TEXAS INSTRUMENTS

MSP430FR5969-SP

SLASEK0A – DECEMBER 2017 – REVISED MARCH 2018

MSP430FR5969-SP Radiation Hardened Mixed-Signal Microcontroller

1 Device Overview

1.1 Features

- Radiation-Hardness Assured
  - Extended Temperature Operation (–55°C to 105°C) [1]
  - Single Event Latchup (SEL) Immune to 72 MeV.cm^2/mg at 125°C
  - Radiation Lot Acceptance Tested to 50 krad
  - 48-pin VQFN Plastic Package
  - Single Controlled Baseline
  - Extended Product Change Notification
  - Product Traceability
  - Extended Product Life Cycle
- Embedded Microcontroller
  - 16-Bit RISC Architecture up to 16-MHz Clock
  - Wide Supply Voltage Range (1.8 V to 3.6 V) [2]
- Optimized Ultra-Low-Power Modes
  - Active Mode: Approximately 100 µA/MHz
  - Standby (LPM3 With VLO): 0.4 µA (Typical)
  - Real-Time Clock (LPM3.5): 0.25 µA (Typical) [3]
  - Shutdown (LPM4.5): 0.02 µA (Typical)
- Ultra-Low-Power Ferroelectric RAM (FRAM)
  - Up to 64KB of Nonvolatile Memory
  - Ultra-Low-Power Writes
  - Fast Write at 125 ns Per Word (64KB in 4 ms)
  - Unified Memory = Program + Data + Storage in One Single Space
  - 10^{15} Write Cycle Endurance
  - Radiation Resistant and Nonmagnetic
- Intelligent Digital Peripherals
  - 32-Bit Hardware Multiplier (MPY)
  - 3-Channel Internal DMA
  - Real-Time Clock (RTC) With Calendar and Alarm Functions
  - Five 16-Bit Timers With up to Seven Capture/Compare Registers Each

[1] Refer to MSP430FR5969-SP EM Lifetime Derating Chart in the *Specifications* Section.
[2] Minimum supply voltage is restricted by SVS levels.
[3] RTC is clocked by a 3.7-pF crystal.

- 16-Bit Cyclic Redundancy Checker (CRC)
- High-Performance Analog
  - 16-Channel Analog Comparator
  - 12-Bit Analog-to-Digital Converter (ADC) With Internal Reference and Sample-and-Hold and up to 16 External Input Channels
- Multifunction Input/Output Ports
  - Accessible Bit-, Byte-, and Word-Wise (in Pairs)
  - Edge-Selectable Wake From LPM on All Ports
  - Programmable Pullup and Pulldown on All Ports
- Code Security and Encryption
  - 128-Bit or 256-Bit AES Security Encryption and Decryption Coprocessor
  - Random Number Seed for Random Number Generation Algorithms
- Enhanced Serial Communication
  - eUSCI_A0 and eUSCI_A1 Support
    - UART With Automatic Baud-Rate Detection
    - IrDA Encode and Decode
    - SPI
  - eUSCI_B0 Supports
    - I^{2}C With Multiple Slave Addressing
    - SPI
  - Hardware UART
- Flexible Clock System
  - Fixed-Frequency DCO With 10 Selectable Factory-Trimmed Frequencies
  - Low-Power Low-Frequency Internal Clock Source (VLO)
  - 32-kHz Crystals (LFXT)
  - High-Frequency Crystals (HFXT)
- Development Tools and Software
  - Free Professional Development Environments With EnergyTrace++™ Technology
  - Development Kit (MSP-TS430RGZ48C)
- For Complete Module Descriptions, See the *MSP430FR58xx, MSP430FR59xx, MSP430FR68xx, and MSP430FR69xx Family User's Guide*

1.2 Applications

- Spacecraft Distributed Telemetry and Housekeeping

- Sensor Management
- Data Logging

An IMPORTANT NOTICE at the end of this data sheet addresses availability, warranty, changes, use in safety-critical applications, intellectual property matters and other important disclaimers. PRODUCTION DATA.

1.3 Description

The MSP430™ ultra-low-power (ULP) FRAM platform combines uniquely embedded FRAM and a holistic ultra-low-power system architecture, allowing innovators to increase performance at lowered energy budgets. FRAM technology combines the speed, flexibility, and endurance of SRAM with the stability and reliability of flash at much lower power.

The ultra low-power architecture of the MSP430FR5969-SP showcases seven low-power modes, optimized to achieve power efficient distributed telemetry/housekeeping systems.

The integrated mixed-signal features of the MSP430FR5969-SP make it ideally suited for distributed telemetry applications in next-generation spacecraft. The strong immunity to single-event latchup and total ionizing dose, enable the device to be used in a variety of space and radiation environments.

Device Information[1]

PART NUMBER	GRADE	PACKAGE[2]
M4FR5969SRGZT-MLS	MLS	48-pin VQFN 7.00 mm × 7.00 mm
M4FR5969SPHPT-MLS	MLS	HTQFP (48) 7.00 mm × 7.00 mm

(1) For the most current part, package, and ordering information for all available devices, see the *Package Option Addendum* in Section 8, or see the TI website at www.ti.com.
(2) The sizes shown here are approximations. For the package dimensions with tolerances, see the *Mechanical Data* in Section 8.