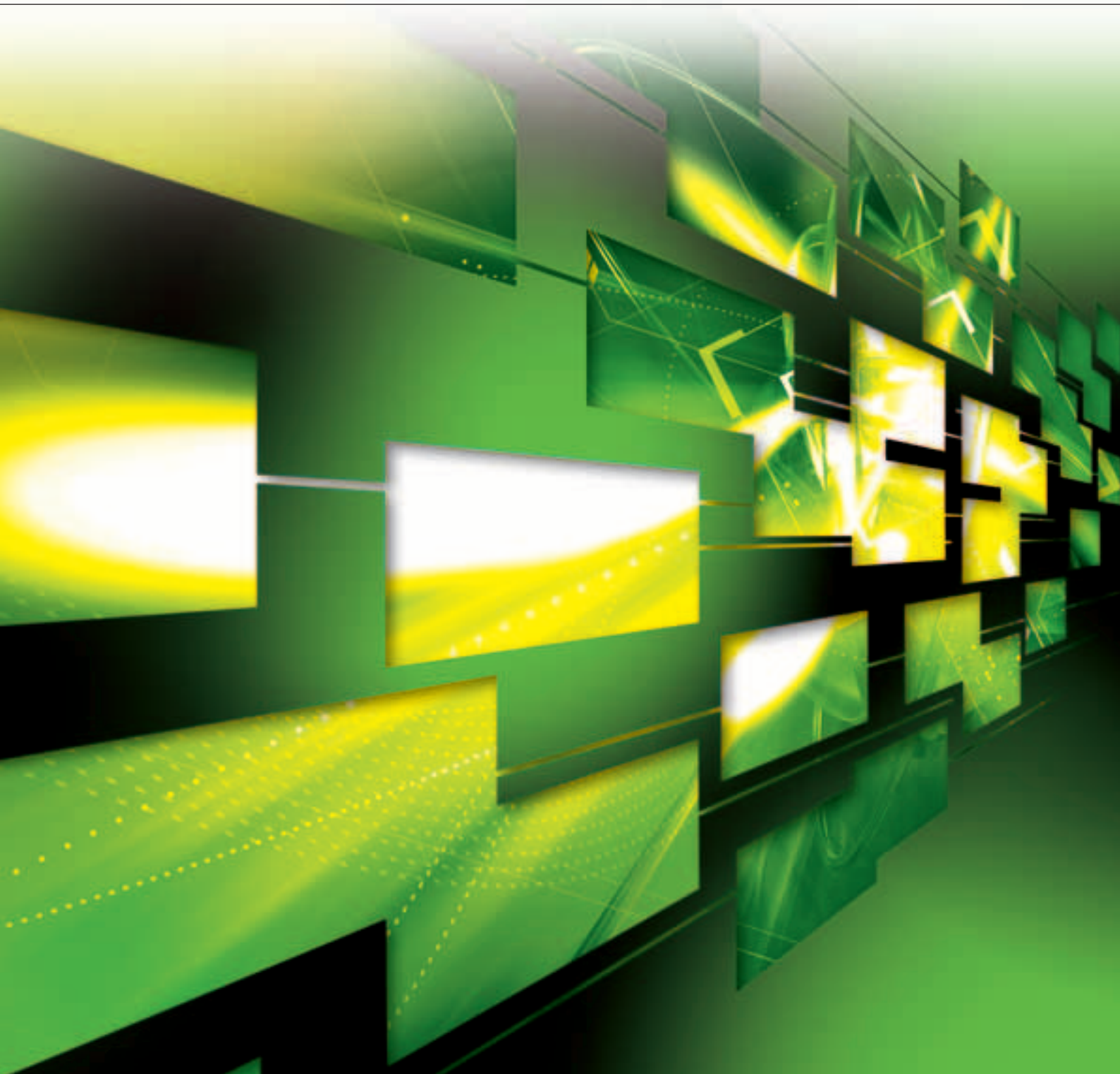


PRODUCT GUIDE

Microcomputers



S E M I C O N D U C T O R

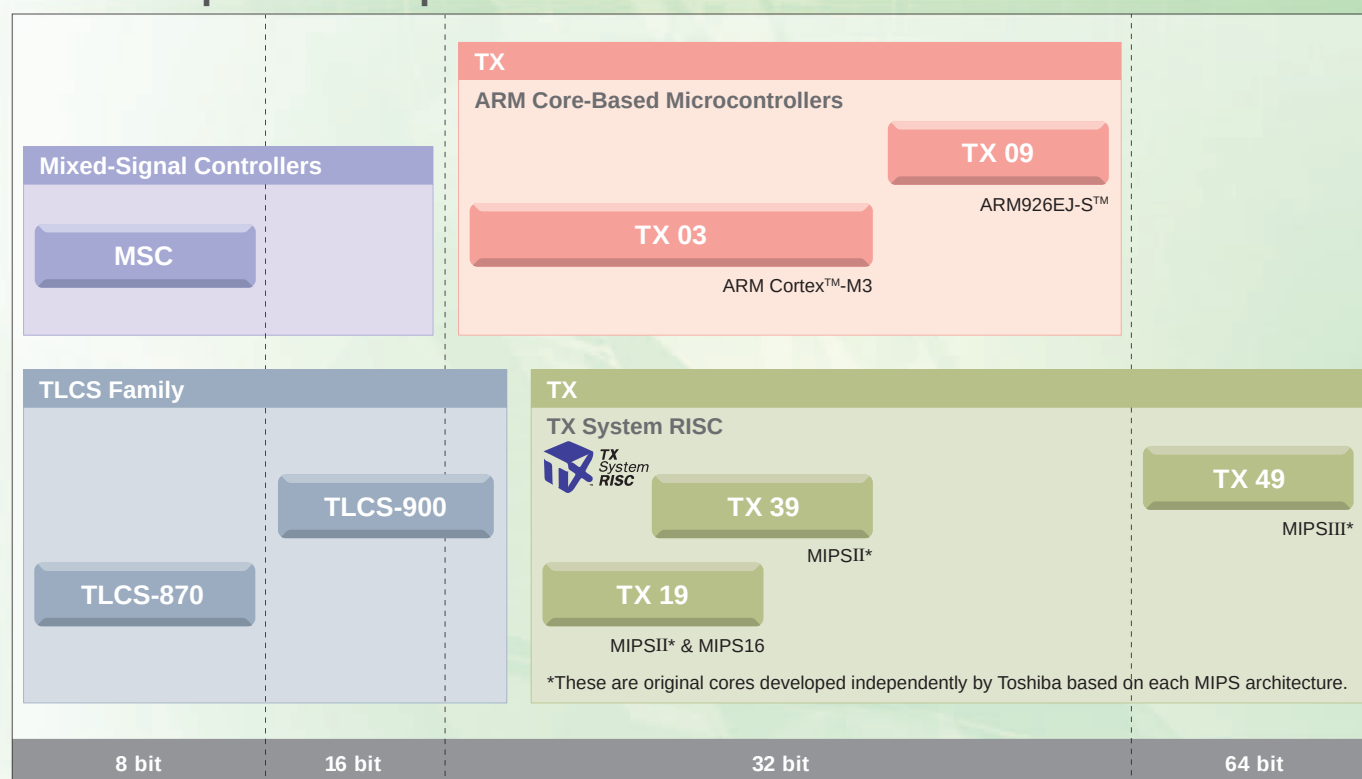
<http://www.semicon.toshiba.co.jp/eng>

Toshiba Microcomputers

Protecting the global environment is all-important, and more and more electronic appliances are being designed with this end in view.

In these circumstances, sensing, power electronics and energy management technologies hold the key to addressing the needs of electronics manufacturers. When it comes to these technology areas, we recognize that it is necessary to improve accuracy and performance and, at the same time, reduce power consumption. Toshiba's product offerings now include mixed-signal controllers and those featuring a high-performance ARM CPU core. Additionally, Toshiba provides system solutions that combine these microcontrollers with a wide array of semiconductor devices such as power drivers.

Microcomputer Lineup



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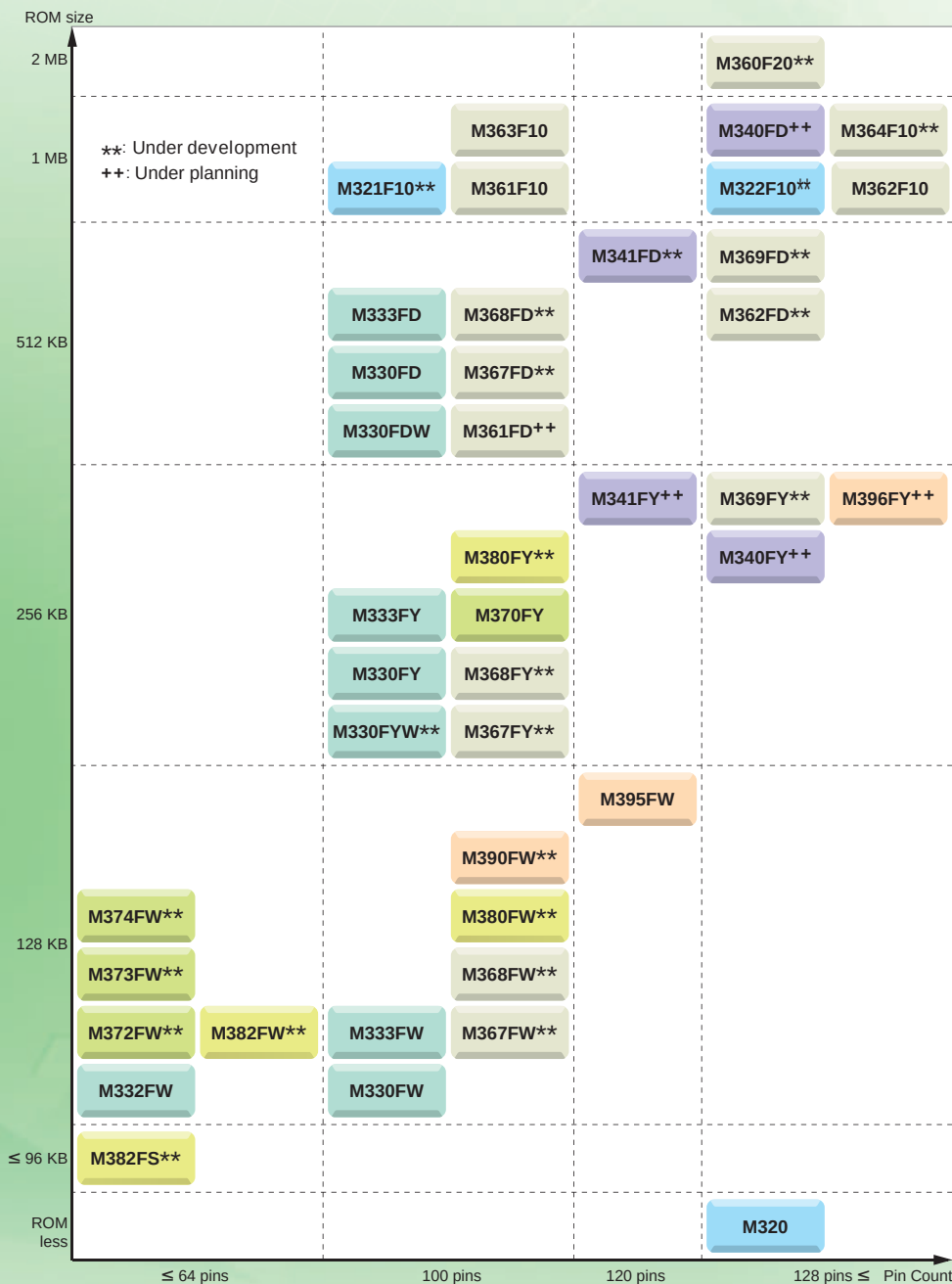
Note: System block diagrams herein only show the typical application examples.

NANO FLASH is a trademark of Toshiba Corporation.

ARM, ARM Cortex, Thumb, ARM Cortex-M3, ARM926EJ-S and ARM Cortex-A9 MPCore are trademarks or registered trademarks of ARM Limited in the EU and other countries.

Toshiba's ARM Core-Based Microcontrollers

TX03 Series Product Lineup



Product Groups with a 3-V Supply

M320 Group

- USB-Host
- Features
 - USB host controller
 - System solutions that combine an MCU and an audio DSP
- Application examples
 - Car audio systems, consumer electronics, office equipment

M330 Group

- Power-saving modes
- CEC controller
- Features
 - Dedicated controller compliant with HDMI 1.3a (CEC)
 - Remote control signal preprocessor essential for digital consumer electronics
- Application examples
 - Digital TVs, projectors, Blu-ray recorders, AV receivers, printers, home appliances, factory automation equipment, office equipment

M340 Group

- High-resolution PPG
- Features
 - High-accuracy analog control interface
 - Small packages ideal for space-critical applications
 - High-resolution PPG ideal for motor control
- Application examples
 - DVCs, DSLR cameras, camera lens controllers

M360 Group

- Multiple serial interfaces
- Features
 - 2-MB FLASH ROM, the industry's largest on-chip memory
 - Multiple serial interfaces
 - Flexible power-saving modes
- Application examples
 - Printers, AV receivers, digital electronics, PC peripherals, industrial equipment, networking equipment, office equipment

M390 Group

- 1.8-V operation
- Features
 - Power-saving modes for 1.8-V operation
 - High-speed on-chip oscillator
 - Small package (6-mm square BGA)
- Application examples
 - Power supply monitors, battery-operated devices, remote-controlled devices, game consoles, AV equipment

Product Groups with a 5-V Supply

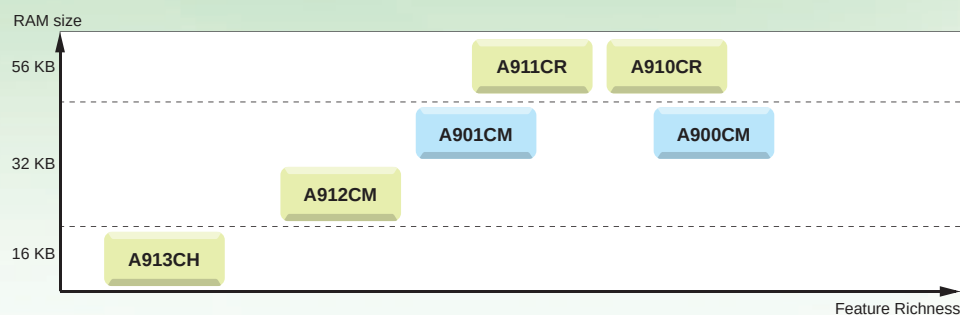
M370 Group

- On-chip vector engine
- Features
 - Toshiba-original vector engine (VE)
 - Single 5-V supply operation with high market demands
 - System solutions that combine an MCU with motor drivers
- Application examples
 - Washing machines, air conditioners, refrigerators, heat pumps, inverter-motor-controlled equipment

M380 Group

- Multiple-purpose timers for IGBT control
- Features
 - Multiple-purpose timers for motor and IGBT control
 - Single 5-V supply operation with high market demands
 - System solutions that combine an MCU with various peripheral ICs
- Application examples
 - Air conditioners, refrigerators, electric oven-grills, rice cookers, IH cooktops

TX09 Series Product Lineup



A900 Group

- USB-Host
- Features
 - USB host and device controllers
 - LCD, CMOS camera interface and SD controllers
 - Packaging: 289- and 177-pin BGAs
 - Oscillation frequency detection (OFD), which warns of irregular clocking
- Application examples
 - Electric ovens with an LCD screen, security devices, versatile remote controllers

A910 Group

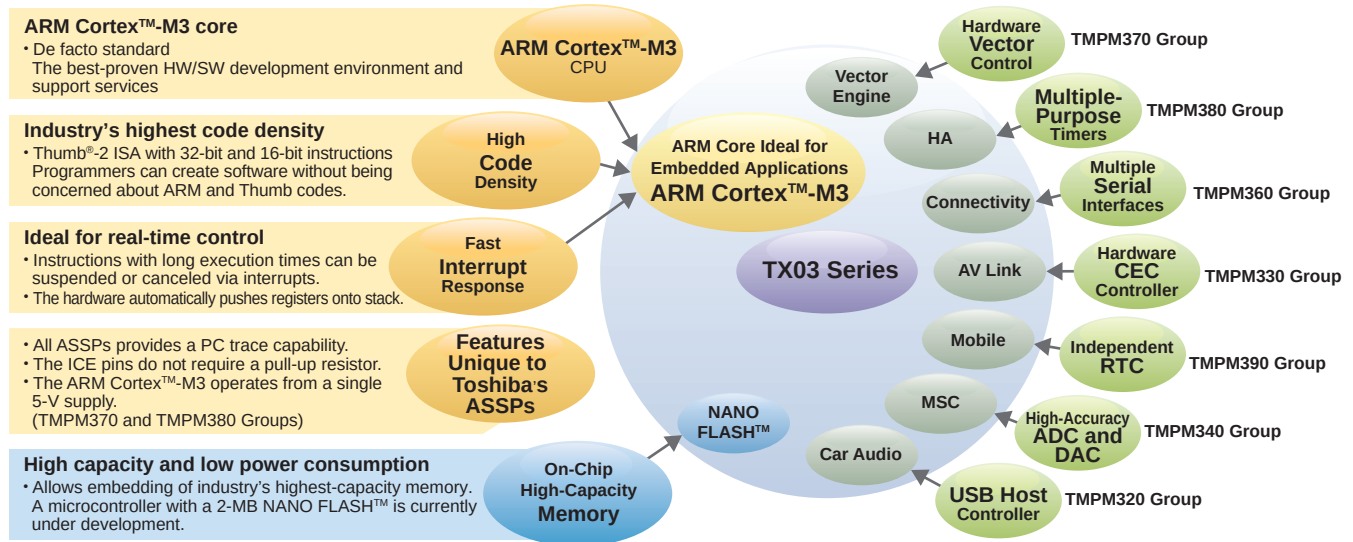
- Designed for up to VGA-size color LCD screen control
- Features
 - LCD data process accelerator
 - USB device controller
 - Various external memory controllers and high-speed interfaces
- Application examples
 - Small to medium-size LCD control, digital photo frames, handheld gadgets

Toshiba's ARM Core-Based Microcontrollers

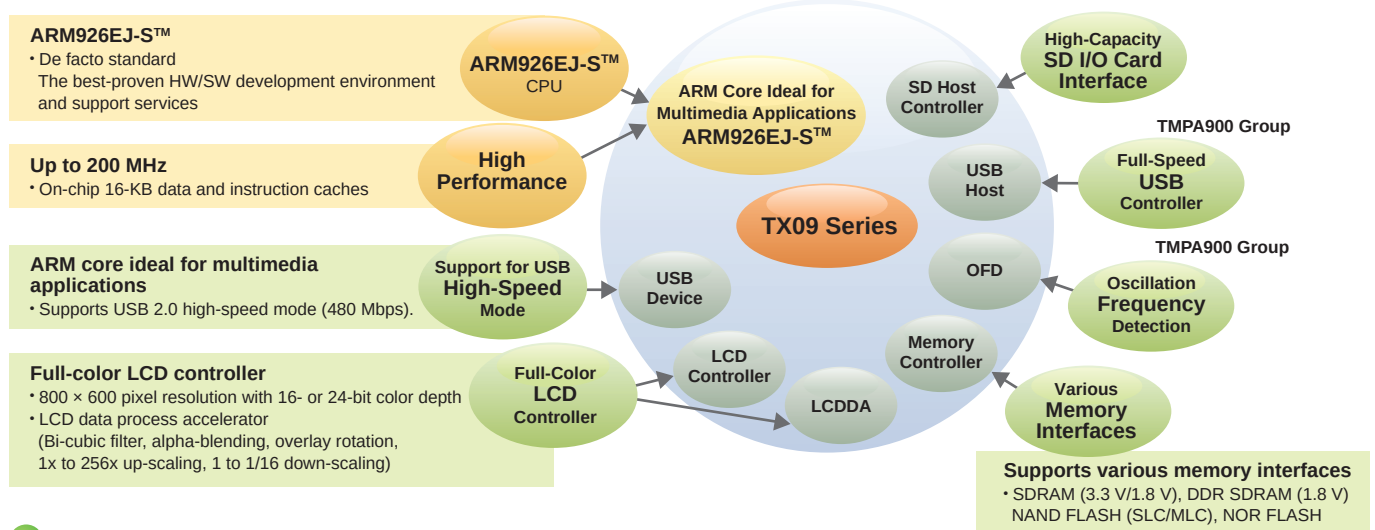
Toshiba has been expanding its portfolio of application-specific standard products (ASSPs) that combine an ARM Cortex™-M3 core, which features high performance, high code density and low power consumption, with a Toshiba-original NANO FLASH™, which features high-speed programming and low power consumption. In addition to the low-cost ARM Cortex™-M3-based ASSPs, Toshiba also offers ASSPs with the ARM926EJ-S™ core that are ideal for applications with an LCD screen. With Toshiba's wide range of ASSP offerings covering 8-bit to 32-bit, you can find the optimum solutions for your applications.

Our product portfolio includes ASSPs that are specifically designed for digital TV, digital audio and motor applications; kitchen appliance and home appliances, as well as industrial, office and automotive applications.

Features of the TX03 Series

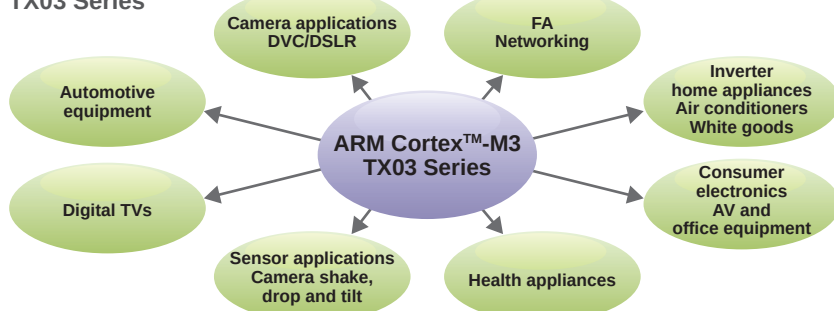


Features of the TX09 Series

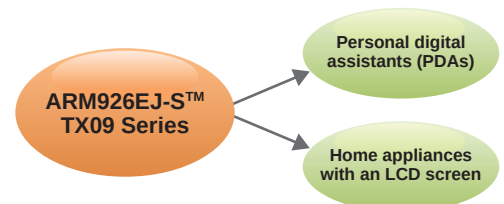


Applications

TX03 Series



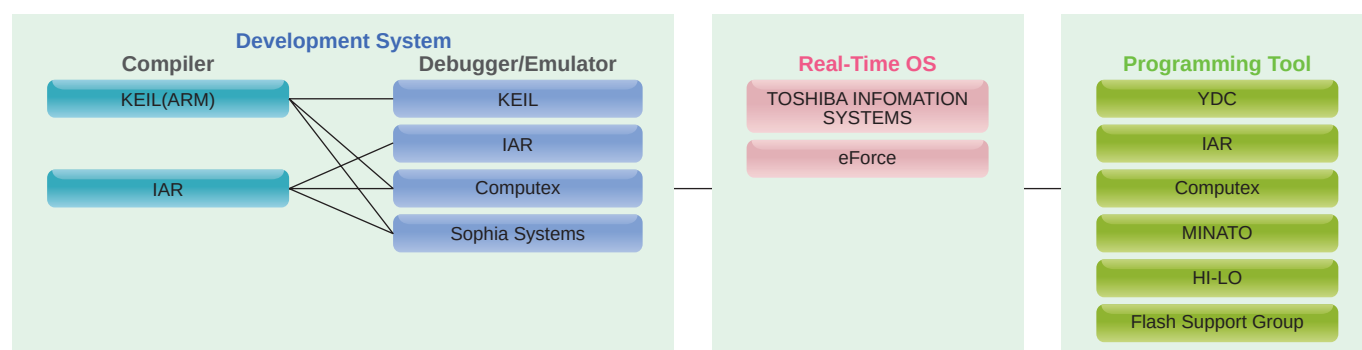
TX09 Series



Toshiba's ARM Core-Based Microcontroller Development Environment

The ARM Core-based microcontrollers are supported by a wide selection of development tools and vendors, from which you can choose the ones that best meet your needs.

TX03 Series



In addition to the development tools shown above, starter kits are available from multiple vendors. For details, see "Reference Models and Microcontroller Starter Kits" on page 31.

Real-Time OS

Partner Vendor	Tool
eForce Co.,Ltd. TOSHIBA INFORMATION SYSTEMS(JAPAN) CORPORATION	ARM Cortex™-M3 μITRON

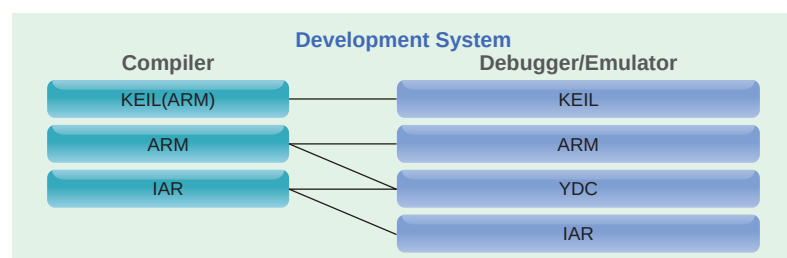
Development Systems

Partner Vendor	Compiler	Debugger	Emulator
KEIL (ARM Ltd.)	RealView® MDK	μVision®	ULINK2®, ULINK® Pro
IAR Systems	EWARM(IAR Embedded Workbench for ARM)		J-LINK, J-TRACE-CM3
Computex Co.,Ltd.	-	CSIDE®	J-STICK, PALMiCE3
Sophia Systems Co.,Ltd.	-	WATCHPOINT	EJSCATT

Programming Tools

Partner Vendor	On-Board Programming	Off-Board Programming
IAR Systems	Flasher ARM	-
Computex Co.,Ltd.	FP-10	-
HI-LO SYSTEM RESEARCH Co.,LTD.	-	ALL-100A
MINATO ELECTRONICS.INC	-	Model1895, Model1895/2, Model1896, Model1940
Yokogawa Digital Computer Corporation	MegaNET IMPRESS	-
Flash Support Group Inc.	AF9101, AF9103	AF9709C, AF9723B + AF9845B/C

TX09 Series



Development Systems

Partner Vendor	Compiler	Debugger	Emulator
KEIL (ARM Ltd.)	RealView® MDK	μVision®	ULINK2®, ULINK® Pro
ARM Ltd.	RVDS (RealView® Development Suite)		RealView ICE®
IAR Systems	EWARM (IAR Embedded Workbench for ARM)		J-LINK, J-TRACE
Yokogawa Digital Computer Corporation	-	microVIEW	advice Pro

For development tools and vendors not listed below, please contact your local Toshiba sales representative.

Toshiba's ARM Core-Based Microcontroller Part Number List

TX03 Family: TX03 Series

Flash Versions

Part Number	ROM (Kbytes)	SRAM (Kbytes)	Maximum Operating Frequency (MHz)	DMA Controller (Ch)	SSP(Ch)	UART/SIO (Ch)	UART/HSIO (Ch)	I ² C (Ch)	I ² C/SIO(Ch)	10-Bit AD Converter (Ch)	12-Bit AD Converter (Ch)	10-Bit DA Converter (Ch)	16-Bit Timer/Counter (Ch)	USB Host (Full Speed) (Ch)	CEC (Ch)	Remote Control Preprocessor (Ch)	Motor Controller (Ch)	Multi-Purpose Timer (MPT) (Ch)	Incremental Encoder Input (Ch)	Op Amp (Ch)	Comparator (Ch)	External Interrupt Pins (Pins)	CS/WAIT Controller (Ch)	Watchdog Timer	Clock Gear	RTC (Ch)	Dual Clocks	On-Chip Debug Unit	Trace Function	Oscillation Frequency Detector	Power-On Reset	Undervoltage Detection	I/O Port (Pins)	Power Supply Voltage (V)	Operating Temperature (°C)	Package	
TMPM382FSFG**	64	8	40	2	1	3			1		10		8			1	(Note3) 1	1				8	Yes	Yes	1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	48	4.0 to 5.5	-40 to 85	QFP64 (14 × 14 mm)	
TMPM330FWFG			40			3			3	12			10		1	2						8	Yes	Yes	1	Yes	Yes	Yes					78	2.7 to 3.6	-20 to 85	LQFP100 (14 × 14 mm)	
TMPM332FWUG			40			2			2	8			10		1	1						5	Yes	Yes	1	Yes	Yes	Yes					44		LQFP64 (10 × 10 mm)		
TMPM333FWFG			40			3			3	12			10									8	Yes	Yes	1	Yes	Yes	Yes					78		LQFP100 (14 × 14 mm)		
TMPM390FWFG**			128	20		1	3		1	1	12			10		1	1						7	Yes	Yes	1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	76	1.7 to 3.6		FBGA120 (6 × 6 mm)
TMPM395FWXBG				20		4	3		1	1	12			10		1	1						11	Yes	Yes	1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	91		LQFP100 (14 × 14 mm)	
TMPM380FWDFG**			12	40	2	2	5			2		18		8			1	(Note3) 2	3	2			16	Yes	Yes	1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	84	4.0 to 5.5	-40 to 85	QFP100 (14 × 20 mm)
TMPM380FWFG**				40	2	2	5			2		18		8			1	(Note3) 2	3	2			16	Yes	Yes	1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	84		LQFP100 (14 × 14 mm)	
TMPM382FWFG**		40		2	1	3			1		10		8			1	(Note3) 1	1				8	Yes	Yes	1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	48	QFP64 (14 × 14 mm)			
TMPM370FYDFG		10	80			4					22		8				2		2	4	4	16	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes	76	4.5 to 5.5		QFP100 (14 × 20 mm)	
TMPM370FYFG			80			4					22		8				2		2	4	4	16	Yes	Yes			Yes	Yes	Yes	Yes	Yes	Yes	76				
TMPM330FYFG		256	40			3			3	12			10		1	2						8	Yes	Yes	1	Yes	Yes	Yes					78	-20 to 85	LQFP100 (14 × 14 mm)		
TMPM330FYWFG**			40			3			3	12			10		1	2						8	Yes	Yes	1	Yes	Yes	Yes					78	2.7 to 3.6		-40 to 85	
TMPM333FYFG			40			3			3	12			10									8	Yes	Yes	1	Yes	Yes	Yes					78	-20 to 85			
TMPM380FYDFG**			40	2	2	5			2		18		8			1	(Note3) 2	3	2			16	Yes	Yes	1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	84	4.0 to 5.5	-40 to 85	QFP100 (14 × 20 mm)	
TMPM380FYFG**			40	2	2	5			2		18		8			1	(Note3) 2	3	2			16	Yes	Yes	1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	84		LQFP100 (14 × 14 mm)		
TMPM330FDFG		512	40			3			3	12			10		1	2						8	Yes	Yes	1	Yes	Yes	Yes					78	-20 to 85	LQFP100 (14 × 14 mm)		
TMPM330FDWFG			40			3			3	12			10		1	2						8	Yes	Yes	1	Yes	Yes	Yes					78	-40 to 85			
TMPM333FDFG			40			3			3	12			10									8	Yes	Yes	1	Yes	Yes	Yes					78	-20 to 85			
TMPM341FDXBG**				54	4	1	5			2		16	2	12									12	2	Yes	Yes		Yes	Yes	Yes				87	-40 to 85	FBGA113 (6 × 6 mm)	
TMPM361F10FG		1024	64	2	1	5		1	3	8			16		1	1						10	4	Yes	Yes	1	Yes	Yes	Yes				76		LQFP100 (14 × 14 mm)		
TMPM362F10FG			64	2	1	12			5	16			16		1	2						16	4	Yes	Yes	1	Yes	Yes	Yes				120			LQFP144 (20 × 20 mm)	
TMPM363F10FG			64	(Note1) 64	2	1	5		1	3	8			16	1	1	1						8	4	Yes	Yes	1	Yes	Yes	Yes				74	(Note2) 2.7 to 3.6	-20 to 85	LQFP100 (14 × 14 mm)
TMPM364F10FG**				(Note1) 64	2	1	12			5	16			16	1	1	2							14	4	Yes	Yes	1	Yes	Yes	Yes				118		LQFP144 (20 × 20 mm)
TMPM360F20FG**	2048	128	64		1	12			5	16			16		1	2						17	4	Yes	Yes	1	Yes	Yes	Yes				120	2.7 to 3.6			

Note 1) 48 MHz when USB is used.

Note 2) 3.0 to 3.6 V when USB is used.

Note 3) The motor controller channel is multiplexed with the multi-purpose timer (MPT).

• Contact the Toshiba sales representative for information about RoHS compliance before you purchase any components.

** : Under development

TX03 Family: TX03 Series

Mask ROM Versions

Part Number	ROM (Kbytes)	SRAM (Kbytes)	eDRAM (Kbytes)	Maximum Operating Frequency (MHz)	DMA Controller (Ch)	USB Host (High Speed) (Ch)	SD Host Controller (Ch)	SSP(SPI/MicroWire) (Ch)	UART (Ch)	I ² C (Ch)	10-Bit AD Converter (Ch)	16-Bit Timer/Counter (Ch)	External Interrupt Pins (Pins)	Watchdog Timer	Static Memory Controller (Ch)	On-Chip Debug Unit	Trace Function	I/O Port (Pins)	Power Supply Voltage (V)	Operating Temperature (°C)	Package
TMPM320C1DFG	NA	320	1024	144	8	1	1	4	4	2	4	8	4	Yes	2	Yes	Yes	55	(Note1) 1.1 to 1.3	-40 to 85	LQFP144 (20 × 20 mm)

Note 1) The following three power supplies are available:

- (1) For external circuitry in general, USB, external AD converter, internal eDRAM: 3.0 V to 3.6 V
- (2) For external USB device : 3.15 V to 3.45 V
- (3) For internal circuitry: 1.1 V to 1.3 V

• Contact the Toshiba sales representative for information about RoHS compliance before you purchase any components.

TX09 Family: TX09 Series

Mask ROM Versions

Part Number	ROM (Kbytes)	RAM (Kbytes)	Minimum Instruction Execution Time (μs)		USB Device (High Speed) (Ch)	USB Host (Full Speed) (Ch)	SD Host Controller (Ch)	UART (Ch)	I ² C (Ch)	SSP (Ch)	DMA Controller (Ch)	Static Memory Controller (Ch)	DRAM Controller (SDR SDRAM / LVCMOS DDR SDRAM) (Ch)	NANDFC (Ch)	10-Bit AD Converter (Ch)	LCD Controller	LCD Data Process Accelerator	16-Bit Timer/Counter (Ch)	32-kHz Timer (for SW RTC)	Watchdog Timer	I ² S(Inter-IC Sound) Interface (Ch)	Touch Screen Interface	CMOS Image Sensor Interface (Ch)	JTAG (Debug)	JTAG (PC Trace)	JTAG (Boundary-Scan)	Clock Gear	Oscillation Frequency Detector	I/O Port (Pins)	Power Supply Voltage (V)	Operating Temperature (°C)	Package
TMPA913CHXBG	NA	16	(1) 0.005 (2) 0.0067	1			2	2	2	8	4	1	2	6			6	Yes	Yes	2	Yes		Yes	Yes	Yes	Yes	Yes	98	(Note1) 1.4 to 1.6	(1) 0 to 70 (2) -20 to 85	FBGA361 (16 × 16 mm)	
TMPA900CMXBG				1	1	1	3	2	2	8	2	1	2	8	Yes	Yes	6	Yes	Yes	2	Yes	1	Yes		Yes	Yes	Yes	91			FBGA289 (15 × 15 mm)	
TMPA901CMXBG				1	1		2	1	1	8	2	1	2	4	Yes	Yes	6	Yes	Yes	1	Yes		Yes	Yes	Yes	Yes	43	FBGA177 (13 × 13 mm)				
TMPA912CMXBG				1			2	2	2	8	4	1	2	6	Yes	Yes	6	Yes	Yes	2	Yes	1	Yes		Yes	Yes	98					
TMPA910CRAXBG	56	0.005	1		2	2	2	2	8	4	1	2	6	Yes	Yes	6	Yes	Yes	2	Yes	1	Yes		Yes	Yes		114	(Note1) 1.4 to 1.6	0 to 70	FBGA361 (16 × 16 mm)		
TMPA910CRBxBG			1		2	2	2	2	8	4	1	2	6	Yes	Yes	6	Yes	Yes	2	Yes	1	Yes		Yes	Yes		114		-20 to 85			
TMPA911CRxBG			(1) 0.005 (2) 0.0067	1			2	2	2	8	4	1	2	6	Yes	Yes	6	Yes	Yes	2	Yes	1	Yes		Yes	Yes			98		(1) 0 to 70 (2) -20 to 85	

Note 1) The following five power supplies are available:

- (1) For external circuitry in general, external AD converter, external USB host (Full-Speed): 3.0 V to 3.6 V
- (2) For external USB device (High-Speed): 3.15 V to 3.45 V
- (3) For external memory: 1.7 V to 1.9 V/3.0 V to 3.6 V
- (4) For external CMOS image sensor, external I²S, external LCD: 1.8 V to 3.6 V
- (5) For internal circuitry: 1.4 V to 1.6 V

Note 2) The external data bus width is as follows:

- TMPA910CRAXBG, TMPA910CRXBG, TMPA911CRXBG, TMPA900CMXBG: Up to 32 bits
- TMPA912CMXBG, TMPA913CHXBG, TMPA901CMXBG: Up to 16 bits

• Contact the Toshiba sales representative for information about RoHS compliance before you purchase any components.



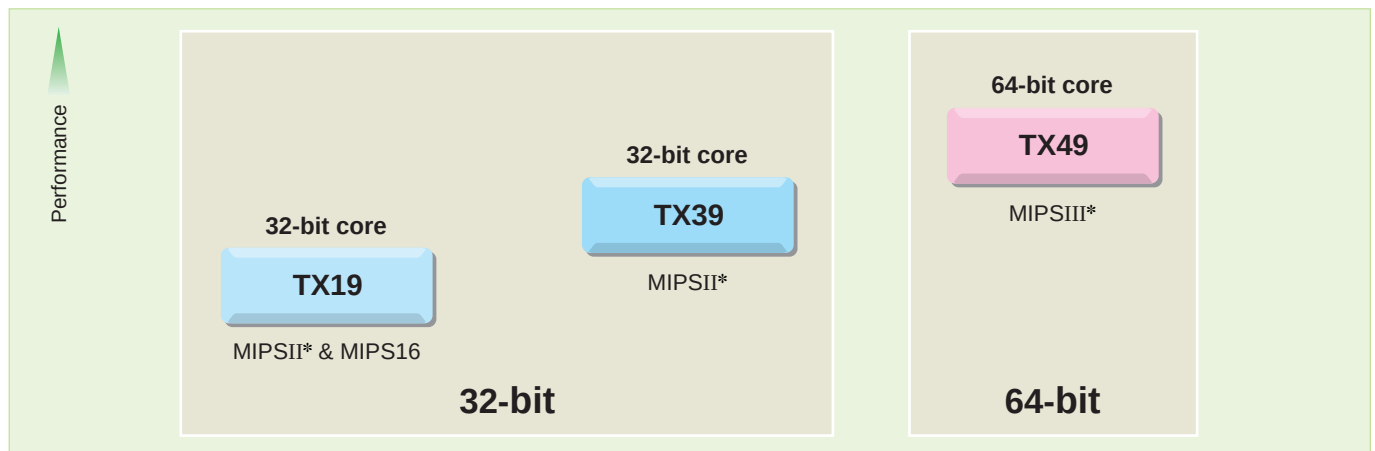
Toshiba TX System RISC

TX System RISC



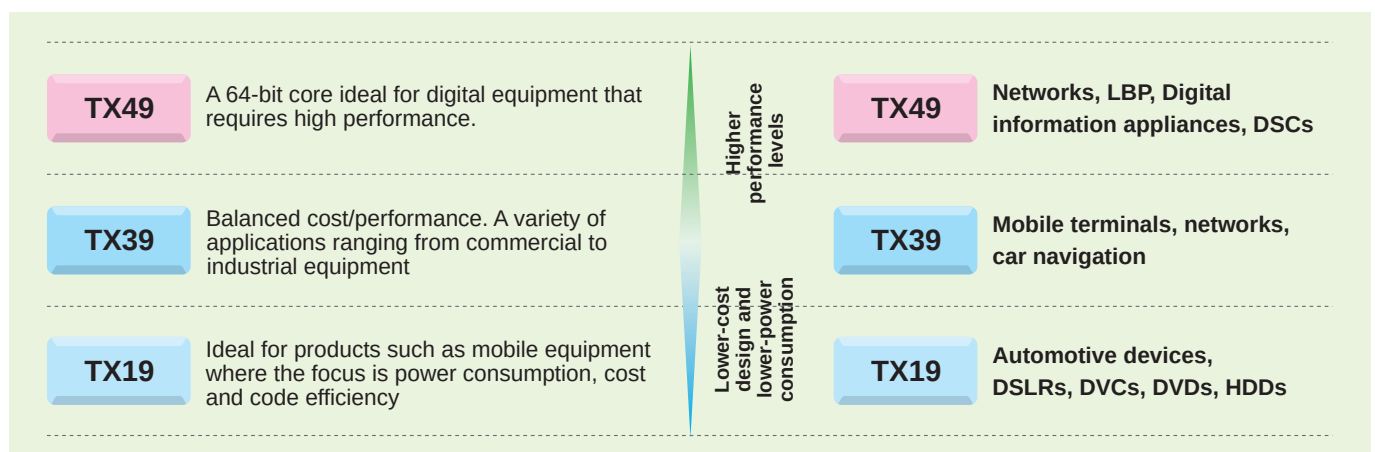
Toshiba offers families of microcontrollers based on a RISC processor from MIPS Technologies, Inc., the TX39 Family with an embedded 32-bit processor, the TX19 Family that allows run-time switching between 32-bit and 16-bit instructions, and the TX49 Family with an embedded 64-bit processor. The TX19, TX39 and TX49 Families of processors and a suite of peripheral megacells are available as ASIC-ready cores.

TX System RISC Lineup



*These are original cores developed independently by Toshiba based on each MIPS architecture.

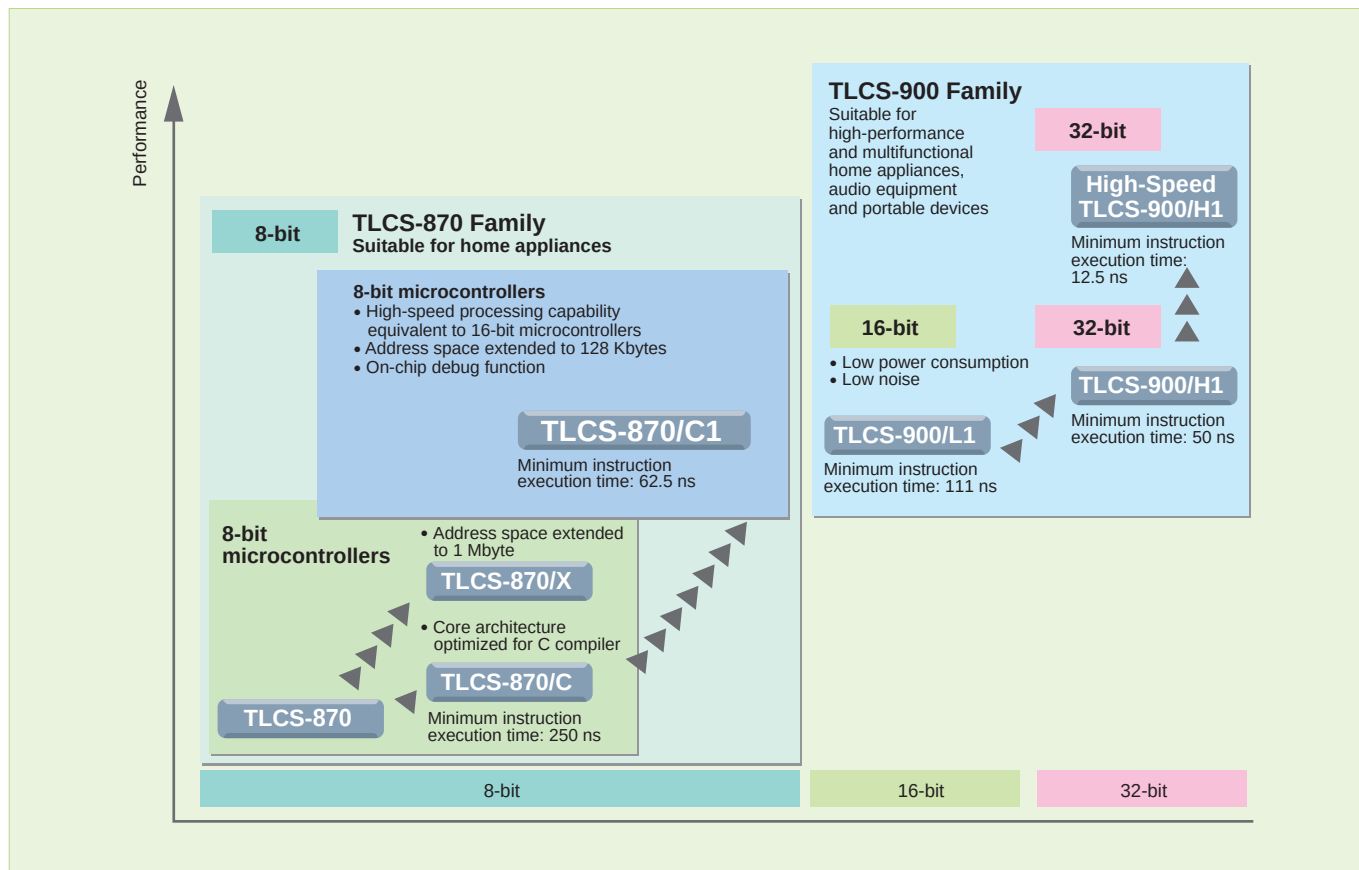
A Complete Lineup of Products, Ranging from Low-Power-Consumption Devices to High-Speed-Processing Devices, to Suit a Wide Variety of Applications



Toshiba TLCS-900 and TLCS-870 Family Lineup

■ TLCS Families

Toshiba's microcontrollers, which combine a high-performance CPU core and a set of CPU peripherals, offer the ideal solutions for a wide variety of applications.



■ Features of the TLCS-900 Family of CPU Cores

The 32-bit TLCS-900/H1 Series is software-compatible with the 16-bit TLCS-900/L1 Series. This makes it easy for customers to produce an array of derivative products.

Series	Maximum Internal Operating Frequency (Note)	Minimum Internal Execution Time	Address Space	Data Transfer Rate	Operating Voltage	Multiplication Instruction Execution Time	Dynamic Bus Sizing
TLCS-900/H1	80 MHz	12.5 ns	Up to 16 Mbytes of linear address space (for program and data)	62.5 ns/4 bytes@80 MHz internal	3.3 V, 1.5 V (two power supplies)	134 ns	8-/16-/32-bit
	20 MHz	50 ns		0.25 μ s/4 bytes@20 MHz internal	5 V/3 V	400 ns	
TLCS-900/L1	18 MHz	111 ns		0.44 μ s/2 bytes@36 MHz	5 V/3 V/2 V	660 ns	8-/16-bit
TLCS-900/H	12.5 MHz	160 ns		0.64 μ s/2 bytes@25 MHz	5 V/3 V	960 ns	
TLCS-900/L	10 MHz	200 ns		1.6 μ s/2 bytes@20 MHz		2.6 μ s	

Note: The maximum operating frequency and the operating voltage differ from device to device. For details, see the appropriate datasheets.

■ Features of the TLCS-870 Family of CPU Cores

The TLCS-870 Family of 8-bit microcontrollers incorporate a suite of CPU peripherals, such as an AD converter, LCD driver, UART, IGBT controller and programmable motor driver (PMD). The TLCS-870/C1 Series also offers several functions necessary for low-voltage and low-power operation, including undervoltage detection (VLTD) and power-on reset (POR) circuits.

Series	Maximum Internal Operating Frequency (Note)	Minimum Internal Execution Time	Address Space	Interrupt Vector (max)	Instruction Set	Operating Voltage
TLCS-870/C1	16 MHz	62.5 ns	128 KB	63	732 instructions	1.8 to 5.5 V
TLCS-870/X	20 MHz	200 ns	1 MB	63	842 instructions	2.7 to 5.5 V
TLCS-870/C	16 MHz	250 ns	64 KB	31	731 instructions	1.8 to 5.5 V
TLCS-870	8 MHz	500 ns	64 KB	15	412 instructions	2.7 to 5.5 V/6.0 V

Note: The maximum operating frequency and the operating voltage differ from device to device. For details, see the appropriate datasheets.

Microcontrollers with Inverter Motor Control Circuit (PMD)

Microcontrollers with a Programmable Motor Driver (PMD)

Since the 1990s, Toshiba has been developing 8-bit microcontrollers containing a Programmable Motor Driver (PMD) specifically designed for inverter motor applications. Toshiba is dedicated to providing flexible motor control solutions to help realize enhanced efficiency and quiet operation.

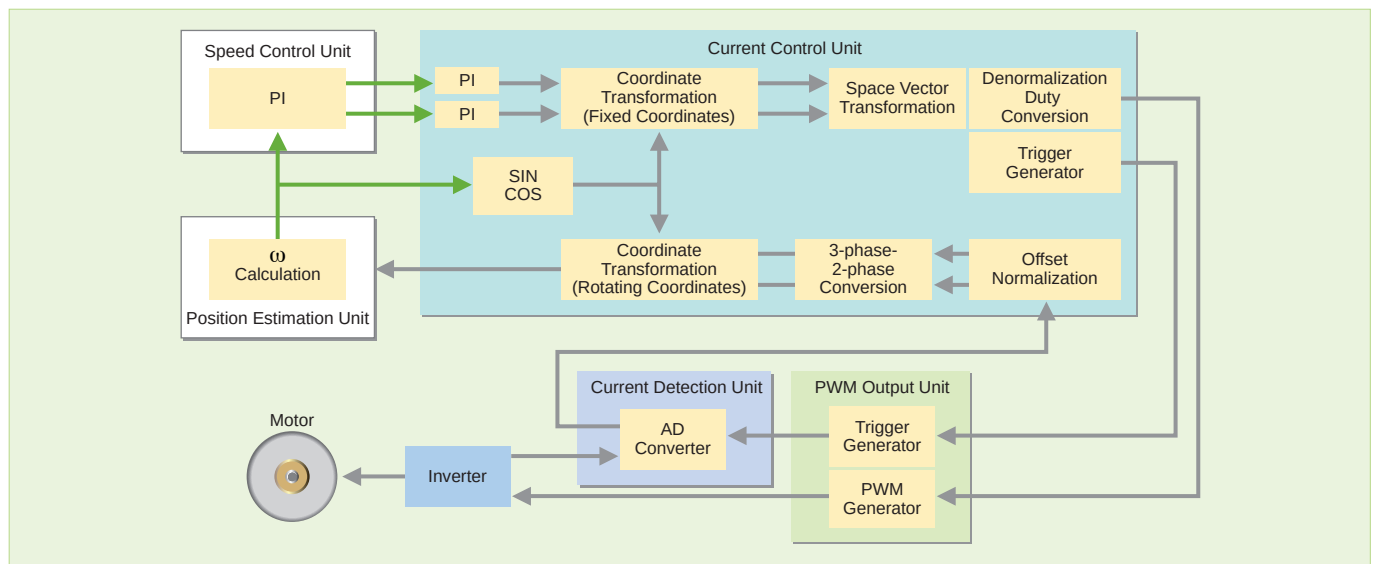
Recently, advanced motor control techniques are being used in inverter home appliances in order to improve efficiency and offer smooth rotation. Toshiba is now expanding its PMD microcontroller portfolio with the TX03 Series of 32-bit microcontrollers, which have a Vector Engine (VE) for vector control (field-oriented control) operation.

With built-in hardware that links the motor drive signals with the feedback signals from a motor, the PMD can realize motor control with less CPU workload. This approach makes it possible to control sine-wave drive at as low a frequency as square-wave drive.

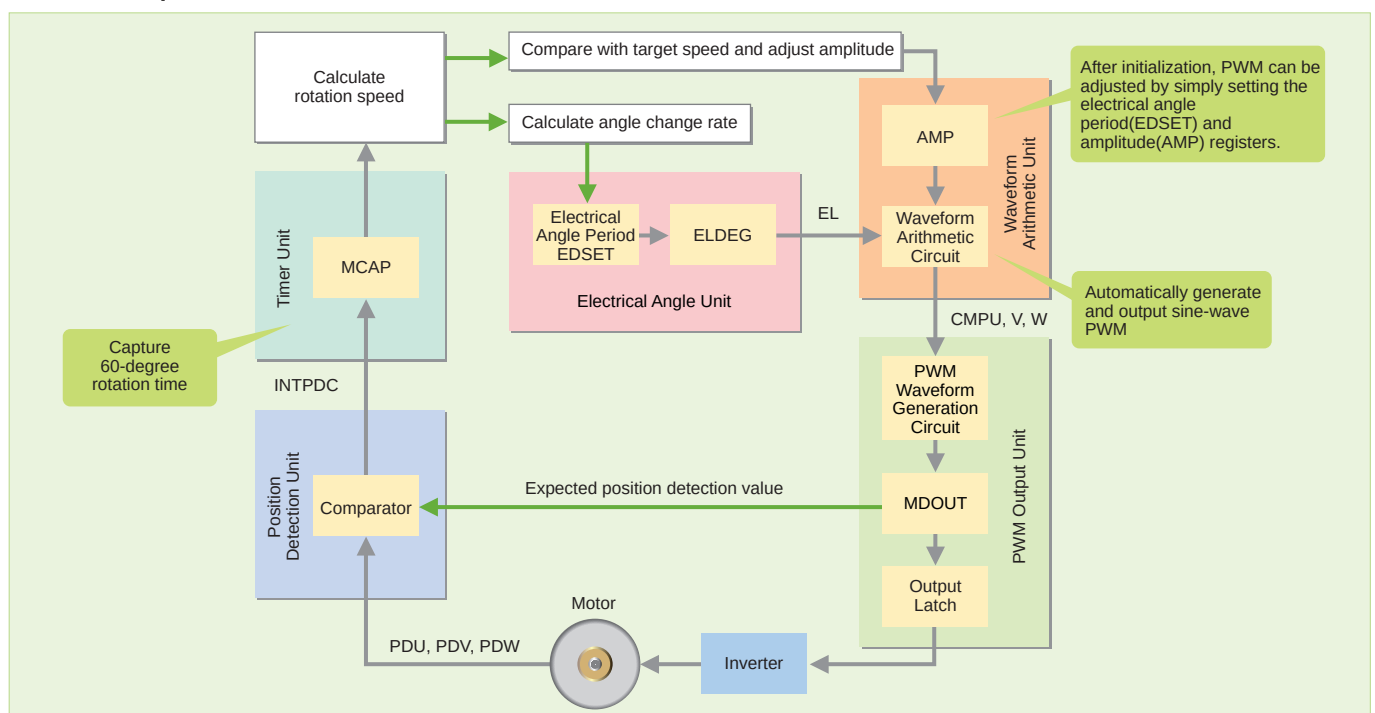
Programmable Motor Driver (PMD) Block Diagrams

The PMD is a Toshiba-original circuit specifically designed for inverter control of a three-phase motor.

Vector Control



Sine-wave/Square-wave Control



Basic Concept behind Toshiba's PMD Microcontrollers

The basic concept behind Toshiba's PMD microcontrollers is to make a maximum use of hardware for routine tasks and to use software only for non-routine processing. This enables customers to control sine-wave drive with a software interrupt period (upon every position detection) comparable to that for square-wave drive.

With built-in hardware that links the motor drive signals with the feedback signals from a motor, the PMD can realize motor control with less CPU workload. This approach makes it possible to control sine-wave drive at as low a frequency as square-wave drive.

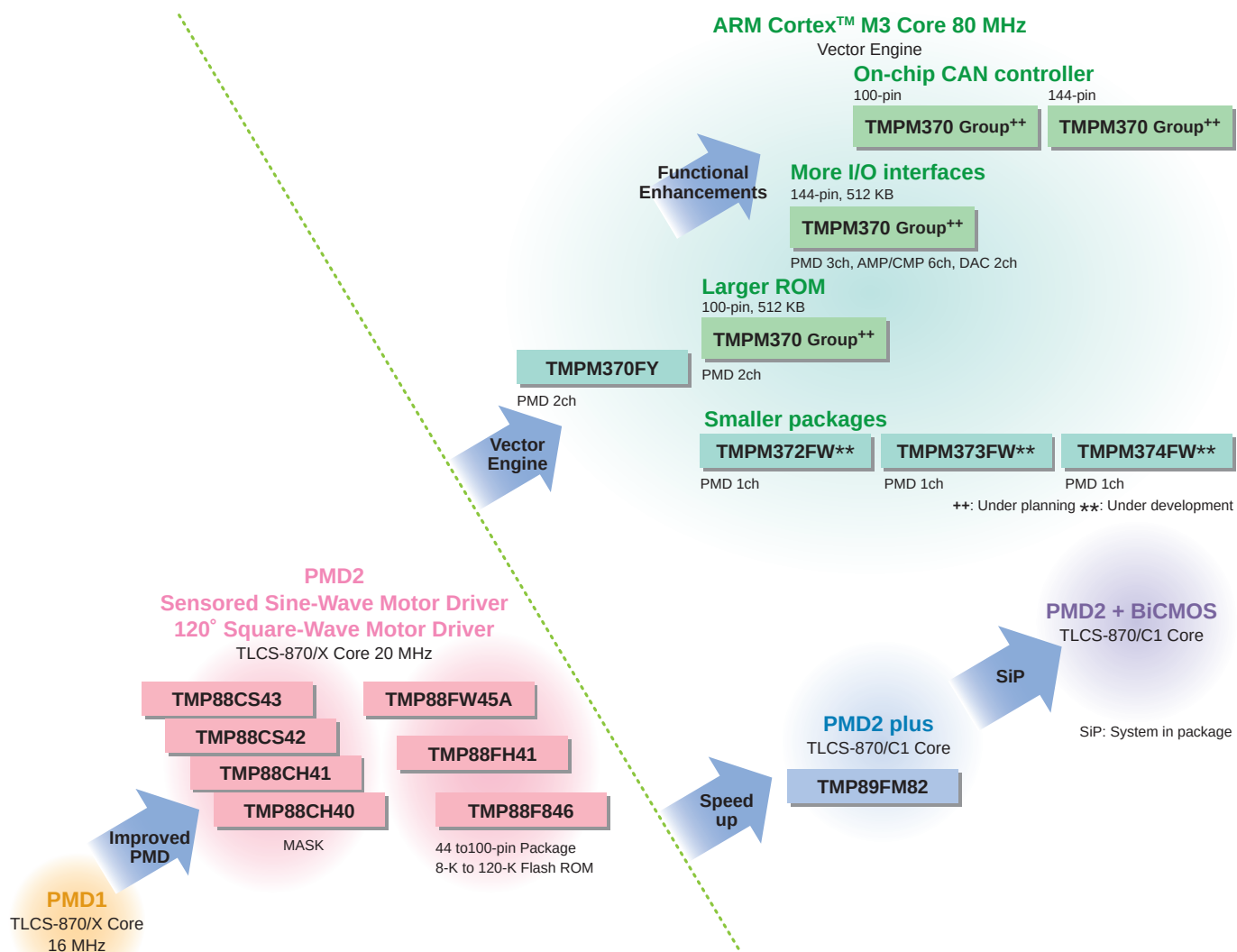
Vector Control Microcontrollers

- Vector Engine (Performs routine tasks such as coordinate conversions and sine and cosine calculations.)
- Three-phase PWM output coupled to a vector engine and a 12-bit A/D converter
- Encoder input (ABZ)
- Built-in analog circuit (Op-amp, comparator for emergency stop, voltage detection circuit, power-on reset and frequency detection circuit)
- ARM Cortex™-M3 Core, 80MHz.
- NANO FLASH™
- +5V single power supply operation
- Over voltage protection circuit (OVV pin)
- Emergency protection (EMG pin)

Sine-wave/Square-wave Control Microcontrollers

- PMD2 sensed sine-wave drive, sensorless/sensored 120 electrical degree square drive
- Position detection (sampling during PWM on period, suspending sampling immediately after PWM is turned on)
- Motor control timer and timer capture
- Three-phase PWM output
- Automatic generation of sine wave duty (PMDRAM, automatic duty calculation)
- Overload protection (CL pin)
- Emergency protection (EMG pin)
- Automatic commutation, automatic position detection start (mode timer, capture)

PMD Microcontroller Product Lineup



Microcontrollers with Inverter Motor Control Circuit (PMD)

Cortex™-M3 Core and Vector Motor Control Engine

TMPM370FYFG/TMPM370FYDFG

ARM Cortex™-M3 CPU core

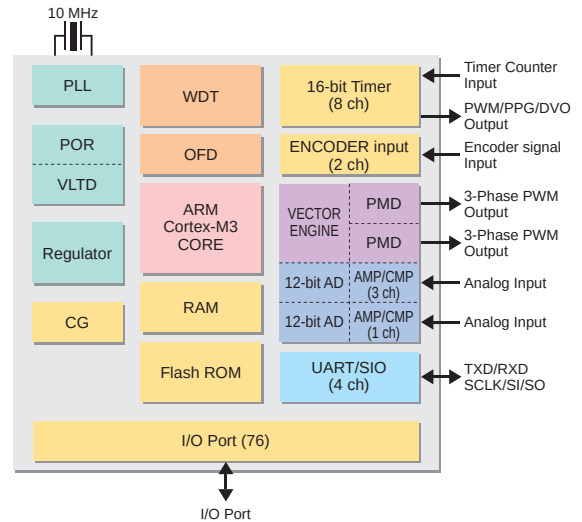
- Operating voltage: I/O = 4.5 to 5.5 V
- Maximum operating frequency: 80 MHz (derived by multiplying a 10-MHz clock by a factor of 8 with on-chip PLL)
- On-chip memory: 256 Kbytes flash ROM, 10 Kbytes RAM
- High-speed computation: Multiplier (1-7 cycles), divider (2-12 cycles)
- On-chip debug circuit: JTAG or 2-wire SWD (Serial Wire Debug) interface; SWV; TRACE (2-bit data)
- Power-saving operation: Clock gear (for dividing clocks to 1/1, 1/2, 1/4, 1/8 or 1/16), operation mode (NORMAL/STOP)

On-chip peripherals

- Next-generation PMDs (motor control timers): 2 channels
 - Vector Engine: 1 channel
 - Encoder inputs: 2 channels
 - Comparator for emergency stop
- 12-bit AD converter: 2- μ s conversion time, 2-unit, 22-channel ADCs (with three channels sharing the same pins)
- 16-bit timer/counter: 8 channels (free-run, compare output, PPG, input capture)
- Serial interface: 4 UART/SIO channels
- Watchdog timer (WDT)
- Voltage detection (VLTD)
- Power-on reset circuit (POR)
- Oscillation frequency detection (OFD)

Packages

- 100-pin LQFP (14 x 14 mm, 0.5-mm lead pitch)
- 100-pin QFP (14 x 20 mm, 0.65-mm lead pitch)

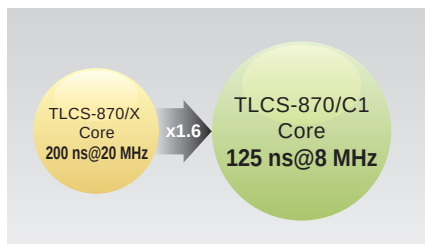


TLCS-870/C1 Core and Sensored Sine-Wave/120° Square-Wave Motor Controller

TMP89FM82DUG/TMP89FM82TDUG <Under development>

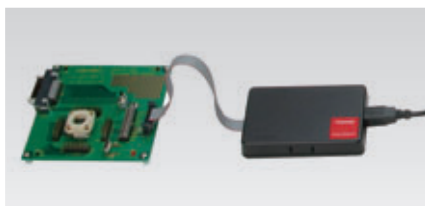
Improved instruction throughput due to the TLCS-870/C1 core

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



On-chip debug features

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



TLCS-870/C1 CPU core

- Operating voltage: 4.5 to 5.5 V
- Minimum instruction execution time: 125 ns @ 8 MHz / 4.5 to 5.5 V
- On-chip memory: 32 Kbytes flash ROM, 2 Kbytes RAM

On-chip peripherals

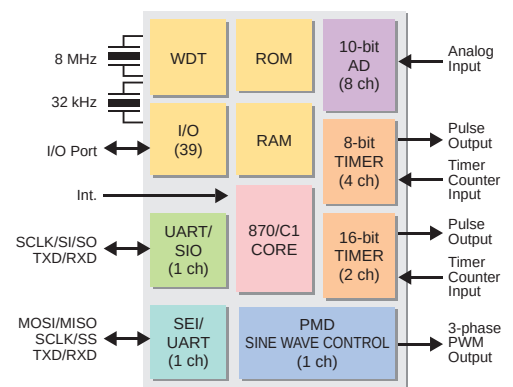
- Programmable Motor Driver: 1 channel
 - PWM resolution: 42 ns
 - Dead time counter resolution: 83 ns
 - Sine-wave control
 - Sensorless and sensored DC motor control
 - Inverter AC motor control
 - Overload protection
 - Automatic commutation; real-time position sensing
- 10-bit AD converters: 8 channels
- 8-bit timers: 4 channels
- 16-bit timers: 2 channels
- UART/SIO: 1 channel
- SEI/UART: 1 channel
- Power-on reset circuit (POR)
- Low-voltage detection circuit

Package

- 48-pin LQFP (7 x 7 mm, 0.5-mm lead pitch)

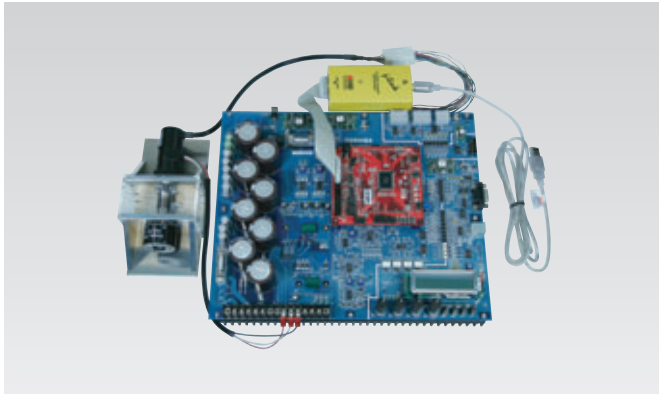
TMP89FM82TDUG only

- Extended operating temperature range: $T_a = -40$ to 125°C
- ISO/TS16949-compliant



● Reference Models (Demo Boards)

TMPM370 Vector Engine Demo Board



This demo board is designed to be able to control two motors in electric appliances, such as air conditioner outdoor units and washing machines.

- IPD: Consists of the TPD4125AK and an intelligent power module (IPM) to allow two motors to be connected to the board.
- Power supply circuit
- The demo board can be connected to the TMPM370 Starter Kit.

TMP89FM82 PMD Microcontroller Demo Board



This demo board has a PMD that is used in the TLCS-870/C1 and TLCS-870/X series and thus can control a small motor easily.

- Accompanied by reference software for sensorless and sensed motor control with a square-wave drive, and sine-wave drive.
- On-board programming of several parameters for Proportional and Integral (PI) control and lead angle control
- Integrated development environment and On-Chip Debug Emulator (OCDE) for software development
- General-purpose motor driver, and comparators for position and overcurrent detection

● Third-Party Microcontroller Starter Kit

IAR Systems

<http://www.iar.com>



TMPM370 Starter Kit: KSK-TMPM370-TPL

<Starter Kit Deliverables>

- M370 evaluation board
- JTAG tool (J-Link for Toshiba Cortex-M3)

Hardware Specifications

- Debugger connectors (insulated/non-insulated)
- Reset circuit
- Clock circuit
- Volume for setting the analog voltage
- 3 LED monitor lamps

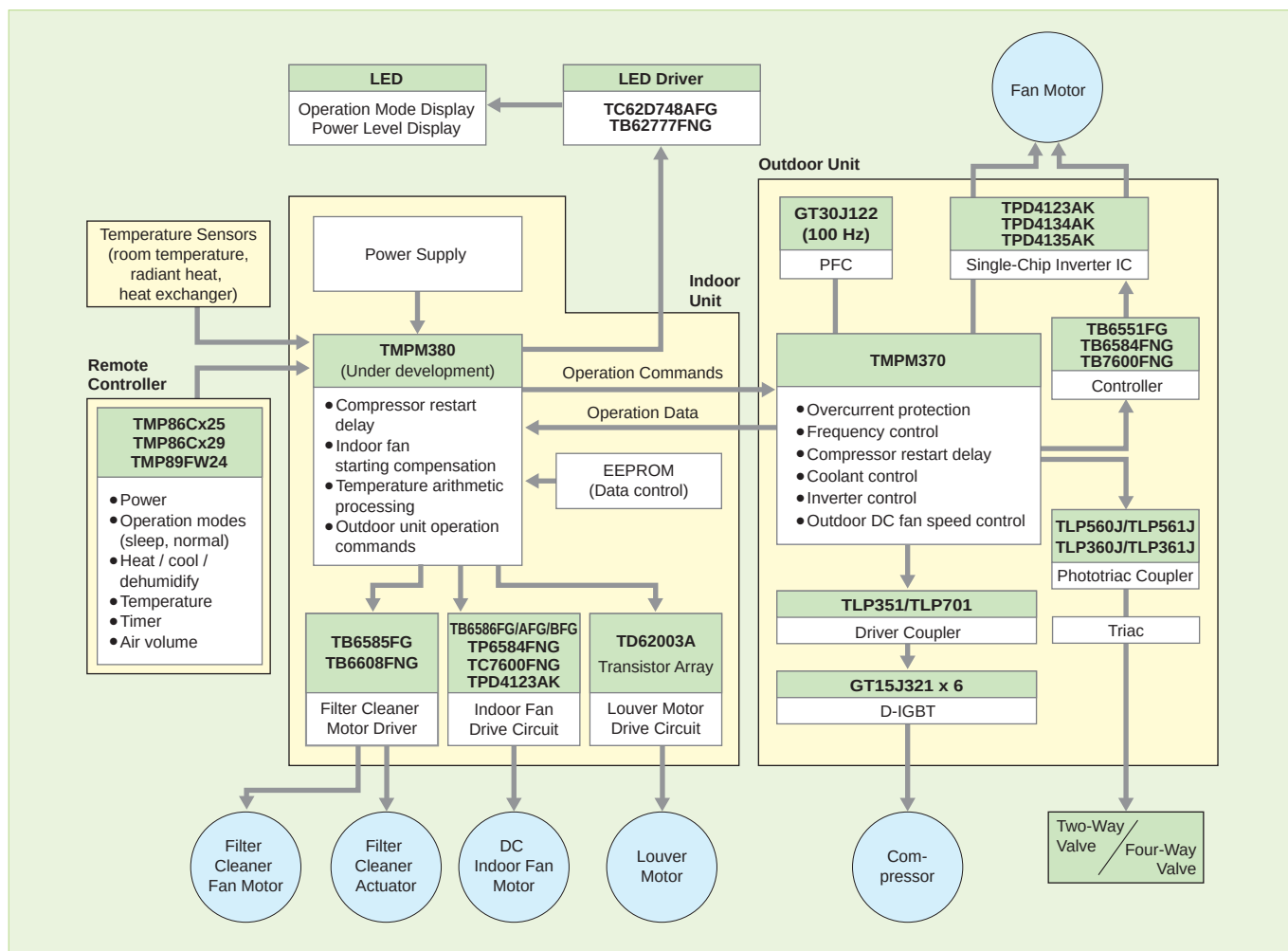
Applications: Home Appliances

Microcontrollers for Inverter-Controlled Home Appliance Applications

Air Conditioners

These days, more and more air conditioners are equipped with a vector-controlled compressor motor for energy-saving purposes. Toshiba offers a wide range of microcontrollers that offer on-chip functions tailored to specific air conditioner applications: PMD microcontrollers that support motor vector control; microcontrollers suitable for indoor unit applications, which provide indoor fan, louver and overall system control; and those ideal for remote controllers with an LCD screen.

System Block Diagram



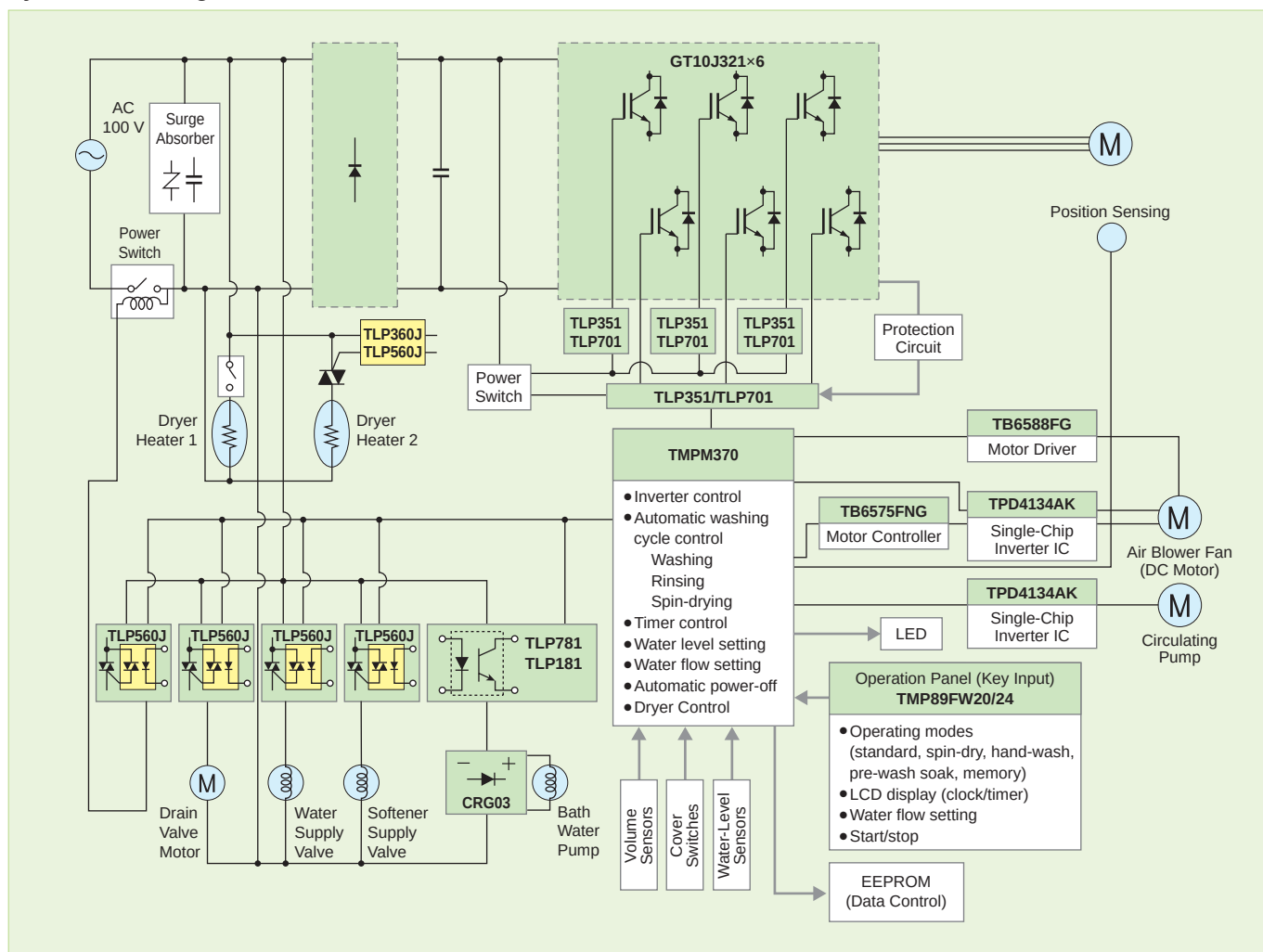
Product Lineup

System Block	Part Number	ROM Size (Kbytes)	RAM Size (Kbytes)	Functions & Features
Indoor unit controller	TMP86FS49BFG/BUG	60	2	13 high-current output pins
	TMP89FS60FG/UG		3	8 high-current output pins
	TMP91FW64DFG/FG	128	8	128 Kbytes FLASH
	TMPM380FYFG**	256	16	3-channel multiple-purpose timer (MPT) 18-channel 12-bit AD converter
Indoor unit remote controller	TMP86FM29FG/UG	32	1.5	LCD driver: 32 seg. x 4 com.
	TMP86CM29BFG/BUG/LUG			
	TMP86FM25FG			
	TMP86CS25AFG/ADFG	60	2	LCD driver: 60 seg. x 16 com.
	TMP86CS28FG/DFG			
	TMP86FS28FG/DFG			LCD driver: 40 seg. x 4 com.
	TMP89FW20UG	124	3	LCD driver: 32 seg. x 4 com.
	TMP89FW24FG/DFG			LCD driver: 40 seg. x 4 com.
Outdoor unit controller	TMPM370FYDFG/FG	256	10	Vector Engine 2-channel next-generation PMD

■ Washing Machines

The direct-drive (DD) inverter motor helps reduce wash/spin noise and vibration. Use of a DD inverter motor enables a washing machine to adjust the amount of water to suit the wash load. IGBT modules are used for motor driver, and microcontrollers for overall control. Additionally, an intelligent power device (IPD) is used to drive a water circulating pump.

System Block Diagram



Product Lineup

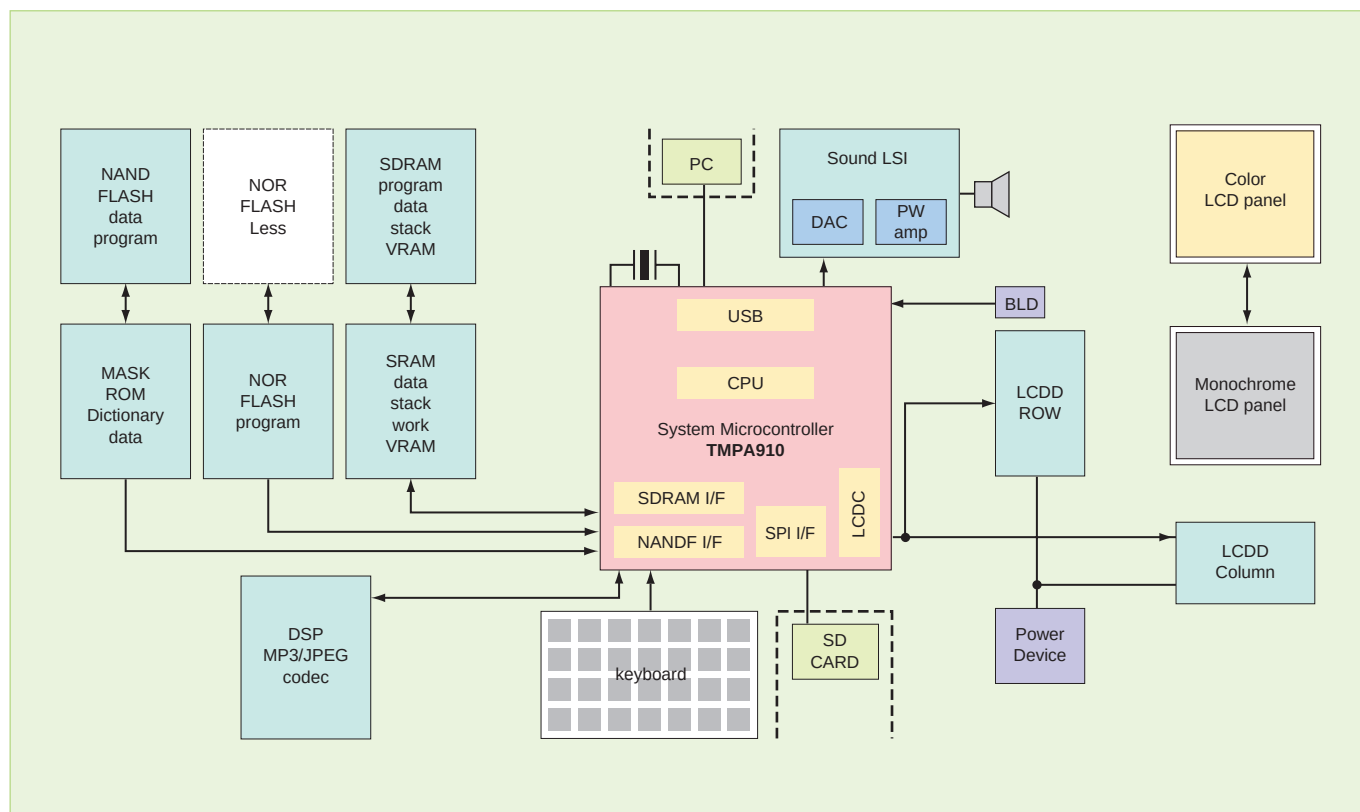
System Block	Part Number	ROM Size (Kbytes)	RAM Size (Kbytes)	Functions & Features
Motor control	TMPM370FYDFG/FG	256	10	Vector Engine 2-channel next-generation PMD
Operation panel (LED lamps)	TMP86FS49BFG/UG	60	2	13 high-current output pins
	TMP89FS60FG/UG		3	8 high-current output pins
	TMP91FW64DFG/FG	128	8	128 Kbytes FLASH
Operation panel (LCD screen)	TMP86FM29FG/UG	32	1.5	LCD driver: : 32 seg. × 4 com.
	TMP86CM29BFG/BUG/LUG			LCD driver: : 60 seg. × 16 com.
	TMP86FM25FG			LCD driver: : 60 seg. × 16 com.
	TMP86CS25AFG/ADFG	60	2	LCD driver: : 40 seg. × 4 com.
	TMP86CS28FG/DFG			LCD driver: : 40 seg. × 4 com.
	TMP86FS28FG/DFG			LCD driver: : 40 seg. × 4 com.
	TMP89FW20UG	124	3	LCD driver: : 32 seg. × 4 com.
	TMP89FW24FG/DFG			LCD driver: : 40 seg. × 4 com.

Applications: Digital Consumer Electronics

Microcontrollers for Personal Digital Assistant (PDA) Applications

With built-in devices such as LCD driver controllers, memory management units and RTC, these microcontrollers are ideal for personal digital assistant (PDA) applications. We also offer products with a built-in touch panel interface, AD converter and power supply detection circuit; and products with a built-in SDRAM controller and NAND flash memory interface featuring outstanding bit unit cost. The TX09 Series incorporates an ARM926EJ-ST[™] core ideal for multimedia control, which contains a 16-KB instruction cache and a 16-KB data cache. The TX09 Series can operate at up to 200 MHz and has a multi-layered on-chip bus architecture to improve performance and reduce power consumption.

System Block Diagram



Product Lineup

Series	Part Number	ROM (Kbytes)	RAM (Kbytes)	Maximum Operating Frequency (MHz)	USB Device (High Speed)(ch)	USB Device (Full Speed)(ch)	USB Host (Full Speed)(ch)	SD Host Controller (Ch)	LCD Data Process Accelerator	32-kHz Timer (for S/W RTC)	Touch Screen Interface	CMOS Image Sensor Interface (Ch)	Power Supply Voltage (V)	Operating Temperature (°C)
TX09	TMPA913CHXBG	NA	16	(1)200 (2)150	1					Yes	Yes		1.4 to 1.6	(1)0 to 70 (2)-20 to 85
	TMPA900CMXBG		32		1		1	1	Yes	Yes	Yes	1		
	TMPA901CMXBG				1		1		Yes	Yes	Yes			
	TMPA912CMXBG				1			Yes	Yes	Yes	1			
	TMPA910CRAXBG		56	200	1		1	Yes	Yes	Yes	1	0 to 70		
	TMPA910CRBxBG			150	1		1	Yes	Yes	Yes	1	-20 to 85		
	TMPA911CRXBG			(1)200 (2)150	1			Yes	Yes	Yes	1	(1)0 to 70 (2)-20 to 85		
TLCS-900/H1	TMP92C820FG	NA	8	20						Yes			3.0 to 3.6	-20 to 70
	TMP92CH21FG		16	20		1				Yes	Yes			
	TMP92CA25FG		10	20						Yes	Yes			
	TMP92CF26AXBG		144	80		1				Yes	Yes			0 to 50
	TMP92CZ26AXBG		288	80		1				Yes	Yes			0 to 70
	TMP92CF29AFG		144	80		1				Yes	Yes			

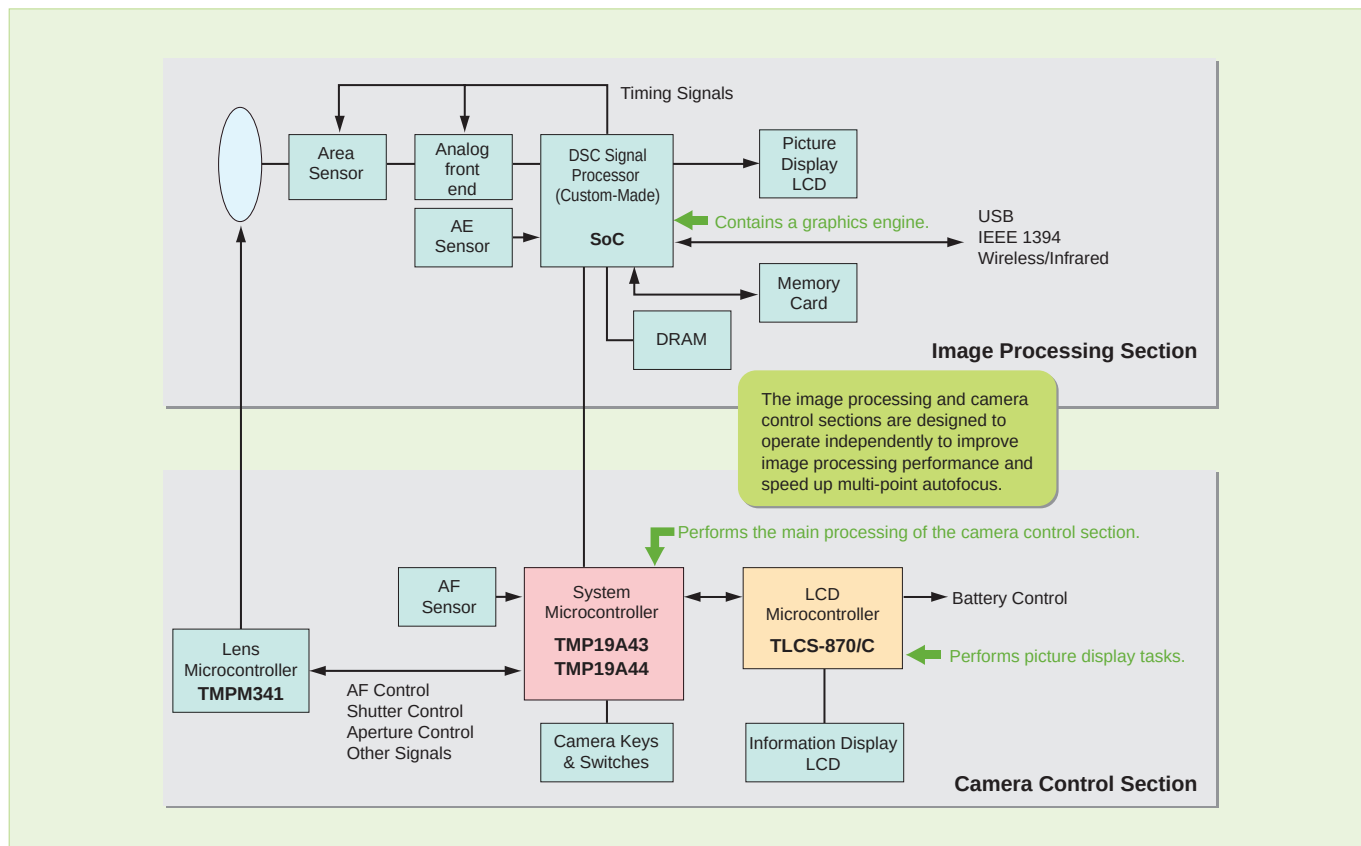
Note 1) Minimum instruction execution times (1) and (2) correspond to power supply voltages (1) and (2).

Microcontrollers for Camera Applications

Digital Single-Lens Reflex (DSLR) Cameras

The microcontrollers specifically designed for DSLR applications offer a rich set of features required for the main control section of a camera, such as a high-speed AD converter, autofocus (AF) engine, auto exposure (AE) engine and a dial input interface.

System Block Diagram



Product Lineup

Part Number	ROM (Kbytes)	RAM (Kbytes)	Maximum Operating Frequency (MHz)	DMA Controller (ch)	Serial Interface (ch)	10-bit AD Converter (ch)	10-bit DA Converter (ch)	Dual Clocks	Power Supply Voltage (V)	Package
TMP19A23FYFG	256	24	54	4	6	12			3.0 to 3.6	LQFP144 (20 × 20 mm)
TMP19A23FYXBG			40	4	6	12			1.36 to 1.65 ^(Note)	FBGA141 (9 × 9 mm)
TMPM341FDXBG**	512	32	54	4	8		2		1.65 to 3.6	FBGA113 (6 × 6 mm)
TMP19A43FZXBG	384	20	40	8	7	16		Yes	1.35 to 1.65 ^(Note)	FBGA193 (12 × 12 mm)
TMP19A43FDXBG	512	24	40	8	7	16		Yes	2.7 to 3.6	FBGA241 (12 × 12 mm)
TMP19A44FDXBG		32	80	8	7	16		Yes		
TMP19A44FEXBG	768	64	80	8	7	16		Yes		
TMP19A44F10XBG	1024		80	8	7	16		Yes		

Note: I/O power supplies are required separately.

** Under development

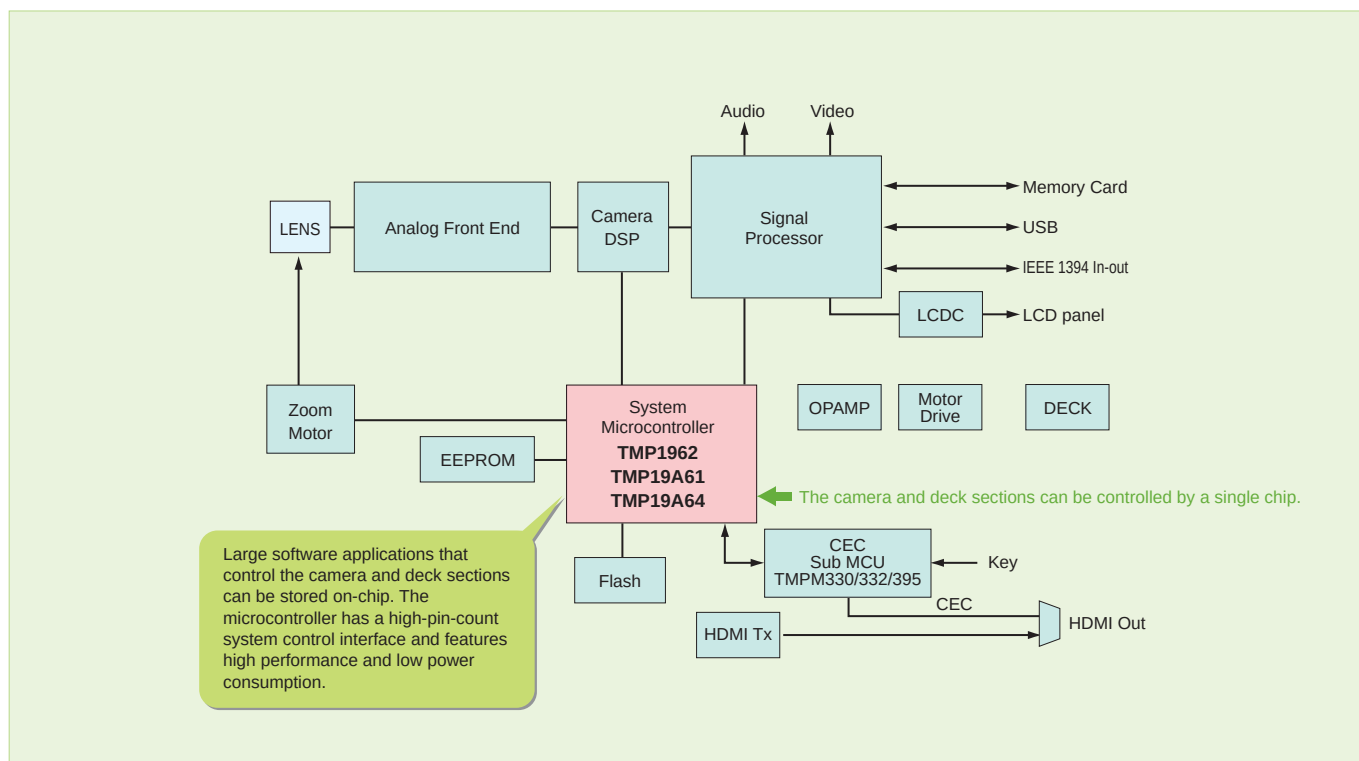
Applications: Digital Consumer Electronics

Microcontrollers for Camera Applications

Digital Video Cameras (DVCs)

The microcontrollers specifically designed for digital video cameras offer a rich set of features required for the main control of the camera and deck sections and contain a large ROM to help reduce product size.

System Block Diagram



Product Lineup

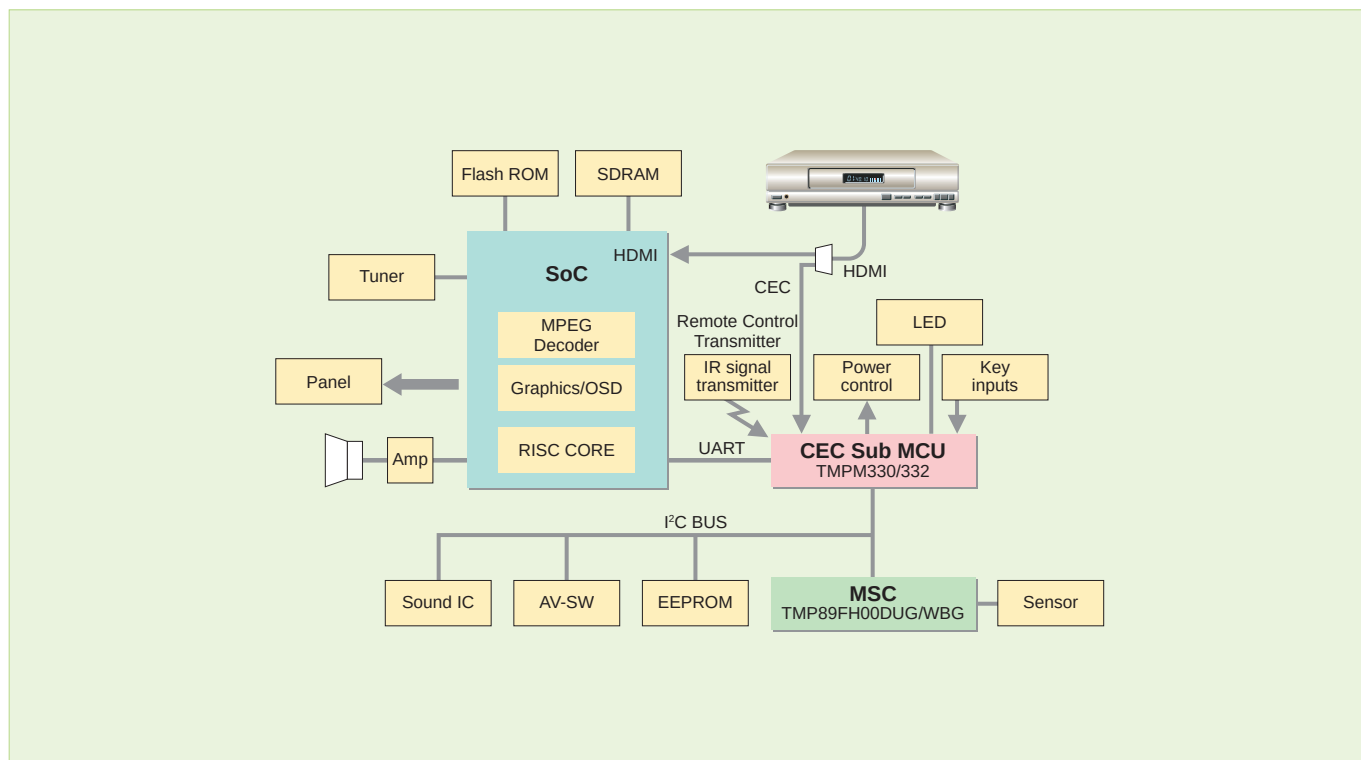
Part Number	ROM (Kbytes)	RAM (Kbytes)	Maximum Operating Frequency (MHz)	DMA Controller (ch)	Serial Interface (ch)	10-bit AD Converter (ch)	Dual Clocks	Power Supply Voltage (V)	Package
TMPM332FWUG	128	8	40		4	8	Yes	2.7 to 3.6	LQFP64 (10 × 10 mm)
TMPM395FWXBG			20		9	12	Yes	1.7 to 3.6	FBGA120 (6 × 6 mm)
TMPM330FWFG			40		6	12	Yes	2.7 to 3.6	LQFP100 (14 × 14 mm)
TMPM330FYFG	256	16	40		6	12	Yes		
TMPM330FDFG	512	32	40		6	12	Yes		
TMP1962F10AXBG	1024	40	40.5	8	8	24		2.2 to 2.7 ^(Note)	FBGA281 (13 × 13 mm)
TMP19A61F10XBG		48	54	8	13	32		1.35 to 1.65 ^(Note)	FBGA289 (11 × 11 mm)
TMP19A64F20BXBG	2048	64	54	8	8	24	Yes		FBGA281 (13 × 13 mm)
TMP19A43FZXBG	384	20	40	8	7	16	Yes		FBGA193 (12 × 12 mm)
TMP19A43FDXBG	512	24	40	8	7	16	Yes	2.7 to 3.6	FBGA241 (12 × 12 mm)
TMP19A44FDXBG		32	80	8	7	16	Yes		
TMP19A44FEXBG	768	64	80	8	7	16	Yes		
TMP19A44F10XBG	1024		80	8	7	16	Yes		

Note: I/O power supplies are required separately.

Microcontrollers for TV Applications

Toshiba offers microcontrollers for TV applications that contain an I²C bus interface, an HDMI CEC decoder and an IR remote control receiver decoder. Optimum TV systems can be created by using a TV microcontroller in tandem with Toshiba's TV processors.

System Block Diagram



Product Lineup

Part Number	ROM (Kbytes)	RAM (Kbytes)	Maximum Operating Frequency (MHz)	Serial Interface (ch)	10-bit AD Converter (ch)	Dual Clocks	Power Supply Voltage (V)	Package
TMP89FH00DUG	16	1	5	1	4	Yes	2.2 to 3.6	LQFP48 (7 × 7 mm)
TMP89FH00WBG			5	1	4	Yes		WCSP39 (3.8 × 3.8 mm)
TMPM332FWUG	128	8	40	4	8	Yes	2.7 to 3.6	LQFP64 (10 × 10 mm)
TMPM395FWXBG			20	9	12	Yes	1.7 to 3.6	FBGA120 (6 × 6 mm)
TMPM330FWFG			40	6	12	Yes	2.7 to 3.6	LQFP100 (14 × 14 mm)
TMPM330FYFG	256	16	40	6	12	Yes		
TMPM330DFDG	512	32	40	6	12	Yes		

Applications: Automotive Safety Systems

Microcontrollers for Automotive Safety System Applications

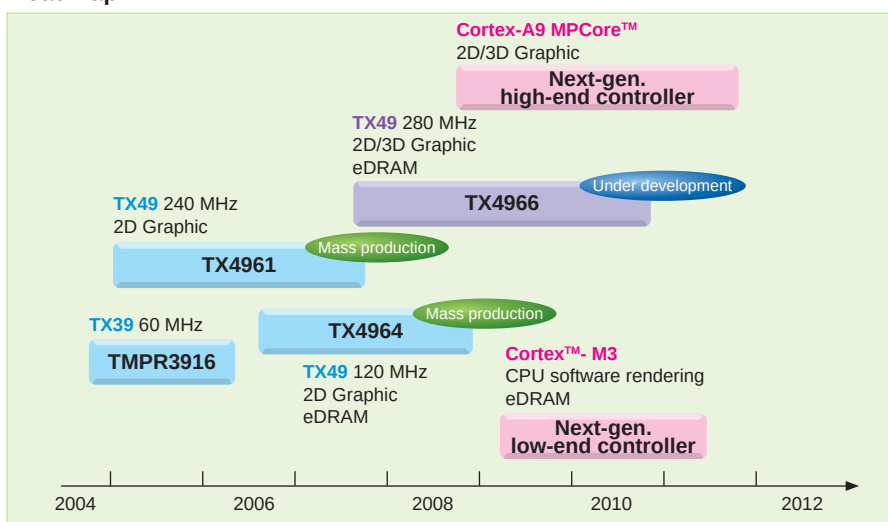
Automotive Display Controllers

Toshiba's automotive display controllers are designed to provide the capability to display instrument clusters, navigation systems and other in-vehicle applications. The controllers integrate a CPU, a graphics accelerator and a variety of interfaces on one single chip, all of which have the unified memory architecture (UMA).

Overview

- Display controllers available for low-end to high-end applications
- 64-bit CPU core
- 24-bit color depth plus 8-bit alpha blending
- Powerful 2D/3D graphics accelerator
- Controllers with an embedded DRAM eliminate the need for external graphics memory.
- Distortion correction for head-up display
- Camera/video input with scaler

Roadmap



Visconti® Automotive Image Recognition Processor Series

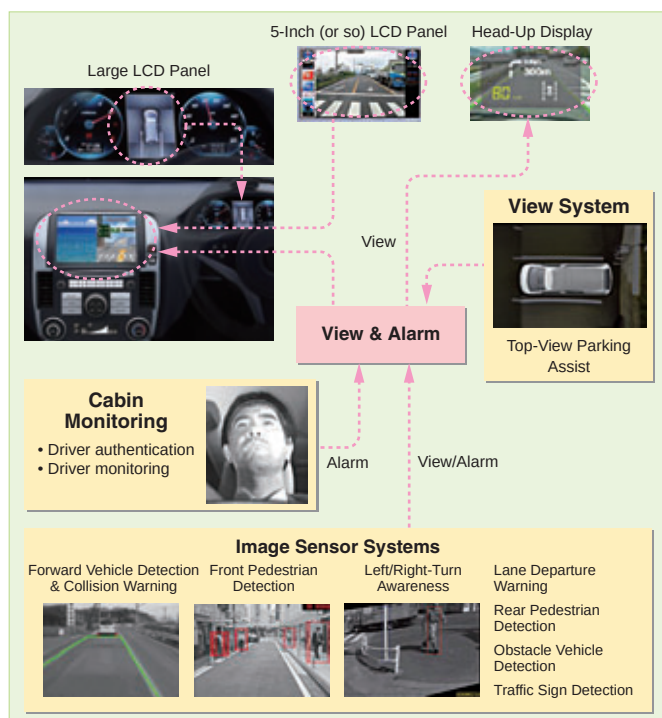
Visconti® is an image recognition processor designed for automotive applications. Using camera-based vision systems, Visconti® recognizes lanes, vehicles, pedestrians, traffic signs and so on. It is suitable for a variety of driving assistance applications such as lane departure warning and front/rear pedestrian detection.

Features of Visconti®

- Parallel processing architecture suitable for image processing
Enables real-time image recognition with hardware accelerator and multiple VLIW processor cores, each of which can execute multiple instructions simultaneously, including SIMD instructions that perform the same operation on multiple data at the same time.
- Multiple heterogeneous cores simplify the implementation of multiple applications.
- Provides a software development kit that supports the development of applications using the C language, backed up by various image-processing libraries.

General Specifications

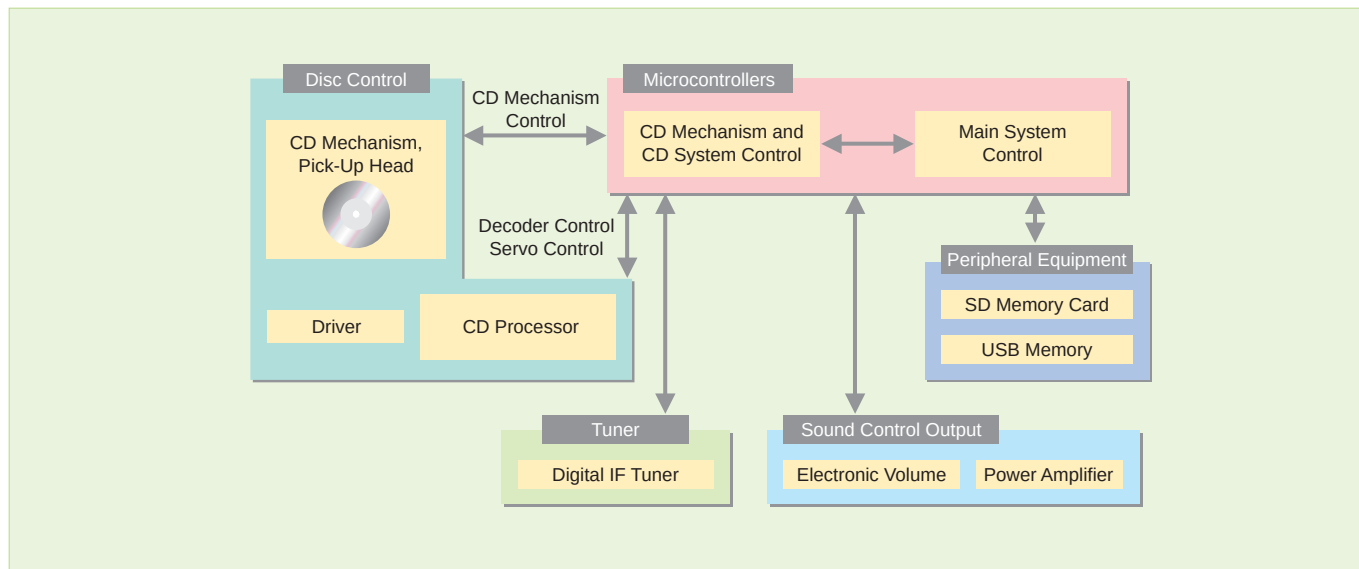
MeP Modules	Multi-core processor with three MeP modules MeP: 32-bit RISC VLIW processor core IVC: Coprocessor capable of executing up to two SIMD instructions DMAC: Each MeP core contains instruction and data RAMs as well as instruction and data caches. DMA controllers speed up data transfers to/from these RAMs.
SDRAM Interface Module	Up to 32-Mbyte SDRAM
Video Input Module	Up to three grayscale cameras can be connected. Supports up to VGA size.
Video Output Module	RGB888 output (Up to 256 colors out of a pallet of 16 million) Supports up to VGA size.
Affine Transform Module	Hardware accelerator for linear and nonlinear image transformations (Images can be enlarged, shrunk, transformed and rotated.)
Package	456-pin PBGA (27 mm x 27 mm)
Operating Ambient Temperature	-40 to 85°C
Supply Voltage	3.3 V (I/O)/1.5 V (core)



Applications: Car Audio Systems

Microcontrollers for Car Audio Applications

Toshiba offers a broad range of devices necessary to create optimum platforms for car audio systems.



Microcontrollers

Microcontrollers are offered with various types of memory configuration and pin count to support audio systems for a wide range of applications. The product lineup also includes products tailored to specific applications, such as USB.

The combination of a microcontroller designed for USB host control and a CD system processor makes it possible to play back music files from USB memory and MTP devices.

Applications	Part Number	ROM (Kbytes)	RAM (Kbytes)	Package	Feature
USB HOST/ SD HOST Control	TMPM320C1DFG	—	320	LQFP144	ARM Cortex™-M3, USB HOST controller (HS/FS), SD HOST controller, eDRAM: 1 MB
USB HOST Control	TMP92CD28AFG	512	32	LQFP100	32-bit CISC controller USB HOST controller (FS)
	TMP92FD28AFG				
CD Mechanism and CD System Control	TMP91CW12AFG	128	4	LQFP100	16-bit CISC controller
	TMP91CY22 FG	256	16		
	TMP91FY42FG				
	TMP91CP27UG	48	4	LQFP64	
	TMP91CU27FG/UG	96	10	QFP/LQFP64	
	TMP91FW27FG/UG	128	12		
Main System Control	TMP92CD23AFG/DFG	512	32	LQFP/QFP100	32-bit CISC controller
	TMP92FD23AFG/DFG				
	TMP92CD54IFG**			LQFP100	32-bit CISC controller, CAN controller
	TMP92FD54AIFG**				
	TMPM330FDWFG	ARM Cortex™-M3, Remote control signal preprocessor			
	TMPM330FYWFG**		256	16	

** : Under development

CD Processors

Various types of audio compression formats are supported. Together with the control microcontroller unit, the disc control unit provides common platforms ranging from low-end to high-end.

Part Number	Feature
TC94A92FG	RF amp, digital CD servo, MP3/WMA/AAC decoder, 2-channel DAC
TC94A93MFG	RF amp, digital CD servo, MP3/WMA/AAC decoder, 2-channel DAC, electronic shock protection (ESP) memory
TC94A99FG	RF amp, digital CD servo, MP3/WMA/AAC decoder, audio signal processor (ASP) for sound field control, ADC, 5-channel DAC

Applications: Car Audio Systems

Tuner

Shown below is a list of processors for digital IF tuner applications for car audio systems. A high-performance single- or dual-tuner AM/FM radio can be created by combining a front-end and a back-end processor.

Part Number	Feature
TB2178FG	Front-end processor for digital IF tuner applications
TC94A90FG	Back-end processor for digital IF tuner applications (for dual-tuner radios)
TC94B01FG	Back-end processor for digital IF tuner applications (for single-tuner radios)

Sound Control and Output

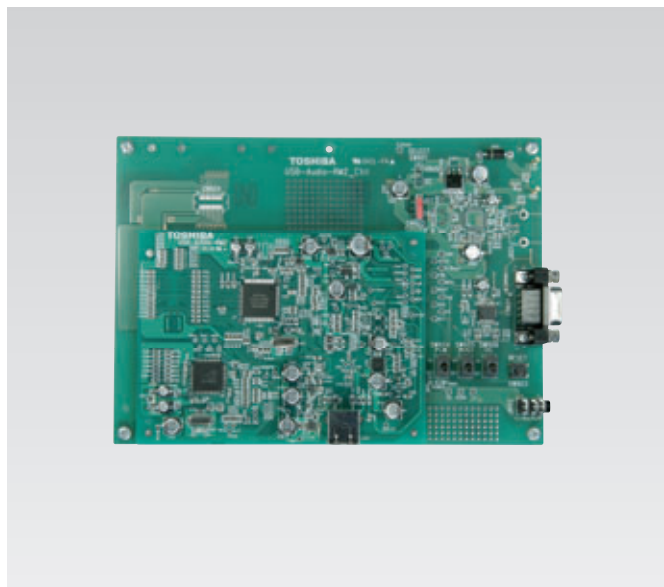
Applications	Part Number	Feature
Power Amplifiers	TB2924FG	D-class 20 W × 2-ch power IC
	TB2922HQ	22 W × 2-ch Power IC
Car Audio Power Amplifiers	TB2921AHQ	Max Power 51 W × 4-ch Power IC
	TB2923AHQ	
	TB2926CHQ	Max Power 49 W × 4-ch Power IC
	TB2936HQ	
	TB2946HQ	
	TB2929HQ	Max Power 45 W × 4-ch Power IC
	TB2932HQ	Max Power 49 W × 4-ch Power IC (bus-controlled with built-in self-diagnosis function)
	TB2933HQ	
Electronic Volumes	TC9260APG	2-ch electronic volume
	TC9260AFG	
	TC9422AFG	One-chip electronic volume (4-input selector + 2-band tone control + 2-channel volume)

USB Audio Reference Models (Demo Boards)

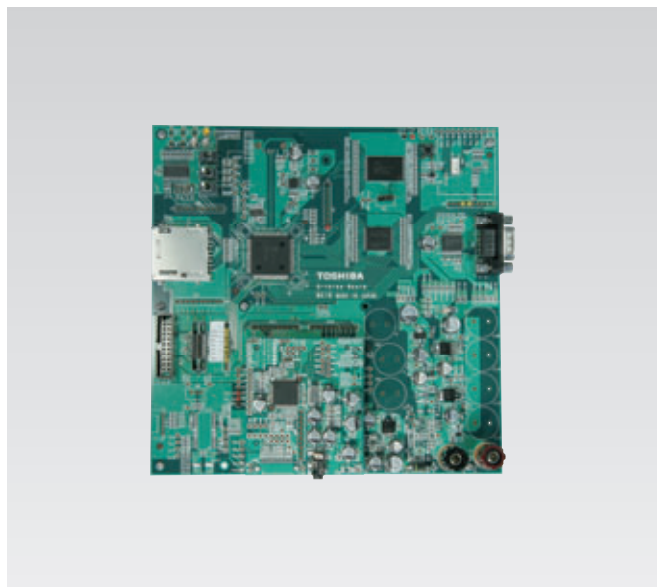
Toshiba offers a reference board specifically designed for evaluation of the on-chip USB host controller.

- Functional verification of the microcontroller / reference board design
- Connectivity verification of a USB storage device
- Software that supports various Digital Rights Management (DRM) standards

USB Audio Demo Board for the TMP92FD28



USB Audio Demo Board for the TMPM320



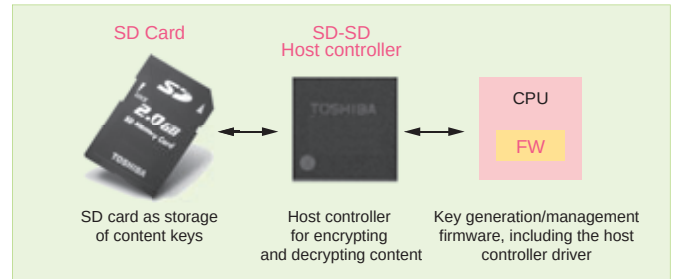
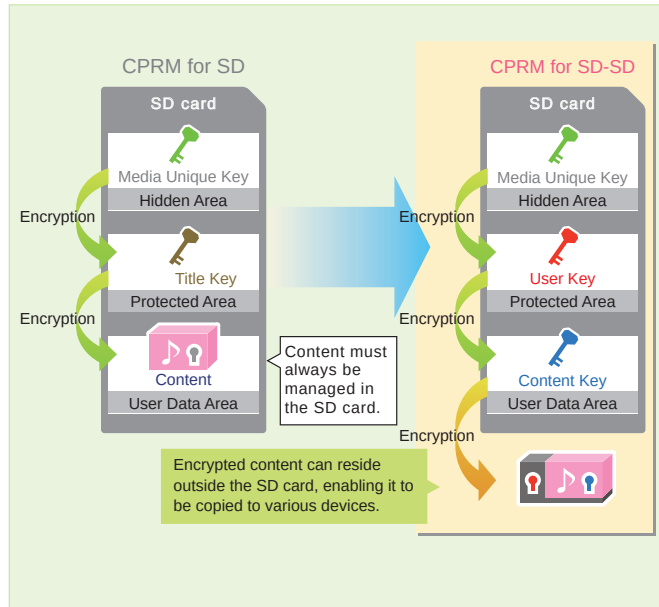


Next-Generation DRM (Digital Rights Management) Technology TranShare™

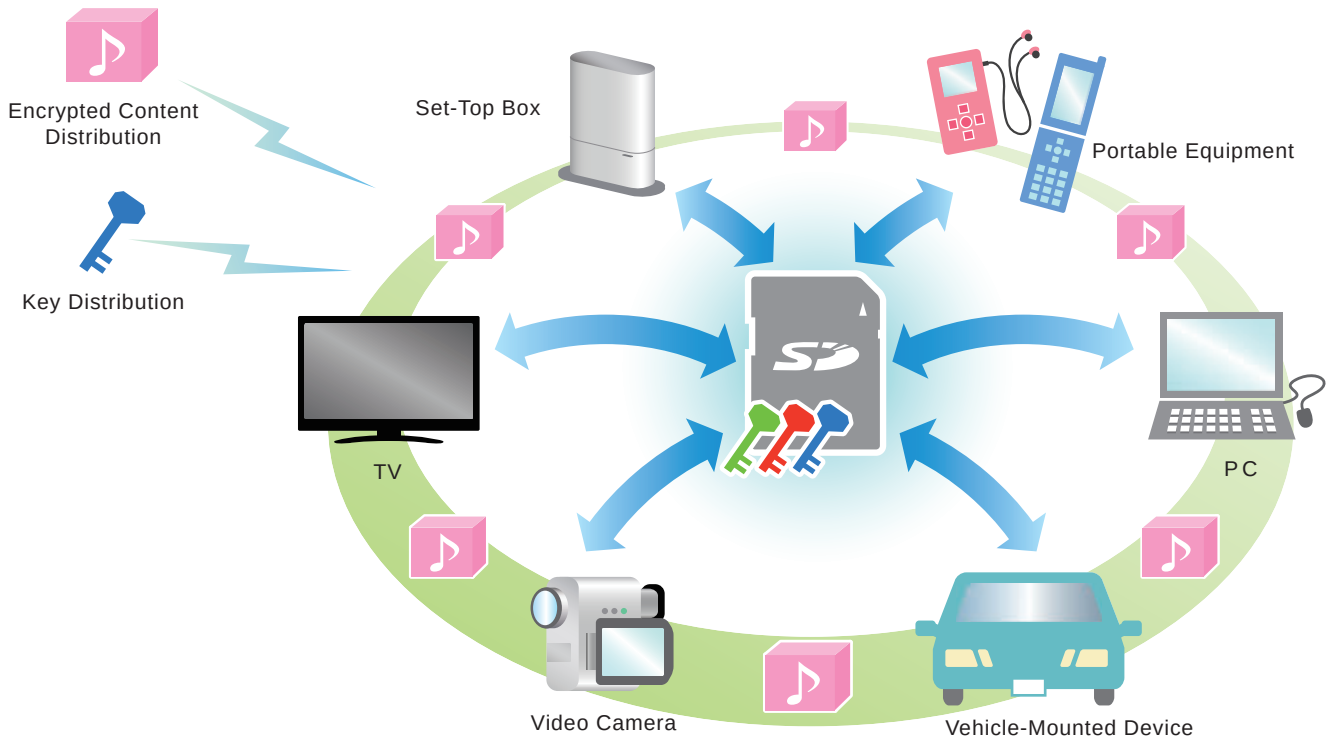
TranShare™ is a new copyright protection management mechanism using the SD memory card, enabling the user to back up, restore and play back protected digital content across various devices.

- Supports digital music and video content requiring copyright protection management.
- Complies with the SD-SD (Secure Digital Separate Delivery) specifications from the SD Card Association.
- Secures keys in an SD memory card by using the Content Protection for Recordable Media (CPRM) technology.
- Allows a backup (copy) of encrypted content to be created in any storage devices.
- Allows the user to specify usage rules, such as the number of times content can be played back and key expiry dates.

* Secure Digital Separate Delivery (Specification from the SD Card Association)



In the conventional SD memory card implementation, encrypted content and the keys that release it must reside in the same SD memory card. The SD-SD specifications allow encrypted content to reside separately from the keys by adding another step to the encryption process in the user area of the SD memory card. The basic concept of the TranShare™ system is to use an SD memory card as storage of content keys, separating encrypted content from the keys that release it. In this way, encrypted content can be distributed across various devices, which can then be played back by inserting an SD memory card containing the valid keys.



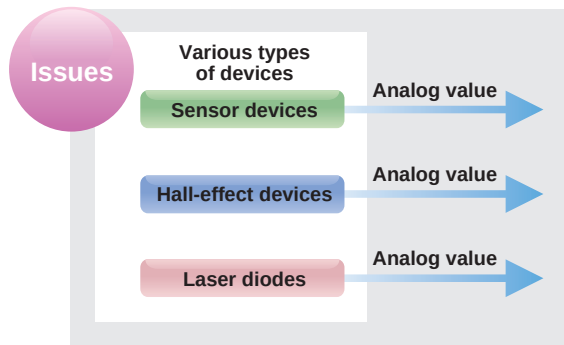
Visit the Toshiba Microcomputer website to view a video presentation of the TranShare™ system overview and application examples.
<http://www.semicon.toshiba.co.jp/eng/>

Mixed-Signal Controllers

– Intelligent analog-based control solutions –

Basic Concept of Mixed-Signal Controllers

Solutions Using On-Chip Analog Circuits and Embedded Software



Circuit boards must be designed and calibrated for each type and instance of sensor device.

- Very small changes in the quantity of the sensor output
- Parametric variations from device to device
- Significant temperature sensitivity
- Offset variations
- Nonlinearity
- Long-term stability drift
- Board rework required to suit specific device manufacturers and devices
- Greatly affected by external conditions

Often, the magnitudes of analog measurements cannot be used without being processed.

Solutions

1. Single-chip integration of an MCU and analog circuits tailored to the required devices and applications
2. Embedded software for controlling analog circuits

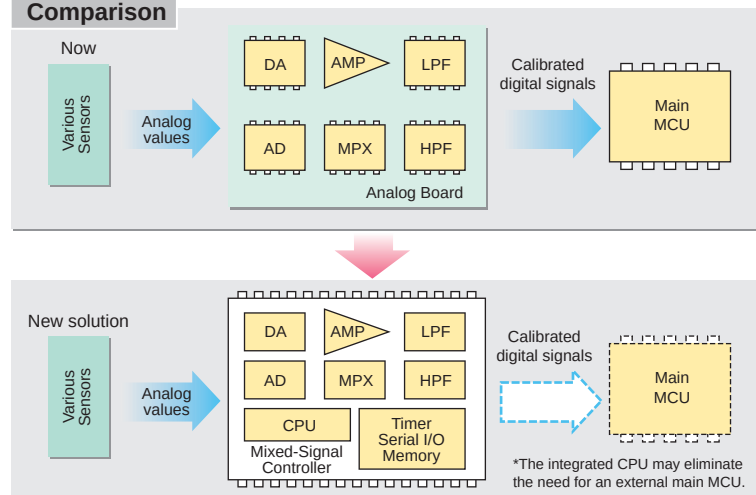
Things Software Can Do Easily

What Is a Mixed-Signal Controller?

The term “mixed-signal” means an integrated circuit that contains both analog and digital circuit elements. Toshiba’s mixed-signal controller incorporates a CPU on the same chip to allow adjustment of the characteristics of on-chip analog circuits.

The market of Micro Electro Mechanical System (MEMS) sensors is growing rapidly, with many applications being introduced one after another. The mixed-signal controller is specifically designed to address such needs by integrating peripheral circuits on the same chip. **Embedded software for the controller simplifies sensor calibration, and the integrated peripheral circuits reduce board component count.**

Comparison



Combination of Analog Circuits and Embedded Software

Embedded software is executed by the CPU and peripheral functions such as a timer and a serial I/O, whereas the integrated analog circuits such as an op amp, multiplexer and lowpass filter capture analog data from various sensor devices.

The mixed-signal controller offers a solution for incorporating even the main MCU on the same chip.

TMP89FH00DUG/TMP89FH00WBG

● TLCS-870/C1 CPU core

- Operating voltage: 2.2 to 3.6 V @5 MHz
- Dual clock: 5 MHz (internal), 300 kHz (internal)

● On-chip memory

- Internal ROM: 16 Kbytes (FLASH)
- Internal RAM: 1 Kbyte

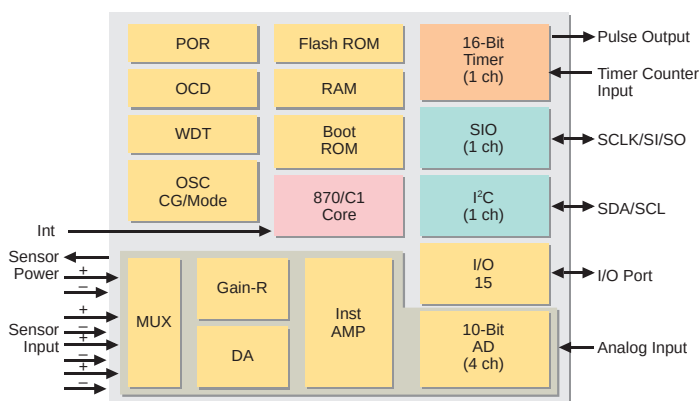
● On-chip functions

- Sensor sampling circuit (resistive bridge type): 4-axis inputs
- Offset voltage adjustment circuit (Gain-R)
- Power-on reset circuit (POR)
- On-chip debug function (OCD)
- 10-bit AD converter: 4 channels
- 16-bit timer/counter: 1 channel
- SIO: 1 channel
- I²C: 1 channel

● Package

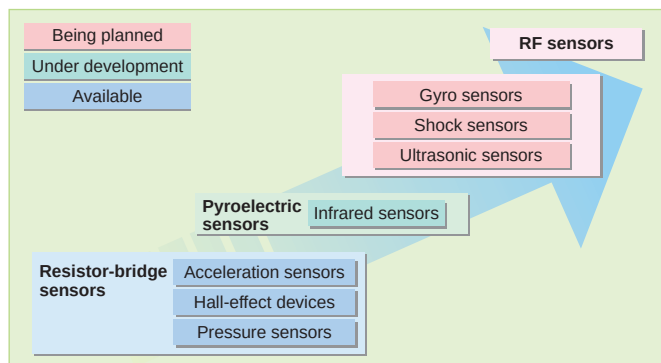
TMP89FH00DUG: 48-pin LQFP (7 x 7 mm, 0.5-mm pitch)

TMP89FH00WBG: 39-pin WCSP (3.73 x 3.73 mm, 0.7-mm thick)



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

● Future Roadmap for Sensor Support



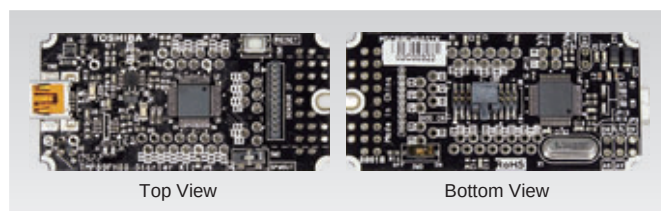
Toshiba is planning to develop mixed-signal controllers for a wide variety of sensors, including products in compact packages highly demanded by sensor applications. Sample software will also be made available.

Bare die products can be supplied as well as packaged products. By integrating sensor devices and an MCU in a single package, Toshiba's mixed-signal controller helps develop an intelligent sensor. Toshiba is dedicated to delivering the best solutions for your needs by supporting application-specific customization and software development.

● Software Development Support

Toshiba offers a suite of sample software that can be commonly used for various sensors (such as automatic offset calibration and averaging routines). Toshiba also provides application software for specific types of sensor (e.g., tilt sensing, vibration sensing, etc. for acceleration sensors). For details, contact your nearest Toshiba sales representative.

● Starter Kit



● Overview

Toshiba offers a starter kit for sensor applications that contains a mixed-signal controller with the TMP89FH00 microcontroller with preloaded software. The starter kit board has a connector for attaching a variety of sensors. You can verify the operation of the TMP89FH00 on a PC by connecting the board via a USB cable.

● Features

- Sensor data calibration by the TMP89FH00 alone
- Bidirectional communications between a PC and a starter kit
- Operates with USB power
- Plug-in sensor replacement

The software running on the TMP89FH00 calibrates sensor data and translates it into a digital form so that the PC can display sensor data without processing it in any way. Additionally, the PC can issue simple data manipulation instructions to the TMP89FH00; thus sensor data can be adjusted on the starter kit side according to the sensor connected. You can also collect logs while viewing a waveform display at the same time.

● Deliverables

The starter kit consists of PC software and a controller board. Controller board: Contains the TMP89FH00DUG on-board.

CD-ROM

- PC software
- USB driver
- User manual

Others

* No USB cable is included in deliverables.

● Support services

Toshiba offers a start kit to customers who wish to evaluate a mixed-signal controller. Contact your nearest Toshiba sales representative.

Development Systems

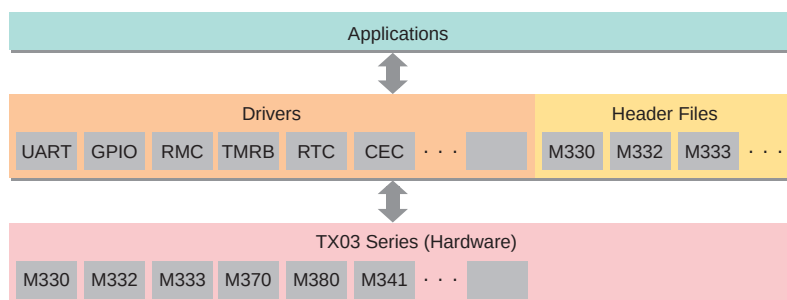
Toshiba offers a complete line of reliable, user-friendly development tools to support customers in each phase of program development from design to evaluation.

Device Drivers for the TX03 ARM-Based Microcontroller Series

Toshiba provides device drivers for commonly used on-chip peripherals. Thus, you can devote your efforts to the development of application-layer software.

■ Features

- Simplifies reuse of software.
- Shortens development times for products using new devices.
- Fast learning curve for new software developers
- Drivers tailored to each microcontroller
- Headers tailored to each microcontroller



Development Systems for the TX19 and TLCS Families In-Circuit Emulators and On-Chip Debug Emulators

Development Environments Offering Excellent Cost Performance

■ Compact and Lightweight

Renewed as smaller and lighter all-in-one tools, the In-Circuit Emulator and On-Chip Debug Emulator provide enhanced functionality.

■ Cost Performance

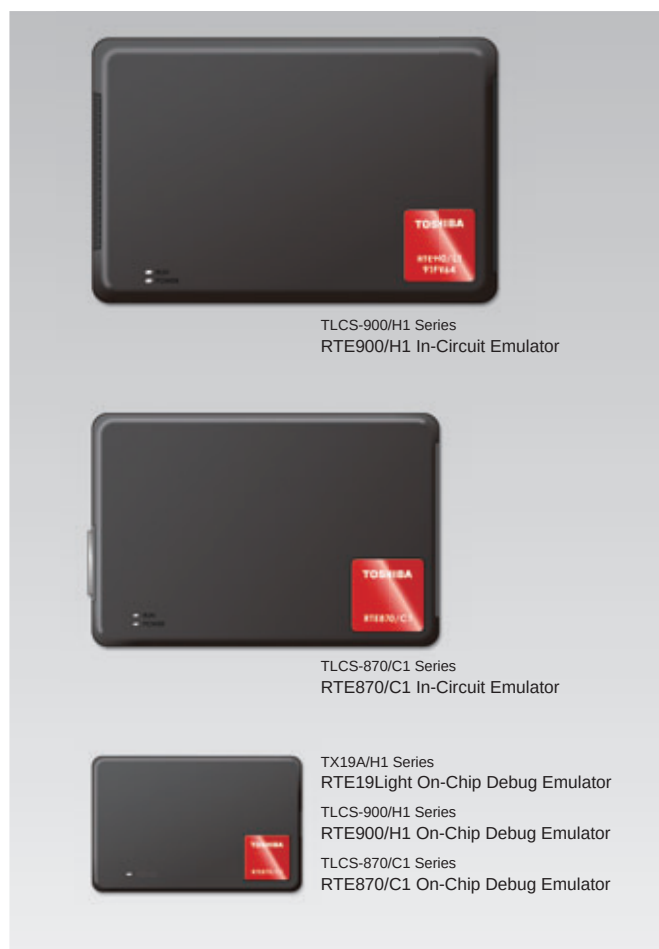
Each emulator product comes with a single-seat download license for the Integrated Development Environment (IDE) while the all-in-one configuration brings cost benefits.

■ Enhanced Usability

Product design has been renovated to offer enhanced usability, such as the common layout of external interfaces across product series. The Integrated Development Environment (IDE) now supports all microcontroller series, providing the common debugging interface to all users.

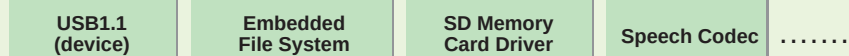


The new-model emulators comply with the RoHS directive. For RoHS compliance information on third-party accessories, please contact their respective manufacturers.



Software IPs

We have various software IPs for customers using (or considering using) Toshiba's MCU products.



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.

TX03 Series

Sample programs for the on-chip peripherals of the TMPM330 Group

<Software functions>

- RS-232 communications using UART
- CPU-to-CPU (master-slave) transfers using I²C
- CEC input and output
- Remote controller input
- Interval timer
- Programmable pulse generator (PPG)
- Frequency measurement
- Real-time clock (RTC)
- 10-bit AD converter input
- User-booted FLASH erase and programming (using the CMSIS Device Peripheral Access Layer for TX03, V2.0.4)

Under development

TX09 Series

Sample programs for the on-chip peripherals of the TMPA910

- DMAC
- Serial communications (SPI, I²C, UART)
- USB device controller
- LCD controller
- LCD data process accelerator
- Memory controller

Under development

TLCS-870/C1 Series

Sample programs for the on-chip peripherals of the TMP89FS60

<Software functions> Accompanied by a software user manual.

- PWM generation using an 8-bit timer
- UART transmission
- 8-bit programmable pulse generator (PPG)
- SIO transmission
- 16-bit programmable pulse generator (PPG)
- I²C transmission
- 10-bit AD converter input

TLCS-870/X Series

Sample programs for the on-chip peripherals of the TLCS-870/X Series

- Interrupt-based counting
- Key capturing using a timer
- Key capturing using an AD converter
- RS-232 communications using UART
- Tone generation using PDO
- CPU-to-CPU communications using SIO (transmitter to receiver)
- CPU-to-CPU communications using SIO (simultaneous transmit and receive)
- AC frequency measurement using pulse width measurement mode

TLCS-900/H Series

Sample programs for the on-chip peripherals of the TLCS-900/H Series

- Periodic interrupt generation using a timer
- Periodic interrupt generation using cascaded timers
- Generation of a pulse train with 50% duty cycle
- PWM generation
- Programmable pulse generator (PPG)
- One-shot pulse generation using an external trigger pulse
- Event counting using a timer
- Frequency measurement using a timer

Development System Support

Toshiba Microcomputer Website

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

The Toshiba Microcomputer website offers device datasheets and information about development systems for Toshiba's microcontrollers.

Development System Product Support

To register, please visit the "New User Registration" page beneath "Development System Product Support." Once you register, you will get your ID and password for access to the "Registered Customers' Exclusive Page."

- Latest information about the products you are using
- Downloadable software and user manuals
- Direct mail of technical reports and upgrade announcements



Third-Party Development Support Tools

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

● ADLINKS Corp.

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



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 Light and TLCS-870/C1 emulators, MCU mounting adapters (Bump Sockets) and simple EV boards.



● 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.



● ARM Ltd.

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



The RealView Microcontroller Development Kit (MDK) is an integrated software development environment for ARM-based microcontrollers. The RealView MDK consists of the ARM RealView Compilation Tools and the Keil mVision IDE, a debugger and simulation environment. It is an easy-to-use yet powerful tool optimized for ARM-based devices.



● CATS CO.,LTD.

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



ZIPC from CATS is a CASE tool based on a state transition matrix targeting embedded applications. Use of a state transition matrix for design and simulation helps prevent specification oversights. ZIPC provides an automatic code generation capability; it allows you to generate MISRA-C-compliant reliable source code from a state transition matrix that represents your design requirements. Additionally, using ZIPC in tandem with the Toshiba Integrated Development Environment, TIDE, allows target debugging while viewing the state transition matrix. This greatly improves development productivity and quality.



● Computex Co.,Ltd.

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



COMPUTEX manufactures development support systems that assist in debugging embedded software. A seamless development environment is available for the TX03 Series that encompasses from evaluation and development to the production phase. The PALMiCE3 JTAG emulators support various target interfaces such as JTAG and ETM. The on-chip flash programmer, FP-10, provides a standalone mode that does not require a host PC and operates at 3 to 5 V. ROMiCEmini supports the TX19A and TLCS-900/H1 Series.



● Flash Support Group, Inc.

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



Flash Support Groups, Inc. offers various semiconductor device tools mainly for Flash microcontrollers. The company's product portfolio includes auto programming systems, a wide variety of programmers (covering low-cost on-board programming to development and mass production programming) and peripheral tools. The programmers support an extensive range of devices including Toshiba's TX19, TLCS-900 and TLCS-870 Families. Speedy and flexible programming services are also available.



● GAIA System Solutions Inc.

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



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 and TX19A/H1 Series. Toshiba Integrated Development Environment (TIDE) and MULTI(r) from Green Hills Software, Inc. support debugging environment without changing the customer's current development environment.



● GAIO TECHNOLOGY CO.,LTD.

<http://www.gαιο.com/>



GAIO TECHNOLOGY develops and offers tools for improving the quality of embedded software, such as CoverageMaster winAMS, a unit testing tool for embedded software, No. 1 System Simulator that uses a high-speed MPU simulator, and CasePlayer2, a program chart and specification document generation tool. These tools support the latest ARM-based TX03 Series in addition to TX19, TLCS-900 and TLCS-870.



● 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').

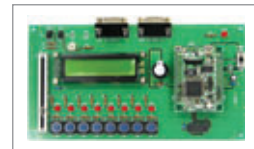


● Hamamatsu TOA Electronics, Inc.

<http://www.h-toa.co.jp/en/>

浜松東亜電機株式会社

Hamamatsu TOA Electronics, Inc. is an authorized distributor of Toshiba's microcontroller support products. 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 SYSTEMS RESEARCH CO.,LTD

<http://www.hilosystems.com.tw/>

HI-LO SYSTEMS

ALL-100A programmer from HI-LO SYSTEMS has 68 sets of Precise Universal Pin Driver to provide high speed, low noise, accurate and reliable programming signals for various IC products including high speed low power devices recently released to market. ALL-100A can be setup for either single-site programming for engineering or multi-site programming for production. If required, up to 8 sets of ALL-100A can be setup for multi-set operation so up to 64 sites can be programmed simultaneously to maximize production. Supporting software for ARM core-based TX03 Series, TLCS-900/H1 Series, TLCS-47E Series & TLCS-870/C1 Series etc. are available now. Device support on web site for check / retrieve through Internet will be updated on weekly basis.



● IAR Systems

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



IAR Systems offers an inexpensive evaluation kit for the ARM Cortex™-M3-based TX03 and ARM9-based TX09 Series. The IAR evaluation kit consists of a target board, an integrated development environment (evaluation version), a JTAG in-circuit emulator and ready-to-run sample application programs. You can readily use it for the entire development cycle from device evaluation to application-level prototyping and evaluation. You can save significant time and costs otherwise needed at the onset of development.



● 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.

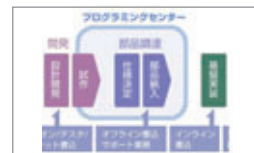


● MICROTEK Inc.

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.



● MINATO ELECTRONICS INC.

<http://www.minato.co.jp/en/index.html>

MINATO ELECTRONICS INC.

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 ARM-based TX03 series, as well as the TX19, TLCS-900, and TLCS-870 Families. Programming services using these products are also available.



Third-Party Development Support Tools

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

● Shanghai GengYan Electronic Technology Co.,Ltd.

<http://www.gengyan.com/en/enindex.asp>



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 offers development environments for Toshiba's microcontrollers, such as a starter kit for the TX19A that readily allows software evaluation, a flash programmer for the TX19A and emulators that support microcontrollers with TX19, MeP, Cell Broadband Engine and ARM Cortex cores (M3/A9/R4). Sophia Systems also provides a wide range of solutions using Toshiba's microcontrollers, including turnkey services for custom boards and systems.

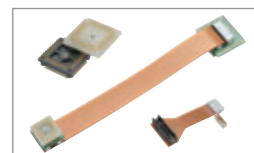


● Tokyo Eletech Corporation

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



TOKYO ELETECH CORPORATION, a manufacturer of useful debug support tools, provides interface products for connecting Toshiba's emulators with microcomputer boards developed by customers. The company's main products include IC sockets for QFP, SOP and BGA, emulator connectors, exchange adapters, signal check boards and extension cables. TOKYO ELETEC also accepts custom orders in small quantities, utilizing the company's expertise in flexible/printed circuit board manufacturing techniques including fine cutting.



● T.S ELECTRONICS CO.,LTD

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



TS Electronics is a support company for Toshiba Electronics Korea. TS Electronics supports programming writers for Flash microcontrollers of the TLCS-870/C, TLCS-870/X and TLCS-900/L1 Series. The programming writers feature compact size and support on-board and off-board programming. For details, please contact the sales and marketing division.



● Yokogawa Digital Computer Corporation

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



Yokogawa Digital Computer Corporation specializes in embedded solutions and offers an extensive range of products related to the design and development of microcomputer and peripheral systems. Included among its products are the "advice" series of in-circuit emulators, the NET IMPRESS series of flash microcontroller programmers, Windows Embedded CE starter kits and development process improvement tools. Yokogawa provides the ideal development environment by leveraging its experience and expertise.



● ZBSolution Co.,Ltd.



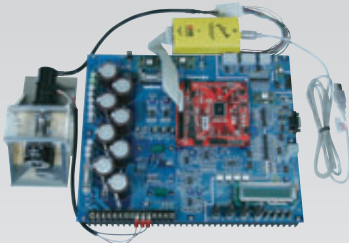
As a design house for Toshiba Electronics Korea, ZBSolution Co., Ltd. provides an easy-to-use Flash writer called "U-Writer" supporting Toshiba's Flash microcontrollers from 8-bit to 32-bit. U-Writer offers a USB interface so that user programs can be stored in advance and programming can be done without connecting a PC. ZBSolution is also planning to offer gang writers in future.



Reference Models and Microcontroller Starter Kits

Reference Models (Demo Boards) and Microcontroller Starter Kits

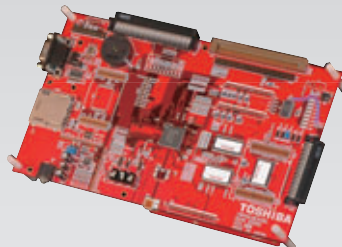
TMPM370 Vector Engine Demo Board



This demo board is designed to be able to control two motors in electric appliances, such as air conditioner outdoor units and washing machines.

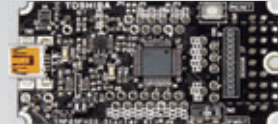
- IPD: Consists of the TPD4125AK and an intelligent power module (IPM) to allow two motors to be connected to the board.
- Power supply circuit
- The demo board can be connected to the TMPM370 Starter Kit.

Demo Board for Embedded Systems with an LCD Screen Using the TMPA910



This board supports color LCD display of up to WVGA and various board support packages (BSPs). It provides simple evaluation capabilities when connected to a development tool.

Mixed-Signal Controller Starter Kit Using the TMP89FH00



Top View



Bottom View

The TMP89FH00 can correct sensor data on its own and allows bidirectional communications with a PC. The starter kit operates from a USB power source and allows plug-in replacement of the sensor.

TMP89FM82 PMD Microcontroller Demo Board



- Accompanied by reference software for sensorless and sensed motor control with a square-wave drive, and sine-wave drive.
- On-board programming of several parameters for Proportional and Integral (PI) control and lead angle control
- Integrated development environment and On-Chip Debug Emulator (OCDE) for software development
- General-purpose motor driver, and comparators for position and overcurrent detection

Audio Demo Boards TMPM320



TMP92FD28



Toshiba offers a reference board specifically designed for evaluation of the on-chip USB host controller.

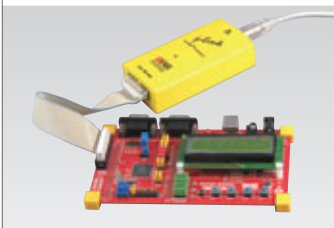
- Functional verification of the microcontroller / reference board design
- Connectivity verification of a USB storage device
- Software that supports various Digital Rights Management (DRM) standards

Microcontroller Starter Kits [Third-Party Products]

ARM Core-Based Microcontrollers:TX03 Series (TMPM330/370/380)/TX09 Series (TMPA910)

IAR Systems
www.iar.com

KSK-TMPM330-TPL



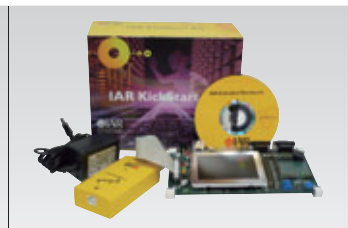
KSK-TMPM370-TPL



KSK-TMPM380-TPL



KSK-TMPA910-PL



IAR
SYSTEMS

Computex Co., Ltd.
www.computex.co.jp/en

Computex

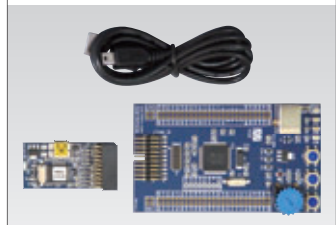
TMPM330 STARTER KIT



KEIL(ARM Ltd.)
www.arm.com

KEIL
An ARM® Company

MCBTMPM330UME



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- El Paso
Tel: (915)771-8156
- Houston
Tel: (713)466-6277
- Marlborough
Tel: (508)481-0034 Fax: (508)481-8828
- Parsippany
Tel: (973)541-4715 Fax: (973)541-4716
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Toshiba Electronics do Brasil Ltda.

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Toshiba Electronics Asia (Singapore) Pte. Ltd.

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- Chengdu Office
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- Qingdao Office
Tel: (532)8579-3328 Fax: (532)8579-3329

Toshiba Electronics Shenzhen Co., Ltd.

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Toshiba Electronics (Shanghai) Co., Ltd.

- Shanghai Head Office
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Previous edition: BCE0021H

2010-8(3k)SO-DQ