

LAPIS SEMICONDUCTOR Low Power Microcontroller



Energy Saving Ultra Low Power MCU



**LAPIS Semiconductor
proposes**

**Ultra-low
power
consumption
MCU**

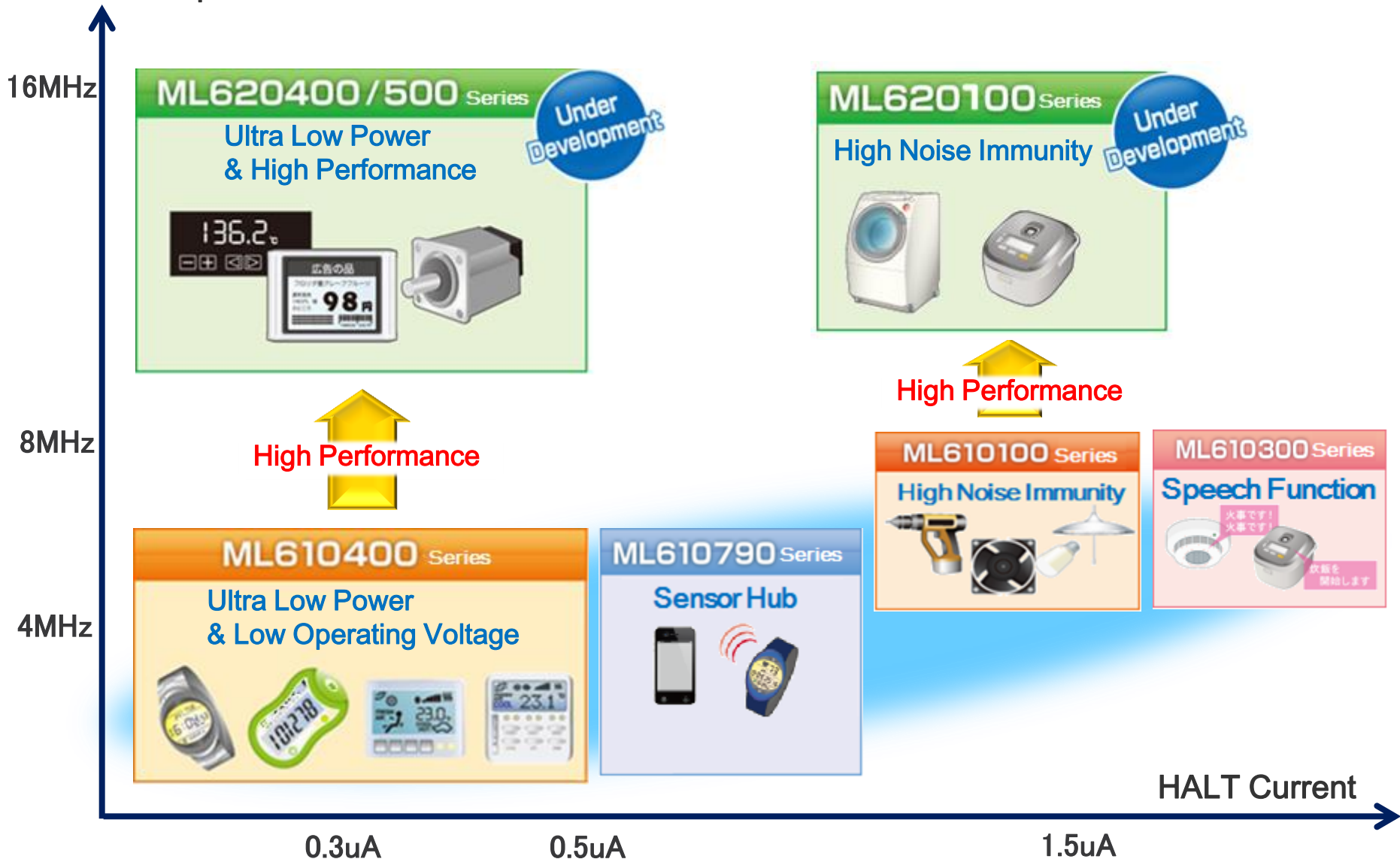
&

**Low voltage
operating
MCU**

**which contribute to a customer's
energy saving.**

LAPIS Low Power Microcontroller Series Overview

CPU Clock Speed



ML610400 Series

Ultra Low Power
& Low Operating Voltage



ML610400 Series Features

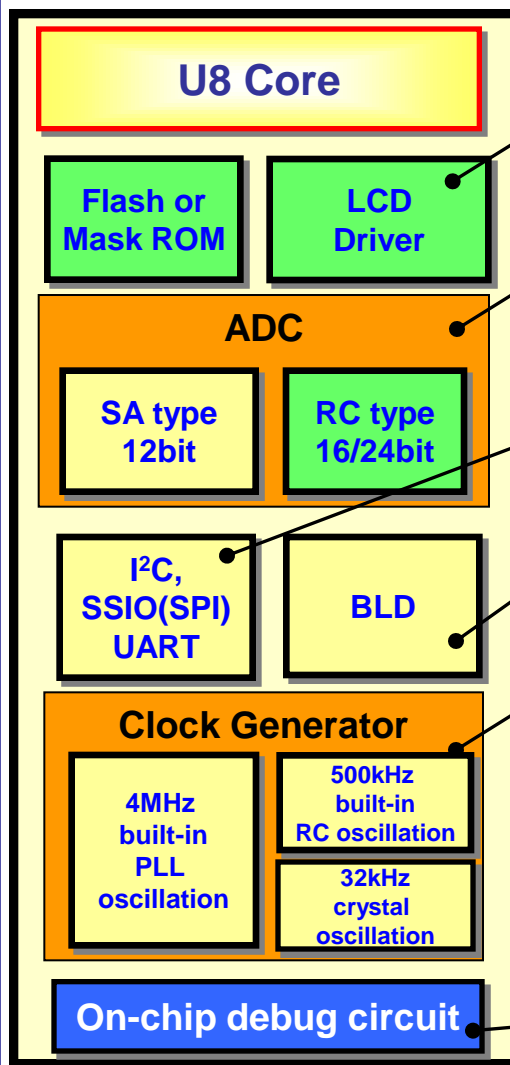
Industry-leading ultra low power & Low operating voltage

Low consumption in all operating, at sleep, and at standby modes.

- ✓ **HALT mode**
→ **0.5 μ A / 0.25 μ A**
- ✓ **STOP mode**
→ **0.15 μ A**
- ✓ **4MHz CPU operating**
→ **800 μ A**
- ✓ **500kHz CPU operating**
→ **70 μ A**
- ✓ **32kHz CPU operating**
→ **5 μ A**

Works on a single battery

- ✓ **Operating voltage**
→ **1.1V to 3.6V**



Suitable for various panel sizes

Dot matrix type : 288 - 1,536 dot
 Segment type : 55 - 185dot

High accuracy A/D converter

16/24bit RC oscillation type
 & 12bit successive approximation type
 A/D converter built-in

Supports a variety of serial interfaces

I²C, SSIO, and UART interfaces are provided for broad compatibility

Battery Level Detector

The built-in A/D converter enables precise voltage measurement ($\pm 2\%$) with low power consumption

Built-in PLL (Phase Locked Loop) oscillation circuit

PLL oscillation circuit generates the 4.096MHz high speed clock by multiplying 32.768KHz clock.

Short-term development by on-chip debug

Supports debug and flash memory writing by LAPIS Semiconductor's emulator "uEASE."

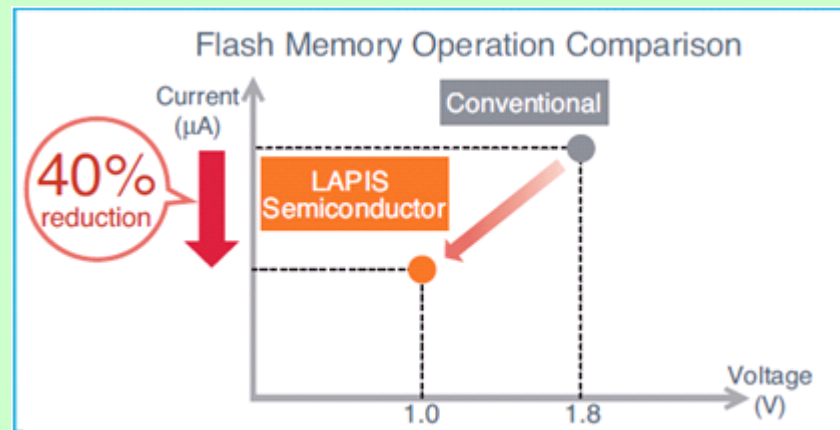
Key Technologies

1.0 V Flash memory Operation

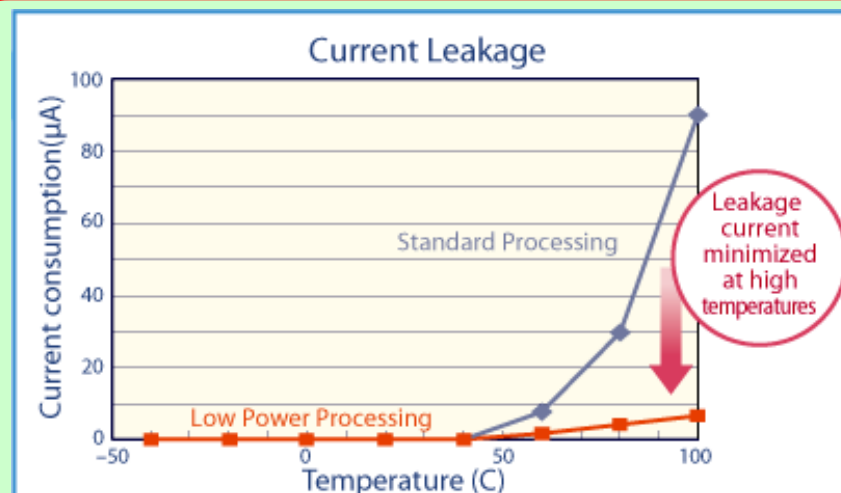
- A unique low-power method enables Flash memory reading at only 1.0V.
- In addition, reducing the charge/discharge current through bit-line division enables low power consumption equivalent to mask

Few current leakage at high temperature

- Original low-power processing prevents current leakage at high temperatures



Flash memory readable at only 1.0V,
enables a 1.5V single battery operation



The low leakage process achieves low power consumption over the entire operational temperature range.

ML610400 Series Product Lineup

Resolution	Package	Product Lineup	Application	Resolution	Package	Product Lineup	Application
128K		Standard (no LCD)				Built-in LCD Dot-matrix type (224~1,536dots)	
96K							Weather Station
64K		ML610(Q)482(P)	Control Panel			ML610Q419(P) ML610Q419(P)C	Thermostat
48K		ML610Q488(P)	TV controller				Bike Meter
40K						ML610(Q)426(P) ML610(Q)426(P)C	Watch
32K	E-bicycle	ML610Q486(P)				ML610(Q)422(P) ML610(Q)421(P)	Smart watch
24K							Graphic Pedometer
16K	3D glass	ML610Q484(P)	Lighting controller			ML610(Q)479(P) ML610(Q)478(P) ML610(Q)477(P)	
						ML610476(P) ML610475(P) ML610474(P) ML610Q476 ML610Q475 ML610Q474	
						ML610424(P) ML610424(P)C ML610(Q)409(P) ML610(Q)408(P) ML610(Q)407(P)	
						ML610Q415 ML610Q412(P) ML610Q411(P)	
							Token
							Pedometer
							Thermometer
8K		ML610(Q)473(P)*1 ML610(Q)472(P)*1 ML610(Q)471(P)*1				ML610406(P) ML610405(P) ML610404(P)	
							Thermo Logger
							Clock
							Thermostat
6K		ML610403(P) ML610402(P) ML610401(P)					Calculator
	28pin	48pin	64pin	80pin	100pin	120pin	128pin
							144pin

*1 ML610(Q)471(P)/ML610(Q)472(P)/ML610(Q)473(P)には48pinと64pinとがあります。

ML620400/500 Series

Ultra Low Power
& High Performance



ML620400/500 Series Key Features



8bit Low Power MCU



*Next
generation*



16bit Low Power MCU

Ultra Low Power & High performance

- LAPIS's high performance 16bit CPU Core U16 @ 16MHz
- Multiplication-and-division co-processor
- 0.3uA @HALT & 250uA/MHz @operating mode

Seamless Upgradable from LAPIS's 8bit MCU

- Instruction compatible with 8bit CPU Core U8
- Comprehensive Software Development Tools

Applicable Applications

ESL

Electric Shelf Label

Control Panels

Logger

Home Appliances

Personal Healthcare

HEMS

Home Energy Management
System

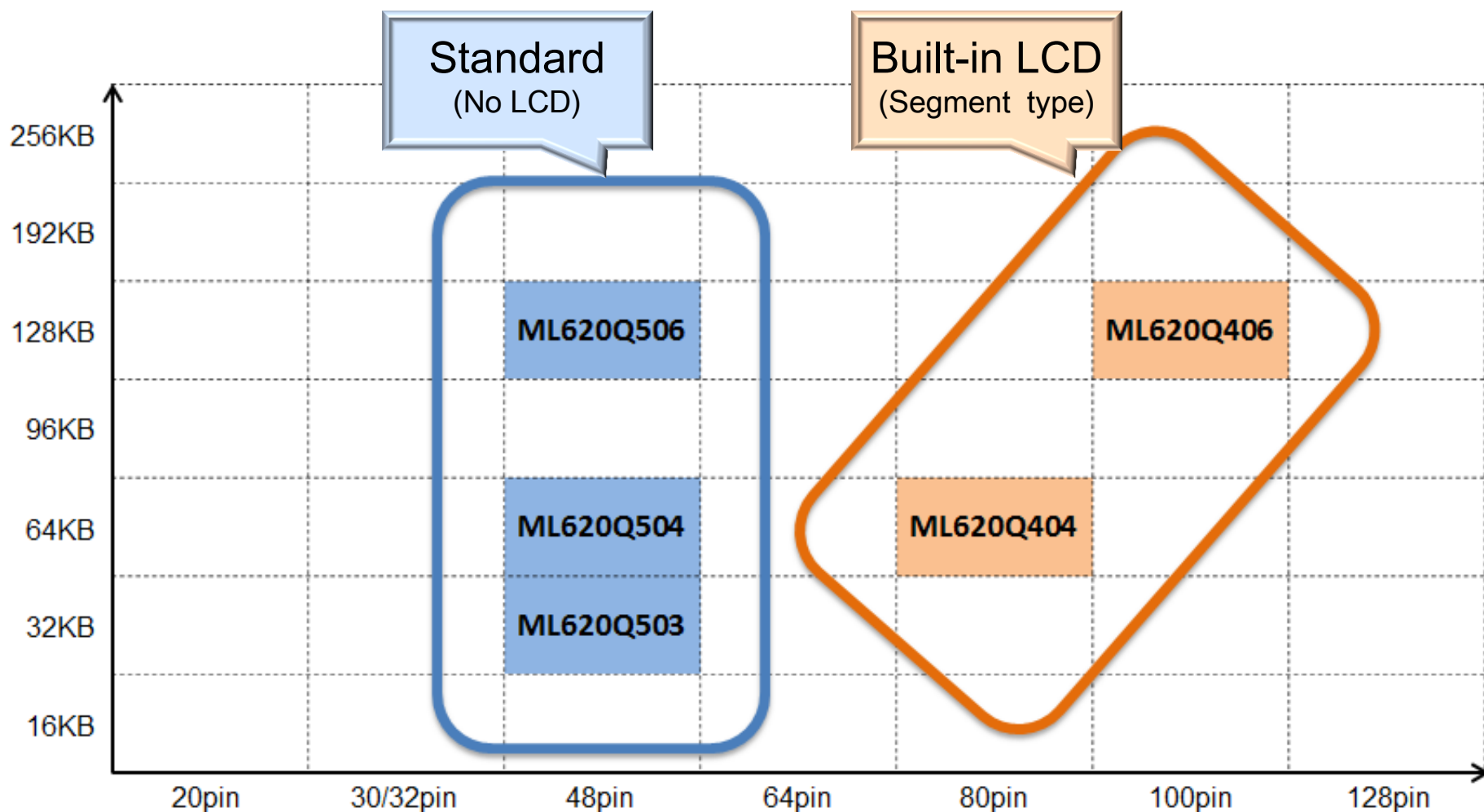
Sensor Nodes

Accessories

Thermostat

ML620400/500 Product Line-up

LAPIS continues adding products for supporting wide range of applications.



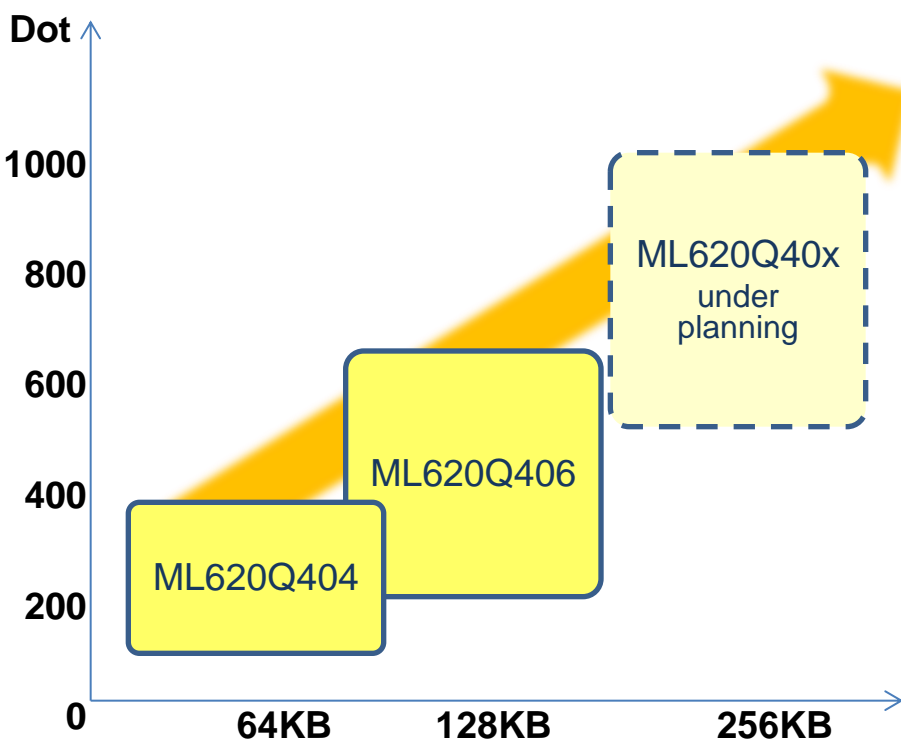
ML620400 Series Overview

■ Key Features

- Built-in LCD : 4/8/16com selectable
- Ultra low power :
 - HALT mode : 300nA
 - Operating mode : <250uA/MHz

■ Schedule

ES : May-2014



	ML620Q404	ML620Q406
Flash ROM with ISP	64KB	128KB
Data Flash	2KB	2KB
RAM	6KB	12KB
I/O Port	38	
ADC	12bit SA-ADC x 12ch RC-ADC x 2ch	
Comparator	2ch	
Serial I/F	I2C (Master) x 2 SPI (master/slave) x 2 UART (Full Duplex Asynchronous) x 2	
Timer	8bit timer x 8 or 16bit timer x 4	
	16bit timer with PWM x 4	
	WDT x 1	
External Interrupt	8ch	
Voltage Level Supervisor	16 level x 1ch	
Power ON Reset	yes	
Clock / Low frequency	External Crystal (32.768kHz) Internal RC Oscillator (32kHz)	
Clock / High frequency	External Crystal (upto 16MHz) Internal RC Oscillator (16MHz)	
Operating voltage	1.8V ~ 5.5V	
Operating temperature	-40°C ~ +85°C	
Power consumption	Stop mode : 200nA	
	Halt mode : 300nA	
	Operating mode : <250uA/MHz	
LCD (400 family)	16com x 26seg (416)	16com x 38seg (608)
	8com x 34seg (272)	8com x 46seg (368)
	4com x 38seg (152)	4com x 50seg (200)
Package	80TQFP, Die	100TQFP, Die

ML620500 Series Overview

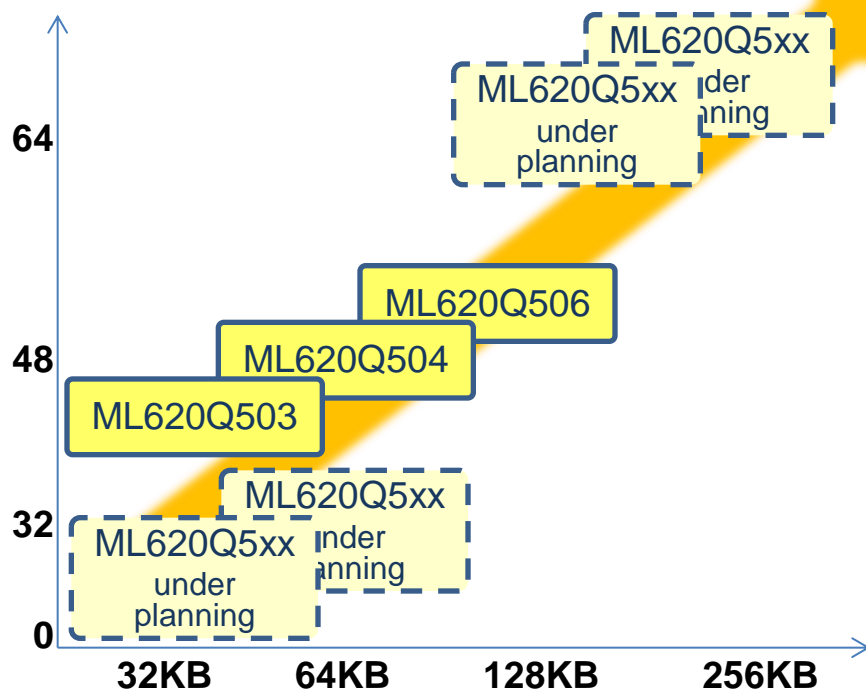
■ Key Features

- Memory upgradable on the same package.
- Ultra low power :
 - HALT mode : 300nA
 - Operating mode : <250uA/MHz

■ Schedule

ES : May-2014

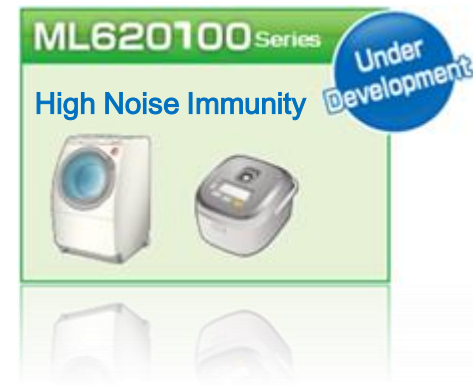
Pin
Count



	ML620Q503	ML620Q504	ML620Q506
Flash ROM with ISP	32KB	64KB	128KB
Data Flash	2KB	2KB	2KB
RAM	3KB	6KB	12KB
I/O Port	32		
ADC	12bit SA-ADC x 12ch RC-ADC x 2ch		
Comparator	2ch		
Serial I/F	I2C (Master) x 2 SPI (master/slave) x 2 UART (Full Duplex Asynchronous) x 2		
Timer	8bit timer x 8 or 16bit timer x 4		
	16bit timer with PWM x 4		
	WDT x 1		
External Interrupt	8ch		
Voltage Level Supervisor	16 level x 1ch		
Power ON Reset	yes		
Clock / Low frequency	External Crystal (32.768kHz) Internal RC Oscillator (32kHz)		
Clock / High frequency	External Crystal (upto 16MHz) Internal RC Oscillator (16MHz)		
Operating voltage	1.8V ~ 5.5V		
Operating temperature	-40°C ~ +85°C		
Power consumption	Stop mode : 200nA		
	Halt mode : 300nA		
	Operating mode : <250uA/MHz		
Package	48TQFP, Die		

ML610100 Series

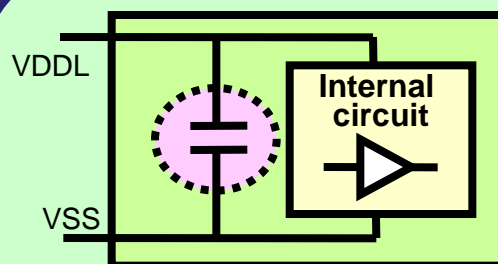
High Noise Immunity



ML610100 Series Key Features

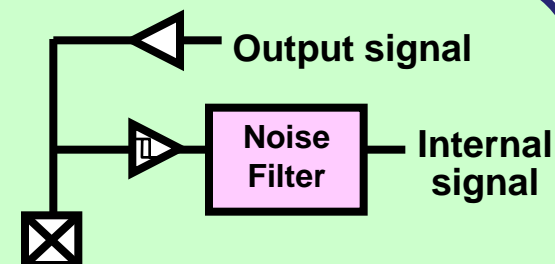
High noise immunity

- In the noise examination of IEC61000-4-2, it passes the summit level 4 (± 15 kV).
- Various noise environment-ization included in a power supply, an input signal, etc. also prevents malfunction.



Measures of power supply noise

A capacitor is built into the inside of a chip and the power supply variation at the time of operation is controlled simultaneously with power supply stabilization.



Measures of the signal-to-noise

Since the noise filter has been arranged appropriately, noise invasion inside is prevented.

Small package equipped with a variety of peripheral circuits

- Ideal for ultra-compact module.
- By internal high precision and highly efficient parts, external part reduction is possible.
- Flexibility is high and MCU-izing of a peripheral part is easy.



SSOP16



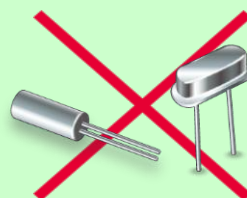
LQFP32



TSSOP20

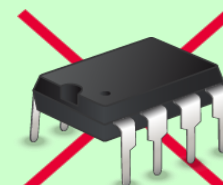
Small Package

Reduction of the mounting area is possible.



Internal high-accuracy oscillator

Reduction of external crystal is possible.



EEPROM

Internal Data Flash

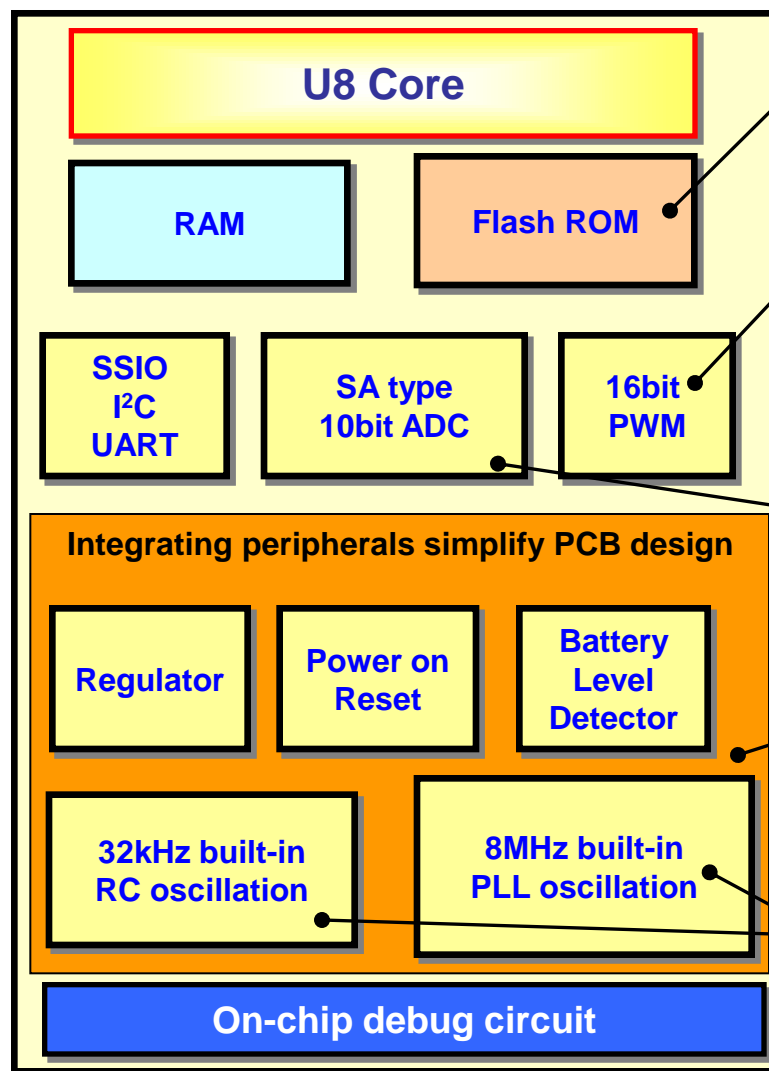
Reduction of external EEPROM is possible

ML610100 Series Overview

■ Small package and Single power supply to reduce system cost.

ML610100 series
operate only 5V and
integrate PCB
peripherals ...

- ✓ Regulators
- ✓ Power on Reset
- ✓ RC/PLL Oscillation
- ✓ No Extra Voltage input



No external Vpp

For write/erase, NO external Vpp input is required.

16bit PWM for 5V application

Motor control, home appliance and lighting etc.

High accuracy A/D converter w/ 16ch

10bit successive approximation type A/D converter built-in with 16ch input

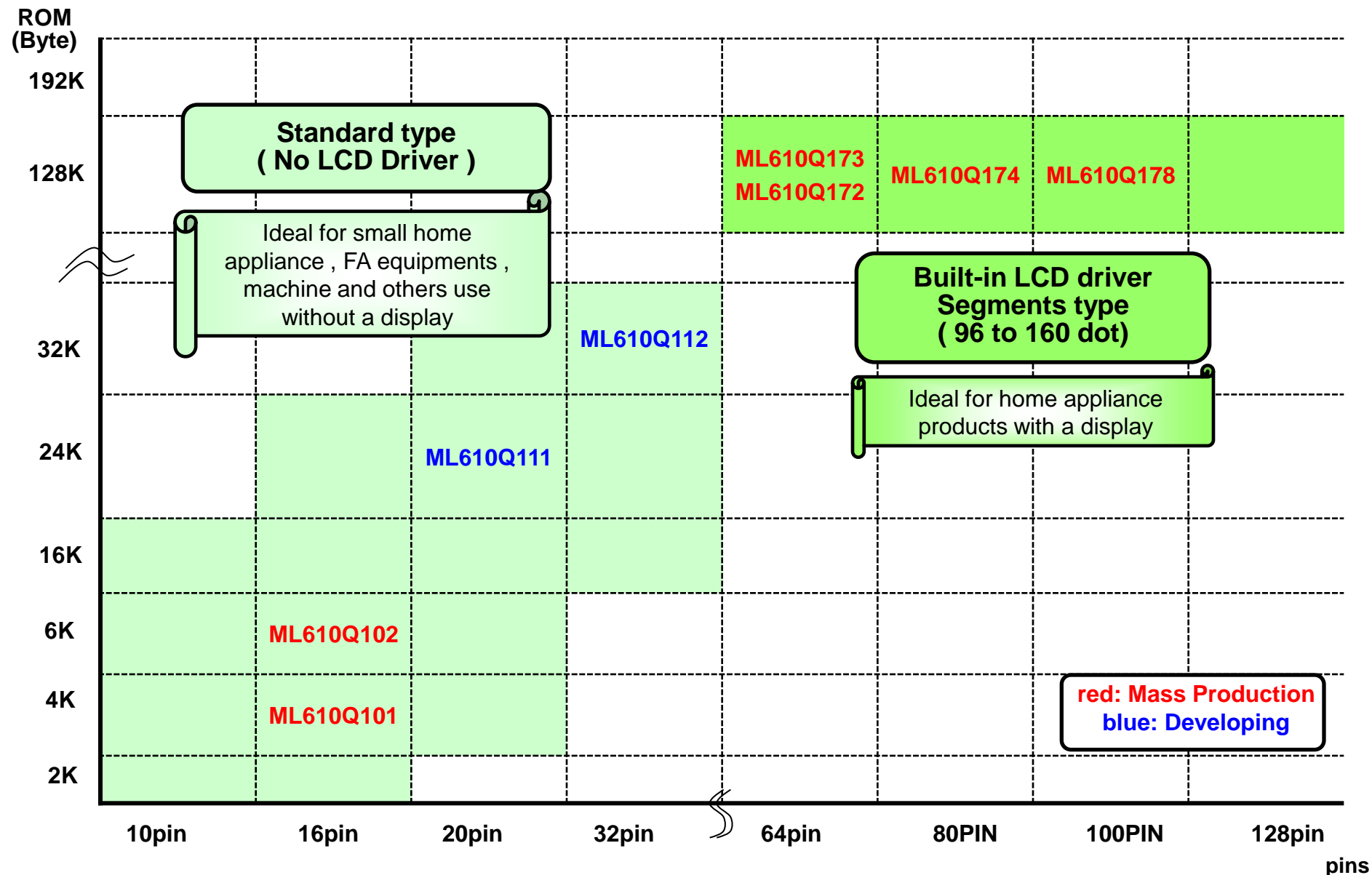
Peripherals on PCB integration

Regulator, POR, BLD, etc are on-Chip to reduce system cost.

Built-in Clock Gen.

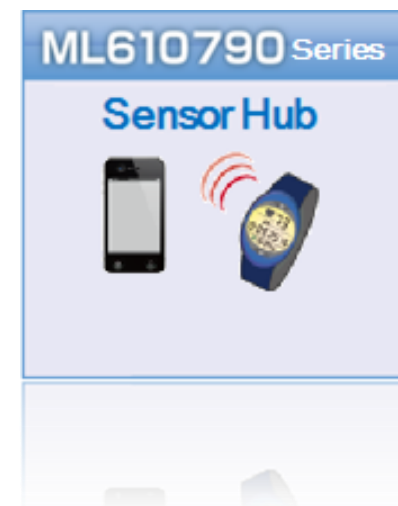
RC oscillation and PLL generate 32kHz and 8MHz clock internally.

ML610100 Series Lineup (ROM size & pin number)



ML610790 Series

Sensor Hub



ML610790 Series Key Features



Highly Optimized Sensor Hub MCU

- Highly Optimized microcontroller for both smartphones and accessories
- WL-CSP and 48pin TQFP are supported

Useful Software development Kit

- Reference board with multiple sensors
- Software : sensor control and data logging
- Algorithm : “pedometer”, “calorie calculation” and “activity detection”

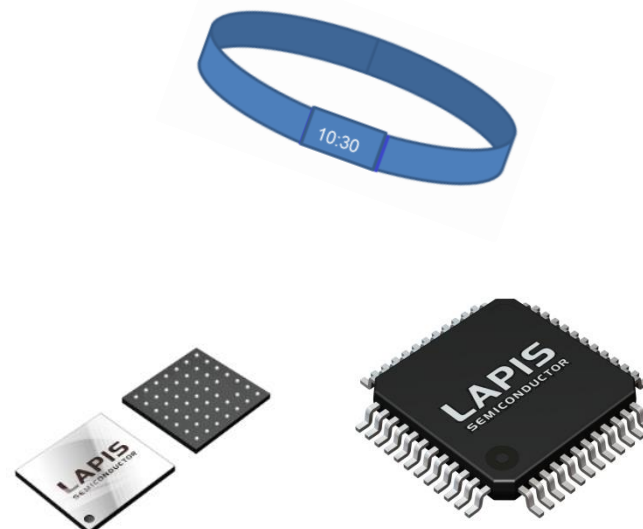
ML610790 Series Key Features

Smartphone



- ✓ Highly optimized hardware fit in smartphone system
- ✓ 8bit and 32bit micros are selectable
- ✓ WL-CSP

Wearable Device



- ✓ Highly optimized hardware fit in smartphone system
- ✓ Long battery life
- ✓ WL-CSP and 48pin QFP are selectable

Sensor Hub MCU Product Roadmap

Smartphone

NOW
ML610Q793

- U8@4MHz
- Flash:64kB
- RAM:4kB
- 48pin WL-CSP(3.1x3.0mm)

Under development
ES:Feb-2014

ML630Q790

- Cortex-M0 @32MHz
- Flash:128kB
- RAM:16kB
- 20pin WL-CSP(2.1x1.8mm)

Under planning

ML630Q79x

- Cortex-M0+ @32MHz
- Flash:192kB
- RAM:24kB
- 12bit-ADC
- Capacitive touch key
- 28pin WL-CSP

The ML630Q79x supports ;
-Capacitive touch key
-12bit ADC for analog output sensors

NOW
ML610Q794G

- U8@4MHz
- Flash:64kB
- RAM:4kB
- IrDA
- 48pin TQFP

The ML630Q790 supports ;
- Geomagnetic sensor's auto offset adjustment
- Self-contained navigation
- Specialized digital I/F sensors

Wearable Device

2013

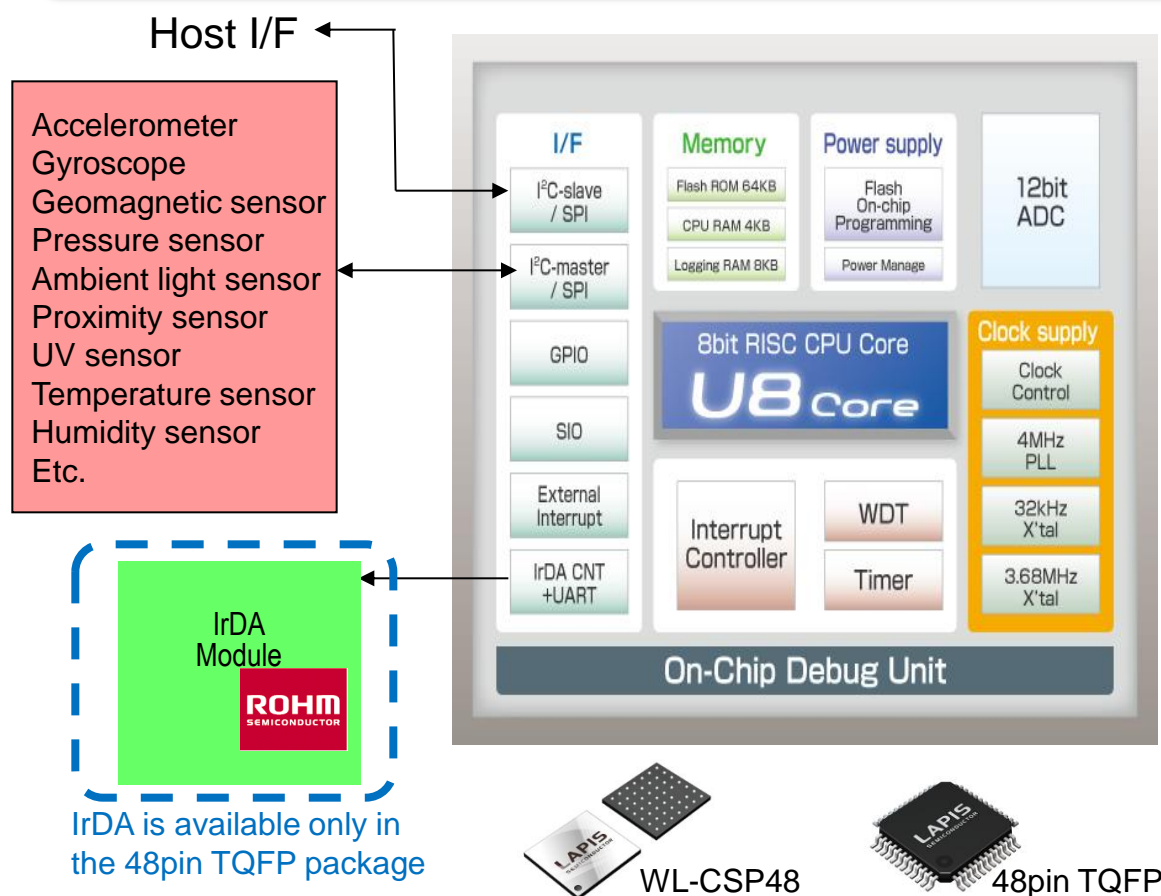
2014

2015

ML610Q793/Q794G Overview

Highly optimized sensor hub solution for both smartphones and accessories such as wearable devices;

- WL-CSP(ML610Q793) and 48pin TQFP(ML610Q794G) are available
- MP : Now



Term		Specification
CPU		U8 (8bit RISC CPU Core)
Power Supply		I/F : 1.65V - 3.6V Digital : 1.7 - 1.9V Analog : 2.5V - 3.6V
Operating Frequency		4MHz (3.68MHz : using IrDA)
Flash ROM		64kB
CPU RAM		4kB
Logging RAM		8kB
Accelerator		16bit Multiply & Division / Multiply & Accumulation / Square Root
Host I/F		SPI (2MHz) / I2C
Sensor I/F		I2C x 1, SPI x 1 UART(FIFO) + IrDA(SIR) x 1
IDD	4MHz	950uA
	Halt	0.7uA
Package		0.4mm pitch WCSP 3.1x3.0mm 48PIN TQFP 0.5mm pitch

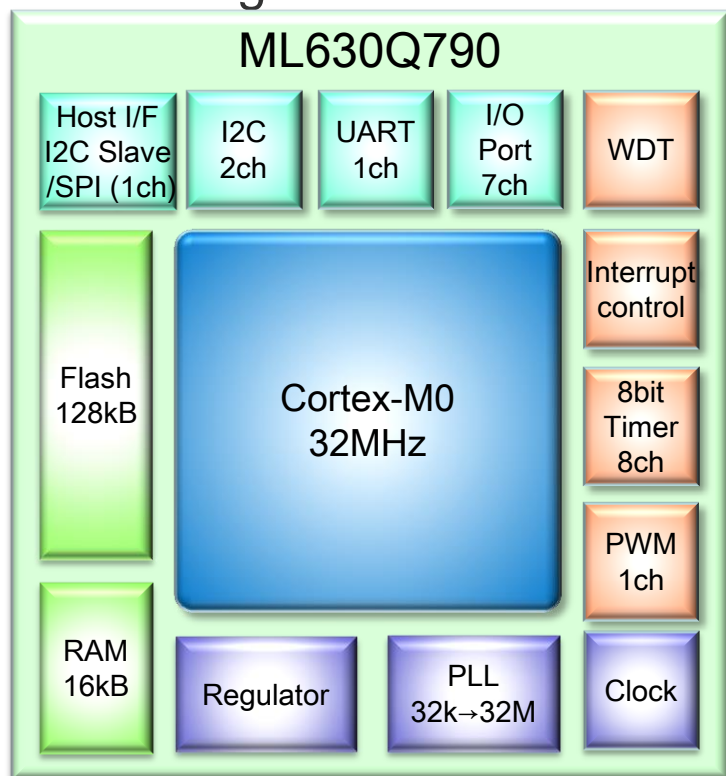
ML630Q790 Overview

Under Development

Cortex-M0 @32MHz supports more features on sensor hub ;

- 1.8V single power supply
- 2.1 x 1.8 mm WL-CSP
- ES : Feb-2014

Block Diagram



Part No.		ML630Q790
CPU		Cortex-M0 32MHz
Flash ROM		128KB
RAM		16KB
Host I/F(Slave)		I2C or SPI (FIFO内蔵)
Serial I/F(Master)		I2C x 2ch, UART x 1ch
Timer		8bit x 8(16bit x 4)
		PWM x 1, WDT x 1
Arithmetic circuit		multiplier, divider, root operation
IO Port		7
Interrupt (external)		7
12bitAD converter		None
Operation Frequency	High	32MHz(Generate by PLL)
	Low	32kHz
Operation voltage		1.7V~1.9V
Temperature		-40 °C ~ 80 °C
Power consumption (Typ.)	HALT	2uA (TBD)
	RUN@32MHz	6mA(TBD)
Package		20pin WCSP 0.4mm pitch(2.1 x 1.8mm)

Software Development Kit (SDK)

Reference board using multiple sensors, sensor control software and algorithm are supported

➤ **Sensor control software *1**

- Software for controlling multiple sensors such as driver is supported.

➤ **Data logging software *1**

- Output from multiple sensors are monitored, pre-calculated and stored.

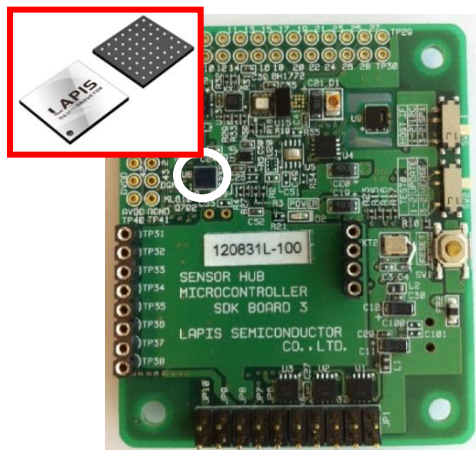
➤ **algorithm such as “pedometer”, “calorie calculation” and “activity detection” *1, *2**

- Activity detection : detecting “stop/walk/run/car/train”

- Pedometer/Calorie calculation : calculating by using accelerometer

*1 NOTE : All software is for reference purpose, and needs validation/qualification by customer for usage in customer’s final product.

*2 NOTE : algorithm requires the license agreement



ML610Q793 reference board

Sensor

Accelerometer

Ambient

Proximity

Hall IC

Temp. & Humidity

Barometer

Geomagnetic

Gyroscope

UV

Sensor Support

Sensor Control		Sensor P/N	Driver & Sample Application
	Accelerometer	KXTF9/KX022(Kionix) BMA250E(Bosch), LIS2DH(STMicro)	Read, Calibration
	Ambient sensor	BH1772(ROHM)	Read, Interrupt
	Proximity	BH1772(ROHM)	Read, Interrupt
	Hall IC	BU52021HFV(ROHM)	Bi-Polar Interrupt
	Temperature & Humidity sensor	SHT20(SENSIRION)	Read, Interrupt
	Barometer sensor	BMP180/280(Bosch) T5400(TDK-EPC)	Read, Altitude calculation
	Geomagnetic sensor	AKE(AK8975)	Read, Interrupt except offset adjustment
	Gyroscope	L3G4200D(ST Micro)	Read, Calibration,
	UV Sensor	ML8511(LAPIS)	Read, UV index calculation, Interrupt
	Capacitive Sensor	BU21077MUV(ROHM)	[under developing] Read, Interrupt
Application			
	Motion detection	Using Accelerometer	Motion detection, Direction detection (up/down, face up/face down), Shake, G detection
	Pedometer	Using Accelerometer	Pedometer
	Activity detection	Using Accelerometer	walk/run/stop/car/train can be detected
	Calorie Calculation	Using Accelerometer, Pressure sensor	Calorie calculation (walking up/down stairs, bicycle etc.)
	Grip detection	Using Accelerometer, capacitive sensor	[under developing] grip detection with certain angle
Android Interface			
	Android Interface	-	Pseudo direct access to various sensors

ML610300 Series

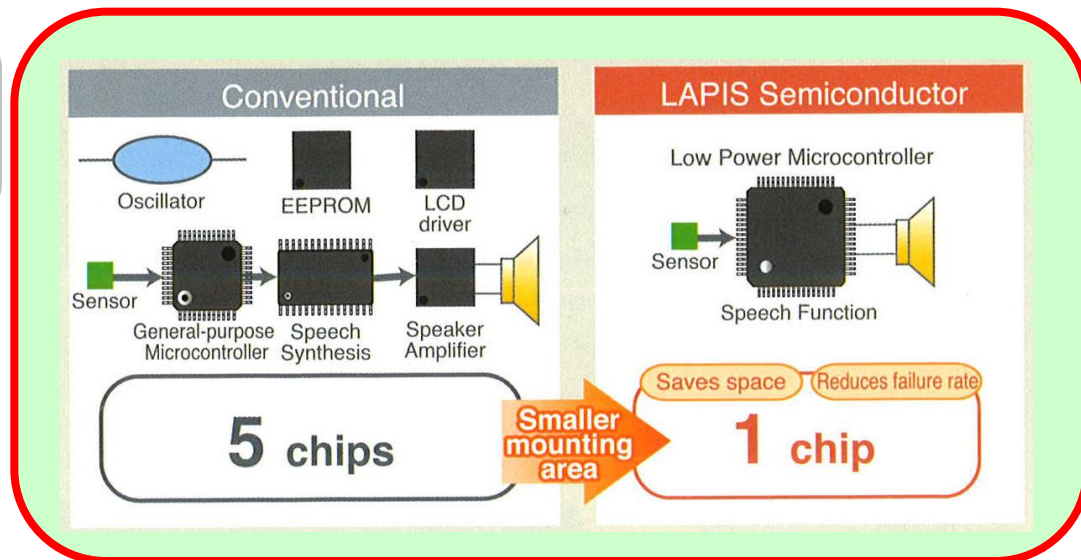
Built-in Speech Function



ML610300 Series Features

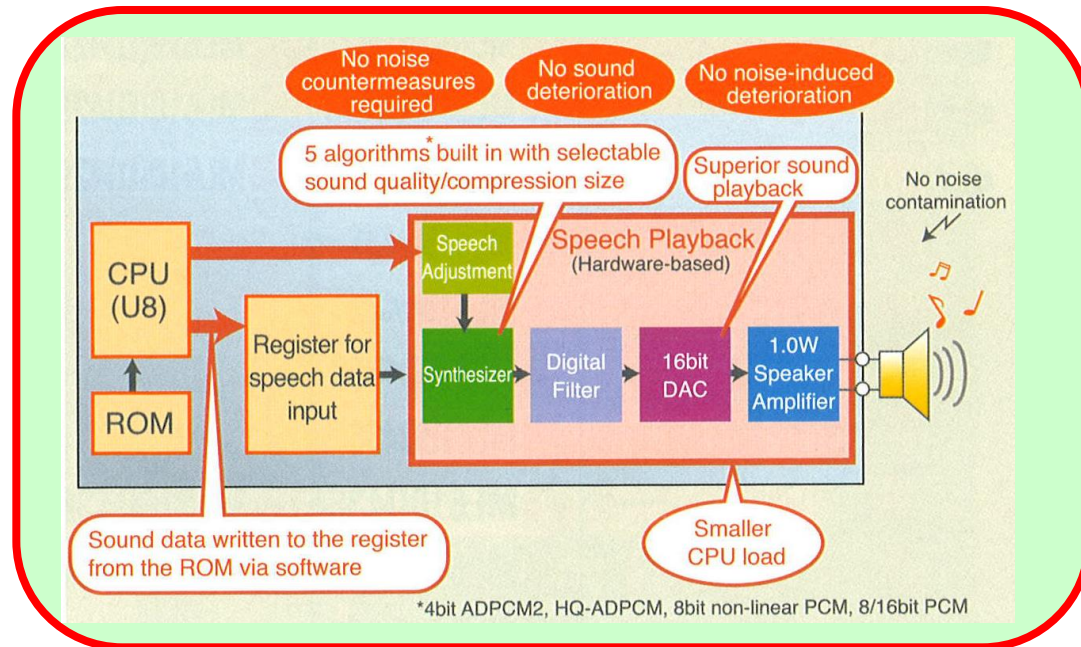
Reduce the peripherals, space saving and improve the reliability

- Built-in from the Speech engine to Speaker amplifier
- The peripherals are very less, that realize down-sizing and reduce the failure rate



High-quality speech and effect sound by exclusive hardware

- Sound function is realized by the Hardware
- Unnecessary troublesome analog and pattern designing, and minimizing sound quality dropping, noise mixing, noise emitting



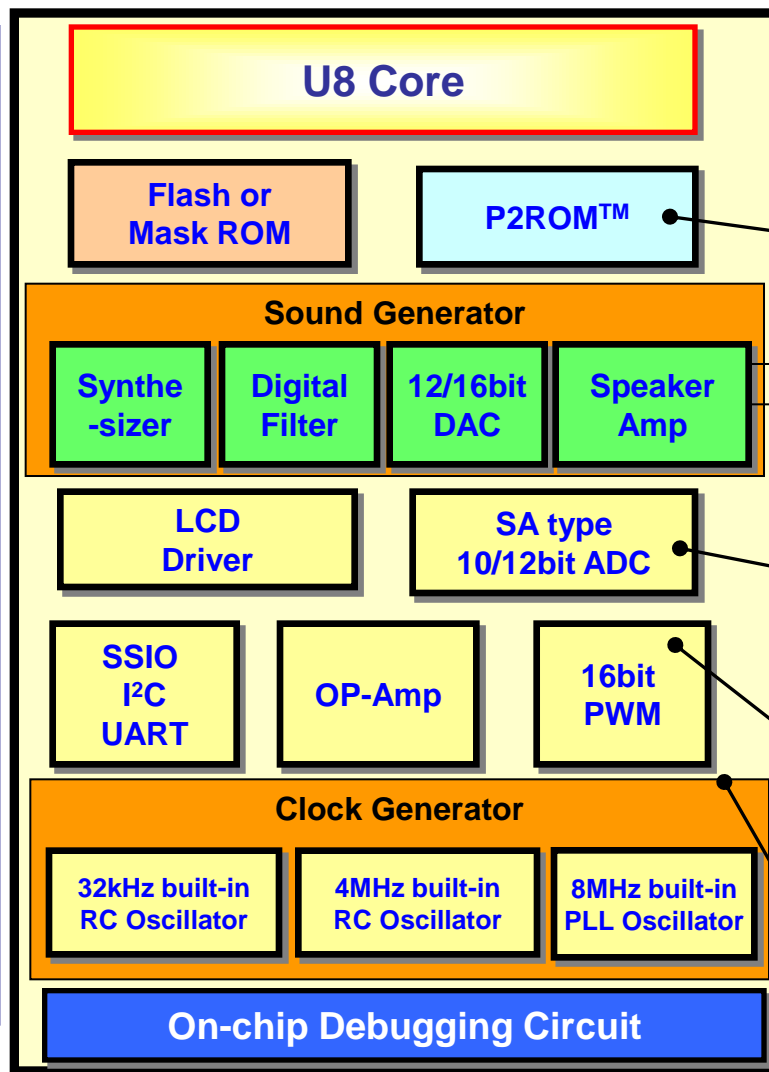
ML610300 Series Overview

■ All the hardware for sound is built-in, multi function and high sound quality

High quality and

High power speech sound

- ✓ 12/16bit DAC
- ✓ 1W Speaker Amp.
- ✓ Filter for high frequency noise reduction
- ✓ HQ-ADPCM
High compression and High quality sound algorithm



Max. 16Mbit ROM for speech data

Besides the program ROM
About 10 min. playback is available

Speaker

Max.8ch SA type ADC

Useful for sensor device of voltage IF

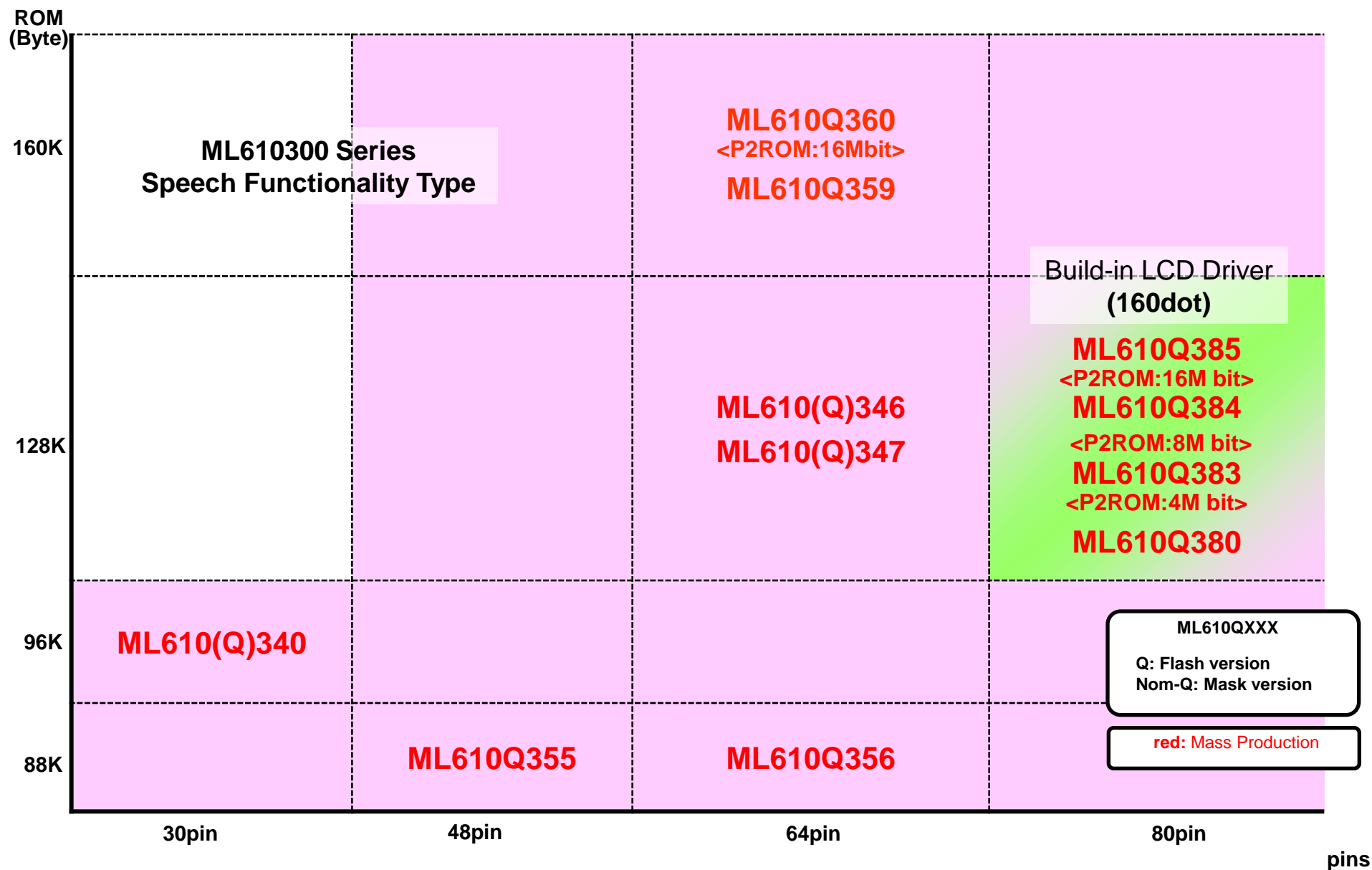
The PWM optimal for inverter control

Ideal for control of IGBT etc.

Various built-in clock

External clock is not necessary

ML610300 Series Lineup

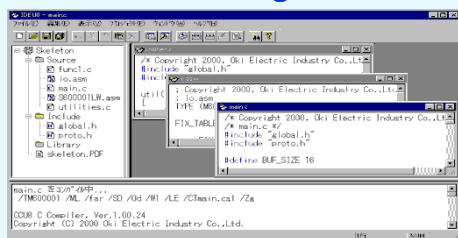


Development Tools & Support

Software Development System Overview

- LAPIS Semiconductor's Tools support all development stage at Customer to develop the software running on U8/U16 MCUs.

Coding



Integrated Development Environment

```

/* API */
/*#####*/
****/
int main( void )
{
    /* Main initialize. ****/
    /* Variable ****/
    gCntTimer = 0;
    _mode = (unsigned char)MODE_INIT;
    _reqNotHalt = (unsigned char)FLG_SET;
    /* Peripheral ****/
    InitPer();
    /* Start ****/

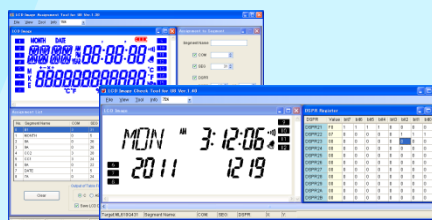
```

Sample Peripheral Driver

Debugging

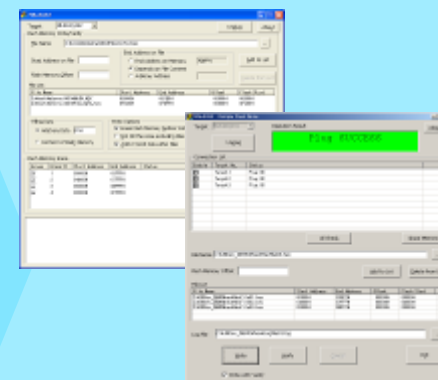


Build tool , Debug tool



LCD Image Tool

Flash programming



Flash programming tool



High performance In Circuit emulator Dr.U8ICE for ML610xxx



Demo board



Reference board



On-chip Debug Emulator
uEASE

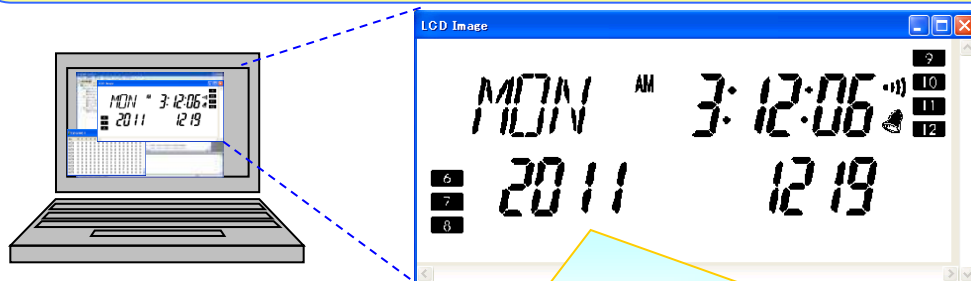


Software Development System Features

<LCD Image Tool>

LCD image tool enables to confirm display images on PC

Prior confirmation of LCD segments assignments and layouts without LCD panel.



The product image is reproduced by the image data of the LCD panel was designed for every products

<On-chip Debug Emulator uEASE>

Independent Debug I/F on MCU

No restriction on memory access, I/O access and etc.



uEASE System Configuration On-board debug & Programming

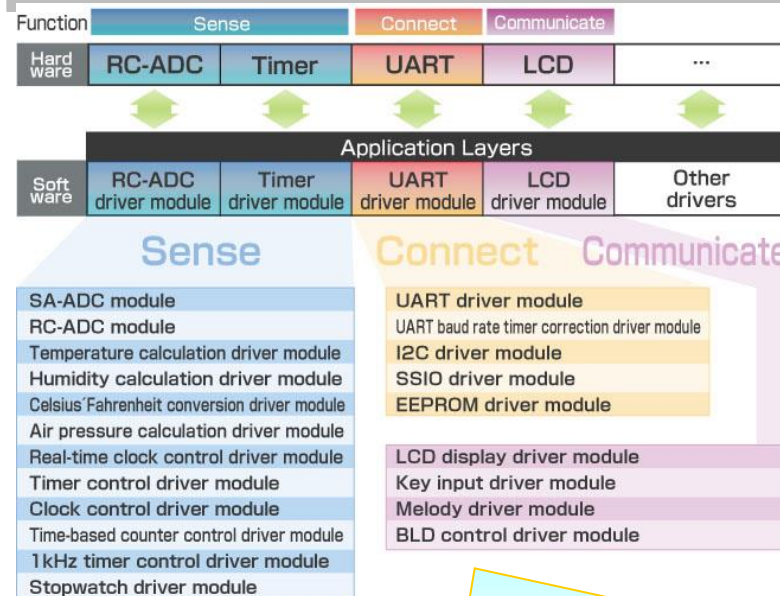
<Demo Kit>

Verify the functions of ML610400s by the Sample Peripheral Drivers

Sample Peripheral Drivers run on Demo board

Composition of Demo Kit

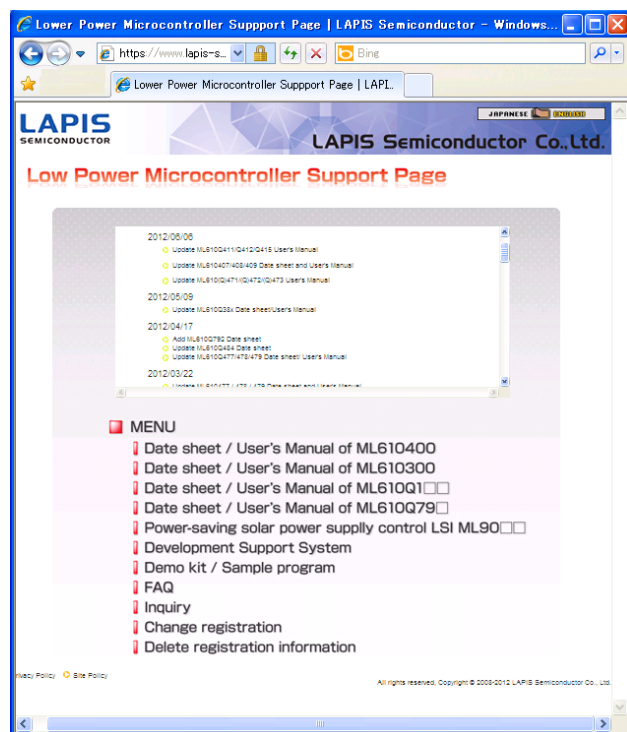
- ML610400 Demo board
- CD-ROM
- (Sample Peripheral Drivers, documents)



Sample Peripheral Drivers are modularized, so that allows customers to integrate only the modules needed.

Customer Support Page

- LAPIS Semiconductor provides latest information on a dedicated Web site for registered users.
- Registered users receive the following benefits:
 - ✓ Downloading latest data sheet/users manuals including preliminary version.
 - ✓ Downloading latest software tools.
 - ✓ Receiving e-mail regarding product update information from LAPIS Semiconductor
- We continue to upgrade the contents.

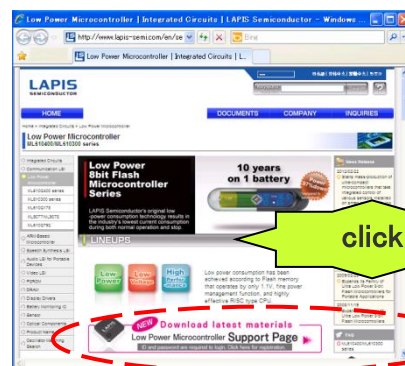


LAPIS Semiconductor Low power microcontroller support page

To access to the support page, users are required to register for obtaining an ID and password. Open the support page from the LAPIS Semiconductor's Web site or enter the following URL and click [New Registration] button.

Support page URL

<https://www.lapis-semi.com/customer/lpmcu/login.html>



LAPIS Semiconductor's Web site



Support page's login screen

World-wide Customer Support



Comprehensive World-Wide customer support System



For customer support,
contact the sales staff
closest to your area





**Thank you and we appreciate
your consideration.**

*your consideration.
Thank you and we appreciate*