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S1C17801

CMOS 16-bit Application Specific Controller

- **16-bit RISC CPU Core S1C17 (Max. 48 MHz operation)**
- **128K-Byte Flash ROM and 4K + 2K-Byte RAM**
  (2K-byte RAM is operable with separated power supply)
- **Multiply and Accumulation Function (16 bits × 16 bits + 32 bits MAC)**
- **Built-in USB FS-Device Controller**
- **10-bit ADC**
- **I^2S Interface**
- **IGBT Control Function by PWM Timer**
- **Infrared Remote Control Signal Transceiver and Receiver Circuit**
- **Built-in STN LCD Controller with 2K-Byte VRAM**
  Display 120 × 120 pixels in 1 bpp Mode using IVRAM
  Support QVGA (320 × 240) in 4 bpp Mode using External VRAM
- **NAND Flash Card Interface**

■ DESCRIPTIONS

The S1C17801 is a high performance and compact 16-bit RISC application specific controller (ASC). It is suitable for various products that require analog inputs, display and interfaces for connection, such as healthcare goods, sensor systems, alarms, home electric appliance (rice cookers, microwave ovens and remote controllers).
The S1C17801 consists of a S1C17 16-bit compact RISC CPU Core, a 128K-byte Flash EEPROM, a 4K + 2K-byte RAM, a 10-bit ADC with eight analog input channels, a USB FS-device controller, a PWM control capture timer/counter, an infrared remote controller, serial interfaces (UART with IrDA 1.0, SPI, I^2C, and I^2S), an RTC driven with an independent power supply, 16-bit and 8-bit timers, a watchdog timer, a NAND Flash card interface, an external bus with an SRAM controller, GPIO ports and an STN LCD controller with built-in VRAM.
The LCD controller supports an external VRAM to display using a large size STN LCD panel. It also supports an LCD driver DMA function to interface with an EPSON S1D15xxx built-in RAM LCD driver and a driver with an SPI.
The USB FS-device controller may be used not only for communication with PCs but also for on-board firmware update.
The S1C17801 provides a 16 bits × 16 bits + 32 bits MAC (multiply and accumulate) instruction to implement a DSP function. Furthermore, an external audio ADC/DAC may be connected via the built-in I^2S interface, this makes it possible to input/output ADPCM sound/voice data.
The S1C17801 has adopted the EPSON SoC (System on Chip) design technology using 0.35 µm mixed analog low power CMOS process.

Product Lineup

Model No.	Flash ROM size	RAM size	Package
S1C17801F	128K bytes	4K + 2K* bytes	TQFP15-128pin
S1C17801B	96K bytes	4K + 2K* bytes	PFBGA7U-144

* The 2K-byte RAM with battery backup (separated power used) is configurable as VRAM.

This product uses SuperFlash® Technology licensed from Silicon Storage Technology, Inc.

■ FEATURES

● Technology

- 0.35 µm AL-4-layers mixed analog low power CMOS process technology

● CPU

- Seiko Epson original 16-bit RISC processor S1C17 Core
- Internal 3-stage pipeline
- Instruction set
  - 16-bit fixed length
  - 111 basic instructions (184 including variations)
  - Compact and fast instruction set optimized for development in C language
- Registers
  - Eight 24-bit general-purpose registers
  - Three special registers (24-bit × 2, 8-bit × 1)
- Memory space
  - Up to 16M bytes accessible (24-bit address)

● Internal Memories

- Flash EEPROM
  - 128K bytes
- RAM
  - 4K bytes
- VRAM
  - 2K bytes
  - Usable as a general-purpose RAM with battery backup feature

● Operating Clock

- Main clock
  - 48 MHz when the USB function is used
  - 1 to 48 MHz (can be divided by 1 to 32) or 32.768 kHz when the USB function is not used
  - On-chip oscillator (crystal or ceramic) or external clock input
- Sub clock
  - 32.768 kHz (typ.) for the RTC
  - On-chip oscillator (crystal)

● SRAM Controller

- Provides a 23-bit external address bus, an 8- or 16-bit width selectable data bus, and four chip enable signals to support a maximum of 15M-byte external memory space.
- Provides an SRAM UMA feature to access an external VRAM for supporting up to 16-grayscale QVGA LCD panel.

● Interrupt Controller

- Four non-maskable interrupts
  - Reset (#RESET pin or watchdog timer)
  - Address misaligned
  - Debug
  - NMI (#NMI pin or watchdog timer)
- 28 maskable interrupts
  - Port inputs (eight systems)
  - PWM control capture timer/counter (one system)
  - A/D converter (two systems)
  - 16-bit timer of clock generator (one system)
  - 8-bit timers of clock generator (two systems)
  - UART (one system)
  - SPI (one system)
  - I^2C (one system)
  - RTC (one system)
  - 8-bit timers (four systems)
  - LCD controller (one system)
  - Extended SPI (one system)
  - USB function controller (one system)
  - I^2S (two systems)
  - Remote controller (one system)
  - The interrupt level (priority) of each maskable interrupt system is configurable (levels 0 to 7).

● Prescaler

- Generates the source clocks for the clock generator.

● PWM Control Capture Timer/Counter

- One channel of 16-bit timer/counter with PWM output function is available.
- Can generate two compare-match interrupts.
- Supports the IGBT output control function using the A/D converter out-of-range signal.

● Clock Generator

- One channel of 16-bit timer and two channels of 8-bit timers are available.
- Can be used as the clock source for the UART, SPI, and I^2C.
- Each timer can generate an underflow interrupt.

● 8-bit Timers

- Four channels of 8-bit timers (presettable down counter) are available.
- Can be used as an interval timer to trigger the ADC.
- Each timer can generate an underflow interrupt.

● Watchdog Timer

- 30-bit watchdog timer to generate a reset or an NMI
- The watchdog timer overflow period (reset or NMI interrupt period) is programmable.
- The watchdog timer overflow signal can be output outside the IC.

● RTC

- Contains time counters (second, minute, and hour) and calendar counters (day, day of the week, month, and year).
- The power source separated with the system power supply (V_{DD}) can be used.
- Provides the WAKEUP output pin and #STBY input pin to control standby mode.
- Periodic interrupts are possible.

● UART

- One channel of UART is available.
- Supports IrDA 1.0 interface.
- Two-byte receive data buffer and one-byte transmit buffer are built in to support full-duplex communication.
- Transfer rate: 150 to 115200 bps, character length: seven or eight bits, parity mode: even, odd, or no parity, stop bit: one or two bits
- Parity error, framing error, and overrun error detectable
- Each channel can generate receive buffer full, transmit buffer empty, and receive error interrupts.

● SPI

- Supports both master and slave modes.
- One-byte receive data buffer and one-byte transmit buffer are built in.
- Data length: eight bits fixed (MSB first)
- Data transfer timing (clock phase and polarity variations) is selectable from among 4 types.
- Can generate receive buffer full and transmit buffer empty interrupts.

● Extended SPI

- Supports both master and slave modes.
- One-byte receive data buffer and one-byte transmit buffer are built in.
- Data length: eight bits fixed (MSB first)
- Data transfer timing (clock phase and polarity variations) is selectable from among 4 types.
- Can generate receive buffer full and transmit buffer empty interrupts.
- Exclusive clock source is available.

● I^2C

- Supports master mode only.
- Data format: 8 bits (MSB first)
- Addressing mode: 7-bit addressing (10-bit addressing is not supported.)
- Supports the noise reject function controlled by a register.
- Can generate an I^2C interrupt.

● I^2S

- Supports universal audio I^2S Bus Interface.
- One I^2S output channel in 24-bit resolution and one I^2S input channel in 16-bit resolution
- Operates as the master to generate the bit clock, word-select signal, data and master clock.
- Can generate an I^2S interrupt.

● USB Function Controller

- Supports USB2.0 full speed (12M bps) mode.
- Supports auto negotiation function.
- Scratch and variable bulk end point size
- Embedded 1K-byte programmable FIFO
- Can generate a USB interrupt.

● CARD Interface

- Generates 8- or 16-bit NAND Flash interface signals.
- The ECC function should be implemented in the application program.

● Infrared Remote Controller

- Outputs a modulated carrier signal and inputs remote control pulses.
- Embedded carrier signal generator and data length counter.
- Can generates REMC interrupts.

● General-Purpose I/O Ports

- Maximum 91 I/O ports and eight input ports are available.
- Can generate input interrupts from the eight ports selected with software.

∗ The GPIO ports are shared with other peripheral function pins (UART, PWM etc.). Therefore, the number of GPIO ports depends on the peripheral functions used.

● A/D Converter

- 10-bit A/D converter with up to eight analog input ports
- Can generates an end of conversion interrupt and an out of range interrupt.
- Outputs an out of range signal to the IGBT circuit in the PWM control capture timer/counter module.

● LCD Controller

- STN LCD controller
- Supports up to 16 gray shades using FRM (Frame Rate Modulation).
- 1/2/4 bpp (2/4/16 grayscale) monochrome LCD interface (bpp: bit-per-pixel)
- 2K-byte IVRAM (internal VRAM)
  - Can be used to display up to 120 × 120 LCD panels in one bpp mode.
  - The IVRAM arbiter is provided allowing the CPU and LCD controller to access the IVRAM via the SRAM controller.
- The UMA feature allows use of an external SRAM as the VRAM.
  - Expands the display size up to QVGA (320 × 240) panels in 4 bpp (16-grayscale) mode.
  - Supports 16-bit SRAMs for the external VRAM. (8-bit SRAMs are not supported.)
  - The EVRAM arbiter is provided allowing the CPU and LCD controller to access the external VRAM via the SRAM controller.
- Supports an LCD driver DMA function
  - Allows display data transfer to the external LCD driver with no software control.
- Supported displays
  - Single panel
  - Single drive passive display
  - Monochrome/grayscale STN LCD panel with a 4/8-bit data bus width SLA or MLA type LCD driver
  - LCD panels with a 4/8-bit parallel MCU interface LCD driver
    (LCD segment/common driver with controller)
    The 80 series parallel MCU interface is supported.
    This interface allows writing to and reading from the external LCD driver.
  - Built-in RAM type LCD panels with an LCD driver (LCD segment/common driver with controller) that supports 8/9-bit SPI
    Supports 8-bit SPI with 4 lines (SCK, SDA, D/#C, #CS: 8-bit data).
    Supports 9-bit SPI with 3 lines (SCK, SDA, #CS: 8-bit data + D/#C).
    This interface allows only writing to the external LCD driver (it does not support reading from the LCD driver).

- Supported drivers
  - EPSON S1D15xxx built-in RAM LCD drivers
  - STN LCD drivers with a 4/8-bit parallel MCU interface
    (LCD segment/common driver with controller)
    The 80 series parallel MCU interface is supported.
    This interface allows writing to and reading from the external LCD driver.
  - STN LCD drivers that support SPI
    Supports 8-bit SPI with 4 lines (SCK, SDA, D/#C, #CS: 8-bit data).
    Supports 9-bit SPI with 3 lines (SCK, SDA, #CS: 8-bit data + D/#C).
    This interface allows only writing to the external LCD driver (it does not support reading from the LCD driver).

● Operating Voltage

- V_{DD}: 3.00 to 3.60 V (3.3 V typ.)
- $RTCV_{DD}$: 3.00 to 3.60 V (3.3 V typ.)
- AV_{DD} (I/O): 2.70 to 5.50 V

● I/O Interface Voltage

- V_{DD}
  (41 GPIO support -0.3 to 5.8 V input voltage.)

● Operating Temperatures

- During flash read: -40 to 85°C
- During flash write: -40 to 70°C
- During the use of USB: 0 to 70°C

● Power Consumption

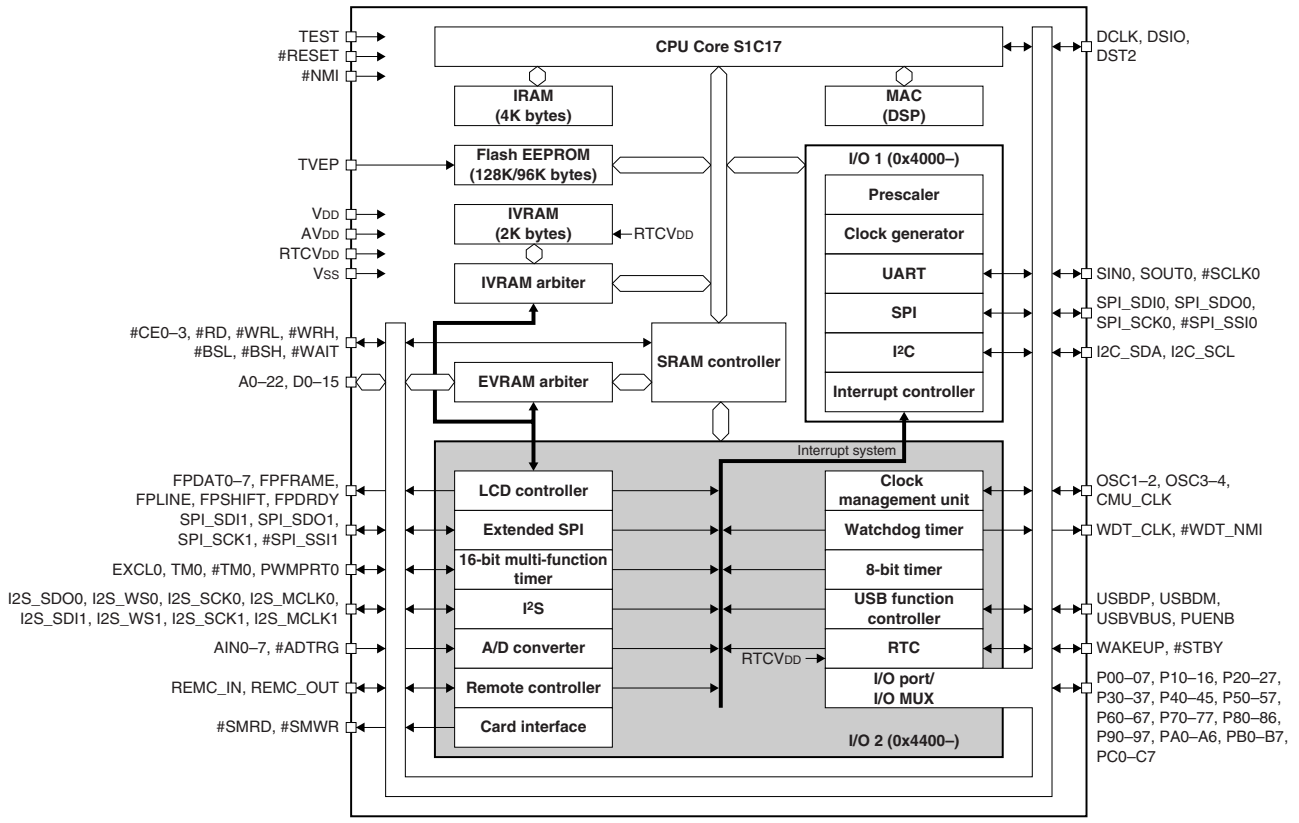
- During SLEEP: 4.5 µW(typ.)
- During HALT: 53 mW(typ.) in 48 MHz/3.3 V operation
- During execution: 116 mW(typ.) in 48 MHz/3.3 V operation
- Battery backup power: 0.28 µW(typ.) 3.3 V, OSC1 deactivated

∗ By controlling the clocks through the Clock-Gear (CMU), power consumption can be reduced.

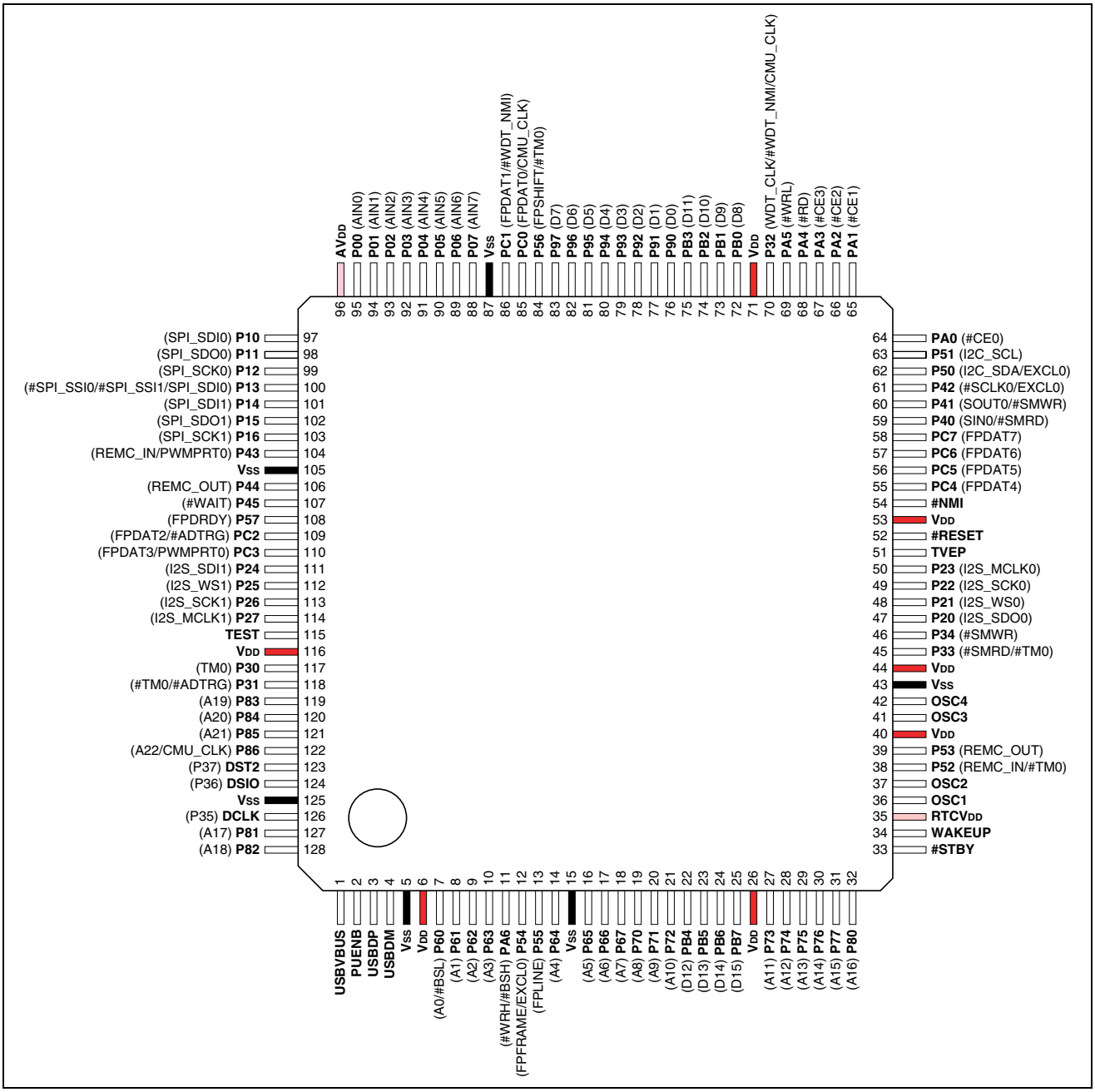
● Shipping Form

- Package: TQFP15-128pin (14 mm × 14 mm × 1.2 mm, 0.4 mm pin pitch)
  PFBGA7U-144 (7 mm × 7 mm × 1.2 mm, 0.5 mm ball pitch)

■ BLOCK DIAGRAM



■ PIN LAYOUT DIAGRAM



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