

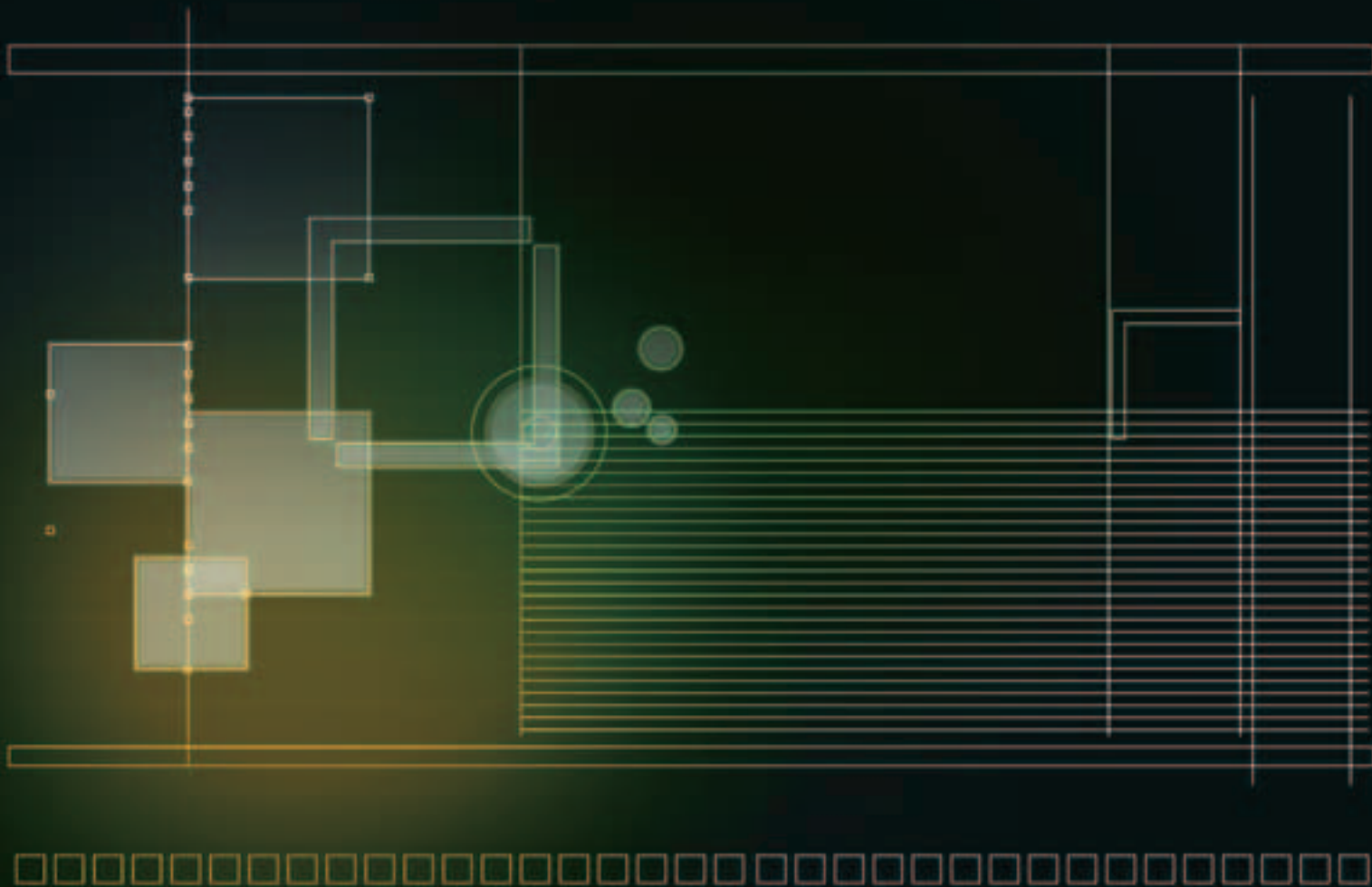
TOSHIBA

2007-5

Leading Innovation >>>

PRODUCT GUIDE

Microcomputers



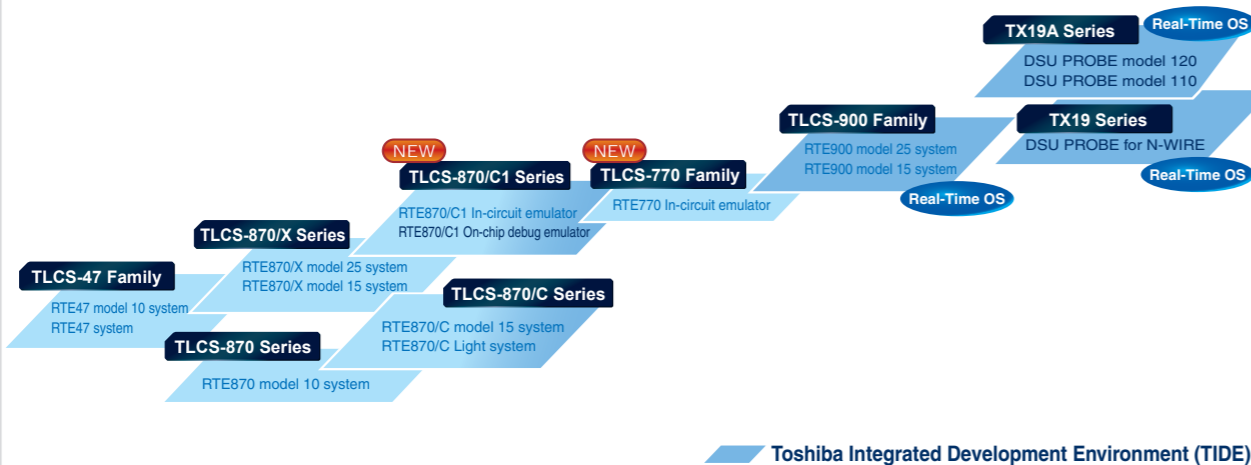
Toshiba's Microcomputers

Connecting the World in the Digital Network Era

In today's digital society, more and more equipment and systems are being connected through various types of microcomputers interacting with one another.

Toshiba contributes to the advancement of digital society by providing an extensive line of microcomputers ranging from high-end 64-bit cores to low-end 8-bit cores, especially Flash microcontrollers. Toshiba's robust development support and services help customers in each phase of product development from the selection and evaluation of microcomputers to the system development and production.

Toshiba Microcomputer Development System Product Lineup



Toshiba Integrated Development Environment (TIDE)

Toshiba Software IP Lineup / Application Notes

Toshiba Software IP Lineup

We have a comprehensive software IP set for customers using (or considering using) Toshiba MCU products. The software IP and its user support are offered on certain terms and conditions. In addition, you are required to make an agreement separately in order to use this software IP.

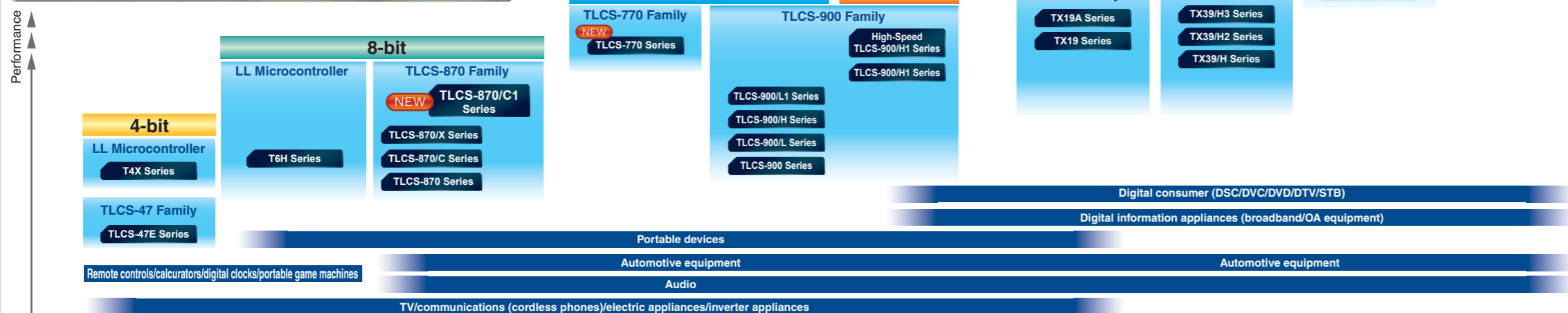
- USB1.1 (device)
- Embedded File System
- SD Memory Card Driver
- Speech Codec
- Handwritten Recognition
-

Application Notes

An application note is a sample software product offered by Toshiba to help customers understand Toshiba microcontrollers and learn how to create programs when developing new products.

TLCS-870/X	TLCS-900/H
<ul style="list-style-type: none"> Creating TOD Clock Using TBT Interrupts Detecting Keys Using a Timer Detecting Keys Using an AD Converter RS-232C Communication Using UART Generating Tone Using PDO Inter-CPU Communication (Transmission + Reception) Using SIO Inter-CPU Communication (Simultaneous Transmission/Reception) Using SIO Measuring AC Frequency Using Pulse Width Measurement Mode 	<ul style="list-style-type: none"> Generating Interrupts at Regular Intervals Using 8-bit Timer Generating Interrupts at Regular Intervals Using Cascaded 8-bit Timer Outputting 50%-Duty Pulses Using 8-bit Timer Outputting PWM Waveform Using 8-bit Timer Outputting PPG Waveform Using 8-bit Timer Outputting Single-Shot Pulse Using External Trigger Pulse Counting Events Using 16-bit Timer Measuring Frequency Using 16-bit Timer

Toshiba Microcomputer Lineup



New Products

NEW

TLCS-870 Family

8-bit

NEW High-speed processing capability equivalent to 16-bit microcontrollers

- Address space extended to 128 Kbytes
- 5-V operation
- On-chip debug function

TLCS-870/C1

Minimum instruction execution time: 125 ns

Address space extended to 1 Mbyte

TLCS-870/X

Core architecture optimized for C compiler

TLCS-870/C

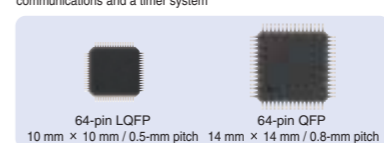
Minimum instruction execution time: 250 ns

[New Core] TLCS-870/C1 Series

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

NEW TMP89FS60UG/FG Under development

General-purpose 64-pin product providing various interfaces for serial communications and a timer system



NEW TLCS-870/C1 Series Development System

Under development

Toshiba Integrated Development Environment (TIDE)

Emulators

- In-circuit emulator: Compact, low-cost, yet highly functional in-circuit emulator. Supports on-chip debug emulation.
- On-chip debug emulator: Business-card-sized compact emulator. No need for power supply (using USB bus power)



On-chip debug emulator

TLCS-770 Family

16-bit

[DSP Cores] TLCS-770 Series

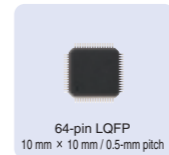
16-bit DSPs for automotive motor control
Digital signal processors capable of high-precision 3-phase motor control

NEW TMP77FM70TUG TMP77CM70TUG

Under development

On-Chip Peripheral Functions

- Motor control circuit (PMD): 1 channel
- 3-phase PWM output (resolution: 25 ns)
- Dead time (0.05 to 12.8 μs)
- Emergency stop function
- 10-bit AD converter: 4 channels x 2 units
- Automatic sampling function synchronized to 3-phase PWM
- SIO/UART: 2 channels
- 16-bit timer: 2 channels



64-pin LQFP
10 mm x 10 mm / 0.5-mm pitch

64-bit

TX99 Family

TX99/H4 Series

64-bit

TX49 Family

TX49/W4 Series

TX49/H4 Series

TX49/H3 Series

TX49/H2 Series

TX49/L4 Series

TX49/L3 Series

MeP

32-bit

TX19 Family

TX19A Series

TX19 Series

32-bit

TX39 Family

TX39/H3 Series

TX39/H2 Series

TX39/H Series

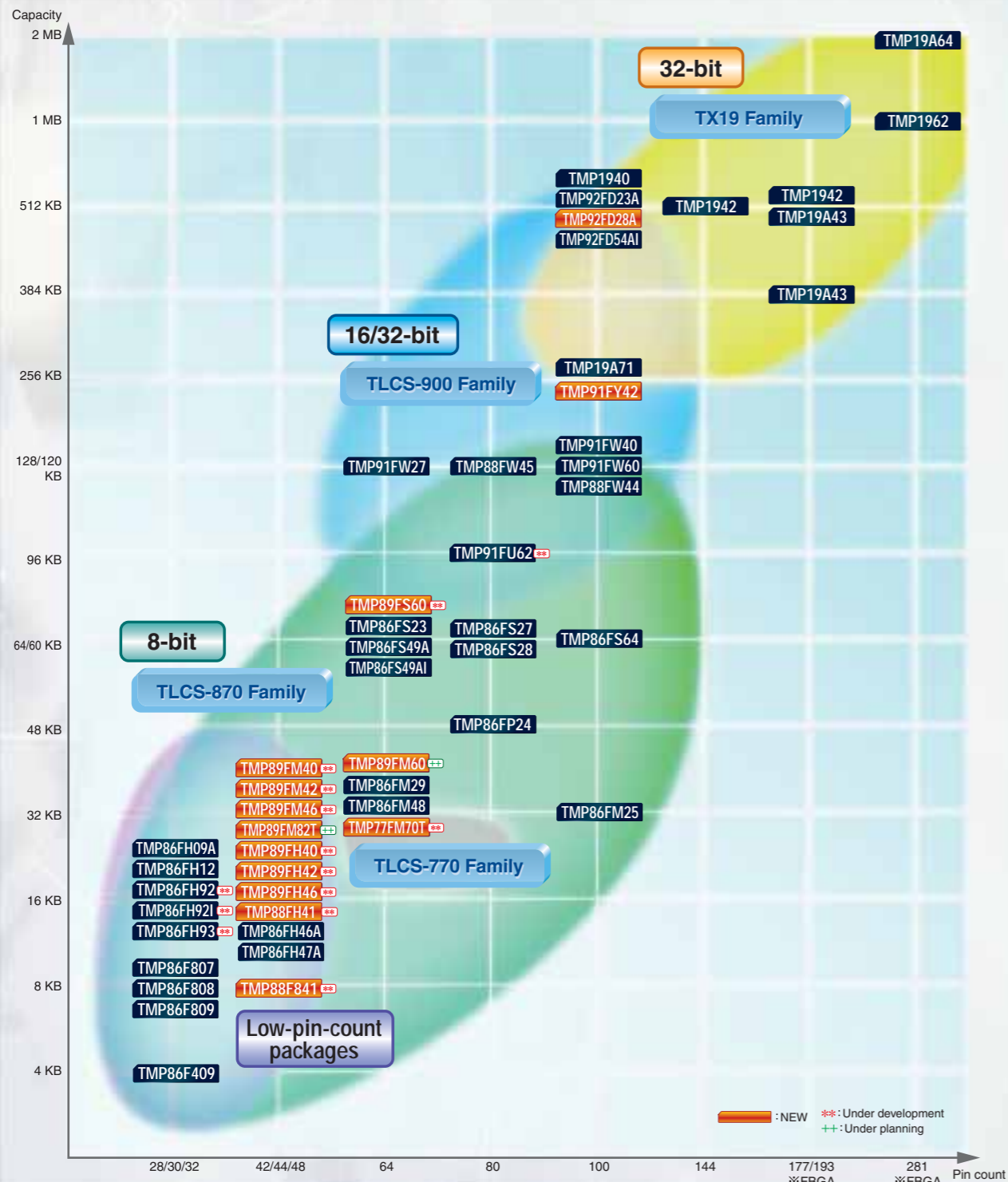
CONTENTS

Microcontrollers Listed by Function / Application

Microcontrollers for personal equipment	12
Microcontrollers for televisions	13
Microprocessors for digital equipment	14
Microcomputers for automotive applications	15
Microcontrollers for automotive motor control	17
Microcontrollers for inverter electric appliances	18
Microcontrollers for digital single-lens reflex cameras (DSLRs)	19
Microcontrollers for digital video cameras (DVCs)	19
Microcontrollers for audio (CD-MP3 control MCUs)	20
Microcontrollers for audio (Main control MCUs)	20
Microcontrollers with motor control circuit (PMD)	21
Microcontrollers with LCD controller	22
Microcontrollers with fluorescent display tube driver	23
Microcontrollers with LCD driver	24
FLASH Microcontrollers	26
Microcontrollers with AD converters	28
General-purpose microcontrollers in compact packages	32
64-Bit Superscalar TX System RISC TX99 Family	36
64-Bit TX System RISC TX49 Family	37
32-Bit TX System RISC TX39 Family	41
MeP(Media embedded Processor)	42
32-Bit TX System RISC TX19 Family	43
16/32-Bit Microcontrollers TLCS-900 Family	46
16-Bit Digital Signal Processors (DSPs) TLCS-770 Family	48
8-Bit Microcontrollers TLCS-870 Family	49
4-Bit / 8-Bit LL Microcontrollers T4X Series / T6H Series	52
Development Systems	53
Outline of TX19 Family Development System	54
Outline of TLCS-900 Family Development System	56
Outline of TLCS-870 Family Development System	58
Development System Programming Tools	60
Development System Accessories	61
Third-Party Development Support Tools	62
Software Development Support	65
Introducing the Latest Software IP	66
Guide to Websites	67
Package List	68

Toshiba's Flash Microcontrollers

Toshiba offers an extensive line of microcontrollers with on-chip Flash memory ranging from small-capacity to 2 Mbytes. You can find a wide variety of products from low-pin-count devices to high-functionality devices.



NANO FLASH™
32-bit TX19 Family
TMP19A43
TMP19A64

DSP core
16-bit TLCS-770 Family
TMP77FM70T**
** : Under development

NEW ** : Under development
8-bit microcontrollers
TMP89FS60**
General-purpose 64-pin product providing various interfaces for serial communications and a timer system
TMP89FH40/42/46**, TMP89FM40/42/46**
Low-pin-count general-purpose microcontrollers based on the 870/C1 core
TMP88F841/FH41**
44-pin microcontrollers containing inverter motor control circuitry

USB HOST system incorporated
32-bit TLCS-900 Family
TMP92FD28A

Microcontrollers with LCD driver
8-bit TLCS-870 Family
TMP86FP24 TMP86FS27
TMP86FM25 TMP86FM29
16-bit TLCS-900 Family
TMP91FW40

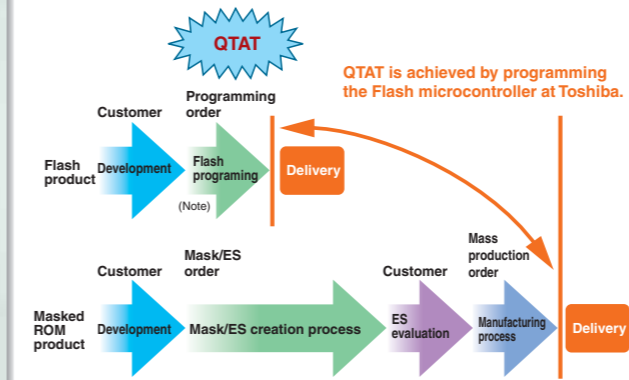
16-bit microcontroller (DSP) **16-bit microcontroller** **32-bit microcontroller**
TMP77FM70TUG**
Digital signal processor capable of high-precision 3-phase motor control
TMP91FY42
100-pin product featuring large-capacity Flash memory (256 Kbytes)
TMP92FD28A
100-pin product incorporating a USB HOST controller

Features of Toshiba's Flash Microcontrollers

- High-speed programming**
NANO FLASH™ allows 0.5 Mbytes of data to be programmed in 2 seconds.
- A wide range of operating voltages**
Operating voltages ranging from 2.7 V to 5 V are supported.
- A wide variety of peripheral functions**
The line-up includes products with various application-specific functions, such as an LCD driver, an inverter motor control function (PMD), or an IGBT control timer, as well as general-purpose products.
- Quick programming service**
Flash programming service is available to enable QTAT (quick turnaround time).
- Enhanced security function**
Up to 255 bytes of password protection can be implemented to prevent illegal read accesses.
- Various Flash programming methods**
In addition to serial mode and parallel mode, ISP (In System Programming) is supported.
- Low power consumption**
NANO FLASH™ realizes the same level of low power consumption compared with mask ROM products.
- On-chip debug function incorporated**
The on-chip debug function improves development efficiency by allowing debugging on mass-production boards.

Full Support Services for Toshiba's Flash Microcontrollers

Flash programming service
Flash programming service enables QTAT (quick turnaround time), allowing customers to achieve shorter time-to-market.



- QTAT**..... Quick Flash programming service is available. (Note)
 - Quality assurance**..... The same level of quality as that of mask ROM products is assured.
 - Marking**..... Custom marking is possible.
 - Support**..... In addition to programming at Toshiba, customers can use our partner programming houses.
- Note:
Delivery time varies with various conditions such as quantity, order acceptance time, factory operation schedule, and product type. For details, please contact your local Toshiba sales representative.

Toshiba Semiconductor website
<http://www.semicon.toshiba.co.jp/eng/index.html>
Information on the entire spectrum of Toshiba semiconductor products is available here.



- Solutions**
Latest information on system solutions is provided by application.
- Product information**
A wide range of product information is available, including new product descriptions and presentation materials.

Various programming tools

Toshiba offers a wide variety of programming tools to meet various needs of customers from development to mass production. Programming services are also available.

Category	Tool type	Tool vendor	Phase		
			Development	Mass production	Maintenance
Off-board programming (Note 1)	Programming adapter	Toshiba Corporation	●	●	●
	Single-device programmer	Flash Support Group, Inc. HI-LO System Research Co., Ltd. MINATO ELECTRONICS INC. Shanghai Gengyan Electronic Technology Co., Ltd T.S. ELECTRONICS CO., LTD**	●	●	●
	Gang programmer	Flash Support Group, Inc. HI-LO System Research Co., Ltd. MINATO ELECTRONICS INC. Shanghai Gengyan Electronic Technology Co., Ltd		●	
On-board programming (Note 2)	In-circuit programmer	Sophia Systems Co., Ltd. Flash Support Group, Inc.(Note 3) Yokogawa Digital Computer Corporation	●	●	●
Programming services (Note 4)		Toshiba Corporation		●	
		MICROTEK Inc.		●	

Note 1: Off-board programming is a method to program a Flash device before it is mounted on the system board.
Note 2: On-board programming is a method to program a Flash device after it has been mounted on the system board.
Note 3: The in-circuit programmer from Flash Support Group allows off-board single-device programming by connecting an optional adapter.
Note 4: Programming services are also available from some of the other programming tool vendors in this table apart from Toshiba and MICROTEK.
Note 5: Some limitations apply when the programming adapter is used for mass production. For details, contact your local Toshiba sales representative.

Toshiba's Flash programming tool Flash Adapter

The Flash adapter is a programming adapter supporting Toshiba's microcontrollers with on-chip Flash memory. Connecting the Flash adapter with your PC allows you to program, erase and verify on-chip Flash memory. The Flash adapter is provided for each package type.



Connection example
* The user is required to connect write signals and mount oscillators as appropriate to each device.

For the latest information on Toshiba's Flash microcontrollers, visit <http://www.semicon.toshiba.co.jp/eng/index.html> (Toshiba Semiconductor Company website).

Selection >>> >>> >>> >>> >>> **Toshiba Semiconductor website**

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

Information on the entire spectrum of Toshiba semiconductor products is available here.

Solutions

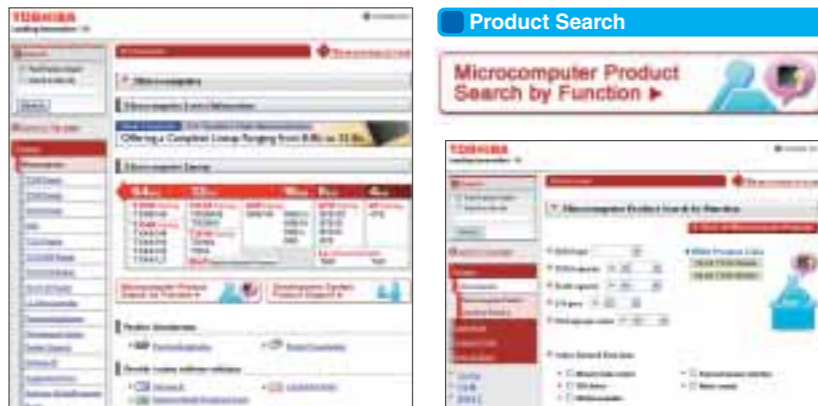
Latest information on system solutions is provided by application.

Product information

A wide range of product information is available, including new product descriptions and presentation materials.

Toshiba Microcomputer website

<http://www.semicon.toshiba.co.jp/eng/product/micro/index.html>



Product Information

A wide range of product information is available, including new product descriptions and presentation materials.

Datasheets/Catalogs

Product datasheets and catalogs in PDF format can be downloaded.

Application Notes

Application notes (sample software) are offered to help customers understand Toshiba's microcontrollers and learn how to create programs.

Development System Product Support

Detailed information on development system products is provided for each microcontroller series. We also offer various support services to customers who have purchased Toshiba's development system, including:

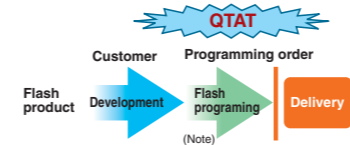
- Downloading of software products and technical documentation
- E-mail updates on technical reports and new version releases



Production

Flash Programming Service

Flash programming service enables QTAT (quick turnaround time), allowing customers to achieve shorter time-to-market.



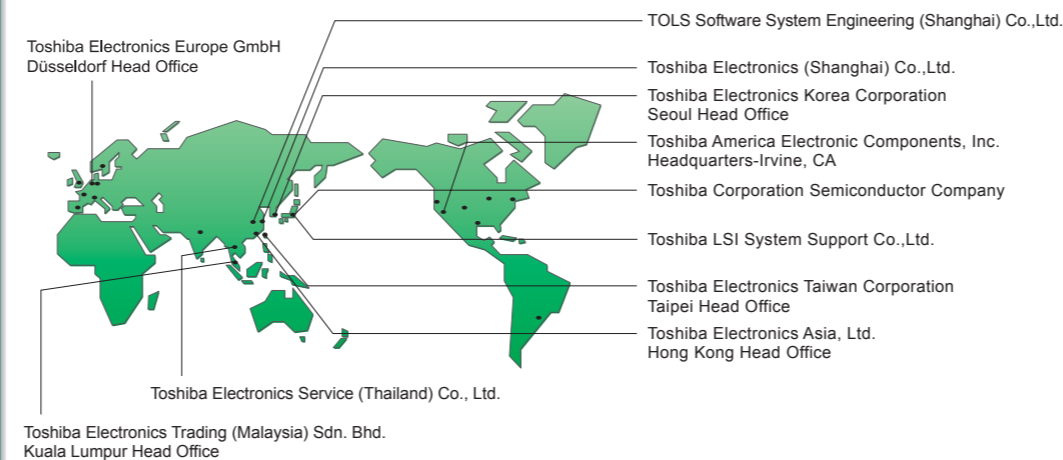
- QTAT..... Quick Flash programming service is available. (Note)
- Quality assurance..... The same level of quality as that of mask ROM products is assured.
- Marking..... Custom marking is possible.
- Support..... In addition to programming at Toshiba, customers can use our partner programming houses.

Note: Delivery time varies with various conditions such as quantity, order acceptance time, factory operation schedule, and product type. For details, please contact your local Toshiba sales representative.

Selection >>> >>> >>> >>> >>> **Global Support Services**

Development Support

Toshiba provides extensive local support to satisfy customer needs varying from region to region.



Development >>> >>> >>> >>> **Development System**

Integrated Development Environment (IDE)

With individual development tools such as Editor, Build Manager, Compiler and Debugger integrated into a single system, the Integrated Development Environment (IDE) enables seamless execution of repetitive tasks in the software development process. Real-time OS debugging is also supported.

Compiler

The C Compiler conforms to the ANSI C standard and offers excellent descriptiveness and portability. A wide range of options are provided to improve code efficiency and RAM utilization.

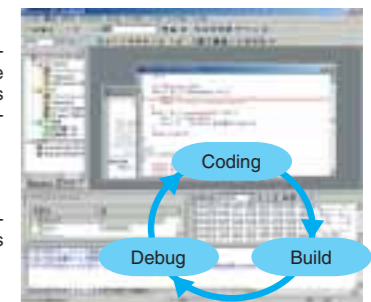
Real-Time OS

The Real-Time OS conforms to the μ TRON specifications. The configuration tool can facilitate various settings.

Emulator

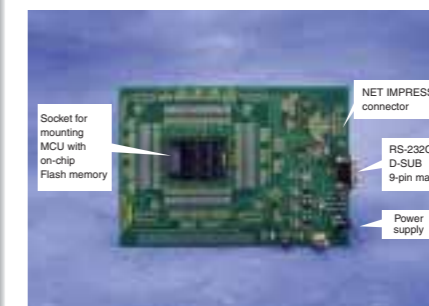
The In-Circuit Emulator and/or On-Chip Debug Emulator are available according to the characteristics of each microcontroller. We are also expanding a line of emulators including the Integrated Development Environment (IDE)*

* To be downloaded from our website.



* The target system requires a separate power supply.

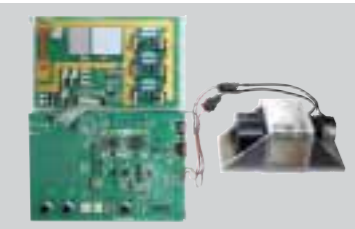
Flash Adapters



- Enables Toshiba's Flash microcontrollers to be programmed on a stand-alone basis.
- Can be used with Toshiba's Flash microcontrollers of any Family or Series in the same package. (*The user is required to connect write signals and mount oscillators as appropriate to each device.)
- Comes with "Flash Programmer"-programming control software controllable on a PC.
- Ensures ease of operation through the GUI-based control software.
- Allows programmed data to be compared on a byte basis.
- Yokogawa Digital Computer's programmer (NET IMPRESS) can be used as a host system.

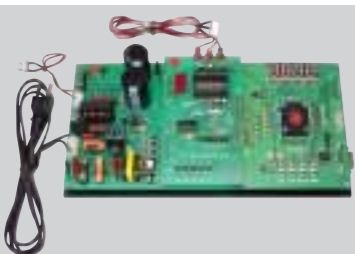
Evaluation >>> >>> >>> >>> >>> **Reference Models/Software IPs**

Reference Models



Evaluation board for Electric Power Steering (EPS)

- Supports brushless DC motor driver using a resolver.
- Allows a user-made motor driver board to be connected.
- Comes with embedded software for vector control.



Evaluation board for PMD microcontrollers

- Supports sensorless brushless DC motors and comes with embedded software for square wave drive.
- Dedicated PC software is provided to modify motor drive parameters.
- 1A and 10A types are available to suit your application needs.

Reference model for induction heating (IH) cookers

- Uses a quasi-class-E inverter (input 200 V AC).
- Controls the inverter by the TMP86FS27's IGBT output circuit
- Equipped with safety features, such as auto shut-off when there is no pot and small object detection.
- Provides 6 levels of heating power.



Software IPs

- USB1.1 (device)
- Embedded File System
- SD Memory Card Driver
- Speech Codec
- Handwritten Recognition
-

We provide a wide range of software development support for customers so that they can reduce the time required for development.

Evaluation board for software IPs (SWIP)



Evaluation board for portable devices



Reliable, User-Friendly Development Systems for Toshiba Microcomputers

Toshiba offers a complete line of reliable, user-friendly development tools to support customers in each phase of program development from design to evaluation.

Compact ICE for TLCS-870/C Series

RTE870/C Light Emulator

The RTE870/C Light emulator is comprised of the minimum functions required for debugging, and comes in three types to support all MCUs in the TLCS-870/C Series (excluding the TMP86xx24FG).

● The price is "Light".

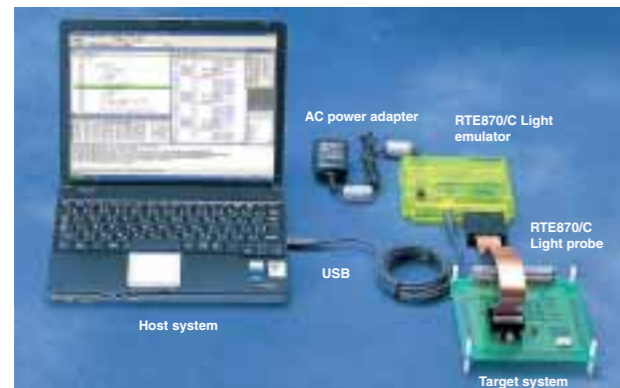
- Integration of the RTE controller and pod system makes the emulator more affordable.
- Comes with a free debugger download.

● The connection is "Light".

- The host interface is through USB.
- Can be easily connected to a notebook PC.

● The size is "Light".

- A new system configuration succeeded in integrating the system on a single board.
- A smaller probe tip takes less space on the target board.



*The target system requires a separate power supply.

Probe Set

The probe set is available for each package pin count or package type of supported MCUs.



The probe set includes:

- **RTE870/C Light probe**
Used to connect the emulator and target system.
- **Target connector**
Used to connect the probe to the target system.
- **Exchange adapter**
Required with some MCUs.

The probe sets and options are manufactured by ADLINKS Corporation.
<http://www.adlinks.co.jp/>

RTE870/C Light Debugger (*)

- Exclusively for RTE870/C Light system
- The same GUI as RTE870/C model15 debugger

Downloadable from our development system website (User registration is required.)

*This product will be replaced by the Integrated Development Environment being developed.



Product components:

- RTE870/C Light emulator
- AC power adapter

Other required items:

- Probe set
- Emulation chip
- Language tool
- Host system (PC)
- USB cable (USB standard A to B)

* For the detailed specifications of the RTE870/C Light emulator, see "Outline of TLCS-870 Family Development System on page 58."

Options

● Stacking adapter

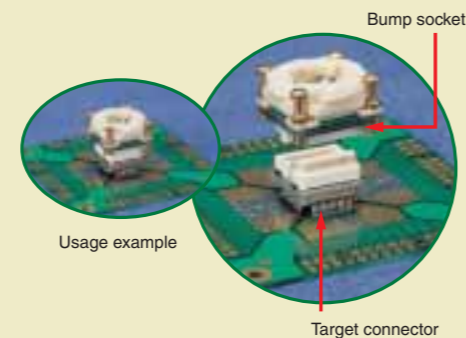
The stacking adapter is used between the probe and the target connector to raise height so that the target system can be connected easily when there is not enough space around the target connector.

● M15-Light connection exchange cable

The M15-Light connection exchange cable allows you to connect the RTE870/C Light system to a target system that has been debugged with the RTE870/C model 15 system. (The target connecting board used with the RTE870/C model 15 system is required.)

● MCU mounting adapter for RTE870/C Light <Bump socket>

The bump socket is used together with the target connector to mount an MCU on the target system.



Toshiba Software IP

As product development becomes sophisticated and increasingly offers technical advantages, high-performance and large-scale development becomes required in software development, and the development cycle has turned longer. To address this situation, Toshiba aims to faster time to market, realize functions with software, and improve quality by producing software components.

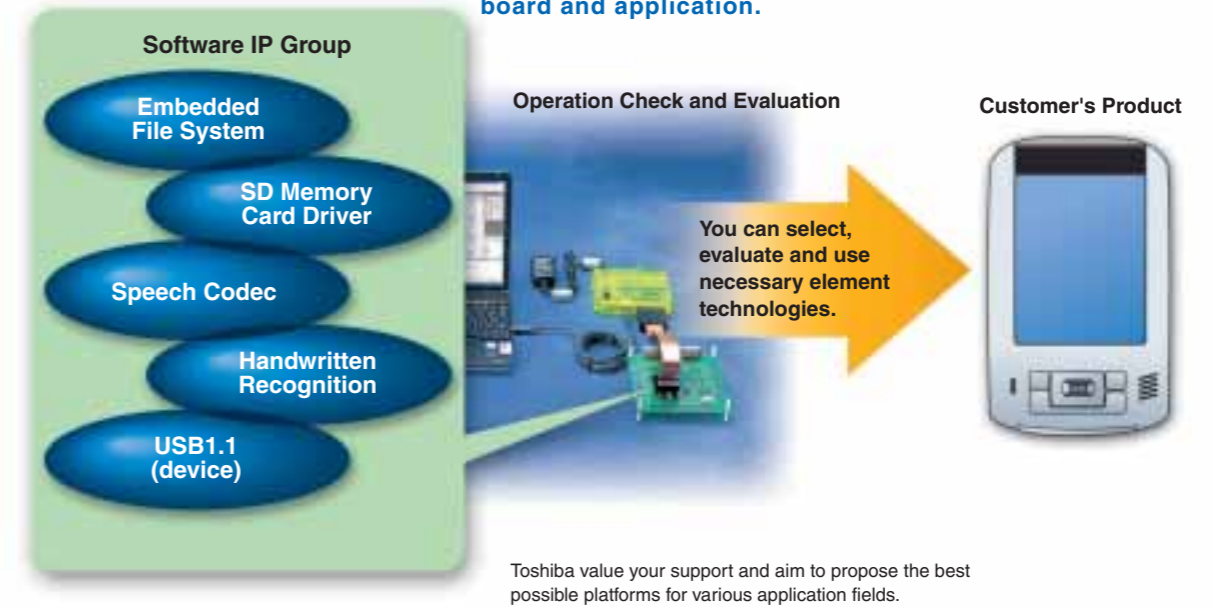
Features of the Software IP

1. Full supports for microcomputers from 8 to 32 bits.
2. Optimized design concept for Toshiba microcomputers.
3. Pursuit of flexible designs and interfaces not limiting application types.
4. Flexible response to any development environments and platforms.



Toshiba's MCU Plus Software IP Platform

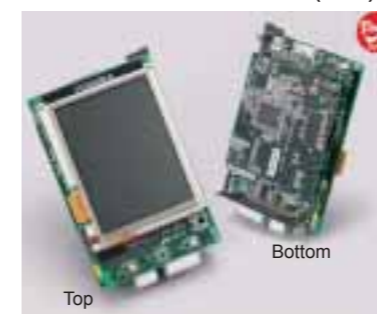
Operation check and evaluation with a demonstration board and application.



System Support

- Software IPs
 - Reference application software
 - Reference models
- We offer a variety of software and solution to speed up your development time.

Evaluation board for software IP (SWIP)



Evaluation board for portable devices



Reference model for LCD TV



* The outlines of microcomputer development systems can be found on page 53 onward.

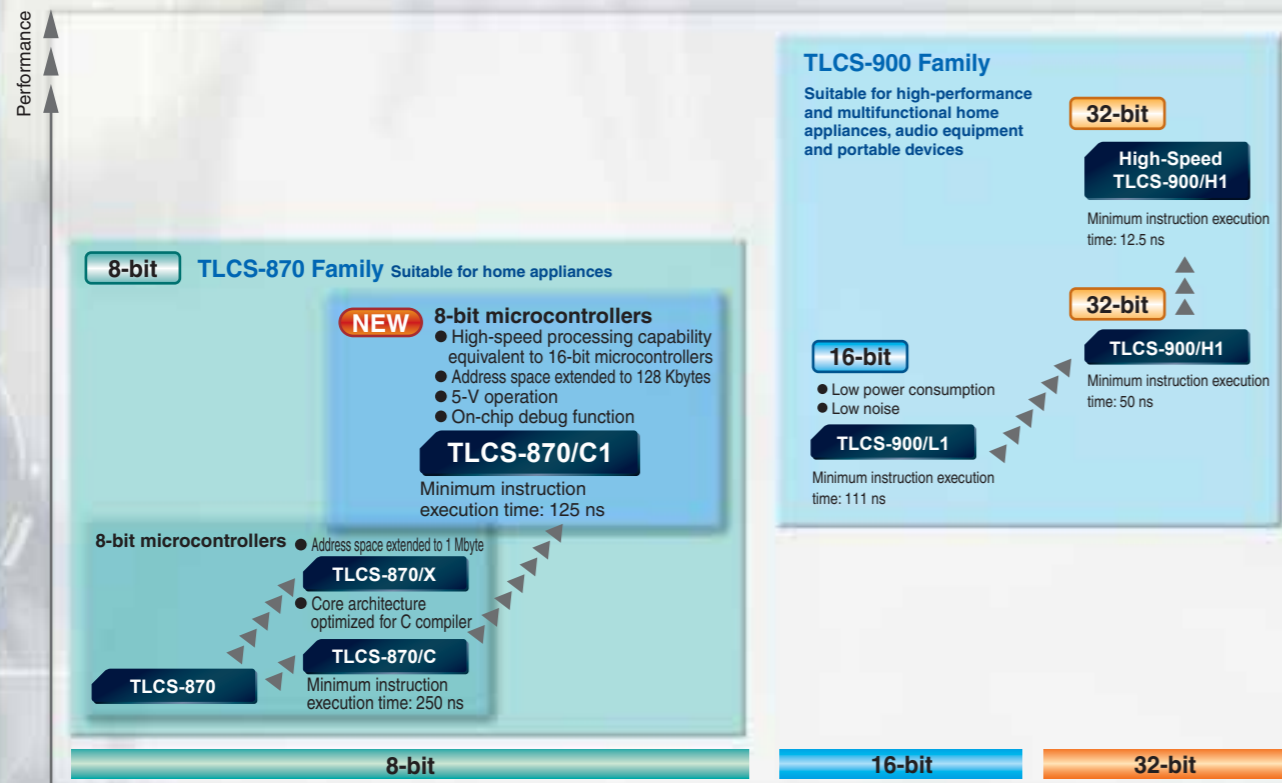
* For details of software IPs, see the page 65 of this product guide.

Toshiba Microcontrollers TLCS-870/C1 Series

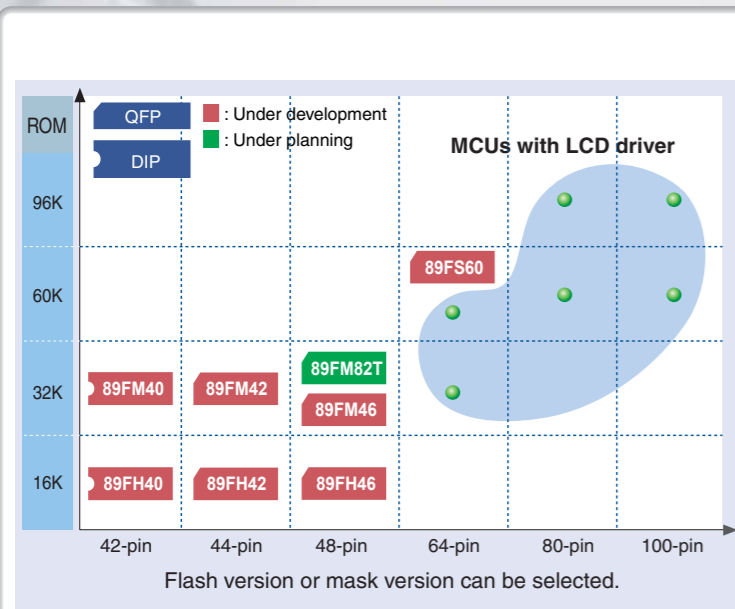
Realizing processing capability equivalent to 16-bit microcontrollers and memory address space extendable up to 128 Kbytes

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

Toshiba Microcontroller Core Lineup

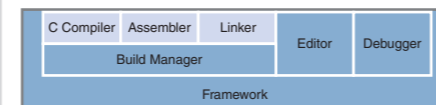


Series Road Map



Development System

Toshiba Integrated Development Environment (TIDE)



Using the Integrated Development Environment (IDE) together with C Compiler enables seamless operations of coding, building and debugging tasks which must be performed repeatedly in the software development process. Toshiba development tools offer a variety of latest functions to realize a user-friendly and highly efficient debug environment.

The C Compiler supports both the TLCS-870/C and TLCS-870/C1 Series with a single product. The Integrated Development Environment (IDE) supports the TLCS-870/C Series, TLCS-870/C1 Series, TLCS-900 Family and TX19 Family with a single product.

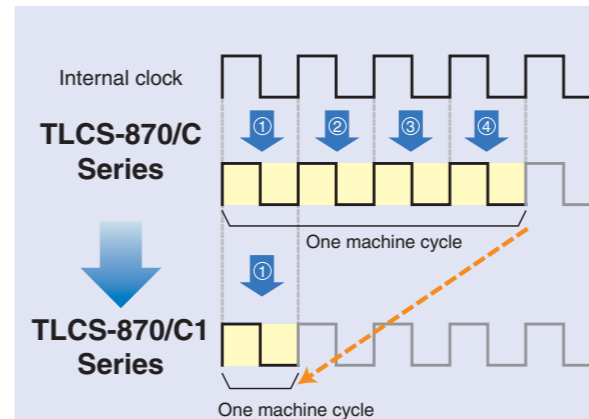
Features of TLCS-870/C1 Series

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

High-speed processing at a low clock frequency

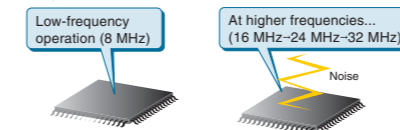
One instruction cycle operated in a single clock cycle

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



Advantages of low-frequency operation

- Compared to the TLCS-870/C, power consumption can be reduced at the same performance level.
- Noise generation can be reduced.



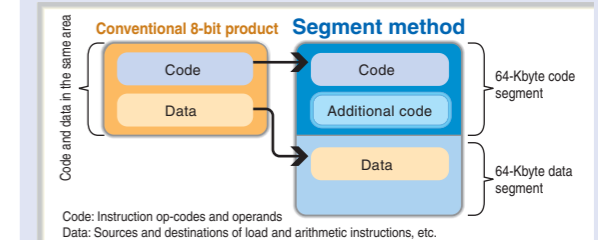
TLCS-870/C1 Series: Minimum instruction execution time of 125 ns
 TLCS-870/C Series: Minimum instruction execution time of 250 ns
 *The minimum instruction execution time is reduced by half compared to TLCS-870/C.

Address space extendable to 128 Kbytes

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

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

Segment method

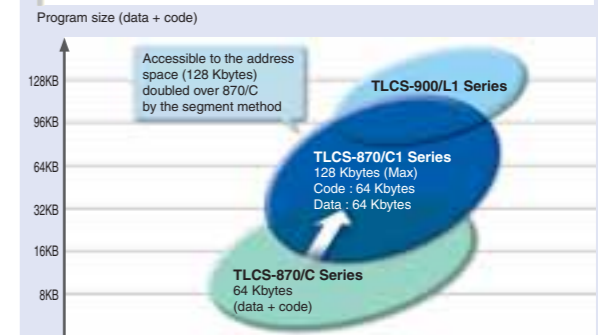


Compact core and object sizes

Compared to the address bus extension method, core and code sizes are reduced. The instruction set is compatible with TLCS-870/C.

Software design facilitated

Unlike the bank switching method, small- to large-sized programs need not be modified. Processing speed and code efficiency are unaffected even if the code size exceeds 64 Kbytes.



Development System

Emulators

*Under development. Specifications are subject to change without notice.

In-circuit emulator

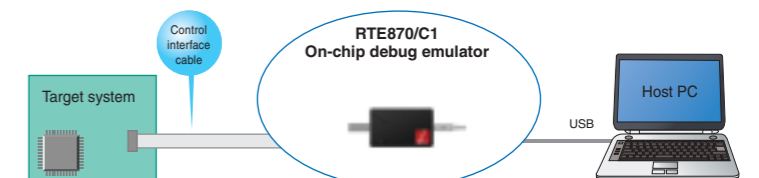
- Compact, low-cost, yet highly functional in-circuit emulator (compared to RTE870/C model 15)
- Various 870/C1 Series devices supported by replacing the probe
- Common probe with RTE870/C Light* (*) Compact emulator for 870/C Series
- Connected with the host system via USB
- IDE included (downloadable from website)
- Supports on-chip debug emulation.



*The target system requires a separate power supply.

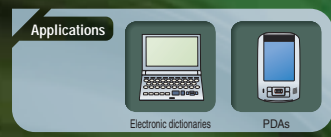
On-chip debug emulator

- Business-card-sized compact emulator
- No need for power supply (using USB bus power)
- Target connection via a narrow-pitched cable
- Extensive on-chip debug functions
- Break/event : 8 breakpoints/1 event
- Trace : The last two branches can be stored in real time.
- Memory access : Display/Rewrite during program execution in 1-byte units (with a wait of 1 clock cycle)
- Debug pin : Two I/O pins
- Flash programming function
- IDE included (downloadable from website)



*The target system requires a separate power supply.

Microcontrollers Listed by Function / Application

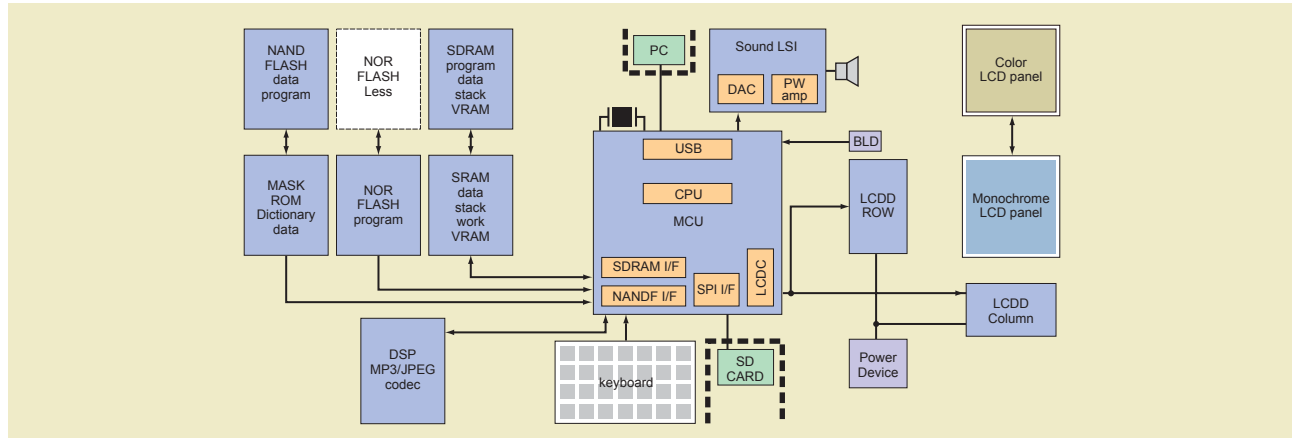


Microcontrollers for personal equipment

With built-in devices such as LCD driver controllers, Memory Management Units and RTC, these microcontrollers are ideal for personal equipment. We also offer products with a built-in touch panel I/F, AD converter and power supply detection circuit; and products with a built-in SDRAM controller and NAND-type flash memory I/F featuring outstanding bit unit cost.

- Main functions**
- LCD driver controller (monochrome to 16M colors)
 - SDRAM controller
 - Large-capacity memory access MMU
 - 10-bit AD converter
 - Shift to high-performance 32-bit 900/H1 core

System block diagram



Product outline

LCD display

- TFT (16M colors)/STN color (262K colors)
TMP92CZ26A
TMP92CF29A
- TFT/STN color (4096 colors)
TMP92CH21
- Monochrome
16 gray levels
TMP92C820
TMP91C820A, etc.
- Monochrome
TMP92CA25
TMP91C815
TMP91C016
TMP91C025, etc.

PC interface

- USB circuit
TMP92CZ26A
TMP92CF29A
TMP92CH21
- UART
TMP91C815, etc.
All products

Clock with calendar

- RTC circuit
TMP91C815, etc.
All products

Keyboard matrix & Key-on wake-up

TMP91C815, etc. All products

Touch panel interface

- AD circuit + Dedicated IF
TMP92CZ26A
TMP92CF29A
TMP92CA25
TMP92CH21
TMP91C025

Memory access with low bit unit cost

- SPI interface
TMP92CZ26A
TMP92CF29A
TMP92CA25
- SDRAM controller
TMP92CZ26A
TMP92CF29A
TMP92CA25
TMP92CH21
TMP92C820
TMP91C820A

Large capacity memory access

- MMU circuit
TMP91C815, etc.
All products

Product line-up for personal equipment

Part Number	TMP91C824FG	TMP91C016FG	TMP91C025FG	TMP91C815FG	TMP91C820AFG	TMP92C820FG	TMP92CH21FG	TMP92CA25FG	TMP92CZ26AXBG	TMP92CF29AFG
LCD-CTRL	-	W/B	W/B	W/B	16Gray	16Gray	Gray/Color	W/B	Gray/Color	Gray/Color
10-bit ADC	8ch	-	4ch	8ch	8ch	5ch	4ch	4ch	6ch	6ch
ROM (bytes)	-	-	-	-	8K	-	8K(Boot)	-	8K(Boot)	8K(Boot)
RAM (bytes)	8K	-	-	8K	8K	8K	16K	10K	288K	144K
DRAM-CTRL	-	EDO	-	-	SDRAM	SDRAM	SDRAM Program execute	SDRAM Program execute	SDRAM Program execute	SDRAM Program execute
UART/SIO	1ch	1ch	1ch	1ch	2ch	3ch	2ch	1ch	1ch	2ch
SIO/IrDA1.0	1ch	1ch	1ch	1ch	1ch	1ch	1ch	1ch	-	-
SBI/I ² C BUS	1ch	-	-	1ch	1ch	1ch	-	1ch	1ch	1ch
SPI	-	-	-	-	-	-	-	1ch	1ch	1ch
MMU	106MBmax	105MBmax	72MBmax	136MBmax	136MBmax	136MBmax	512MBmax	512MBmax	3.1GBmax	2.1GBmax
Min Instruction CLK(internal)	121ns 16.5MHz/2.7V	148ns 13.5MHz/2.7V	112ns 18MHz/3.0V	148ns 13.5MHz/2.7V	112ns 18MHz/3.0V	50ns 20MHz/3.0V	50ns 20MHz/3.0V	50ns 20MHz/3.0V	12.5ns 80MHz/3.0V, 1.4V (Two power supplies)	12.5ns 80MHz/3.0V, 1.4V (Two power supplies)
8-bit timer	4ch	4ch	4ch	4ch	4ch	4ch	4ch	4ch	8ch	8ch
16-bit timer	-	-	-	-	1ch	1ch	1ch	1ch	2ch	2ch
USB-CTRL	-	-	-	-	-	-	USB Device	-	USB Device	USB Device
NANDF-I/F	-	-	-	-	-	-	2ch	2ch	2ch(MLC/SLC)	2ch(MLC/SLC)
DMA-CTRL	-	-	-	-	-	-	-	-	6ch	6ch
MAC	-	-	-	-	-	-	-	-	1ch	1ch
Package	LQFP100	LQFP100	LQFP100	TQFP128	LQFP144	LQFP144	LQFP144	LQFP144	FPGA228	LQFP176

* For details of the products listed above, see the "Part Number List".

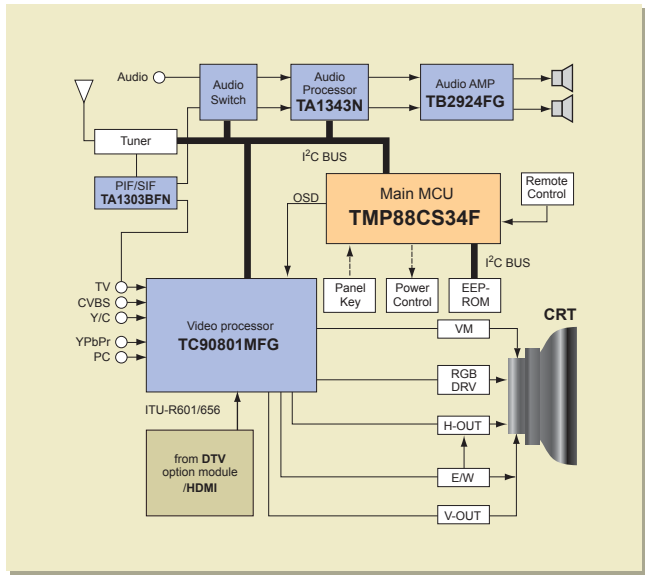
Microcontrollers for televisions

For color TV applications Toshiba offers a line-up of 8-bit microcontrollers with an OSD function and an I²C bus interface circuit.

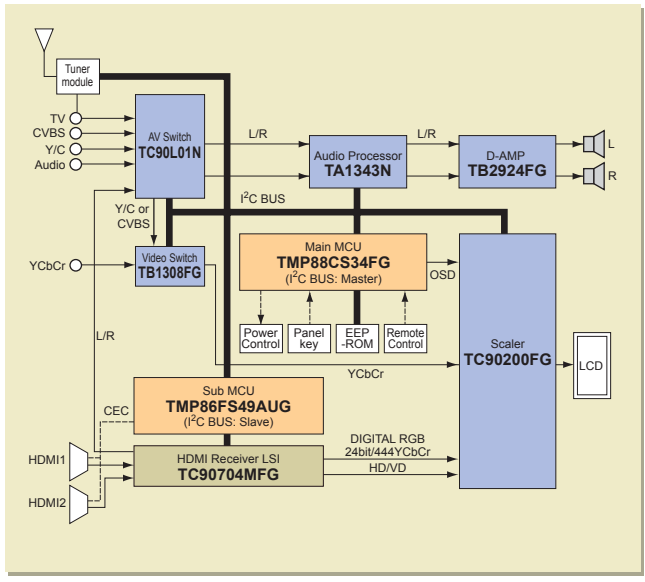
- Main functions**

 - High-functionality 8-bit core (870/X Series)
 - High ROM and RAM capacity
 - High-speed operation, low power consumption
 - Serial interface: I²C bus

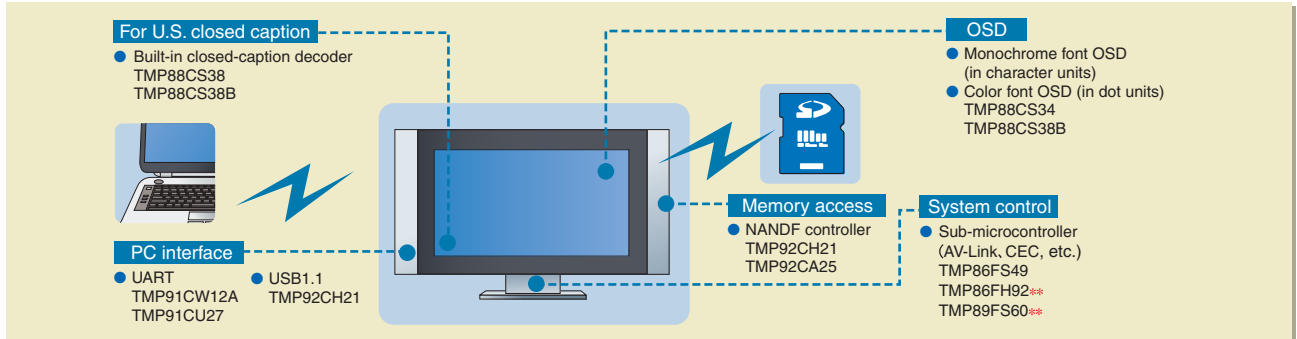
CRT TV System block diagram



LCD TV System block diagram



Product outline



Product line-up

Part Number	TMP88CP34NG/FG	TMP88CS34NG/FG	TMP88CM38ANG/AF	TMP88CP38ANG/AF	TMP88CS38NG/FG	TMP88CM38BNG/BFG	TMP88CP38BNG/BFG	TMP88CS38BNG/BFG
ROM (bytes)	48K	64K	32K	48K	64K	32K	48K	64K
RAM (bytes)	1.5K			2K		1.5K		2K
PWM	14-bit x 2ch 12-bit x 2ch		14-bit x 2ch 12-bit x 2ch 7-bit x 6ch					
I/O	33							
AD converter	8-bit x 6ch							
I ² C interface	1ch ^{Note 1)}							
On Screen Display	Dot coloring character 32-digit x 12-line display			For U.S. closed caption 32-digit x 12-line display				
OSD clock	External LC oscillation circuit			Internal oscillation circuit			External LC oscillation circuit	
Version with OTP	TMP88PS34NG/FG			TMP88PS38NG/FG			TMP88PS38BNG/BFG	
Packages	SDIP42/QFP44 (14x14mm)							

* For details of the products listed above, see the "Part Number List".
Note1: Although there is only one channel, the circuit has two sets of input/output lines, which can be selected.



Digital equipment



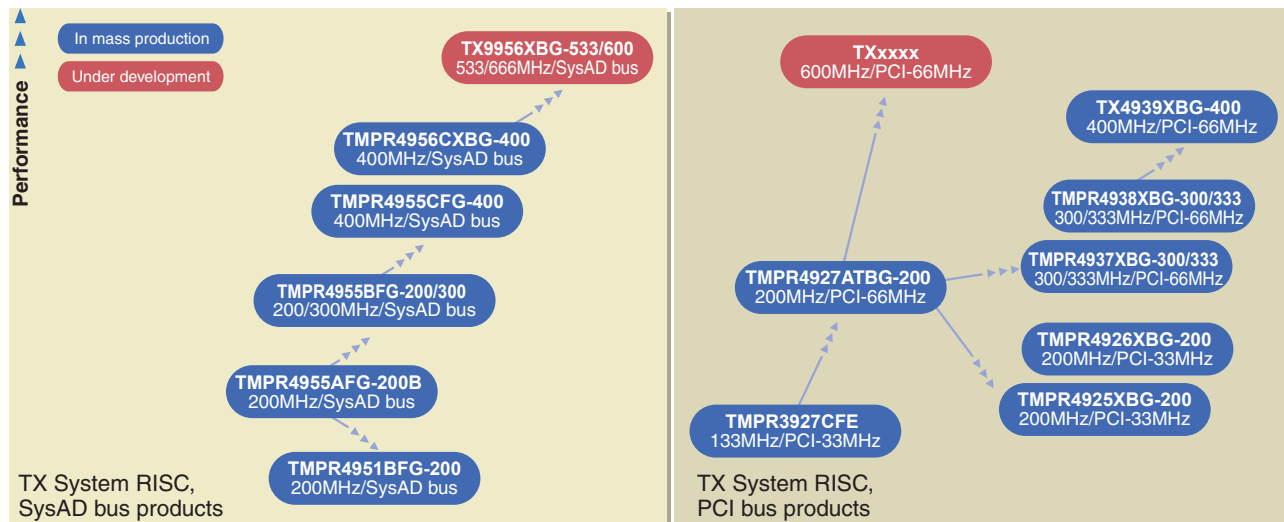
Printers



Network equipment

Microprocessors for digital equipment

These 32- and 64-bit microprocessors are ideal for use as the main controller in digital equipment, such as printers and network equipment. The units with a built-in PCI bus interface are outstanding for peripheral equipment expandability. These microprocessors are also useful in other applications.



32-/64-bit RISC processors

Part Number	Package	Additional functions
TX9956XBG-533/600**	PBGA272	<ul style="list-style-type: none"> 64-bit Superscalar RISC processor Built-in instruction cache 32 Kbytes, data cache 32 Kbytes 256 Kbyte level 2 cache Built in FPU conforming to IEEE754 (single precision/double precision) Employs 32-bit/64-bit SysAD Bus interface Power supply voltage (I/O 2.5 V or 3.3 V, internal 1.25 V) Operating frequency 533 MHz/600 MHz
TMPR4956CXBG-400 TMPR4955CFG-400 TMPR4955BFG-200/300	QFP160 (4955) PFBGA217 (4956)	<ul style="list-style-type: none"> 64-bit RISC processor Built-in instruction cache 32 Kbytes, data cache 32 Kbytes Built-in FPU conforming to IEEE754 (single precision/double precision) Employs 32-bit/64-bit SysAD Bus interface Power supply voltage (I/O 3.3 V, internal 1.5 V; TMPR4955B), (I/O 2.5 V or 3.3 V, internal 1.25 V; TMPR4955C, TMPR4956) Operating frequency 200 MHz/300 MHz (TMPR4955B), 400 MHz (TMPR4955C, TMPR4956)
TMPR4951BFG-200	LQFP100	<ul style="list-style-type: none"> 64-bit RISC processor Built-in instruction cache 16 Kbytes, data cache 8 Kbytes No FPU Employs 32-bit SysAD Bus interface Power supply voltage (I/O 2.5 V or 3.3 V, internal 1.5 V) Operating frequency: 200 MHz
TX4939XBG-400	PBGA456	<ul style="list-style-type: none"> 64-bit RISC processor Built-in instruction cache 32 Kbytes, data cache 32 Kbytes Built-in FPU conforming to IEEE754 (single precision/double precision) Encryption engine (DES, 3DES, AES etc.), DDR-SDRAM controller, AC-Link, 10/100 BASE-T EtherMAC (2 channels), ATA-100 (2 channels), ITU656 video output port, PCI controller, etc. Power supply voltage (I/O 3.3 V, Internal 1.25 V, DDR-SDRAM 2.5 V (DDR333 or less)/2.6 V (DDR400)) Operating frequency 400 MHz
TMPR4937XBG-300/333 TMPR4938XBG-300/333	PBGA484	<ul style="list-style-type: none"> 64-bit RISC processor Built-in instruction cache 32 Kbytes, data cache 32 Kbytes Built-in FPU conforming to IEEE754 (single precision/double precision) PCI controller, Memory controller, DMA controller, timer, serial, AC-link, Ether MAC (TMPR4938), etc. Power supply voltage (I/O 3.3 V, internal 1.5 V) Operating frequency 300 MHz/333 MHz.
TMPR4925XBG-200 TMPR4926XBG-200	PBGA256	<ul style="list-style-type: none"> 64-bit RISC processor Built-in instruction cache 16 Kbytes, data cache 16 Kbytes Built-in FPU conforming to IEEE754 (single precision/double precision) NAND Flash controller, PCI controller, DMA controller, memory controller, timer, serial, AC-link, Data Encryption Standard (TMPR4926), etc. Power supply voltage (I/O 3.3 V, internal 1.5 V) Operating frequency 200 MHz
TMPR3927CFE	QFP240	<ul style="list-style-type: none"> 32-bit RISC processor Built-in instruction cache 8 Kbytes, data cache 4 Kbytes PCI controller, memory controller, DMA controller, timer, serial, etc. Power supply voltage (I/O 3.3 V, internal 2.5 V) Operating frequency 133 MHz

* For details of the products listed above, see the "Part Number List".

** Under development

PCI connection companion chip

Part Number	Package	Additional functions
TC86C001FG (GOKU-S)	LQFP144	<ul style="list-style-type: none"> PCI/IF (32-bit, 33 MHz) ATA/ATAPI host controller, Ultra DMA transfer (mode 4), maximum transfer rate 66 Mbytes/s USB1.1 host controller 2 ports (OpenHCI 1.0a supported) USB device controller 1 port I²C bus/SIO Power supply voltage (I/O 3.3 V, internal 1.5 V)

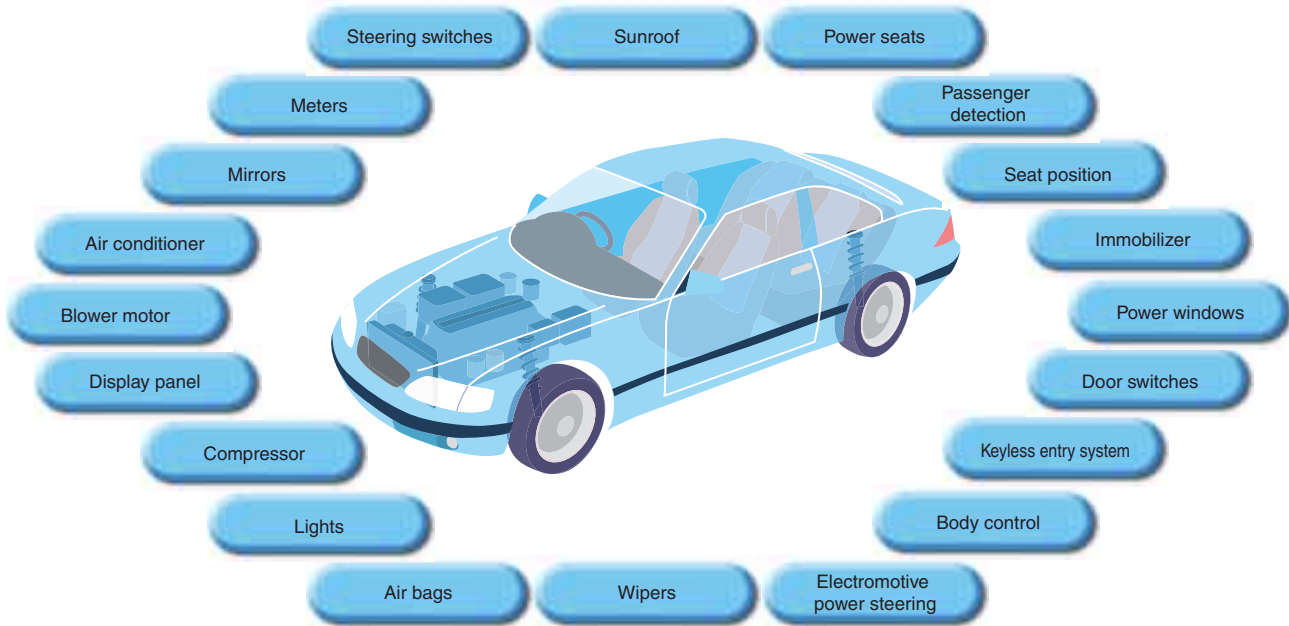
* For details of the products listed above, see the "Part Number List".

Microcontrollers for automotive applications

Toshiba offers a wide selection of automotive microcontrollers with various communications functions such as CAN and SEI. These microcontrollers are manufactured to Toshiba's exacting automotive grade standards ^{Note)} to ensure high quality in a wide range of operating temperatures.

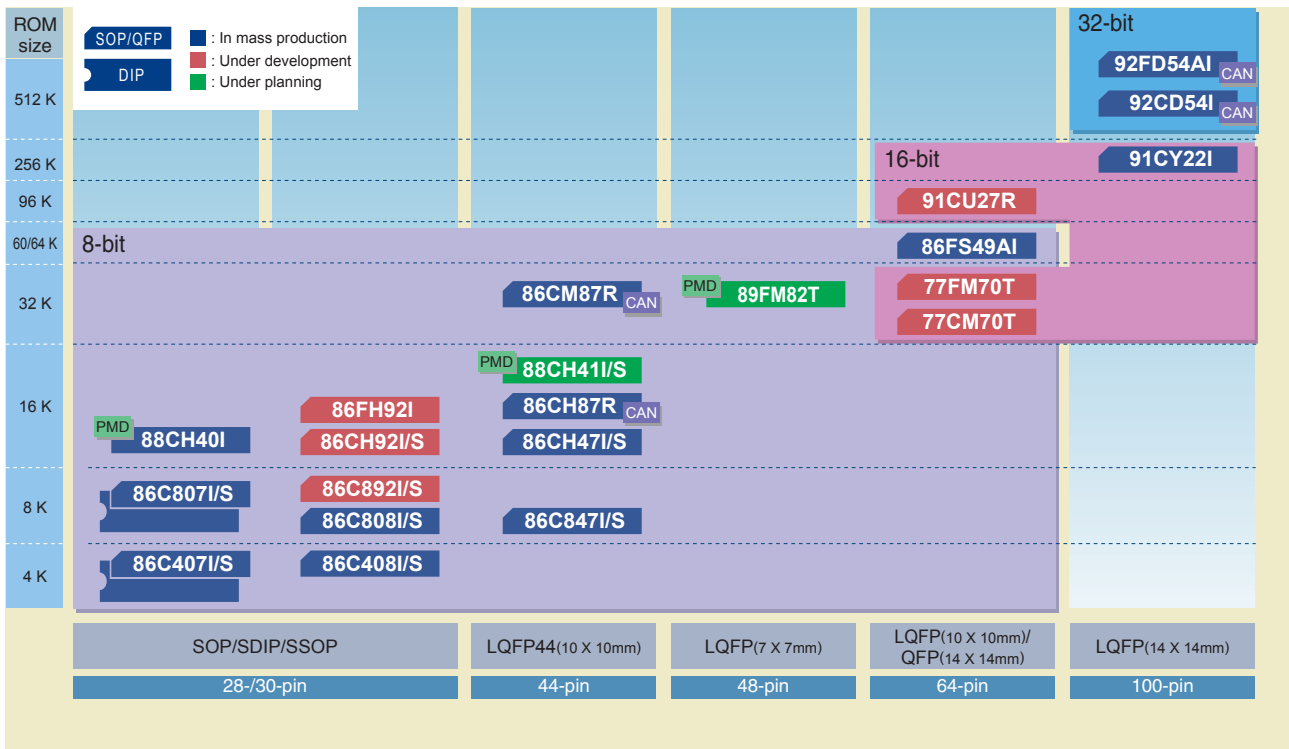
Main functions

- CAN
- SEI



Note: For details about the automotive grade products, please contact your local Toshiba sales representative.

Product line-up for automotive





8-bit microcontrollers for automotive

Part Number	TMP86C407I/S TMP86C807I/S	TMP86C408I/S TMP86C808I/S	TMP86C847I/S TMP86CH47I/S	TMP86CH87R TMP86CM87R
ROM (bytes)	4K/8K	4K/8K	8K/16K	16K/32K
RAM (bytes)	256	256	512	1K
I/O	22	24	35	35
CAN (4 mailboxes)	-	-	-	1ch
SEI	1ch	1ch	-	1ch
SIO	-	-	1ch	-
UART	1ch	1ch	1ch	1ch
I ² C	-	-	-	-
AD converter	8-bit x 6ch	8-bit x 6ch	10-bit x 8ch	10-bit x 14ch
8-bit timer counter	2ch	2ch	2ch	2ch
16-bit timer counter	1ch	1ch	1ch	1ch
Watchdog timer	●	●	●	●
Dual clocks	●	●	●	●
OTP/Flash version	TMP86P807/F807	TMP86P808/F808	TMP86PM47A/PH47/FH47A	TMP86PM87R
Package	SOP28/SDIP28	SSOP30	LQFP44(10 x 10mm)	LQFP44(10 x 10mm)

Part Number	TMP86C892I/S** TMP86CH92I/S**	TMP86FS49AI	TMP88CH40I	TMP88CH41I/S++	TMP89FM82TUG++
ROM (bytes)	8K/16K	60K	16K	16K	32K
RAM (bytes)	512	2K	512	512	1.5K
I/O	24	56	19	33	39
CAN	-	-	-	-	-
SEI	1ch	-	-	-	1ch
SIO	-	2ch	1ch	1ch	1ch
UART	1ch	2ch	1ch	1ch	2ch
I ² C/UART	1ch	-	-	-	-
I ² C	-	1ch	-	-	-
AD converter	10-bit x 6ch	10-bit x 16ch	10-bit x 4ch	10-bit x 8ch	10-bit x 8ch
8-bit timer counter	2ch	4ch	2ch	2ch	4ch
16-bit timer counter	1ch	2ch	1ch	2ch	2ch
Motor controller	-	-	1ch	1ch	1ch
Watchdog timer	●	●	●	●	●
Dual clocks	●	●	-	-	●
OTP/Flash version	TMP86FH92I**	-	TMP88PH40	TMP88PH41	-
Package	SSOP30	LQFP64(10 x 10mm)/ QFP64(14 x 14mm)	SOP28	LQFP44(10 x 10mm)	LQFP48(7 x 7mm)

** : Under development
++ : Under planning

16-bit microcontrollers for automotive

Part Number	TMP91CU27R**	TMP91CY22I	TMP92CD54I
ROM (bytes)	96K	256K	512K
RAM (bytes)	10K	16K	32K
I/O	53	81	68
CAN (16 mailboxes)	-	-	1ch
SEI	-	-	1ch
SIO/UART	2ch	2ch	2ch
I ² C	1ch	1ch	3ch
AD converter	10-bit x 4ch	10-bit x 8ch	10-bit x 12ch
8-bit timer counter	6ch	8ch	8ch
16-bit timer counter	1ch	2ch	2ch
32-kHz timer (for S/W RTC)	●	●	-
H/W RTC	-	-	●
16-bit PWM timer	-	-	-
PDC	-	-	-
CS/WAIT controller	3ch	4ch	1ch
Watchdog timer	●	●	●
Dual clocks	●	●	-
OTP/Flash version	TMP91FW27	TMP91FY42	TMP92FD54AI
Package	LQFP64(10 x 10mm)	LQFP100(14 x 14mm)	LQFP100(14 x 14mm)

** : Under development

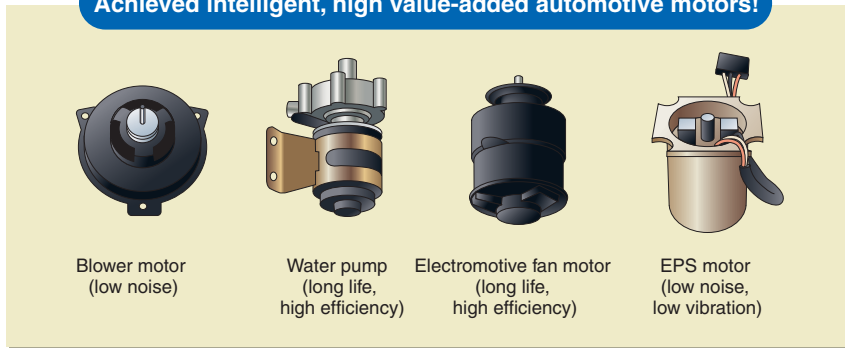
32-bit microcontrollers for automotive

Microcontrollers for automotive motor control

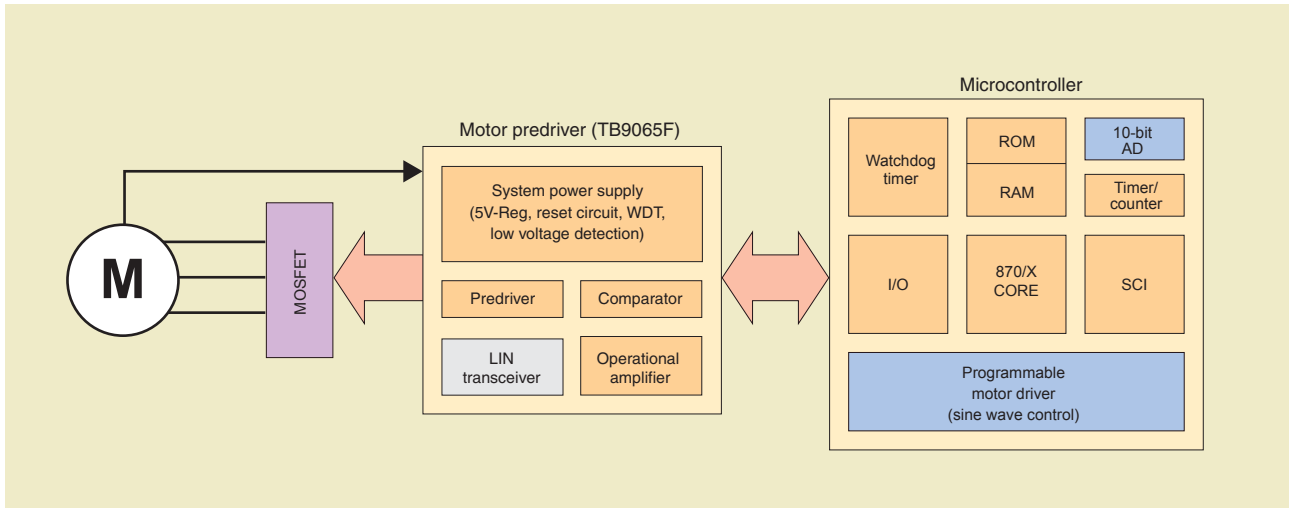
These microcontrollers incorporate an inverter control function for sensorless/sensor-equipped 3-phase DC and AC motors and a sine wave drive circuit for supporting high reliability and high temperature operation. The sine wave drive circuit enables easy sine wave drive suited to high efficiency and low noise.

- Main functions**
- Sine wave drive circuit
 - Rotor position detection function
 - Motor control timer and timer capture
 - PWM waveform generation function
 - Overload protection function
 - Abnormality protection function
 - Automatic commutation start and automatic position detection start

Achieved intelligent, high value-added automotive motors!



Automotive motor system block diagram



Product line-up

Microcontrollers

Part Number	TMP88CH40IMG	TMP88CH41UG ^(Note2)	TMP89FM82TUG ⁺⁺
Series name	870/X	870/X	870/C1
Motor control circuit (PMD) ^(Note1)	1ch	1ch	1ch
AD converter	10-bit x 4ch	10-bit x 8ch	10-bit x 8ch
Memory (ROM/RAM)	16KB/512B	16KB/512B	32KB/1.5KB
Package	SOP28	QFP44	LQFP48
OTP version ^(Note3)	TMP88PH40MG	TMP88PH41UG	-

Note 1: Programmable Motor Driver

Note 2: Automotive-grade products under consideration

Note 3: Standard grade

* For details of the products listed above, see the "Part Number List".

DSP

Part Number	TMP77CM70TUG ^{**}
Series name	770
DSP	16-bit fixed-point
Motor control circuit (PMD) ^(Note1)	1ch
AD converter	10-bit x 4ch x 2 units
Memory (ROM/RAM)	32KB/1KB
Package	LQFP64
Flash version	TMP77FM70TUG ^{**}

** : Under development

++ : Under planning

Microcontrollers Listed by Function / Application

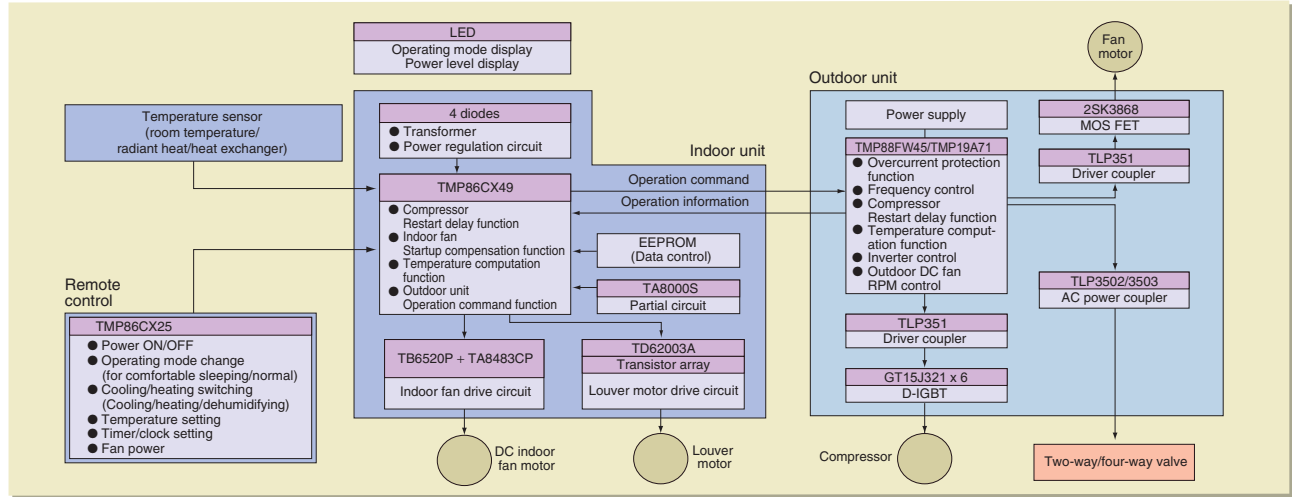


Microcontrollers for inverter electric appliances

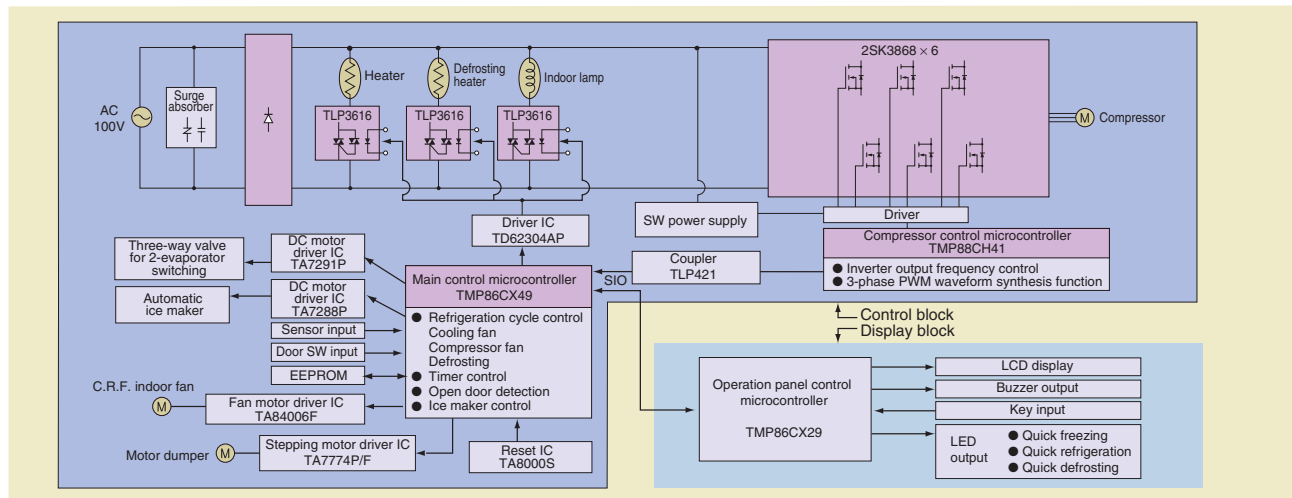
The following microcontrollers incorporate various functions suitable for electric appliances that require user interfaces, sensor inputs, actuator control, and communications.

- Main functions**
- AD converter
 - Serial communication
 - Motor control circuit
 - LCD driver

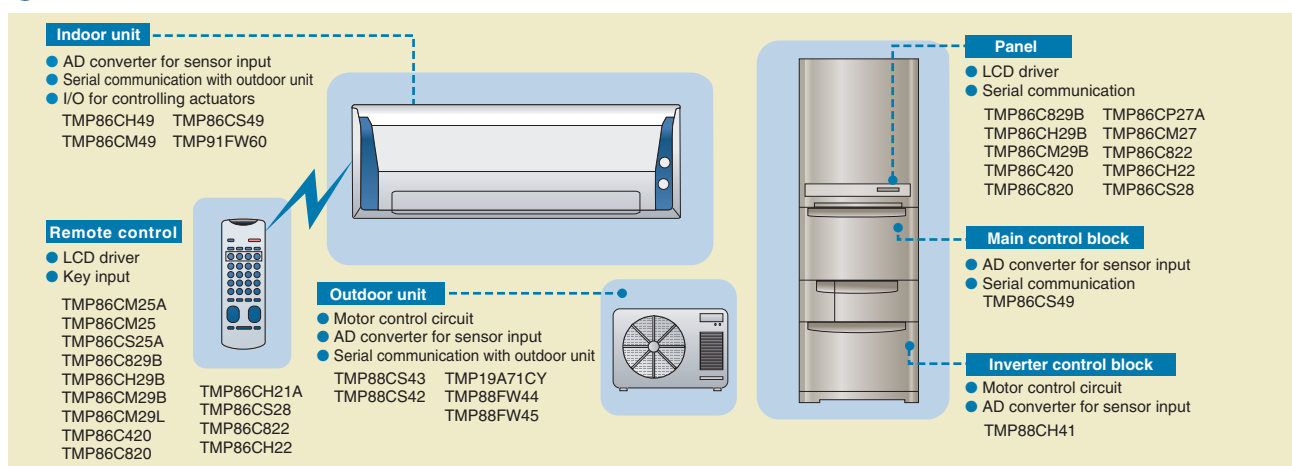
Air conditioner system block diagram



Refrigerator system block diagram



Product outline



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



DVCs



DSLRs

Microcontrollers for digital single-lens reflex cameras (DSLRs)

These microcontrollers incorporate high-speed AD converters to support AF/AE control (computation), dial input, and other features suitable for the main controller of a single-lens reflex camera.

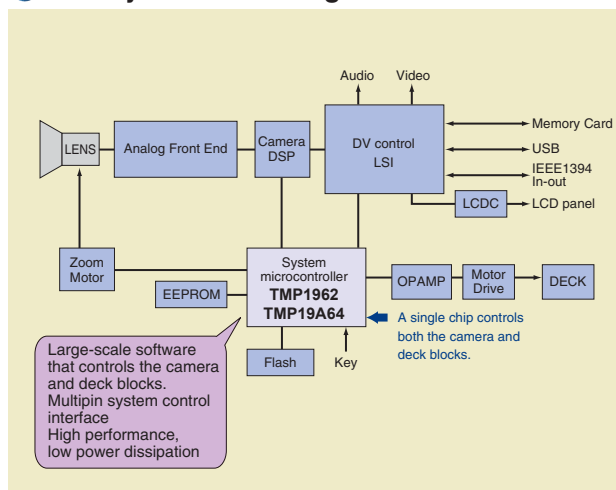
Microcontrollers for digital video cameras (DVCs)

These microcontrollers, responsible for controlling the camera and tape deck sections, contain large-capacity ROM to help minimizing the product size and support various features suitable for main DVC control.

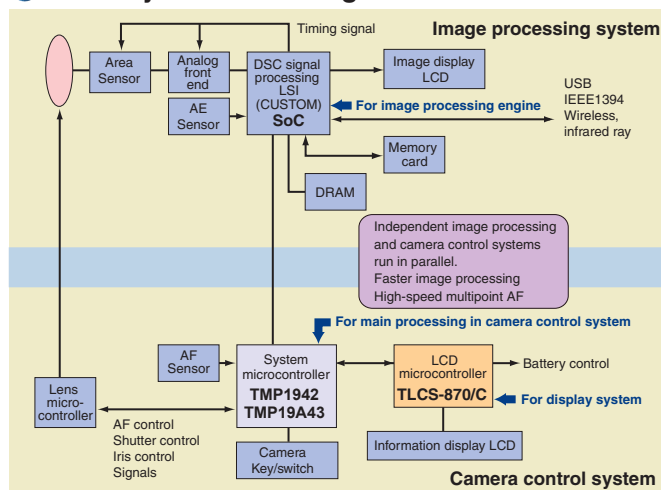
Main functions

- AF/AE control (high-speed AD/multidigit operation)
- Dial input control
- Shutter control
- Tape control
- LCD display control

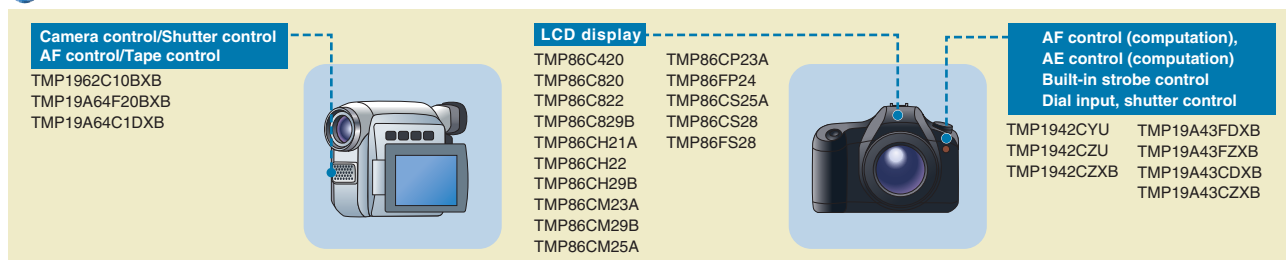
DVC system block diagram



DSLR system block diagram



Product outline



Product line-up

Part Number	TMP1942CYUG/CZUG/CZXBG	TMP1962C10BXBG	TMP19A43FDXBG/CDXBG	TMP19A43FZXBG/CZXBG	TMP19A64F20BXBG/C1DXBG
Maximum operating frequency (MHz)	32	40.5	40	40	54
Supply voltage (V)	2.7 to 3.6	1.35 to 1.65 I/O: 1.65 to 3.3 AD: 2.7 to 3.5	1.35 to 1.65 I/O, AD: 2.7 to 3.6 DA: 2.3 to 2.7	1.35 to 1.65 I/O, AD: 2.7 to 3.6 DA: 2.3 to 2.7	1.35 to 1.65 I/O: 1.65 to 3.3 AD: 2.7 to 3.3
Internal bus width	32	32	32	32	32
External bus width	16 (address/data multiplexed)	16 (multiplexed or separate selectable)	16 (multiplexed or separate selectable)	16 (multiplexed or separate selectable)	16 (multiplexed or separate selectable)
Internal ROM (bytes)	256K/384K	1024K	512K	384K	2048K/1536K
Internal RAM (bytes)	16K	40K	24K	20K	64K/56K
AD converter	16ch (conversion time: 2μs)	24ch	16ch (conversion time: 1.15μs)	16ch (conversion time: 1.15μs)	24ch
DMAC channels	4ch	8ch	8ch	8ch	8ch
I/O ports	108	202	143	143	209
Serial interface	6ch	8ch	7ch	7ch	8ch
Timer channels	28ch	18ch	17ch	17ch	12ch
External interrupt pins	29	25	48	48	20
Dual clock	●	-	●	●	●
Debug support unit	● (Flash product only)	●	●	●	●
Package	LQFP144(16 x 16mm)/ FBGA177(13 x 13mm)	FBGA281(13 x 13mm)	FBGA193(12 x 12mm)	FBGA193(12 x 12mm)	FBGA281(13 x 13mm)
Others	10-bit DA converter x 3 channels ROM correction 2-phase pulse input counter Dynamic pull-up 5 V capable ports (x 15)	ROM correction 2-phase pulse input counter	8-bit DA converter x 2 channels ROM correction 2-phase pulse input counter Dynamic pull-up	8-bit DA converter x 2 channels ROM correction 2-phase pulse input counter Dynamic pull-up	Built-in back-up block ROM correction 2-phase pulse input counter

* For details of the products listed above, see the "Part Number List".

Microcontrollers Listed by Function / Application



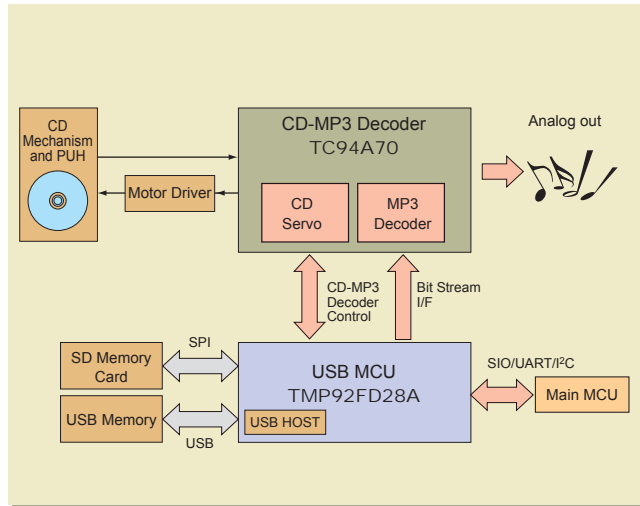
Microcontrollers for audio (CD-MP3 control MCUs)

Toshiba's extensive line-up of microcontrollers for audio applications includes 16-bit products ideal for controlling CD-MP3 decoder ICs, and 32-bit products incorporating a USB HOST controller which are software-compatible with the 16-bit products.

Main functions

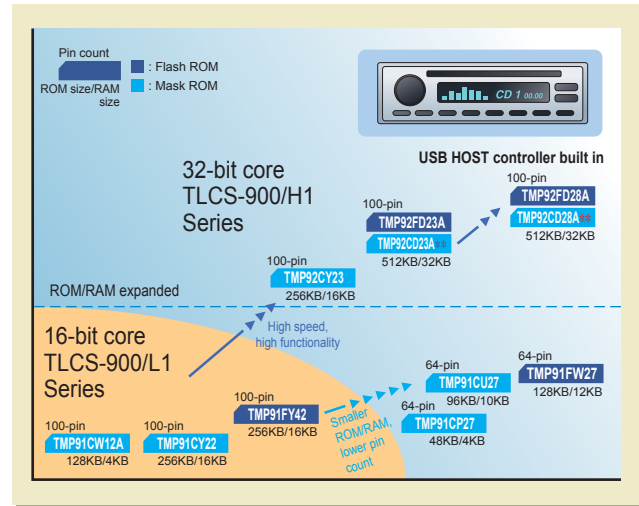
- Controlling CD servo and CD-MP3 decoder ICs
- Memory variations
- Pin count variations

Sample application: CD-MP3/USB/SD system



* MP3 and WMA are trademarks or registered trademarks of their respective holders.

Roadmap for audio MCUs



** : Under development

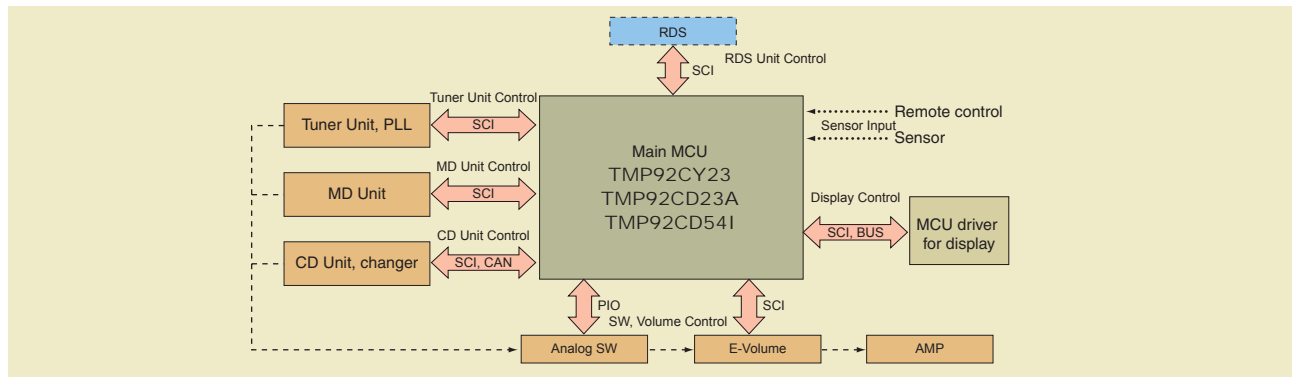
Microcontrollers for audio (Main control MCUs)

These 32-bit microcontrollers incorporate large-capacity memory and a wide range of serial interfaces, hence they are suitable for main control, for example, in car audio. The series also includes products that contain CAN controllers.

Main functions

- High performance
- Large-capacity memory
- Range of serial interfaces
- Peripheral unit control

Sample application : Main control system



Product line-up

CD-MP3 control MCUs

Part Number	TMP91CP27UG/ TMP91CU27UG	TMP91CW12AFG/ TMP91CY22FG	TMP92CY23FG/DFG TMP92CD23AFG/DFG**	TMP92CD28AFG/ TMP92CD28ADFG**
Series name	900/L1	900/L1	900/H1	900/H1
ROM (bytes)	48K/96K	128K/256K	256K/512K	512K
RAM (bytes)	4K/10K	4K/16K	16K/32K	32K
I/O port	53	81	84	72
10-bit AD converter (ch)	4	8	12	-
UART/SIO (ch)	2	2	3	2
I²C bus/SIO (ch)	1	1	2	2
USB HOST controller	-	-	-	1
Package	LQFP64	LQFP100	LQFP100/QFP100	LQFP100/QFP100

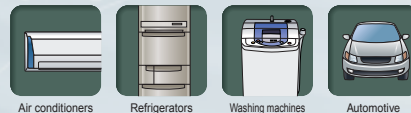
** : Under development

Main control MCUs

Part Number	TMP92CY23FG/DFG	TMP92CD23AFG/DFG**	TMP92CD54IFG
Series name	900/H1	900/H1	900/H1
ROM (bytes)	256K	512K	512K
RAM (bytes)	16K	32K	32K
I/O port	84	84	68
10-bit AD converter (ch)	12	12	12
UART/SIO (ch)	3	3	2
I²C bus/SIO (ch)	2	2	3
CAN	-	-	1
Package	LQFP100/QFP100	LQFP100/QFP100	QFP100

** : Under development

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



Air conditioners Refrigerators Washing machines Automotive

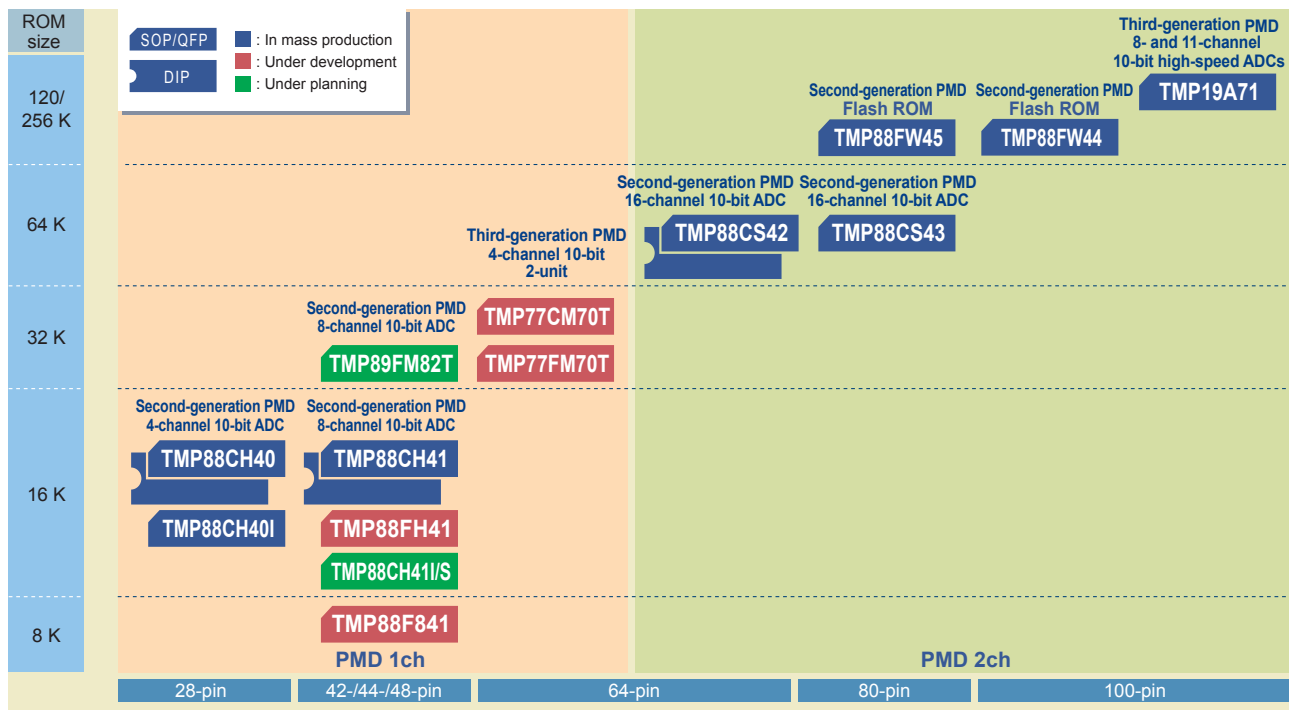
Microcontrollers with motor control circuit (PMD)

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

Main functions

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

8-bit microcontrollers with motor control circuit (PMD)



※ PMD : Programmable Motor Driver

Product line-up

Series Name	Part Number	Flash	ROM (bytes)	RAM (bytes)	I/O	PMD (channel)	Additional Functions	Supply Voltage (V)	Version with OTP/Flash	Package	
870/X	TMP88CH40NG/MG		16 K	512	19	1	● 10-bit AD converter ● UART ● SIO	4.5 to 5.5	TMP88PH40NG/MG	SDIP28/SOP28	
	TMP88CH40IMG								TMP88PH40MG	SOP28	
	TMP88CH41NG/UG								TMP88PH41NG/UG	SDIP42/LQFP44(10 x 10mm)	
	TMP88CH41UG++/SUG++								TMP88PH41UG	LQFP44(10 x 10mm)	
	TMP88F841UG**	●	8 K	33	2	● 10-bit AD converter ● UART ● SIO ● PWM	4.5 to 5.5	TMP88PS42NG/FG	SDIP64/QFP64 (14 x 20mm)		
	TMP88FH41UG**	●	16 K					TMP88PS43FG	QFP80(14 x 20mm)		
	TMP88FW44FG	●	120K	4K	91	2	● 10-bit AD converter ● UART ● SIO ● PWM	4.5 to 5.5	-	QFP100(14 x 20mm)	
	TMP88FW45FG	●	120K	4K	71	2	● 10-bit AD converter ● UART ● SIO ● PWM	4.5 to 5.5	-	QFP80(14 x 20mm)	
	870/C1	TMP89FM82TUG++	●	32K	1.5K	39	1	● 10-bit AD converter ● UART ● SIO ● SEI	4.5 to 5.5	-	LQFP48(7 x 7mm)
	770	TMP77CM70TUG**		32K	1K	18	1	● 10-bit AD converter ● UART/SIO	4.5 to 5.5	TMP77FM70TUG**	LQFP64(10 x 10mm)
TMP77FM70TUG**		●	-							-	
TX19A	TMP19A71CYUG/FG		256 K	10K	75	2	● 10-bit AD converter ● UART/SIO ● PWM ● Encoder input	3.0 to 3.6	TMP19A71FYUG/FG	LQFP100(14 x 14mm)/ QFP100(14 x 20mm)	

* For details of the products listed above, see the "Part Number List".

** : Under development

++ : Under planning

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

Microcontrollers Listed by Function / Application

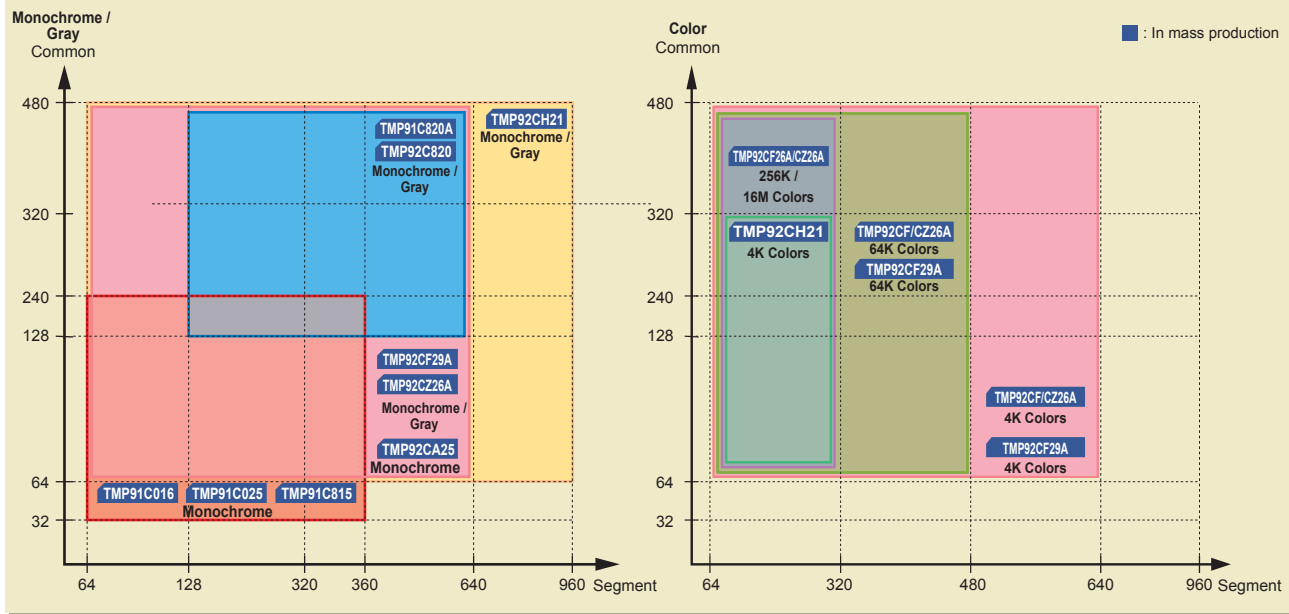


Microcontrollers with LCD controller

The following microcontrollers contain LCD controller circuitry that supports monochrome and color STN/TFT. The line-up thus supports a wide range of LCDs with different sizes.

- Main functions**
- Monochrome/Gray/Color LCD controller
 - Memory interface: SDRAM, NAND Flash, SD card
 - Large-capacity memory access MMU
 - Touch Screen interface

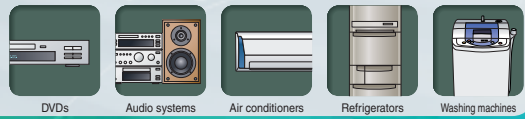
16-/32-bit microcontrollers with LCD controller



Product line-up

Part Number	ROM (bytes)	RAM (bytes)	I/O	LCD-CTRL		Additional Functions	Supply Voltage (V)	Package
				Color	Display Size			
TMP91C016FG	-	-	31	W/B	64seg. x 32com. to 360seg. x 240com.	<ul style="list-style-type: none"> ● MMU (105MB) ● DRAM controller ● Display data X/Y axis conversion circuit (8 x 8) 	1.8 to 3.6	LQFP100 (14 x 14mm)
TMP91C025FG	-	-	38					
TMP91C815FG	-	8K	61				1.8 to 3.6	
TMP91C820AFG	8K	8K	77	16 Gray	128seg. x 128com. to 640seg. x 480com.	<ul style="list-style-type: none"> ● MMU (136MB) ● SDRAM controller 	2.7 to 3.6	LQFP144 (16 x 16mm)
TMP92C820FG	-	8K	83					
TMP92CH21FG	8K (Boot)	16K	82	Gray/Color	64seg. x 64com. to Color: 320seg. x 320com. Gray: 960seg. x 480com.	<ul style="list-style-type: none"> ● MMU (512MB) ● SDRAM controller ● NAND Flash interface ● Touch Screen interface ● USB1.1 interface 	2.7 to 3.6	
TMP92CA25FG	-	10K	92	W/B	64seg. x 64com. to 640seg. x 480com.	<ul style="list-style-type: none"> ● MMU (512MB) ● SDRAM controller ● NAND Flash interface ● Touch Screen interface ● SPI interface 	2.7 to 3.6	
TMP92CZ26AXBG	8K (Boot)	288K	136	Gray/Color	64seg. x 64com. to 16M/256K colors: 320seg. x 480com. 64K colors: 480seg. x 480com. 4K or fewer colors: 640seg. x 480com.	<ul style="list-style-type: none"> ● MMU (3.1GB) ● SDRAM controller ● MLC NAND Flash interface ● USB1.1 interface ● SPI interface 	1.4 to 1.6 3.0 to 3.6 (Two power supplies)	FBGA228 (15 x 15mm, 0.8-mm pitch)
TMP92CF29AFG	8K (Boot)	144K	92	Gray/Color	64seg. x 64com. to 64K colors: 480seg. x 480com. 4K or fewer colors: 640seg. x 480com.	<ul style="list-style-type: none"> ● MMU (2.1GB) ● SDRAM controller ● MLC NAND Flash interface ● USB1.1 interface ● SPI interface 	1.4 to 1.6 3.0 to 3.6 (Two power supplies)	LQFP176 (20 x 20mm)

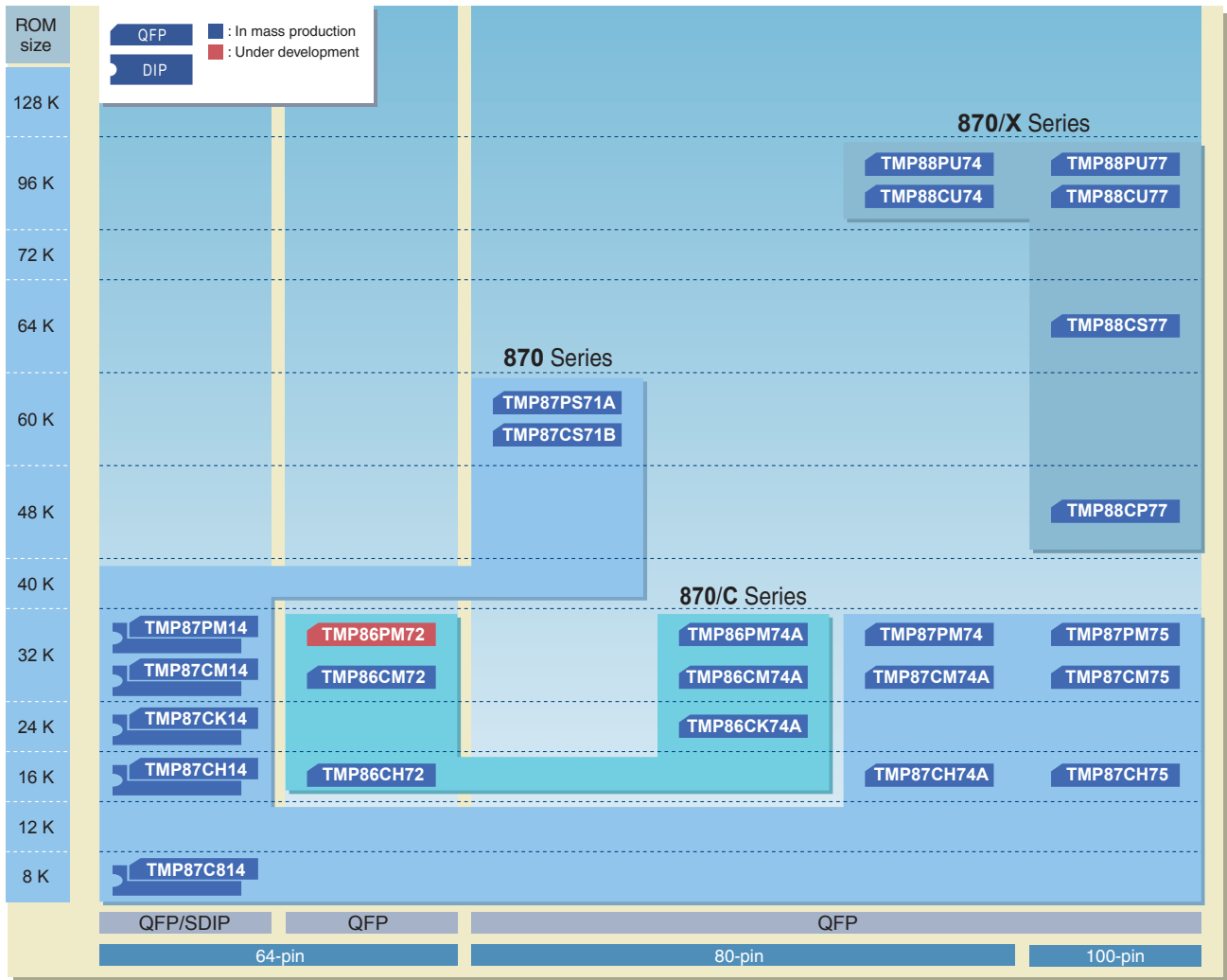
* For details of the products listed above, see the "Part Number List".



Microcontrollers with fluorescent display tube driver

The following microcontrollers incorporate high breakdown voltage output for directly driving a fluorescent display tube and a display circuit for automatically transferring display data to a port. In addition to existing products, such as a VFT driver circuit which can display digits on a segmented display, Toshiba offers a line of products which support automatic display on universal-grid display tubes.

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



8-bit microcontrollers with fluorescent display tube driver

Series Name	Part Number	ROM (bytes)	RAM (bytes)	I/O	VFT Driver(Fluorescent Tube Driver)	Additional Functions	Package
870	TMP87C814NG/FG	8 K	512	55	Maximum breakdown voltage: 40 V on each of 24 pins	<ul style="list-style-type: none"> 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 (14 x 20mm)
	TMP87CH14NG/FG	16 K					
	TMP87CK14NG/FG	24 K	1K				
	TMP87CM14NG/FG	32 K					
870	TMP87CS71BFG	60 K	2 K	73	16 seg. x 16 dig.	<ul style="list-style-type: none"> AD converter input: 6 channels 8-bit SIO: 1 channel High-speed serial output 	QFP80 (14 x 20mm)
	TMP87CH74AFG	16 K	512	71	Maximum breakdown voltage: 40 V on each of 37 pins Programmable grid scan output	<ul style="list-style-type: none"> 8-bit AD converter: 12 channels 8-bit SIO: 2 channels 16-bit timer/counter: 2 channels, 8-bit timer/counter: 2 channels 	QFP100 (14 x 20mm)
	TMP87CM74AFG	32 K	1K				
	TMP87CH75FG	16 K	512	89	Maximum breakdown voltage: 40 V on each of 51 pins Programmable grid scan output	<ul style="list-style-type: none"> 16-bit timer/counter: 2 channels, 8-bit timer/counter: 2 channels 	
	TMP87CM75FG	32 K	1K				
870/C	TMP86CK74AFG	24 K	1K	70	Maximum breakdown voltage: 41 V on each of 37 pins Programmable grid scan output	<ul style="list-style-type: none"> 8-bit AD converter: 8 channels 8-bit SIO: 1 channel 16-bit timer/counter: 2 channels, 8-bit timer/counter: 2 channels 	QFP80 (14 x 20mm)
	TMP86CM74AFG	32 K	2K				
	TMP86CH72FG	16 K	1K				
TMP86CM72FG	32 K						
870/X	TMP88CU74FG	96 K	2K	71	Maximum breakdown voltage: 40 V on each of 37 pins Programmable grid scan output	<ul style="list-style-type: none"> 8-bit SIO: 1 channel 16-bit timer/counter: 2 channels, 8-bit timer/counter: 2 channels 	QFP80 (14 x 20mm)
	TMP88CP77FG	48 K	1K	88	Maximum breakdown voltage: 40 V on each of 53 pins Programmable grid scan output	<ul style="list-style-type: none"> 8-bit AD converter: 12 channels 8-bit SIO: 2 channels 16-bit timer/counter: 3 channels, 8-bit timer/counter: 1 channel 	QFP100 (14 x 20mm)
	TMP88CS77FG	64 K	2K				
	TMP88CU77FG	96 K	3K				

* For details of the products listed above, see the "Part Number List".

Microcontrollers Listed by Function / Application

Microcontrollers with LCD driver

The following microcontrollers contain LCD driver circuitry. Some products also incorporate a voltage booster, enabling stable LCD display even at low operating voltages and realizing low power consumption.

8-/16-bit microcontrollers with LCD driver

ROM size	QFP	DIP	In mass production	Package	Pin
128 K					
64 K					
60 K					
48 K					
32 K					
24 K					
16 K					
8 K					
4 K					

Package	Pin
LQFP44 (10 x 10mm)	44-pin
SDIP64/LQFP (10 x 10mm)	64-pin
LQFP(10 x 10mm)/QFP(14 x 14mm)	64-pin
QFP (14 x 20mm)	80-pin
LQFP (12 x 12mm)	80-pin
QFP (14 x 20mm)	100-pin
LQFP (14 x 14mm)	100-pin
LQFP (16 x 16mm)	144-pin

4-bit microcontrollers with LCD driver

ROM size	QFP	DIP	In mass production	Package	Pin
4 K					
2 K					

Package	Pin
SDIP / QFP	42- / 44-pin



Game machines

Telephones

Remote controls

Audio systems

Air conditioners

Refrigerators

Washing machines

Rice cookers

16-bit microcontrollers with LCD driver

Series Name	Part Number	ROM (bytes)	RAM (bytes)	I/O	LCD Driver	Additional Functions	Power Voltage (V)	Package
900/L	TMP93CS20FG	64 K	2 K	88	40 seg. x 4 com. (On-chip voltage booster)	<ul style="list-style-type: none"> Serial interface: 3 channels 10-bit AD converter: 8 channels 16-bit timer/counter: 4 channels, 8-bit timer/counter: 4 channels 	5V ± 10% 3V ± 10%	LQFP144 (16 x 16 mm)
900/L1	TMP91CW40FG	128 K	4 K	61	40 seg. x 4 com. (Not voltage booster type)	<ul style="list-style-type: none"> Serial interface: 4 channels 10-bit AD converter: 12 channels 16-bit timer/counter: 3 channels, 8-bit timer/counter: 4 channels 	2.7 to 3.6	LQFP100 (14 x 14 mm)
	TMP91FW40FG							

8-bit microcontrollers with LCD driver

Series Name	Part Number	ROM (bytes)	RAM (bytes)	I/O	LCD Driver	Additional Functions	Power Voltage (V)	Package	
870	TMP87CH21CFG/CDFG	16 K	1 K	52	32 seg. X 4 com.	<ul style="list-style-type: none"> 8-bit AD converter: 8 channels 8-bit SIO: 2 channels 16-bit timer/counter: 2 channels, 8-bit timer/counter: 2 channels 	2.7 to 5.5	QFP80 (14 X 20mm)/ LQFP80 (12 X 12mm)	
	TMP87CM21CFG/CDFG	32 K							
	TMP87CP21CFG/CDFG	48 K	2 K	70	40 seg. X 4 com.		2.2 to 5.5	LQFP100 (14 X 14mm)	
	TMP87CM23AFG	32 K							
	TMP87CP23FG	48 K	2 K	69	40 seg. X 4 com. (On-chip voltage booster)		2.7 to 5.5	SDIP64/ LQFP64 (10 X 10mm)	
	TMP87CM24AFG	32 K							
	TMP87CP24AFG	48 K	1 K	43	24 seg. X 4 com.		<ul style="list-style-type: none"> 8-bit AD converter: 5 channels 8-bit UART: 1 channel 18-bit timer/counter: 1 channel, 8-bit timer/counter: 4 channels 	1.8 to 5.5	LQFP44 (10 X 10mm)
	TMP87CH29NG/UG	16 K							
TMP87CK29NG/UG	24 K	32 K	32	23 seg. X 4 com.	<ul style="list-style-type: none"> 8-bit AD converter: 4 channels 8-bit SIO: 1 channel, 8-bit UART: 1 channel 18-bit timer/counter: 1 channel, 8-bit timer/counter: 2 channels 	1.8 to 5.5	LQFP64 (10 X 10mm)/ QFP64 (14 X 14mm)		
TMP87CM29NG/UG	32 K								
870/C	TMP86CH22UG ◊	16 K	512	32	23 seg. X 4 com.	<ul style="list-style-type: none"> 8-bit AD converter: 8 channels 8-bit SIO: 1 channel 18-bit timer/counter: 1 channel, 8-bit timer/counter: 2 channels 	1.8 to 5.5	LQFP64 (10 X 10mm)/ QFP64 (14 X 14mm)	
	TMP86C822UG ◊	8 K							
	TMP86C420UG/FG	4 K	256	39	32 seg. X 4 com. (On-chip voltage booster)	<ul style="list-style-type: none"> 10-bit AD converter: 8 channels 8-bit SIO/UART: 1 channel 18-bit timer/counter: 1 channel, 8-bit timer/counter: 4 channels 	1.8 to 5.5	LQFP64 (10 X 10mm)/ QFP64 (14 X 14mm)	
	TMP86C820UG/FG	8 K							
	TMP86CH21FG	16 K	512	39	32 seg. X 4 com. (On-chip voltage booster)	<ul style="list-style-type: none"> 8-bit AD converter: 8 channels 8-bit SIO: 1 channel 18-bit timer/counter: 1 channel, 8-bit timer/counter: 4 channels 	1.8 to 5.5	LQFP64 (10 X 10mm)/ QFP64 (14 X 14mm)	
	TMP86CH21AUG ◊	16 K							
	TMP86C829BUG/BFG	8 K	32 K	1.5K	39	<ul style="list-style-type: none"> 10-bit AD converter: 8 channels 8-bit SIO/UART: 1 channel 18-bit timer/counter: 1 channel, 8-bit timer/counter: 4 channels 	1.8 to 3.6	LQFP64 (10 X 10mm)/ QFP64 (14 X 14mm)	
	TMP86CH29BUG/BFG	16 K							
	TMP86CM29BUG/BFG	16 K	32 K	1.5K	39	<ul style="list-style-type: none"> 10-bit AD converter: 8 channels 8-bit SIO/UART: 1 channel 18-bit timer/counter: 1 channel, 8-bit timer/counter: 4 channels 	1.8 to 3.6	LQFP64 (10 X 10mm)/ QFP64 (14 X 14mm)	
	TMP86CM29LUG	16 K							
	TMP86FM29UG/FG	32 K	48 K	2 K	48	32 seg. X 4 com.	<ul style="list-style-type: none"> 10-bit AD converter: 8 channels 8-bit SIO: 1 channel, 8-bit UART: 1 channel 18-bit timer/counter: 1 channel, 8-bit timer/counter: 4 channels Multiply-accumulate calculator (MAC) 	1.8 to 5.5	LQFP64 (10 X 10mm)
	TMP86CM23AUG ◊	48 K							
	TMP86CP23AUG ◊	48 K	48 K	2 K	54	24 seg. X 4 com. (On-chip voltage booster)	<ul style="list-style-type: none"> 10-bit AD converter: 8 channels 8-bit SIO: 1 channel, 8-bit SIO/UART: 1 channel 16-bit timer/counter: 2 channels, 8-bit timer/counter: 2 channels Program patch logic 	1.8 to 3.6	LQFP80 (12 X 12mm)
	TMP86FS23UG △	60 K							
	TMP86FP24FG	48 K	48 K	1 K	55	40 seg. X 4 com. (On-chip voltage booster)	<ul style="list-style-type: none"> 10-bit AD converter: 8 channels 8-bit UART: 1 channel, 8-bit SIO: 1 channel 10-bit timer/counter: 1 channel, 8-bit timer/counter: 2 channels 	2.7 to 5.5	QFP80 (14 X 20mm)
	TMP86CM27FG	32 K							
	TMP86CP27AFG	48 K	32 K	2 K	42	60 seg. X 16 com. (On-chip voltage booster)	<ul style="list-style-type: none"> 8-bit AD converter: 8 channels 8-bit SIO/UART: 1 channel, 8-bit SIO: 1 channel 18-bit timer/counter: 1 channel, 8-bit timer/counter: 4 channels 	1.8 to 5.5	QFP100 (14 X 20mm)
	TMP86FS27FG	60 K							
	TMP86CM25FG	32 K	60 K	2 K	42	60 seg. X 16 com. (On-chip voltage booster)	<ul style="list-style-type: none"> 8-bit AD converter: 8 channels 8-bit SIO/UART: 1 channel, 8-bit SIO: 1 channel 18-bit timer/counter: 1 channel, 8-bit timer/counter: 4 channels 	1.8 to 3.6	QFP100 (14 X 20mm)
	TMP86CM25AFG	32 K							
TMP86CS25AFG ◊	60 K	60 K	2 K	62	40 seg. X 4 com. (On-chip voltage booster)	<ul style="list-style-type: none"> 10-bit AD converter: 8 channels 8-bit SIO/UART: 1 channel, 8-bit UART: 1 channel 16-bit timer/counter: 2 channel, 8-bit timer/counter: 4 channels 	2.7 to 5.5	QFP80 (14 X 20mm)/ LQFP80 (12 X 12mm)	
TMP86CS25ADFG ◊	60 K								
TMP86CS28FG/DFG △	60 K	60 K	2 K	62	40 seg. X 4 com. (On-chip voltage booster)	<ul style="list-style-type: none"> 10-bit AD converter: 8 channels 8-bit SIO/UART: 1 channel, 8-bit UART: 1 channel 16-bit timer/counter: 2 channel, 8-bit timer/counter: 4 channels 	2.7 to 5.5	QFP80 (14 X 20mm)/ LQFP80 (12 X 12mm)	
TMP86CS28FG/DFG △	60 K								

◊: Guaranteed over the ambient temperature (Topr) range of -20°C to 85°C at 1.8 V to 2.0 V.

△: Guaranteed over the ambient temperature (Topr) range of -20°C to 85°C at 2.7 V to 3.0 V.

4-bit microcontrollers with LCD driver

Series Name	Part Number	ROM (bytes)	RAM (Nibbles)	I/O	LCD Driver	Additional Functions	Power Voltage (V)	Package
47E	TMP47C222N/F/U	2 K	192	22	20 seg. x 4 com.	<ul style="list-style-type: none"> 8-bit AD converter: 4 channels 8-bit SIO: 1 channel Pulse output: remote control transmission carrier 	2.5 to 5.5	SDIP42/ QFP44 (14 x 14 mm)/ QFP44 (10 x 10 mm)
	TMP47C422N/F/U	4 K	256					

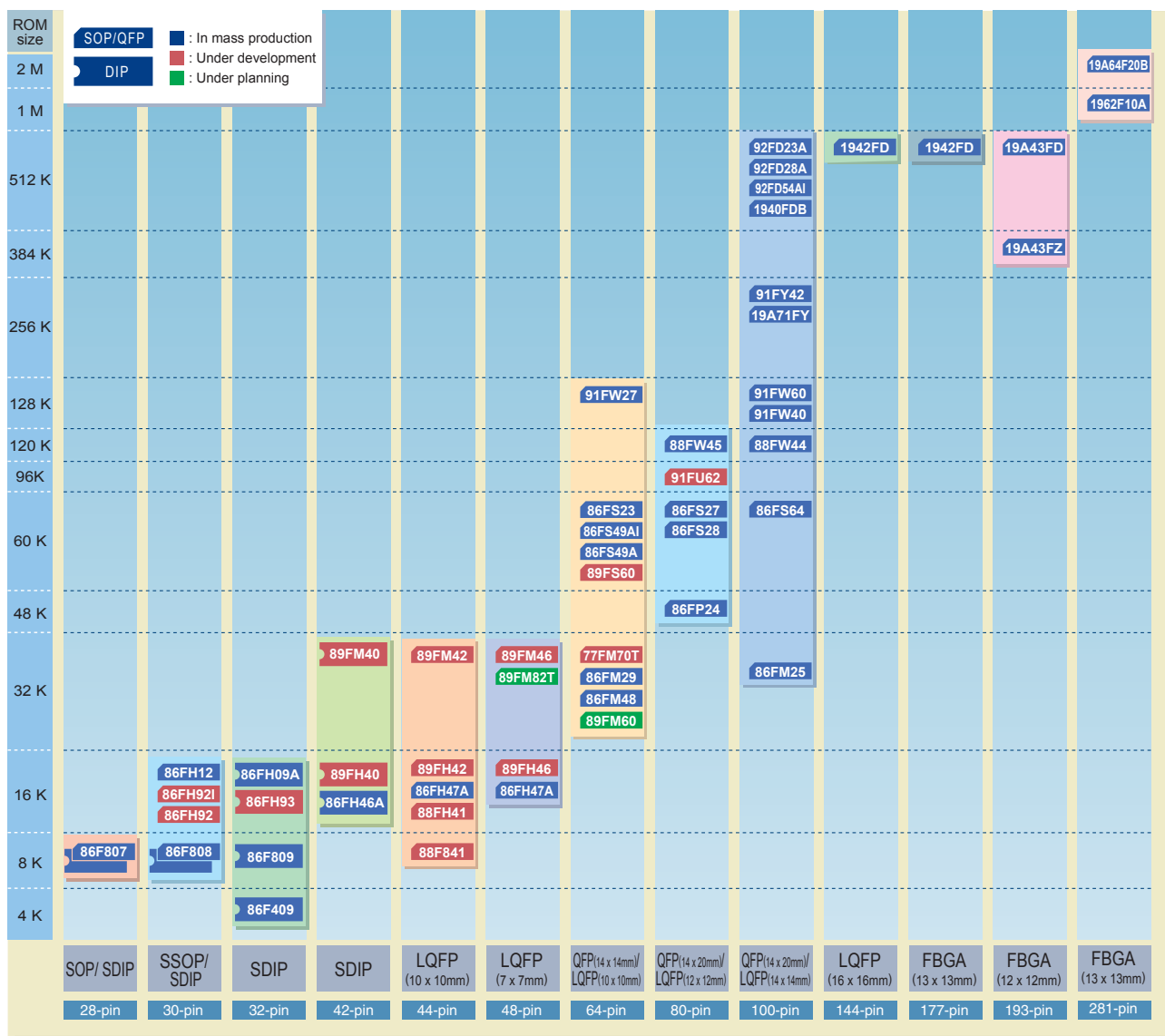
* For details of the products listed above, see the "Part Number List".

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

Microcontrollers Listed by Function / Application

Flash microcontrollers

Flash microcontrollers



Product line-up

Series Name	Part Number	ROM (bytes)	RAM (bytes)	I/O	Additional Functions	Package					
870/C	TMP86F807MG/NG	8K	256	22	<ul style="list-style-type: none"> SEI: 1 channel UART: 1 channel 8-bit AD converter: 6 channels 	<ul style="list-style-type: none"> 16-bit timer/counter: 1 channel 8-bit timer/counter: 2 channels 	SOP28/SDIP28				
	TMP86F808DMG/NG			24		SSOP30/SDIP30					
	TMP86F409NG	4K	512	26	<ul style="list-style-type: none"> SEI: 1 channel UART: 1 channel 10-bit AD converter: 6 channels 	<ul style="list-style-type: none"> 16-bit timer/counter: 1 channel 8-bit timer/counter: 2 channels 	SDIP32				
	TMP86F809NG	8K									
	TMP86FH09ANG										
	TMP86FH12MG	16K						24	<ul style="list-style-type: none"> SIO: 1 channel UART: 1 channel 10-bit AD converter: 8 channels 	<ul style="list-style-type: none"> 16-bit timer/counter: 1 channel 10-bit timer/counter: 1 channel 8-bit timer/counter: 2 channels 	SSOP30
	TMP86FS23UG	60K						48	<ul style="list-style-type: none"> SIO: 1 channel UART: 1 channel 10-bit AD converter: 8 channels 	<ul style="list-style-type: none"> 18-bit timer/counter: 1 channel 8-bit timer/counter: 4 channels 	LQFP64 (10 x 10mm)
	TMP86FP24FG	48K	2K	54	<ul style="list-style-type: none"> SIO: 1 channel SIO/UART: 1 channel 10-bit AD converter: 8 channels 	<ul style="list-style-type: none"> 16-bit timer/counter: 2 channels 8-bit timer/counter: 2 channels 	LQFP80 (12 x 12mm)				
	TMP86FM25FG	32K	60K	42	<ul style="list-style-type: none"> SIO: 1 channel SIO/UART: 1 channel 8-bit AD converter: 8 channels 	<ul style="list-style-type: none"> 18-bit timer/counter: 1 channel 8-bit timer/counter: 4 channels 	QFP100 (14 x 20mm)				
	TMP86FS27FG	1K						55	<ul style="list-style-type: none"> SIO: 1 channel UART: 1 channel 10-bit AD converter: 8 channels 	<ul style="list-style-type: none"> 10-bit timer/counter: 1 channel 8-bit timer/counter: 2 channels 	QFP80 (14 x 20mm)
	TMP86FS28FG/DFG	2K						62	<ul style="list-style-type: none"> UART: 1 channel SIO/UART: 1 channel 10-bit AD converter: 8 channels 	<ul style="list-style-type: none"> 16-bit timer/counter: 2 channels 8-bit timer/counter: 4 channels 	QFP80 (14 x 20mm)/LQFP80 (12 x 12mm)



Electronic dictionaries



PDAs



Game machines



Telephones



Remote controls



Audio systems



Air conditioners



Refrigerators



Washing machines



Rice cookers



Automotive



TVs

Product line-up

Series Name	Part Number	ROM (bytes)	RAM (bytes)	I/O	Additional Functions	Package	
870/C	TMP86FM29UG/FG	32K	1.5K	39	<ul style="list-style-type: none"> ● SIO/UART: 1 channel ● 10-bit AD converter: 8 channels ● 18-bit timer/counter: 1 channel ● 8-bit timer/counter: 4 channels 	LQFP64 (10 x 10mm)/ QFP64 (14 x 14mm)	
	TMP86FH46ANG	16K	512	33	<ul style="list-style-type: none"> ● SIO: 1 channel ● UART: 1 channel ● 10-bit AD converter: 8 channels ● 16-bit timer/counter: 1 channel ● 8-bit timer/counter: 2 channels 	SDIP42	
	TMP86FH47AUG/DUG			35		LQFP44 (10 x 10mm)/ QFP44 (7 x 7mm)	
	TMP86FM48UG/FG	32K	2K	54	<ul style="list-style-type: none"> ● SIO: 1 channel ● SIO/UART: 1 channel ● I²C: 1 channel ● 10-bit AD converter: 16 channels ● 16-bit timer/counter: 2 channels ● 8-bit timer/counter: 2 channels 	LQFP64 (10 x 10mm)/ QFP64 (14 x 14mm)	
	TMP86FS49AUG/FG	60K		56			<ul style="list-style-type: none"> ● SIO: 2 channels ● UART: 2 channels ● I²C: 1 channel ● 10-bit AD converter: 16 channels ● 16-bit timer/counter: 2 channels ● 8-bit timer/counter: 4 channels
	TMP86FS49AIUG/FG			91		QFP100 (14 x 20mm)	
	TMP86FS64FG	16K	512	24	<ul style="list-style-type: none"> ● SEI: 1 channel ● UART: 1 channel ● I²C/UART: 1 channel ● 10-bit AD converter: 6 channels ● 16-bit timer/counter: 1 channel ● 8-bit timer/counter: 2 channels 	SSOP30	
	TMP86FH92DMG**			26		<ul style="list-style-type: none"> ● SEI: 1 channel ● UART: 1 channel ● I²C/UART: 1 channel ● I²C: 1 channel ● 10-bit AD converter: 6 channels ● 16-bit timer/counter: 1 channel ● 8-bit timer/counter: 2 channels 	SDIP32
	TMP86FH93NG**						
870/X	TMP88F841UG**	8K	512	33	<ul style="list-style-type: none"> ● SIO: 1 channel ● UART: 1 channel ● 10-bit AD converter: 8 channels ● 16-bit timer/counter: 2 channels ● 8-bit timer/counter: 2 channels ● Motor control: 1 channel 	LQFP44 (10 x 10mm)	
	TMP88FH41UG**	16K					
	TMP88FW44FG	120K	4K	91	<ul style="list-style-type: none"> ● SIO: 1 channel ● UART: 2 channels ● PWM: 2 channels ● 10-bit AD converter: 16 channels ● 16-bit timer/counter: 2 channels ● 8-bit timer/counter: 4 channels ● Motor control: 2 channels 	QFP100 (14 x 20mm)	
	TMP88FW45FG			71		QFP80 (14 x 20mm)	
870/C1	TMP89FH40NG**	16K	2K	36	<ul style="list-style-type: none"> ● UART: 1 channel ● SIO/UART: 1 channel ● I²C/SIO: 1 channel ● 10-bit AD converter: 8 channels ● 16-bit timer/counter: 2 channels ● 8-bit timer/counter: 4 channels 	SDIP42	
	TMP89FM40NG**	32K					
	TMP89FH42UG**	16K					
	TMP89FM42UG**	32K	3K	56	<ul style="list-style-type: none"> ● UART: 1 channel ● SIO/UART: 2 channels ● I²C/SIO: 1 channel ● 10-bit AD converter: 16 channels ● 16-bit timer/counter: 2 channels ● 8-bit timer/counter: 4 channels 	LQFP64 (10 x 10mm)/ QFP64 (14 x 14mm)	
	TMP89FH46DUG**	16K					
	TMP89FM46DUG**	32K	1.5K	39	<ul style="list-style-type: none"> ● SIO/UART: 1 channel ● SEI/UART: 1 channel ● 10-bit AD converter: 8 channels ● 16-bit timer/counter: 2 channels ● 8-bit timer/counter: 4 channels ● Motor control: 1 channel 	LQFP48 (7 x 7mm)	
	TMP89FM60UG/FG++	60K					
TMP89FS60UG/FG**	32K						
770	TMP77FM70TUG**	32K	1K	18	<ul style="list-style-type: none"> ● SIO/UART: 2 channels ● 10-bit AD converter: 8 channels ● 16-bit timer/counter: 2 channels ● Motor control: 1 channel 	LQFP64 (10 x 10mm)	
900/L1	TMP91FW27UG	128K	12K	53	<ul style="list-style-type: none"> ● SIO/UART: 2 channels ● I²C bus/SIO: 1 channel ● 10-bit AD converter: 4 channels ● 8-bit timer/counter: 6 channels ● 16-bit timer/counter: 1 channel 	LQFP64 (10 x 10mm)	
	TMP91FW40FG			4K	61		<ul style="list-style-type: none"> ● SIO/UART: 4 channels ● 10-bit AD converter: 4 channels ● LCD driver: 40 channels ● 8-bit timer/counter: 4 channels ● 16-bit timer/counter: 3 channels
	TMP91FY42FG	256K	16K	81	<ul style="list-style-type: none"> ● SIO/UART: 2 channels ● I²C bus/SIO: 1 channel ● 10-bit AD converter: 8 channels ● 8-bit timer/counter: 8 channels ● 16-bit timer/counter: 2 channels 	LQFP100 (14 x 14mm)	
	TMP91FW60FG/DFG	128K	8K	83	<ul style="list-style-type: none"> ● SIO/UART: 3 channels ● I²C bus: 2 channels ● 10-bit AD converter: 16 channels ● 8-bit timer/counter: 6 channels ● 16-bit timer/counter: 5 channels 	LQFP100 (14 x 14mm)/ QFP100 (14 x 20mm)	
	TMP91FU62FG/DFG**	96K	4K	69	<ul style="list-style-type: none"> ● SIO/UART: 3 channels ● I²C bus: 1 channel ● 10-bit AD converter: 16 channels ● 8-bit timer/counter: 4 channels ● 16-bit timer/counter: 4 channels 	LQFP80 (12 x 12mm)/ QFP80 (14 x 20mm)	
900/H1	TMP92FD23AFG/DFG	512K	32K	84	<ul style="list-style-type: none"> ● High-speed SIO: 1 channel ● SIO/UART: 3 channels ● I²C bus/SIO: 2 channels ● 10-bit AD converter: 12 channels ● 8-bit timer/counter: 6 channels ● 16-bit timer/counter: 2 channels 	LQFP100 (14 x 14mm)/ QFP100 (14 x 20mm)	
	TMP92FD28AFG/DFG			70	<ul style="list-style-type: none"> ● USB HOST ● SPI (SD card) ● High-speed SIO: 1 channel ● SIO/UART: 2 channels ● I²C bus/SIO: 2 channels ● 8-bit timer/counter: 6 channels ● 16-bit timer/counter: 2 channels 		
	TMP92FD54AIFG			68	<ul style="list-style-type: none"> ● CAN (16 mailboxes): 1 channel ● SEI: 1 channel ● SIO/UART: 2 channels ● I²C/SIO: 3 channels ● 10-bit AD converter: 12 channels ● 8-bit timer/counter: 8 channels ● 16-bit timer/counter: 2 channels 	LQFP100 (14 x 14mm)	
TX19	TMP1940FDBFG	512K	16K	77	<ul style="list-style-type: none"> ● DMA controller: 4 channels ● Serial interface: 5 channels ● 10-bit AD converter: 8 channels ● 16-bit timer/counter: 8 channels 	LQFP144 (16 x 16mm)	
	TMP1942FDUG			20K	108		<ul style="list-style-type: none"> ● DMA controller: 4 channels ● Serial interface: 6 channels ● 10-bit DA converter: 3 channels ● 10-bit AD converter: 16 channels ● 8-bit timer/counter: 12 channels ● 16-bit timer/counter: 14 channels
	TMP1942FDXBG	1024K	40K			202	<ul style="list-style-type: none"> ● DMA controller: 8 channels ● Serial interface: 8 channels ● 10-bit AD converter: 24 channels ● 8-bit timer/counter: 12 channels ● 16-bit timer/counter: 8 channels ● 32-bit timer output compare: 8 channels ● 32-bit timer input capture: 8 channels
	TMP1962F10AXBG						
TX19A	TMP19A43FDXBG	512K	24K	143	<ul style="list-style-type: none"> ● DMA controller: 8 channels ● Serial interface: 7 channels ● 10-bit AD converter: 16 channels ● 8-bit DA converter: 2 channels ● 16-bit timer/counter: 16 channels ● 32-bit timer output compare: 8 channels ● 32-bit timer input capture: 4 channels 	FBGA193 (12 x 12mm)	
	TMP19A43FZXBG	384K	20K				
	TMP19A64F20BXXBG	2048K	64K	209	<ul style="list-style-type: none"> ● DMA controller: 8 channels ● Serial interface: 8 channels ● 10-bit AD converter: 24 channels ● 16-bit timer/counter: 11 channels ● 32-bit timer output compare: 10 channels ● 32-bit timer input capture: 4 channels 	FBGA281 (13 x 13mm)	
	TMP19A71FYUG	256K	10K	75	<ul style="list-style-type: none"> ● DMA controller: 8 channels ● Serial interface: 4 channels ● 10-bit AD converter: 19 channels ● 16-bit timer/counter: 4 channels ● Motor control: 2 channels 	LQFP100 (14 x 14mm)	
	TMP19A71FYFG					QFP100 (14 x 20mm)	

* For details of the products listed above, see the "Part Number List".

** Under development

++ Under planning

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



Electronic dictionaries



PDAs



Game machines



Telephones



Remote controls



Audio systems



Air conditioners



Refrigerators



Washing machines



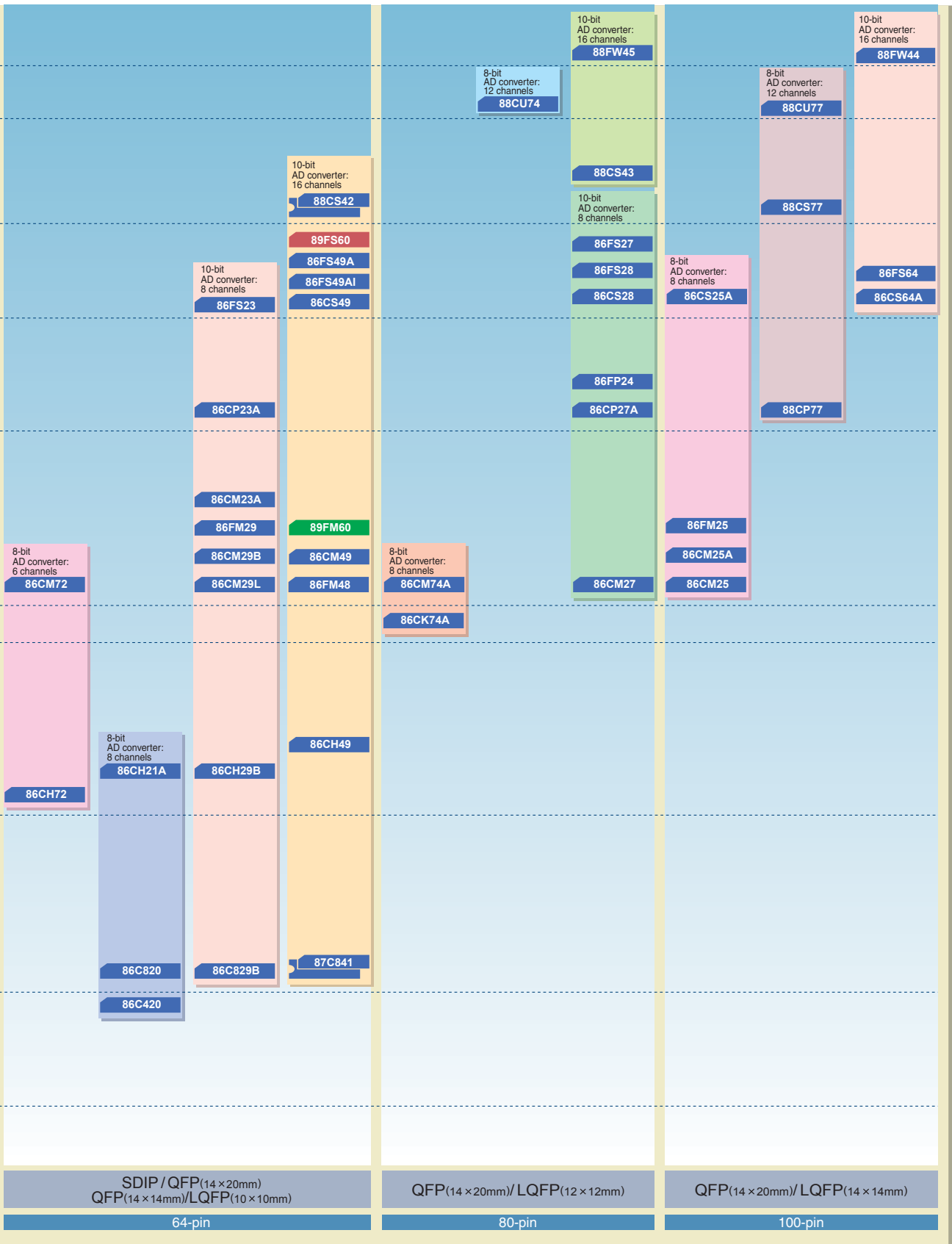
Rice cookers



Automotive



TVs



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

Microcontrollers Listed by Function / Application

16-/32-bit microcontrollers with AD converters

ROM size	QFP		QFP		QFP		QFP		QFP		QFP	
	: In mass production		: Under development									
2 M												
1.5 M												
1 M												
512 K												10-bit AD converter: 8 channels 1940FDB
384 K												
256 K											10-bit AD converter: 19 channels 19A71FY 19A71CY 1940CYA	10-bit AD converter: 8 channels 91CY22 91FY42 91CY22I 91CY28
128 K												91CW11 91CW12 91CW12A 91CW28 93CW40D 93CW46A 95CW64
96 K												10-bit AD converter: 4 channels 91FW27 91CU27 91CU27R
96 K												10-bit AD converter: 16 channels 91FU62 91FU62
96 K												10-bit AD converter: 8 channels 93CW44 91CW18A
64 K	10-bit AD converter: 4 channels 93CS36		10-bit AD converter: 6 channels 93CS32		10-bit AD converter: 8 channels 93CS44		10-bit AD converter: 16 channels 93CU44 91FU62		10-bit AD converter: 12 channels 91CW18A		10-bit AD converter: 5 channels 93CS42A	91CU10 93CS40 95CS64
48 K												91CP27
32 K												10-bit AD converter: 8 channels 77FM70T 77CM70T
32 K												96CM40 93CM40
24 K												10-bit AD converter: 4 channels 91CK27
8 K												
N/A												1941A 91C824 91C829 91C025 91C630 92CM22 93CS41 93CW41 95C265 95CW65
												6-bit AD converter: 4 channels 96C031Z 93CS45 96C041B 96C141B 95C061B
	LQFP (10 x 10mm)	LQFP (10 x 10mm)	QFP (14 x 14mm)	QFP (14 x 20mm)	LQFP (12 x 12mm)	QFP (14 x 20mm)						LQFP (14 x 14mm)
	44-pin		64-pin			80-pin						100-pin

* For details of the products listed above, see the "Part Number List".

Applications



Electronic dictionaries



PDA's



Game machines



Telephones



Remote controls



Audio systems



Air conditioners



Refrigerators



Washing machines



Rice cookers



Automotive

										10-bit AD converter: 24 channels 19A64F20B 19A64C1D 1962F10A 1962C10B
10-bit AD converter: 12 channels 92FD54AI 92CD54I 92FD23A 92CD23A	10-bit AD converter: 12 channels 92FD23A 92CD23A		10-bit AD converter: 16 channels 1942FD 1942CZ 1942CY					10-bit AD converter: 16 channels 19A43FD 19A43CD 19A43FZ 19A43CZ		
10-bit AD converter: 16 channels 91FW60 91CW60	10-bit AD converter: 16 channels 91FW60 91CW60									
10-bit AD converter: 4 channels 91FW40 91CW40										
			10-bit AD converter: 8 channels 93CS20							
			91C820A							
			10-bit AD converter: 12 channels 92CM27							
			10-bit AD converter: 4 channels 92CA25 92CH21							
		10-bit AD converter: 8 channels 91C815	10-bit AD converter: 5 channels 92C820	10-bit AD converter: 8 channels 94C251A 95C063	10-bit AD converter: 8 channels 94C241C	10-bit AD converter: 6 channels 92CF29A			10-bit AD converter: 6 channels 92CF26A 92CZ26A	
LQFP (14 x 14 mm)	QFP (14 x 20mm)	TQFP (14 x 14mm)	LQFP (16 x 16mm)	LQFP (20 x 20mm)	QFP (28 x 28mm)	LQFP (20 x 20mm)	FBGA (12 x 12mm)	FBGA (15 x 15mm)	FBGA (13 x 13mm)	
100-pin		128-pin	144-pin		160-pin	176-pin	193-pin	228-pin	281-pin	

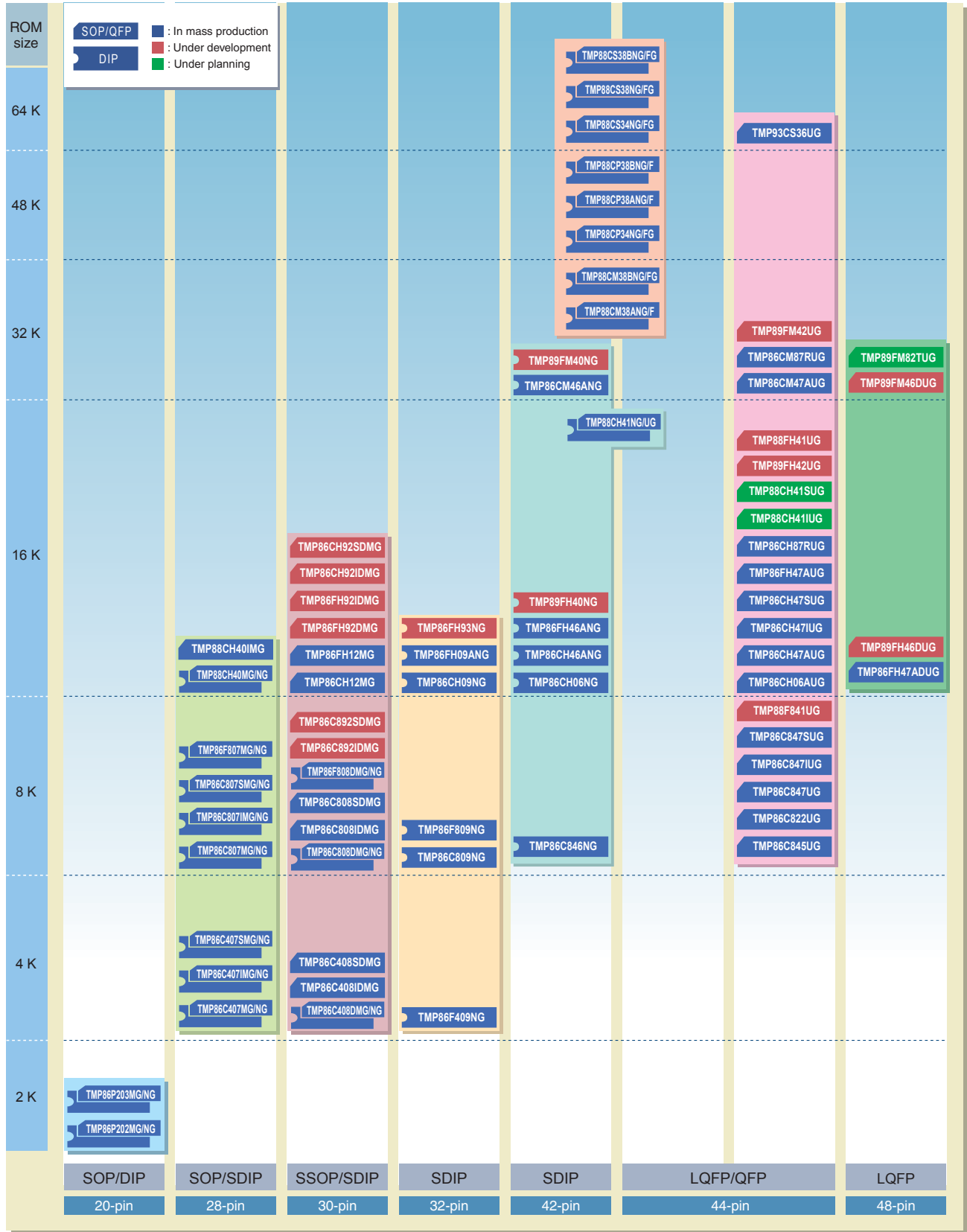
* Some of the flash memories use the SuperFlash® technology under the license of Silicon Storage Technology, Inc. SuperFlash® is a registered trademark of Silicon Storage Technology, Inc.

Microcontrollers Listed by Function / Application

General-purpose microcontrollers in compact packages

This comprehensive product line comes in compact packages, including SOPs, SSOPs and 7 mm x 7 mm 48-pin flat packages.

General-purpose microcontrollers in compact packages





Electronic dictionaries



PDAs



Game machines



Telephones



Remote controls



Audio systems



Air conditioners



Refrigerators



Washing machines



Rice cookers



Automotive



TVs

8-bit microcontrollers (TLCS-870/C Series)

Series Name	Part Number	Flash	ROM (bytes)	RAM (bytes)	I/O	Compact Package	Additional Functions	Supply Voltage (V)	Version with OTP/Flash
870/C	TMP86P202MG		2 K	128	14	SOP20	<ul style="list-style-type: none"> ● 8-bit AD converter: 4 channels ● 8-bit timer/counter: 2 channels 	3.3 to 5.5	—
	TMP86P202PG	DIP20							
	TMP86P203MG	SOP20							
	TMP86P203PG	DIP20							
	TMP86CH06NG		16 K	512	35	SDIP42	<ul style="list-style-type: none"> ● 8-bit SIO/UART (switchable): 1 channel ● UART: 1 channel ● 16-bit timer/counter: 1 channel, 8-bit timer/counter: 2 channels 	1.8 to 5.5	TMP86PH06NG
	TMP86CH06AUG ◊	LQFP44 (10 x 10mm)				TMP86PH06UG			
	TMP86C407MG		4 K	256	22	SOP28	<ul style="list-style-type: none"> ● SEI ● UART: 1 channel ● 8-bit AD converter: 6 channels ● 16-bit timer/counter: 1 channel, 8-bit timer/counter: 2 channels 	2.7 to 5.5	TMP86P807MG
	TMP86C407NG	SDIP28				TMP86F807MG			
	TMP86C407IMG	SOP28				TMP86P807NG			
	TMP86C407ING	SDIP28				TMP86F807NG			
	TMP86C407SMG ☆	SOP28				TMP86P807MG			
	TMP86C407SNG ☆	SDIP28				TMP86F807NG			
	TMP86C807MG	SOP28				TMP86P807MG			
	TMP86C807NG	SDIP28				TMP86F807NG			
	TMP86C807IMG	SOP28				TMP86P807MG			
	TMP86C807ING	SDIP28				TMP86F807NG			
	TMP86C807SMG ☆	SOP28	TMP86P807MG						
	TMP86C807SNG ☆	SDIP28	TMP86F807NG						
	TMP86F807MG	●	—						
	TMP86F807NG	●	—						
	TMP86C408DMG		4 K	24	24	SSOP30	<ul style="list-style-type: none"> ● SEI ● UART: 1 channel ● 10-bit AD converter: 6 channels ● 16-bit timer/counter: 1 channel, 8-bit timer/counter: 2 channels 	2.7 to 5.5	TMP86P808DMG
	TMP86C408NG	SDIP30				TMP86F808DMG			
	TMP86C408IDMG	SSOP30				TMP86P808NG			
	TMP86C408SDMG ☆	SDIP30				TMP86F808NG			
	TMP86C808DMG		8 K	24	24	SSOP30	<ul style="list-style-type: none"> ● SEI ● UART: 1 channel ● 10-bit AD converter: 6 channels ● 16-bit timer/counter: 1 channel, 8-bit timer/counter: 2 channels 	2.7 to 5.5	TMP86P808DMG
	TMP86C808NG	SDIP30				TMP86F808DMG			
	TMP86C808IDMG	SSOP30				TMP86P808NG			
	TMP86C808SDMG ☆	SDIP30				TMP86F808NG			
	TMP86F808DMG	●	—						
	TMP86F808NG	●	—						
	TMP86F409NG △	●	4 K	26	26	SDIP32	<ul style="list-style-type: none"> ● SEI ● UART: 1 channel ● 10-bit AD converter: 6 channels ● 16-bit timer/counter: 1 channel, 8-bit timer/counter: 2 channels 	2.7 to 5.5	TMP86P809ANG △
	TMP86C809NG	●	8 K			TMP86F809ANG △			
	TMP86F809NG △	●	—			—			
	TMP86FH09ANG △	●	—			TMP86FH09ANG △			
	TMP86CH12MG		16 K	512	24	SSOP30	<ul style="list-style-type: none"> ● 8-bit SIO: 1 channel ● UART: 1 channel ● 10-bit AD converter: 8 channels ● 16-bit timer/counter: 1 channel, 10-bit timer/counter: 1 channel, 8-bit timer/counter: 2 channels 	1.8 to 5.5	TMP86FH12MG △
	TMP86FH12MG △	●	—						
	TMP86C822UG ◊		8 K	16 K	33	LQFP44 (10 x 10mm)	<ul style="list-style-type: none"> ● LCD ● 8-bit SIO: 1 channel ● UART: 1 channel ● 8-bit AD converter: 4 channels ● 18-bit timer/counter: 1 channel, 8-bit timer/counter: 2 channels 	1.8 to 5.5	TMP86PH22UG ◊
	TMP86CH22UG ◊		—						
	TMP86C845UG		8 K	256	35		<ul style="list-style-type: none"> ● 8-bit SIO: 1 channel ● 10-bit AD converter: 8 channels ● 8-bit timer/counter: 2 channels 	2.7 to 5.5	TMP86PM47AUG
	TMP86C846NG		16 K	512	33	SDIP42	<ul style="list-style-type: none"> ● 8-bit SIO: 1 channel ● UART: 1 channel ● 10-bit AD converter: 8 channels ● 16-bit timer/counter: 1 channel, 8-bit timer/counter: 2 channels 	1.8 to 5.5	TMP86PH46NG ◊
TMP86CH46ANG ◊		TMP86PM46NG							
TMP86FH46ANG △	●	TMP86FH46ANG △							
TMP86CM46ANG		32 K	1 K			<ul style="list-style-type: none"> ● 8-bit SIO: 1 channel ● UART: 1 channel ● 10-bit AD converter: 8 channels ● 16-bit timer/counter: 1 channel, 8-bit timer/counter: 2 channels 	1.8 to 5.5	TMP86PM46NG	
TMP86C847UG		8 K	512	35	LQFP44 (10 x 10mm)	<ul style="list-style-type: none"> ● 8-bit SIO: 1 channel ● UART: 1 channel ● 10-bit AD converter: 8 channels ● 16-bit timer/counter: 1 channel, 8-bit timer/counter: 2 channels 	1.8 to 5.5	TMP86PM47AUG	
TMP86C847IUG								TMP86PH47UG ◊	
TMP86C847SUG ☆								TMP86FH47AUG △	
TMP86CH47AUG ◊		16 K				<ul style="list-style-type: none"> ● 8-bit SIO: 1 channel ● UART: 1 channel ● 10-bit AD converter: 8 channels ● 16-bit timer/counter: 1 channel, 8-bit timer/counter: 2 channels 	1.8 to 5.5	TMP86PM47AUG	
								TMP86PH47UG ◊	
								TMP86FH47AUG △	
								TMP86FH47ADUG △	

◊: Guaranteed over the ambient temperature (Topr) range of -20°C to 85°C at 1.8 V to 2.0 V.
 △: Guaranteed over the ambient temperature (Topr) range of -20°C to 85°C at 2.7 V to 3.0 V.
 ☆: Guaranteed over the ambient temperature (Topr) range of -40°C to 125°C.



8-bit microcontrollers (TLCS-870/C Series, TLCS-870/X Series, TLCS-870/C1 Series)

Series Name	Part Number	Flash	ROM (bytes)	RAM (bytes)	I/O	Compact Package	Additional Functions	Supply Voltage (V)	Version with OTP/Flash							
870/C	TMP86CH47IUG		16 K	512	35	LQFP44 (10 x 10mm)	<ul style="list-style-type: none"> 8-bit SIO: 1 channel UART: 1 channel 10-bit AD converter: 8 channels 16-bit timer/counter: 1 channel, 8-bit timer/counter: 2 channels 	2.7 to 5.5	TMP86PM47AUG TMP86PH47IUG TMP86FH47AUG							
	TMP86CH47SUG ☆															
	TMP86FH47AUG △	●														
		TMP86FH47ADUG △	●				LQFP48 (7 x 7mm)		1.8 to 5.5	TMP86PM47AUG						
		TMP86CM47AUG		32 K	1 K	35	LQFP44 (10 x 10mm)	<ul style="list-style-type: none"> CAN SEI UART: 1 channel 10-bit AD converter: 14 channels 16-bit timer/counter: 1 channel, 8-bit timer/counter: 2 channels 	4.5 to 5.5	TMP86PM87RUG						
		TMP86CH87RUG		16 K												
		TMP86CM87RUG		32 K												
		TMP86C892IDMG**		8 K	16 K	512	SSOP30	<ul style="list-style-type: none"> SEI UART: 1 channel I²C/UART (switchable) 10-bit AD converter: 6 channels 16-bit timer/counter: 1 channel, 8-bit timer/counter: 2 channels 	2.7 to 5.5	TMP86FH92IDMG**						
		TMP86C892SDMG**☆														
		TMP86CH92IDMG**														
		TMP86CH92SDMG**☆														
		TMP86FH92DMG**	●													
	TMP86FH92IDMG**	●										3.0 to 5.5				
	TMP86FH93NG**	●								26	SDIP32		2.7 to 5.5			
870/X	TMP88CP34FG		48 K	1.5 K	33	QFP44 (14 x 14mm)	<ul style="list-style-type: none"> I²C: 1 channel PWM: 4 channels 8-bit AD converter: 6 channels 16-bit timer/counter: 2 channels, 8-bit timer/counter: 2 channels Remote control detection Program patch logic 	4.5 to 5.5	TMP88PS34FG							
		TMP88CP34NG											TMP88PS34NG			
		TMP88CS34FG				64 K							TMP88PS34FG			
		TMP88CS34NG											TMP88PS34NG			
		TMP88CM38AF				32 K			33	QFP44 (14 x 14mm)	<ul style="list-style-type: none"> I²C: 1 channel PWM: 10 channels 8-bit AD converter: 6 channels 16-bit timer/counter: 2 channels, 8-bit timer/counter: 2 channels Remote control detection Program patch logic 	4.5 to 5.5	TMP88PS38FG			
		TMP88CM38ANG														TMP88PS38NG
		TMP88CM38BFG														TMP88PS38BFG
		TMP88CM38BNG														TMP88PS38BNG
		TMP88CP38AF				48 K			33	QFP44 (14 x 14mm)	<ul style="list-style-type: none"> I²C: 1 channel PWM: 10 channels 8-bit AD converter: 6 channels 16-bit timer/counter: 2 channels, 8-bit timer/counter: 2 channels Remote control detection Program patch logic 	4.5 to 5.5	TMP88PS38FG			
		TMP88CP38ANG														TMP88PS38NG
		TMP88CP38BFG														TMP88PS38BFG
		TMP88CP38BNG														TMP88PS38BNG
		TMP88CS38FG		64 K	2 K	QFP44 (14 x 14mm)	<ul style="list-style-type: none"> I²C: 1 channel PWM: 10 channels 8-bit AD converter: 6 channels 16-bit timer/counter: 2 channels, 8-bit timer/counter: 2 channels Remote control detection Program patch logic 	4.5 to 5.5	TMP88PS38FG							
		TMP88CS38NG										TMP88PS38NG				
		TMP88CS38BFG										TMP88PS38BFG				
		TMP88CS38BNG										TMP88PS38BNG				
		TMP88CH40MG		16 K	512	SOP28	<ul style="list-style-type: none"> 8-bit SIO: 1 channel UART: 1 channel 10-bit AD converter: 4 channels 16-bit timer/counter: 1 channel, 8-bit timer/counter: 2 channels Motor control 	2.7 to 5.5	TMP88PH40MG							
		TMP88CH40NG										TMP88PH40NG				
		TMP88CH40IMG										TMP88PH40MG				
		TMP88CH41UG										TMP88PH41UG				
		TMP88CH41NG		8 K	33	LQFP44 (10 x 10mm)	<ul style="list-style-type: none"> 8-bit SIO: 1 channel UART: 1 channel 10-bit AD converter: 8 channels 16-bit timer/counter: 2 channels, 8-bit timer/counter: 2 channels Motor control 	2.7 to 5.5	TMP88PH41NG							
		TMP88CH41IUG++										TMP88PH41UG				
		TMP88CH41SUG++☆														
		TMP88F841UG**	●													
	TMP88FH41UG**	●	16 K													
870/C1	TMP89FH40NG**	●	16 K	2 K	36	SDIP42	<ul style="list-style-type: none"> SIO/UART: 1 channel UART: 1 channel I²C/SIO: 1 channel * Only one SIO channel can be used at a time. 16-bit timer/counter: 2 channels, 8-bit timer/counter: 4 channels 10-bit AD converter: 8 channels 	2.7 to 5.5								
	TMP89FM40NG**	●	32 K													
	TMP89FH42UG**	●	16 K													
	TMP89FM42UG**	●	32 K													
	TMP89FH46DUG**	●	16 K													
		TMP89FM46DUG**	●													
	TMP89FM82TUG++	●	32 K	1.5 K	39	LQFP48 (7 x 7mm)	<ul style="list-style-type: none"> SIO/UART: 1 channel 8-bit SEI/UART: 1 channel 16-bit timer/counter: 2 channels, 8-bit timer/counter: 4 channels 10-bit AD converter: 8 channels Motor control 	4.5 to 5.5								

◇: Guaranteed over the ambient temperature (T_{opr}) range of -20°C to 85°C at 1.8 V to 2.0 V.
 △: Guaranteed over the ambient temperature (T_{opr}) range of -20°C to 85°C at 2.7 V to 3.0 V.
 ☆: Guaranteed over the ambient temperature (T_{opr}) range of -40°C to 125°C.

** : Under development
 ++ : Under planning

16-bit microcontrollers (TLCS-900/L Series)

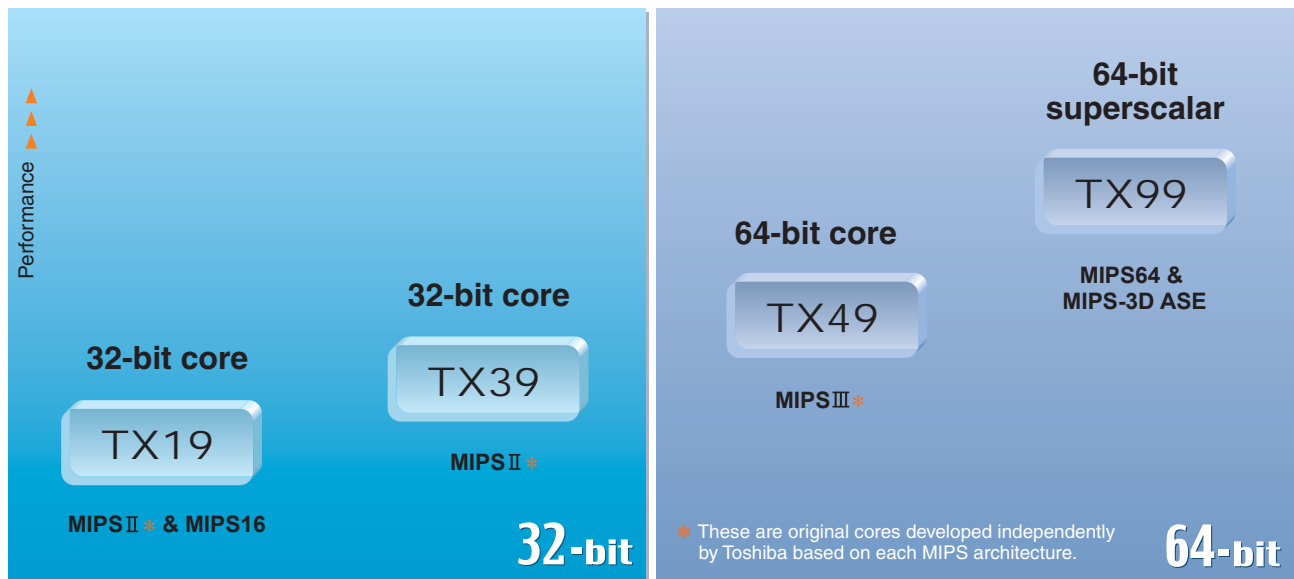
Series Name	Part Number	Flash	ROM (bytes)	RAM (bytes)	I/O	Compact Package	Additional Functions	Supply Voltage (V)	Version with OTP/Flash
900/L	TMP93CS36UG		64 K	2 K	33	LQFP44 (10 x 10mm)	<ul style="list-style-type: none"> SIO/UART: 2 channels 10-bit AD converter: 4 channels 16-bit timer/counter: 2 channels, 8-bit timer/counter: 4 channels clock gear 	5V ± 10%	



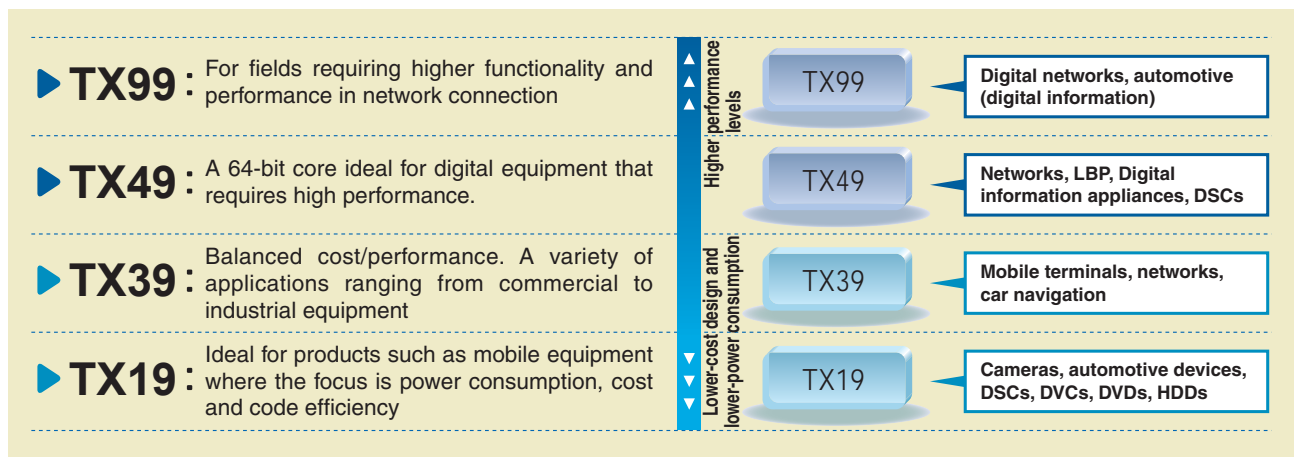
RISC stands for **Reduced Instruction Set Computer**. The smaller, fixed-length instruction set of a RISC processor allows fast program execution. Compared to the conventional **CISC (Complex Instruction Set Computer)**, the RISC processor's simplified circuit structure offers attractive features such as increased execution speed and reduced power consumption.

Toshiba has adopted the **RISC** processor technology developed by MIPS Technologies, Inc. In addition to the 32-bit processor **TX39** Family for embedded use, Toshiba has also developed the **TX19** Family of processors, featuring an additional 16-bit instruction set, and the 64-bit **TX49** and **TX99** Family of processors for embedded use. The **TX19**, **TX39**, **TX49** and **TX99** families serve as CPU cores, which, together with megacells for peripherals, offer solutions for the implementation of ASICs.

Seamless core
TX System RISC line-up



A complete line-up of products, ranging from low-power-consumption devices to high-speed-processing devices, to suit a wide variety of applications



TX99 Family

The **TX99** Family of **RISC** microprocessors is based on the MIPS64™ microarchitecture of MIPS Technologies, Inc. (U.S.A.) These microprocessors have a 64-bit superscalar architecture developed jointly by MIPS and Toshiba. MIPS64™ has the highest performance in the industry, enabling simultaneous execution of two instructions. By using this architecture in semiconductors and systems, it is possible to achieve high-speed data processing in fields such as automotive (digital information), OA, home servers, digital information appliances and networks where cost and power consumption are the top priority.

TX99 Processor Core Features

- Based on MIPS 25Kf high-end RISC core
 - Instruction set: MIPS 64™ with MIPS-3D™ ASE
- Employs dual issue superscalar pipeline (7-stage)
- Core operation frequency: 533 MHz/600 MHz
- Equipped with 32-Kbyte instruction cache and 32-Kbyte data cache
 - employs 4-way set-associative system
- Level 2 cache of up to 256 Kbytes can be installed (optional)
- Built-in single/double precision floating point coprocessor
- SOC I/F with a high bus band width (12.8 Gbytes/s)
 - with numerous bus frequency division ratios for core vs. SOC I/F

Can be used as a CPU core for custom SoC

- **TX99/H4**: 90-nm process technology
- Complete development environment

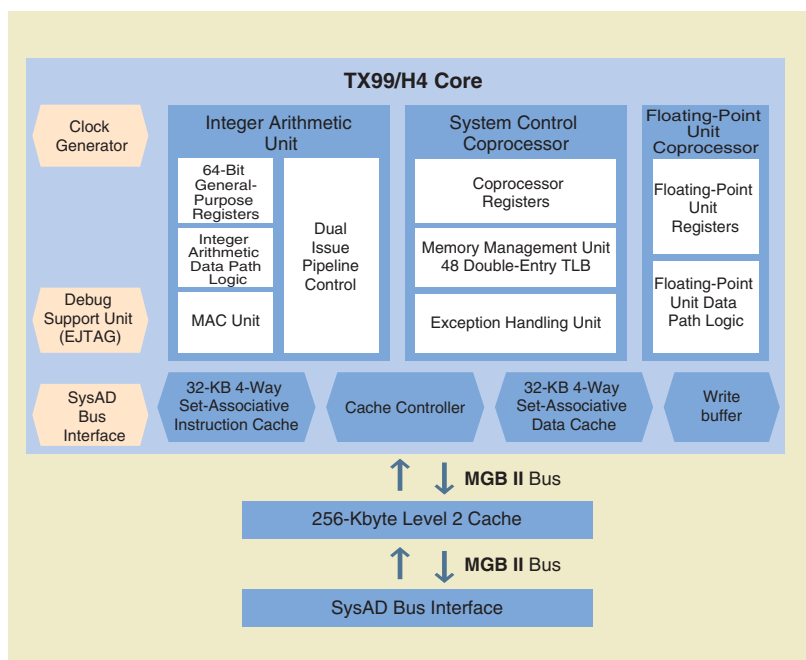
Superscalar Architecture

TX9956XBG-533/600

Under development

64-bit RISC microprocessor using a Superscalar architecture

The **TX9956XBG** is equipped with a **TX99/H4** core that uses a 90 nm process to enable 533 or 600 MHz operation. This processor has a built-in floating-point unit (FPU) and SysAD bus interface, and is useful in a wide range of applications areas including LBP and set-top boxes. It contains 32-Kbyte instruction cache and 32-Kbyte data cache, as well as large secondary cache of 256 Kbytes.



- 64-bit Superscalar equipped with **TX99/H4** core
- On-chip caching
 - Four-way set-associative caches
 - Instruction cache: 32 Kbytes
 - Data cache: 32 Kbytes
 - Level 2 cache: 256 Kbytes
- External bus (SysAD bus) 64-/32-bit
- Single-/double-precision FPU
- Clock generator (CG)
- Low power consumption mode
- Built-in debug support unit (DSU)
- Maximum operating frequency:
 - Core: 533 MHz/600 MHz
 - External bus: 133 MHz
- I/O operating voltage: 2.5 V or 3.3 V
- Internal operating voltage: 1.25 V
- Package:
 - 272-pin PBGA, 27 mm x 27 mm,
 - 1.27-mm pitch (with 16 thermal balls)

TX49 Family

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 MIPS Technologies, Inc. The customer can implement a custom SoC using the **TX49 Family** cores in conjunction with general-purpose ASSP products.

64-bit RISC architecture

- R4000A architecture
 - Upward-compatible instruction set including MIPS I, MIPS II and MIPS III instruction set architectures (ISAs)
- **TX49/H2**: Internal operating frequency: 200 MHz
- **TX49/H3**: Internal operating frequency: 300 MHz/333 MHz
- **TX49/H4**: Internal operating frequency: 400 MHz
- **TX49/L3**: Internal operating frequency: 200 MHz
- **TX49/L4**: Internal operating frequency: 333 MHz
- **TX49/W4**: Internal operating frequency: 400 MHz
 - Level 2 cache of up to 512 Kbytes can be installed for each instruction and data (optional)
- Non-blocking load function
 - The instructions which follow the instruction currently being executed are executed while the cache is being refilled.
- DSP function
- Thirty-two 64-bit general-purpose registers
- Optimized 5-stage pipelining
- Single- or double-precision floating-point unit (FPU) (**TX49/H2**, **TX49/H3**, **TX49/H4** and **TX49/W4** core)
- Debug support unit (DSU)
 - Supports EJTAG.

Low-power consumption design

- Low-power consumption modes (Doze/Halt)

Built-in high-capacity primary cache

- Instruction cache: 32 Kbytes
 - 4-way set-associative
 - Lock function supported
- Data cache: 32 Kbytes
 - 4-way set-associative
 - Lock function supported
 - Write-back/write-through (every page)

Can be used as a CPU core for custom SoC

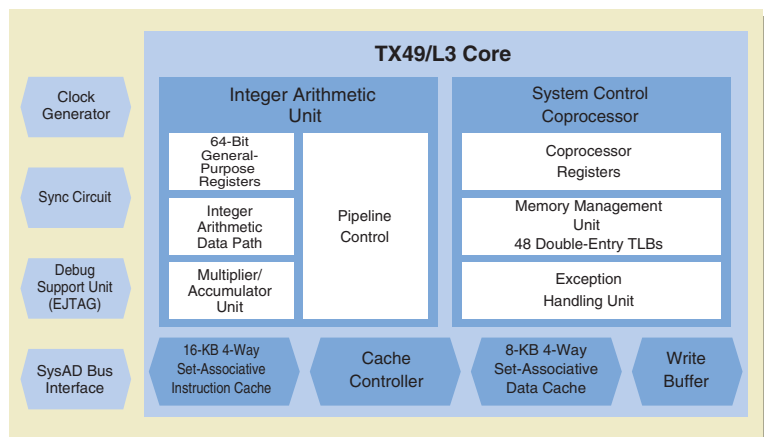
- **TX49/H2**: 0.18- μ m process technology
- **TX49/H3**, **TX49/L3**: 0.13- μ m process technology
- **TX49/H4**, **TX49/L4**, **TX49/W4**: 90-nm process technology
- Complete development environment

First product incorporating the TX49/L3 core

TMPR4951BFG-200

64-bit RISC microprocessor offering excellent cost performance

The **TMPR4951BFG** incorporates a 0.13- μ m process **TX49/L3** core, and by minimizing the built-in functions and external interfaces, it offers the industry's highest cost-performance ratio in the 200 MHz class and low-power consumption, all encapsulated in a compact package. Moreover, the SysAD bus interface adopted for this microprocessor enables diverted use of existing resources and facilitates system development. These and other features make it an ideal controller for low-end LBPs, networks, and settop boxes.



- **TX49/L3** 64-bit RISC core
- Five-stage pipeline
- On-chip caching
 - 4-way set-associative caches
 - Instruction cache: 16 Kbytes built in
 - Data cache: 8 Kbytes built in
 - Cache lock function
- 48 double-entry
- External bus (32-bit SysAD bus)
- Low-power consumption mode
- Debug support unit (DSU) built in (execution control only)
- Maximum operating frequency:
 - Core: 200 MHz
 - External bus: 100 MHz
- I/O supply voltage: 2.5 V or 3.3 V
- Internal supply voltage: 1.5 V
- Package: 100-pin LQFP (14 mm x 14 mm, 0.5-mm pitch)

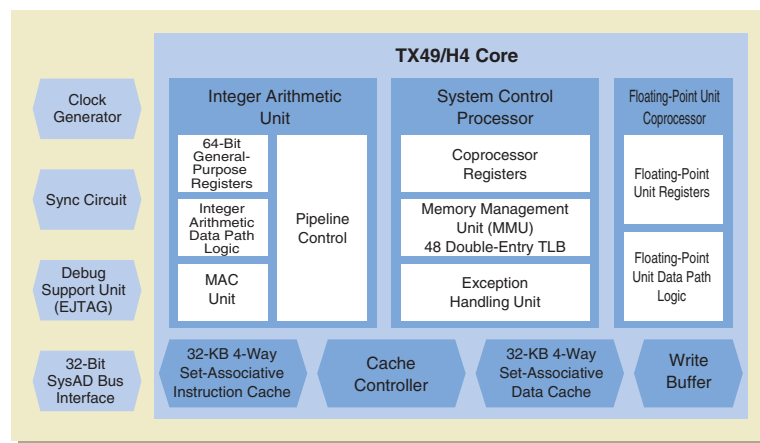
TX49 Family

Achieves 400 MHz operation

TMPR4955CFG-400 TMPR4956CXBG-400

64-bit RISC microprocessors that can easily be enhanced with desired functions

The **TMPR4955CFG** and **TMPR4956CXBG** are equipped with a **TX49/H4** core that uses a 90-nm process to enable 400 MHz operation. These processors have a built-in floating point unit (FPU) and SysAD bus interface, and are useful in a wide range of application areas including LBP, networks and set-top boxes. A debug support unit (DSU) is also built in, and this enables real-time PC tracing and various types of execution control.



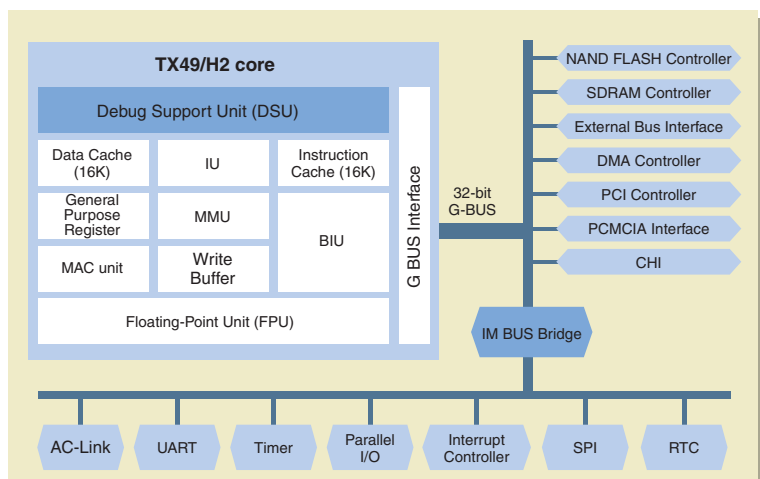
- 64-bit RISC equipped with **TX49/H4** core
- Five-stage pipeline
- On-chip caching
 - 4-way set-associative caches
 - Instruction cache: 32 Kbytes built in
 - Data cache: 32 Kbytes built in
 - Cache lock function
- 48 double-entry TLB
- External bus (SysAD bus):
 - 32-bit (**TMPR4955CFG**)
 - 64-/32-bit (**TMPR4956CXBG**)
- Single-/double-precision FPU
- Low power consumption mode
- Built-in debug support unit (DSU)
- Maximum operating frequency:
 - Core: 400 MHz
 - External bus: 133 MHz
- I/O supply voltage: 2.5 V or 3.3 V
- Internal supply voltage: 1.25 V
- Package:
 - 160-pin QFP (**TMPR4955CFG**)
 - 217-pin PFBGA (**TMPR4956CXBG**)

Built-in PCI controller, NAND Flash controller

TMPR4925XBG-200

General-purpose 64-bit RISC microprocessor with NAND Flash controller, PCI and DMA

The **TMPR4925XBG-200** is a 64-bit RISC microcomputer that is based on a **TX49/H2** processor core and contains a NAND flash controller, a PCI controller, a memory controller, a UART, a timer and other peripherals. It supports a **TX49/H2** core suitable for high-speed mode. The processor operates at a frequency of 200 MHz, while the PCI bus runs at a frequency of 33 MHz.



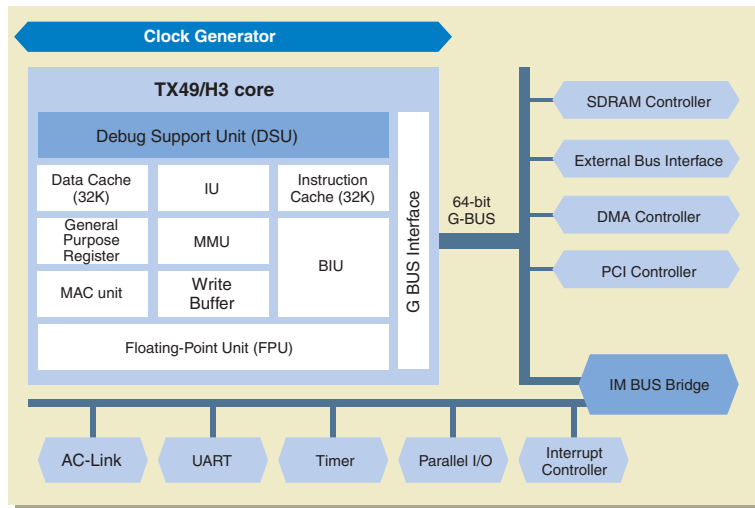
- Instruction cache: 16 Kbytes (4-way set-associative caches)
- Data cache: 16 Kbytes (4-way set-associative caches)
- MAC: Multiply-accumulate
- Memory management unit (TLB):
 - 48 double entries (odd/even)
 - Joint TLB, 4 K/16 K/64 K/256 K/1 M/4 M bytes pages
- Memory controller:
 - Supports NAND Flash, SDRAM (32-bit, 80 MHz), SRAM, ROM, NOR Flash and I/O
- Interrupt controller: 8 external sources
- 32-bit timer: 3 channels
- UART: 2 channels
- SPI
- PCI controller (32-bit, 33 MHz)
- DMA controller: 4 channels
- PCMCIA: 2 slots
- AC-Link (AC97 interface)
- Real-time clock
- CHI
- I/O port: 32-bit
- RF (Reduced Frequency) function
- Maximum operating frequency: 200 MHz
- I/O supply voltage: 3.3 V
- Internal supply voltage: 1.5 V
- Package: 256-pin PBGA (27 x 27 mm)

Built-in PCI controllers

TMPR4937XBG-300/333

64-bit RISC microprocessor with built-in PCI controller

The **TMPR4937XBG** is based on a **TX49/H3** core, and contains a PCI controller, a DMA controller, a memory controller, a UART, a timer and other peripherals. It is a 64-bit RISC microcomputer well adapted to networks and digital information appliances. The processor operates at frequencies of 300 MHz and 333 MHz, while the PCI bus runs at a frequency of 33/66 MHz.



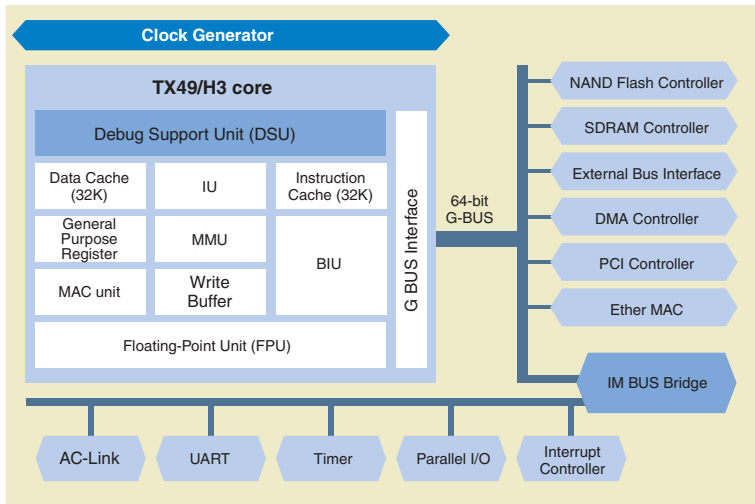
- **TX49/H3** 64-bit RISC core
- On-chip caching
 - Four-way set-associative caches
 - Instruction cache: 32 Kbytes
 - Data cache: 32 Kbytes
 - Cache lock function
- Memory management unit (TLB): 64 entries
4 K / 16 K / 64 K / 256 K / 1 M / 4 Mbyte pages
- Memory controller: SDRAM (64-bit, 133 MHz)
SRAM, ROM, NOR Flash and I/O
- Interrupt controller: 6 external sources
- 32-bit timer: 3 channels
- UART: 2 channels
- PCI controller (32-bit, 33/66 MHz)
- DMA controller: 8 channels
- AC-Link (AC97 interface)
- I/O ports: 16-bit
- Maximum operating frequency: 300/333 MHz
- I/O supply voltage: 3.3 V
Internal supply voltage: 1.5 V
- Package: 484-pin PBGA
(with 64-pin thermal balls)

Built-in PCI controllers, Ether MAC

TMPR4938XBG-300/333

64-bit RISC microprocessor with built-in PCI controller and Ether MAC

The **TMPR4938XBG** is a 64-bit RISC microprocessor ideal for networks and digital consumer applications. It is based on the **TX49/H3** core and has a variety of built-in functions, including PCI controller, Ether MAC, DMA controller, NAND Flash controller, memory controller, UART and timers. The processor runs at 33/66 MHz, and the PCI bus at 300/333 MHz.



- 64-bit RISC equipped with **TX49/H3** core
- On-chip caching
 - Four-way set-associative caches
 - Instruction cache: 32 Kbytes built in
 - Data cache: 32 Kbytes built in
 - Cache lock function
- Memory management unit (TLB): 64 entries
4 K / 16 K / 64 K / 256 K / 1 M / 4 Mbyte pages
- Memory controller: SDRAM (64-bit, 133 MHz)
Supports NAND Flash, SRAM, ROM, NOR Flash and I/O
- Interrupt controller: 6 external sources
- 32-bit timer: 3 channels
- UART: 2 channels
- PCI controller (32-bit, 33/66 MHz)
- DMA controller: 8 channels
- AC-Link (AC97 interface)
- Ether MAC: 2 channels
- I/O ports: 16-bit
- Maximum operating frequency: 300/333 MHz
- I/O supply voltage: 3.3 V
Internal supply voltage: 1.5 V
- Package: 484-pin PBGA
(with 64-pin thermal balls)

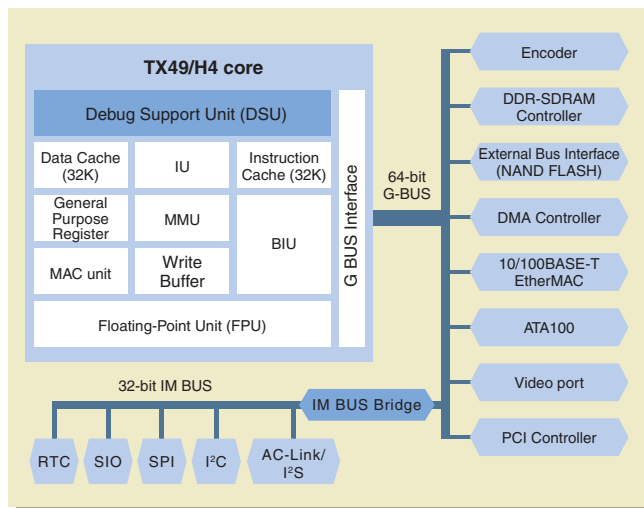
TX49 Family

This highly functional, high-performance family contains an encoder, and is well adapted to digital information equipment.

TX4939XBG-400

64-bit RISC microprocessor with encoder, DDR-SDRAM controller, EtherMAC, and ATA100

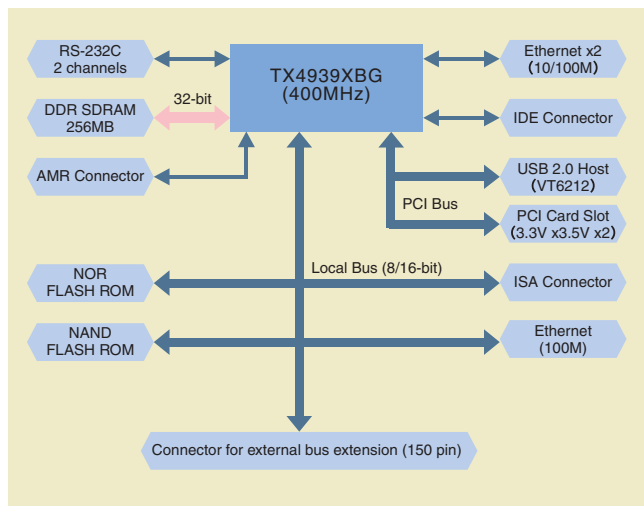
The **TX4939XBG-400** is based on a **TX49/H4** core, and contains an encoder, a DDR-SDRAM controller, an ATA100, an EtherMAC, a PCI controller and other peripherals. It is a highly functional, high-performance, 64-bit RISC microcomputer optimally applicable to digital information appliances. The processor operates at a frequency of 400 MHz, while the PCI bus runs at a frequency of 33/66 MHz.



- **TX49/H4** 64-bit RISC core
- On-chip caching
 - 4-way set-associative caches
 - Instruction cache: 32 Kbytes
 - Data cache: 32 Kbytes
 - Cache lock function
- Memory management unit
- Memory controller: DDR-SDRAM (32-bit, DDR400)
 - Supports NAND Flash, SRAM, ROM and NOR Flash
- Encoder: Supports DES, 3DES, AES, MD5 and SHA1
- DMA controller: 8 channels
- 10/100BASE-T EtherMAC: 2 channels
- ATA100: 2 channels
- Video port: 1-parallel I/O, 3-serial in
- PCI controller: 33/66 MHz
- AC-Link
- I²S
- SIO: 4 channels
- SPI
- I²C
- Interrupt controller
- Maximum operating frequency: 400 MHz
- I/O supply voltage: 3.3 V
 - Internal supply voltage: 1.25 V
- I/O (DDR 400): 2.6 V
 - I/O (less or equal to DDR 333): 2.5 V
- Package: 456-pin PBGA (with 36-pin thermal balls)

TX4939 reference board

This board consists of a CPU module and a base board.



CPU module

- **TX4939XBG-400**
- Contains four 512 M-bit DDR-SDRAMs suitable for the DDR400 in the standard configuration sized totally at 256 MB.
- Contains a power supply necessary to drive the DDR memory.
- Supports an EJTAG interface that allows data to be read and written.
- Supports a DIP switch used for boot setting.
- Provided with the CPU around which reset, clock and RTC circuits are installed.

Base board

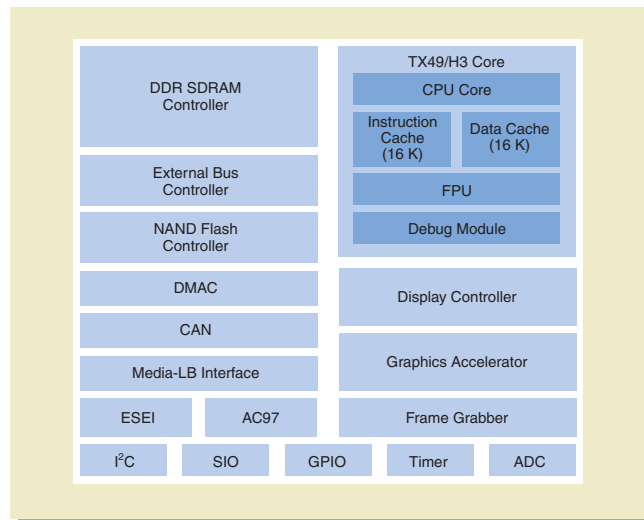
- The **TX4939** contains two channels of Ethernet controllers each of which consists of a 10/100M Ethernet MAC and an external PHY.
- Supports a NOR flash ROM (x 16 bits) consisting of 32 MB of a user ROM and 8 MB of a monitor ROM.
- Contains 32 MB of a NAND flash ROM (x 8 bits).
- Supports two channels of ATA (IDE) interfaces.
- Contains an AUDIO (AC-link/I²S) interface.
- Supports five channels of PCI slots.
- Provided with a USB 2.0 host.
- Supports four channels of RS-232C interfaces.
- Contains a 100 Base-TX Ethernet controller used for debugging.
- Equipped with a ROM emulator connector.
- Supports two ISA slots.
- Contains a connector for external bus extension.
- Provided with an I/O controller.
- Contains a power supply.
- Full size: ATX size
- The model ID required for ordering **TX4939** reference board is RBHMS4700 (CE).

On-chip graphic controller

TX4961XBG-240/TX4962XBG-120

64-bit RISC microprocessor with on-chip graphic controller for automotive display applications

The **TX4961XBG** and **TX4962XBG** are 64-bit RISC microprocessors based on a **TX49/H3** core, and contain a graphic controller, a camera input, a memory controller, CAN controllers, a Media-LB, an ADC and other peripherals. These controllers are best suited for an automotive display system requiring WVGA-class LCD.



- TX49/H3 64-bit RISC core
- On-chip caching
 - Instruction cache: 16 Kbytes
 - Data cache: 16 Kbytes
- Display controller:
 - 4 display planes and a hardware cursor plane with alpha blending, 32-bit RGBA/16-bit RGB, displays of up to 4095 x 1023 dots
- 2D graphics accelerator:
 - Line and triangle drawing, bit blitting, rotation, transformation and anti-aliasing
- Frame grabber: camera/video input, RGB or YCrCb input, clipping and scaling support, frames of up to 1024 x 512 dots
- Memory controller: DDR-SDRAM (32/16-bit, 120 MHz) Supports SRAM, ROM, NOR Flash and NAND Flash
- CAN controller: 3 channels (16 mail boxes x 3)
- MOST Media-LB interface
- Serial expansion interface (SEI): 2 channels (supports SPI mode)
- UART: 3 channels (with FIFO)
- I²C module: 1 channel
- AC-Link (AC97 interface)
- 16-bit timer: 6 channels
- PWM output: 6 channels
- 10-bit AD converter: 8 channels
- Maximum operating frequency:
 - 240 MHz (TX4961XBG)
 - 120 MHz (TX4962XBG)
- I/O supply voltage: 3.3 V/2.5 V
- Internal supply voltage: 1.5 V
- Package: 456-pin PBGA (TX4961XBG)
289-pin PFBGA (TX4962XBG)

32-Bit TX System RISC

TX39 Family

The **TX39** Family of **RISC** microprocessors for embedded use was developed by Toshiba based on the R3000A architecture designed by MIPS Technologies, Inc. It is an original Toshiba 32-bit processor family. Using the **TX39/H** or the high-speed **TX39/H2**, **TX39/H3** as the CPU core for gate arrays and cell-based ICs, you can accomplish a high level of integration in your system.

High-performance RISC technology

- R3000A architecture
- Internal operating frequency
 - TX39/H**: 92 MHz, **TX39/H2**, **H3**: 133 MHz
- 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
 - 32-bit multiply-accumulate (MAC) operations take only one 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.

Ideal as CPU core in embedded arrays/cell-based ICs

- **TX39/H2**: 0.25 μ m process technology
- **TX39/H3**: 0.18 μ m process technology
- Complete development environment

MeP

Media embedded Processor (MeP) is a processor for media processing based on Toshiba's original architecture. Given its flexible configuration and extensibility, MeP can be customized for targeted applications.

Overview of the MeP Core

MeP core is a configurable and extensible processor core.

- 32-bit RISC architecture
- High code efficiency due to 32-bit/16-bit variable length instructions
- Supports optional instructions and other configuration items
- Supports interface for hardware extensions
- Fully-synthesizable design not dependent on process technology
- High performance and low power consumption

Configuration Items

It is possible to set up the optimum configuration by selecting the optional instructions or cache memory size required for media processing.

- Optional instructions
 - 32-bit multiplication/division, bit manipulation, zero detection, differential absolute value, and others
- Memory configuration
 - Instruction cache: 0 to 16 Kbytes (Direct-mapped or 2-way)
 - Data cache: 0 to 16 Kbytes (Direct-mapped or 2-way)
 - Instruction RAM: 0 to 32 Kbytes
 - Data RAM: 0 to 128 Kbytes
- Interrupt controller: 1 to 32 interrupt sources and 1, 3, 7, or 15 priority levels
- Timer/counter: 0 to 4 channels
- Debug support function
- Bus width: 32 or 64 bits

Hardware Extensions

Application-specific extensions can be connected to the MeP core for high-performance processing.

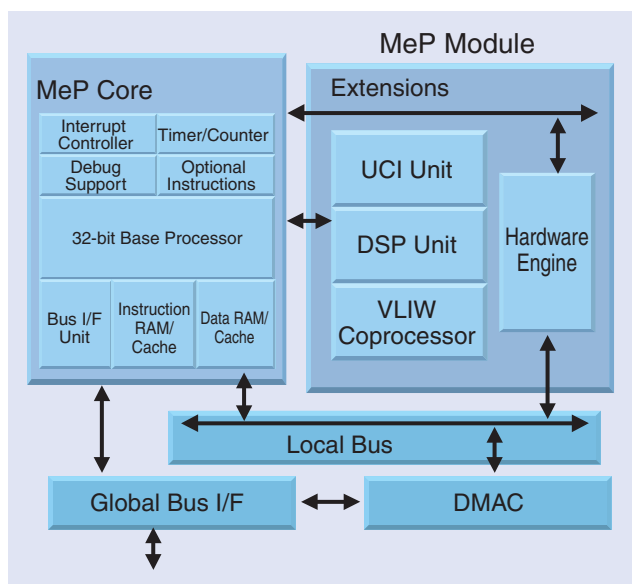
- User-customized instruction (UCI) unit
 - Customized instructions for single-cycle arithmetic operations.
- DSP unit
 - Customized instructions for multi-cycle arithmetic operations.
 - Can access Internal data RAM of MeP core.
 - Simultaneous two-bank access to data RAM of MeP core.
- VLIW coprocessor
 - Works as a 2-way or 3-way VLIW processor with the MeP core.
- Hardware engines
 - Extensible control registers (up to 4K words for each)

Development Environment

Third-party vendors provide the software development environments that support the configuration items and hardware extensions described here.

- MeP integrator
- Language tools (C/C++ compiler, assembler, and linker)
- Simulator
- Debugger
- Evaluation board

MeP Module



The MeP module is a processor module customized for specific applications.

- MeP core
 - Configurable processor core
- Extensions
 - Four kinds of hardware extensions
 - Multiple extensions
- Local bus
 - Internal data bus in MeP module
 - Hierarchical bus structure for higher transfer efficiency
- DMAC
 - Transfers data between the global bus and MeP core or extensions.
- Global bus I/F
 - Provides a bus bridge for connection to on-chip bus.

TX19 Family

Features of TX19 Family

CPU core ideal for embedded applications

TX19

High-speed computational capability

High-performance multiply-accumulate (MAC) unit
 · A 32-bit x 32-bit + 64-bit operation can be executed in one clock cycle.

Quick interrupt response

Suitable for real-time control
 · Dedicated interrupt controller
 · Simplified register stacking using shadow registers (TX19A)

Excellent code efficiency

Code efficiency of the highest standard in the industry
 · 16-bit instruction set for higher code efficiency
 · TX19A features an enhanced 16-bit instruction set (with extra instructions to enable bit manipulation, etc.).

NANO FLASH™ memory

NANO FLASH™ realizing a significant improvement over conventional Flash memory
 · Product line-up including the industry's largest memory capacity (2MB) device
 · Low power consumption equivalent to the mask ROM version
 · High-speed programming capability ideal for development and mass production

High-speed computational capability

■ The high-performance MAC unit enables a 32-bit x 32-bit + 64-bit operation to be executed in one clock cycle.

When not using MAC

1) 32-bit x 32-bit → 2 clock cycles
 MULT r2, r6, r7
 MFHI r3

2) 64-bit + 64-bit → 4 clock cycles
 ADDU r10, r2, r4
 SLTU r11, r10, r2
 ADD(U) r11, r11, r3
 ADD(U) r11, r11, r5

Total: 6 clock cycles

When using MAC

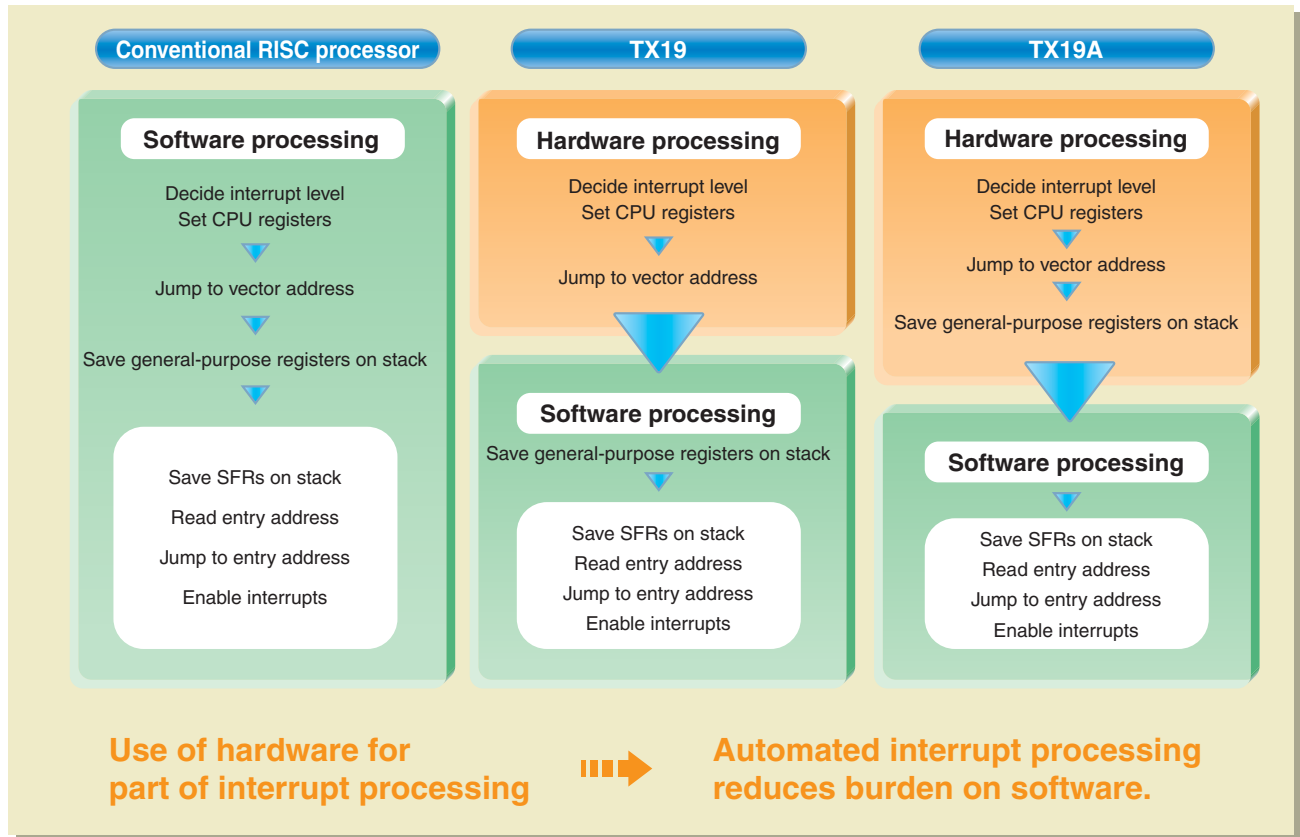
32-bit x 32-bit + 64-bit
 MADD r4, r6, r7

Can be executed in one clock cycle by the dedicated MAC unit.

Ideal for applications requiring high-speed computations

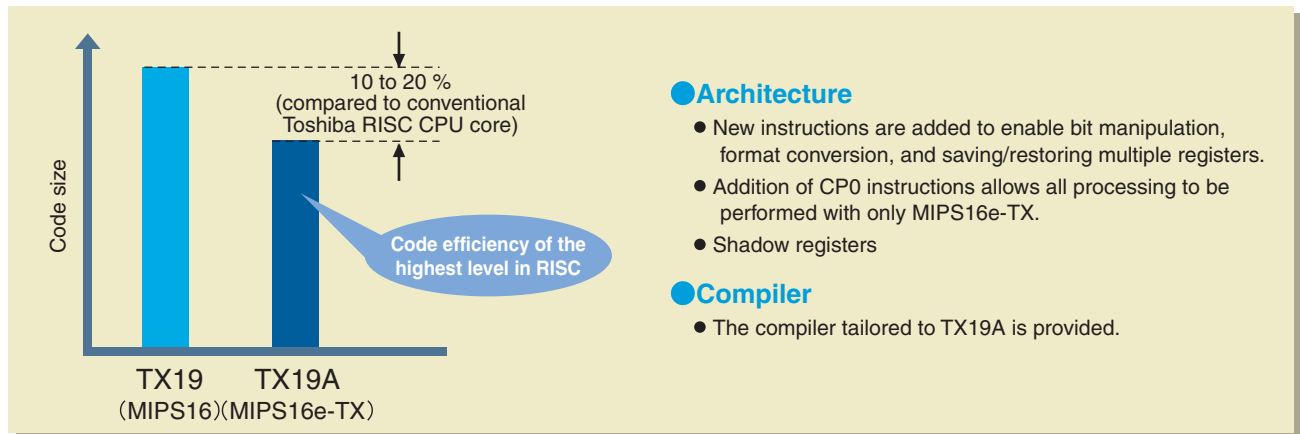
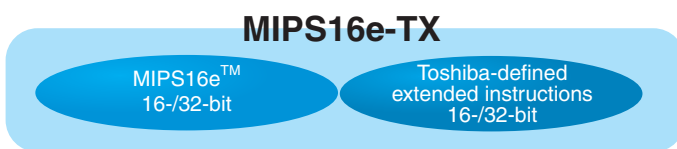
TX19 Family

Quick interrupt response



Excellent code efficiency

The TX19A core features the MIPS16e-TX architecture that realizes enhanced code efficiency and performance.



Architecture

- New instructions are added to enable bit manipulation, format conversion, and saving/restoring multiple registers.
- Addition of CP0 instructions allows all processing to be performed with only MIPS16e-TX.
- Shadow registers

Compiler

- The compiler tailored to TX19A is provided.

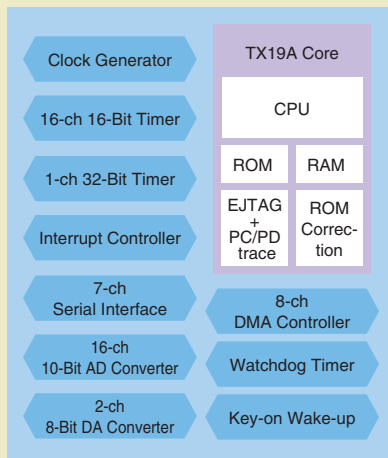
Displays outstanding efficiency in control programs heavy with bit operations.

TX19 Series single-chip microcontroller with NANO FLASH™

TMP19A43FZXBG

Single-chip 32-bit RISC microcontroller for real-time control

The **TMP19A43** is a 32-bit RISC microcontroller based on the **TX19A** core and containing NANO FLASH™, a high-speed AD converter, a large number of external interrupts, and timer/counters. The microcontroller features low-voltage and low-power-consumption operation, making it ideal for battery-driven applications such as portable information equipment for personal use.



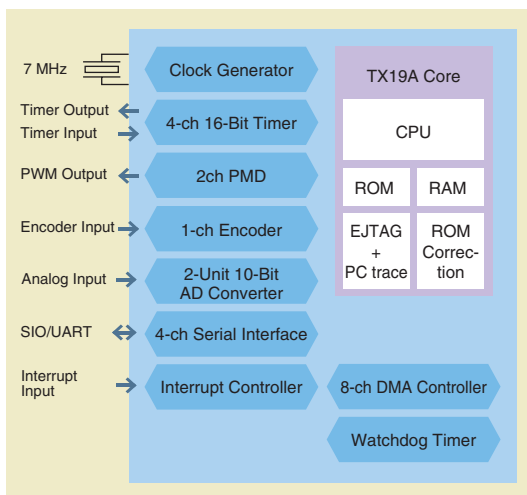
- Internal ROM: Flash 384 Kbytes
- Internal RAM: 20 Kbytes
- 10-bit AD converter: 16 channels (conversion time 1.15 μ s)
- 8-bit DA converter: 2 channels (2.5 V)
- 32-bit timer/counter: 1 channel
- Output compare register: 8 channels
- Input capture register: 4 channels
- 16-bit timer/counter: 16 channels (Four of the 16 channels are used for a dual-phase pulse input counter)
- UART/SIO: 4 channels (One of the four channels is used for I²C/SIO)
- UART/HSIO: 3 channels (10 Mbps)
- DMA controller: 8 channels
- ROM correction: 1 word x 8 blocks
8 words x 4 blocks
- Key-on wake-up: 32 channels
- External interrupt: 48 channels
- Operating temperature: -20 to 85°C
- Maximum operating frequency: 40 MHz (PLL multiplication)
- Internal supply voltage: 1.35 to 1.65 V
- ADC, I/O supply voltage: 2.7 to 3.6 V
- Package: 193-pin FBGA (12 x 12 mm, 0.65-mm pitch, 1.2-mm thick)

TX19 Series single-chip microcontroller with ROM/RAM

TMP19A71

Single-chip 32-bit RISC microcontroller for inverter control

The **TMP19A71** is a single-chip 32-bit RISC microcontroller, which integrates major features for controlling home electric appliances, including motor control. It is based on the **TX19A** core, an enhanced version of the **TX19** core, which incorporates high-speed ROM and RAM. The **TMP19A71** is ideal for controlling home electric appliances that require energy saving or low vibration/noise.



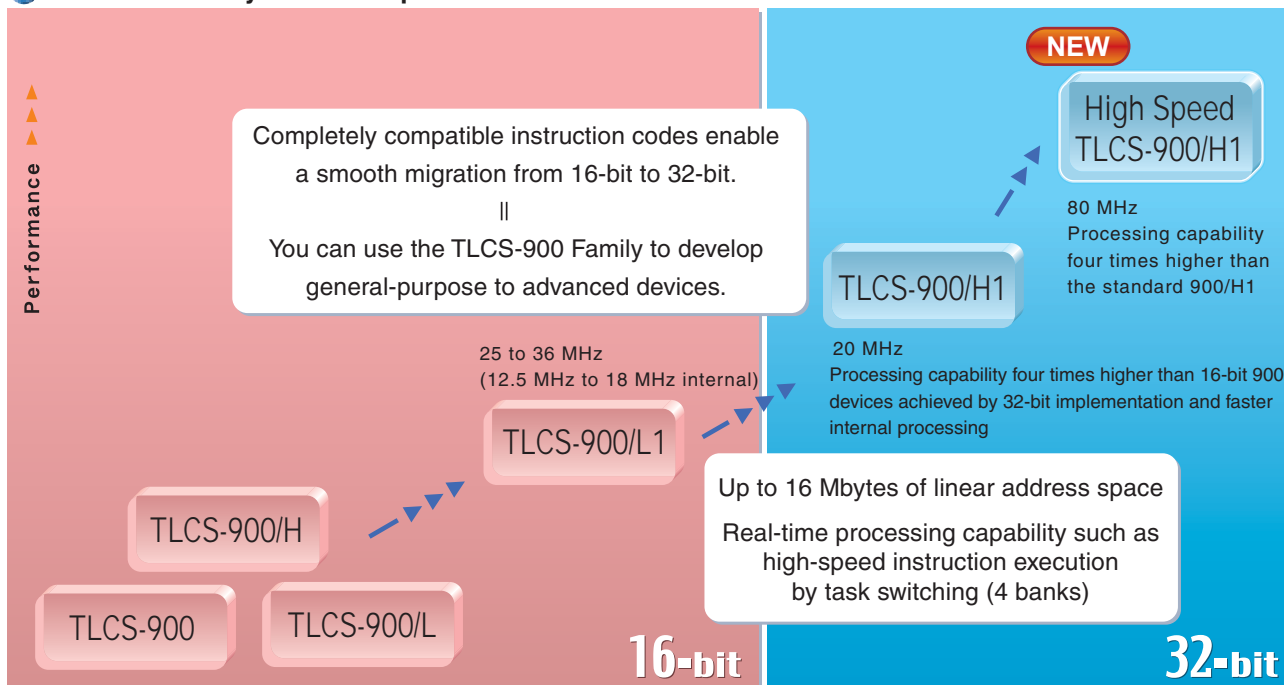
- Internal ROM
- **TMP19A71CYUG/FG:** Mask ROM 256 Kbytes
- **TMP19A71FYUG/FG:** Flash 256 Kbytes
- Internal RAM: 10 Kbytes
- 3-phase PWM output: 2 channels
- Resolution: 35.7 ns (16 bits)
- Dead time insertion
- Output stop on failure
- Incremental encoder input: 1 channel
- 10-bit AD converter: 2 units
- Analog input: 8 channels + 11 channels
- Conversion time: 2.36 μ s/channel
- Start synchronization with PWM cycle or timer
- DMA controller: 8 channels
- Interrupt controller: 10 external sources
- 16-bit timer/counter: 4 channels
- UART: 2 channels
- UART/SIO: 2 channels
- Watchdog timer
- I/O ports: 75 pins
- ROM correction: 8 areas
- Maximum operating frequency: 56 MHz
- Supply voltages:
 - **TMP19A71CYUG/FG:** Internal 1.35 to 1.65 V
 - I/O 3.0 to 3.6 V
 - **TMP19A71FYUG/FG:** Internal 2.3 to 2.7 V
 - ADC, I/O 3.0 to 3.6 V
- Package: 100-pin QFP
 - **TMP19A71CYUG/FYUG:** 14 x 14 mm, 0.5-mm pitch
 - **TMP19A71CYFG/FYFG:** 14 x 20 mm, 0.65-mm pitch

TLCS-900 Family

Suitable for high-performance and multifunctional home appliances, audio equipment and portable devices

The **TLCS-900** Family of 16-bit and 32-bit microcontrollers provides solutions in every application field by offering a wide variety of built-in peripheral functions that can be used in combination with our software IP products. The instruction code compatibility within the **900** Family which ensures a smooth migration from the **TLCS-900/L1** 16-bit to **TLCS-900/H1** 32-bit systems enhances the product line-up strategies.

TLCS-900 Family core line-up

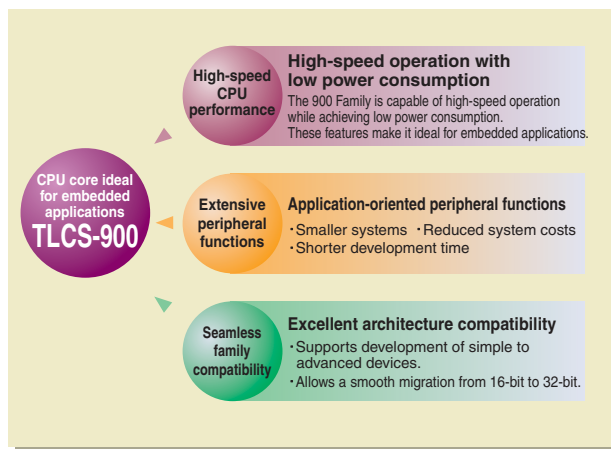


Processor core features

	900/L Series	900/H Series	900/L1 Series	900/H1 Series	
Maximum internal operating frequency ^{Note 1)}	10 MHz	12.5 MHz	18 MHz	20 MHz	80 MHz
Minimum instruction execution time	200 ns	160 ns	111 ns	50 ns	12.5 ns
Address space	Up to 16 Mbytes of linear address space (for program and data)				
Data transfer rate (micro DMA)	1.6 μs/2 bytes @20 MHz	0.64 μs/2 bytes @25 MHz	0.44 μs/2 bytes @36 MHz	0.25 μs/4 bytes @20 MHz internal	62.5 ns/4 bytes @80 MHz internal
Operating voltage	5 V/3 V		5 V/3 V/2 V	5 V/3 V	3.3 V, 1.5 V (two power supplies)
Multiplication instruction execution time (16-bit operands, 32-bit result)	2.6 μs	960 ns	666 ns	400 ns	134 ns
Dynamic bus sizing	8-/16-bit			8-/16-/32-bit	

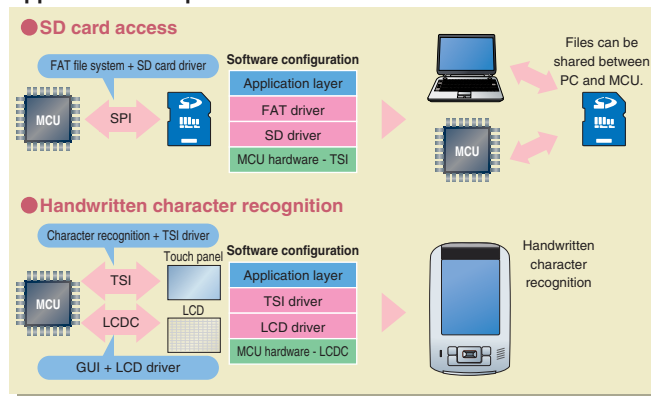
Note 1) Maximum operating frequency varies depending on the product, so please see the "Part Number List" for details.

Features of TLCS-900 Family



Toshiba offers total solutions including hardware, systems and software.

Application examples



TLCS-900/H1 Series

TMP92CY23FG/DFG **NEW** TMP92CD23AFG/DFG Under development

Single-chip 32-bit microcontrollers with a wide range of built-in I/O functions

The **TMP92CY23** and **TMP92CD23A** are single-chip 32-bit microcontrollers containing a wide range of I/O functions based on the **900/H1** core.

- Internal ROM: **TMP92CY23** 256 Kbytes
TMP92CD23A 512 Kbytes
- Internal RAM: **TMP92CY23** 16 Kbytes
TMP92CD23A 32 Kbytes
- Operating voltage: 3.0 to 3.6 V
- Minimum instruction execution time: 50 ns (internal: 20 MHz)
- SIO/UART: 3 channels*
- SIO/I²C: 2 channels
- 16-bit timer: 2 channels
- 8-bit timer: 6 channels
- 10-bit AD converter: 12 channels
- Key-on wake-up: 8 channels
- Program patch logic: 8 banks
- Package: **TMP92CY23FG/CD23AFG**: 100-pin LQFP (14 x 14 mm, 0.5-mm pitch)
TMP92CY23DFG/CD23ADFG: 100-pin QFP (14 x 20 mm, 0.65-mm pitch)
- Flash version: **TMP92FD23AFG/DFG**

*One of the channels in the TMP92CD23A can operate as a high-speed SIO.

This product uses the SuperFlash® technology under the license of Silicon Storage Technology, Inc. SuperFlash® is a registered trademark of Silicon Storage Technology, Inc.

High-speed TLCS-900/H1 Series

TMP92CF29AFG **NEW**

Highly functional 32-bit microcontroller with color LCD controller, capable of operating at 80 MHz

The **TMP92CF29A** is a 32-bit microcontroller incorporating large-capacity RAM (144 Kbytes) housed in a 176-pin LQFP.

- Internal ROM: 8 Kbytes (Boot)
- Internal RAM: 144 Kbytes
- Operating voltage
Internal : 1.4 to 1.6 V
I/O : 3.0 to 3.6 V
- Minimum instruction execution time: 12.5 ns (internal: 80 MHz)
- USB device: 1 channel
- Memory management unit: 2.1 GB (max)
- SDRAM controller: 512 Mbits (max)
- Color LCD controller: 65K colors (TFT)/262K colors (STN)
- MLC/SLC NAND Flash interface: 2 channels
- DMA controller: 6 channels
- Multiply-accumulate (MAC): 1 channel (32 x 32 + 64 = 64)
- SD card interface: 1 channel (SPI mode)
- I²S interface: 1 channel
- SIO/UART: 1 channel
- I²C bus: 1 channel
- 8-bit timer/counter: 8 channels
- 16-bit timer/counter: 2 channels
- 10-bit AD converter: 6 channels
- RTC: 1 channel
- Touch screen interface: 1 channel
- Package: 176-pin LQFP (20 x 20 mm, 0.4-mm pitch)

TLCS-900/H1 Series

TMP92FD28AFG/DFG **NEW** TMP92CD28AFG/DFG Under development

Highly functional 32-bit microcontrollers with a USB HOST controller

The **TMP92FD28A** and **TMP92CD28A** are 32-bit microcontrollers containing a USB HOST controller based on the **900/H1** core.

- Internal ROM: 512 Kbytes
- Internal RAM: 32 Kbytes
- Operating voltage: 3.0 to 3.6 V
- Minimum instruction execution time: 50 ns (internal: 20 MHz)
- USB HOST controller
- UART/SIO: 2 channels
- SBI: 2 channels
- HSIO: 1 channel
- SPI controller: 1 channel
- 8-bit timer: 6 channels
- 16-bit timer: 2 channels
- Key-on wake-up: 4 channels
- Program patch logic: 8 banks
- Package: **TMP92FD28AFG/TMP92CD28AFG**: 100-pin LQFP (14 x 14 mm, 0.5-mm pitch)
TMP92FD28ADFG/TMP92CD28ADFG: 100-pin QFP (14 x 20 mm, 0.65-mm pitch)

This product uses the SuperFlash® technology under the license of Silicon Storage Technology, Inc. SuperFlash® is a registered trademark of Silicon Storage Technology, Inc.

TLCS-900/L1 Series

TMP91FW60FG/DFG **NEW** TMP91CW60FG/DFG Under development

16-bit microcontrollers supporting 5-V operation and a wide range of I/O functions on a single chip

The **TMP91FW60** and **TMP91CW60** are 16-bit microcontrollers that support 5-V operation and incorporate a wide variety of I/O functions on a single chip.

- Internal ROM: 128 Kbytes
- Internal RAM: 8 Kbytes
- Operating voltage: 4.5 to 5.5 V
- Minimum instruction execution time: 200 ns (internal: 20 MHz)
- SIO/UART: 3 channels
- I²C: 2 channels
- 8-bit timer/counter: 6 channels
- 16-bit timer/counter: 5 channels
- 10-bit AD converter: 16 channels
- Program patch logic: 6 banks
- Package: **TMP91FW60FG/TMP91CW60FG**: 100-pin LQFP (14 x 14 mm, 0.5-mm pitch)
TMP91FW60DFG/TMP91CW60DFG: 100-pin QFP (14 x 20 mm, 0.65-mm pitch)

This product uses the SuperFlash® technology under the license of Silicon Storage Technology, Inc. SuperFlash® is a registered trademark of Silicon Storage Technology, Inc.

TLCS-770 Family

Digital signal processors (DSPs) capable of high-precision 3-phase motor control

TLCS-770 Series

NEW

TMP77CM70TUG

Under development

TMP77FM70TUG

Under development

Traditional electric power steering (EPS) control systems have implemented both system and motor control with a single main microcontroller. Toshiba has newly developed a DSP specifically optimized for automotive motor control. By separating system control and motor control functionalities, Toshiba offers a new two-chip solution for EPS systems that provides various advantages resulting from efficient control and flexibility, such as reduced power consumption due to lowered operating frequencies, future provisions for performance improvement, and ease of broadening application product lines.

The **TMP77CM70TUG** and **TMP77FM70TUG** are high-speed processors based on Toshiba's proprietary 16-bit DSP core adopting Harvard architecture which allows an instruction and data to be read simultaneously.

These new products contain two units of AD converter for simultaneous conversion of two motor current waveforms and a 3-phase PWM output circuit with a minimum resolution of 25 ns. These features greatly contribute to improving performance of automotive motor applications, including an enhanced steering feel and reduced vibration in the car air conditioner compressor.

Package solutions for Electric Power Steering (EPS)

Efficient control

- Motor drive at approximately half the system clock speed of RISC processors (Compared to Toshiba processors)
- Contributes to enhanced EMI/EMS protection and reduced power consumption.
- Separating motor control functionality promises future provisions for performance improvement.

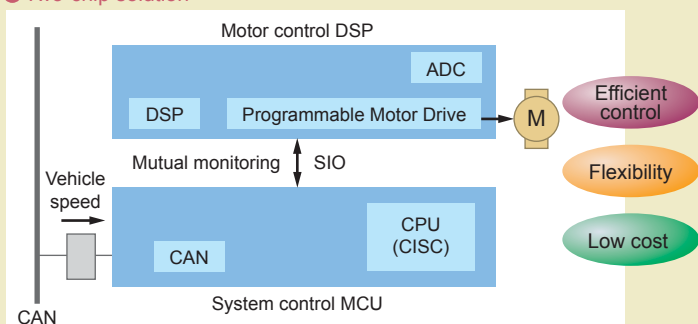
Flexibility

- Ease of broadening application product lines
- The DSP is dedicated to motor control.
- The system control microcontroller can be selected from general-purpose products.

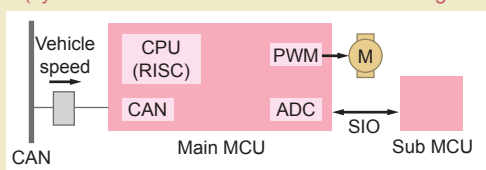
Low cost

- Reduced system costs
- Use of an optimized DSP and a less expensive general-purpose microcontroller enables a reduction in system costs.

Two-chip solution

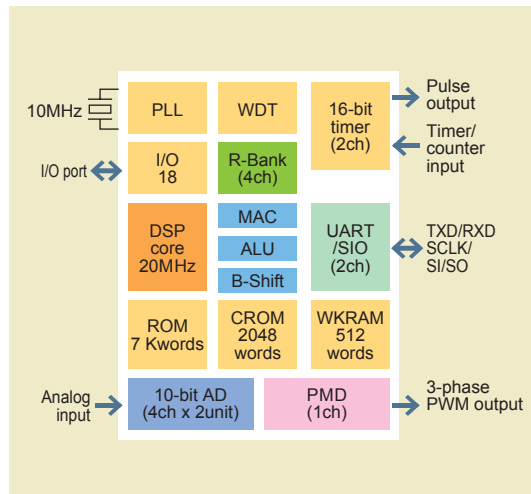


Single-chip solution (system control and motor control with a single MCU)



Product line-up

Part Number	TMP77FM70TUG	TMP77CM70TUG
Type	Flash ROM	Mask ROM
Memory	ROM: 7 Kwords x 32 bits Data RAM: 512 words x 16 bits Coefficient ROM: 2 Kwords x 16 bits	
I/O	18	
Minimum instruction execution time	50 ns (internal: 20 MHz)	
Operating voltage	Internal: 3.0 to 3.6 V, I/O: 4.5 to 5.5 V	
Operating frequency	20 MHz (external: 10 MHz)	
Motor control circuit (PMD)	Number of channels: 1 channel 3-phase PWM output (resolution: 25 ns) Dead time: 0.05 to 12.8 μs Protection feature: Emergency output stop	
10-bit AD converter	4 channels x 2 units	
Communication	UART/SIO (selectable): 2 channels	
Timer	16-bit timer: 2 channels Watchdog timer: 1 channel	
Package	64-pin LQFP (10 x 10 mm, 0.5-mm pitch)	



Development system

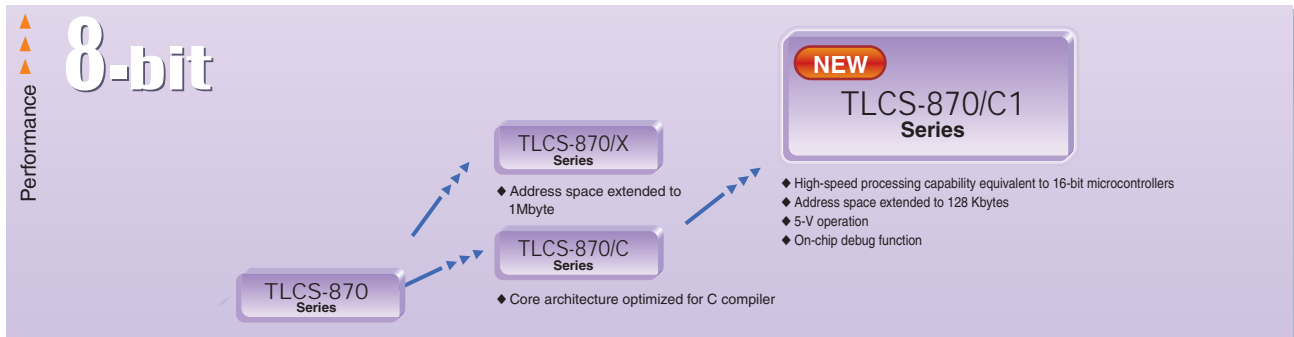
For product part numbers and system configurations, please refer to the "PART NUMBER LIST" or the Toshiba Microcomputer website.

TLCS-870 Family

8-bit microcontrollers suitable for a wide range of consumer products such as home appliances, communications devices and inverter-controlled equipment

The **TLCS-870** Family consists of 8-bit microcontrollers developed for consumer applications such as home appliances, TVs, audio equipment, telephones, motor control and lighting devices. The product line-up includes microcontrollers incorporating various functions to suit these applications, including an AD converter, LCD driver, UART, on-screen display circuit, IGBT controller and PMD circuit. The **870** Family also offers products featuring low-voltage, low-power-consumption and low-noise operation that are suitable for portable equipment and many other applications. The **870** Family has been reinforced by the **TLCS-870/C1** Series which delivers enhanced processing capability and upgraded low-voltage and low-power-consumption features such as on-chip Flash memory, a voltage detecting circuit and a power-on reset circuit.

TLCS-870 Family core line-up



Processor core features

	870/C Series	870/X Series	870 Series	870/C1 Series
Maximum operating frequency	16 MHz	20 MHz	8 MHz	8 MHz
Minimum instruction execution time	0.25 μ s/0.167 μ s	0.2 μ s	0.5 μ s	0.125 μ s
Address space	64 Kbytes	1 Mbyte	64 Kbytes	128 Kbytes
Interrupt vector (max)	31	63	15	52
Instruction set	731 instructions	842 instructions	412 instructions	732 instructions
Operating voltage range (typ.)	1.8 to 5.5 V	2.7 to 5.5 V	2.7 to 5.5 V/6.0 V	2.7 to 5.5 V

Features of TLCS-870 Family

Noise reduction measures

The TLCS-870 Family implements various measures for improving noise immunity.

Separate power supplies

Prevents internal noise from propagating to I/O pins.

- Separate power supplies are used for internal logic and I/O.
- Internal EMI noise can be prevented from propagating to I/O pins.

Decoupling capacitor

Enables power supply decoupling and current loop minimization.

- A decoupling capacitor is attached to the noise source.
- High-frequency currents directly flowing to power supply lines can be reduced.
- Spurious noise can be suppressed by minimizing current loops created by circuit operations.

Optimized pin layout

- Oscillator pins are guarded by GND pins.
- Spurious noise from oscillator pins can be suppressed.

Oscillator protection

- High-frequency noise can be eliminated by placing a noise filter.

Noise filter

Prevents noise propagation.

- Spike noise can be eliminated.

TLCS-870 Family

TLCS-870/C1 Series

TMP89FM40NG/FH40NG TMP89FM42UG/FH42UG TMP89FM46DUG/FH46DUG

Under development

8-bit microcontrollers delivering high functionality and performance in low-pin-count packages

These 8-bit microcontrollers based on the **TLCS-870/C1** core offer sub-sets of the TMP89FS60UG/FG functionality in low-pin-count (42-pin/44-pin/48-pin) packages. Instruction code compatibility with the TMP89FS60UG/FG allows smooth porting of software. These products are ideal as a main microcontroller in home appliances and as a secondary microcontroller in digital consumer appliances.

- Internal ROM: 32 K/16 Kbytes
- Internal RAM: 2 K/2 Kbytes
- I/O ports:
 - TMP89FM40/FH40:** 36 pins
 - TMP89FM42/FH42:** 40 pins
 - TMP89FM46/FH46:** 42 pins
- Operating voltage: 2.7 to 5.5 V
- Minimum instruction execution time:
 - 0.125 μ s (8 MHz/4.5 to 5.5 V)
 - 0.24 μ s (4.2 MHz/2.7 to 5.5 V)
 - 122 μ s (32.768 kHz/2.7 to 5.5 V)
- 10-bit AD converter: 8 channels
- Serial interface
 - UART/SIO: 1 channel
 - I²C/SIO: 1 channel
 - UART: 1 channel

* Only one SIO channel can be used at a time.
- Timer/counter
 - 16-bit: 2 channels
 - 8-bit: 4 channels
- Voltage detecting circuit:
 - Two voltage levels detectable
- Power-on reset circuit
- Key-on wake-up: 8 channels
- Package:
 - TMP89FM40NG/FH40NG:** 42-pin SDIP
 - TMP89FM42UG/FH42UG:** 44-pin LQFP (10 x 10 mm, 0.80-mm pitch)
 - TMP89FM46DUG/FH46DUG:** 48-pin LQFP (7 x 7 mm, 0.50-mm pitch)

This product uses the SuperFlash[®] technology under the license of Silicon Storage Technology, Inc. SuperFlash[®] is a registered trademark of Silicon Storage Technology, Inc.

TLCS-870/C1 Series

TMP89FS60UG/FG

Under development

8-bit microcontroller based on the new 870/C1 core realizing enhanced functionality and performance

The **TMP86FS60** is an 8-bit microcontroller based on the new **870/C1** core that achieves processing capability four times higher than our popular high-performance **870/C** Series (at the same internal clock frequency). This new microcontroller contains large-capacity Flash memory, a voltage detecting circuit, a power-on reset circuit, various serial interfaces and timer/counters. In addition to the standard real-time emulator, the **TMP86FS60** also supports on-board debugging to enhance development efficiency and product quality.

- Internal ROM: 60 Kbytes (Flash)
- Internal RAM: 3 Kbytes
- I/O ports: 56 pins
- Operating voltage: 2.7 to 5.5 V
- Minimum instruction execution time:
 - 0.125 μ s (8 MHz/4.5 to 5.5 V)
 - 0.24 μ s (4.2 MHz/2.7 to 5.5 V)
 - 122 μ s (32.768 kHz/2.7 to 5.5 V)
- 10-bit AD converter: 16 channels
- Serial interface
 - UART/SIO: 2 channels
 - I²C/SIO: 1 channel
 - UART: 1 channel

* Up to two SIO channels can be used simultaneously.
- Timer/counter
 - 16-bit: 2 channels
 - 8-bit: 4 channels
- Voltage detecting circuit:
 - two voltage levels detectable
- Power-on reset circuit
- Key-on wake-up: 8 channels
- Package:
 - TMP89FS60UG:** 64-pin LQFP (10 x 10 mm, 0.50-mm pitch)
 - TMP89FS60FG:** 64-pin QFP (14 x 14 mm, 0.80-mm pitch)

This product uses the SuperFlash[®] technology under the license of Silicon Storage Technology, Inc. SuperFlash[®] is a registered trademark of Silicon Storage Technology, Inc.

TLCS-870/C1 Series

TMP89FM82TUG

Under planning

8-bit microcontroller for automotive applications offering an enhanced inverter motor control circuit (PMD)

The **TMP89FM82TUG** is an 8-bit microcontroller with a second generation PMD that offers an increased PWM counter resolution and flexible programmability of PWM output waveforms.

- Internal ROM: 32 Kbytes (Flash)
- Internal RAM: 1.5 Kbytes
- Operating voltage: 4.5 to 5.5V
- Minimum instruction execution time:
 - 0.125 μ s (8 MHz/4.5 to 5.5 V)
- 10-bit AD converter: 8 channels
- Serial interface
 - SEI/UART: 1 channel
 - SIO/UART: 1 channel
- Timer/counter
 - 16-bit: 2 channels
 - 8-bit: 4 channels
- Motor control circuit: 1 channel
- Power-on reset circuit
- Voltage detecting circuit
- Pins with an internal pull-up resistor: 8 pins
- Package: 48-pin LQFP (7 x 7 mm, 0.50-mm pitch)

This product uses the SuperFlash[®] technology under the license of Silicon Storage Technology, Inc. SuperFlash[®] is a registered trademark of Silicon Storage Technology, Inc.

TLCS-870/X Series

TMP88FH41UG/841UG

Under development

8-bit microcontrollers incorporating an inverter motor control circuit (PMD) and Flash memory

The **TMP88FH41UG** and **TMP88FH841UG** are follow-up products to our popular **TMP88CH41UG** containing a second-generation PMD. These new microcontrollers offer enhanced usability by incorporating a power-on reset circuit, a voltage detecting circuit and Flash memory.

- Internal ROM: 16 K/ 8Kbytes
- Internal RAM: 512 bytes
- Operating voltage: 4.5 to 5.5 V
- Minimum instruction execution time: 200 ns (20 MHz)
- 10-bit AD converter: 8 channels
- Serial interface
UART/SIO: 1 channel
- Timer/counter
16-bit: 1 channel
8-bit: 2 channels
- Motor control circuit: 1 channel
- Power-on reset circuit
- Voltage detecting circuit
- Package: 44-pin LQFP (10 x 10 mm, 0.80-mm pitch)

This product uses the SuperFlash® technology under the license of Silicon Storage Technology, Inc. SuperFlash® is a registered trademark of Silicon Storage Technology, Inc.

TLCS-870/C Series

TMP86FH09ANG/809NG/409NG

NEW

8-bit Flash microcontrollers in a compact package suitable for home appliances and control equipment

The **TMP86FH09A**, **TMP86F809** and **TMP86F409** are follow-up products to our popular **TMP86C807/808**. These new microcontrollers offer enhanced usability by incorporating a 10-bit AD converter and Flash memory.

- Internal ROM: 16 K/8 K/4 Kbytes (Flash)
- Internal RAM: 512 bytes
- I/O ports: 26 pins
- Operating voltage: 2.7 to 5.5 V
- Minimum instruction execution time:
0.25 μ s (16 MHz/4.5 to 5.5 V)
0.50 μ s (8 MHz/2.7 to 5.5 V)
122 μ s (32.768 kHz/2.7 to 5.5 V)
- 10-bit AD converter: 6 channels
- Serial interface
8-bit SEI: 1 channel
UART: 1 channel
- Timer/counter
16-bit: 1 channel
8-bit: 2 channels
- Key-on wake-up: 4 channels
- Package: 32-pin SDIP

This product uses the SuperFlash® technology under the license of Silicon Storage Technology, Inc. SuperFlash® is a registered trademark of Silicon Storage Technology, Inc.

TLCS-870/C Series device with power-on reset and voltage detecting circuits

TMP86FH92IDMG

Under development

8-bit microcontroller incorporating a power-on reset circuit and a voltage detecting circuit

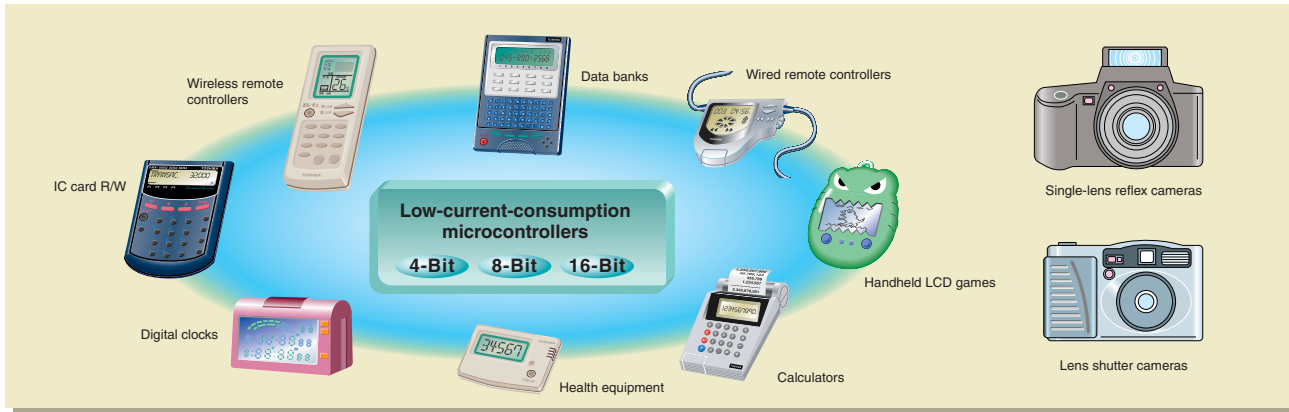
The **TMP86FH92I** is an 8-bit microcontroller that incorporates synchronous and asynchronous serial interfaces, a power-on reset circuit and a voltage detecting circuit. The mask ROM version is also being developed.

- Internal ROM: 16 Kbytes
- Internal RAM: 512 bytes
- Minimum instruction execution time:
0.25 μ s (16 MHz/4.0 to 5.5 V)
0.50 μ s (8 MHz/3.0 to 5.5 V)
- Operating voltage: 4.0 to 5.5 V (16 MHz)
3.0 to 5.5 V (8 MHz)
- UART: 1 channel
- I²C/UART: 1 channel
- SEI: 1 channel
- 10-bit AD converter: 6 channels
- Package: 30-pin SSOP
- Power-on reset circuit
- Voltage detecting circuit: two voltage levels detectable

This product uses the SuperFlash® technology under the license of Silicon Storage Technology, Inc. SuperFlash® is a registered trademark of Silicon Storage Technology, Inc.

T4X Series / T6H Series

Microcontrollers for portable equipment



T4X Series

Low-power and low-voltage microcontrollers for reduced system costs

Suitable for battery-operated equipment with an LCD (calculators, watches, health equipment, remote controllers, LCD game consoles, toys, etc.)

- **High-speed CPU:** A special architecture enables execution of one instruction in two clock cycles. Use of a 16-bit instruction bus improves instruction throughput.
- **Low power consumption:** The circuit design optimized for battery-operated equipment reduces power consumption, helping you to extend system battery life.
- **Low-voltage operation:** Peripheral circuits suitable for portable equipment (memory, an LCD driver, I/O ports, etc.) are integrated on a single chip.
- **Die form:** All T4X Series devices can be supplied in die form, contributing to reduced system costs.

T6H Series

Microcontrollers enabling faster development turnaround time for reduced system costs

Suitable for battery-operated equipment with an LCD (compact cameras, health equipment, home appliances, remote controllers, toys, etc.)

- **Low-voltage and low-power operation suitable for battery-operated equipment**
 - Operating voltage: 1.8 to 5.5 V
 - Sleep current: IQD < 15 μ A (VDD = 5.0 V, LCD display ON)
 - Low-power oscillator: Low-frequency clock=32.768 kHz
 - Low-power regulators for the LCD driver and low-frequency oscillator
- **Special-purpose on-chip circuits for faster software development**
 - LCD blinking
 - External interrupt input with sampling function
- **On-chip analog circuits for actuator control**
 - 8-bit AD converter, 8-bit DA converter
 - Comparator with variable thresholds for interrupt control based on external analog voltages
 - Motor pre-driver for DC motor control and large current output

T4X Series line-up

	TMP04030	TMP04070	TMP04081	TMP04100	T6F36	T6F42
CPU	T4X	T4X	T4X	T4X	T4X	T4X
ROM	32 KW	16 KW	32 KW	64 KW	24 KW	52 KW
Work RAM	4 K bits	2 K bits	2 K bits	4 K bits	4 K bits	4 K bits
Data RAM	4 K bits	6 K bits	16 K bits	4 K bits	-	-
I/O port	18 ch	17 ch	17 ch	20 ch	18 ch	18 ch
LCD driver (Built-in regulator)	64SEG x 16COM	60SEG x 8COM 58SEG x 10COM	60SEG x 8COM 60SEG x 10COM	60SEG x 16COM	50SEG x 15COM	50SEG x 15COM
Timer/Counter	8 bit x 2 ch or 16 bit x 1 ch	8 bit x 2 ch or 16 bit x 1 ch	8 bit x 2 ch or 16 bit x 1 ch	8 bit x 2 ch or 16 bit x 1 ch	8 bit x 2 ch	8 bit x 2 ch
Buzzer circuit	-	1 ch	1 ch	-	1 ch	1 ch
Melody circuit	1 ch	-	-	1 ch	-	-
SIO	1 ch	-	-	-	-	-
UART	-	-	-	-	1 ch	1 ch
USB	-	-	-	○(ver1.1)	-	-
External SRAM I/F	-	-	-	○	○	○
External LCDD I/F	-	-	-	○	○	○
Operating voltage	2.5 to 3.5 V	1.2 to 1.8 V or 2.4 to 3.6 V	1.2 to 1.8 V	2.5 to 3.5 V	1.8 to 3.5 V	1.8 to 3.5 V
Package	Die (117-pin)	QFP100/Die	Die (102-pin)	Die (121-pin)	Die (132-pin)	Die (132-pin)

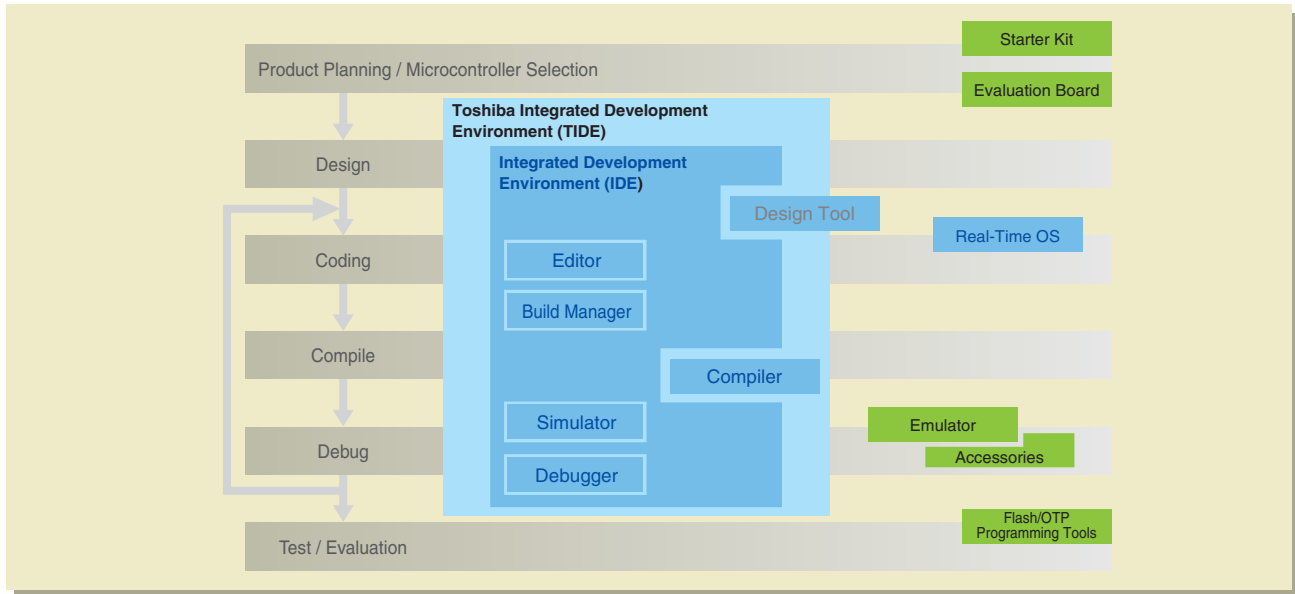
T6H Series line-up

	T6H82C	T6H87
CPU	TLCS-870/C	TLCS-870/C
ROM	32 KB	24 KB
RAM	1 KB	1 KB
I/O port	64	44
LCD driver (Built-in regulator/Charge-pump)	40SEG x 4COM	24SEG x 4COM
8-bit ADC	Input 8 ch (Internal 1 ch)	Input 8 ch (Internal 1 ch)
8-bit DAC	Output 2 ch (Internal 2 ch)	Output 2 ch (Internal 2 ch)
16-bit timer/counter	1 ch	1 ch
8-bit timer/counter	4 ch	4 ch
SIO	1 ch	1 ch
UART	1 ch	1 ch
External interrupt	12 ch	8 ch
Motor pre-driver	1.5 ch (P-ch/N-ch open drain x 3 ch)	1.5 ch (P-ch/N-ch open drain x 3 ch)
Operating voltage	1.8 to 5.5 V	1.8 to 5.5 V
Package	TQFP100/Die	LQFP80/Die

Development Systems

Toshiba offers a complete line of reliable, user-friendly development tools to support customers in each phase software development from product planning to evaluation.

Software Development Flowchart



Integrated Development Environment (IDE)

With individual development tools such as Editor, Build Manager, Compiler and Debugger integrated into a single system, the Integrated Development Environment (IDE) enables seamless execution of repetitive tasks in the software development process. Real-time OS debugging is also supported. The same IDE can be used for the TLCS-900 and TX19 Families.

Compiler

The C Compiler conforms to the ANSI C standard and offers excellent descriptiveness and portability. A wide range of options are provided to improve code efficiency and RAM utilization.

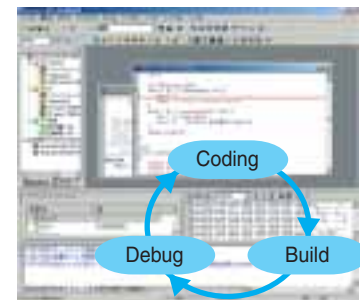
Real-Time OS

The Real-Time OS conforms to the μ TRON specifications. The configuration tool can facilitate various settings.

Emulator

The In-Circuit Emulator and/or On-Chip Debug Emulator are available according to the characteristics of each microcontroller. We are also expanding a line of emulators including the Integrated Development Environment (IDE)*.

* To be downloaded from our website.



Development System Offerings

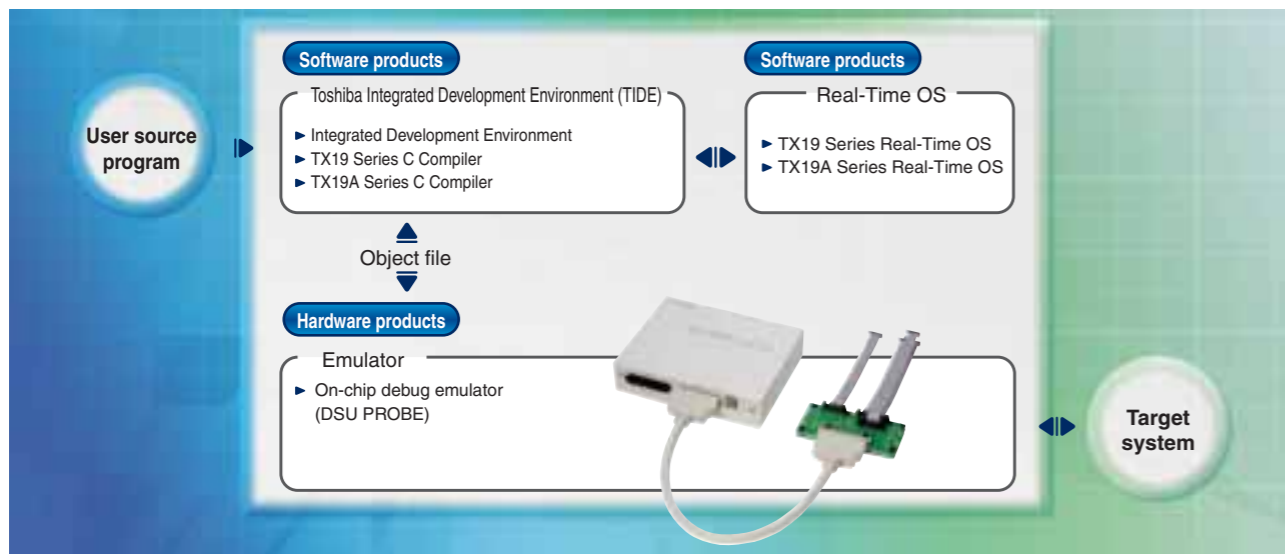
Toshiba offers various development systems for each microcontroller family. For details, please refer to the respective development system pages that follow.

In addition to the Toshiba original development systems, third-party tools are supported to aid your software development. For information about third party products supporting Toshiba's microcontrollers, please refer to pages 62 to 64.

Toshiba Microcontroller Family/Series	Software Products				Hardware Products	
	Integrated Development Environment	Debugger	Compiler	Real-Time OS	In-Circuit Emulator	On-Chip Debug Emulator
TX19 Family	●		●	●		●
TLCS-900 Family	●		●	●	●	○
TLCS-870 Family	870 Series	●	●		●	
	870/X Series		●		●	
	870/C Series	●**	●	●	●	
	870/C1 Series	●**		●**	●**	●**

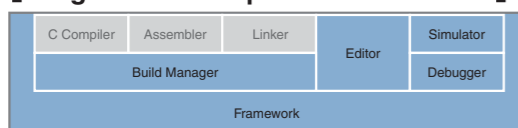
●: Available ○: Available for some products **: Under development

Outline of TX19 Family Development System



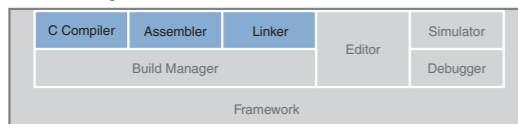
Toshiba Integrated Development Environment (TIDE)

【Integrated Development Environment】



With individual development tools such as Editor, Build Manager, Compiler and Debugger integrated into a single system, the Integrated Development Environment enables seamless operations of coding, building and debugging tasks which must be performed repeatedly in the software development process. It also contains a simulator function for simulating MCU operations for logical debugging, and a debug function supporting real-time OS.

【C Compiler】



The C Compiler package containing C Compiler, Assembler and Linker allows you to generate object files such as HEX files from source code written in C or assembly language. It conforms to the ANSI C standard and offers excellent descriptiveness and portability. A wide range of options are provided to improve code efficiency and RAM utilization. This product is used in combination with the Integrated Development Environment. TX19 Series version and TX19A Series version are available.

Real-Time OS

Software used to control multitasking in embedded systems.

- Conforms to μ TRON specifications.
- Provides various system calls required for embedded systems.
- Use of the configuration tool facilitates various settings.
- Offered in two versions: object code version and object code with source code version. The object code with source code version allows users to modify the source programs.

	TX19 Series		TX19A Series	
	Object code version	Object code with source code version	Object code version	Object code with source code version
μ TRON specifications	μ TRON 3.0 specifications		μ TRON 4.0 specifications	
Source programs	Not included	Included	Not included	Included
Configuration tool	TR Configurator		TRcEditor	

Emulator

The DSU PROBE is an on-board emulator that enables efficient debugging. It provides emulation and debugging features that are useful for developing application programs by being connected to the target system and operated from the debugger on a PC. The DSU PROBE comes with a download license for the Integrated Development Environment.



Development System Configuration Examples

The basic development system environment for the TX19 Family is summarized below. The specified values are the recommended values for comfortable use. For the minimum operating environment, check with the product manual of each development system product.

This section provides detailed configuration examples. It includes requirements for the Host machine (OS: Windows 2000/XP, CPU: Pentium 4 1 GHz or faster, Memory: 512 MB or larger, Display resolution: XGA (1020 x 768) or above, I/O port: 1 port (RS-232C) (TX19A only), Expansion slots: 1 port (for LAN card)), Hub (Ethernet hub, Support for 10BASE-T, Conformance to IEEE 802.3 Ethernet standard), LAN expansion card for PC (Ethernet network interface card, Support for 10BASE-T, Conformance to IEEE 802.3 Ethernet standard), and LAN cable (Twisted-pair cable). It also shows connection examples for the DSU PROBE to the target board.

Three specific configurations are detailed:

- TX19 series (DSU PROBE for N-WIRE system):**
 - Products required for minimal system: TIDE, C Compiler, Emulator, DSU PROBE for N-WIRE.
 - Other required products: Windows PC, LAN expansion card, Hub, RS-232C cross cable, LAN cable, Target connectors (20-pin half-pitch plug from AMP, 20-pin half-pitch plug from SAMTEC).
- TX19A series (DSU PROBE model 110 system):**
 - Products required for minimal system: TIDE, C Compiler, Emulator, DSU PROBE model 110.
 - Other required products: Windows PC, LAN expansion card, Hub, RS-232C cross cable, LAN cable, Target connectors (20-pin half-pitch plug from SAMTEC, 34-pin half-pitch plug from SAMTEC).
- TX19A series (DSU PROBE model 120 system):**
 - Products required for minimal system: TIDE, C Compiler, Emulator, DSU PROBE model 120.
 - Other required products: Windows PC, LAN expansion card, Hub, RS-232C cross cable, LAN cable, Target connectors (20-pin half-pitch plug from SAMTEC, 34-pin half-pitch plug from SAMTEC).

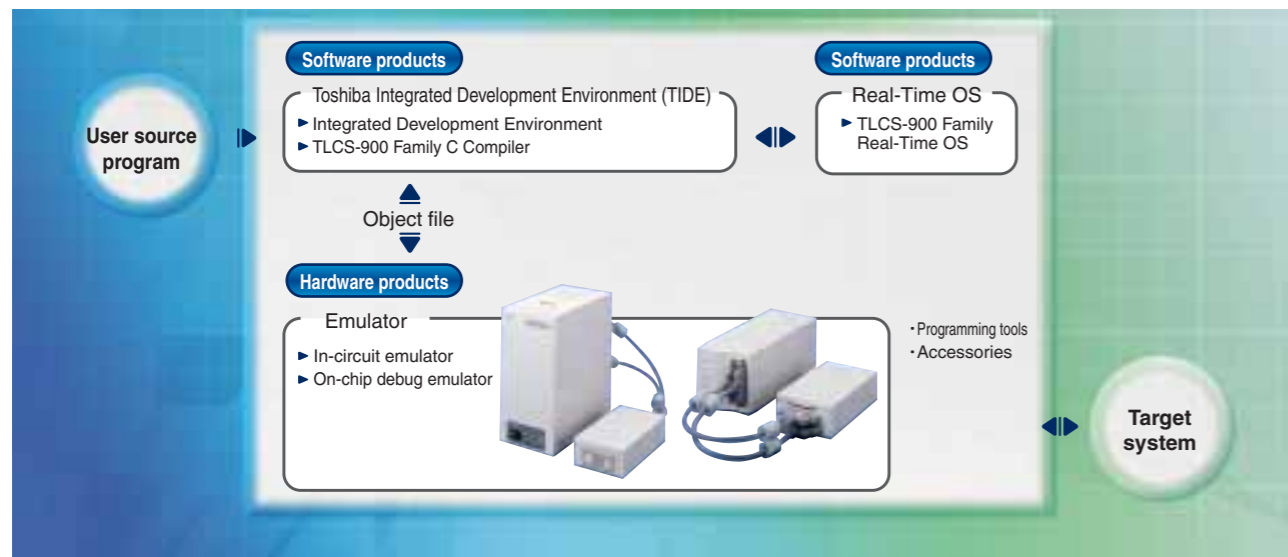
* For part numbers, see "PART NUMBER LIST" or our Development System website.

Basic Performance

System name	TX19 Series		TX19A Series	
	DSU PROBE for N-WIRE system		DSU PROBE model 110 system	DSU PROBE model 120 system
Host interface	Ethernet, RS-232C		Ethernet, RS-232C	
Events	Number of points	Instruction: 4 points, Data: 1 point (Note 1)	Instruction: 8 points, Data: 4 points	
	Comparison Items	Address, data, status, external input		
	Comparison conditions	Match		
	Pass count	Once	Once	1 to 256 times
Event trigger actions	Break, trace control, timer control, external trigger output		Break, trace control, timer control, external trigger output, external pulse output, memory write	
	Event combinations	-	-	OR, sequential
Break	Hardware break	4 points (Note 1)	8 points	
	Software break	256 points (settable only on RAM)	256 points (settable only on RAM)	
Trace memory	Capacity	4K frames	4K frames	128K frames
	Trace modes	Free trace, trigger trace, overflow stop	Free trace, trigger trace, overflow stop	
	Trace items	PC address, status, tag timer	PC address, status, tag timer	PC address, data address, data value, status, tag timer
External output	-		4 lines	
Timer measurement	Run timer: 1 channel	Lap timer: 1 channel	Run timer: 1 channel	Lap timer: 1 channel
Memory access	Memory display during program execution	-	Variables: 16-byte area x 32, Memory: Up to 1024 bytes	
	Memory rewrite during program execution	-	4 bytes x 4 blocks can be written simultaneously.	
Program variables	Display	Binary, octal, decimal or hexadecimal display can be selected for each variable.	Binary, octal, decimal or hexadecimal display can be selected for each variable.	
	Registration	Variables, arrays, structures and unions can be registered by the elements.	Variables, arrays, structures and unions can be registered by the elements.	
Source display	<ul style="list-style-type: none"> ● Source ● Source + assembler code ● Source + assembler code + machine language 		<ul style="list-style-type: none"> ● Source ● Source + assembler code ● Source + assembler code + machine language 	
Flash programming/security feature	Internal/external Flash memory can be programmed during debugging. (Note 2)		Internal/external Flash memory can be programmed during debugging.	
External input	1 line		1 line	

Note 1: Varies with the MCU to be used. Note 2: Some MCUs do not support this feature.

Outline of TLCS-900 Family Development System



Development System Configuration Examples

The basic development system environment for the TLCS-900 Family is summarized below. The specified values are the recommended values for comfortable use. For the minimum operating environment, check with the product manual of each development system product.

Host machine
 ● OS: Windows 2000/XP ● Host machine CPU: Pentium 4 1 GHz or faster (recommended)
 ● Memory: 512 MB or larger (recommended) ● Display resolution: XGA (1024 x 768) or above ● Expansion slots: 1 port (for LAN card)

Hub
 ● Ethernet hub
 ● Support for 10BASE-T
 ● Conformance to IEEE 802.3 Ethernet standard

LAN expansion card for PC
 ● Ethernet network interface card
 ● Support for 10BASE-T
 ● Conformance to IEEE 802.3 Ethernet standard

LAN cable
 ● Twisted-pair cable

RTE900 model 15 system

Products required for minimal system
 【Toshiba Integrated Development Environment (TIDE)】
 ● Integrated Development Environment1
 ● TLCS-900 Family C Compiler1
 【Emulator】
 ● model 15 controller1
 ● model 15 emulation pod1
 【Accessories】
 ● MCU probe ● Pin protector ● OTP programming adapter
 ● QFP adapter ● MCU mounting adapter ● Flash adapter

Other required products
 ● Windows PC1
 ● LAN expansion card for PC1
 ● Hub1
 ● RS-232C cross cable1
 ● LAN cable2

RTE900 model 25 system

Products required for minimal system
 【Toshiba Integrated Development Environment (TIDE)】
 ● Integrated Development Environment1
 ● TLCS-900 Family C Compiler1
 【Emulator】
 ● model 25 controller1
 ● model 25 emulation pod1
 【Accessories】
 ● MCU probe ● Pin protector ● OTP programming adapter
 ● QFP adapter ● MCU mounting adapter ● Flash adapter

Other required products
 ● Windows PC1
 ● LAN expansion card for PC1
 ● Hub1
 ● RS-232C cross cable1
 ● LAN cable2

* For part numbers, see "PART NUMBER LIST" or our Development System website.

Basic Performance

System name	TLCS-900/H1 Series ^(Note 1)		TLCS-900, 900/H, 900/L, 900/L1 Series	
	model 15 system	model 25 system	model 15 system	model 25 system
Host interface	Ethernet, RS-232C		Ethernet, RS-232C	
Emulation memory	Capacity: 4 Mbytes	Capacity: 4 Mbytes	Capacity: 1 Mbyte	Capacity: 4 Mbytes
Events	Number of points: 8 points	Number of points: 8 points	Number of points: 8 points	
	Comparison items: Address, data, status, external input	Comparison items: Address, data, status, external input	Comparison items: Address, data, status	Comparison items: Address, data, status, external input
	Comparison conditions: Match, unmatched, within scope	Comparison conditions: Match, unmatched, within scope	Comparison conditions: Match, unmatched, within scope	
	Pass count: 1 to 256 times	Pass count: 1 to 256 times	Pass count: 1 to 65535 times	
Break	Event trigger actions: Break, trace control, timer control, external trigger output	Event trigger actions: Break, trace control, timer control, external trigger output	Event trigger actions: Break, trace control, timer control, external trigger output	
	Event combinations: AND, OR, sequential	Event combinations: AND, OR, sequential	Event combinations: AND, OR, sequential	
Trace memory	Hardware break: 4 points	Hardware break: 4 points	Hardware break: 3 points	
	Software break: 1024 points	Software break: 1024 points	Software break: 1024 points	
External output	Capacity: 8K frames	Capacity: 8K frames	Capacity: 8K frames	
	Trace modes: Free trace, trigger trace, sampling trace, overflow stop	Trace modes: Free trace, trigger trace, sampling trace, overflow stop	Trace modes: Free trace, trigger trace, sampling trace, overflow stop	
Timer measurement	Trace items: PC address, data address, data value, status, external output, external input, tag timer, event	Trace items: PC address, data address, data value, status, external output, external input, tag timer, event	Trace items: PC address, data address, data value, status	Trace items: PC address, data address, data value, status, external input, tag timer, event
	External output: 1 line	External output: 1 line	External output: 1 line	
Memory access	Run timer: 1 channel, Lap timer: 1 channel	Run timer: 1 channel, Lap timer: 1 channel	Run timer: 1 channel, Lap timer: 1 channel	
	Memory display during program execution: 128 bytes	Memory display during program execution: 128 bytes	Memory display during program execution: 32 bytes	
Program variables	Display: Binary, octal, decimal or hexadecimal display can be selected for each variable.	Display: Binary, octal, decimal or hexadecimal display can be selected for each variable.	Display: Binary, octal, decimal or hexadecimal display can be selected for each variable.	
	Registration: Variables, arrays, structures and unions can be registered by the elements.	Registration: Variables, arrays, structures and unions can be registered by the elements.	Registration: Variables, arrays, structures and unions can be registered by the elements.	
Source display	● Source	● Source	● Source	
	● Source + assembler code	● Source + assembler code	● Source + assembler code	
External input	● Source + assembler code + machine language	● Source + assembler code + machine language	● Source + assembler code + machine language	
	External input: 1 line	External input: 1 line	External input: 16 lines	
Performance analysis	Time measurement per module: Max., min, average, count, dispersion	Time measurement per module: Max., min, average, count, dispersion	Time measurement per module: Max., min, average, count, dispersion	
	Coverage measurement: C0 coverage	Coverage measurement: C0 coverage	Coverage measurement: C0 coverage	

Note 1: When you are using a device whose part number starts with TMP92.

Toshiba Integrated Development Environment (TIDE)

【Integrated Development Environment】

With individual development tools such as Editor, Build Manager, Compiler and Debugger integrated into a single system, the Integrated Development Environment enables seamless operations of coding, building and debugging tasks which must be performed repeatedly in the software development process. It also contains a simulator function for simulating MCU operations for logical debugging, and a debug function supporting real-time OS.

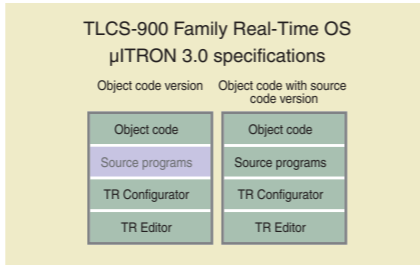
【C Compiler】

The C Compiler package containing C Compiler, Assembler and Linker allows you to generate object files such as HEX files from source code written in C or assembly language. It conforms to the ANSI C standard and offers excellent descriptiveness and portability. A wide range of options are provided to improve code efficiency and RAM utilization. This product is used in combination with the Integrated Development Environment.

Real-Time OS

Software used to control multitasking in embedded systems.

- Conforms to μITRON specifications.
- Provides various system calls required for embedded systems.
- Use of the TR Configurator facilitates various settings.
- The TR Editor can be used to describe task operations graphically and to generate program outlines.
- Offered in two versions: object code version and object code with source code version. The object code with source code version allows users to modify the source programs.



Emulator

【RTE900 model 15 system】

The model 15 system is a low-cost version of the model 25 system that is realized by offering the minimum functionality required for development work and an extensive use of gate arrays.

【RTE900 model 25 system】

The model 25 system features enhanced hardware that enables faster processing to support high-speed and high-functionality MCUs and provide advanced debug capability such as performance analysis.

* A combination of the model 25 controller and the model 15 emulation pod is also possible.

The controller comes with a download license for the Integrated Development Environment.



Outline of TLCS-870 Family Development System



【Language Tools】

C Compiler / C-Like Compiler	Assembler	Linker
Build Manager		

These software tools containing C Compiler, Assembler and Linker allow you to generate object files such as HEX files from source code written in C, C-Like(*) or assembly language. They conform to the ANSI C standard and offer excellent descriptiveness and portability. A wide range of options are provided to improve code efficiency and RAM utilization. * Supported only with some series in the TLCS-870 Family.

【Debugger】

- The emulator system for a TLCS-870 Family MCU can be configured by an appropriate combination of a debugger and an emulation pod.
- A wide variety of debug functions are available including various types of break settings and real-time trace.

【Integrated Development Environment】(Under development)

The TLCS-870/C Series Debugger and TLCS-870/C Series Light Debugger are scheduled to be replaced by the Integrated Development Environment.

Basic Performance

System name	TLCS-870 Series	TLCS-870/C Series		TLCS-870/X Series	
	model 10 system	Light system	model 15 system	model 15 system	model 25 system model 15 pod model 25 pod (Note 1)
Host interface	RS-232C	USB2.0 Full-speed	Ethernet, RS-232C	Ethernet, RS-232C	
Emulation memory	Capacity	64 Kbytes	64 Kbytes	1 Mbyte	
	Number of points	4 points	4 points	8 points	
Events	Comparison items	Address, data, status, external input	Address, data, status	Address, data, status	Address, data, status, external input
	Comparison conditions	Match, unmatched, within scope	Match, unmatched, within scope	Match, unmatched, within scope	
	Pass count	1 to 65535 times	1 to 65535 times		1 to 65535 times
	Event trigger actions	Break, trace control, timer control, external trigger output	Break	Break, trace control, timer control, external trigger output	Break, trace control, timer control, external trigger output
	Event combinations	OR, sequential	OR, sequential	AND, OR, sequential	AND, OR, sequential
Break	Hardware break	4 points	2000 points	2000 points	3 points
	Software break	-	2000 points	2000 points	-
Trace memory	Capacity	4K frames	1K frames	8K frames	8K frames
	Trace modes	Overflow stop	Overflow stop	Free trace, trigger trace, sampling trace, overflow stop	Free trace, trigger trace, sampling trace, overflow stop
	Trace items	PC address, data address, data value, status, external input	PC address, data address, data value, status	PC address, data address, data value, status, external input, tag timer	PC address, data address, data value, status, external input, tag timer
External output	1 line	-	1 line	1 line	
Timer measurement	Run timer or Lap timer: 1 channel	Run timer: 1 channel	Run timer: 1 channel	Lap timer: 1 channel	Run timer: 1 channel
Memory access	Memory display during program execution	-	-	32 bytes	32 bytes
	Memory rewrite during program execution	-	2 bytes		2 bytes (Note 2)
Program variables	Display	Binary, octal, decimal or hexadecimal display can be selected for each variable.	Binary, octal, decimal or hexadecimal display can be selected for each variable.	Binary, octal, decimal or hexadecimal display can be selected for each variable.	
	Registration	Variables, arrays, structures and unions can be registered by the elements.	Variables, arrays, structures and unions can be registered by the elements.	Variables, arrays, structures and unions can be registered by the elements.	
Source display	<ul style="list-style-type: none"> Source Source + assembler code Source + assembler code + machine language 	<ul style="list-style-type: none"> Source Source + assembler code Source + assembler code + machine language 	<ul style="list-style-type: none"> Source Source + assembler code Source + assembler code + machine language 	<ul style="list-style-type: none"> Source Source + assembler code Source + assembler code + machine language 	
External input	8 lines	-	-	16 lines	
Performance analysis	Time measurement per module	-	-	-	Max., min., average, count, dispersion
	Coverage measurement	-	-	-	C0 coverage

Note 1: model 25 pod: BM88CM49N0A, BM88CU74F0A, BM88CP77F0A, BM88C060F0A
 Note 2: This function is not supported with the BM88CM49N0B-M15.

Development System Configuration Examples

The basic MCU-dependent development system environment for the TLCS-870 Family is summarized below. The specified values are the recommended values for comfortable use. For the minimum operating environment, check with to the product manual of each development system product.

【Hub】

- Ethernet hub
- Support for 10BASE-T
- Conformance to IEEE 802.3 Ethernet standard

【LAN expansion card for PC】

- Ethernet network interface card
- Support for 10BASE-T
- Conformance to IEEE 802.3 Ethernet standard

【Host machine】

- Host machine CPU: Pentium 4 133 MHz or faster
- Memory: 128 MB
- Display resolution: XGA (1024 x 768) or above
- Expansion slots: 1 port (for LAN card)

TLCS-870/C Series

RTE870/C Light system

As the RTE870/C Light system is designed to share products within the system, the probe, target connector and emulation chip need to be changed to accommodate different MCUs in the TLCS-870/C Series. * Detailed information on the RTE870/C Light system can be found on page 8. The RTE870/C Light system is a low-cost version of the RTE870/C model 15 system with the minimum functionality required for development work.

Products required for minimal system

- TLCS-870/C Series C Compiler1
- TLCS-870/C Series Light Debugger1

【Emulator】

- Light emulator1
- Emulation chip1

【Accessories】

- Light-system probe (probe set).....1
- MCU mounting adapter (Bump socket)

【Programming tools】

- OTP programming adapter
- Flash adapter

Other required products

- Windows PC1
- USB cable (USB standard A to B).....1

RTE870/C model 15 system

As the RTE870/C model 15 system is designed to share products within the system, only the target connecting board and emulation chip need to be changed to accommodate different MCUs in the TLCS-870/C Series. In this way, the cost associated with a change of MCU is lowered. (Some MCUs also require a change of the emulation module.)

Products required for minimal system

- TLCS-870/C Series C Compiler1
- TLCS-870/C Series Debugger1

【Emulator】

- model 15 controller1
- Interface module1
- Emulation module1
- Target connecting board1
- Emulation chip1

【Accessories】

- QFP adapter
- Pin protector
- MCU mounting adapter

【Programming tools】

- OTP programming adapter
- Flash adapter

Other required products

- Windows PC1
- LAN expansion card for PC1
- Hub1
- LAN cable2

TLCS-870/X Series

RTE870/X model 25 system

The RTE870/X model 25 system offers advanced debug capability such as performance analysis.

RTE870/X model 15 system

The RTE870/X model 15 system is a low-cost version of the RTE870/X model 25 system with the minimum functionality required for development work.

Products required for minimal system

- TLCS-870/X Series C Compiler1
- TLCS-870/X Series Debugger1

【Emulator】

- model 15 controller1
- model 15 emulation pod1

【Accessories】

- MCU probe
- QFP adapter
- Pin protector
- MCU mounting adapter

【Programming tools】

- OTP programming adapter
- Flash adapter

Other required products

- Windows PC1
- LAN expansion card for PC1
- Hub1
- LAN cable2

TLCS-870 Series

RTE870 model 10 system

Products required for minimal system

- TLCS-870 Series C/C-Like Compiler1
- TLCS-870 Series Debugger1

【Emulator】

- model 10 controller1
- model 10 emulation pod1

【Accessories】

- MCU probe
- QFP adapter
- Pin protector
- MCU mounting adapter

【Programming tools】

- OTP programming adapter

Other required products

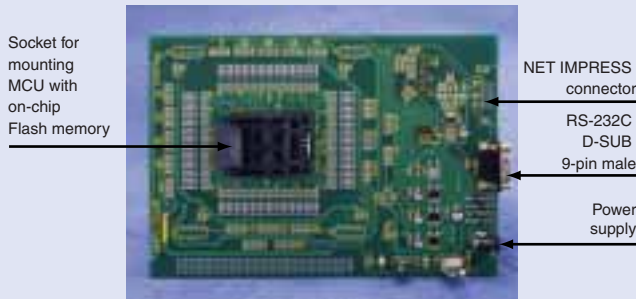
- Windows PC1
- RS-232C cross cable1

* For part numbers, see "PART NUMBER LIST" or our Development System website.

Development System Programming Tools

Flash adapter

The Flash adapter is provided for each package type of Toshiba's microcontrollers with on-chip Flash memory. Connecting the Flash adapter with a host system allows you to program, erase, and verify on-chip Flash memory. Although this tool can be used both for product development and mass production, some limitations apply when it is used for mass production. For details, visit Toshiba's Microcomputer website. The website provides various support information for the Flash adapter including its control software upgrades to flexibly support newly developed devices.



- Enables Toshiba's Flash microcontrollers to be programmed on a stand-alone basis.
- Can be used with Toshiba's Flash microcontrollers of any Family or Series in the same package.
(*The user is required to connect write signals and mount oscillators as appropriate to each device.)
- Comes with "Flash Programmer"-programming control software controllable on a PC.
- Ensures ease of operation through the GUI-based control software.
- Allows programmed data to be compared on a byte basis.
- Yokogawa Digital Computer's programmer (NET IMPRESS) can be used as a host system.



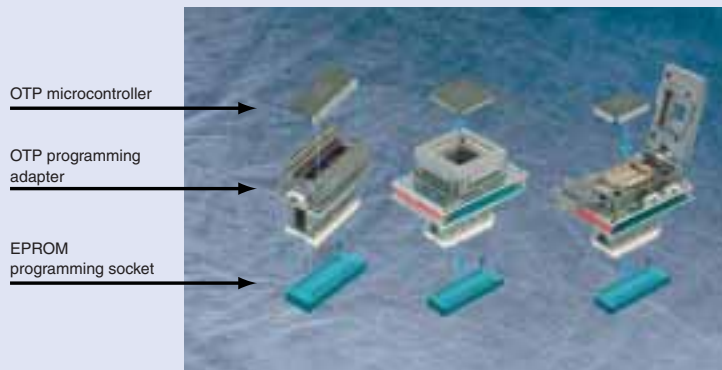
Connection example

Specifications of the Flash Adapter

Writing mode	Serial Interface mode
Supported MCU	Toshiba microcontrollers with on-chip flash memory
Device functions	Save, Program, Read, Erase, Blank check, Verify, Compare, Auto programming
Supported OS	Windows 2000, Windows XP
Host interface	Connecting to PC: 9-pin male D-sub, UART, straight cable Connecting to NET IMPRESS: DX10-28S, UART/CSI
Power supply	100 to 240 V AC

OTP programming adapter

This is an adapter for converting the pinout of an OTP microcontroller to that of a general-purpose EPROM. The OTP programming adapter enables an OTP microcontroller to be programmed and verified by an off-the-shelf EPROM programmer. This adapter is provided for each OTP microcontroller type.



Development System Accessories

MCU probe

The MCU probe is used to connect a target system and an emulation pod, and is provided for each package type. The MCU probe used for a flat package comes with a QFP adapter and a pin protector.

Pin protector

The pin protector is a protective socket for an MCU probe and a QFP adapter. Be sure to use the pin protector to prevent MCU probe's joint from losing its spring after repeated attachments and detachments.

* We recommend replacing the pin protector after 100 attach-detach cycles.

QFP adapter

The QFP adapter is used to connect an emulation pod or an emulation module to a target system designed for a QFP-type microcontroller. It is soldered onto the foot pattern on the target system board.

* Once soldered, the QFP adapter cannot be reused.

Probe set

The probe set is used specifically with the RTE870/C Light emulator or the RTE870/C1 in-circuit emulator. It is available for each package pin count or package type of the supported MCUs.

* For example, the probe set includes:

- Probe
- Exchange adapter
- Target connector

Package exchange adapter

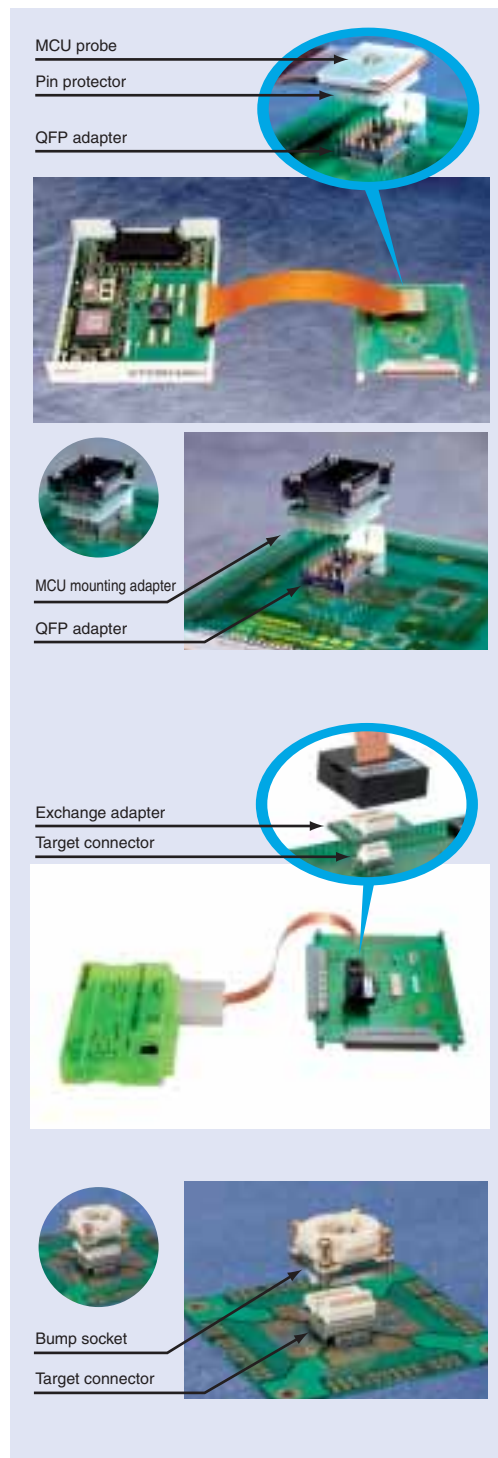
The package exchange adapter is used when the target MCU package and probe package are of different types.

MCU mounting adapter

The MCU mounting adapter is used together with the QFP adapter to mount a microcontroller on the target system.

Bump socket

The bump socket is used specifically with the RTE870/C Light emulator or the RTE870/C1 in-circuit emulator. It is used together with the target connector to mount an MCU on the target system.



The pin protector and QFP adapter of the same specifications are also available from Tokyo Eletech Corporation. http://www.tetc.co.jp/e_index.htm

The probe sets and bump sockets are manufactured by ADLINKS Corporation. For product specifications, visit the ADLINKS website. <http://www.adlinks.co.jp>

For part numbers and tool combinations, see "PART NUMBER LIST" or Development System website.

Third-Party Development Support Tools

For details, please contact the third-party companies directly. (Listed in alphabetical order)

ADLINKS Corporation

<http://www.adlinks.co.jp/>

ADLINKS

ADLINKS Corp. is an innovative company that specializes in sockets, adapters, harnesses and boards for high-speed transmission with the aim of ensuring 'comfortable user interface'. The ADLINKS products supporting Toshiba's development systems include the probe sets for the TLCS-870/C Series and MCU mounting adapters (Bump Socket).



Advanced Data Controls Corp.

<http://www.adac.co.jp/eng/>



Since its incorporation in 1982, Advanced Data Controls Corp. has always been committed to pursuing 'Optimum Software Development Environments' to provide cutting-edge total solutions that best meet the customer needs. As a technical partner of Green Hills Software, Inc. of the United States, the company also distributes Green Hills Software's high-performance, high-quality embedded software development solutions with extensive support services in Japan and the Asian region.



CATS CO., LTD.

<http://www.zipc.com/english/>



CATS CO., LTD is a supplier of 'ZIPC', a CASE tool for embedded systems based on the state transition matrix. ZIPC provides seamless support for each phase of software development by offering the modeling, model debug (simulation) and automatic code generation functions through its editor supporting six types of document. In addition, the connection of ZIPC with the Toshiba Integrated Development Environment (TIDE) allows unified debugging of the actual system and design specification (state transition matrix), contributing to the enhancement of product manufacturability and quality.



COMPUTEX CO., LTD.

<http://www.computex.co.jp/>

Computex

COMPUTEX CO., LTD. is an expert in software debug tools for embedded systems. 'PALMICE2 Series' is a JTAG emulator supporting the TX49 Family that provides a highly efficient debug solution covering high-level languages and Linux. 'ROMICE64' supports the TLCS-900/L1 Series.



Flash Support Group, Inc.

<http://www.j-fsg.co.jp/en/>



Flash Support Group, Inc. offers a line of products that enable high-speed programming for development to prototyping and volume production. The company's programmers support the TX19, TLCS-900, and TLCS-870 Families. Programming services using these programmers are also available.



GAIA System Solutions Inc.



GAIA System Solutions Inc. is engaged in the sales of high-speed software/hardware co-simulators for embedded software development and related support and consulting services. Supported CPU models include the TX19 Series, TX19A Series, TX49 Family and TX99 Family. Supported debugger models include the Toshiba Integrated Development Environment (TIDE) and MULTI® from Green Hills Software, Inc.



GAIO TECHNOLOGY CO., LTD.<http://www.gaio.com/>

GAIO TECHNOLOGY CO., LTD. offers high-quality software verification tools for embedded systems.

'Coverage Master - winAMS' is a testing simulator supporting the TLCS-900 Family and TLCS-870/C Series that enables high-precision function module testing and C0/C1 coverage testing. 'CasePlayer2' is an embedded program analysis tool which can be used to automatically generate flow charts and module structure charts and to perform MISRA-C code verification.

**GOTOP MICRO-ELECTRONICS CO., LTD.**<http://www.itool.com.cn/>

GOTOP MICRO-ELECTRONICS CO., LTD. boasts a professional team with more than 10-year experience specializing in the design, manufacture and support of embedded development tools. GOTOP offers a complete range of development tools, such as the Integrated Development Environments, emulators, debuggers, programmers, etc. For Toshiba, GOTOP provides an emulator tool for the 870/C Series ('TMPmate') and a demo board for the 870/C Series ('TPDEM4').

**Hamamatsu TOA Electronics, Inc.**

浜松東亜電機株式会社

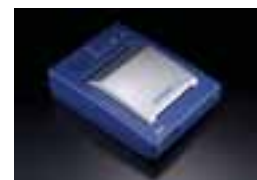
Hamamatsu TOA Electronics, Inc. is an authorized distributor of Toshiba's microcontroller support products based in Hamamatsu in the Shizuoka prefecture. In addition to the sales of various electronic components, Hamamatsu TOA Electronics is also engaged in the commercialization and online sales of boards and starter kits using Toshiba's microcontrollers. The company can deliver total services encompassing the designing, prototyping, volume production and inspection for MCU control circuitry, logic circuitry and analog circuitry with short delivery times.

**HI-LO SYSTEM RESEARCH CO., LTD.**<http://www.hilosystems.com.tw/>

HI-LO SYSTEMS is a professional company dedicated to providing cost-effective device programming solutions to customers. Established in 1983 and located in Nei-Hu Technology Park in Taipei Taiwan, HI-LO distributes its famous ALL-100 Universal/Gang Programmer series and AT3-300 Automated Programmer series to customers worldwide. HI-LO has a very good reputation in providing high-quality engineering programmers and automated programmers for MCU and Flash memory.

**Kyoto Microcomputer Co., Ltd.**<http://www.kmckk.co.jp/eng/>

As a company specializing in debugger software and in-circuit emulators, Kyoto Microcomputer Co., Ltd. has been engaged in the improvement of embedded development environments. Its JTAG ICE, 'PARTNER-Jet', offers a powerful and efficient debug environment incorporating advanced features ahead of other companies, such as support for multi-core processors and operating systems with an MMU (Linux, Windows CE, T-Engine, etc.) that are recently adopted in high-end embedded environments. PARTNER-Jet supports the TX49 and TX99 Families.

**MICROTEK Inc.**http://www.microtek.co.jp/english/index_f.html

MICROTEK Inc. embarked on contract IC programming in 2000. Since then, the company has been building a successful track record in a wide range of fields including communications, information home appliances and automotive applications as a reliable provider of IC programming services.



Third-Party Development Support Tools

For details, please contact the third-party companies directly. (Listed in alphabetical order)

MINATO ELECTRONICS INC.

http://www.minato.co.jp/index_e.asp



MINATO ELECTRONICS INC. developed the first 'device programmer' in Japan when PROM first came on the market. Since then, the company has been occupying the leading position in the programmer field. Its product line includes not only programmers but also auto programming equipment and exchange adapters for a wide variety of packages to meet various programming needs of customers. MINATO's programmers support the TX19, TLCS-900, and TLCS-870 Families.



Shanghai Gengyan Electronic Technology Co., Ltd.

<http://www.gengyan.com/>



Shanghai Gengyan Electronic Technology Co., Ltd provides programmers for the Toshiba 870/C Series. These high-quality and high-speed programmers have a USB interface. The programmers support TMP86P807/808, TMP86F807/808, TMP86FH09, TMP86FH46A/47A, TMP86FS49A/23 and others.



Sophia Systems Co., Ltd.

<http://www.sophia-systems.com/>



Sophia Systems Co., Ltd. provides development environments supporting Toshiba's microcomputers, including a starter kit for the TX19A71, a Flash ROM programmer for the TX19A, and emulators for the TX49/TX99, MeP, Cell Broadband Engine and ARM7/9/11. The company's cooperation with Toshiba extends to the design and development of custom boards and the development and manufacture of microcomputer systems on a contract basis.



TOKYO ELETECH CORPORATION

http://www.tetc.co.jp/e_index.htm



TOKYO ELETECH CORPORATION develops and manufactures interface products for connecting Toshiba's emulators with microcomputer boards developed by customers. In addition to standard IC sockets, adapters and cables, TOKYO ELETECH also accepts custom orders in small quantities.
[Standard products]

1. TQPACK, NQPACK, NSPAC, BGA sockets
2. KC cables, TEC-KC cables
3. SICA (JTAG adapters), EXA adapters



T.S ELECTRONICS CO., LTD

<http://www.tsecl.com/>



T.S Electronics is a support company for Toshiba Korea. T.S Electronics supports programming writers for Flash microcontrollers. The programming writers feature compact size and support the TLCS-870 Family. T.S Electronics also has a plan for a TLCS-900 Family writing board. For details, please contact the sales and marketing division.



Yokogawa Digital Computer Corporation

<http://www.yokogawa-digital.com/en/>



Yokogawa Digital Computer Corporation offers an extensive range of products related to the design and development of microcomputer and peripheral systems, including the 'advice' series of in-circuit emulators and the 'NET IMPRESS' series of flash microcomputer programmers. Drawing on its expertise in the embedded development field, the company also offers various development platforms, the Windows Embedded CE development starter kit and development process improvement tools for building an ideal development environment. The 'advice' series supports the TX49, TX99, and TLCS-900 Families. The 'NET IMPRESS' series supports the TX19, TLCS-900, and TLCS-870 Families.



Software Development Support

Toshiba provides a variety of reference software for supporting system development. At customer request, we can also develop application software for embedding in microcontroller units (MCUs).

Toshiba Software IP Lineup

We have a comprehensive software IP set for customers using (or considering using) Toshiba MCU products. The software IP and its user support are offered on certain terms and conditions. In addition, you are required to make an agreement separately in order to use this software IP.

Software IP	MCU/Series	Features	Status
USB1.1 (device)	TMP92CH21FG TMP92CZ26A TMP92CF26A TMP92CF29	Exchange of various data is readily achievable by connecting to PC. Supports standard request, various types of class request, and vendor commands.	Available
Embedded file system	TLCS-900/L1, H1	File system for embedding. Supports FAT12/16/32 and VFAT, and can perform file sharing with PC.	Available
Speech codec	TLCS-870/C TLCS-900/L1, H1	Toshiba original compression algorithm. The CPU load and memory usage are optimized to enable also the control of peripheral devices with embedded state in single-chip microcontroller. Speech codec application development environment and evaluation board are available.	Available
SD Memory Card Driver	TLCS-900/L1, H1	Driver Software for reading and writing SD card with MCU. Can transfer files to and from a PC, being incorporated in an embedded file system.	Available
Handwritten Recognition	TLCS-900/L1, H1	Software that recognizes handwritten characters on a LCD panel with a touchscreen. An embedded device incorporating this software can realize a user-friendly input interface without any exclusive input device such as key board.	Available

Some of the above software IPs require a separate real-time OS (Toshiba's TR900).

Display the following URL for the overviews of these software IPs.

http://www.semicon.toshiba.co.jp/eng/product/micro/software_ip/index.html

Software IP [Partner Vendor]

Partner Vendor	Software IP	MCU/Series	Features
Techno Mathematical Co.,Ltd. http://www.tmath.co.jp/index.html	MP3 Decoder	TMP92CZ26A TMP92CF26A TMP92CF29	This is a decoder that complies with MPEG1/MPEG2 Audio Layer III (ISO/IEC 11172-3, 13818-3) and is optimized for Toshiba microcontrollers. It has achieved high-quality sound and low power consumption.

To learn more about this software product and the software license, please contact your local Toshiba office.

Reference Application Software (RAS)

RAS is software for driving an entire system, whose specifications have been created by Toshiba. RAS is developed for reference with the aim of reducing customer software development time, so it is used and evaluated by customers themselves.

System name	FTS-171	FTS-172 (Under development)	FTS-151	CTS-777	CTS-851
Application	Multi-system color LCD TVs	Multi-system color LCD TVs supporting HDMI with CEC function	FS channel tuning for NTSC color LCD-TV with support for North American CCD and V-Chip	VS channel tuning for multi-system color TVs	FS channel tuning for NTSC color TVs with support for North American CCD and V-Chip
Display	VGA/WXGA	VGA	VGA/WXGA	CRT	CRT
MCU	TMP88CS34FG TMP88CS38BFG	TMP88CS34FG	TMP88CS34FG TMP88CS38BFG	TMP88CP34NG/FG	TMP88CS38NG/FG
Sub MCU	-	TMP86FS49AUG (HDMI Receiver LSI:TC90704MFG)	-	-	-
Chip IC for color TVs	TC90200FG	TC90200FG	TC90200FG	TB1261ANG	TB1263NG
Channels in memory	200	200	US181CH	100/200	US181CH
Sound multiplexing	NICAM/IGR	NICAM/IGR	Sound multiplexing for US	NICAM/IGR	Sound multiplexing for US

A separate contract is necessary to use RAS. Please consult with us about modifying software to suit customer systems and specifications.

Introducing the Latest Software IP

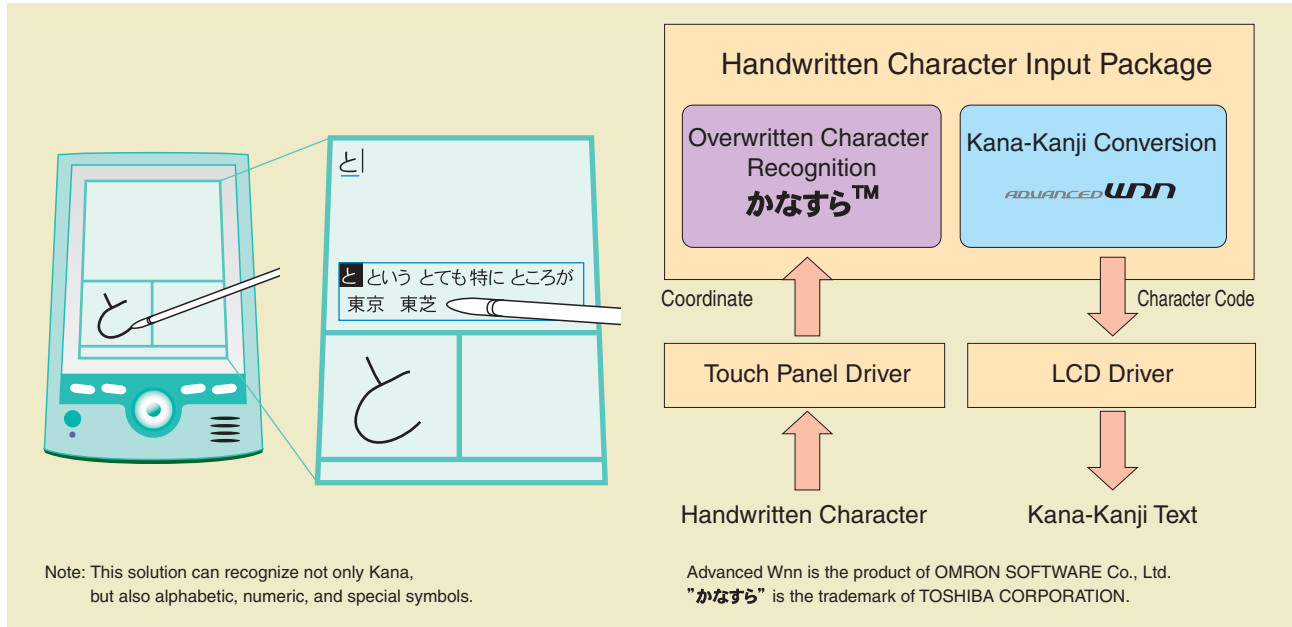
Handwritten Character Input Solution

We offer a comfortable solution of handwritten character input achieved by the interaction between the handwritten character recognition and Kana-Kanji conversion.

In addition to the input continued at an uninterrupted pace that was succeeded by Toshiba's original technology of overwritten character recognition, the cooperation with an advanced Kana-Kanji prediction and conversion technology has achieved costless input, which made the input of long sentences stressless. This software is the best thing for wide range of applications that use LCD and touch panel such as PDA (Personal Digital Assistant), electric dictionary, home electric appliances.

As for MCU to use, our TLCS-900/H1 series is recommended.

Example of Application



Start of Web download services

Application Notes

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

An application note is a sample software product offered by Toshiba to help customers understand Toshiba microcontrollers and learn how to create programs when developing new products. To access a download page, go to "Application Notes" from the above URL through "Microcomputer." If you accept and agree to the terms and conditions for usage, you will see an application notes list displayed. The application notes for Toshiba **870/X** and **900/H** Series are released first, and those for other MCUs will also be released sequentially.

TLCS-870/X	TLCS-900/H
Creating TOD Clock Using TBT Interrupts	Generating Interrupts at Regular Intervals Using 8-bit Timer
Detecting Keys Using a Timer	Generating Interrupts at Regular Intervals Using Cascaded 8-bit
Detecting Keys Using an AD Converter	Outputting 50%-Duty Pulses Using 8-bit Timer
RS-232C Communication Using UART	Outputting PWM Waveform Using 8-bit Timer
Generating Tone Using PDO	Outputting PPG Waveform Using 8-bit Timer
Inter-CPU Communication (Transmission + Reception) Using SIO	Outputting Single-Shot Pulse Using External Trigger Pulse
Inter-CPU Communication (Simultaneous Transmission/Reception) Using SIO	Counting Events Using 16-bit Timer
Measuring AC Frequency Using Pulse Width Measurement Mode	Measuring Frequency Using 16-bit Timer
⋮	⋮

Guide to Websites

Toshiba Semiconductor Website

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

Solutions

Latest information on system solutions is provided by application.

Product Information

A wide range of product information is available, including new product descriptions and presentation materials.

Toshiba Microcomputer Website

<http://www.semicon.toshiba.co.jp/eng/product/micro/index.html>

The Toshiba Microcomputer website offers the latest information on Toshiba's microcomputer and development systems. Customers looking for a microcomputer can browse through our web pages containing presentation materials and product descriptions which introduce Toshiba's microcomputer products by function and application. These pages allow you to access the datasheet download page with a single click. The product search feature enables you to quickly find the datasheet of a Toshiba microcomputer that best meets your needs by simply selecting desired product features, such as on-chip peripherals and a ROM type and capacity.

The website also offers various support services to customers who have purchased Toshiba's development system, including downloading of software products and technical documentation as well as technical updates on purchased products.

To support your product development, we provide application notes to assist you in understanding Toshiba's microcomputers and creating software programs as well as a variety of software IP.

Microcomputer Product Search by Function

Quick product search



64bit	32bit	16bit	8bit	4bit
T8000 Family	T8000 Family	80000 Series	80000 Series	41E
T8000 Series	T8000 Series	80000 Series	80000 Series	41E
T8000 Series	T8000 Series	80000 Series	80000 Series	41E
T8000 Series	T8000 Series	80000 Series	80000 Series	41E
T8000 Series	T8000 Series	80000 Series	80000 Series	41E
T8000 Series	T8000 Series	80000 Series	80000 Series	41E
T8000 Series	T8000 Series	80000 Series	80000 Series	41E
T8000 Series	T8000 Series	80000 Series	80000 Series	41E
T8000 Series	T8000 Series	80000 Series	80000 Series	41E
T8000 Series	T8000 Series	80000 Series	80000 Series	41E

Product datasheets and information on development systems are provided for each series.

Select Microcomputer > Family > Series. The Development System page can be accessed from the left-hand navigation area.

Development System Product Support

We provide various support services to customers who have purchased Toshiba's development system, including the following:

- Latest information on your purchased product
- Downloading of software products and technical documentation
- E-mail updates on technical reports and new version releases

User registration from the website will give you a customer ID and password for receiving these services.

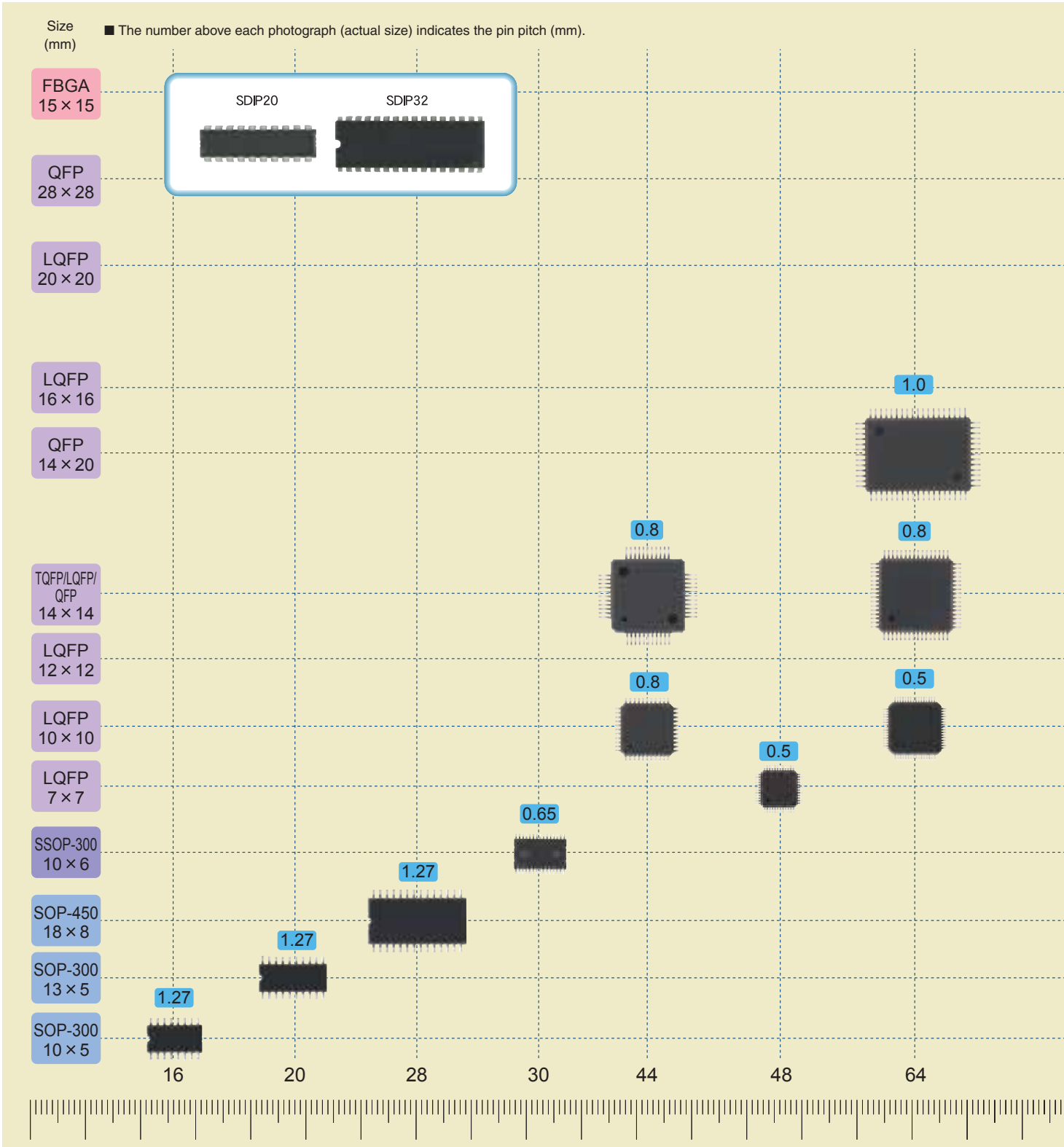


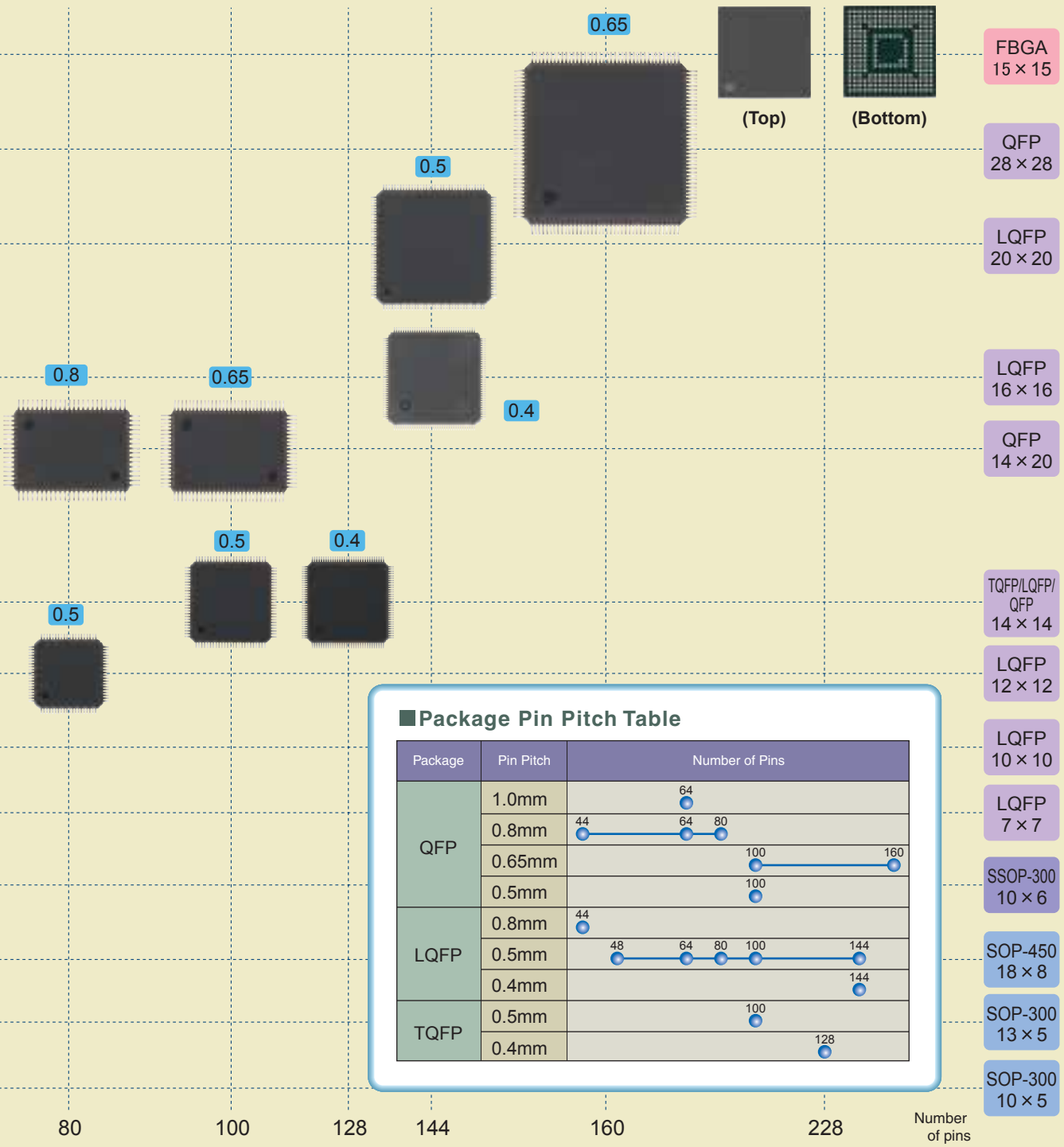
Package List

Microcomputer package summary

To meet customers' needs Toshiba provides a wide range of highly reliable packages for high-density mounting. In particular, Toshiba's miniature packages for portable applications offer extensive choices ranging to products as compact as 144-pin and 0.4-mm pitch.

SDIP/SOP/SSOP/QFP/FBGA Packages for 4-/8-/16-/32-Bit Microcontrollers





Package List

TX System RISC Packages (Actual Size)

TX99:



TX9956XBG(Top)



TX9956XBG (Bottom)

TX39:



TMPR3927CFE



TMPR3916FG

TX19:



TMP1940CYAFG
TMP1940FDBFG
TMP1941AFG
TMP19A71CYUG
TMP19A71FYUG



TMP1942CYU
TMP1942CZUE
TMP1942FDU

(Top)



TMP1942CZXBG
TMP1942FDXBG

(Bottom)

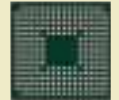


(Top)



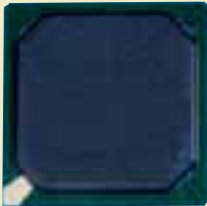
TMP1962C10BXBG
TMP1962F10AXBG
TMP19A64C1DXBG
TMP19A64F20BXBG

(Bottom)



TX49:

(Top)

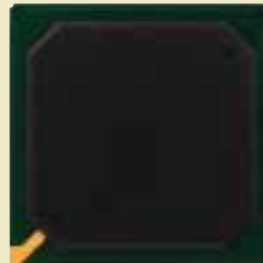


TX4939XBG

(Bottom)

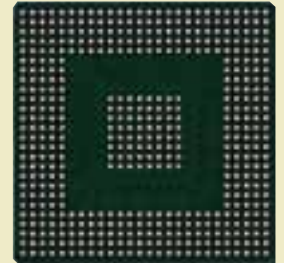


(Top)



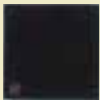
TMPR4937XBG
TMPR4938XBG

(Bottom)



TMPR4937XBG
TMPR4938XBG

(Top)



TMPR4956CXBG

(Bottom)



(Top)



TMPR4951BFG

(Top)



TC86C001FG



TMPR4955AFG
TMPR4955BFG
TMPR4955CFG





TMPR3911BU



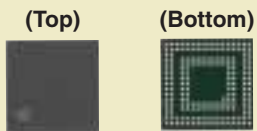
TMPR3912AUG-92



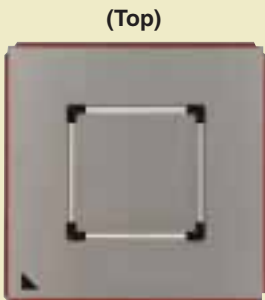
TMPR3911BxB



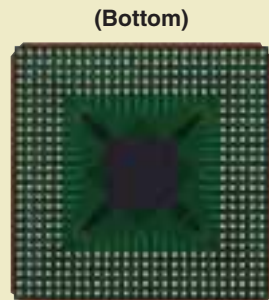
TMPR3912XB-92



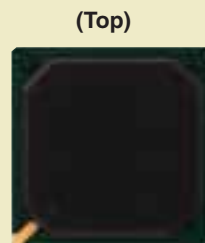
TMP19A43FDXBG
TMP19A43FZXBG
TMP19A43CDXBG
TMP19A43CZXBG



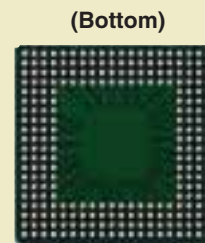
TMPR4927ATBG



TMPR4927ATBG



TMPR4925XBG
TMPR4926XBG



TMPR4925XBG
TMPR4926XBG

Toshiba America Electronic Components, Inc.

Headquarters-Irvine, CA
19900 MacArthur Boulevard,
Suite 400, Irvine, CA 92612, U.S.A.
Tel: (949)623-2900 Fax: (949)474-1330

Boulder, CO (Denver)
3100 Araphahoe #500,
Boulder, CO 80303, U.S.A.
Tel: (303)442-3801 Fax: (303)442-7216

Buffalo Grove (Chicago)
2150 E. Lake Cook Road, Suite 310,
Buffalo Grove, IL 60089, U.S.A.
Tel: (847)484-2400 Fax: (847)541-7287

Duluth, GA (Atlanta)
3700 Crestwood Pkwy, #160,
Duluth, GA 30096, U.S.A.
Tel: (770)931-3363 Fax: (770)931-7602

Portland, OR
2560 NW 141st Place Portland,
OR 97229, U.S.A.
Tel: (503)784-8879 Fax: (503)466-9729

Raleigh, NC
3120 Highwoods Blvd., #108, Raleigh,
NC 27604, U.S.A.
Tel: (919)859-2800 Fax: (919)859-2898

Richardson, TX (Dallas)
777 East Campbell Rd., #650, Richardson,
TX 75081, U.S.A.
Tel: (972)480-0470 Fax: (972)235-4114

San Jose Engineering Center, CA
2590 Orchard Parkway San Jose,
CA 95131, U.S.A.
Tel: (408)526-2400 Fax: (408)526-2410

Wakefield, MA (Boston)
401 Edgewater Place, #360, Wakefield,
MA 01880-6229, U.S.A.
Tel: (781)224-0074 Fax: (781)224-1095

Wixom (Detroit)
48679 Alpha Drive, Suite 100, Wixom,
MI 48393 U.S.A.
Tel: (248)449-6165 Fax: (248)449-8430

Toshiba Electronics do Brasil Ltda.
Rua Afonso Celso, 552-8 andar, C.J. 81
Vila Mariana, Cep 04119-002 Sa o Paulo SP, Brasil
Tel: (011)5576-6619 Fax: (011)5576-6607

Toshiba India Private Ltd.
6F DR. Gopal Das Bhawan 28,
Barakhamba Road, New Delhi, 110001, India
Tel: (011)2331-8422 Fax: (011)2371-4603

Toshiba Electronics Europe GmbH

Düsseldorf Head Office
Hansaallee 181, D-40549 Düsseldorf,
Germany
Tel: (0211)52296-0 Fax: (0211)52296-400

München Office
Büro München Hofmannstrasse 52,
D-81379, München, Germany
Tel: (089)748595-0 Fax: (089)748595-42

France Branch
Les Jardins du Golf 6 rue de Rome F-93561,
Rosny-Sous-Bois, Cedex, France
Tel: (1)48-12-48-12 Fax: (1)48-94-51-15

Italy Branch
Centro Direzionale Colleoni,
Palazzo Perseo 3,
I-20041 Agrate Brianza, (Milan), Italy
Tel: (039)68701 Fax: (039)6870205

Spain Branch
Parque Empresarial, San Fernando, Edificio Europa,
1ª Planta, E-28831 Madrid, Spain
Tel: (91)660-6798 Fax: (91)660-6799

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

Sweden Branch
Gustavslundsvägen 8, 5th Floor,
S-167 15 Bromma, Sweden
Tel: (08)704-0900 Fax: (08)80-8459

Toshiba Electronics Asia (Singapore) Pte. Ltd.
438B Alexandra Road, #06-08/12 Alexandra
Technopark, Singapore 119968
Tel: (6278)5252 Fax: (6271)5155

Toshiba Electronics Service (Thailand) Co., Ltd.
135 Moo 5, Bangkadi Industrial Park, Tivanon Road,
Pathumthani, 12000, Thailand
Tel: (02)501-1635 Fax: (02)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: (03)5631-6311 Fax: (03)5631-6307

Penang Office
Suite 13-1, 13th Floor, Menara Penang Garden,
42-A, Jalan Sultan Ahmad Shah,
10050 Penang, Malaysia
Tel: (04)226-8523 Fax: (04)226-8515

Toshiba Electronics Philippines, Inc.
26th Floor, Citibank Tower, Valero Street, Makati,
Manila, Philippines
Tel: (02)750-5510 Fax: (02)750-5511

Toshiba Electronics Asia, Ltd.

Hong Kong Head Office
Level 11, Tower 2, Grand Century Place, No.193,
Prince Edward Road West, Mongkok, Kowloon, Hong Kong
Tel: 2375-6111 Fax: 2375-0969

Beijing Office
Room 714, Beijing Fortune Building, No.5 Dong San Huan Bei-Lu,
Chao Yang District, Beijing, 100004, China
Tel: (010)6590-8796 Fax: (010)6590-8791

Chengdu Office
Room 2508A, 2 Zongfu Street, Times Plaza,
Chengdu 610016 Sichuan, China
Tel: (028)8675-1773 Fax: (028)8675-1065

Qingdao Office
Room 4(D-E), 24F, International Financial Center,
59 Xiang Gang Zhong Road, Qingdao, Shandong, China
Tel: (0532)579-3328 Fax: (0532)579-3329

Toshiba Electronics Shenzhen Co., Ltd.
Room 2601-2609, 2616, Office Tower Shun Hing Square,
Di Wang Commercial Center, 5002 Shennan Road East,
Shenzhen, 518008, China
Tel: (0755)2583-0810 Fax: (0755)8246-1581

Toshiba Electronics (Shanghai) Co., Ltd.

Shanghai Head Office
11F, HSBC Tower, 1000 Lujiazui Ring Road,
Pudong New Area, Shanghai 200120, China
Tel: (021)6841-0666 Fax: (021)6841-5002

Hangzhou Office
502 JiaHua International Business Center,
No.28 HangDa Road, Hangzhou, 310007, China
Tel: (0571)8717-5004 Fax: (0571)8717-5013

Nanjing Office
23F Shangmao Century Plaza,
No.49 Zhong Shan South Road, Nanjing, 210005, China
Tel: (025)8689-0070 Fax: (025)8689-0125

Toshiba Electronics (Dalian) Co., Ltd.
14/F, Senmao Building, 147, Zhongshan Road,
Xigang Dist., Dalian, 116011, China
Tel: (0411)8368-6882 Fax: (0411)8369-0822

Tsurong Xiamen Xiangyu Trading Co., Ltd.
14G, International Bank BLDG., No.8 Lujiang Road,
Xiamen, 361001, China
Tel: (0592)226-1398 Fax: (0592)226-1399

Toshiba Electronics Korea Corporation

Seoul Head Office
891, Samsung Life Insurance Daechi Tower 20F, Daechi-dong,
Gangnam-gu, Seoul, 135-738, Korea
Tel: (02)3484-4334 Fax: (02)3484-4302

Gumi Office
6F, Goodmorning Securities Building, 56 Songjung-dong,
Gumi-shi, Gyeongbuk, 730-090, Korea
Tel: (054)456-7613 Fax: (054)456-7617

Toshiba Electronics Taiwan Corporation

Taipei Head Office
17F, Union Enterprise Plaza Building, 109
Min Sheng East Road, Section 3, Taipei, 10544, Taiwan
Tel: (02)2514-9988 Fax: (02)2514-7892

Kaohsiung Office
16F-A, Chung-Cheng Building, 2, Chung-Cheng 3Road,
Kaohsiung, 80027, Taiwan
Tel: (07)237-0826 Fax: (07)236-0046

The information contained herein is subject to change without notice. 021023_D

TOSHIBA is continually working to improve the quality and reliability of its products. Nevertheless, semiconductor devices in general can malfunction or fail due to their inherent electrical sensitivity and vulnerability to physical stress. It is the responsibility of the buyer, when utilizing TOSHIBA products, to comply with the standards of safety in making a safe design for the entire system, and to avoid situations in which a malfunction or failure of such TOSHIBA products could cause loss of human life, bodily injury or damage to property. In developing your designs, please ensure that TOSHIBA products are used within specified operating ranges as set forth in the most recent TOSHIBA products specifications. Also, please keep in mind the precautions and conditions set forth in the "Handling Guide for Semiconductor Devices," or "TOSHIBA Semiconductor Reliability Handbook" etc. 021023_A

The TOSHIBA products listed in this document are intended for usage in general electronics applications (computer, personal equipment, office equipment, measuring equipment, industrial robotics, domestic appliances, etc.). These TOSHIBA products are neither intended nor warranted for usage in equipment that requires extraordinarily high quality and/or reliability or a malfunction or failure of which may cause loss of human life or bodily injury ("Unintended Usage"). Unintended Usage include atomic energy control instruments, airplane or spaceship instruments, transportation instruments, traffic signal instruments, combustion control instruments, medical instruments, all types of safety devices, etc. Unintended Usage of TOSHIBA products listed in this document shall be made at the customer's own risk. 021023_B

The products described in this document shall not be used or embedded to any downstream products of which manufacture, use and/or sale are prohibited under any applicable laws and regulations. 060106_Q

The information contained herein is presented only as a guide for the applications of our products. No responsibility is assumed by TOSHIBA for any infringements of patents or other rights of the third parties which may result from its use. No license is granted by implication or otherwise under any patents or other rights of TOSHIBA or the third parties. 070122_C

Please contact your sales representative for product-by-product details in this document regarding RoHS compatibility. Please use these products in this document in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances. Toshiba assumes no liability for damage or losses occurring as a result of noncompliance with applicable laws and regulations. 060819_Z

The products described in this document may include products subject to the foreign exchange and foreign trade control laws. 060925_F

The products described in this document may contain components made in the United States and subject to export control of the U.S. authorities. Diversion contrary to the U.S. law is prohibited. 021023_H

TOSHIBA has made this document deliberately in order to make its contents as accurate as possible. Nevertheless, if any trouble should occur due to any error contained in this document, TOSHIBA shall not have any liability therefor. Also, please keep in mind the precautions and conditions set forth in the "Instruction Manual or Operation Manual of TOSHIBA Products," or "The Precautions or Procedure Files described in the Installation Disk such as Floppy Disk or CD-ROM etc." Please constantly pay attention to the latest information on the TOSHIBA products which is to be released through the web page of TOSHIBA microcomputer development system. (<http://www.semicon.toshiba.co.jp/eng/>) 060824_N

TOSHIBA

TOSHIBA CORPORATION
Semiconductor Company

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