87CH40N/F	0.50/122 / 0.95/122	8			2				8					2	2		●		●		56	4.5 to 6.0 / 2.7 to 6.0	−30 to 70	TMP87PH40AN/AF	SDIP64/ QFP64
	512	TMP87CH41N/F/U	0.50/122 / 0.95/122	8			2					16				2	2		●		●		56	4.5 to 5.5 / 2.7 to 5.5	−40 to 85	TMP87PM41N/F/U	SDIP64/ QFP64/ µQFP64 (10×10 mm)
	512	TMP87CH46N	0.50/122 / 0.95/122	8			1		●		8					2	2		●		●		35	4.5 to 5.5 / 2.7 to 5.5	−30 to 70	TMP87PH46N	SDIP42
	512	TMP87CH47U	0.50/122 / 0.95/122	8			1		●		8					2	2		●		●		37	4.5 to 5.5 / 2.7 to 5.5	−30 to 70	TMP87PH47U	µQFP44 (10×10 mm)
	512	TMP87CH47LU	0.50/122 / 0.95/122	8			1		●		8					2	2		●		●		37	1.8 to 4.0	−30 to 70	TMP87PH47LU	µQFP44 (10×10 mm)
	512	TMP87CH48U/DF	0.50/122 / 0.95/122	8				1	1			16				2	2		●		●		56	4.5 to 5.5 / 2.7 to 5.5	−40 to 85	TMP87PH48U/DF	µQFP64 (10×10 mm)/ LQFP64
	512	†TMP87CH48IU	0.50/122 / 0.95/122	8				1	1			16				2	2		●		●		56	4.5 to 5.5 / 2.7 to 5.5	−40 to 85	TMP87PH48U/DF	µQFP64 (10×10 mm)/ LQFP64
	512	TMP87CH70BF	0.50/122 / 0.95/122			16	1		●					6		2	2		●		●		73	4.5 to 5.5 / 2.7 to 5.5	−30 to 70	TMP87PM70F	QFP80
	512	TMP87CH74AF	0.50/122 / 0.95/122	16	37	1		1			12					2	2		●		●		71	4.5 to 5.5 / 2.7 to 5.5	−30 to 70	TMP87PM74F	QFP80
	512	✳TMP87CH75F	0.50/122 / 0.95/122	16	51	1	1				16					2	2		●		●		89	4.5 to 5.5 / 2.7 to 5.5	−30 to 70	TMP87PM75F	QFP100
	512	TMP87CH78F	0.50/122 / 0.95/122			40	2				8					2	2		●		●		89	4.5 to 5.5 / 2.7 to 5.5	−30 to 70	TMP87PM78F	QFP100
	512	TMP87CH21F/DF	0.50/122 / 0.95/122		32	2					8					2	2		●		●		52	4.5 to 5.5 / 2.7 to 5.5	−30 to 70	TMP87PP21F/DF	QFP80/ QFP80
	512	✳TMP87CH21AF/ADF	0.50/122 / 0.95/122		32	2					8					2	2		●		●		52	4.5 to 5.5 / 2.7 to 5.5	−30 to 70	TMP87PP21F/DF	QFP80/ QFP80
	1K	TMP87CH29N/U	0.50/122 / 0.95/122	3	24		1				5			1			4		●		●		43	4.5 to 5.5 / 2.7 to 5.5	−30 to 70	TMP87PM29N/U	SDIP64/ µQFP64 (10×10 mm)
	1K	TMP87CH34BN	0.50	4				2			4					2	2	●	●	●			33	4.5 to 5.5	−30 to 70	TMP87PM34AN	SDIP42
	1K	TMP87CH36N	0.50	4				1			4					2	2	●	●	●			34	4.5 to 5.5	−30 to 70	TMP87PM36N	SDIP42

I²C BUS — Purchase of TOSHIBA I²C components conveys a license under the Philips I²C Patent Rights to use these components in an I²C system, provided that the system conforms to the I²C Standard Specification as defined by Philips.

870 Series Selection Guide

ROM (bytes)	RAM (bytes)	Product No.	Min. Instr. Exec. Time (µs)	LED	LCD	VFT	SIO Ch.	UART Ch.	I²C Bus Ch.	High-Speed Serial Out	AD 8-bit ch.	AD 10-bit ch.	AD Conv. Input	DA Conv. Ch.	18-bit ch.	Timer 16-bit	Timer 8-bit	Remote Ctrl Pulse Det.	Watchdog Timer	OSD	Dual Clock	Clock Gear	No. of I/O Ports	Power Supply Voltage (V)	Operating Temp (°C)	Version with Built-in OTP	Packages
24K	512	TMP87CK38N/F	0.50	4			2				6					2	2	●	●	●			33	4.5 to 5.5	−30 to 70	TMP87PS38N/F ★	SDIP42/QFP44
		TMP87CK14N/F	0.50/122 0.95/122			16	1				8					2	2		●		●		55	4.5 to 5.5 2.7 to 5.5		TMP87PM14N/F	SDIP64/QFP64
		TMP87CK20AF		2	32	1						8				1	4		●		●		45			TMP87PM20F	QFP80
		TMP87CK29N/U		3	24				1		5			1			4		●		●		43			TMP87PM29N/U	SDIP64/µQFP64 (10×10 mm)
		TMP87CK34BN	0.50	4			2					4				2	2	●	●	●			33	4.5 to 5.5		TMP87PM34AN	SDIP42
		TMP87CK36N		4					1			4				2	2	●	●	●			34			TMP87PM36N	
		TMP87CK40AN/AF		8		2					8					2	2		●		●		56	4.5 to 6.0 2.7 to 6.0		TMP87PM40AN/AF	SDIP64/QFP64
		TMP87CK41N/F/U		8		2						16				2	2		●		●		56		−40 to 85	TMP87PM41N/F/U	SDIP64/QFP64/µQFP64 (10×10 mm)
		TMP87CK43N					2				6					2	2		●		●		35			TMP87PM43N	SDIP42
		TMP87CK78F			40	2					8					2	2		●		●		89			✳TMP87PM78F	QFP100
32K	512	TMP87CM70BF	0.50/122 0.95/122			16	1			●				6		2	2		●		●		73	4.5 to 5.5 2.7 to 5.5	−30 to 70	TMP87PM70F	QFP80
		TMP87CM14N/F				16	1				8					2	2		●		●		55			TMP87PM14N/F	SDIP64/QFP64
		TMP87CM20AF		2	32	1									1	4		●		●		45			TMP87PM20F	QFP80
		TMP87CM21F/DF		1	32	2					8					2	2		●		●		52			TMP87PP21F/DF	QFP80/QFP80 (12×12 mm)
		TMP87CM23F		1	40	2					8					2	2		●		●		70			TMP87PP23F	QFP100
		TMP87CM29N/U		3	24				1		5			1			4		●		●		43			TMP87PM29N/U	SDIP64/µQFP64 (10×10 mm)
	1K	TMP87CM34BN	0.50	4			2					4				2	2	●	●	●			33	4.5 to 5.5		TMP87PM34AN	SDIP42
		TMP87CM36N		4					1			4				2	2	●	●	●			34			TMP87PM36N	
		TMP87CM38N/F		4			2				6					2	2	●	●	●			33			TMP87PS38N/F	SDIP42/QFP44
		TMP87CM39N	0.50/122 122	4			2				8					2	2	●	●	●	●		55			TMP87PS39N	SDIP64
		TMP87CM40AN/AF	0.50/122 0.95/122	8		2					8					2	2		●		●		56			TMP87PM40AN/AF	SDIP64/QFP64
		TMP87CM41N/F/U		8		2						16				2	2		●		●		56	4.5 to 5.5 2.7 to 5.5	−40 to 85	TMP87PM41N/F/U	SDIP64/QFP64/µQFP64 (10×10 mm)
		TMP87CM43N	0.50/122 122				2				6					2	2		●		●		35		−30 to 70	TMP87PM43N	SDIP42
		TMP87CM45N		4			2				8					2	2	●	●		●		55			TMP87PS39N	SDIP64
		✳TMP87CM48U/DF		8			1	1				16				2	2		●		●		56		−40 to 85	TMP87PM48U/DF	µQFP64 (10×10 mm)/LQFP64
		TMP87CM53F		7		1	1				8					2	2		●		●	●	72	4.5 to 5.5 2.2 to 5.5	−30 to 60	TMP87PM53F	QFP80
		TMP87CM64F		16		3					16					2	3		●		●		90			TMP87PS64F	QFP100
		TMP87CM74AF		16	37	1		1			12					2	2		●		●		71			TMP87PM74F	QFP80
		✳TMP87CM75F		16	51	1		1			16					2	2		●		●		89	4.5 to 5.5 2.7 to 5.5		TMP87PM75F	QFP100
		TMP87CM78F	0.50/122 0.95/122		40	2					8					2	2		●		●		89			TMP87PM78F	
	1.5K	TMP87CM71F				16	1			●				6		2	2		●		●		73			TMP87PS71F	QFP80
	2K	TMP87CM24AF		1	40	2					8					2	2		●		●		69	4.5 to 5.5 2.2 to 5.5		✳TMP87PP24AF	QFP100 (14×14 mm)
40K	1.5K	TMP87CN71F				16	1			●						2	2		●		●		73				
48K	1.5K	TMP87CP71F				16	1			●				6		2	2		●		●		73	4.5 to 5.5 2.7 to 5.5	−30 to 70	TMP87PS71F	QFP80
	2K	TMP87CP23F			40	2					8					2	2		●		●		70			TMP87PP23F	QFP100
		TMP87CP24AF		1	40	2					8					2	2		●		●		69	4.5 to 5.5 2.2 to 5.5		✳TMP87PP24AF	QFP100 (14×14 mm)
		TMP87CP38N/F	0.50	4			2				6					2	2	●	●	●			33	4.5 to 5.5		TMP87PS38N/F	SDIP42/QFP44
		TMP87CP39N	0.50/122 122	4			2				8					2	2	●	●	●	●		55			TMP87PS39N	SDIP64
		TMP87CP64F	0.50/122 0.95/122	16		3					16					2	3		●		●		90	4.5 to 5.5 2.7 to 5.5		TMP87PS64F	QFP100
60K	2K	TMP87CS38N/F	0.50	4			2				6	6				2	2	●	●	●			33	4.5 to 5.5		TMP87PS38N/F	SDIP42/QFP44
		TMP87CS39N	0.50/122 122	4			2				8					2	2	●	●	●	●		55			TMP87PS39N	SDIP64
		TMP87CS64F	0.50/122 0.95/122	16		3					16					2	3		●		●		90	4.5 to 5.5 2.7 to 5.5		TMP87PS64F	QFP100
		✳TMP87CS68DF		7		1	1				8					2	2		●		●	●	72			TMP87PS68DF	QFP80 (12×12 mm)
		TMP87CS71F				16	1			●				6		2	2		●		●		73			TMP87PS71F	QFP80

✳: Under development
★: Samples available
†: I/W version

Note 1: Product number suffixes   **N**: Plastic shrink dual in-line package (SDIP)   **F**: Plastic quad flat package (QFP)
M: Plastic small-outline package (SOP)   **U**: Plastic microflat package (µQFP)
Note 2: I²C bus circuit can be switched between I²C bus circuit and SIO circuit in software.
Note 3: USP 4,382,279 owned by BULL CP8.
◆ For further information about the I/W version, please contact your nearest Toshiba office or authorized Toshiba dealer.
◆ OTP products are provided for system development and evaluation.

870/C Series

*Suitable for home appliances and cellular equipment
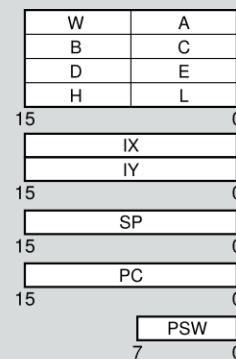which require low-voltage operation capability
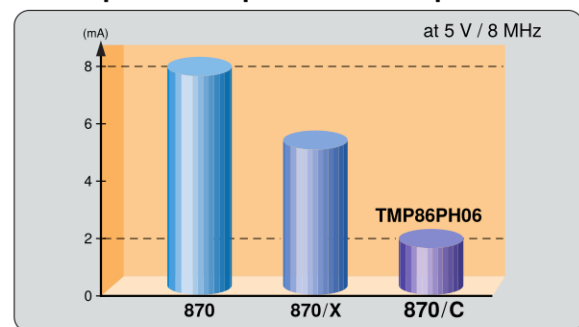and low power consumption*
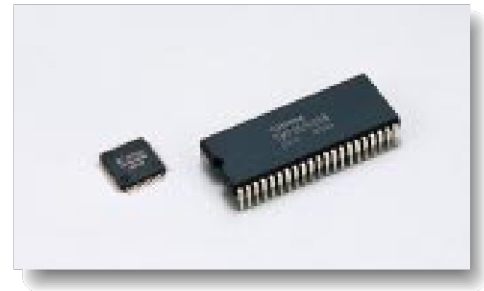
Basic functions

● 64 Kbytes of memory space

■ ROM-less version and versions including up to 60 Kbytes of ROM
(all devices at planning stage)

● Architecture suitable for real-time control

■ 0.25 µs per instruction cycle at 16 MHz
■ Up to 15 interrupt vectors
(23 with multiplexing between interrupt sources)

● Low-voltage, high-speed operation; low power consumption

■ Wide operating voltage range: 1.8 V to 5.5 V (standard type)
■ Reduced power consumption (2/3 less than the TLCS-870)
■ Clock gear
High-frequency clock (6 types), low-frequency clock (1 type)

● Instruction set for embedded controller: 731 instructions

■ Registers: isolated from memory space
■ Variety of bit-manipulation instructions
■ 16-bit transfer/calculation instructions
■ Multiplication and division instructions

● One-time PROM or flash E²PROM product versions

■ PROM or E²PROM product versions with features
compatible with those of mask ROM products

● Small package

■ Microflat package/Miniflat package

● Measures to combat electrical noise

■ Reduced spontaneous noise, resistance to noise

● Improved compilation of C source code

(30% reduction in source code size
compared to TLCS-870 and TLCS-870/X)

■ Register configuration

(Only a single general register bank is shown here.)

W	A
B	C
D	E
H	L

15 ... 0

IX
IY

15 ... 0

SP

15 ... 0

PC

15 ... 0

PSW

7 ... 0

■ Comparison of power consumption levels

(mA)   at 5 V / 8 MHz

TMP86PH06

870   870/X   870/C

▶ 870/C Series Selection Guide

ROM (bytes)	RAM (bytes)	Product No.	Minimum Instruction Execution Time (µs)	Driver LED	Driver VFT	Number of SIO Channels	SIO/UART Channels	AD Converter 8-bit channels	AD Converter 10-bit channels	Timer/Counter 18-bit channels	Timer/Counter 16-bit channels	Timer/Counter 8-bit channels	Remote Control Pulse Detector	Watchdog Timer	Dual Clock	Clock Gear	Number of I/O Ports	Power Supply Voltage (V)	Operating Temperature (°C)	Version with Built-in OTP	Packages
4K	256	✳TMP86C420U/F		4	32	1		8		1		2		●	●						µQFP64 (10 × 10 mm)/ LQFP64
8K		✳TMP86C820U/F		4	32	1		8		1		2		●	●		39			✳TMP86PM29U/F	
	512	✳TMP86C829U/F	0.25/122	4	32		(Note 3) 1		8	1		4		●	●						
16K		✳TMP86CH06N/U		8			(Note 2) 2			1		2		●	●	●	35	1.8 to 5.5	−40 to 85	✳TMP86PH06N/U	SDIP42/ µQFP44
		✳TMP86CH29U/F		4	32		(Note 3) 1		8	1		4		●	●		39			✳TMP86PM29U/F	µQFP64 (10 × 10 mm)/ LQFP64
32K	1K	✳TMP86CM29U/F		4	32		(Note 3) 1		8	1		4		●	●						

✳ Under development
Note 1: Product number suffixes   N: Plastic shrink dual in-line package (SDIP)   F: Plastic quad flat package (QFP)   U: Plastic microflat package (µQFP)
Note 2: Either of the two UART channels can be selected in software as the SIO channel.
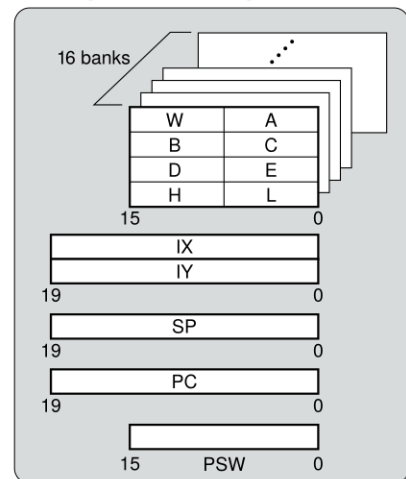Note 3: SIO circuit or UART can be selected in software.

870 Family

870/X Series

Basic functions

● 1-Mbyte memory space

- Planned products range from devices without any ROM to others with high-capacity ROMs.

● Architecture suitable for real-time control

- 0.25 µs per instruction cycle at 16 MHz
- High-speed task switching
  High-speed Interrupt Register save/restore using automatic register bank switching
- Up to 63 interrupt vectors

● Low-voltage, high-speed operation; low power consumption

- Wide operating voltage range: 2.7 V to 5.5 V (standard type)
- 1.8 V / 0.95 µs at 4.2 MHz (low-voltage type)
- Dual clock system
  Main clock for high-speed operation (16 MHz) and sub-clock for low-power operation (32.768 kHz)
- Power consumption can be reduced by changing the instruction execution speed.

● Instruction set for embedded controller: 842 instructions

- 1-byte jump/call instructions, direct memory-to-memory transfer instructions and arithmetic instructions to improve memory efficiency
- Variety of bit-manipulation instructions
- 16-/20-bit transfer/operation instructions
- Multiplication and division instructions (16×8, $16/8$)
- Enhanced arithmetic, logic, bit-manipulation and sign-handling instructions
- Additional instructions to improve the efficiency of the C compiler in generating object code

● One-time PROM product versions

- One-time PROM product versions with features compatible with mask ROM products

● Well-developed support environment

- Assembler
- High-level languages
  (C compiler, C-Like compiler)
- High-level language debugger
- Real-time emulator: RTE Model 25

■ Register configuration

```
16 banks
        W   |   A
        B   |   C
        D   |   E
        H   |   L
       15        0
        IX
        IY
       19        0
        SP
       19        0
        PC
       19        0
       15   PSW   0
```

▶ 870/X Series Selection Guide

ROM (bytes)	RAM (bytes)	Product No.	Minimum Instruction Execution Time (µs)	Driver			SIO Channels	UART Channels	I²C Bus Channels (Note 2)	AD Converter		Timer/Counter		Motor Control	External Memory Interface	E²PROM	Remote Control Pulse Detector	Watchdog Timer	Dual Clock	Clock Gear	Number of I/O Ports	Power Supply Voltage (V)	Operating Temperature (°C)	Version with Built-in OTP	Packages
				LED	VFT	LCD				8-bit channels	10-bit channels	16-bit channels	8-bit channels												
NA		TMP88C060F	0.32/122 0.95/122	8			1	1		8		2	4	●		●	●	●	●	●	42	4.5 to 5.5 / 2.7 to 5.5		–	QFP80 (12 × 12 mm)
16K	512	✴TMP88CH21F/DF	0.5/122 0.95/122		40		1	1	8			2	2					●	●	●	47	4.5 to 5.5 / 2.7 to 4.5	−40 to 85	✴TMP88PM21F/DF	QFP80/ LQFP80 (12 × 12 mm)
		TMP88CH47N/F		8			1	1		8	2	1	1					●			34		−40 to 85	✴TMP88PH47N/F	SDIP42/ QFP44
24K	1K	TMP88CK48N/F	0.25	8			1	1		16	2	2	1					●			56	4.5 to 5.5	−40 to 85	TMP88PS49N/F	SDIP64/ QFP64
		TMP88CK49N/F		8			1	1		16	2	2	2					●			56		−40 to 85		
32K		✴TMP88CM21F/DF	0.5/122 0.95/122		40		1	1	8			2	2				●	●	●	●	47	4.5 to 5.5 / 2.7 to 4.5	−40 to 85	✴TMP88PM21F/DF	QFP80/ LQFP80 (12 × 12 mm)
		TMP88CM48N/F	0.25	8			1	1		16	2	2	1					●			56	4.5 to 5.5	−40 to 85	TMP88PS49N/F	SDIP64/ QFP64
		TMP88CM49N/F		8			1	1		16	2	2	2					●			56		−40 to 85		
96K	2K	TMP88CU74F	0.32/122		37			1	1	12		2	2				●	●	●		71	4.5 to 5.5 / 2.7 to 5.5	−30 to 70	TMP88PU74F	QFP80

✴ Under development
★: Samples available

Note 1: Product number suffixes   N: Plastic shrink dual in-line package (SDIP)   F: Plastic quad flat package (QFP)
Note 2: I²C bus circuit or SIO circuit can be selected in software.

NEW PRODUCTS

*870 Series device with built-in UART & key-on wake-up function*

TMP87CS68DF

■ *8-bit microcontroller suitable for communications equipment with UART and key-on wake-up function*

The **TMP87CS68DF** has high ROM and RAM capacities, includes a UART, and incorporates a key-on wake-up function. It is housed in a small package (12 mm × 12 mm) and is suitable for pagers, telephones and other communications equipment.

In addition, it has a clock gear system which can keep power consumption low.
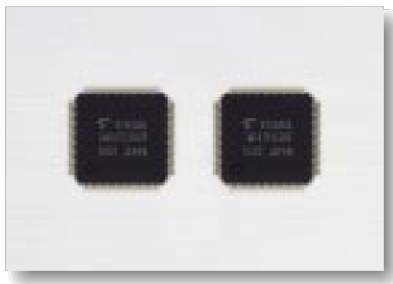
(Actual size)

- ● Internal ROM: 60 Kbytes
- ● Internal RAM: 2 Kbytes
- ● I/O ports: 72
- ● Minimum instruction execution time:
    - 0.50 μs (at 8 MHz and 4.5 V to 5.5 V)
    - 0.95 μs (at 4.2 MHz and 2.7 V to 5.5 V)
- ● LED driver: 7 channels
- ● Key-on wake-up: 8 channels
- ● Low power consumption modes (attained using clock gearing)
- ● 8-bit AD converter: 8 channels
- ● 16-bit timer/counter: 2 channels
- ● 8-bit timer/counter: 2 channels
- ● 8-bit serial interface
    - UART: 1 channel
    - Synchronous SIO: 1 channel
- ● 80-pin QFP (12 mm × 12 mm)
- ● OTP version: **TMP87PS68DF**

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870 Series device with built-in AD converter and clock gear

TMP87C408DM

■ *Small-package version of TMP87C408M with clock gear for low power consumption*

The **TMP87C408DM** is a small-package version of the **TMP87C408M** featuring ROM and RAM capacities, input/output ports, multi-function timer/counters, a serial interface and an AD converter.

In addition, it has a clock gear system which can keep power consumption low.

SOP28 → New product SSOP30

Package size comparsion (actual size)

- ● Internal ROM: 4 Kbytes
- ● Internal RAM: 256 bytes
- ● I/O ports: 22
- ● Minimum instruction execution time:
    - 0.50 μs (at 8 MHz and 4.5 V to 5.5 V)
- ● 8-bit AD converter: 6 channels
- ● 16-bit timer/counter: 2 channels
- ● 8-bit serial interface
    - Synchronous SIO: 1 channel
- ● Timebase timer
- ● Watchdog timer
- ● 30-pin SSOP
- ● OTP version: **TMP87P808M** (28-pin SOP)

NEW PRODUCTS

870 Series device with built-in UART and 10-bit AD converter

TMP87CM48U*

✳ Under development

■ Mini-package 8-bit microcontroller with low power consumption

The **TMP87CM48U** is an 8-bit microcontroller which incorporates a 10-bit AD converter, a UART/I²C bus interface and an advanced function timer which make it ideal for such applications as portable information terminal equipment, battery charging controllers and power supply monitoring control.
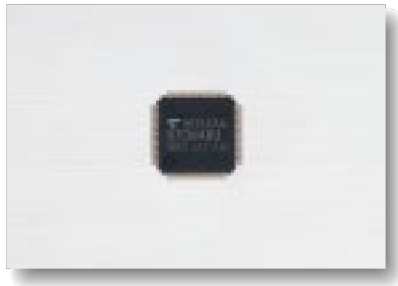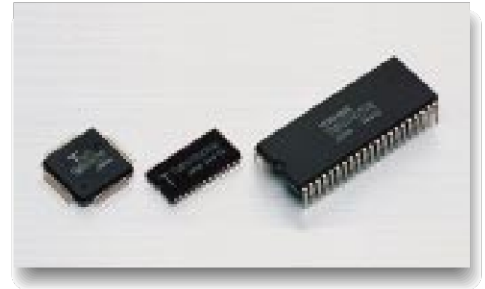

(Actual size)

- ● Internal ROM: 32 Kbytes
- ● Internal RAM: 1 Kbyte
- ● I/O port: 56 pins
- ● Minimum instruction execution time:
    - 0.50 μs (at 8 MHz and 4.5 V to 5.5 V)
    - 0.95 μs (at 4.2 MHz and 2.7 V to 5.5 V)
    - 122 μs (at 32.768 kHz and 2.7 V to 5.5 V)
- ● 10-bit AD converter: 16 channels
- ● DA conversion (pulse width modulation) output: 4 channels
- ● 8-bit serial interface
- ● UART: 1 channel
- ● I²C bus/Synchronous SIO: 1 channel
- ● 16-bit timer/counter: 2 channels
- ● 8-bit timer/counter: 2 channels
- ● Timebase timer
- ● Watchdog timer
- ● 64-pin μQFP package (10 mm × 10 mm)
- ● OTP version: **TMP87PM48U**

870/X Series devices with built-in LCD driver

TMP88CH21F*/DF* TMP88CM21F*/DF*

✳ Under development

■ Low-voltage 8-bit microcontrollers with built-in LCD driver

The **TMP88CH21/CM21** contain LCD driver circuitry which includes a voltage booster enabling them to continue to drive the LCD, even when battery power is low.

In Low Power Mode the microcontrollers reduce their own internal clock frequency (clock gear).

(Actual size)

- ● Internal ROM
    - **TMP88CM21**: 32 Kbytes
    - **TMP88CH21**: 16 Kbytes
- ● Internal RAM
    - **TMP88CM21**: 1 Kbyte
    - **TMP88CH21**: 512 bytes
- ● Minimum instruction execution time:
    - 0.50 μs (at 8 MHz and 4.5 V to 5.5 V)
    - 122 μs (at 32.768 kHz)
- ● LCD driver: LCD driver with voltage booster
    - 16 to 40 segment outputs
    - 4 common outputs
- ● 8-bit AD converter: 8 channels
- ● Low power consumption modes (attained using clock gearing)
- ● 16-bit timer/counter: 2 channels
- ● 8-bit timer/counter: 2 channels
- ● 8-bit serial interface   UART: 1 channel
    - Synchronous SIO: 1 channel
- ● AC zero-cross: 2 channels
- ● Key-on wake-up: 4 channels
- ● 80-pin QFP: 14 mm × 14 mm (0.65-mm pitch)
    - 12 mm × 12 mm (0.5-mm pitch)
- ● OTP version: **TMP88PM21F/DF*** (under development)

NEW PRODUCTS

870/X Series device with built-in VFT driver

TMP88CU74F

■ 8-bit microcontroller capable of programmable grid scan output

The **TMP88CU74F** is an 8-bit microcontroller with a VFT driver control circuit which provides programmable grid scan output. It features an 8-bit AD converter, an I²C bus interface and other features making it suitable for displays for audio and video equipment.

- Internal ROM: 96 Kbytes
- Internal RAM: 2 Kbytes
- I/O ports: 71
- Minimum instruction execution time:
    0.32 µs (at 12.5 MHz and 4.5 V to 5.5 V)
- 8-bit AD converter: 12 channels
- 16-bit timer/counter: 2 channels
- 8-bit timer/counter: 2 channels
- Serial interface
    8-bit SIO and I²C bus: 1 channel each
- Watchdog timer
- 80-pin QFP
- Emulation pod: **BM88CU74F0A**
- OTP version: **TMP88PU74F**

870/X Series device with built-in motor controller

TMP88CH47N/F*

✻ Under development

■ High-speed 8-bit microcontroller with high memory capacity capable of controlling DC and AC motors

The **TMP88CH47N/F** is a high-speed **870/X** Series product capable of operating at 0.25 µs / 5.0 V and incorporating sensor/sensorless DC motor control capability, AC motor inverter control capability, a 10-bit AD converter and a serial interface.

- Internal ROM: 16 Kbytes
- Internal RAM: 512 bytes
- I/O port: 34 pins
- Minimum instruction execution time:
    0.25 µs (at 16 MHz / 4.5 V to 5.5 V)
- Motor control circuits: 1 channel
- 10-bit AD converter: 8 channels
- 16-bit timer/counter: 2 channels
- 8-bit timer/counter: 1 channel
- Serial interface
    8-bit SIO/I²C bus: 1 channel
    UART: 1 channel
- Timebase timer
- Watchdog timer
- 42-pin SDIP / 44-pin QFP (14 mm × 14 mm)
- OTP version: **TMP87PH47N*/F***

4-Bit Microcontrollers

47 Family

The **47** Family is mede up of 4-bit microcontrollers which include various peripheral circuits. Devices with from 1 Kbyte to 16 Kbytes of built-in ROM are available. These devices are suitable for a variety of applications.
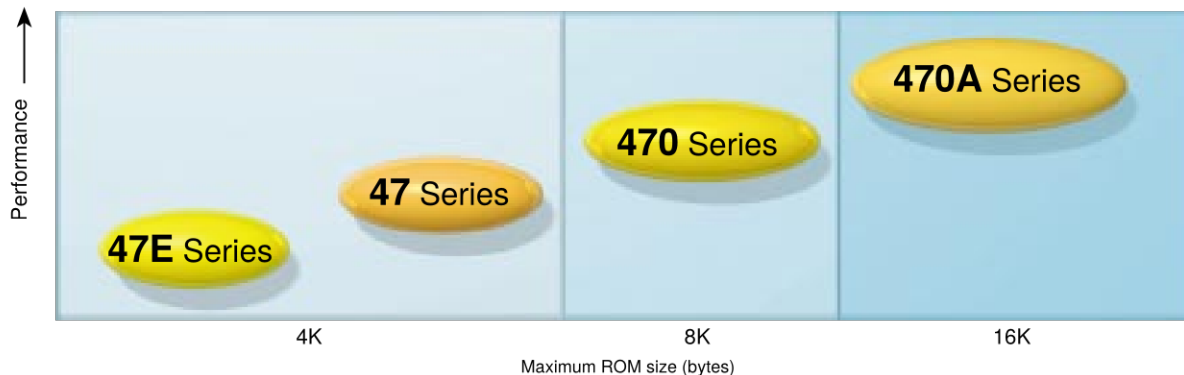
Basic functions

- Instructions: maximum 105
- Minimum instruction execution time: 1.0 µs
- ROM table look-up instructions
- 5-bit data to 8-bit data conversion instruction
- Subroutine nesting: maximum 15 levels
- Interrupt sources: 2 external, 4 internal
- Interval timer
- Serial interface

Additional functions

- VFT driver
- LCD driver
- LED driver
- Hold function (low power consumption modes)
- Multi-pin input/output
- DA conversion (PWM) output
- AD conversion input
- AD converter input
- 16-bit high-speed event counter
- E^2PROM
- On-screen display circuit
- DTMF generator
- DTMF receiver
- Watchdog timer Pulse generato
- Remote control pulse detector
- High-speed timer/counter
- Dual-clock system

■ Core development

Performance →

470A Series

470 Series

47 Series

47E Series

| 4K | 8K | 16K |

Maximum ROM size (bytes)

■ Features

	47E Series	**47** Series	**470** Series	**470A** Series
Maximum ROM size (bytes)	4K × 8		8K × 8	16K × 8
Maximum RAM size (bytes)	256 × 4	768 × 4	1024 × 4	
Minimum instruction execution time	1.0 µs (at 8 MHz, V_{DD} = 2.7 V to 5.5 V) 1.3 µs (at 6 MHz, V_{DD} = 4.5 V to 5.5 V) 1.9 µs (at 4.2 MHz, V_{DD} = 2.7 V to 5.5 V) 3.2 µs (at 2.5 MHz, V_{DD} = 2.2 V to 5.5 V)	1.9 µs (at 4.2 MHz, V_{DD} = 4.5 V ~ 6 V)	1.3 µs (at 6 MHz, V_{DD} = 4.5 V ~ 5.5 V) 244 µs (at 32.8 kHz, V_{DD} = 2.7 V ~ 5.5 V)	
Number of instructions	90		92	105
Number of interrupts	5 or 6	6		
Packages	DIP16~DIP20 SOP16~SOP28 SDIP28~SDIP42 SSOP30 QFP44	SDIP30~SDIP42 QFP44~QFP80	SDIP28~SDIP64 QFP44~QFP100	SDIP42~SDIP64 QFP44~QFP80

⚑ Wide temperature range performance

Special products with a guaranteed operating temperature range of –40˚ to 85˚C are also provided.
If you are interested in using them, please contact your nearest Toshiba office or authorized Toshiba dealer.

▶ 47E Series Selection Guide

ROM (bytes)	RAM (nibbles)	Product No.	Minimum Instruction Execution Time (µs)	Driver LED	Driver LCD	SIO 4-bit channels	SIO 8-bit channels	AD Converter Channels	Pulse Output Channels	Watchdog Timer	E²PROM	Dual Clock	Hold Function	Number of I/O Ports	Wide Temperature Range	Power Supply Voltage (V)	Operating Temperature (°C)	Version with Built-in OTP	Packages
1K	64	TMP47C101P/M	1.3	4									●	11		2.2 to 5.5 Note 2	−30 to 70	TMP47P201VP	DIP16/SOP16
		✽TMP47C101WP		4									●	11	●		−40 to 110		DIP16/SOP16
		TMP47C102P/M		4						●			●	15			−30 to 70	TMP47P202VP/VM	DIP20/SOP20
		TMP47C103N/M		8		1				●			●	23				TMP47P403VN/VM	SDIP28/SOP28
		† TMP47E186M Note 3	1.3							●	●		●			2.0 to 5.5	−40 to 85	TMP47P186M	SOP16
		† TMP47E187M Note 3								●	●		●	11		2.7 to 5.5		TMP47P187M	SOP16
2K	128	TMP47C201P/M	1.3	4									●	11		2.2 to 5.5 Note 2	−40 to 110	TMP47P201VP	DIP16/SOP16
		✽TMP47C201WP		4									●	11	●				DIP16/SOP16
		TMP47C202P/M		4						●			●	15			−30 to 70	TMP47P202VP/VM	DIP20/SOP20
		TMP47C203N/M		8		1				●			●	23				TMP47P403VN/VM	SDIP28/SOP28
		TMP47C206P/M	1.0	5					1	●			●	15		4.0 to 5.7	−40 to 85	TMP47P206VP/VM	DIP20/SOP20
		TMP47C241N/M	1.3	5		1		4		●			●			2.7 to 6.0	−30 to 70	TMP47P241VN/VM	SDIP28/SOP28
		TMP47C241IN/IM		5		1		4		●			●	21	●		−40 to 85		SDIP28/SOP28
		TMP47C241WM		5		1		4		●			●		●		−40 to 110		SDIP28/SOP28
		TMP47C243N/M/DM Note 6	1.0	8			1	8	1	●			●	23				TMP47P443VN/VM/VDM	SDIP28/SOP28/SSOP30
	192	TMP47C222N/F Note 6	1.0 (244)		20	1		4	1	●		●	●	22		2.2 to 5.5	−30 to 70	TMP47P422VN/VF	SDIP42/QFP44
4K	256	TMP47C422N/F Note 6	1.0 (244)		20	1		4	1	●		●	●	22		2.2 to 5.5	−30 to 70	TMP47P422VN/VF	SDIP42/QFP44
		TMP47C443N/M/DM Note 6	1.0	8			1	8	1	●			●	23				TMP47P443VN/VM/VDM	SDIP28/SOP28/SSOP30
		†✽TMP47E486M Note 7	1.3			1		4		●	●		●	21		2.7 to 5.5 Note 8	−40 to 85	✽TMP47W486M	SOP28
		†✽TMP47E487M Note 7				1		4		●	●		●			2.7 to 5.5		✽TMP47W487M	SOP28

▶ 47 Series Selection Guide

ROM (bytes)	RAM (nibbles)	Product No.	Minimum Instruction Execution Time (µs)	Driver LED	Driver LCD	Driver VFT	SIO 4-bit channels	AD Converter Channels	Pulse Output Channels	Watchdog Timer	High-Speed Event Counter Channels	DTMF Generator	Dual Clock	Hold Function	Number of I/O Ports	Power Supply Voltage (V)	Operating Temperature (°C)	Version with Built-in OTP	Packages
2K	128	TMP47C200BN/BF	1.9	8			1							●	36	2.7 to 6.0	−30 to 70	TMP47P400VN/VF	SDIP42/QFP44
		TMP47C210AN/AF				20	1							●	36	4.5 to 6.0		TMP47P410AN/AF	QFP44
		TMP47C212AN				20	1							●	35	4.5 to 6.0		–	SDIP42
		TMP47C242BN		8				4	1	●				●	23	2.7 to 6.0		TMP47P242VN	SDIP30
	192	TMP47C221ADF			24		1							●	28	4.5 to 6.0		TMP47P421ADF	QFP64
4K	256	TMP47C400BN/BF	1.9	8			1							●	36	2.7 to 6.0	−30 to 70	TMP47P400VN/VF	SDIP42/QFP44
		TMP47C410AN/AF				20	1							●	36	4.5 to 6.0		TMP47P410AN/AF	QFP44
		TMP47C412AN				20	1							●	35	4.5 to 6.0		–	SDIP42
		TMP47C421ADF			24		1							●	28			TMP47P421ADF	QFP64
		TMP47C423ADF			24		1		1			1		●	28			–	QFP64
		TMP47C440BN/BF		8			1	8		●				●	34	2.7 to 5.5		TMP47P440VN/VF	SDIP42/QFP44
		TMP47C441AN/AF				16	1	4		●				●	34	4.5 to 6.0		TMP47P441AN/AF	QFP44
		TMP47C446ADF	1.9 (244)		24		1	4		●			●	●	24			TMP47P446VDF	QFP64
	768	TMP47C407AN/AF	2.1				1	1				●		●	35	2.7 to 6.0	−30 to 60	TMP47P407VN/VF	SDIP42/QFP44
		TMP47C451BN	16.7				1					●		●	23			TMP47P451VN	SDIP30
		TMP47C452BN/BF					1	1				●		●	35	2.2 to 6.0		TMP47P452VN/VF	SDIP42/QFP44
		TMP47C453AN/AF	8.3				1	1				●		●	35		−30 to 60	TMP47P453VN/VF	QFP44
		TMP47C454AN	2.1				1					●		●	23	2.7 to 6.0		TMP47P454VN	SDIP30
		TMP47C456ADF	8.3 (244)		32		1	1	1	●		●	●	●	34			–	QFP80

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47 Family Selection Guide

▶ 470 Series Selection Guide

ROM (bytes)	RAM (nibbles)	Product No.	Min. Instr. Exec. Time (µs)	LED	LCD	VFT	SIO 8-Bit Channels	UART	AD Converter Channels	AD Conversion Input Channels	PWM channels	PPG channels	Pulse channels	Remote Control Pulse Detector	Watchdog Timer	High-Speed Event Counter Channels	DTMF Generator	Receiver	E²PROM	Dual Clock	Hold Function	Number of I/O Ports	Wide Temperature Range	Power Supply Voltage (V)	Operating Temperature (°C)	Version with Built-in OTP	Package
2K	128	TMP47C215N	1.0 (244)	1		23	1		4						●					●	●	36		4.5 to 5.5	−30 to 70	TMP47P415VN	SDIP42
		TMP47C216F		1		24	1		4						●					●	●	38				TMP47P416VF	QFP44
4K	256	TMP47C415N		1		23	1		4						●					●	●	36				TMP47P415VN	SDIP42
		TMP47C416F		1		24	1		4						●					●	●	38				TMP47P416VF	QFP44
6K	384	TMP47C620DF	1.3 (244)	8	32		1						1		●	2				●	●	36		4.5 to 6.0	−40 to 70	TMP47P820VDF	QFP80
		TMP47C640N/F		8			1			8				●	●					●	●	34		2.7 to 5.5		TMP47P840VN/VF	SDIP42/QFP44
		TMP47C647F	1.3 (244)	8	32		1			8			1		●					●	●	35		4.5 to 6.0		TMP47P847VF	QFP80
		TMP47C660AN/AF		8			1			8				●	●					●	●	56		2.7 to 5.5		TMP47P860VN/VF	SDIP42/QFP64
		TMP47C662AN		4	27		1			8			2	●	●					●	●	55		4.5 to 6.0	−40 to 70	TMP47P862VN	SDIP64
		TMP47C670N		8	28		1		4				1	●	●					●	●	53				TMP47P870N	
	896	TMP47C655F	8.3 (244)		32		1						1		●			●		●	●			2.2 to 6.0	−30 to 60	TMP47P855VF	QFP80
8K	512	TMP47C800N/F		8			1								●					●	●	36		4.5 to 6.0	−40 to 70	TMP47P800N/F	SDIP42/QFP44
		TMP47C820DF		8	32		1						1		●	2				●	●					TMP47P820VDF	QFP80
		TMP47C840N/F	1.3 (244)	8			1			8				●	●					●	●	34		2.7 to 5.5		TMP47P840VN/VF	SDIP42/QFP44
		TMP47C847F		8	32		1			8			1		●					●	●	35		4.5 to 6.0	−40 to 70	TMP47P847VF	QFP80
		TMP47C850N/F	2.23 (244)	16			1			4		2			●			●		●	●	52		4.5 to 5.5		TMP47P850VN/VF	SDIP64/QFP64
		TMP47C858F	8.3 (244)		44		1											●		●	●	36		2.7 to 6.0	−30 to 60	–	QFP100
		TMP47C860AN/AF		8			1			8				●	●					●	●	56		2.7 to 5.5		TMP47P860VN/VF	SDIP64/QFP64
		TMP47C862AN	1.3 (244)	4	27		1			8			2	●	●					●	●	55		4.5 to 6.0	−40 to 70	TMP47P862VN	SDIP64
		TMP47C870N		8	28		1		4				1	●	●					●	●	53				TMP47P870N	
		†TMP47E885AIF	1.3				1	●	8		2				●		1		●	●	●		●	4.5 to 5.5	−40 to 85	TMP47P885F	QFP44
		†TMP47E885WF					1	●	8		2				●		1		●	●	●	36	●	4.5 to 5.5	−40 to 110		
	1024	TMP47C855AF	8.3 (244)		32		1						1		●			●		●	●			2.2 to 6.0	−30 to 60	TMP47P855VF	QFP80

▶ 470A Series Selection Guide

ROM (bytes)	RAM (nibbles)	Product No.	Min. Instr. Exec. Time (µs)	LED	LCD	VFT	SIO 8-Bit Channels	AD Converter Channels	AD Conversion Input Channels	PWM channels	Pulse channels	Remote Control Pulse Detector	Watchdog Timer	High-Speed Event Counter Channels	DTMF Generator	Dual Clock	Hold Function	Number of I/O Ports	Power Supply Voltage (V)	Operating Temperature (°C)	Version with Built-in OTP	Packages
4K	768	TMP47C457N/F	2.1 (244)				1				1		●		●	●	●	35	2.7 to 6.0	−30 to 60	TMP47P857VN/VF	SDIP42/QFP44
6K	384	TMP47C623F	1.3 (244)	4	24		1				1		●	1		●	●	32	4.5 to 6.0	−40 to 70	TMP47P823VF	QFP64
8K	512	TMP47C823F		4	24		1				1		●	1		●	●	to 28			TMP47P823VF	
	1024	TMP47C853N/F	8.3 (244)				1				1		●		●	●	●	35	2.2 to 6.0	−30 to 60	TMP47P853VN/VF	SDIP42/QFP44
		TMP47C857N/F	2.1 (244)				1				1		●		●	●	●	35	2.7 to 6.0		TMP47P857VN/VF	
12K	768	TMP47C1220F	1.3 (244)	8	32		1				1		●			●	●	36	4.5 to 6.0	−40 to 70	TMP47P1620VF	QFP80
		TMP47C1260N/F		8			1		8				●			●	●	56			TMP47P1660VN/VF	SDIP64/QFP64
		TMP47C1270AN		8		28	1	4		1		●		2	●	●	53			TMP47P1670VN	SDIP64
16K	768	TMP47C1620F		8	32		1				1		●			●	●	36			TMP47P1620VF	QFP80
		TMP47C1660N/F		8			1		8				●			●	●	56			TMP47P1660VN/VF	SDIP64/QFP64
		TMP47C1670AN		8		28	1	4		1		●		2	●	●	53			TMP47P1670VN	SDIP64

✽ Under development

Note 1: Product number suffixes **P**: Plastic standard dual in-line package (DIP) **N**: Plastic shrink dual in-line package (SDIP)
  M: Plastic small-outline package (SOP) **F**: Plastic quad flat package (QFP)
Note 2: When using CR circuit (2.7 V to 5.5 V when using resonator)
Note 3: **TMP47E186M** (CR version), **TMP47E187M** (resonator version)
Note 4: Numbers in ( ) show the minimum instruction execution time when operating at a low clock frequency.
Note 5: †: USP 4,382,279 owned by BULL CP8.
Note 6: The CPU core used is that of the 470 Series.
Note 7: **TMP47E486M** (CR version), **TMP47E487M** (resonator version)
Note 8: The minimum operating voltage for the **TMP47E486M** has not yet been finalized.

◆ For further information about the I/W version, please contact your nearest Toshiba office or authorized Toshiba dealer.
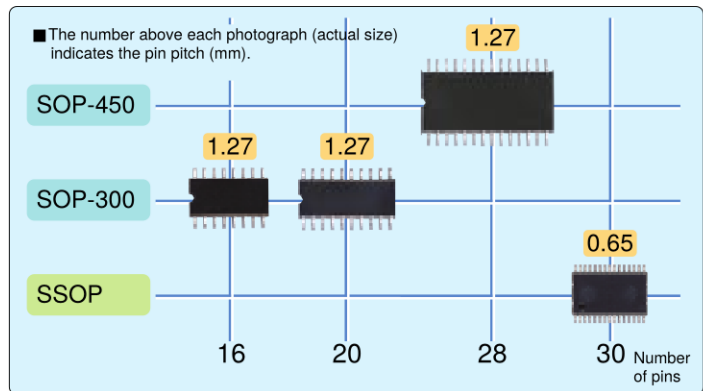◆ Products with an OTP are not available with a wide operating temperature range and are not designed for high-performance applications.

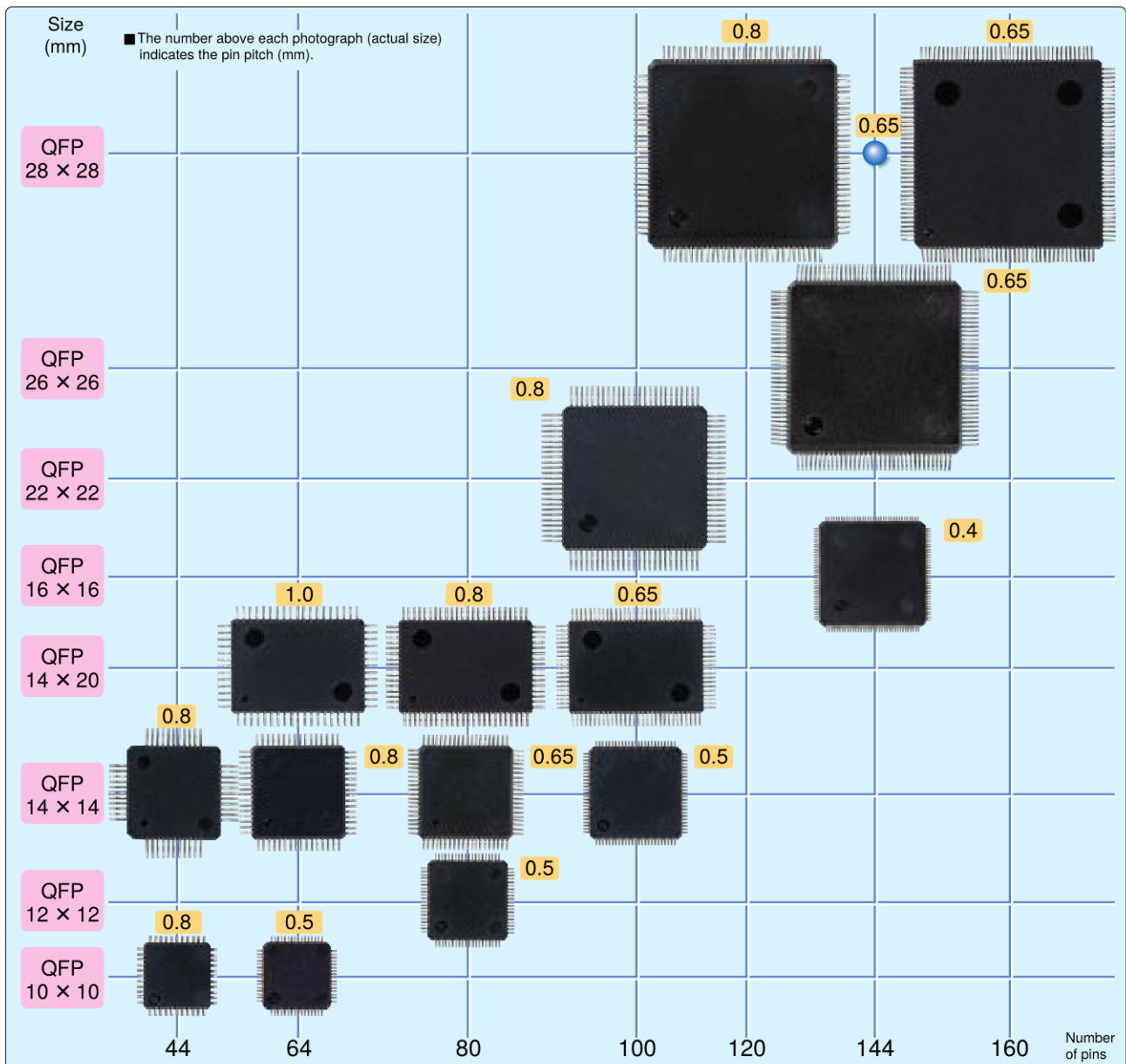# Surface-Mount Package List

(comparison of surface area of small and large packages)

To meet customer needs Toshiba offer a wide range of highly reliable packages for high-density mounting, ranging from 16-pin to 160-pin products. In particular, Toshiba's miniature packages for portable applications anticipate customer needs for miniaturization by offering formats as compact as the 144-pin, 0.4-mm pitch format.

SOPs/SSOPs for 4-/8-bit microcontrollers

■ The number above each photograph (actual size) indicates the pin pitch (mm).

SOP-450 — 1.27

SOP-300 — 1.27   1.27

SSOP — 0.65

Number of pins: 16   20   28   30

QFPs for 4-/8-/16-bit microcontrollers

Size (mm)

■ The number above each photograph (actual size) indicates the pin pitch (mm).

QFP 28 × 28 — 0.8   0.65   0.65

QFP 26 × 26 — 0.65

QFP 22 × 22 — 0.8

QFP 16 × 16 — 0.4

QFP 14 × 20 — 1.0   0.8   0.65

QFP 14 × 14 — 0.8   0.8   0.65   0.5

QFP 12 × 12 — 0.5

QFP 10 × 10 — 0.8   0.5

Number of pins: 44   64   80   100   120   144   160

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Development Environment

Toshiba offer various integrated development systems which include language tools and evaluation tools. Toshiba call this the *Integrated Development Environment*.

In addition to original Toshiba development systems, various development support tools by third parties are also available. For details please refer to the **Microcomputer Development System Product Catalog**.

The chart below is a schematic representation of Toshiba's *Integrated Development Environment*.

■ **Example of a development system environment (using RTE Model 25)**

LAN (Ethernet TCP/ IP) or SIO (RS-232C)

PC or EWS

Emulation controller

Emulation pod

Target system

Toshiba Integrated Development Environment

Users' PC

Development Environment Software

Debugger — Test tools

Simulator

Middleware — Embedded control

Real-time OS

Build Manager — Management tools

C compiler | C++ compiler

Assembler — CASE tools

CASE tools

LAN

Serial cable

Debug monitor

Test tools

Controller

Pod

Third-Party Development System

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Toshiba America Electronic Components, Inc.

Headquarters-Irvine, CA
9775 Toledo Way, Irvine,
CA 92618, U.S.A.
Tel: (949)455-2000 Fax: (949)859-3963

Altamonte Springs, FL(Orland)
600 S, North Lake Blvd., Suite 250,
Altamonte Springs, FL 32701, U.S.A.
Tel: (407)332-0966 Fax: (407)339-3777

Deerfield, IL(Chicago)
One Pkwy., North, Suite 500, Deerfield,
IL 60015-2547, U.S.A.
Tel: (847)945-1500 Fax: (847)945-1044

Denver, CO
8400 E, Prentice Englewood, CO 80111, U.S.A.
Tel: (303)220-9848 Fax: (303)220-9856

Edison, NJ
2035 Lincoln Hwy. Ste. #3000, Edison
NJ 08817, U.S.A.
Tel: (908)248-8070 Fax: (908)248-8030

Irvine, CA
2 Venture Plaza, Suite 500, Irvine,
CA 92718, U.S.A.
Tel: (949)453-0224 Fax: (949)453-0125

Microelectronics Center-Sunnyvale, CA
1220 Midas Way, Sunnyvale,
CA 94088-3509, U.S.A.
Tel: (408)739-0560 Fax: (408)746-0577

Norcross, GA(Atlanta)
655 Engineering Dr. #160, Norcross,
GA 30092, U.S.A.
Tel: (404)368-0203 Fax: (404)368-0075

Richardson, TX(Dallas)
777 East Campbell Rd., Suite 650, Richardson,
TX 75081, U.S.A.
Tel: (214)480-0470 Fax: (214)235-4114

Wakefield, MA(Boston)
401 Edgewater Place, Suite #360, Wakefield,
Essex, MA 01880-6229, U.S.A.
Tel: (617)224-0074 Fax:(617)224-1095

San Jose Engineering Center, CA
1060 Rincon Circle, San Jose,
CA 95131, U.S.A.
Tel: (408)456-8900 Fax: (408)456-8910

Toshiba Electronics Europe GmbH

Düsseldorf Head Office
Hansaallee 181, D-40549 Düsseldorf
Germany
Tel: (0211)5296-0 Fax: (0211)5296-400

München Office
Büro München Hofmannstrasse 52,
D-81378, München, Germany
Tel: (089)748595-0 Fax: (089)748595-42

Toshiba Electronics France SARL
Immeuble Robert Schumann 3 Rue de Rome,
F-93561, Rosny-Sous-Bois, Cedex, France
Tel: (1)48-12-48-12 Fax: (1)48-94-51-15

Toshiba Electronics Italiana S.R.L.
Centro Direzionale Colleoni
Palazzo Perseo Ingr. 2-Piano 6,
Via Paracelso n.12,
1-20041 Agrate Brianza Milan, Italy
Tel: (039)68701 Fax:(039)6870205

Toshiba Electronics España, S.A.
Parque Empresarial San Fernando Edificio Europa,
1^a Planta, ES-28831 Madrid, Spain
Tel: (91)660-6700 Fax:(91)660-6799

Toshiba Electronics(UK) Limited
Riverside Way, Camberley Surrey,
GU15 3YA, U.K.
Tel: (01276)69-4600 Fax: (01276)69-4800

Toshiba Electronics Scandinavia AB
Gustavslundsvägen 12, 2nd Floor
S-161 15 Bromma, Sweden
Tel: (08)704-0900 Fax: (08)80-8459

Toshiba Electronics Asia (Singapore) Pte. Ltd.

Singapore Head Office
438B Alexandra Road, #06-08/12 Alexandra
Technopark, Singapore 119968
Tel: (278)5252 Fax: (271)5155, (270)6056

Bangkok Office
135 Moo 5 Bangkadi Industrial Park, Tivanon Rd.,
Bangkadi Amphur Muang Pathumthani 12000, Thailand
Tel: (2)501-1635 Fax: (2)501-1638

Toshiba Electronics Trading (Malaysia)Sdn. Bhd.

Kuala Lumpur Head Office
Suite W1203, Wisma Consplant, No.2,
Jalan SS 16/4, Subang Jaya, 47500 Petaling Jaya,
Selangor Darul Ehsan, Malaysia
Tel: (3)731-6311 Fax: (3)731-6307

Penang Office
Suite 13-1, 13th Floor, Menard Penang Garden,
42-A, Jalan Sultan Ahmad Shah,
100 50 Penang, Malaysia
Tel: 4-226-8523 Fax: 4-226-8515

Toshiba Electronics Asia, Ltd.

Hong Kong Head Office
Level 11, Top Glory Insurance Building,
Grand Century Place,
No.193, Prince Edward Road West,
Mong Kok, Kowloon, Hong Kong
Tel: 2375-6111 Fax: 2375-0969

Seoul Branch
14/F, KEC B/D, 257-7 Yangjae-dong,
Seocho-ku, Seoul, Korea
Tel: (02)589-4334 Fax: (02)589-4302

Seoul Branch, Gumi Office
6/F, Ssangyong Investment Securities B/D,
56 Songjung-Dong, Gumi City
Kyeongbuk, Korea
Tel: (0645)456-7613-6 Fax: (0546)456-7617

Beijing Office
Rm 714, Beijing Fortune Building,
No.5 Dong San Huan Bei-Lu, Chao Yang District,
Beijing, 100004, China
Tel: (010)6590-8795 Fax: (010)6590-8791

Chengdu Office
Unit F, 18/F, 42 Wenwu Road
Xinhua Avenue, Chengdu, 610017, China
Tel: (028)675-1773 Fax: (028)675-1065

Shenzhen Office
Rm 3010-3012, Office Tower Shun Hing Square,
Di Wang Commercial Centre, 333 ShenNan
East Road, Shenzhen, 518008, China
Tel: (0755)246-1582 Fax: (0755)246-1581

Toshiba Technology Development (Shanghai) Co., Ltd.
23F, Shanghai Senmao International Building, 101
Yin Cheng East Road, Pudong New Area, Shanghai,
 200120, China
Tel: (021)6841-0666 Fax: (021)6841-5002

Tsurong Xiamen Xiangyu Trading Co., Ltd.
8N, Xiamen SEZ Bonded Goods Market Building,
Xiamen, Fujian, 361006, China
Tel: (0592)562-3798 Fax: (0592)562-3799

Toshiba Electronics Taiwan Corporation

Taipei Head Office
17F, Union Enterprise Plaza Bldg. 109
Min Sheng East Rd., Section 3, 0446 Taipei,
Taiwan R.O.C.
Tel: (02)514-9988 Fax: (02)514-7892

Kaohsiung Office
16F-A, Chung-Cheng Bldg., Chung-Cheng 3Rd.,
80027, Kaohsiung, Taiwan R.O.C.
Tel: (07)222-0826 Fax: (07)223-0046

Toshiba Display Devices (Thailand) Co., Ltd.
142 Moo 5, Bangkadi Industrial Park,
Tivanon Rd., Pathumthani 12000, Thailand
Tel: (2)501-1200 Fax: (2)501-1209

In Touch with Tomorrow
TOSHIBA

TOSHIBA CORPORATION
Electronic Devices Sales & Marketing Group
1-1, Shibaura 1-chome, Minato-ku, Tokyo, 105-8001, Japan
Tel: (03)3457-3405   Fax: (03)5444-9324