

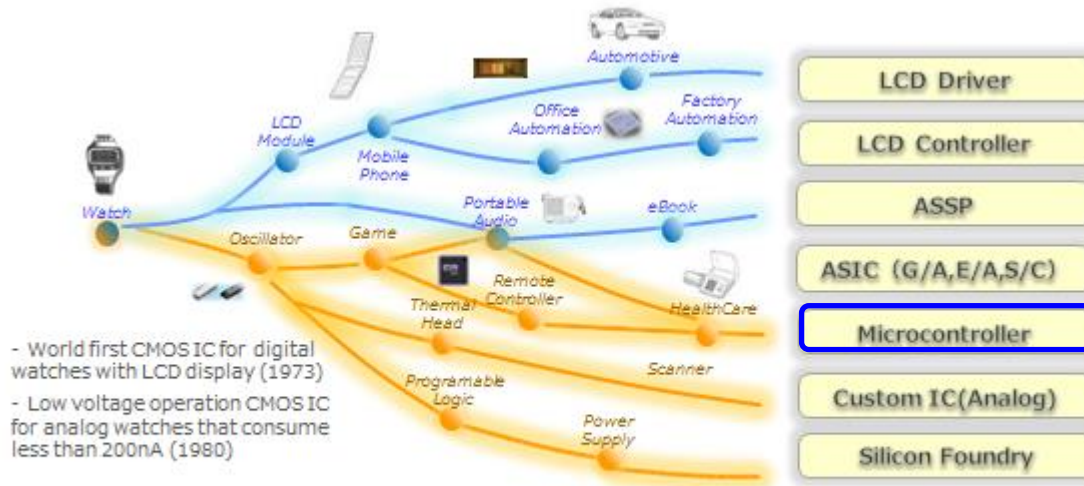
# Dedicated Microcontroller for Digital Multimeter

April 2022



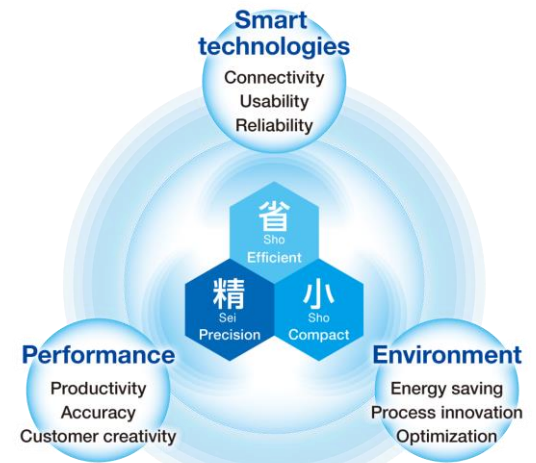
Our MCU was originally developed for Seiko watches and expanded to other applications. We have been developing MCU for over 40 years based on Epson's energy-saving technology. Our MCU's are used for various applications like healthcare devices, home appliances, remote controllers, industrial and security products.

We believe Epson can be a good partner of your projects.



- World first CMOS IC for digital watches with LCD display (1973)
- Low voltage operation CMOS IC for analog watches that consume less than 200nA (1980)

**Energy-Saving Technology** ; Technology that reduces power consumption from both sides of process and circuit have been nurtured by Epson over 40 years since division was founded.



**Value generated by Epson's efficient, compact and precision technologies**



## – Core Line-up

### Epson 16-bit CPU

S1C17 Family

- Low power consumption
- Wide voltage range from 1.2V to 5.5V
- Int. LCD / LED / EPD driver

### Arm® Cortex® –M0+

S1C31 Family

- Low power consumption
- High Performance
- Support 5V operation
- Large capacity Flash memory
- Unique peripherals with MDC / Voice

## – Application example

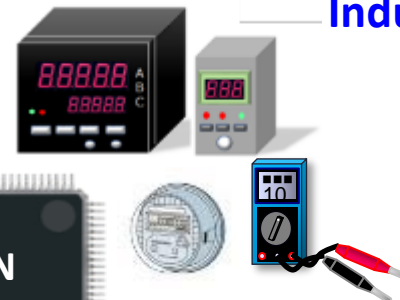
### Consumer products

Watch, Clock  
Remote controller  
Label writer  
White goods



### Industrial products (FA)

Time switch  
Thermostat  
Temperature monitor  
**Digital Multimeter**  
HCA  
Heat meter



### Healthcare / Medical

Pedometer  
Active monitor  
Thermometer  
Insulin pen



### Security products

Smart card  
E-Token  
Card reader  
Logistics Tag



## DMM = Digital Multimeter

DMM is a tool to measure and verify multiple electrical parameters such as voltage, current, resistance, capacitance and so on...

### Note about "display"

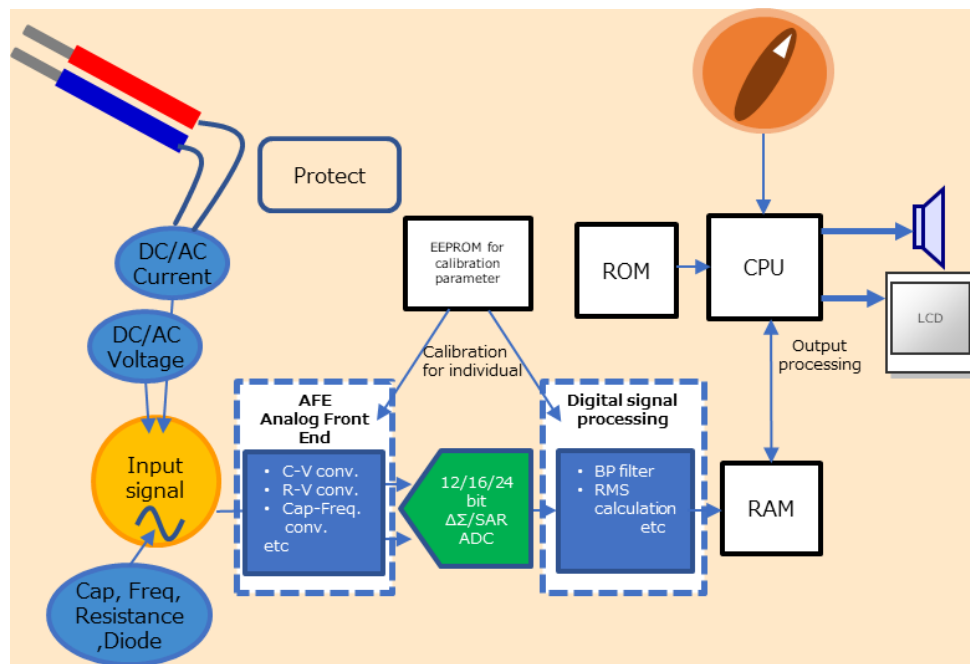
If the most significant digit cannot take all value from 0-9, it is termed a fractional digit.

Ex.) Multimeter which can read up to 1,999 count is said to read 3½ digit.

Up to 4,000 = 3½ digit

Up to 6,000 = 3½ digit

Up to 60,000 = 4½ digit

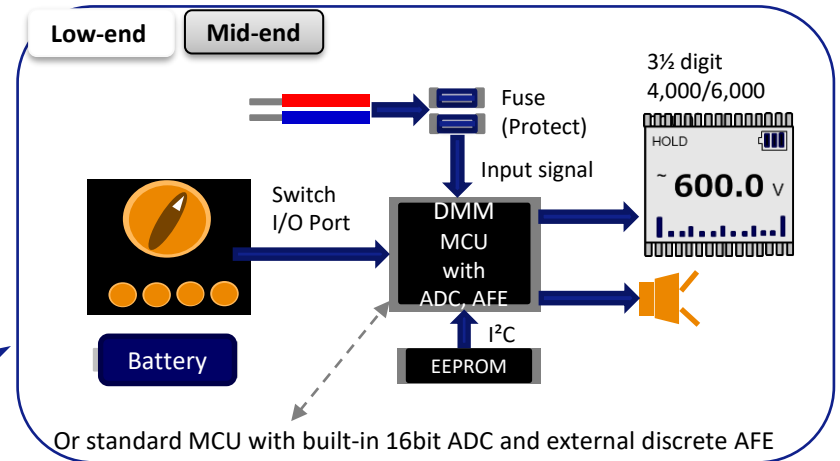
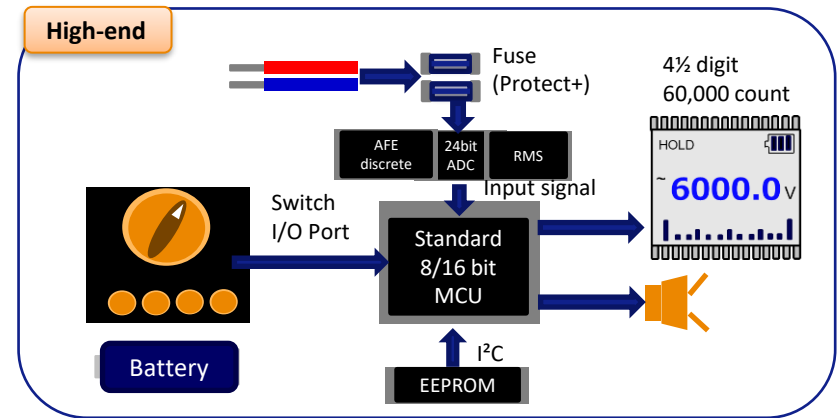
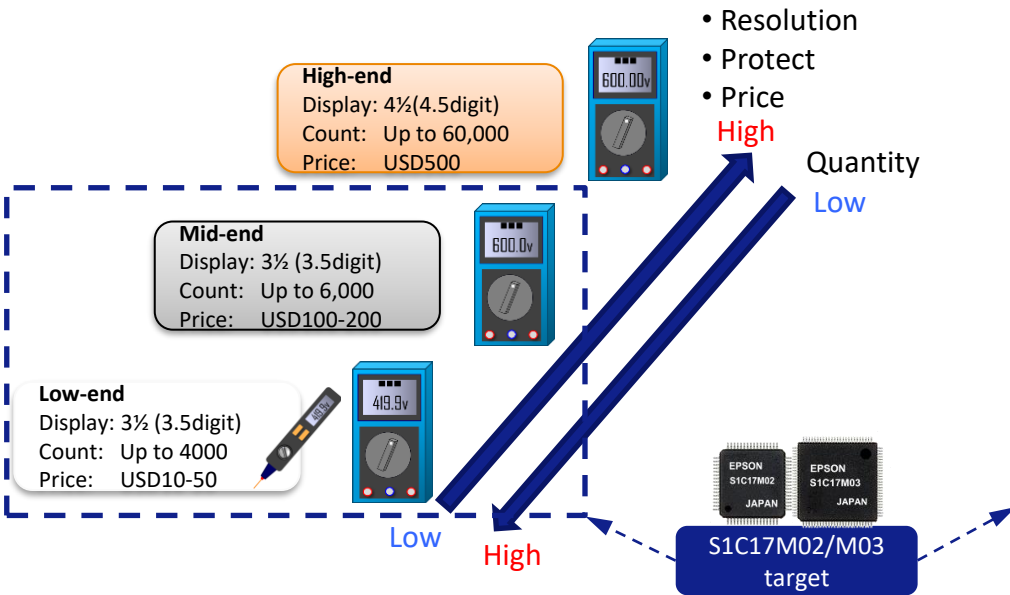


S1C17M02/M03 target

Type	Product	Display, Count (generally)	Price image	Use
Handheld		Display: 3½ - 4½ digit Count: 1,999 - 60,000	\$10.0 - \$500.0	Field test Maintenance Development
Benchtop		Display: 5½ - 8½ digit Count: 199,999 - xxx,xxx,xxx	\$1,000 - \$2,000	Laboratory Development



- ▶ **High-end DMMs** consist of a standard MCU and external discrete parts
- ▶ **Low/Mid-end DMMs** consist of single chip DMM MCU with built-in ADC, AFE



## Arm® Cortex®—M0+ S1C31 Family

- Low power
- High Performance **up to 32MHz**
- **5V operation**
- Large memory
- Unique peripherals

### S1C31W series “LCD driver”

#### S1C31W74

Flash:512KB  
LCD: 80x16/72x32  
Max.20MHz  
(Up to 3.6V)

#### S1C31W73

Flash:384KB  
LCD: 96x16/80x32  
Max.32MHz

#### S1C31W65

Flash:128KB  
LCD: 56x4/52x8  
Max.32MHz

#### S1C31W6-n-aes

Flash:128KB  
LCD: 44x16 / 48x8  
NFC, AES  
Max.32MHz

#### S1C31W7-b

Flash:128KB  
LCD: 56x4 / 52x8  
NFC, AES  
Max.32MHz

### S1C31D series “Unique HMI”

#### S1D13C00

Memory disp. I/F  
2D Graphic  
EPD

#### S1C31D01

Flash:256KB  
Memory disp. I/F  
2D Graphic  
Max.20MHz

#### S1C31D50

Flash:192KB  
Voice & Audio speaker  
Max.20MHz

#### S1C31D51

#### S1C31D41

Flash:96KB  
Voice & Audio speaker/buzzer  
Max.16MHz

#### S1C31D6-a

Flash:512KB  
Voice  
Max.32MHz

#### S1C312-n-aes

Flash:64KB  
NFC, AES, RSA  
Max. 32MHz

#### S1C312-a

Flash:64KB  
DTCXO  
Max. 32MHz

#### S1C312-b

Flash:32KB  
LED dr.5x8  
Max. 32MHz

### S1C312 series “Small pin”

## Epson 16-bit CPU S1C17 Family

- Low power
- Wide voltage operation
- LCD / LED / EPD driver

### S1C17M series “5V operation”

#### S1C17W3 Group

Flash:128KB-384KB  
LCD: 80x16/72x24/64x32

#### S1C17W2 Group

Flash:64KB-96KB  
LCD: 72x8/64x16/56x24

#### S1C17W1 Group

Flash:32KB-128KB  
LCD: 26x4-60x4/56x8

#### S1C17W0 Group

Flash:16KB-32KB  
32-48 small pin PKG

### S1C17W series “Low power”

#### S1C17M2 Group

Flash:16KB-32KB  
Max.16MHz  
24-48 small pin PKG

#### S1C17M1 Group

Flash:16KB-32KB  
LED dr.  
Max.16MHz

#### S1C17M4 Group

Flash:48KB  
LCD: 28x4-40x4/24x8-36x8  
EEPROM  
Max.16MHz ±1% high accuracy

#### S1C17M3 Group

Flash:48KB-96KB  
LCD: 26x4-50x4/22x8-46x8  
Max.16MHz

#### S1C17M0 Group

Flash:32KB-64KB  
LCD: 16x4-32x4  
EEPROM  
16bit ΔΣADC

### S1C17F series “EPD driver”

#### S1C17F63

Flash:32KB  
EEPROM  
EPD: 42segment  
Max.16MHz  
110nA RTC

#### S1C17F57

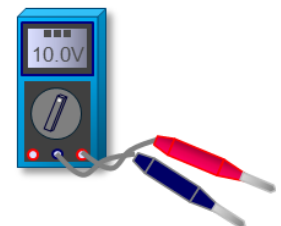
Flash:32KB  
EPD: 64segment  
210nA RTC

- Easy to achieve measurement functions for Digital Multimeter (DMM) by **specific AFE circuit**
  - DC/AC voltage measurement
  - DC/AC current measurement
  - Resistance measurement
  - Conduction check
  - Capacitance, Diode, Frequency measurement
- Integrated memory
  - **Flash ROM 32kB or 64kB** (min.1000 times) with self-programming function
  - **EEPROM 256B (2kbit;** min. 100.000 times)
- Long battery lifetime
  - Low current leakage process
  - Low power analog IP
  - Multiple power down mode
- Easy development environment
  - Can be developed in an integrated development environment
  - Can be developed in C language

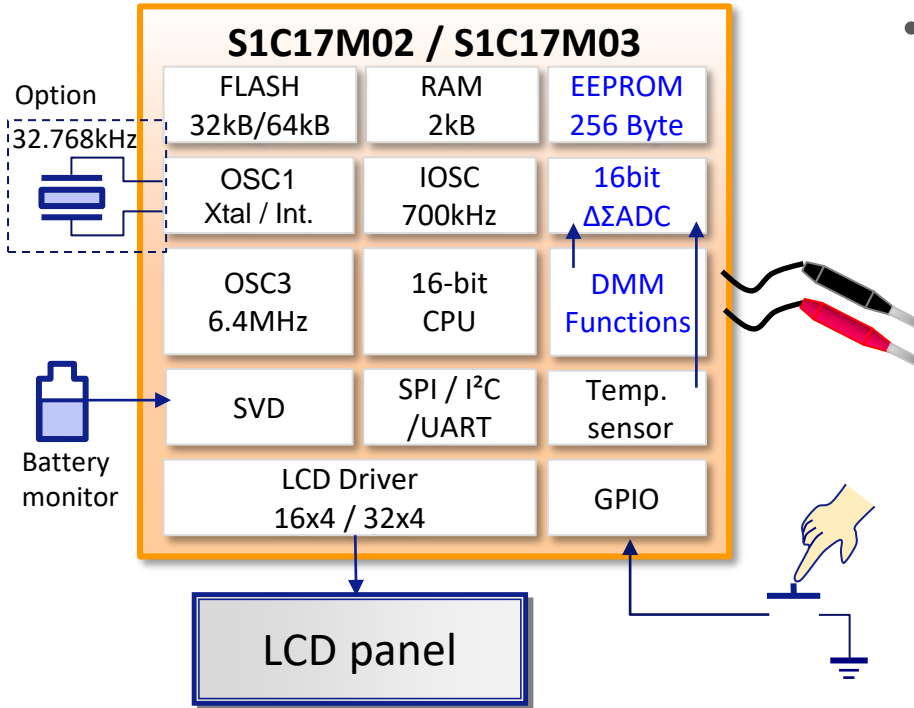
- Supports each measurement mode
- Ext. part reduction (AMP, Analog SW)
- True-RMS support, CPU load reduction by arithmetic circuit

- Rewritable Flash ROM
- Large memory and scalability to support function expansion
- EEPROM for calibration, no ext. part

- Epson unique low power and low leakage process for longer battery life

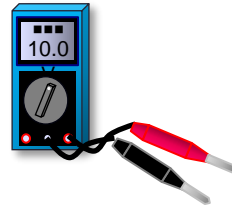


## All-in-One single chip 16-bit RISC core MCU for DMM



### • Features

- Measurement function for DMM
  - ✓ DC/AC voltage
  - ✓ DC/AC current
  - ✓ Resistance / Capacitance / Diode
  - ✓ Frequency / Conduction check
- 16bit  $\Delta\Sigma$ ADC
- Flash ROM 32kB – 64kB
- EEPROM 256 byte
- LCD driver 16x4 – 32x4
- Supply Voltage Detection (SVD)
- Low speed (32kHz) internal oscillator



### • Power Consumption

- SLEEP: 0.24 $\mu$ A (typ.)
- HALT: 1.8 $\mu$ A (typ.)
- RUN (1MHz operation): 129 $\mu$ A (typ.)

### • Shipping forms

- QFP13-64 (P-LQFP064-1010-0.50)
- QFP15-100 (P-LQFP100-1414-0.50)

### • Schedule

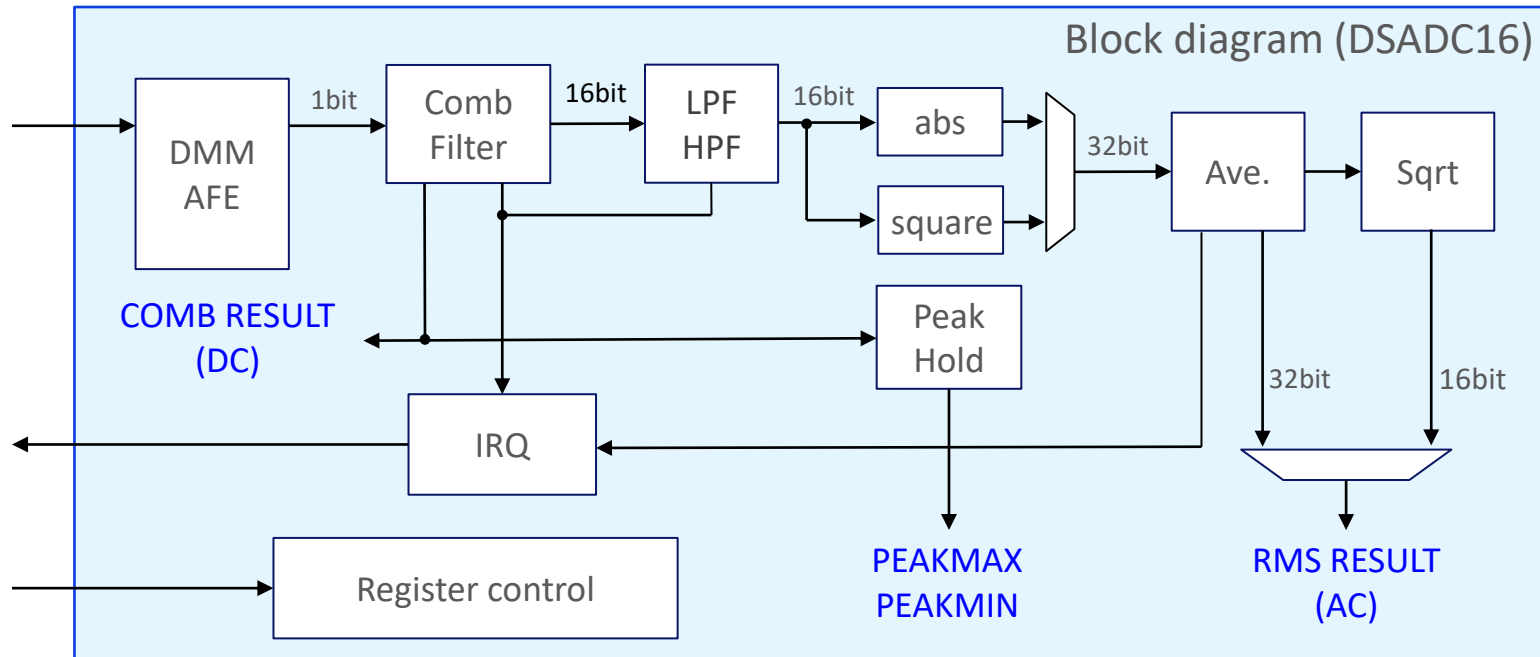
- ES samples: ✓
- Datasheet: Rev.1.0
- Manual: Rev.1.0
- MP: ✓
- SVT17M03: E/May 2022

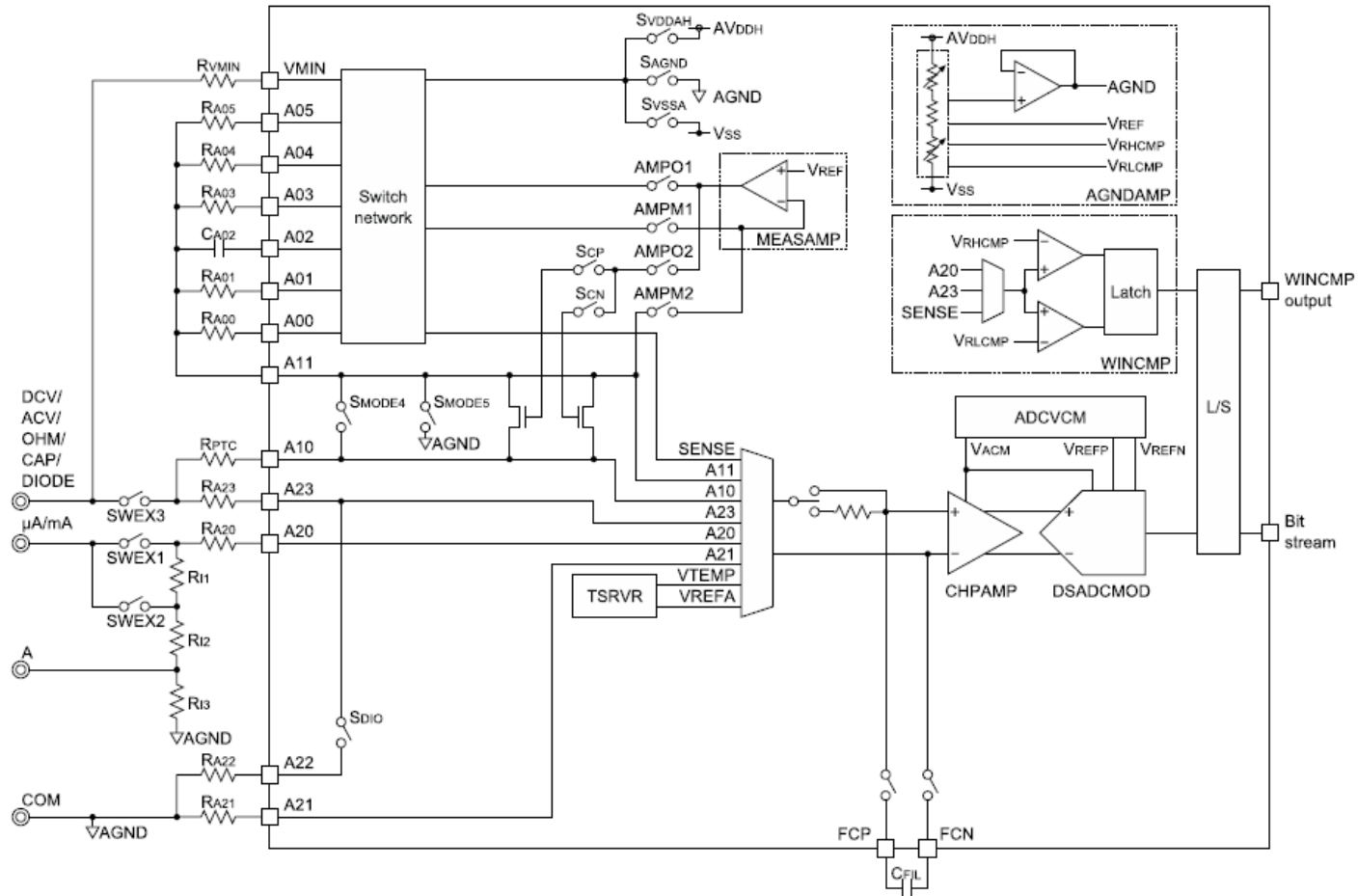


Evaluation board  
SVT17M03



- The MCU offers all circuits required to realize DMM measurement functions. In particular, the averaging circuit is built-in a square root calculation circuit, which makes it possible to calculate the root mean square error (RMS) at high speed.
  - Various DMM measurement modes
  - Built-in digital filter
  - Peak hold function
  - Effective value conversion circuit (square, average absolute value)
  - Square root calculation circuit





DMM AFE



S1C17M02/M03 offers following measurement functions and specification for Digital Multimeter

Temperature: 0 to 50°C  
Operating voltage: VDD=3V

Function	Measurement range	Target Specification <sup>*3</sup>
Display (Count)	-	Up to 6000dgt
DC Voltage (DCV)	600mV/6V/60V/600V/1000V	±0.05%rdg. ±2dgt
AC Voltage (ACV)	600mV/6V/60V/600V/1000V	±0.2%rdg. ±2dgt
DC Current (DCC)	600uA / 6mA / 60mA / 600mA / 6A / 10A	±0.2%rdg. ±2dgt
AC Current (ACC)	600uA / 6mA / 60mA / 600mA / 6A / 10A	±0.6%rdg. ±5dgt
Resistance (OHM)	Current input: <sup>*1</sup> 600Ω/6kΩ/60kΩ/600kΩ/6MΩ/60MΩ Voltage input: <sup>*2</sup> 600Ω/6kΩ/60kΩ	±0.5%rdg. ±1dgt
Capacitance	Current input: <sup>*1</sup> 1uF/10uF/100uF/1000uF Voltage input: <sup>*2</sup> 0.01uF / 0.1uF	±0.9%rdg. ±1dgt
Frequency	5Hz to 100kHz	±0.1%rdg. ±1dgt
Diode	VF = 0.2 to 2.0V correspondence	2.000V±1%rdg
Internal Temperature	-	±4°C (0 to 50°C) ±6°C (-40 to 85°C)

Note) This target specification is a reference value for DMM application which is not specified and guaranteed by S1C17M02/M03

\*1 Method of applying a constant current to a target and measuring the voltage to obtain the result

\*2 Method of applying a constant voltage to a target and measuring the voltage to obtain the result

\*3 Further high precision measurement is possible by adding calibration algorithms



## Evaluation board specification

Measurement mode and range:

- ✓ DCV/ACV: 600mV, 6V, 60V
- ✓ DCI/ACI: 600µA, 6mA, 60mA
- ✓ Resistance: Support all ranges
- ✓ Capacitance: Support all ranges
- ✓ Conduction check, Diode

Measurement result output:

- ✓ LCD display (14Seg x 8-digit)
- ✓ Transfer to PC via USB/SPI I/F
- ✓ Piezoelectric buzzer mounted



Debugger for software development

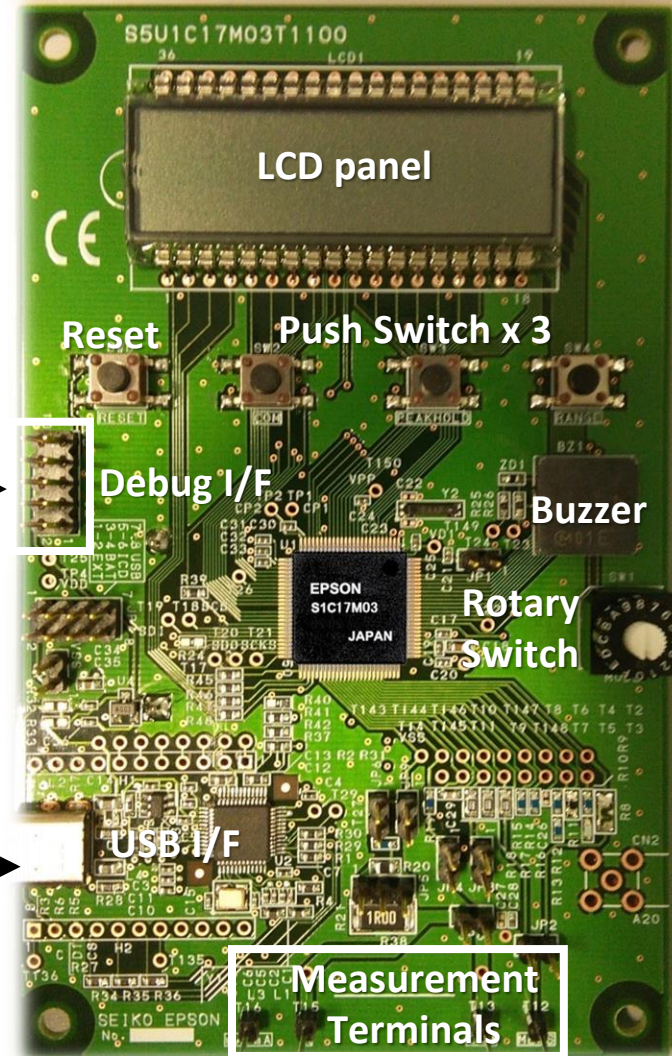


USB interface for characteristic data acquisition

Acquisition of characteristics data / Program development

Power source selection:

- ✓ By CR2032 battery
- ✓ By power generator
- ✓ By debugger



# MCU Specification (1)

Function		S1C17M02	S1C17M03
Core		Epson original 16bit RISC CPU core S1C17	
Memory	Flash ROM	32KB	64KB
	RAM	2KB	
	EEPROM	256B	
Measurement function	DC/AC voltage	Up to 5 ranges, 600mV / 6V / 60V / 600 V / 1000V	
	DC/AC current	Up to 6 ranges, 600uA / 6mA / 60mA / 600mA / 6A / 10A	
	Resistance	Current input: Up to 6 ranges, 600Ω / 6kΩ / 60kΩ / 600kΩ / 6MΩ / 60MΩ Voltage input: Up to 3 ranges, 600Ω / 6KΩ / 60KΩ	
	Conduction check	Supported	
	Capacitance	Current input: Up to 4 ranges, 1uF / 10uF / 100uF / 1000uF Voltage input: Up to 2 ranges, 0.01uF / 0.1uF	
	Diode	VF = 2.0V correspondence	
	Frequency	Counter measurement: Up to 4 ranges, 100Hz / 1kHz / 10kHz / 100kHz	
A/D converter		Sigma-delta type 16bit, Built-in peak hold circuit Built-in digital filter, RMS circuit Square root calculation circuit	
LCD driver		16seg x 4com	32seg x 4com

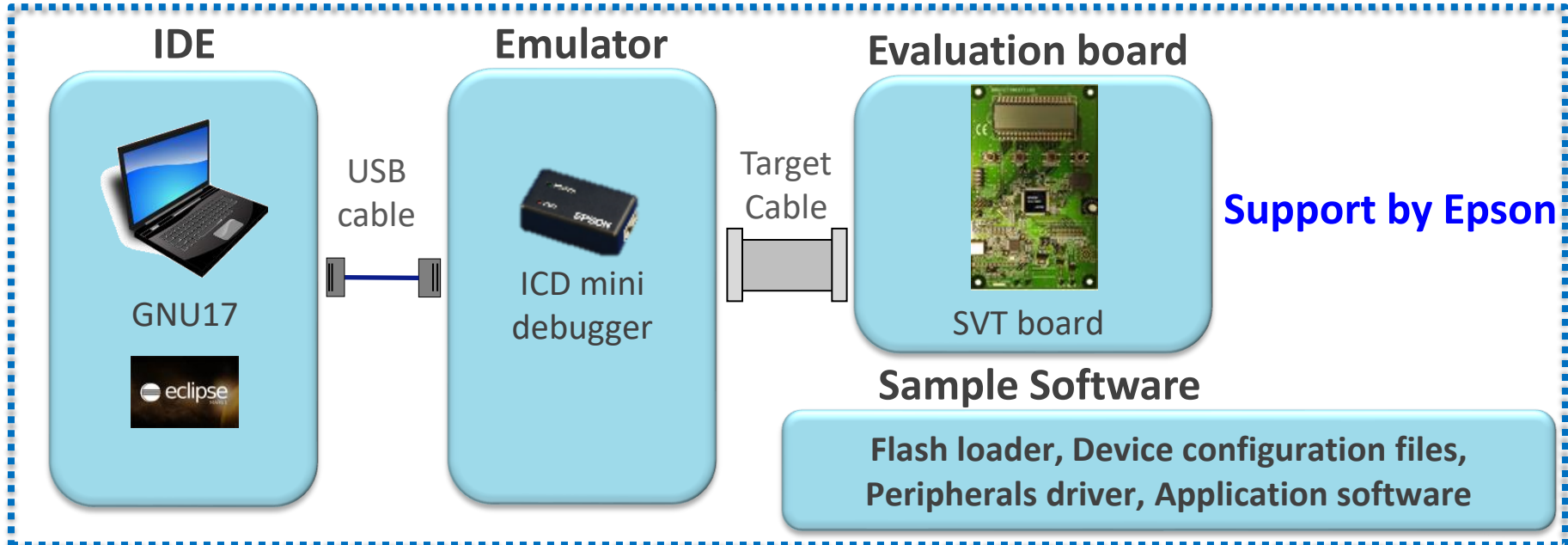
# MCU Specification (2)

Function		S1C17M02	S1C17M03
Clock generator	IOSC	700kHz internal	
	OSC1	32kHz internal 32.768kHz external crystal	
	OSC3	3.2M or 6.4MHz internal	
	EXOSC	Max. 6.4MHz	
I/O port		Max.16bit	Max.40bit
Timer	Watchdog	Yes	
	RTC	-	
	16bit	4ch	
	16bit PWM	-	
Supply Voltage Detector(SVD)		19 levels (1.7 to 3.6V)	
Serial interface	UART	1ch	
	SPI	1ch	
	I2C	1ch	
Operation voltage		2.1 to 3.6V <sup>*1</sup>	
Operation temperature		-40 to 85 degree	
Shipment		QFP13-64 <sup>*2</sup>	QFP15-100 <sup>*3</sup>

\*1 During operating an analog circuit, erasing/programming in flash memory, EEPROM programming: 2.2~3.6V

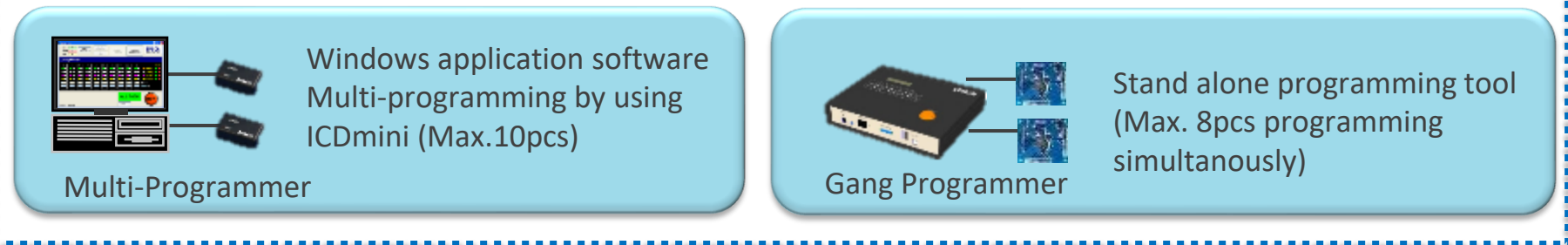
\*2 QFP13-64: P-LQFP064-1010-0.50, \*3 QFP15-100: P-LQFP100-1414-0.50

## – Development environment



## – Production tools

Support by Epson



# EPSON

EXCEED YOUR VISION

## Thank you!!

### *Exceed Your Vision*

*Epson always tries to offer products and services that exceed your expectations and thoughts and help you create colorful and affluent life.*





# Comparison Table

		Company A	Company B	Company C	<b>EPSON S1C17M02/M03</b>	
CPU		8bit	8bit	<b>16bit</b>	<b>16bit</b>	High performance C-lang. develop
ROM (Byte)		<b>OTP</b> 12K	<b>OTP</b> 16K	<b>Flash</b> 48K+256	<b>Flash</b> 32K/64K	Flash ROM Large capacity Scalability
RAM (Byte)		256	384	2K	2K	
EEPROM (Byte)		-	-	-	<b>256</b>	EEPROM inside Min. 100k times
LCD driver		15x4	32x4	40x4	16x4/32x4	
Serial Interface		UART	UART	UART / I <sup>2</sup> C / SPI	UART / I <sup>2</sup> C / SPI	Variety of Serial I/F Function expansion
ADC		$\Delta\Sigma$ -19bit <b>RMS</b> , Peak Hold (DC)	$\Delta\Sigma$ -14bit Peak Hold	$\Delta\Sigma$ -16bit	$\Delta\Sigma$ -16bit <b>RMS</b> , Peak Hold (DC/AC)	
DMM measur ement Function	Voltage	✓	✓	Support by reference design guide (External circuit)	✓	RMS support CPU workload reduction by arithmetic circuit
	Current	✓	✓		✓	
	Resistance	✓	✓		✓	
	Diode	✓	✓		✓	
	Transistor		✓			
	Open/short	✓	✓		✓	
	Temperature	✓	✓		✓	
	Capacitance	✓	✓		✓	
	Frequency	✓	✓		✓	
Counts		5000	<b>6000</b>	-	<b>6000</b>	Up to 6000 count
Sleep current		0.65uA (typ.)	10uA(max.)	<b>0.1uA (typ.)</b>	<b>0.24uA (typ.)</b>	Low power consumption
PKG		LQFP64	QFP100	LQFP100	QFP13-64/QFP15-100	

QFP13-64: P-LTQFP064-1010-0.50, QFP15-100: P-LQFP100-1414-0.50