RENESAS

Everywhere you imagine.

LIN and CAN Solutions for **Industrial Applications**

M16C PLATFORM™

LIN AND CAN NETWORKING TECHNOLOGIES are excellent solutions for a wide range of industrial embedded applications. They are well proven in the automotive field, where their speed, reliability and standardization have been continually tested under the most difficult conditions. Using Renesas microcontrollers, with their comprehensive set of development tools, enables you to economically implement LIN and CAN into your industrial applications.

	LIN *versus* CAN	
Access control:	Single Master	Multiple Master
Max. bus speed:	20Kbps	1Mbps
Typical # nodes:	2 to 16	4 to 20
Message routing:	6-bit identifier	11/29-bit identifier
Data byte/frame:	2, 4, 8 bytes	0 to 8 bytes
Error detection:	8-bit checksum	16-bit CRC
Physical layer:	Single-wire	Twisted-pair

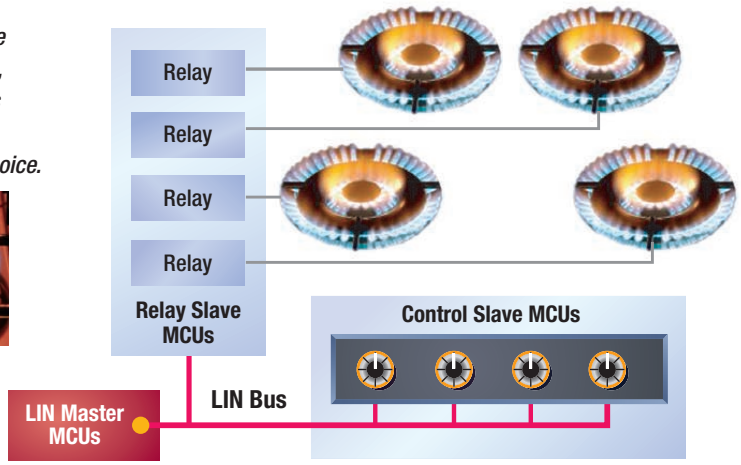
LIN Network Solutions

Proven 1-wire single-master/multiple-slave architecture – low-cost, providing communication up to 20Kbps

LIN technology is an excellent low-cost choice for networking intelligent sensors, actuators and other embedded system elements in situations that don't require CAN's bandwidth and versatility. The LIN communication protocol is based on the standard UART data format and a single-master, multiple-slave concept. EMC considerations limit speed to 20Kbps, and most LIN networks have 16 nodes or less. LIN's per-node cost is significantly less than that of a CAN network, and a seamless chain of development and design tools accelerates system design.

LIN Master/Slave Solution

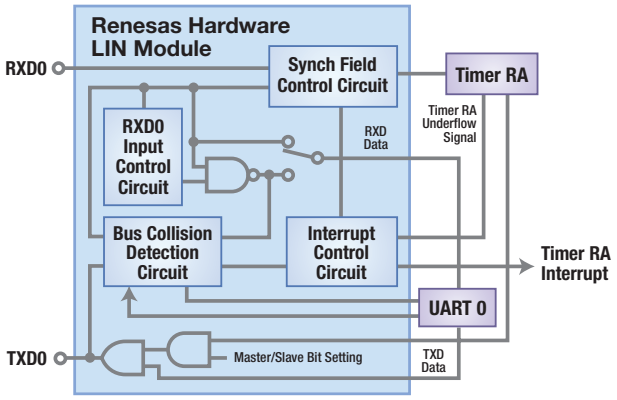
- *Where cost-per-node is of key importance, proven LIN networks using Renesas LIN MCU's are a solid choice.*



Hardware and Software Solutions

There are two basic ways to design a LIN network using Renesas MCUs:

- Entire LIN functionality is implemented in software using a standard UART and timer for flexible user implementation
- Built-in LIN hardware is used with a standard UART and timer to reduce CPU overhead



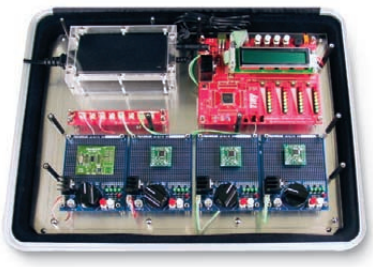
Renesas MCU with Built-in LIN Hardware

- Generates/detects synch break
- Detects bus collision
- Measures synch field
- Controls synch break and synch field signal
- Accurate on-chip oscillator for master/slave clock synchronization
- Guaranteed latency times for signal transmission
- Dynamic configuration capability
- LIN 2.0 API support absolutely free

Renesas LIN Solution Benefits

- Single wire is multiplexed to carry multiple signals, reducing wiring cost and increasing reliability
- Low baud-rate and controlled signal rise and fall times ensure good EMC performance
- Built-in LIN hardware with on-chip UART and timer reduces CPU overhead
- On-chip oscillator eliminates the need for external crystal
- Dynamic configuration capability allows reuse of "standardized" LIN master and slave modules for lower manufacturing costs
- Network configuration and scheduling are easy

- *User-friendly LIN Master/Slave demonstration system is available.*



CAN Network Solutions

Proven 2-wire multiple-master/multiple-slave architecture – versatile, robust, providing communication up to 1Mbps

Controller Area Networks (CAN) offer excellent cost-performance, ensure highly reliable communication between nodes, and provide easy network scalability.

High-integrity networking in real-time control applications are economically implemented using Renesas MCUs with on-chip CAN peripheral functions. In particular, the CAN MCUs in the Renesas M16C platform, ranging from the low-cost 8/16-bit R8C to the high-end 32-bit performance M32C, provide 1 to 3 channels of FullCAN 2.0B embedded CAN controllers.

With their unique CAN controller features that guarantee optimized application functions and simultaneous high-speed CAN communication, Renesas M16C MCUs are the best choice for CAN networked industrial distributed systems. The M16C MCU family offers such features as built-in noise cancellation circuits for robust EMI/EMS characteristics, and full pin and peripheral compatibility which simplifies upward/downward changes of memory size and performance. It's easy to create platform designs and decrease the effort needed to design different types of nodes or redesign legacy codes. A consistent and very intuitive toolchain across the M16C family and a network-ready design kit helps significantly shorten system development time and cost.

▶ *When real-time control is crucial, Renesas CAN MCUs are the ideal solution.*

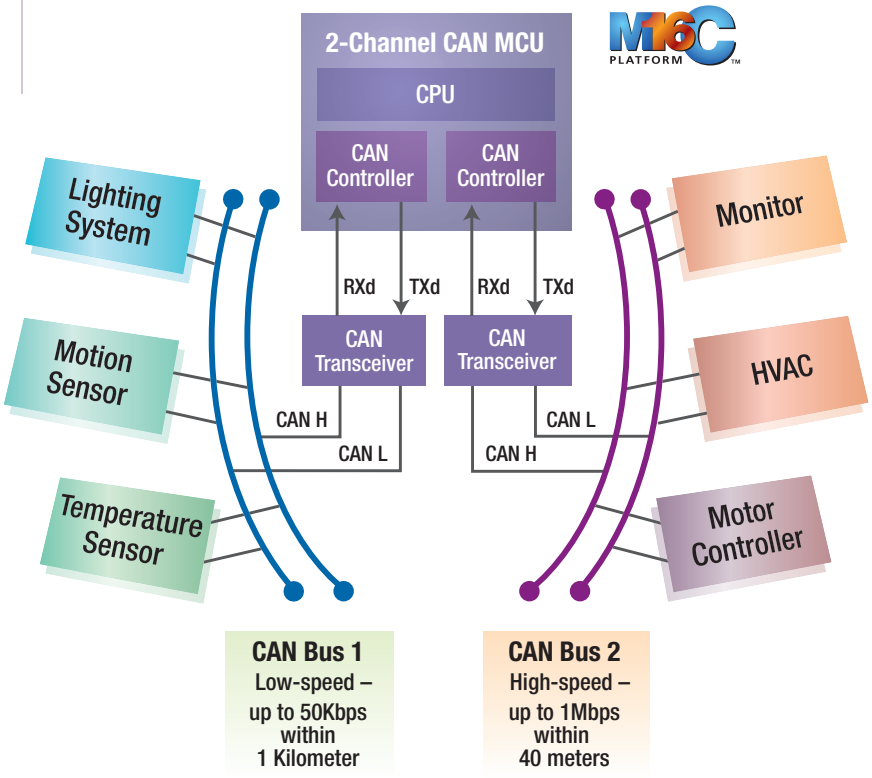
Renesas CAN MCU Features

- Supports both CAN protocol versions 2.0A and 2.0B
- 16 or 32 transmit/receive configurable message buffers
- Hardware acceptance filters
- Automatic remote frame response
- Acceptance filter support unit (ASU)
- Re-transmission abort function
- Forced bus-off restore function
- Listen-only mode
- Flash programming via CAN BUS

Renesas CAN Solution Benefits

- FullCan (Extended CAN) controller with 16 or 32 flexibly configurable buffers for efficient data management
- Acceptance filter support unit (ASU) is a hardware-based message pre-screening mechanism for increased network rigidity and decreased CPU overhead
- Manual re-transmission abort function prevents retransmitting a message that is lost in arbitration to avoid bus congestion
- Forced bus-off restore function for quick state recovery and listen-only mode for node startup and communication analysis

Typical 2-Channel M16C Family CAN Solution



▶ *Renesas CAN and LIN Solutions provide an impressive scalable MCU platform for an ever-expanding range of industrial applications.*

Fully Integrated Hardware and Software Develop

Whether you're designing a LIN or CAN embedded system, Renesas offers a comprehensive suite of hardware and software development tools that help make the process quick and easy. Renesas' suite of tools include the High-performance Embedded Workshop (HEW), various emulators (full ICE and low-cost on-chip emulators), Flash Development Toolkit (FDT), and other software utilities.

Tools for LIN Solutions

▸ america.renesas.com/LIN-CAN

Quickly and easily begin evaluating your LIN solutions with Renesas Starter Kits (RSK). These low-cost evaluation development tool kits provide a user-friendly introductory and evaluation platform for assessing the suitability of a chosen Renesas MCU, as well as a basic development platform.

Additional Software Resources

LIN specific software tools are downloadable from the Renesas web site and from various third parties.

- Full LIN 2.0 API *(downloadable)*
- LIN Description File *(downloadable)*
- LIN Line Monitor *(downloadable)*
- Lin Analyzer – Available from third parties, including Sunny Giken, Vector, Volcano and more

LIN Development Resources

Renesas Starter Kit (RSK) *(Typical contents)*

- CPU board
- Detachable LCD display module
- Detachable AD adjustment shaft
- E8 on-chip debug emulator
- Connection cable (USB cable, user interface cable)
- Quick-start guide
- CD-ROM with the following files:
  - HEW 4 integrated development environment
  - C Compiler (64K evaluation version)
  - Flash memory programmer
  - User manual, tutorial and more

Renesas Starter Kit (RSK) Listings

Series	Group	Starter Kit/ Evaluation Kit
R8C/Tiny	19	R0K5211B4S000BE
	1B	R0K5211B4S000BE
	21	R0K521237S000BE
	22	R0K521237S000BE
	23*	R0K521237S000BE
	25	R0K521256S000BE
	27	R0K521276S000BE
	29	R0K521276S000BE
	2B	R0K5212D8S000BE [TBD]
	2D	R0K5212D8S000BE [TBD]
M16C/Tiny	29*	R0K330290S000BE

Series	Group	Starter Kit/ Evaluation Kit
M16C	6N4*	R0K3306NKS000BE
	6N5*	R0K3306NKS000BE
	6NK*	R0K3306NKS000BE
	6NL*	R0K3306NKS000BE
	6NM*	R0K3306NKS000BE
	6NN*	R0K3306NKS000BE
M32C	83*	SKP32C83
	84*	SKP32C84
	85*	SKP32C84
	86*	SKP32C84
	87*	R0K330879S000BE
	88*	R0K330879S000BE

* These RSKs are available with CAN functionality.

Tools for CAN Solutions

▸ america.renesas.com/LIN-CAN

Evaluate M16C CAN network performance and learn more about CAN technology with the Renesas CAN Development Kit.

In addition to the hardware and software tools included in a standard Renesas Starter Kit, the CAN Development Kit provides two target boards with network-ready CAN MCUs, CAN transceivers, CAN-standard twisted-pair cable and connectors, as well as examples of CAN code and a CAN "Sniffer" made by Sys Tec Electronics.

▸ *More CAN MCU nodes can be added by ordering standard RSKs shown in the RSK table. The CAN Development Kit can also be used to evaluate LIN connectivity with LIN software.*

Renesas CAN Development Kit

- Two Renesas target boards with:
  - Renesas R8C or M16C MCUs
  - ISO 11898-2 compliant CAN transceivers
  - LCD, switches and LEDs
  - 5V DC power supply
- USB-based E8 on-chip debug emulator
- ISO 11898-2 specification twisted-pair cables
- Sys Tec Electronics USB CANmodul1 (CAN BUS sniffer) and CD
- Software CD which includes HEW 4 integrated development environment and M16C debug environment
- Quick-start guide
- Sample CAN network demo program
- CAN sample driver code

ment Tools and Support

▶ *Free comprehensive 24-hour online support is provided, including course, tool evaluation and much more. Simply log on to www.renesasinterative.com.*

HEW 4 Integrated Development Environment

▶ america.renesas.com/evaluation_software

The High-performance Embedded Workshop (HEW) is a single integrated development and debugging environment with project management features and a complete set of software tools (optimizing C compiler, etc.) across all Renesas microcontroller families. A 64KB version is available free for download from the Renesas web site.

Project Manager
– Graphical control of compiler/linker options
– Function browser
– Drag and drop code templates
– Built-in (or external) project make

Output Window
– Shows messages from build and find-in-files
– Linked to source in editor
– Version-control log

Built-in Editor
– Syntax sensitive coloring
– Multiple files open at once
– Source-level debugging

Full Bus Trace

Local Variable Watch

C/C++ Variable Watch

Stack Trace

Complex Break Conditions

Memory View
– Highlights changed values

Virtual Desktop
– Allows multiple screen layouts to be recalled at the click of a button

Emulators

▶ america.renesas.com/emulator_debugging

Renesas offers a full range of emulation products, from our low-cost E8 on-chip debug emulator, through compact emulators, to our powerful PC7501, a full in-circuit emulation system. Further details about tool selection can be found on the web site.

▶ *On-chip debug emulators allow low-cost, in-system debugging using the original chip.*

▶ *Compact emulators provide optimal cost-performance in-circuit emulation.*

▶ *Powerful in-circuit emulators provide real-time debugging capabilities.*

LIN/CAN MCU Product Selection Table

This table focuses on M16C platform solutions. H8® and SuperH® solutions are also available. Please visit our web site for more information.

Group	Product	Flash Size* (Kbytes)	Data Flash (Kbytes)	RAM (Kbytes)	Vcc Min.	Vcc Max.	Max MHz @ Vcc Max.	32 kHz Sub Clock	8-bit Timers	16-bit Timers	Serial (Sync/Async)	SSU (SPI Compatible)	I²C	CAN	A/D 10-bit	D/A 8-bit	DMA Channels	External Interrupts	GPIO	External Data Bus	Special Features	Package**
LIN Master																						
R8C/21	R5F21216	32	2	2	2.7	5.5	20	–	3	2	2	1	1	–	12	–	–	5	44	–	1 ch. LIN (H/W), POR, LVD, SSU, WDTO	48LQFP
	R5F21227	48	2	2.5	2.7	5.5	20	–	3	2	2	1	1	–	12	–	–	5	44	–		48LQFP
R8C/23	R5F21236	32	2	2	2.7	5.5	20	–	3	2	2	1	1	1	12	–	–	6	44	–	1 ch. LIN (H/W), 1ch. CAN, POR, LVD, SSU, WDTO	48LQFP
	R5F21237	48	2	2.5	2.7	5.5	20	–	3	2	2	1	1	1	12	–	–	6	44	–		48LQFP
R8C/25	R5F21254	16	2	1	2.2	5.5	20	Y	3	2	2	1	1	–	12	–	–	5	44	–	1 ch. LIN (H/W), POR, LVD, SSU, WDTO	52LQFP
	R5F21256	32	2	2	2.2	5.5	20	Y	3	2	2	1	1	–	12	–	–	5	44	–		52LQFP
	R5F21257	48	2	2.5	2.2	5.5	20	Y	3	2	2	1	1	–	12	–	–	5	44	–		52LQFP
	R5F21258	64	2	3	2.2	5.5	20	Y	3	2	2	1	1	–	12	–	–	5	44	–		52LQFP
R8C/2B	R5F212B7	48	2	2.5	2.2	5.5	20	Y	3	4	3	1	1	–	12	2	–	5	57	–		64LQFP
	R5F212B8	64	2	3	2.2	5.5	20	Y	3	4	3	1	1	–	12	2	–	5	57	–		64LQFP
	R5F212BA	96	2	7	2.2	5.5	20	Y	3	4	3	1	1	–	12	2	–	5	57	–		64LQFP
R8C/2D	R5F212D7	48	2	2.5	2.2	5.5	20	Y	3	4	3	1	1	–	20	2	–	5	73	–		80LQFP
	R5F212D8	64	2	3	2.2	5.5	20	Y	3	4	3	1	1	–	20	2	–	5	73	–		80LQFP
	R5F212DA	96	2	7	2.2	5.5	20	Y	3	4	3	1	1	–	20	2	–	5	73	–		80LQFP
LIN Slave																						
R8C/13	R5F21132	8	4	0.5	2.7	5.5	20	–	3	1	2	–	–	–	12	–	–	5	24	–	1 ch. LIN (S/W), POR, LVD	32LQFP
	R5F21133	12	4	0.75	2.7	5.5	20	–	3	1	2	–	–	–	12	–	–	5	24	–		32LQFP
	R5F21134	16	4	1	2.7	5.5	20	–	3	1	2	–	–	–	12	–	–	5	24	–		32LQFP
R8C/19	R5F21191	4	2	0.375	2.7	5.5	20	–	2	1	2	–	–	–	–	–	–	4	16	–	1 ch. LIN (S/W), POR, LVD, WDTO, 4 ch. comparator	20SSOP
	R5F21192	8	2	0.5	2.7	5.5	20	–	2	1	2	–	–	–	–	–	–	4	16	–		20SSOP
	R5F21193	12	2	0.75	2.7	5.5	20	–	2	1	2	–	–	–	–	–	–	4	16	–		20SSOP
	R5F21194	16	2	1	2.7	5.5	20	–	2	1	2	–	–	–	–	–	–	4	16	–		20SSOP
R8C/1B	R5F211B1	4	2	0.375	2.7	5.5	20	–	2	1	2	1	1	–	4	–	–	4	16	–	1 ch. LIN (S/W), POR, LVD, WDTO	20SSOP
	R5F211B2	8	2	0.5	2.7	5.5	20	–	2	1	2	1	1	–	4	–	–	4	16	–		20SSOP
	R5F211B3	12	2	0.75	2.7	5.5	20	–	2	1	2	1	1	–	4	–	–	4	16	–		20SSOP
	R5F211B4	16	2	1	2.7	5.5	20	–	2	1	2	1	1	–	4	–	–	4	16	–		20SSOP
R8C/27	R5F21272	8	2	0.5	2.2	5.5	20	Y	3	1	2	1	1	–	12	–	–	4	28	–	1 ch. LIN (H/W), POR, LVD	32LQFP
	R5F21274	16	2	1	2.2	5.5	20	Y	3	1	2	1	1	–	12	–	–	4	28	–		32LQFP
	R5F21275	24	2	1.5	2.2	5.5	20	Y	3	1	2	1	1	–	12	–	–	4	28	–		32LQFP
	R5F21276	32	2	1.5	2.2	5.5	20	Y	3	1	2	1	1	–	12	–	–	4	28	–		32LQFP
R8C/29	R5F21292	8	2	0.5	2.2	5.5	20	Y	3	1	1	1	1	–	12	–	–	4	16	–		20 SSOP
	R5F21294	16	2	1	2.2	5.5	20	Y	3	1	1	1	1	–	12	–	–	4	16	–		20 SSOP
CAN																						
R8C/22	R5F21226	32	–	2	2.7	5.5	20	–	3	2	2	1	1	1	12	–	–	6	44	–	1 ch. CAN 2.0B (16-msg slots), 1 ch. LIN (H/W), POR, LVD, SSU, WDTO	48LQFP
	R5F21227	48	–	2.5	2.7	5.5	20	–	3	2	2	1	1	1	12	–	–	6	44	–		48LQFP
R8C/23	R5F21236	32	2	2	2.7	5.5	20	–	3	2	2	1	1	1	12	–	–	6	44	–		48LQFP
	R5F21237	48	2	2.5	2.7	5.5	20	–	3	2	2	1	1	1	12	–	–	6	44	–		48LQFP
M16C/29	M30291FA	96	4	8	2.7	5.5	20	Y	–	9	4	–	2	1	16	–	2	8	55	–	1 ch. CAN 2.0B (16-msg slots), POR, LVD, 3-ph PWM, CRC, 1 ch. IC/OC, 1 ch. IE Bus	64LQFP
	M30291FC	128	4	12	2.7	5.5	20	Y	–	9	4	–	2	1	16	–	2	8	55	–		64LQFP
M16C/6N4	M306N4FC	128	–	5	3.0	5.5	24	Y	–	11	4	–	3	2	26	2	2	9	88	Y	2 ch. CAN 2.0B (16-msg slots), POR, 3-phase PWM, CRC, 3 ch. IE Bus	100QFP/LQFP
	M306N4FG	256	–	10	3.0	5.5	24	Y	–	11	4	–	3	2	26	2	2	9	88	Y		100QFP/LQFP
M16C/6N5	M306N5FC	128	–	5	3.0	5.5	24	Y	–	11	4	–	3	1	26	2	2	9	88	Y	1 ch. CAN 2.0B (16-msg slots), POR, 3-phase PWM, CRC, 3 ch. IE Bus	100QFP/LQFP
M16C/6NK	M306NKFH	384	–	31	3.0	5.5	24	Y	–	11	5	–	3	2	26	2	2	9	88	–	2 ch. CAN 2.0B (16-msg slots), POR, 3-ph PWM, CRC	100LQFP
	M306NKFJ	512	–	31	3.0	5.5	24	Y	–	11	5	–	3	2	26	2	2	9	88	–		100LQFP
M16C/6NL	M306NLFH	384	–	31	3.0	5.5	24	Y	–	11	5	–	3	1	26	2	2	9	88	–	1 ch. CAN 2.0B (16-msg slots), POR, 3-ph PWM, CRC	100LQFP
	M306NLFJ	512	–	31	3.0	5.5	24	Y	–	11	5	–	3	1	26	2	2	9	88	–		100LQFP
M32C/83	M30835FJ	512	–	31	3.0	5.5	32	Y	–	11	5	–	5	1	34	2	4	8	124	Y	1 ch. CAN 2.0B (16-msg slots), 2 ADCs, X-Y convrt, 3 ph. PWM, CRC, DMAC II, DRAMC, Intelligent IO (12 ch. IC, 28 ch. OC, HDLC), POR	144LQFP
M32C/84	M30845FW	320	–	24	3.0	5.5	32	Y	–	11	5	–	5	1	34	2	4	8	124	Y	1 ch. CAN 2.0B (16-msg slots), X-Y convrt, 3 ph. PWM, CRC, DMAC II, Intelligent IO (8 ch. IC, 8 ch. OC, HDLC), POR, LDV	144LQFP
	M30845FH	384	–	24	3.0	5.5	32	Y	–	11	5	–	5	1	34	2	4	8	124	Y		144LQFP
	M30845FJ	512	–	24	3.0	5.5	32	Y	–	11	5	–	5	1	34	2	4	8	124	Y		144LQFP
M32C/85	M30855FW	320	–	24	3.0	5.5	32	Y	–	11	5	–	5	2	34	2	4	8	124	Y	2 ch. CAN 2.0B (32-msg slots), X-Y convrt, 3-ph. PWM, CRC, DMAC II, Intelligent IO (8 ch. IC, 8 ch. OC, HDLC), POR, LDV	144LQFP
	M30855FH	384	–	24	3.0	5.5	32	Y	–	11	5	–	5	2	34	2	4	8	124	Y		144LQFP
	M30855FJ	512	–	24	3.0	5.5	32	Y	–	11	5	–	5	2	34	2	4	8	124	Y		144LQFP
M32C/86	M30865FJ	512	–	24	3.0	5.5	32	Y	–	11	5	–	5	2	34	2	4	8	124	Y	2 ch. CAN 2.0B (32-msg slots), X-Y convert, 3-ph PWM, Step motor cont., CRC, DMAC II, CAN 2.0B, Intelligent IO (8 ch. IC; 8 ch. OC; HDLC), POR, LDV	144LQFP
M32C/87	M30875FH	384	–	24	3.0	5.5	32	Y	–	11	7	–	5	1or2	34	2	4	11	124	Y	1 ch. or 2 ch. CAN 2.0B (32-msg slots), X-Y convert, 3 ph. PWM, CRC, DMAC II, Intelligent IO (8 ch. IC; 16 ch. OC; HDLC), POR, LVD	144LQFP
	M30878FJ	512	–	31	3.0	5.5	32	Y	–	11	7	–	5	1or2	34	2	4	11	124	Y		144LQFP
	M3087BFK	768	–	48	3.0	5.5	32	Y	–	11	7	–	5	1or2	34	2	4	11	124	Y		144LQFP
	M3087BFL	1024	–	48	3.0	5.5	32	Y	–	11	7	–	5	1or2	34	2	4	11	124	Y		144LQFP
M32C/88	M30882FWT	320	–	18	4.2	5.5	32	Y	–	11	5	–	5	3	34	2	4	8	124	–	3 ch. CAN 2.0B (32-msg slots), X-Y convert, 3 ph. PWM, Cld/Wrm Strt-Up, CRC, DMAC II, Intelligent IO (8 ch. IC; 8 ch. OC; HDLC), POR	144LQFP
	M30882FHT	384	–	18	4.2	5.5	32	Y	–	11	5	–	5	3	34	2	4	8	124	–		144LQFP
	M30882FJT	512	–	18	4.2	5.5	32	Y	–	11	5	–	5	3	34	2	4	8	124	–		144LQFP

* Check web site for availability of Mask ROM versions. **Check web site for other package availability.

Abbreviations

AEC: Asynchronous event counter
BGR: Band gap regulator
CAN: Controller area network
CRC: Cyclic redundancy check
DMAC: Direct memory access controller
HDLC: High-level data link control
IC/OC: Input capture, output compare
Intelligent I/O: Multiple function I/O composed of timer unit and communication unit
LIN: Local interconnect network
LVD: Low-voltage detect
MP: Mass production
OCD: On-chip debugger
OSCD: One-shunt current detection
POR: Power-on reset
PLL: Phase-lock loop
PWM: Pulse-width modulation
RTC: Real-time clock
SSU: Synchronous serial unit (SPI™ comparable)
WDT: Watchdog timer
WS: Working sample

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