Technical White Paper

MSPM0L134x Transimpedance Amplifier (TIA) Empowers Future Sensing Applications

ABSTRACT

Transimpedance Amplifier (TIA) is a dedicated amplifier mode used to convert current signals into voltage signals widely applied in photodetection, sensor interfaces, and other applications requiring high sensitivity. These applications place great emphasis on the multifunctionality and scalability of microcontrollers (MCU), as well as low power consumption and integrated functions that can reduce system size. In the future, many sensing applications can exhibit a wide diversity, with each application having a unique set of functions and system resources. Designers can increasingly turn to highly integrated, yet multifunctional low-power microcontrollers, such as the MSPM0L134x MCU, to simplify system design and expedite time-to-market.

Table of Contents

List of Figures

Trademarks

1 Introduction

An increasing number of applications require intelligent sensing capabilities at the endpoint. These applications span various industry segments, including building automation, healthcare and fitness, as well as personal and portable electronics. Today, the next generation of microcontrollers can quickly and efficiently adapt to many different types of sensing and measurement applications, such as sensors involved in light, humidity, temperature, power current, carbon monoxide, and many other conditions or parameters. The MSPM0L134x MCU is one of the most prominent examples of this new type of microcontroller. This MCU is based on a cost-effective Arm® Cortex® M0+ architecture, easy-to-use ecosystem, and by integrating one of the industry's sensitive transimpedance amplifiers (TIA), enabling precise current sensing while optimizing system costs.

2 MSPM0L134x MCU Overview

The ultra-low-power MSPM0L134x MCU features a cost-effective, ultra-low power (71µA/MHz), 32MHz Arm Cortex-M0+ CPU, with excellent standby low-power performance (1µA) across full temperature ranges (see Figure 2-1). The MCU can output up to 8 channels of PWM signals in the standby mode and supports multiple protocols such as LIN, IrDA, DALI, Manchester, smart card, SMBus, PMBus, FM+. The 12-bit ADC offers a conversion rate of 1.68MSPS and can achieve an accuracy of 11.2 effective number of bits (ENOB). The MSPM0L1346 device offers one comparator supporting both high-speed mode and low-power mode. The MSPM0L134x MCU is equipped with two operational amplifiers (OPA) that support transimpedance amplifier (TIA) mode, a built-in high-frequency oscillator with 1.2% accuracy across the entire temperature range, two 5V tolerant open-drain I/Os (ODIO), a wide operating voltage range of 1.62V to 3.6V, and a VSSOP28 package size of 7.1mm × 4.9mm. Due to the high integration of the MSPM0L134x MCU series, the design can save multiple discrete components, simplifying system design, optimizing the physical size of the printed circuit board (PCB), and significantly reducing bill of materials (BOM) costs.

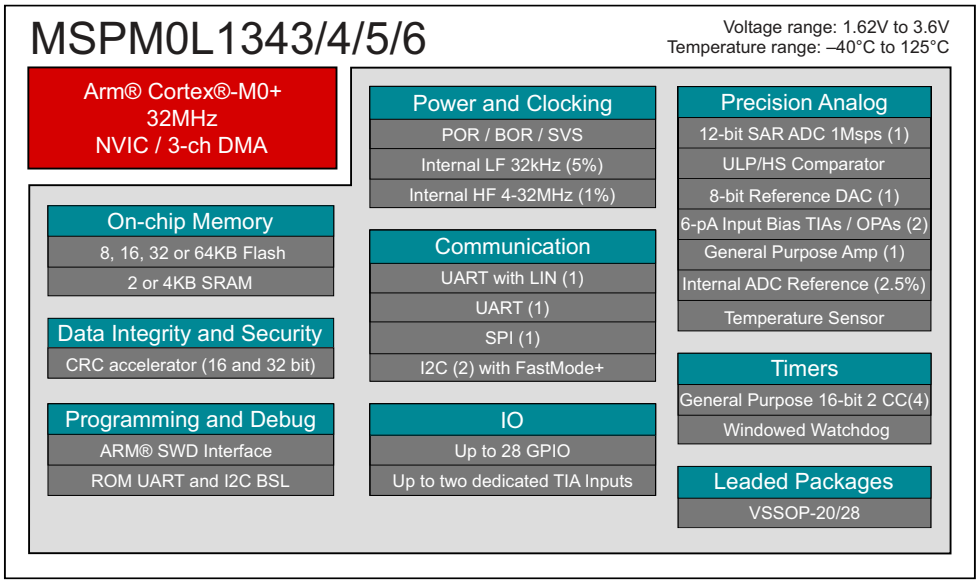

Figure 2-1. MSPM0L134x MCU Block Diagram

The integrated low-leakage transimpedance amplifier (TIA) empowers the MSPM0L134x MCU for cost-effective sensing applications. For example, the integrated transimpedance amplifier (TIA) has a more effective capability for detecting current compared to conventional integrated operational amplifiers. Additionally, through the dedicated OPA1_IN0 pin attributes, compared with the 50pA OPA input bias current on MSPM0L130x MCU, the MSPM0L134x MCU transimpedance amplifier (TIA) features industry-leading input bias current which is only 6pA. Here, the designer can check the OPA and TIA electrical characteristics parameter by search the key words "*MSPM0L134x devices only*" on the *MSPM0L130x Mixed-Signal Microcontrollers* data sheet. Additionally, the user can check the dedicated OPA1_IN0 pin attributes of the MSPM0L134x MCU by searching the key words "*MSPM0L134x only*" on the device data sheet. Both MSPM0L134x and MSPM0L130x operational amplifiers (OPA) support low-power modes and rail-to-rail operation, thereby enhancing current detection capabilities and extending the battery life of the system.

3 Applications

The application areas appropriate to the MSPM0L134x MCU are very broad, but three of them stand out: building automation, medical health and fitness, and personal and portable electronics.

3.1 Building Automation

Many building automation systems include smoke detectors and smoke alarm systems. Smoke detectors and alarms based on the MSPM0L134x microcontroller can handle the entire signal chain within a single device. Furthermore, the extreme sensitivity to low currents of the integrated TIA makes the smoke detectors and alarms responsive to small amounts of smoke in the air. Naturally, the low-power leakage of the integrated TIA, the overall low power requirements, and the standby power mode of these microcontrollers allow the smoke detectors and alarms to operate normally under the lowest possible current supply.

Figure 3-1 displays some building automation systems that require the ability to monitor several sensors at once.

Figure 3-1. Building Automation Systems

3.2 Medical Health and Fitness

Small thermometer-based MSPM0L134x devices can easily sense the temperature when the probe of the instrument comes into contact with skin or body tissue. The temperature can be communicated over one of the general purpose I/O channels to a small liquid crystal diode (LCD) display. Any number of specialized health monitors like a pregnancy tester or other such devices can also be enabled with the cost-effective analog integrated low-power microcontroller, MSPM0L134x.

Figure 3-2 shows an example medical device.

Figure 3-2. Medical Devices

3.3 Personal and Portable Electronics

Due to the increasing popularity of battery-powered consumer electronics and the demand for lower power consumption and enhanced charging efficiency, power sensing or monitoring has become increasingly important in many consumer electronic products. Of course, in battery-powered systems, the low power consumption of the power monitoring subsystem is a prerequisite. For example, in battery packs or portable chargers used in consumer electronics, users must know the remaining battery capacity to initiate the charging cycle before the battery charge is depleted. The compact, cost-effective, and ultra-low-power MSPM0L134x MCU with an integrated TIA can detect the current during battery discharge and track the remaining capacity. The MSPM0L134x MCU is also at the core of various energy-efficient green power applications. For instance, different types of printers can utilize these microcontrollers to monitor power usage and control when to switch the printer to standby mode to reduce system power consumption. Pressing a button or an automatic signal from the microcontroller can wake the printer to full power mode when needed.

Figure 3-3 shows examples of some of the applications that can benefit from the MSPM0L134x MCUs.

Figure 3-3. Printers and Power Banks

4 Conclusions

Sensing and measurement instruments are going to be more widely applied in the future. Sensors managed and controlled by microcontrollers (MCU) can provide the necessary information and data for applications to respond, operate efficiently, and overall serve users more effectively. Cost-effective, low-power microcontrollers (such as the MSPM0L134x MCU) and the remarkable integrated low-leakage TIA features offer system designers the optimized combination of lower system costs, ease of integration, compact size, and ultra-low-power consumption required for the rapid development of various successful products.

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATA SHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI’s products are provided subject to TI’s Terms of Sale or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI’s provision of these resources does not expand or otherwise alter TI’s applicable warranties or warranty disclaimers for TI products.

TI objects to and rejects any additional or different terms you may have proposed.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265