SAMV71Q21RT

Radiation-Tolerant 32-bit Arm® Cortex®-M7 MCU

Introduction

The SAMV71Q21RT is a radiation-tolerant Arm® Cortex®-M7-based microcontroller providing the best combination of connectivity interfaces along with highest performance levels. The embedded dual CAN-FD interface and Ethernet-AVB controller provide state-of-the-art technology for high bandwidth communication. In addition to one of the most powerful Arm cores delivering 600 DMIPS, the SAMV71Q21RT features a flexible bus and memories architecture coupled with a powerful Floating Point Unit (FPU), thus providing advanced DSP and real-time capabilities to serve the most demanding aerospace applications.

Features

Core

- Arm Cortex-M7 running at up to 300 MHz
- 16 Kbytes of ICache and 16 Kbytes of DCache with Error Code Correction (ECC)
- Single- and double-precision HW Floating Point Unit (FPU)
- Memory Protection Unit (MPU) with 16 zones
- DSP Instructions, Thumb®-2 Instruction Set
- Embedded Trace Module (ETM) with instruction trace stream, including Trace Port Interface Unit (TPIU)

Memories

- 2048 Kbytes embedded Flash with unique identifier and user signature for user-defined data
- 384 Kbytes embedded Multi-port SRAM
- Tightly Coupled Memory (TCM) interface with four configurations
  (disabled, 2 x 32 Kbytes, 2 x 64 Kbytes, 2 x 128 Kbytes)
- 16 Kbytes ROM with embedded Bootloader routines (UART0, USB) and IAP routines
- 16-bit Static Memory Controller (SMC) with support for SRAM, PSRAM, LCD module, NOR and NAND Flash with on-the-fly scrambling
- 16-bit SDRAM Controller (SDRAMC) interfacing up to 256 MB and with on-the-fly scrambling
- Flash Write/Erase Cycles (Ground Level only): 10K Cycles within -40°C to 125°C temperature range
- Flash Data Retention:
  - 12 years with T_A = 125°C
  - 26 years with T_A = 110°C
  - 62 years with T_A = 95°C

System

- Embedded voltage regulator for single-supply operation

- Power-on-Reset (POR), Brown-out Detector (BOD) and Dual Watchdog for safe operation
- Quartz or ceramic resonator oscillators: 3 to 20 MHz main oscillator with failure detection, 12 MHz or 16 MHz needed for USB operations. Optional low-power 32.768 kHz for RTC or device clock
- RTC with Gregorian Calendar mode, waveform generation in low-power modes
- RTC counter calibration circuitry compensates for 32.768 kHz crystal frequency variations
- 32-bit low-power Real-time Timer (RTT)
- High-precision Main RC oscillator with 12 MHz default frequency for device start-up. In-application trimming access for frequency adjustment. 8/12 MHz are factory-trimmed.
- 32.768 kHz crystal oscillator or Slow RC oscillator as source of Low-Power mode device clock (SLCK)
- One 500 MHz PLL for system clock
- Temperature Sensor
- One dual-port 24-channel central DMA Controller (XDMAC)

Low-Power Features

- Low-power Sleep, Wait and Backup modes, with typical power consumption down to 1.1 µA in Backup mode with RTC, RTT and wake-up logic enabled
- Ultra-low-power RTC and RTT
- 1 Kbyte of backup RAM (BRAM) with dedicated regulator

Peripherals

- One Ethernet MAC (GMAC) 10/100 Mbps in MII mode and RMII with dedicated DMA. IEEE®1588 PTP frames and 802.3az Energy-efficiency support. Ethernet AVB support with IEEE802.1AS Timestamping and IEEE802.1Qav credit-based traffic-shaping hardware support.
- 12-bit ITU-R BT. 601/656 Image Sensor Interface (ISI)Two master Controller Area Networks (MCAN) with Flexible Data Rate (CAN-FD) with SRAM-based mailboxes, time- and event-triggered transmission
- MediaLB® device with 3-wire mode, up to 1024 x Fs speed, supporting MOST25 and MOST50 networks
- Three USARTs. USART0/1/2 support LIN mode, ISO7816, IrDA®, RS-485, SPI, Manchester and Modem modes; USART1 supports LON mode.
- Five 2-wire UARTs with SleepWalking™ support
- Three Two-Wire Interfaces (TWIHS) (I2C-compatible) with SleepWalking support
- Quad I/O Serial Peripheral Interface (QSPI) interfacing up to 256 MB Flash and with eXecute-In-Place and on-the-fly scrambling
- Two Serial Peripheral Interfaces (SPI)
- One Serial Synchronous Controller (SSC) with I2S and TDM support
- Two Inter-IC Sound Controllers (I2SC)
- One High-speed Multimedia Card Interface (HSMCI) (SDIO/SD Card/e.MMC)
- Four Three-Channel 16-bit Timer/Counters (TC) with Capture, Waveform, Compare and PWM modes, constant on time. Quadrature decoder logic and 2-bit Gray Up/Down Counter for stepper motor
- Two 4-channel 16-bit PWMs with complementary outputs, Dead Time Generator and eight fault inputs per PWM for motor control, two external triggers to manage power factor correction (PFC), DC-DC and lighting control.

- Two Analog Front-End Controllers (AFEC), each supporting up to 12 channels with differential input mode and programmable gain stage, allowing dual sample-and-hold at up to 1.7 Msps. Offset and gain error correction feature.
- One 2-channel 12-bit 1 Msps-per-channel Digital-to-Analog Converter (DAC) with Differential and Over Sampling modes
- One Analog Comparator Controller (ACC) with flexible input selection, selectable input hysteresis

Cryptography

- True Random Number Generator (TRNG)
- AES: 256-, 192-, 128-bit Key Algorithm, Compliant with FIPS PUB-197 Specifications
- Integrity Check Monitor (ICM). Supports Secure Hash Algorithm SHA1, SHA224 and SHA256.

I/O

- 114 I/O Lines with external interrupt capability (edge- or level-sensitivity), debouncing, glitch filtering and On-die Series Resistor Termination
- Five Parallel Input/Output Controllers (PIO)

Operating Range

- Temperature
  - CQFP144: -40°C to +125°C
  - LQFP144: -55°C to +125°C
- Single Supply Voltage: 3.0V to 3.6V
- Dual Supply Voltage
  - VDDIO: 3.0V to 3.6V
  - VDDCORE: 1.2V to 1.32V

Packages

- CQFP144, 144-lead CQFP, 22 x 22 mm, pitch 0.5 mm
- LQFP144, 144-lead LQFP, 20 x 20 mm, pitch 0.5 mm

Radiation Performance

- No Single Event Latch-up Below an LET Threshold of 60 MeV.cm^2/mg @125°C
- Total Ionizing Dose of 30 krad(Si) RHA

ESD

- HBM 3000V
- CDM 750V

Mass

- CQFP144: 6187 mg
- LQFP144: 1365 mg