Panasonic

MN101 Series
MN103 Series
&
Development
Environments

PanaXSeries®

2013.4

Panasonic AM microcomputer series provides embedded controllers optimized for applications, and automotive fields.

Low power and high efficiency

- Unique ReRAM technology
- Ultralow voltage
- Dedicated extended ALU

Low system cost

- High-accuracy Analog ICs
- High voltage ICs
- On-chip EEPROM

Sensor
Battery, Touch panel, Smart meter, Camera, Watch

Applications

Power
Home appliance, Inverter, Digital power supply, Solar power

Automotive
Cockpit, Car body, HEV/EV

high-performance
mainly in sensor, power,

Easy to use

High noise immunity

Integrated development environment

Support system

● Product range

	2009	2010	2011	2012	2013	2014

32-bit MCU

MN103H Series ~120MHz

MN103S Series ~60MHz

MN103L Series ~40MHz

8-bit MCU

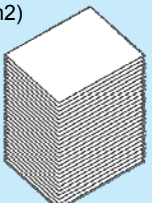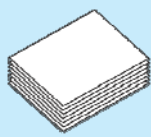MN101L Series ~10MHz

MN101E Series ~20MHz

MN101C Series ~10MHz

Performance

INDEX

C Language Oriented Architecture

Develop systems efficiently in C
Program development is 3-10 times faster

Past — Assembler program
Syntax dependent on the microcomputer

```
       cmp(ram1),(ram2)
       bgt $label
       mov (ram5),r0
       sub (ram4),r0
       jmp $label2
label  mov (ram5),r0
       add (ram4),r0
label2 mov r0,(ram3)
```

3-10 times the development time

Future — C language program

```
if(a>b)
   c=d+e;
else
   c=d-e;
```

The C programming language makes it easier and faster to program large systems, but generates more code than assembler. Larger code size in turn means higher ROM costs and slower execution speed. Panasonic eliminates this tradeoff with its C language-oriented microcomputers, which combine a true microcomputer architecture with a highly optimized C compiler to achieve unprecedented code efficiencies. This combination minimizes the size of the resulting code while retaining the threefold to tenfold development speed advantage afforded by the C programming language. The approach yields efficient system development in C over the entire range of 8- and 32-bit microcomputers.
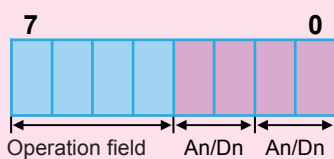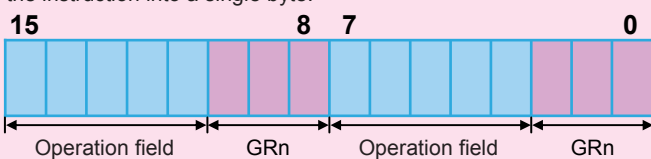
C Language Oriented Microcomputer for
[Higher Performan

High Performance

Single-cycle execution for higher throughput
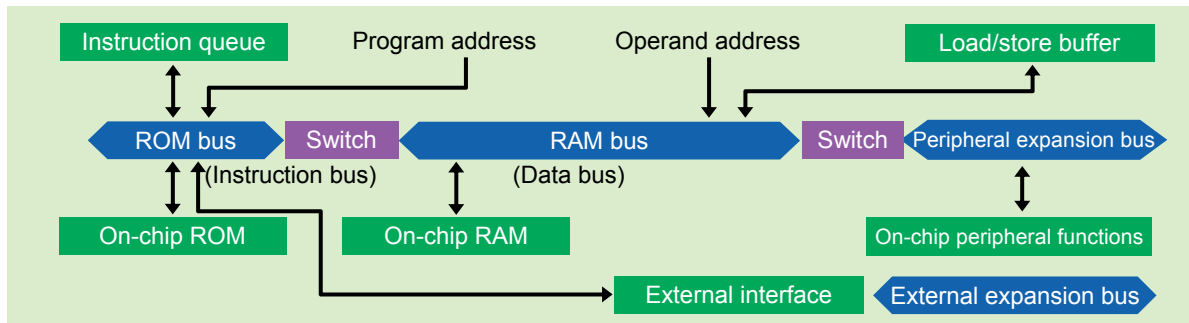## AM3 (MN103) instruction code assignment

New instruction code assignments
Basic instructions (register-to-register operations, load/store operations) fit within a single byte.

7   0

Operation field   An/Dn   An/Dn

Conventional code assignment for general register instruction
Because register field take up six bits, it is impossible to fit the instruction into a single byte.

15   8   7   0

Operation field   GRn   Operation field   GRn

An: Address register field   Dn: Data register field   GRn: General register field

The register set represents a careful balancing of hardware needs against C compiler code generation efficiency. From the eight available registers, the instruction format requires four bits to specify registers. As a result, the architecture assigns the basic instructions most frequently used in C code to single bytes. The compiler uses register optimization techniques to maximize the efficiency of register usage. Finally, a high-performance pipeline executes these instructions at the rate of one every machine cycle.

Low Power Consumption

Low

Optimized internal bus design lowers power consumption
AM1 (MN101) bus conversion

| Instruction queue | Program address | | Operand address | Load/store buffer |

ROM bus — Switch — RAM bus — Switch — Peripheral expansion bus
(Instruction bus) — (Data bus)

On-chip ROM — On-chip RAM — On-chip peripheral functions
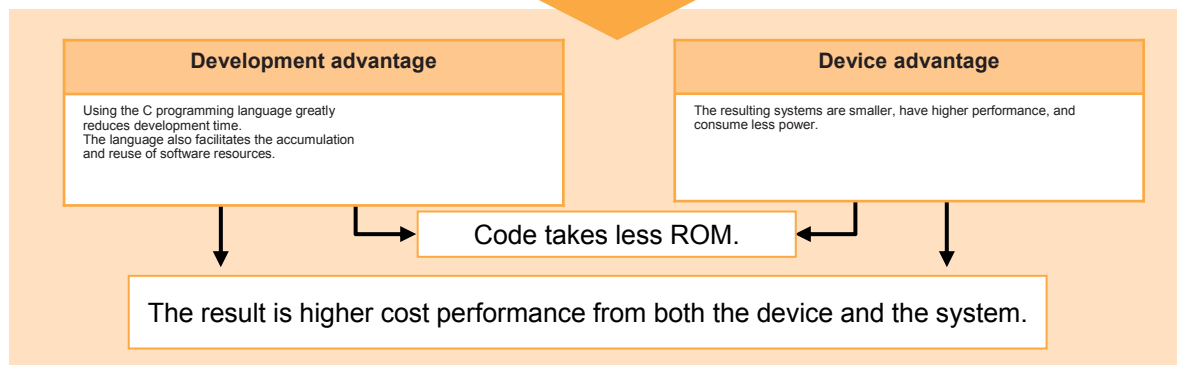
External interface — External expansion bus

The CPU features separate buses for instructions and data, and even provides a separate bus for expanding the latter for use with on-chip peripheral functions.

ce] + [Faster Development]

We Match Your Needs. You Don't Have to Match Ours.

Result : Greatly Reduced System Costs

Using an AM Series C language oriented microcomputers

Development advantage

Using the C programming language greatly reduces development time.
The language also facilitates the accumulation and reuse of software resources.

Device advantage

The resulting systems are smaller, have higher performance, and consume less power.

Code takes less ROM.

The result is higher cost performance from both the device and the system.

These C language oriented microcomputers (the AM Series) offer twin advantages to system development. First, they permit program development in C, a language that cuts development time. Secondly, they help reduce system costs by fitting programs into smaller ROM spaces. The result is higher cost performance from systems that are smaller, have higher performance, and consume less power.
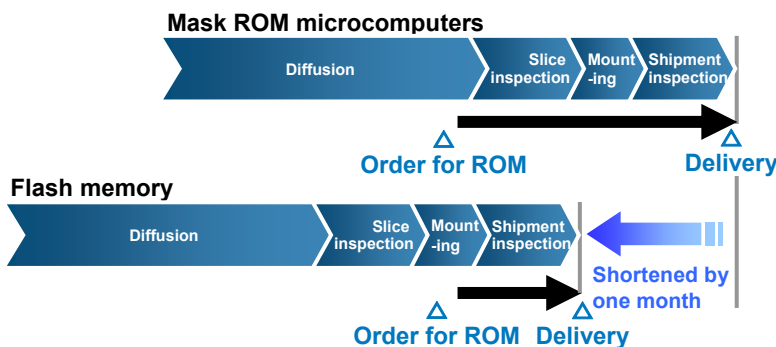
Microcomputer with Flash-memories
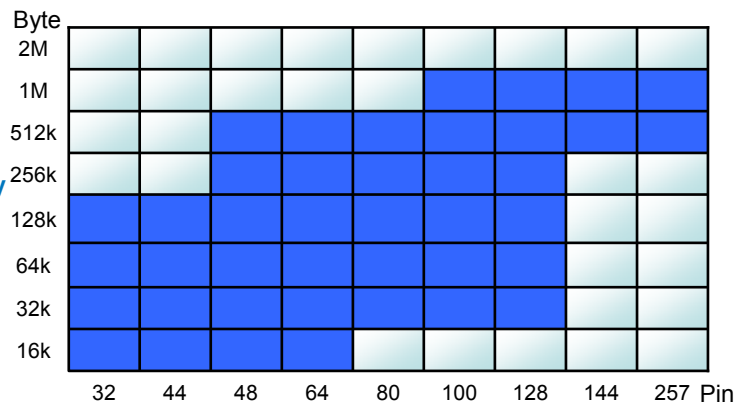
Microcomputers with Flash Memory

Microcomputers equipped with flash memory - rewritable - is indispensable to shorten the development lead time and rewrite the program implemented into end products.

Panasonic microcomputers with flash memory feature high performance and low power consumption, allowing you to develop excellent products in a short lead time.

■Shortens the lead time

Mask ROM microcomputers

Diffusion | Slice inspection | Mount-ing | Shipment inspection

△ **Order for ROM**   △ **Delivery**

Flash memory

Diffusion | Slice inspection | Mount-ing | Shipment inspection

Shortened by one month

△ **Order for ROM**   △ **Delivery**

■Number of pins and ROM capacity

Byte	32	44	48	64	80	100	128	144	257 Pin
2M									
1M						■	■	■	■
512k			■	■	■	■	■	■	■
256k			■	■	■	■	■		
128k	■	■	■	■	■	■	■		
64k	■	■	■	■	■	■	■		
32k	■	■	■	■					
16k	■	■	■	■					

Microcomputers with 110 nm Flash Memory Feature High Performance and Environmentally Friendly Operation

The transition from a 0.18 μ m process to a 110 nm process provides higher system performance and more environmentally friendly operation.

Thanks to a newly developed mixed process for producing flash memory specifically for use in microcomputers, Panasonic microcomputers equipped with 110 nm flash memory deliver smaller area, lower power consumption, higher reliability, and faster operation than previous models equipped with 0.18 μ m flash memory.

Microcomputer equipped with 0.18 μ m flash memory

Flash 256KB

Process evolution

Microcomputer equipped with 110 nm flash memory

Flash 256KB
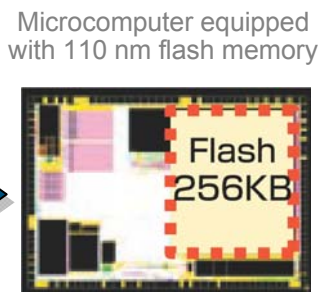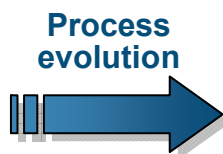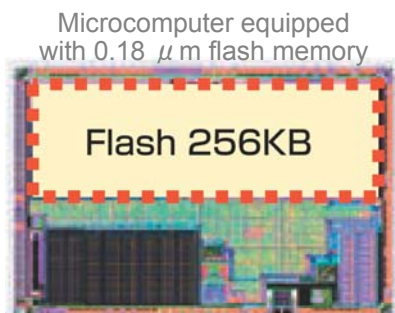
Flash memory occupies 40% less area

■110 nm flash memory microcomputer features

* Percentages indicate performance relative to Panasonic 0.18 μ m models.

Low power consumption
- ●Operating current: 30% lower
- ●Slow current: 90% lower

Rewriting characteristics
- ●Number of rewrites: 100,000
- ●Rewrite time: 50% faster

Vehicle on-board electrical component characteristics
- ●Sufficient quality for high-temperature (125°C) on-board application

High-speed operation
- ●Maximum operating frequency: 120 MHz

Secure Guard of Important Software

Reliable Security Function

Equipped with a protection function to prevent unauthorized access to ROM code
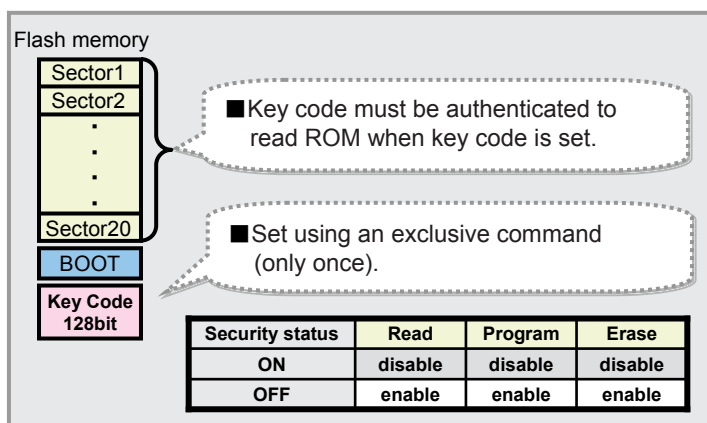
- A key code (128 bits) storage area is provided.
- The key code must be authenticated using an exclusive command to read the ROM data.
- Only one setting of key code is available.
- Shipment is possible with security information set.

The flash core has a 128 bit key code. Writing this key code prevents the ROM data from being read by third parties. The key code can be written only once. The flash memory with a key code written to it cannot be accessed unless the key code is authenticated.

Accordingly, persons that do not have the key code cannot read the ROM data using programming various tools. Executing instructions from the CPU or reading ROM data via executed commands are, of course, possible without the key code.

Flash memory

Sector1
Sector2
.
.
.
Sector20
BOOT
Key Code 128bit

■Key code must be authenticated to read ROM when key code is set.

■Set using an exclusive command (only once).

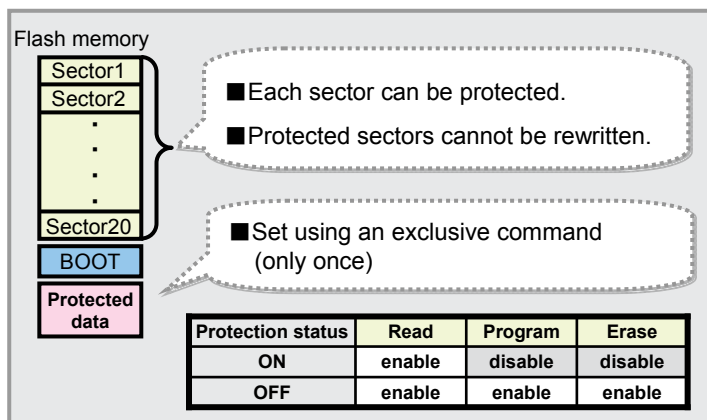| Security status	Read	Program	Erase
ON	disable	disable	disable
OFF	enable	enable	enable

Protection Function

The writable area is limited to protect data even when the microcomputer has runaway.

- A protected data storage area is provided.
- Shipment is possible with protect data set.
- Each sector is protected using an exclusive command (only once).
- The protected sector cannot be rewritten.

The flash core has a protection function. This function prevents the flash memory from being rewritten accidentally even when the microcomputer has runaway.

Once the protection for the protection data area is set to [ON], each sector can be protected. The protection data area can be written only once.

The protected sector cannot be rewritten, so the memory data will not be damaged even when the program has runaway.
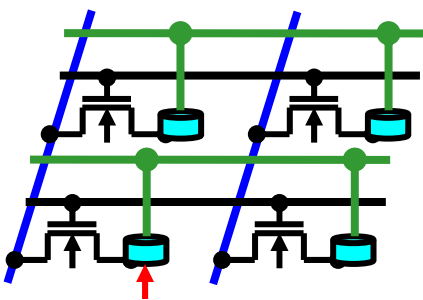
Flash memory

Sector1
Sector2
.
.
.
Sector20
BOOT
Protected data

■Each sector can be protected.
■Protected sectors cannot be rewritten.

■Set using an exclusive command (only once)

Protection status	Read	Program	Erase
ON	enable	disable	disable
OFF	enable	enable	enable

Microcomputer with ReRAM (Resistive RAM)

Industry's First Resistance-Change Memory, New 8-bit Core, and Low Leakage Process Deliver Low Power Consumption.

Microcomputer with new non-volatile memory ReRAM developed

Panasonic has developed an industry's first new non-volatile memory ReRAM. The 1T1R-ReRAM memory is fabricated by the CMOS process with 0.18-μm low power consumption ReRAM, enabling readout at low-voltage and fast memory cell rewriting at 10 ns. Microcomputer with ReRAM reduces power consumption of applications, in particular allowing longer battery life and downsizing for environment infrastructure equipment, such as smart meter, and mobile devices, such as smart phone requiring low power consumption.

1T1R-ReRAM Memory Cell

Resistance-change element

1μm

Metal

Metal

Plug
Resistance-change element
Top electrode
TaOx layer
Bottom electrode
Plug
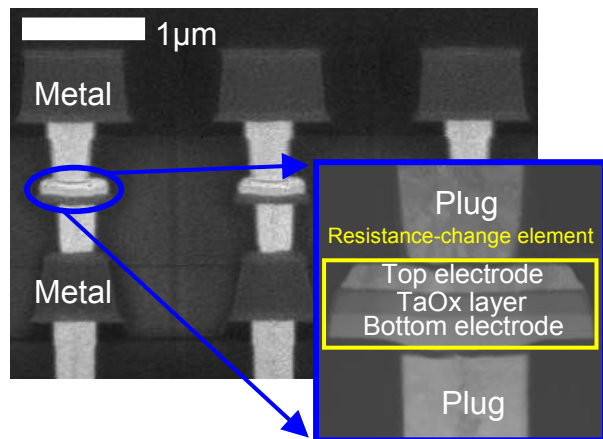
Mechanism of ReRAM Memory

ReRAM is a device capable of changing its resistance at intervals of at least 10ns and holding the value, therefore allowing high-speed rewriting. Furthermore, it can be easily applied to fine process and has a potential leading to large memory capacity.
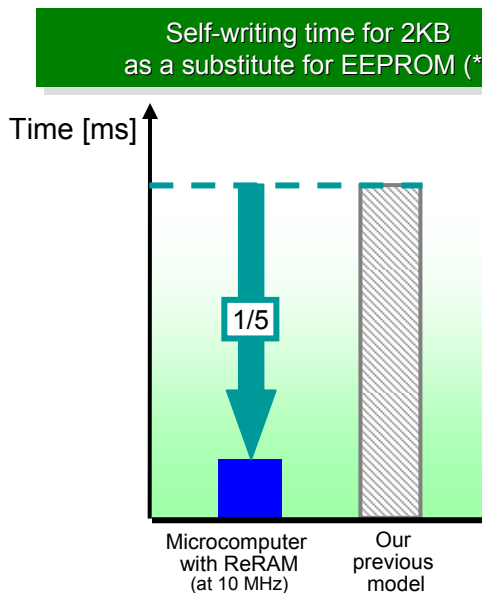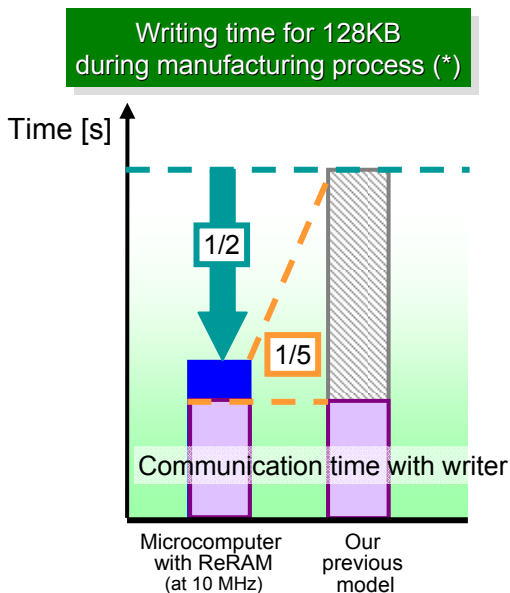

Positive pulse applied

Negative pulse applied

High resistive layer produced

High resistive layer erased
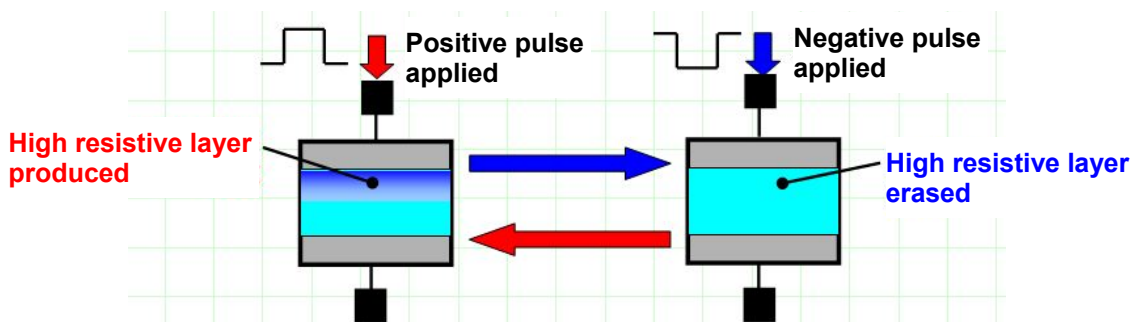
Comparison of ReRAM Memory and Flash Memory

Items	ReRAM memory	Flash memory
Operating principles	Resistance change by oxidation and reduction	Charge injection and ejection by high voltage applied
Features	① Power-saving readout ② Rewritten in units of bytes ③ High-speed rewriting	①Space-saving and large capacity ②Written in units of bytes, but erased in units of sectors

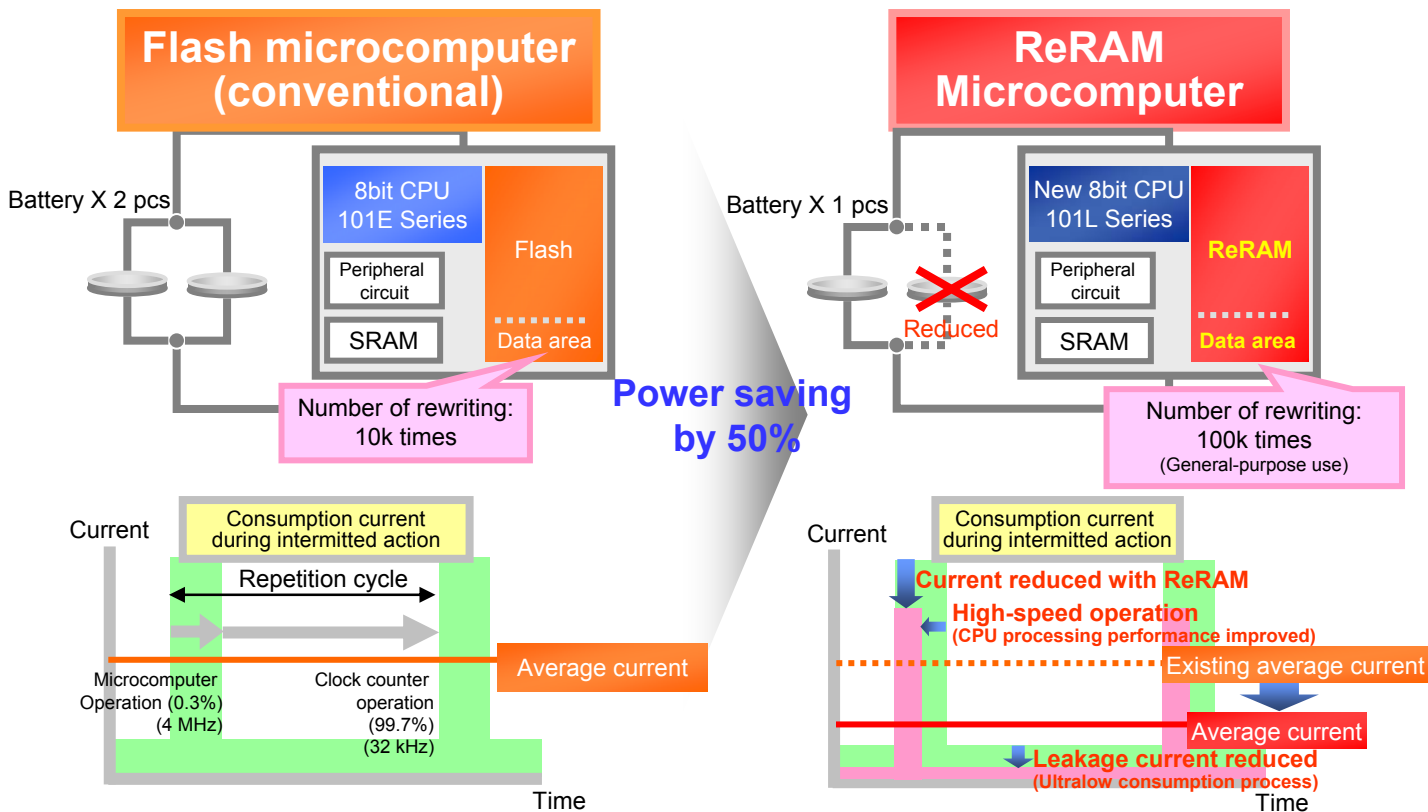# Features of Microcomputer with ReRAM

Rewriting Property

· Unlike flash memory or EEPROM, no data erase required
· Over 5 times faster rewriting than flash memory or EEPROM
　　　　　　　　　　　　　　　　　(See the figure below.)

Writing time for 128KB during manufacturing process (*)

Time [s]

1/2

1/5

Communication time with writer

Microcomputer with ReRAM (at 10 MHz)	Our previous model

Self-writing time for 2KB as a substitute for EEPROM (*)

Time [ms]

1/5

Microcomputer with ReRAM (at 10 MHz)	Our previous model

*) When writing a checker pattern (1,0,1,0..) in erase state (All "1").

50% lower power consumption with ReRAM and high-performance CPU

Thanks to low-power consumption ReRAM, shorter processing time and voltage control by high-performance CPU, and leakage current reduction of new fabrication process, power consumption has been reduced by 50%, compared to the existing Flash microcomputer.

Flash microcomputer (conventional)

Battery X 2 pcs

8bit CPU 101E Series

Peripheral circuit

SRAM

Flash

Data area

Number of rewriting: 10k times

Current

Consumption current during intermitted action

Repetition cycle

Average current

Microcomputer Operation (0.3%) (4 MHz)

Clock counter operation (99.7%) (32 kHz)

Time

Power saving by 50%

ReRAM Microcomputer

Battery X 1 pcs

Reduced

New 8bit CPU 101L Series

Peripheral circuit

SRAM

ReRAM

Data area

Number of rewriting: 100k times (General-purpose use)

Current

Consumption current during intermitted action

Current reduced with ReRAM
High-speed operation
(CPU processing performance improved)

Existing average current

Average current

Leakage current reduced
(Ultralow consumption process)

Time

* Please note that these value are subject to change without prior notice.

8

8-bit
AM1 (MN101) Series
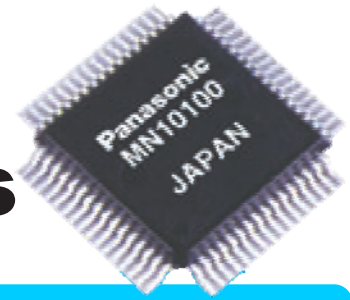
C Language Development for 8-bit High-performance Microcomputers

The AM1 Series of 8-bit microcomputers allows short-time program development in the C programming language. Its half-byte instruction set and other architectural features yield ROM code sizes that are small enough to rival those achieved with assembly language.

These devices are compact and have low power consumptions, yet offer high-speed operation with a minimum instruction execution time of 100 ns (at 5 V, 3 V)*1 and 50 ns (at 5 V, 3 V).*2

These microcomputers are suitable for a wide range of applications demanding high cost performance. The MN101 Series consists of the MN101C, MN101E, and MN101L Series.

*1: MN101C and MN101L Series, *2: MN101E Series

C Language Oriented Architecture

Programs in C the same size or smaller as those in assembler

Powerful architectural features such as a half-byte instruction set and handy addressing, plus aggressive code optimization mean that the C compiler can generate ROM code that is the same size or smaller as that produced using assembly language. (This conclusion is based on comparison with previous Panasonic microcomputers.)
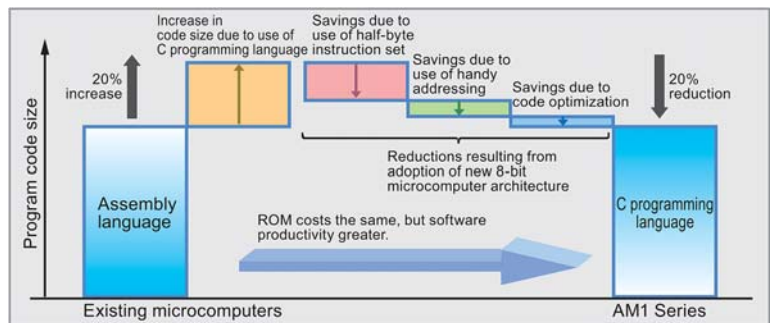
Half-byte Instruction Set

The Series adopts a variable-word length approach with basic instructions 1 byte long and extensions only 4 bits long. Since the resulting instruction set permits the specification of such operands as branch offsets and immediate values in units of four bits, instructions are shorter. Program sizes are therefore smaller.
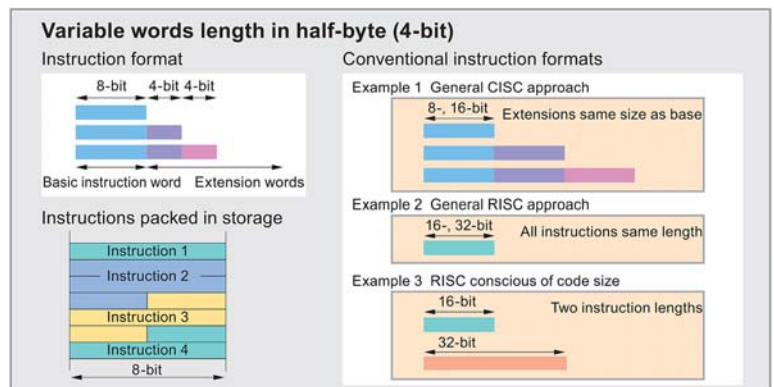
Handy Addressing

This technique focuses on the point that when variable data in memory is manipulated, load and store instructions will, in many cases, be to the same address. This technique allows the code size to be reduced by omitting the store instruction operand.
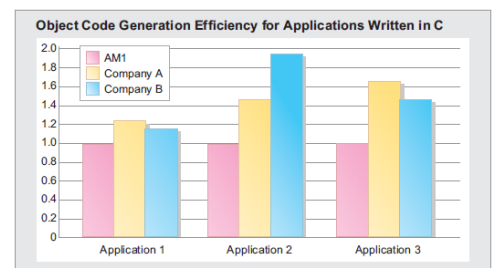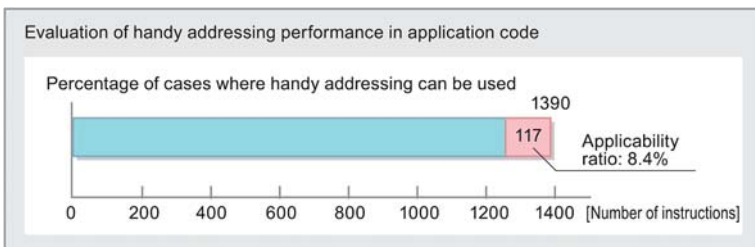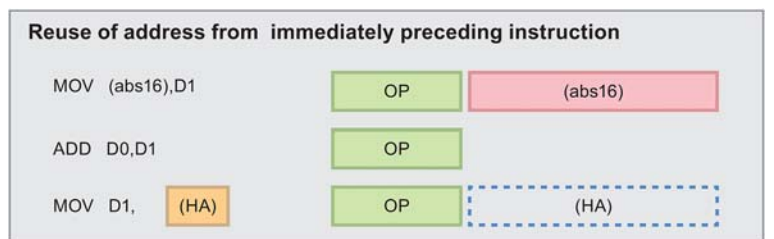
High-Speed Extended Memory Space Series (MN101E Series)

This series is upwardly compatible with the MN101C Series.

1 MB Linear Address Space

The 1 MB address space allows these microcontrollers to support more advanced and sophisticated systems.

	Memory space	Maximum on-chip ROM	Maximum on-chip RAM	Maximum operating frequency	Minimum instruction execution cycle
MN101C Series	256 KB	244 KB	11.75 KB	10 MHz	100 ns
MN101E Series	1 MB	944 KB	64 KB(Allocated in separate banks)	20 MHz	50 ns

Improved Processing Performance Series (MN101L Series)

Performance improved while maintaining compatibility with existing 8-bit microcomputer

MN101L Series has achieved higher processing performance and lower power consumption than those of existing 8-bit microcomputer (MN101E Series), based on new pipeline and ALU system configuration.

Enhanced processing performance and lower power consumption operation

Thanks to both the improved processing performance for memory access instruction by reviewing the pipeline and that for 16-bit data by using 16-bit bus, the MN101L Series has achieved the processing performance of 16-bit microcomputer even on 8-bit microcomputer hardware. (Dhrystone 2.1: 0.45 DMIPS/MHz; 1.75 times compared with existing core)

In addition, it supports one cycle I/O BUS access to allow fast peripheral circuit control.

16-bit processing and enhanced instruction improve processing performance

PC | Instruction queue | General-purpose register (8/16-bit)

Instruction decoding

Instruction performance improved by fetch width enhancement

ALU | SFT

Instruction control

Processing performance improved by 16-bit ALU

BUS controller

Memory

Processing performance improved by 16-bit bus

New pipeline improves memory access performance

High-frequency (approx. 40%) memory access instruction for speed-up

AM13E

Instruction 1	IF	ID	EX(MEM)	
Instruction 2		IF	ID	EX
Instruction 3			IF	ID	EX

AM13L

The execution cycle of memory access instruction reduced

Instruction 1	IF	ID	EX	MEM
Instruction 2		IF	ID	EX
Instruction 3			IF	ID	EX

Extended calculation function

In addition to multiplication/division instruction of MN101E Series, the MN101L series allows calculation function such as BCD calculation to be implemented according to system needs, achieving higher cost performance microcomputer system for a variety of applications.
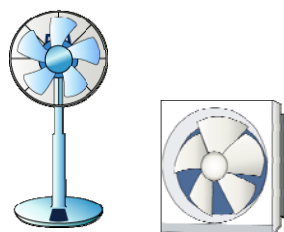
MN101 Series Applications

The series has low power consumption and high performance, allowing a variety of applications.
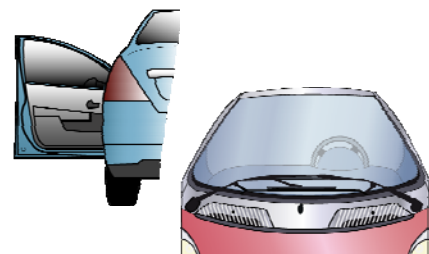
Sensor

Power

Automotive

32-bit
AM3 (MN103) Series

32-bit Microcomputer Controlling Equipment with Higher Processing Performance

The AM3 (MN103) Series of 32-bit microcomputers covers a broad range of applications from equipment control to multimedia processing.

The combination of a C language oriented architecture and optimizing compiler delivers both high performance and lower power consumption.
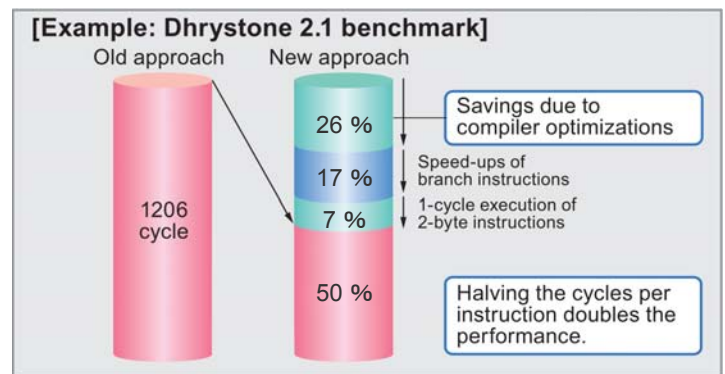
To streamline the development of applications high in both performance and functionality, these devices incorporate the AM Series standard on-chip I/O bus (C-bus) and the extended calculation instruction function for adapting them for ASSP enhancement and ASIC microcomputer development.

The MN103 Series consists of the MN103S, MN103H, and MN103L Series.

C Language Oriented Architecture

Optimizing compiler generates highly efficient instructions.

The optimizing compiler examines overall C program structure as it assigns variables to make most efficient use of the available registers. For frequently repeated loops, it preloads branch registers with the first instruction and the address of the next instruction. This small investment in additional hardware produces great advances in branch execution speed.

[Example: Dhrystone 2.1 benchmark]

Old approach   New approach

26 % — Savings due to compiler optimizations

17 % — Speed-ups of branch instructions

7 % — 1-cycle execution of 2-byte instructions

1206 cycle

50 % — Halving the cycles per instruction doubles the performance.

High Performance, Greater Efficiency

Minimum variable word lengths (8 bits) of instructions reduce program size.

Cutting program size is always a major issue in embedded microcomputer applications. The AM3 (MN103) Series organizes registers by function and is thus able to adapt a variable instruction length approach with a minimum length of only 8 bits. Making the most frequently used instructions shorter and then maximizing register usage with an optimizing C compiler minimizes program size. The AM3 (MN103) Series has eight basic registers available. It also uses a Harvard architecture with separate instructions and data memory to boost throughput by eliminating conflicts between instruction fetches and data access.

Address registers: A0*, A1*, A2*, A3*
Data registers: D0*, D1*, D2*, D3*

Stack pointer: SP
Program counter: PC
Multiply/divide register: MDR

Processor status word: PSW
Branch registers: LIR, LAR

AM3 Series basic registers
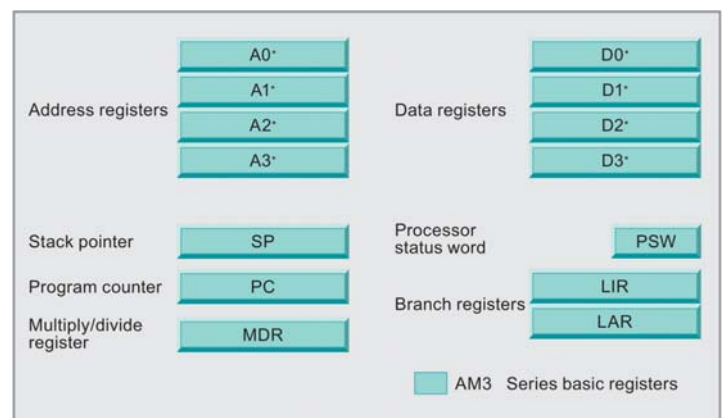
High-Performance Series for Inverter Control (MN103S/H Series)

Extended arithmetic function enhances equipment control performance.

The 103S/H Series provides a reserved instruction group and an extended arithmetic interface, to which high-speed multiplication/division and multiply-and-accumulate operation functions are appended according to system needs, in order to perform high-precision control in real time, thereby allowing high cost-performance microcomputer system suited for applications with inverter control.

Furthermore, MN103H Series capable of high-speed operation at 120 MHz is also provided to support advanced control devices. The series uses AM32R core, the same as that of MN103S Series, therefore allowing you to develop applications using the same tool.
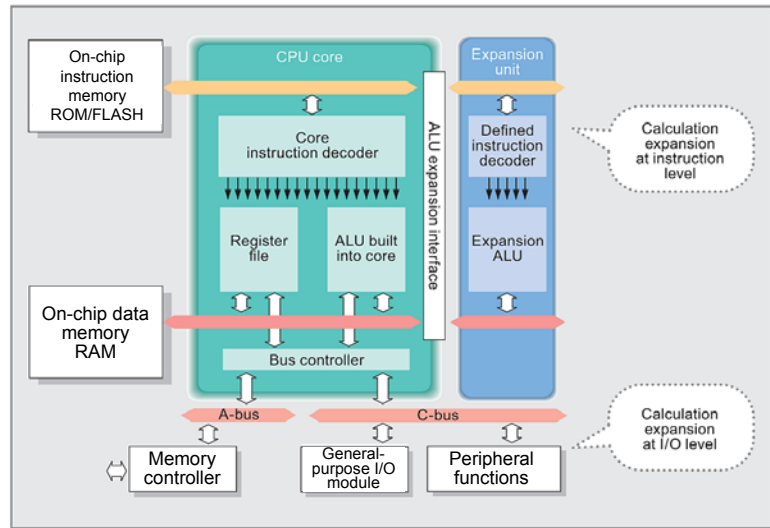
Low Power Series (MN103L Series)

Low power series offers instruction set compatibility with the MN103S Series

The MN103L Series features a simple architecture with a 3-stage pipeline that preserves instruction set compatibility in order to deliver optimal performance in the medium to low speed segment. Furthermore, it is able to deliver both high performance and low power consumption by implementing 32 extended instruction functions that are shared with the CPU's internal operations, including 32×32 high-speed multiplication and multiply-and-accumulate operations.

The series adopts 110-nm flash memory process with low leakage current technology, delivering low power consumption. In addition, it is based on the high-reliability technology, such as high-temperature operation for automotive applications, and memory data rewrites (100k times).

It can incorporate reset IC, oscillator, high multiplication PLL, and other high-accuracy analog circuits, which are external parts in previous model.
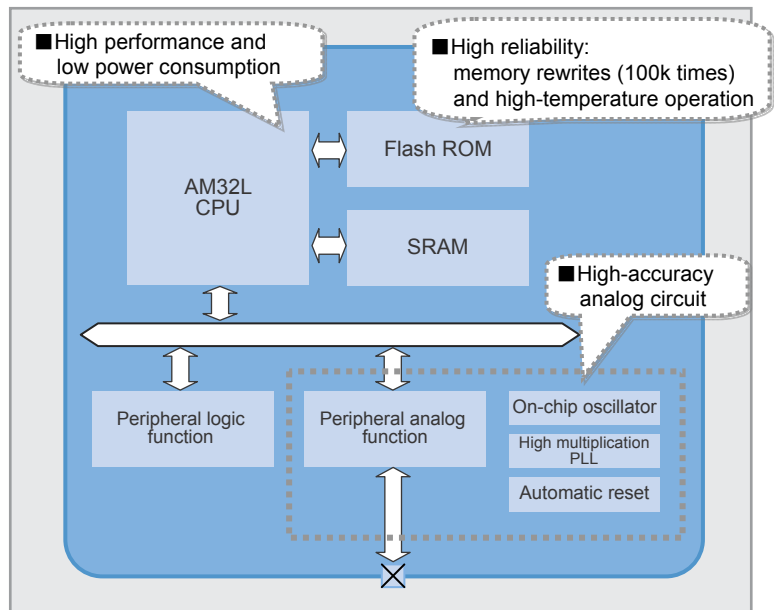
MN103 Series Applications

The high-performance features of the series allow a variety of applications.

Sensor

Power
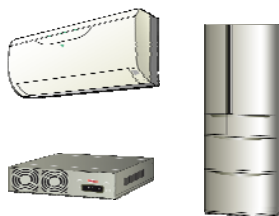
Automotive

Microcomputer with Improved Resistance to Noise

Why is Electromagnetic Compatibility (EMC) So Required Now?

As the functionality provided by the latest electronic equipment continues to advance, even higher integration levels and even higher speeds are required in their ICs. At the same time, the popularity of portable electronic equipment has led to demands for further miniaturization and lower operating voltages. To respond to these needs and demands, IC fabrication processes have moved to ever finer feature sizes, progressing in tandem with other IC developments.
Due to these advances, IC malfunctions due to noise are becoming a significant issue.

The focus of EMC workarounds is changing.
End product → Circuit board → IC
EMS
EMI
As speeds and functionality increase, EMC workarounds become increasingly difficult.
Thus EMC solutions at the IC (component) level are now indispensable.

Since EMC problems largely depend on the PCB design, until now, EMC problems have been seen as an issue for end product design, and workarounds have largely focused on the end product. However due to the lower voltages and higher speeds of the latest equipment, it has become harder then ever to distinguish between noise and normal signals. This in turn makes workarounds in the end product harder to achieve. Therefore, improved resistance to noise at the independent IC level is becoming increasingly important.
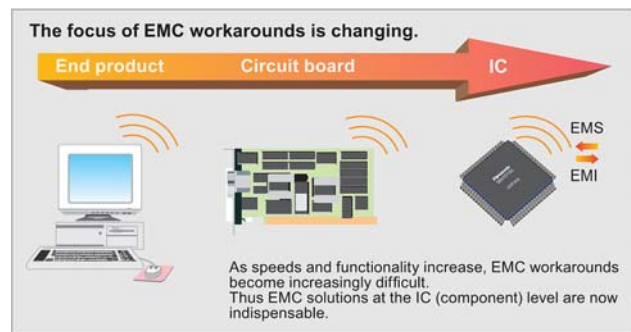
Examples of Improved EMC Performance

Achievement of both high noise immunity and low EMI

Panasonic has achieved a significant improvement in noise immunity over earlier products. Despite progress in process feature sizes, Panasonic has achieved even further improvements in voltage handling capacity. And assured better noise immunity than provided by earlier improved products, even in low-voltage process devices.

The following measures are implemented for EMC strengthening;
- EMS countermeasures (Electro Magnetic Susceptibility)
- EMI countermeasures (Electro Magnetic Interference)

■Power line noise test
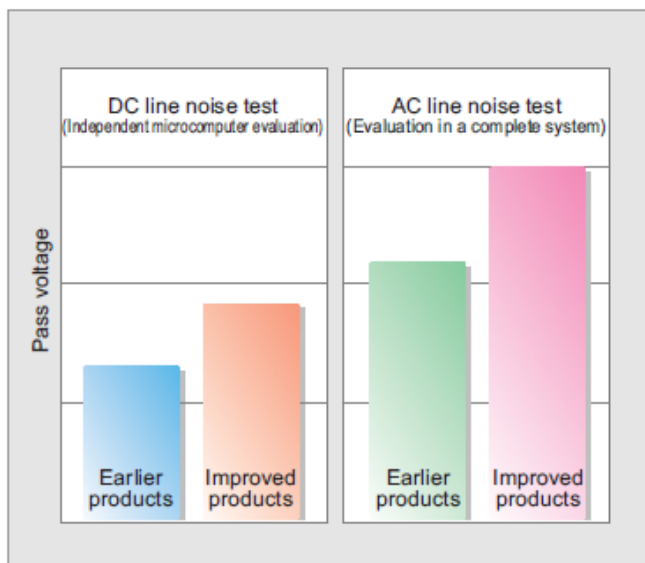
■Loop radiation noise test
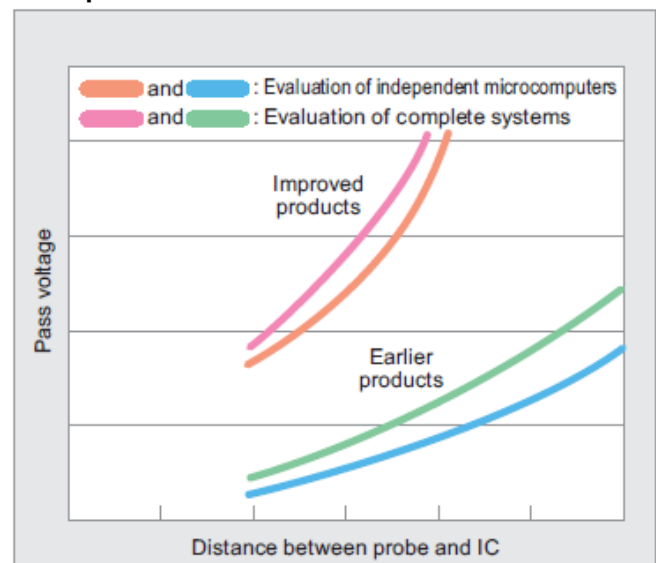
The DC line noise and loop radiation noise test methods were developed by Panasonic, and are based on two models, one for noise transmitted to the IC via conduction and one for noise transmitted to the IC via radiation.
To eliminate dependency of the test result on the application program, these tests are standardized with a common program that improves observability and a dedicated noise evaluation board.

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EMS Countermeasures (EMS: Electromagnetic Susceptibility)

Cause of IC Malfunctions

The ICs used in electronic equipment are subject to a wide range of noise sources. These include power supply noise, electrostatic noise (ESD), radio noise, and spark noise from high-voltage components in the vicinity. These noise signals enter the end product through power supply lines and the chassis, affect the PCBs the ICs are mounted on, and finally impinge on the ICs.
The following phenomena are thought to cause IC malfunctions in this type of environment.

(1) Noise is superimposed on the input signals, the IC is unable to distinguish between noise and the actual input signals, and as a result, the IC malfunctions.

(2) Power supply level fluctuations cause internal signal levels to fluctuate and the IC to malfunction.

■**What is the noise that enters ICs?**
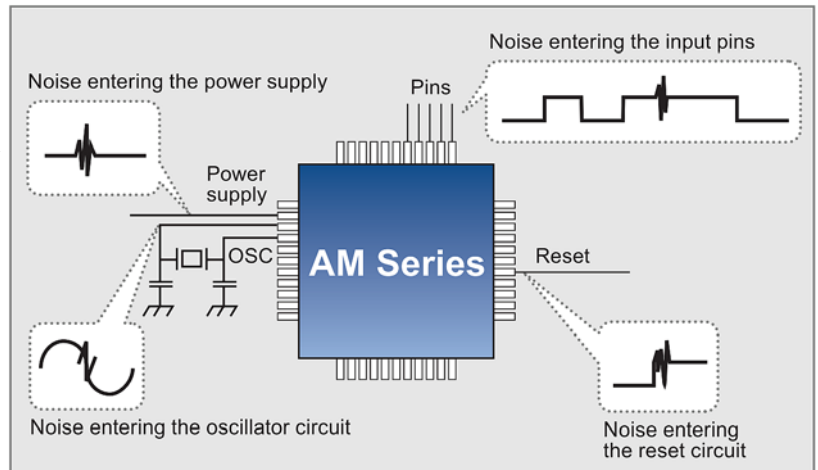
Enhancements to Noise Immunity Characteristics

Panasonic has enhanced the noise immunity of the AM microcomputers based on the following points.

(1) Improved immunity to noise superimposed on input signals: Strengthening the ability to reject noise on the oscillator, reset, and interrupt signal pins.

(2) Improved immunity to power supply fluctuations: Fabricating capacitors internally on the chip itself to both improve power supply stability and to suppress fluctuations in the power supply levels.

(3) Operating mode stabilization: Optimizing the circuits to prevent unexpected mode transition due to noise.

EMI Countermeasures (EMI: Electromagnetic Interference)

Causes of EMI Emission in Electronic Equipment

ICs used in electronic equipment handle digital signals and generate harmonic currents.
It is thought that the PCBs, wiring harnesses, and chassis in application systems act as antennas and radiate these high-frequency signals to the surrounding environment.
Of these, harmonics due to the power supply currents associated with internal logic operation show little attenuation, and as a result can easily cause problems.

■**EMI generation mechanisms**
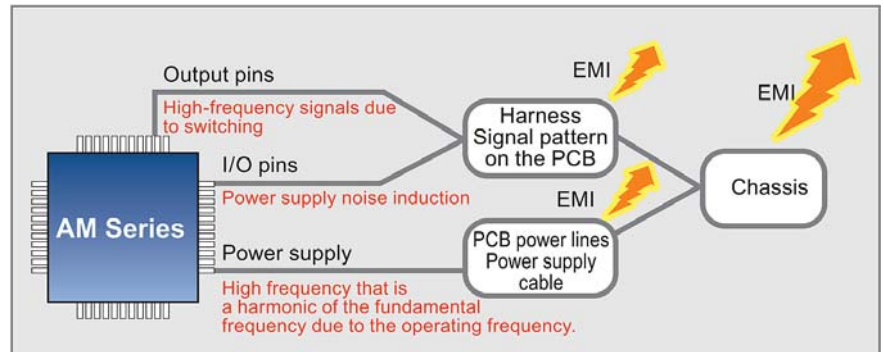
EMI Reduction Measures

The following EMI reduction measures are implemented in the AM microcomputers.

(1) Improved decoupling capacitors: High-frequency noise leakage is suppressed by forming capacitors on the chip internal power supply lines.

(2) Current smoothing: IC internal peak currents were reduced by implementing gated clock circuits, optimizing the clock driver circuits, and other measures.

(3) Power supply isolation: Interference due to internal noise is prevented by isolating the CPU, I/O system, and analog system power supplies.
Furthermore, the noise power itself is reduced by achieving both reduced power consumption and reduced EMS.
In addition, it is now possible to create EMI countermeasures early in the IC design stage with EMI prediction technologies that use power supply current analysis technologies.
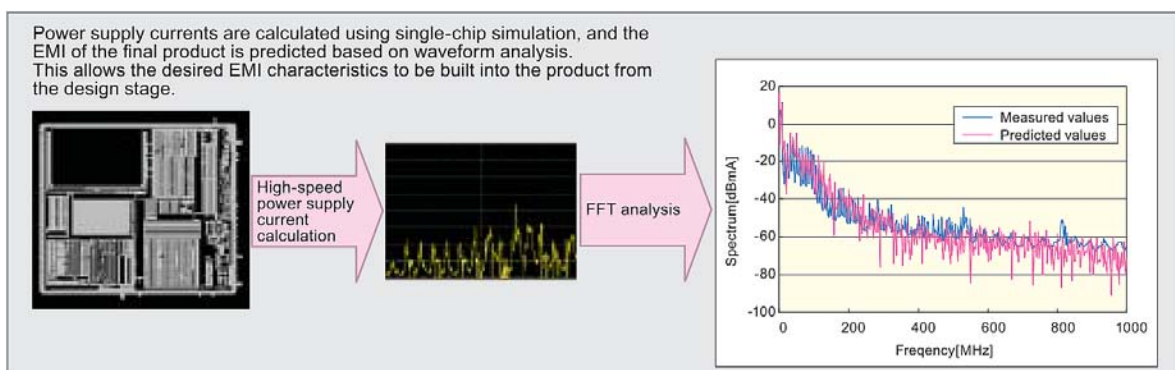
Development Environment PanaXSeries®

PanaXSeries
*The One to Watch for Constant Innovation - Making the Future Come Alive*

Optimized C Compiler

Delivers compact, fast code generation suitable for microcomputers.

Panasonic compilers maximize the performance of AM microcomputer by implementing both general optimization and original optimization that utilizes high functionality instructions of each microcomputer. In addition, these compilers feature a language extension function and extensive utilities to support development process from program description to a write to ROM.

C compiler supporting AM1 (MN101C/MN101E/MN101L) Series

● High code generation efficiency required for 8-bit microcomputer
　・Extending and modifying parts of the ANSI C specifications takes maximum advantage of the 8-bit microcontroller instruction set
　・Code generation utilizing the characteristic of AM1 Series, such as half-byte instruction and handy addressing
　・Optimization by instruction unit such as new instruction scheduling, register trace, and optimized resource assignment
● Advanced operability
　・Operation by integrated environment **DebugFactory® Builder**
　・Simple operation by command line
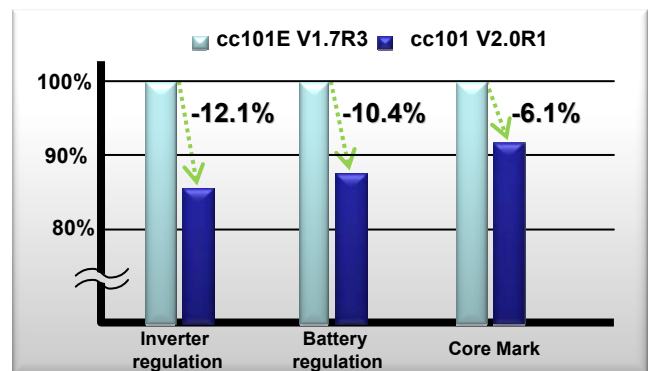
Comparison of Code Size and Conventional Compiler

C compiler supporting AM3 (MN103S/MN103H/MN103L) Series

● Superior language extension
　・Extended inline assembler allowing a seamless connection between variables in C and registers in assembler
　・Corresponding to long-long type (C99 standard)
● Higher code generation and execution performance both achieved
　・Balanced optimization between increasing execution speed (function in-line expansion, loop expansion, instruction scheduling) and increasing efficiency of code generation (common subexpression, tail merge)

● Compliant with a global standard, ANSI
● High performance both in control processing and media processing *1
　・Speeding up of function call by using high-functional subroutine call instruction
　・Faster loop processing by using loop first instruction and also branching instruction for loop
● Advanced operability
　・Operation by the integrated environment **DebugFactory® Builder**
　・Simple operation by command line
　　　　　　　　　　　*1: Depending on microcomputer type

Utility tools

● Stack consumption analytical tool
　・Displays a list of indirect call function and recursive function.
　・Displays the maximum value of accumulated stack consumption by specifying the auxiliary information (functions called indirectly, and recursive count).
● Unused symbol (variable/function) detection tool
　・Displays a list of unused variables and functions for reducing ROM.
● Executable format file dump tool (AM1 Series)
　・Allows optimized code to be output from executable format file when linked.


Stack Consumption Analytical Tool

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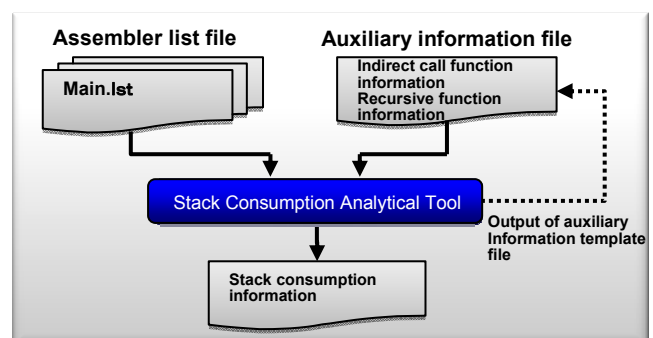
DebugFactory® Builder Version 5

Microcomputer software integrated development environment

DebugFactory Builder streamlines the microcomputer software development process by allowing you to repeatedly perform the sequence of debugging operations such as editing source files, performing builds (generating make files and compiling), and debugging code on a single application. Enhanced support functions for source code edit, build, and debugging make software development effective.
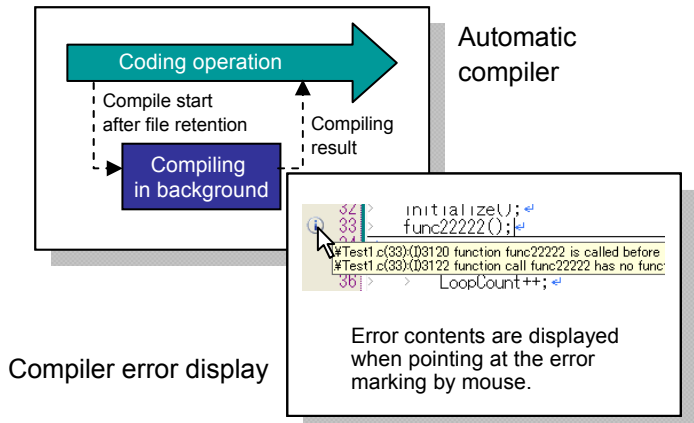
Source code edit support function

● Code navigation
  ・Reduces coding and debugging time by a quick access to desired information in source code, such as input candidate list display and function format display, and jump to function/variable definition and declarative positions.
● I/O control sample code display
  ・Reduces development time by using sample code for built-in timer function and serial function control for microcomputer

Display of functional parameter hint

Jump to declarative and definition row

Code navigation

I/O control sample code display
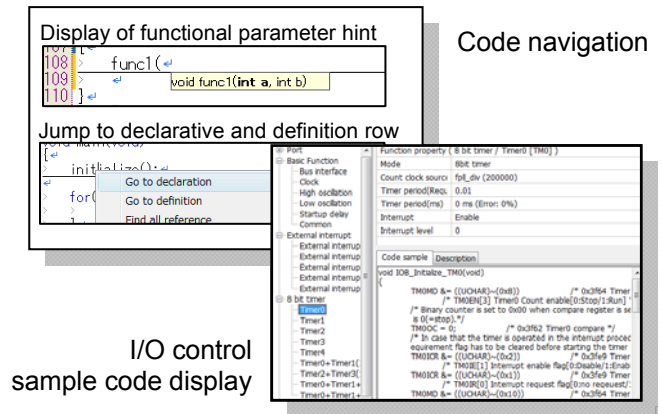
Build support function

● Automatic compiling function
  ・Reduces build time by performing source code retention and compiling in the background at the same time.
● Compile error display on editor
  ・Displays the compile error point on editor to allow compile error to be corrected.
● Significantly enhanced, higher built-in make function
  ・Delivers the function equivalent to commercial make file.
  ・Reduces make time by reading and internally converting recursive make file.

Coding operation

Compile start after file retention

Compiling result

Compiling in background

Automatic compiler

Error contents are displayed when pointing at the error marking by mouse.

Compiler error display

Debugging support function

● Special register setting value / pin value check
  ・Displays a list of special register setting values or pin values to enable a quick error detection.
● Debug window designer
  ・Allows custom window to be created, in which button and check box used for debugging are assigned.
  ・Assigns various operations to each button, allowing multiple operations to be executed with just one click.
  ・Assigns display panels and buttons of real target to the window of personal computer to build a virtual target, allowing a debugging before hardware is available.

Display of special register values

Debug window designer
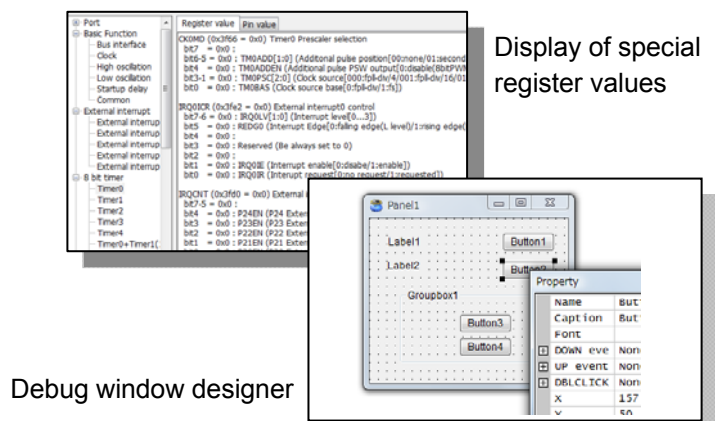
On-board Environment

Low-cost on-board debugging and programming environment PanaX® EX Series

● Embedded microcomputer on-board debugging and flash programming environment
  (Flash programming supports mass-production writing.)
● Delivers high-speed operation despite low cost.
● Supports the MN101C, MN101E, MN101L, MN103L, MN103S, and MN103H Series.
● Provides attached debugger (DebugFactory Builder) and programmer software
  (EX Commander) for each microcomputer series.
  Installing additional product definition file allows new products to be supported.
● Target connection types include 14- and 10-pin box connectors and compact flexible
  cables.
● Optional remote control
● Connecting maximum eight PanaX® EX to personal computer through USB HUB enables
  gang-programming.
● Four kinds of lineup to meet customer needs

PanaX EX1

Feature / Cost	EX1	Low-cost version (Always use, connecting with host PC)
	EX2	Stand-alone version (Available for stand-alone programming without host PC)
Target connecting method	Standard edition	Regular connecting with target
	Insulated edition	Electrically-insulated connection with target

PanaX EX2

High-speed and highly-functional PanaX® NEO On-Board Debugging Environment

● High-speed and highly-functional on-board debugging environment with hardware assist
● When used with trace pin-equipped hardware, an optional data gathering unit
  enables real-time trace functionality for capturing program execution log data.
● Standard host computer connectivity is via USB1.1/2.0 and Ethernet 10Base- T
  /100Base-TX.
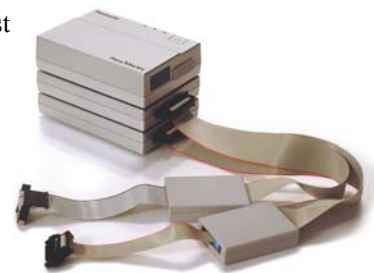
PanaX® EX Programming System

Low-cost stand-alone programming environment

● As with existing parallel programmer, mounting microcomputer on socket board
  enables stand-alone programming.
● PanaX ® EX is also available for debugging.
● Supports a variety of products by changing socket board.
● Offers low-cost and fast programming compared with the existing parallel
  programmer environment (PX-FW2)
● Connecting multiple PanaX® EX programming system to personal computer
  through USB HUB enables gang programming.
(Note) EX Series whose target connecting method is an insulated edition is not available.

In-Circuit Emulator (ICE)

ICE supporting a system development with advanced debug function.

Supports debugging with extensive functions such as break function, real-time trace function for instruction execution history, RAM monitoring function that visualizes RAM data change without stopping the target program.

PX-ICE101C/E-Advance, PX-ICE103L

● Real-time emulation
  Integration of emulator circuit and high-density mounting technology provides high-speed real-time emulation.
● Equipped with large-capacity emulation memory
● Extensive event / break / trace functions
  ・Allow hardware break point to be used as trigger event for various debug functions.
  ・Connect multiple events on sequential, AND, and other conditions, allowing easy debugging even in a difficult situation.
  ・Provide a versatile, convenient trace operation mode such as event-conditioned delayed trigger and so on.
● On-the-fly function
  Enables memory reference, and event, break, and trace settings and display without stopping target program execution
● Sampling function
  ・High-precision profile
   (Approx. 300 times sampling rate compared with existing Panasonic ICE)
  ・High-speed RAM sampling
● Supports low-voltage devices.
● Supports a wide variety of products .
  (For specific products supported, please see our website.)

(Note) PX-ICE101C/E-Advance is not available to MN101L Series.

ICE101C/E-Advance

ICE103L

PX-ICE101C/E-Lite

● Well-selected functions have reduced the cost.
● Boards depending on each microcomputer are commonly used for both this product and PX-ICE101C/E-Advance.
  (For specific supporting products, please see our website.)

(Note) Not available to MN101L Series

Real-time Operating Systems

Operating systems that deliver the real-time performance and compact footprint needed for embedded devices

These real-time operating systems comply with the industry-standard μ ITRON 4.0 Specification.

● They provide an OS kernel that implements scalable specifications so that it can be applied in hardware ranging from small to large-scale systems.

・Light edition

It provides a low-memory implementation that is ideal for small-scale systems.

・Standard edition

It implements high-speed processing along with a standard function set that can be applied to even large-scale systems. Synchronous communications between processors are implemented via the μ ITRON 4.0 standard SVC.

● A development environment that complies with the ITRON debugging interface specifications is provided.

・Resource information display function, trace log analysis function, and break function with real-time OS support
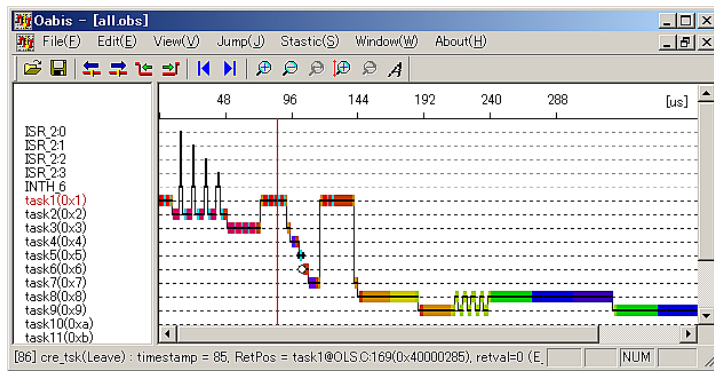
Trace log analytical functions

	Light Edition		Standard Edition
■Specifications	Compliant with μ ITRON4.0 Specification Automobile Control Profile		Compliant with μ ITRON4.0 Specification Standard Profile
■Compatible microcomputers	MN101C/MN101E Series	MN103S/MN103H/MN103L Series	MN103S/MN103H Series
■Basic specifications ・Max. no. of tasks ・Task states ・Scheduling method	16 Standard tasks: 4 states Constrained tasks: 3 states Priority-based event drive method (Same priority: FCFS)	256 Standard tasks: 4 states Constrained tasks: None Priority-based event drive method (Same priority: FCFS)	256 Standard tasks: 7 states Constrained tasks: None Priority-based event drive method (Same priority: FCFS)
■Static APIs	8 types (Proprietary configuration format)		
■No. of service calls ・Task management ・Task-attached synchronization ・Task exception processing ・Synchronization/communications ・Memory pool management ・Time management ・System state management ・Interrupt management ・System architecture management	56 types Yes Yes No Yes: Semaphores, event flags, data queues, mailboxes No Yes Yes Yes No	69 types Yes Yes No Yes: Semaphores, event flags, data queues, mailboxes Yes: Fixed-length memory pools Yes Yes Yes Yes	160 types Yes Yes No Yes: Semaphores, event flags, data queues, mailboxes, mutex, message buffers, condition variables Yes: Fixed-length memory pools, variable-length memory pools Yes Yes Yes Yes
■Max. no. of OS resources	16 of each	16 of each	16 of each
■Memory — ROM	1KB to 5.5KB	5KB to 20KB	20KB to 50KB
■Memory — RAM	200 bytes to several tens of KB	200 bytes to several tens of KB	2K bytes to several MB
■Service call speed	6 to 172[μ s]	38 to 660[cycle]	28 to 667[cycle]
■Interrupt response — Under OS management	20 to 127[μ s] 6 to 172[μ s]	61 to 721[cycle]	78 to 745[cycle]
■Interrupt response — Not under OS management	20 to 33[μ s]	61[cycle]	78[cycle]
■Build environment	DOS	DOS and Gmake support (Cygwin + Linux), DF * Task-specific static stack use calculation	
■OS debugging functionality	Task trace function (CPU utilization rate display, transition display, acquisition time: 0.5 s to 10 s) OS resource state display (state and other information for tasks, etc; back-tracing for individual tasks; dynamic stack calculation, etc.)		
■Example target product fields	White goods, compact control equipment	DVD players, SD audio	DTV / DSC / Movie / Onboard vehicle audiovisual

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Programming Tools Available from Panasonic Business Partners

In Circuit Flash Programmer (Yokogawa Digital Computer Corp.)

● Simultaneous multi-control model: G-NETIMPRESS
● Standard model: NETIMPRESS

・Mass production line support, DLLs provided, sequencer control,
bar-code hardware switching, support for unique data (serial, correction
value, etc.) programming

http://www2.yokogawa-digital.com/en/

Flash Programmer (Flash Support Group, Inc.)

● Extensive product line includes parallel programmers, on-board
programmers, gang programmers, and related equipment.
● Products support high-volume programming with automated programming
and on-board programming systems.
● Company offers programming services for Panasonic microcontrollers
in Japan and China
http://www.j-fsg.co.jp/e/prod/pro01.html
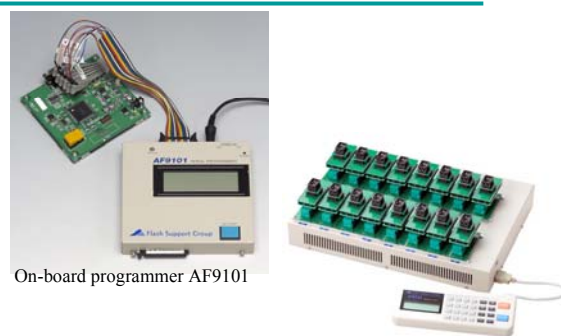
On-board programmer AF9101

Gang programmer AF9724

On-board Tools (OBJECT Co., LTD.)

● Provide support for both debuggers and programmers in a single package.
● Support the MN101C/E and MN103S/L Series.
● Deliver faster performance than conventional products.
● Support stand-alone offline operation (no computer required).
● Provide robust protection with a digital isolator.
● Include a full C compiler and are available at a reasonable price.
http://www.object.co.jp/panamc/panamc_eng/amot/index.html
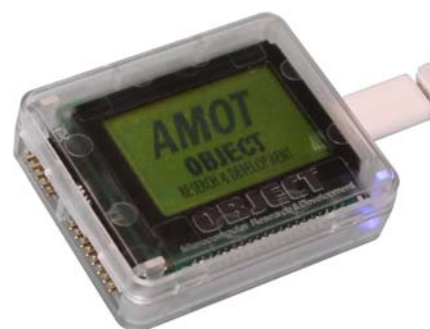
Evaluation Starter Kit (OBJECT Co., Ltd.)

● All-in-one package is ideal for AM microcomputer education and
deployment evaluation
● Includes CPU board, host connection cable, debugger, evaluation edition C compiler,
sample programs, and associated documentation.
● Connects directly to the host computer with a USB cable for easy debugging
(no external power supply required).
● Equipped with two 7-segment LEDs, two 2-color LEDs, a reset switch,
and an interrupt switch.
● The target device (microcomputer on the user's target hardware) can also be
debugged using DIP switch settings (same model only).
● Microcomputer I/O can be connected to an external device via an expansion
connector (includes unmounted components).
http://www.object.co.jp/panamc/panamc_eng/amskdw/index.html

Package List

Package type	Package size (mm)	Pin pitch (mm)	20	22	24	28	32	42	44	48	52	64	76	80	84	100	128	144	152	176	257
FLGA	11 X 11	0.8																	●		
UBGA	7 x 7	0.50															●				
UBGA	11 x 11	0.50																			●
HQFN	4 x 4	0.40					●														
HQFN	5 x 5	0.50					●														
HQFN	5 x 7	0.40							●												
SSOP	6.1 x 11	0.65					●														
SOP	5.5 x 12.63	1.27	●																		
SOP	7.2 x 17.8	1.27				●															
SOP	7.2 x 15.27	1.27			●																
TQFP	7 x 7	0.80					●														
TQFP	7 x 7	0.50								●											
TQFP	10 x 10	0.50										●									
TQFP	12 x 12	0.65										●									
TQFP	12 x 12	0.50												●							
TQFP	14 x 14	0.40														●					
LQFP	7 x 7	0.50								●											
LQFP	14 x 14	0.80										●									
LQFP	14 x 14	0.65												●							
LQFP	14 x 14	0.50														●					
LQFP	18 x 18	0.50															●				
LQFP	20 x 20	0.50																●			
LQFP	24 x 24	0.50																		●	
HQFP	7 x 7	0.50								●											
QFP	10 x 10	0.80							●												
QFP	14 x 14	0.80										●									
QFP	18 x 18	0.80													●						
QFP	18 x 18	0.65														●					

■Package Outline
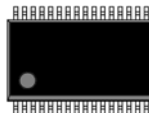
•FLGA　　•UBGA　　•HQFN　　•SSOP　　•SOP
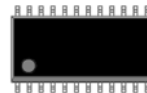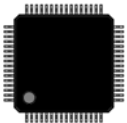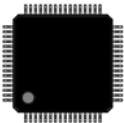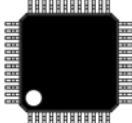
•TQFP　　•LQFP　　•HQFP　　•QFP
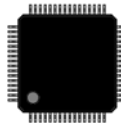
Contact Information

Website

Panasonic Microcomputer

Panasonic Microcomputer product information is available online.

http://www.semicon.panasonic.co.jp/en/products/microcomputers/

- Development tool information： **http://www.semicon.panasonic.co.jp/e-micom/support.html**
- Document downloads： **http://www.semicon.panasonic.co.jp/e-micom/document.html**
- Inquiry： **http://www.semicon.panasonic.co.jp/e-micom/qa.html**

Semiconductor Technical Support System

Panasonic provides information overviews by email, and customers can obtain more information by clicking the included link for the Panasonic Semiconductor Technical Support System.
The customer site is also available to ask questions and download development tools.

User registration for access

Please access the following URL and register as a user.

https://www.semicon.panasonic.co.jp/semi-spt/general/?lang=en&

Rental Company

Company	Products	URL
Orix Rentec Corporation	PanaX Series rentals	http://www.orixrentec.jp/cgi/en/

Business Partner

Company	Products	URL
Kyoto Microcomputer Co., Ltd.	On-board debugging environments, compilers	http://www.kmckk.co.jp/eng/index.html
Red Hat, Inc.	Compiler	http://www.redhat.com/
Yokogawa Digital Computer Corporation	On-board programmers, quality performance measurement tools	http://www2.yokogawa-digital.com/en/
Flash Support Group, Inc.	On-board programmers, parallel programmers, gang programmers, parallel write adapters	http://www.j-fsg.co.jp/en/index.html
Wave Technology Co., Ltd.	Gang programmers	http://www.wavetechnology.co.jp/en/index.html
OBJECT Co., Ltd.	On-board programmers, starter kits, on-board debugging environments	http://www.object.co.jp/
Tokyo Eletech Corporation	Device mounting sockets, ICE connection adapters	http://www.tetc.co.jp/e_index.htm
Ablty	PanaX Series manufacturing, repair, and shipment management	http://www.ablty.jp
GAIO TECHNOLOGY CO., LTD.	Embedded module standalone testing and coverage measurement automation tools	http://www.gaio.com/
JOHNAN Corporation	Support for writing to Flash microcomputer	http://www.johnan.com/en/

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TRON is an abbreviation of "The Real-time Operating system Nucleus."

ITRON is an abbreviation of "Industrial TRON."

µITRON is an abbreviation of "Micro Industrial TRON."

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