

# Webinar

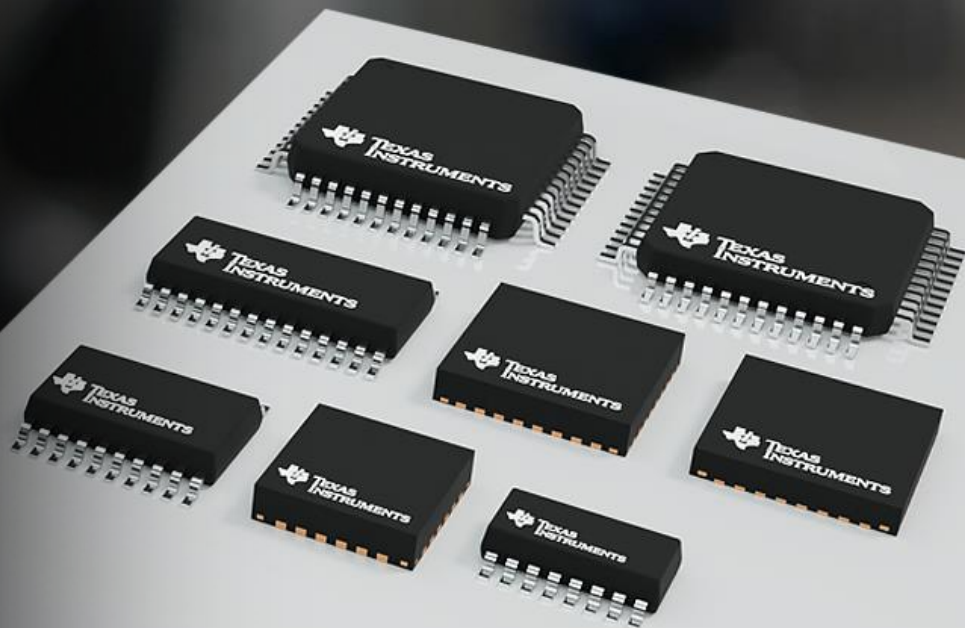
Enable MSPM0 low-cost MCUs  
for building automation and home  
healthcare

**Christian Greef**  
Medical systems engineer

**Colin Hice**  
Systems engineer

**David Stout**  
Systems engineer

**Shreya Mandal**  
Product marketing engineer



# MSPM0 MCUs | More options. Unlimited possibilities.

The most comprehensive portfolio of Arm® Cortex® M0+ microcontrollers that delivers the sensing and processing features you need



## Cost optimized

- Leveraging recent capacity and cost investments
- Industry's smallest packages enable the smallest PCB designs
- High performance integrated analog to reduce BOM cost



## Scalable

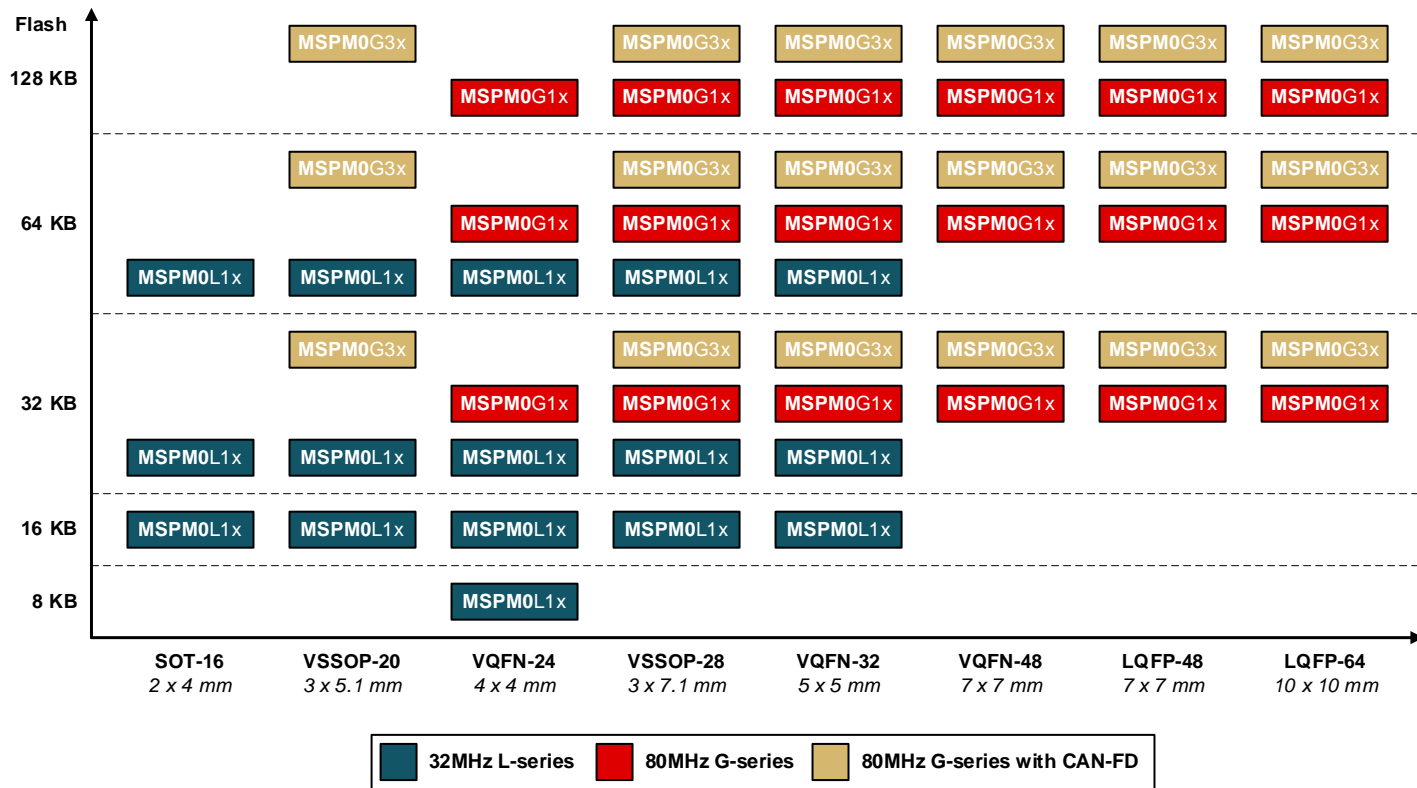
- 32/80MHz, 8-128 kB flash, 16-64 pins, and scalable analog
- Pin to pin compatible across wide range of memory & analog options
- 105C, 125C, and AEC- Q100 automotive options



## Simple to use

- Fast, fully graphical device configuration with code generation
- Code size optimized drivers (1/3rd the size of competitors)
- Plug-and-play subsystems, code examples, and reference designs

# MSPM0 MCUs | Broad scalability



**32MHz**  
L-series MCUs

**80MHz**  
G-series MCUs

**Pin to pin**  
Hardware and software  
compatible

# MSPM0 L-series microcontrollers

MSPM0L13xx/110x		1.62 - 3.6V -40 to 125 C
<b>CPU</b> Arm Cortex-M0+ 32 MHz  NVIC / 3-ch DMA	<b>Power &amp; Clocking</b> POR / BOR / SVS  Internal LF 32kHz (3%)  Internal HF 4-32MHz (1%)	<b>Analog</b> 12-bit ADC 1.45Msps (10-ch)  Comparator w/ 8-bit DAC  Zero-drift chopper op-amps (2)  General purpose amp  Internal ADC reference (1.5%)  Temperature sensor
<b>On-chip Memory</b> 8, 16, 32 or 64 kB flash  2 or 4 kB SRAM	<b>Communication</b> UART w/ LIN (1)  UART (1)  SPI (1)  I2C (2) w/ FastMode+	<b>Timers</b> Low power 16-bit 2 CC (4)  Windowed watchdog
<b>Data Integrity &amp; Security</b> CRC accelerator (16 and 32 bit)	<b>IO</b> Up to 28 GPIO  Up to 2 low Ib OPA inputs	
<b>Programming &amp; Debug</b> ARM SWD interface  UART & I2C bootloader		
Leaded packages: SOT-16, VSSOP-20/28 No-lead packages: WQFN-16, VQFN-24/32		

**< \$0.39**  
starting at 1 kU

**< 0.5  $\mu\text{V}/^\circ\text{C}$**   
Op-amp input offset  
drift

**46**  
8 kB- 64 kB memory,  
package, peripheral options

# MSPM0 G-series microcontrollers

MSPM0G350x/310x/150x/110x			1.62 - 3.6V -40 to 125 C
<b>CPU</b> <b>Arm Cortex-M0+</b> <b>80 MHz</b>  NVIC / MPU / 7-ch DMA	<b>Power &amp; Clocking</b>	<b>Precision Analog</b>	
	POR / BOR / SVS	12-bit ADC 4Msps (9-ch)	
	External LF 32kHz XTAL	12-bit ADC 4Msps (8-ch)	
	External HF 4-48MHz XTAL	Comparators w/ 8-bit DACs (3)	
	Internal LF 32kHz (3%)	12-bit 1Msps buffered DAC (1)	
	Internal HF 4-32MHz (1%)	Zero-drift chopper op-amps (2)	
	PLL (up to 80 MHz)	Internal reference (1.5%)	
		General purpose amp (1)	
		Temperature sensor	
<b>Accelerators</b>  Math (DIV, SQRT, TRIG, MAC)	<b>Communication</b>	<b>Timers</b>	
	UART w/ LIN (1)	Advanced control 16-bit 4 CC (1)	
	UART (3)	Advanced control 16-bit 2 CC (1)	
	SPI (2)	General purpose 32-bit 2 CC (1)	
	I2C (2) w/ FastMode+	General purpose 16-bit 2 CC (2)	
	CAN-FD (1)	Low power 16-bit 2 CC (2)	
		Windowed watchdog (2)	
		Real-time clock (1)	
<b>On-chip Memory</b>  32, 64, or 128 kB flash [ECC]  16 or 32 kB SRAM [ECC]	<b>IO</b>		
	Up to 60 GPIO		
<b>Data Integrity &amp; Security</b>  CRC accelerator (16 and 32 bit)  AES256 accelerator + TRNG			
<b>Programming &amp; Debug</b>  ARM SWD interface  UART & I2C bootloader			
Leaded packages: VSSOP-2 No-lead packages: VQFN-24/32/48, nFBGA-64, WCSP-28			

## Dual 4 Msps

12- bit ADCs with 14 bit  
oversampling

## 3X lower latency

In field oriented motor control  
loops

## 87

32 kB- 64 kB memory,  
package, peripheral options

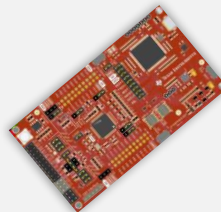
# MSPM0 software and tools ecosystem

*Rapidly develop with low-cost MSPM0 microcontrollers*



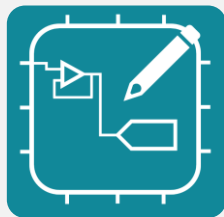
## MSPM0 SDK

*Software, tools, and documentation to accelerate product development*



## MSPM0 LaunchPad

*An unconstrained prototyping platform*



## SysConfig & Analog Configurator

*Intuitive graphical configuration and code generation*



## CCS Theia

*A modern, high performance integrated development environment*

# MSPM0 in building and home healthcare

## Pulse Oximeter

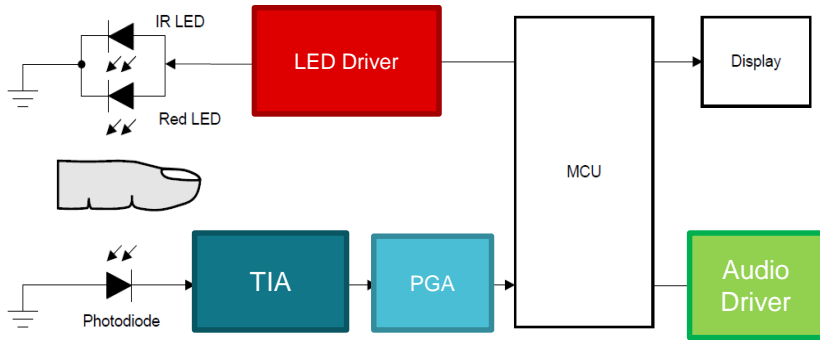


Transimpedance Amplifier

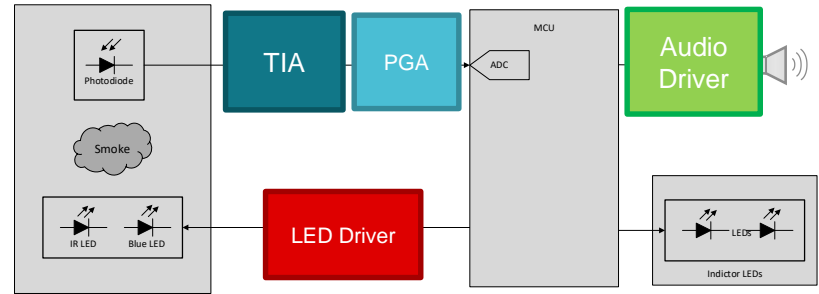
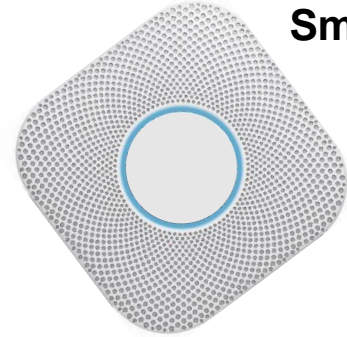
Programmable Gain Amplifier

LED Driver

Audio Driver



## Smoke Alarm

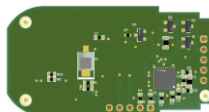


# MSPM0 in home healthcare

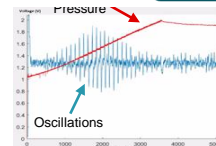
**Christian Greeff**  
**Medical systems**



## Blood Pressure Monitoring



The diagram illustrates the system architecture for the MSPM0L1306. It features a power management section with a 4 x AA battery connected to a TPS7A24 (LDO) and an AT1431LI (REF). The LDO provides a 3.3V supply to the REF and the MSPM0L1306. The REF provides a reference voltage to the VREF pin. The MSPM0L1306 contains an INA (INA219) with two input pins (INA1P, INA1N) connected to a pressure sensor. The MSPM0L1306 also contains two ADCs (ADC0, ADC1) connected to pressure and oscillation sensors. The MSPM0L1306 is connected to a DRV8210 motor driver, which controls a pump and a valve. The MSPM0L1306 is also connected to a PC via a UART interface.



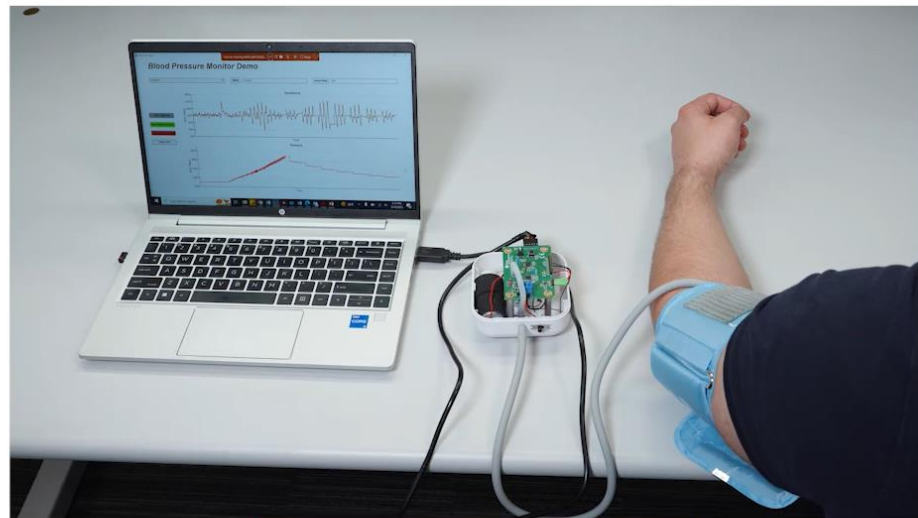
The diagram illustrates the system architecture for the bq25720/31. It shows the power flow from External Power (3.5 - 24V) through a TPS2663 EFuse 6A to the bq25720/31 Charger A. The charger is connected to a 1-5S Battery Pack. The system load is shown as a variable current (3 - 24V). The charger is controlled by an MSP430 MCU, which is connected to a TCA9548A SMBUS Switch Channel. The MCU also controls the charger's status (OTC/VAP, VILIM, HIZ) and the battery pack's status (OTC/VAP, VILIM, HIZ). The charger is shown in three states: N=1, N=2, and N=3, each connected to a 1-5S Battery Pack.

# Demo

## Pulse Ox and BPM demos



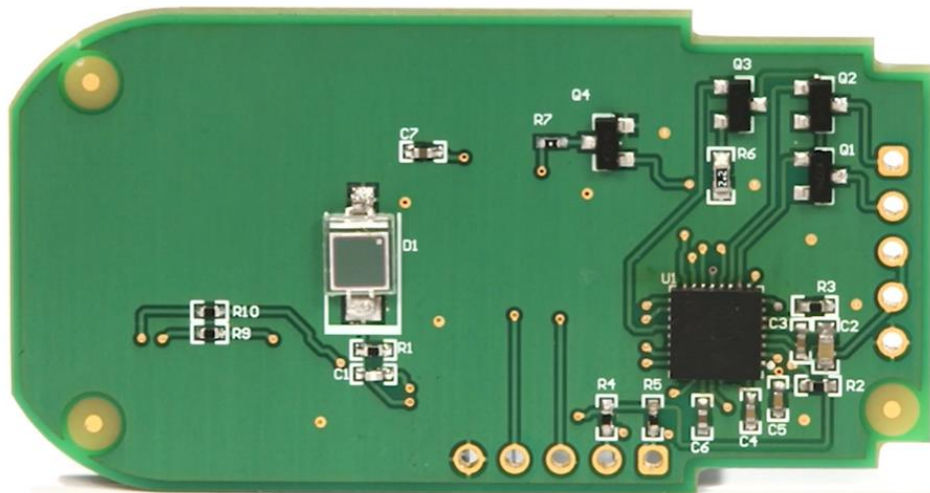
Pulse Oximeter



Blood Pressure Monitor

# MSPM0 example applications

Application/system	Hardware key features	Software key features	Device
<b>Pulse Ox</b>	<ul style="list-style-type: none"> <li>Analog integration               <ul style="list-style-type: none"> <li>TIA, OPA, DAC, ADC, HFXT</li> </ul> </li> <li>Precision signal chain               <ul style="list-style-type: none"> <li>Low voltage offset &amp; drift</li> <li>Low 1/f noise</li> <li>±1% SYSOSC accuracy</li> </ul> </li> <li>Low cost</li> <li>1µA standby &amp; 61nA shutdown,</li> <li>Small QFN &amp; BGA packages</li> </ul>	<ul style="list-style-type: none"> <li>DC tracking and oversampling for increased resolution (16 bit oversampling) and &gt;90dB dynamic range</li> <li>Digital filtering for ambient 50/60hz noise</li> </ul>	MSPM0L1306
<b>Blood Pressure Monitor</b>	<ul style="list-style-type: none"> <li>Analog integration               <ul style="list-style-type: none"> <li>VREF, OPA, DAC, ADC</li> </ul> </li> <li>Precision signal chain               <ul style="list-style-type: none"> <li>Low voltage offset &amp; drift</li> <li>Low 1/f noise</li> </ul> </li> <li>Low cost</li> <li>1µA standby &amp; 61nA shutdown</li> </ul>	<ul style="list-style-type: none"> <li>SW for fast and precise pressure measurement algorithm</li> <li>Digital filtering for ambient 50/60hz noise</li> <li>Smooth motor control</li> </ul>	MSPM0L1306
<b>Medical Alarm</b>	<ul style="list-style-type: none"> <li>OPA, ADC, RTC</li> <li>Flash space: 32, 64, 128kB flash</li> <li>12 Bit DAC:               <ul style="list-style-type: none"> <li>Up to 1Msps output sampling rate</li> <li>Integrated sample time generator</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>IEC60601-1-8 Standard Compliant</li> <li>Configurable Alarms</li> <li>Custom Alarm Capability</li> </ul>	MSPM0G150x
<b>Scalable Battery Backup System</b>	<ul style="list-style-type: none"> <li>Analog integration               <ul style="list-style-type: none"> <li>OPA, COMP</li> </ul> </li> <li>Low cost</li> </ul>	<ul style="list-style-type: none"> <li>Charger/Gauge Configurability</li> <li>Scalability for different pack configurations</li> </ul>	MSPM0L1306 or MSPM0G3506



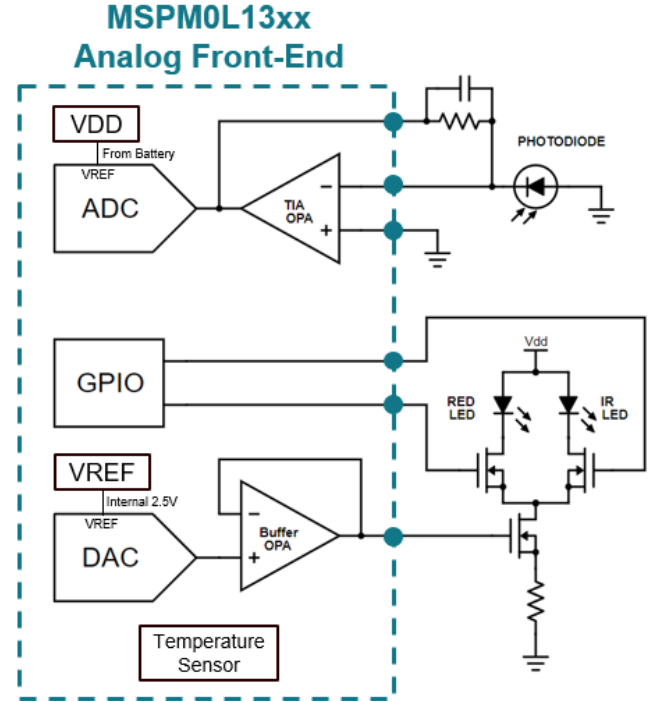
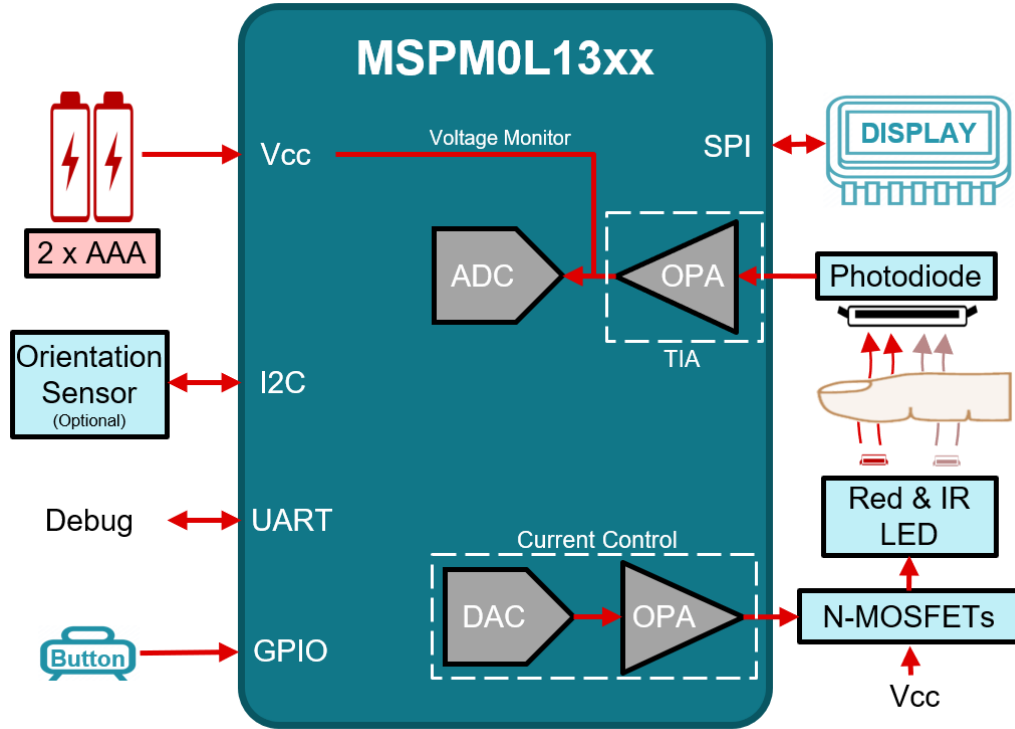
## Single-Chip Pulse Oximeter With MSPM0 MCUs

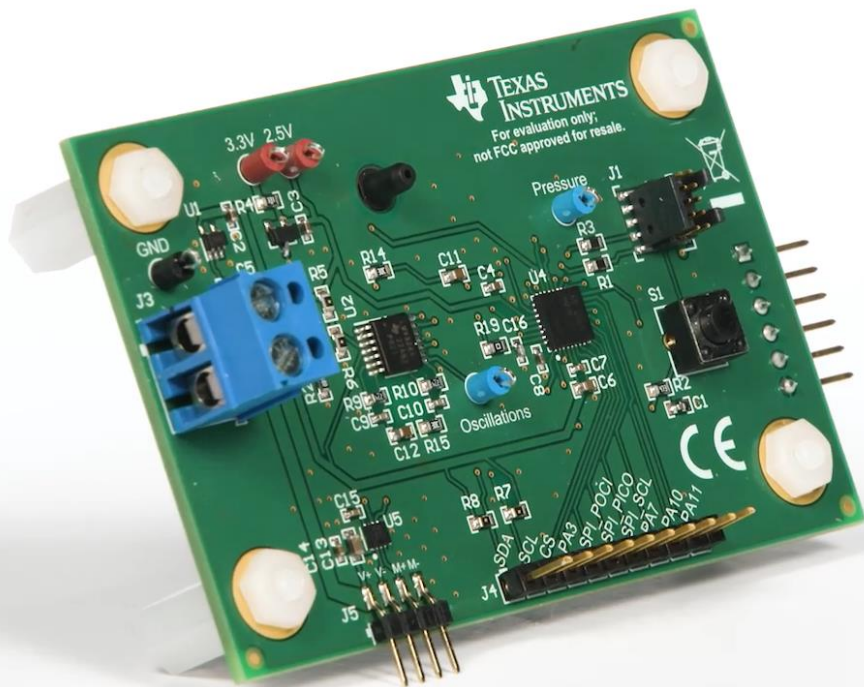
- Dynamic Range:
  - ~90dB by oversampling to 16 bits
- Range:
  - BPM: 30 – 240
  - Perfusion Index: 0.1% - 20%
- Resolution:
  - 1 BPM
  - 1% SPO<sub>2</sub>

# Single-chip pulse oximeter

Design challenge/problem statement	Block diagram/schematic	Additional resources								
<p>Single-Chip Pulse Oximeter With MSPM0 MCUs</p> <p><b>Dynamic Range:</b></p> <ul style="list-style-type: none"><li>~90dB by oversampling to 16 bits</li></ul> <p><b>Range:</b></p> <ul style="list-style-type: none"><li>BPM: 30 – 240</li><li>Perfusion Index: 0.1% - 20%</li></ul> <p><b>Resolution:</b></p> <ul style="list-style-type: none"><li>1 BPM</li><li>1% SPO<sub>2</sub></li></ul>		<table><tr><th></th><th>MCU / BLE</th></tr><tr><td>GPN</td><td><a href="#">MSPM0L1306</a> <a href="#">MSPM0G1506</a> <a href="#">CC2340R2</a></td></tr><tr><td>Description</td><td>Cortex-M0+, 64kB Flash, 2x chopper OPAs: 2μVpp 1/f. BLE 5.3, &lt; 11mA @ +8dBm TX, 256kB Flash</td></tr><tr><td>Technical resources</td><td><a href="#">Single chip pulse oximeter design based on MSP430FR2355</a> <a href="#">MSPM0 reference design product overview</a> <a href="#">MSPM0 full reference design coming soon!</a></td></tr></table>		MCU / BLE	GPN	<a href="#">MSPM0L1306</a> <a href="#">MSPM0G1506</a> <a href="#">CC2340R2</a>	Description	Cortex-M0+, 64kB Flash, 2x chopper OPAs: 2μVpp 1/f. BLE 5.3, < 11mA @ +8dBm TX, 256kB Flash	Technical resources	<a href="#">Single chip pulse oximeter design based on MSP430FR2355</a> <a href="#">MSPM0 reference design product overview</a> <a href="#">MSPM0 full reference design coming soon!</a>
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GPN	<a href="#">MSPM0L1306</a> <a href="#">MSPM0G1506</a> <a href="#">CC2340R2</a>									
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What differentiates this subsystem solution	Sims/measurements	Applications								
<p><b>OPA:</b></p> <ul style="list-style-type: none"><li>2μVpp 1/f noise</li><li>100μV Offset, ±0.5μV/°C drift</li><li>Down to 6pA I<sub>b</sub> on MSPM0L134x</li></ul> <p><b>DAC:</b></p> <ul style="list-style-type: none"><li>8-bit DAC on MSPM0L and 12-bit DAC on MSPM0G</li></ul> <p><b>ADC:</b></p> <ul style="list-style-type: none"><li>12-bit 1.68MSPS ADC with up to 71dB SNR</li><li>x128 Hardware Oversampling Available</li></ul> <p><b>61nAShutdown</b></p>		<ul style="list-style-type: none"><li>Clip PPG</li><li>Patient Monitoring PPG</li></ul>								

# Single-chip pulse oximeter block diagram





## Highly Integrated Low-Cost Blood Pressure Monitor

- Achieve lower noise bridge sensing at a lower cost, with INA designs using chopper stabilized integrated op-amps.



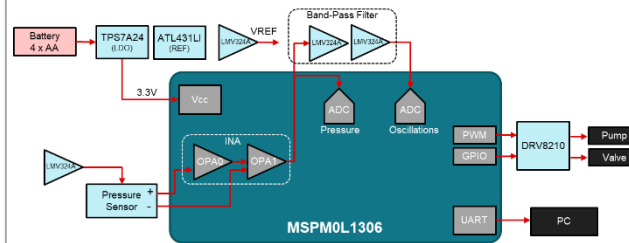
# Highly integrated low-cost blood pressure monitor

## Design challenge/problem statement

Low-cost blood pressure monitors have the following challenges:

- Cost Sensitivity
- Accuracy of  $\pm 3\text{mmHg}$  (0.4kPa) from range of 0mmHg - 290mmHg (0kPa - 38.67kPa)
  - Low 1/f noise < 10 $\mu\text{Vpp}$
  - Low  $V_{\text{offset}}$  / Temp drift (<1mV / <5 $\mu\text{V}/^\circ\text{C}$ )
- Support 40 – 240 BPM measurement range
  - 0.5 Hz – 8 Hz @ 60+ dB of gain bandpass filter
- Low-power / Low Voltage (Low  $I_{\text{SD}}$ , < 3.3V )
- High Integration

## Block diagram/schematic



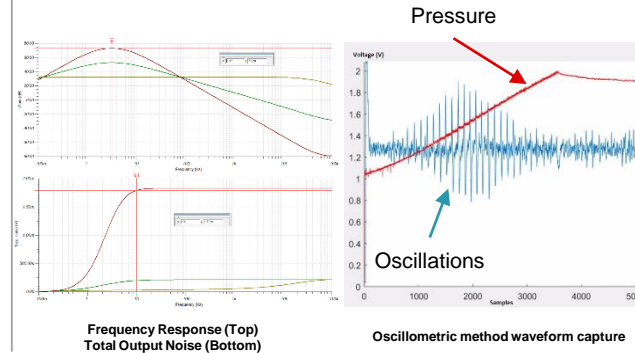
## Additional resources

	MCU / BLE	Amplifiers	Pump/Valve Driver	Power / Reference
GPN	<a href="#">MSPM0L1306</a> <a href="#">CC2340R2</a>	<a href="#">LM324LV</a> <a href="#">INA350</a>	<a href="#">DRV8210</a>	<a href="#">TPS7A24</a> <a href="#">TLV7A20</a> <a href="#">TPS61220</a> <a href="#">TPS61040</a> <a href="#">ATL431LI</a>
Description	Cortex-M0+, 64kB Flash, 2x chopper OPAs: 2 $\mu\text{Vpp}$ 1/f.	\$0.045/1ku, 5.1 $\mu\text{Vpp}$ 1/f, $\pm 1\text{mV}$ offset	1.76A Iout, Iq(sleep)<84.5nA 2mm x 2mm (WSON), Integrated diodes and load switch	Fixed, 2 $\mu\text{A}$ Iq LDO 0.7V, 5 $\mu\text{A}$ Iq Boost Adjustable, 0.5% accuracy, 80 $\mu\text{A}$ Imin Shunt Ref
Technical resources	<a href="#">Blood Pressure and Heart Rate Monitor Reference Design</a>			

## What differentiates this subsystem solution

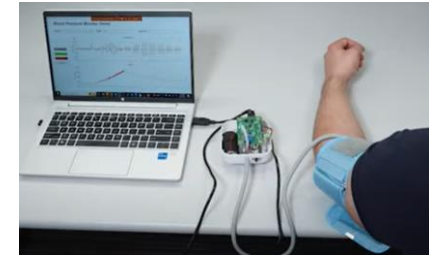
- TI's MSPM0L family integrates low-power precision signal chain to a low cost Cortex-M0+ MCU.
  - < \$0.60 /1ku
  - OPA: 2 $\mu\text{Vpp}$  1/f noise, 100 $\mu\text{V}$  Offset,  $\pm 0.5\mu\text{V}/^\circ\text{C}$  drift
  - 12-bit 1.68MSPS ADC, up to 71dB SNR
  - 61nA Shutdown
- **Integrated 2-Amp INA** for bridge sensing with low-noise chopper OPAs, enable high dynamic range at lower power levels.
- A single quad-package LMV324A can be used for oscillometric method band pass filter, bridge current biasing, and Vref
- Single-chip independent pump and valve driver with DRV8210 (~4.5mm x 4.4mm)

## Sims/measurements



## Applications

- Arm-based Blood Pressure Monitor
- Wrist-based Blood Pressure Monitor





# Detailed design

- The 2SMPP-03 has a full scale output range of  $42 \pm 5.5$  mV -50kPa to 50kPa with 100 $\mu$ A bias current.

## Pressure Sensor

- ~15mV Pressure range
- ~150μV Pulse amplitude

### INA (OPAs)

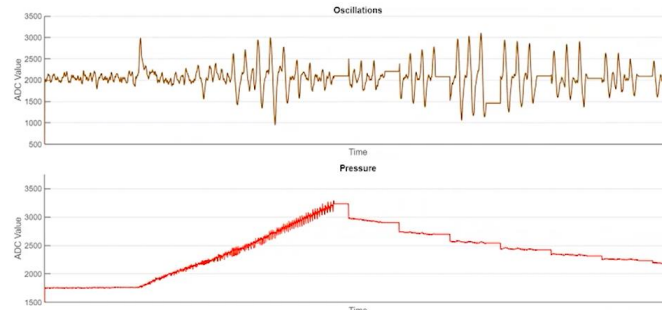
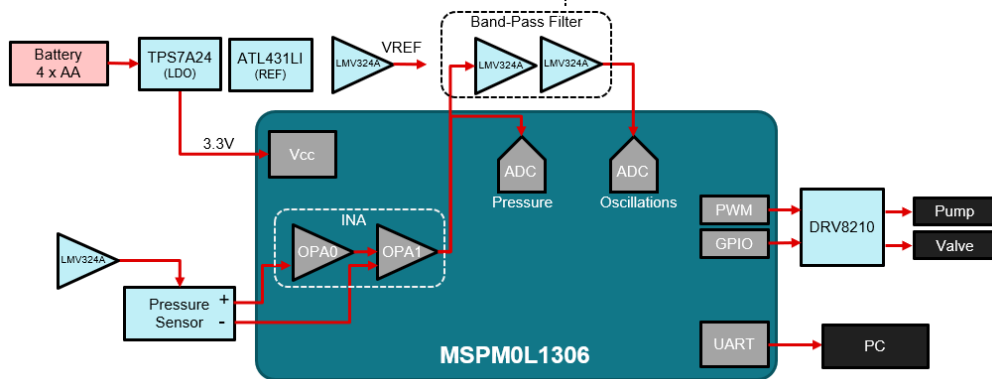
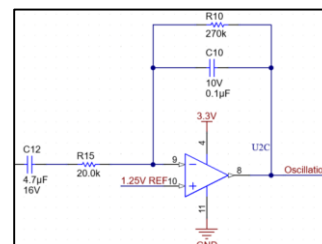
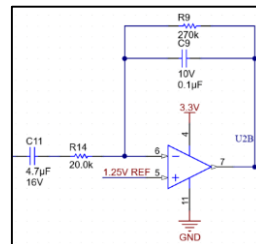
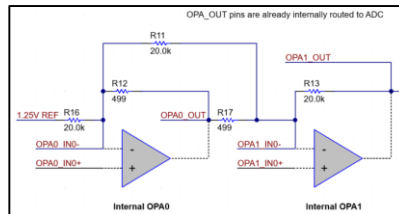
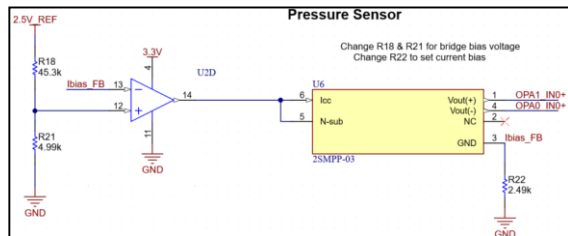
- ~750mV Pressure range
- ~7.5mV Pulse amplitude

**BP Filter 1**

- ~55mV Pulse amplitude

**BP Filter 2**

- ~0.53V Pulse amplitude



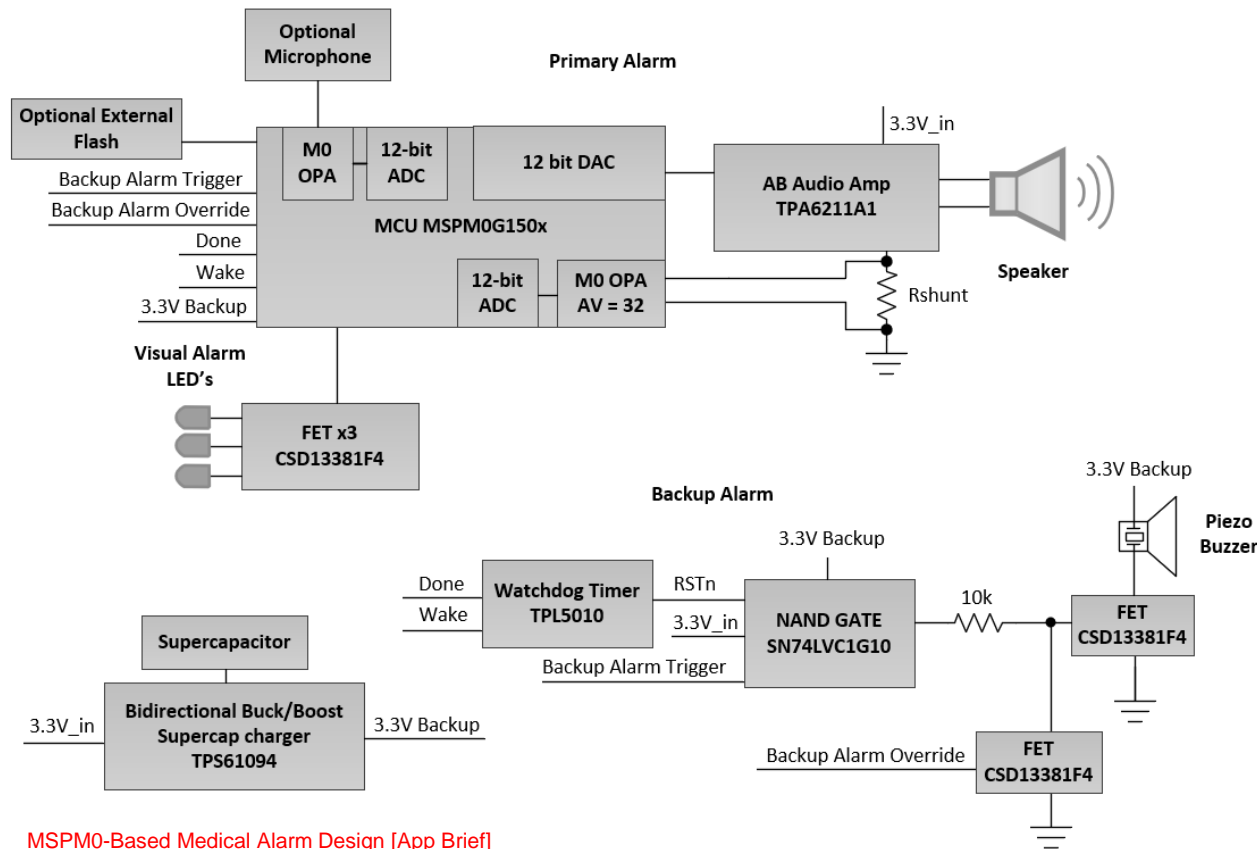
**Oscillations (Top)**  
**Pressure (Bottom)**

# IEC60601-1-8 compliant medical alarm/tone generator using MSPM0 MCU

Design challenge/problem statement	Primary Alarm Block Diagram	Additional resources			
<ul style="list-style-type: none"><li>All the medical devices in hospitals must raise both visual and audio alarms for alerting nurses.</li><li>IEC 60601-1-8<ul style="list-style-type: none"><li>Classification: low, medium or high priority depending on the intensity of the failure event.</li><li>No. of pulses, the pulse frequency range, shape of the pulses, pattern of the signal burst and maximum amplitude difference between the pulses</li></ul></li></ul>			MCU	Audio Amplifier	Reference Design
		GPN	MSPM0G150x	<a href="#">TPA6211A1</a>	<a href="#">TIDA-010040</a>
		Description	12bit DAC	3.1-W, mono, analog input Class-AB audio amplifier	Alarm tone generator reference design
		Technical resources	<ul style="list-style-type: none"><li><a href="#">MSPM0-Based Medical Alarm Design [App Brief]</a></li><li><a href="#">Demystifying medical alarm Designs, Part 1: IEC606001-1-8 standard requirements [Blog]</a></li><li><a href="#">Demystifying medical alarm Designs, Part 2: Design inputs and existing techniques [Blog]</a></li><li><a href="#">Demystifying Medical Alarm Designs with Smart DACs [Tech note]</a></li><li><a href="#">Hardware-Based Smart DAC Medical Alarm Design [App Brief]</a></li></ul>		
What differentiates this subsystem solution	Waveforms	Applications			
<ul style="list-style-type: none"><li>Standard or custom alarm capability</li><li>12 bit high fidelity audio, 48kHz+</li><li>Primary alarm speaker malfunction (coincidence detection)</li><li>External host control or standalone</li><li>Integrated RTC</li><li>Low Cost</li></ul>	<p>Coincidence detect (MSPM0 OPA)</p> <p>DAC output</p>	<ul style="list-style-type: none"><li>Multiparameter Patient Monitor</li><li>Infusion Pumps</li><li>Dialysis machine</li><li>Ventilator</li></ul>			

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# IEC60601-1-8 compliant medical alarm/tone generator block diagram



Evaluation hardware:



49 mm diameter

## Scalable battery backup subsystem with adjustable output

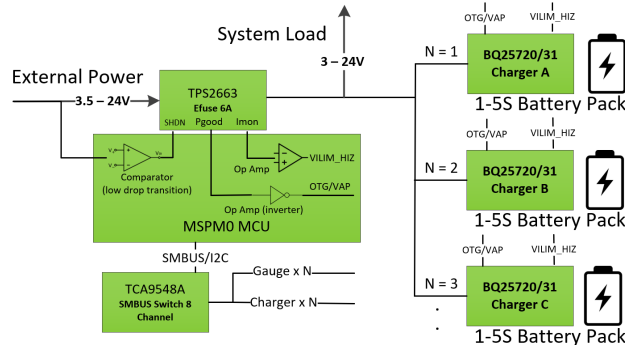
## Design challenge/problem statement

- Multi battery solution for **flexible and scalable battery backup** systems
- Battery capacity is limited to **100Wh for air travel for O2 Concentrator, CPAP, etc.**
- **Adjustable**, regulated system output voltage
- **Integrated protections** – Overvoltage, Reverse Polarity, Overcurrent

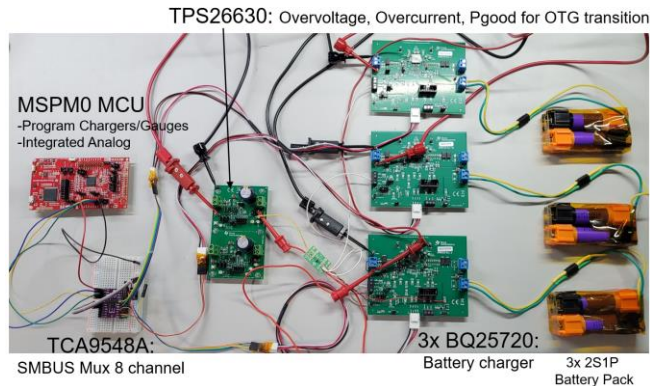
## What differentiates this subsystem solution

- Capable of **scalable output power (>1kW)** using up to **32 battery chargers and gauges**
- **Load sharing**, OTG functionality (**3-24V**), and **simultaneous** battery charging using BQ25720/31
- **Automatic charge current modulation** based on load
- **Automatic switchover** between external adapter and battery power (resistor programmable)
- **Integrated analog** with MSPM0 MCU

### Block diagram/schematic



## Prototype



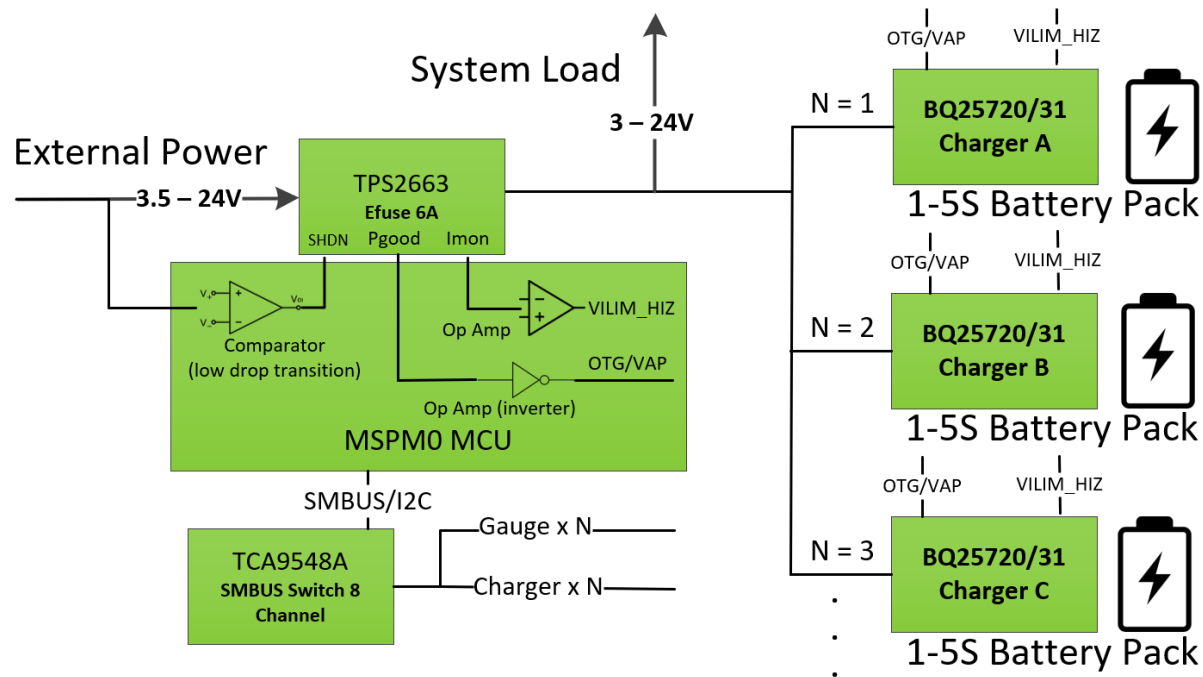
## Additional resources

	Battery Charger	eFuse	MCU	I2C/SMBUS Mux
GPN	<a href="#"><u>BQ25720</u></a> <a href="#"><u>BQ25731</u></a>	<a href="#"><u>TPS2663</u></a>	<a href="#"><u>MSPM0</u></a> <a href="#"><u>G/L</u></a>	<a href="#"><u>TCA9548A</u></a>
Key Benefits	OTG 3-24V Fast Role Swap USB PD support	PGOOD, SHDN Current Monitor RVP protection	Integrated Analog	Connect up to 4 chargers and 4 gauges per mux
Technical resources	<a href="#"><u>Multi-battery management in medical ultrasound systems</u></a> <a href="#"><u>Scalable multi-pack smart battery charger reference design</u></a>			

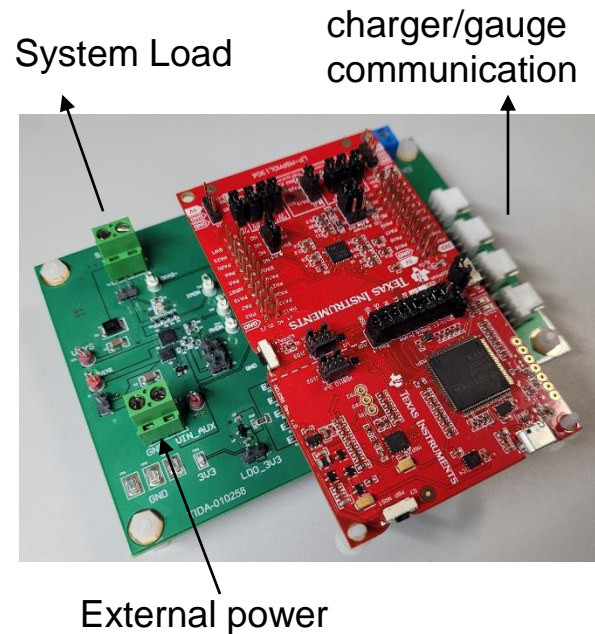
## Applications

- CPAP
- Oxygen Concentrator
- Ultrasound Cart

# Scalable battery backup block diagram



## Evaluation hardware:



# Additional MSPM0 applications in medical

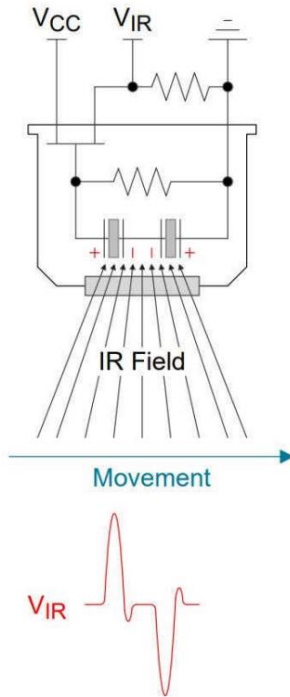
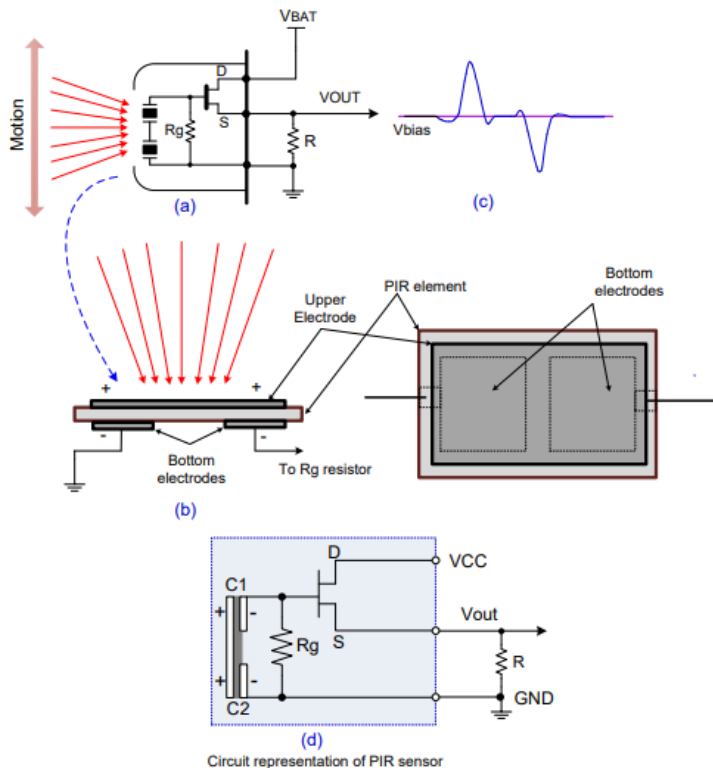
- Fetal doppler monitor
- IR thermometer
- Blood glucose monitor

# MSPM0 in building automation

**Colin Hice & David Stout**

Building automation systems

# PIR sensor overview

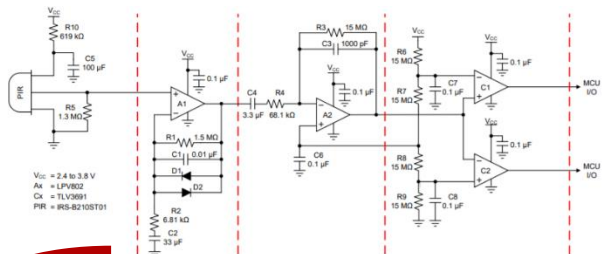


## Technology overview

- Passive Infrared (PIR)
- Cost-optimized and low-power motion detection technique
- Temperature sensitive electrodes generate alternating pulses when motion is detected
- Amplitude changes with distance
- Frequency changes with speed
- Generally produces a low-amplitude, need external filtering and processing to interpret data (Hundreds of microvolts to low millivolts)



# PIR motion sensor solution with low-cost MSPM0



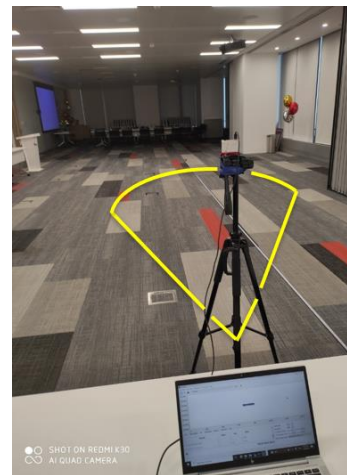
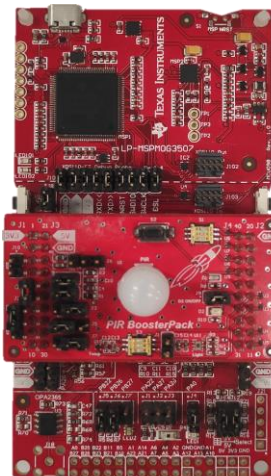
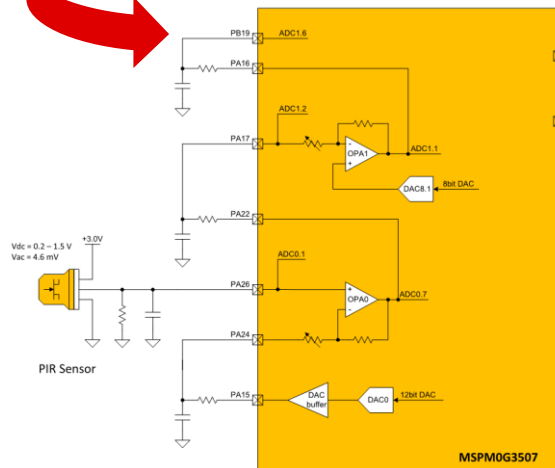
## TI system value proposition

2 zero-drift chopper stabilized op-amps give **low noise signal chain for reduced false triggers**

12-bit ADC with windowed threshold for low-power sensors; **use of ADC rather than simple comparator allows for advanced signal processing**

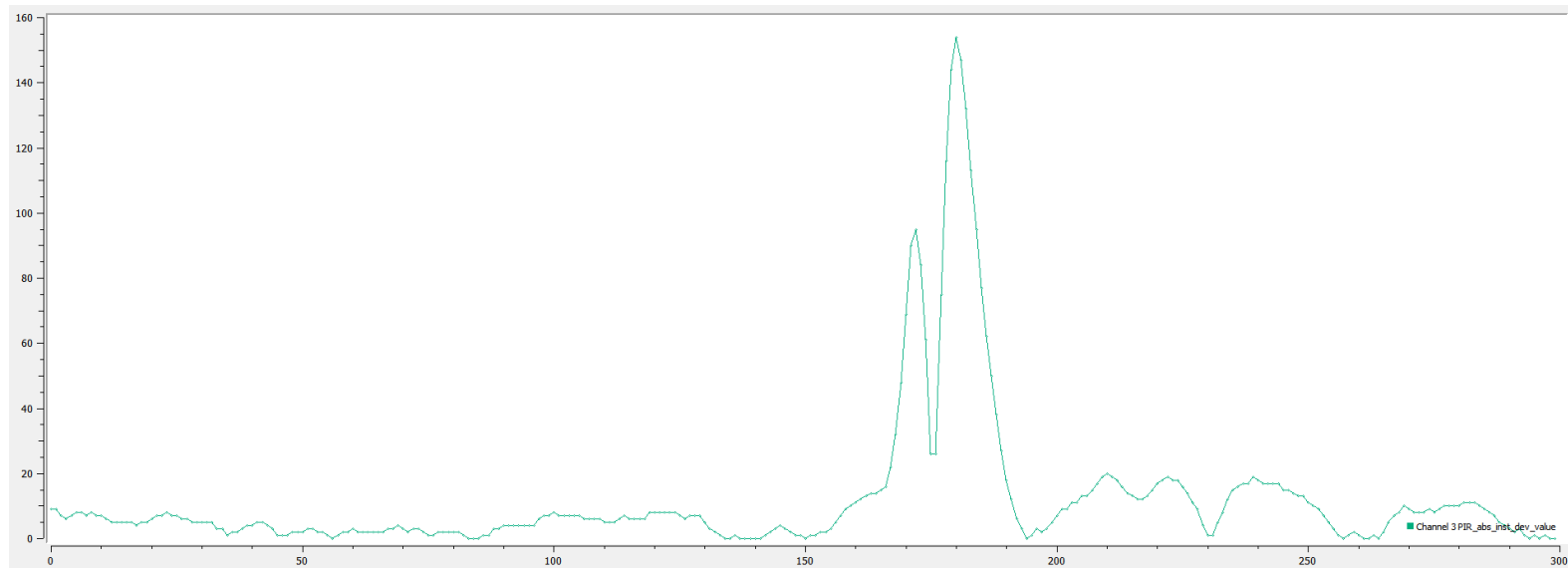
12-bit and 8-bit DAC for setting custom Op-amp bias voltage – can be used to track sensor DC offset, **eliminating noisy capacitors in HPF stages**

1  $\mu\text{A}$  standby mode current consumption help to **extend battery life**



*In preliminary testing, have been able to achieve detection of human motion (both latitudinal and longitudinal) at 10 m across  $100^\circ$  field of view without registering false triggers*

# Data visualization



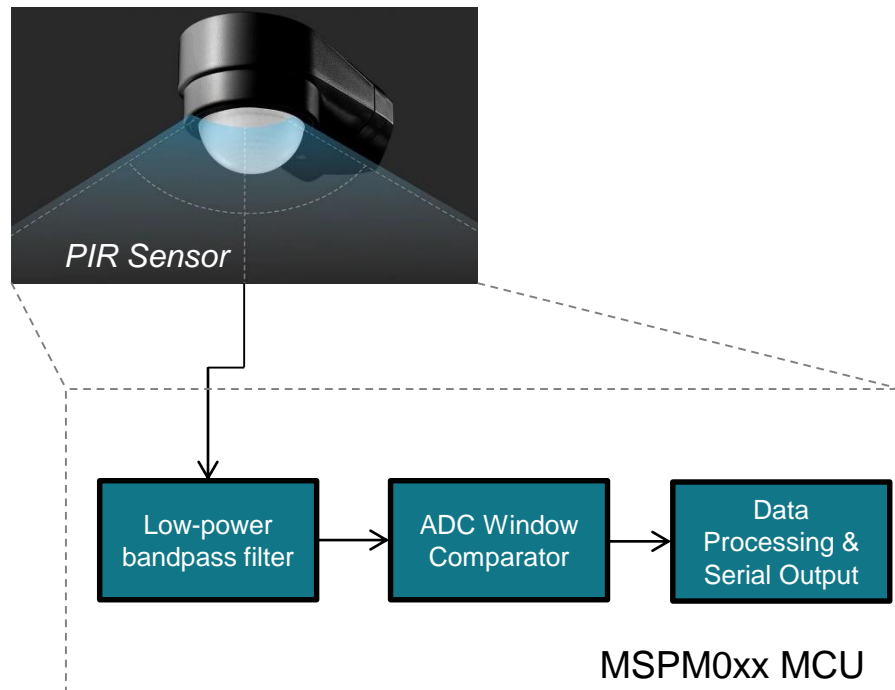
Absolute Value Visualization

# PIR motion sensor solution with low-cost MSPM0

## Key Features for motion sensors

- 2 Zero-Drift chopper stabilized Op-Amps
- 12-bit ADC with windowed threshold for low-power sensors
- Integrated voltage reference (1.4V and 2.5V)
- DAC for setting custom Op-amp bias voltage
- 1uA Standby mode current consumption

Supported devices	Core	Interface	Analog	Timers
MSPM0L1303/4/5/6 8-64kB 8-32 pin	32MHz ARM CM0+	1x LIN	ADC12, COMP, 2x OPA 1x GPAMP	4x GP 1x SysTick
MSPM0G3505/6/7 32-128kB 32-64 pin	80MHz ARM CM0+	1x LIN 1x CAN-FD	2x ADC12, DAC12 3x COMP, 2x OPA 1x GPAMP Shared VREF	3x GP 3x Advanced 1x HiRes 1x SysTick



# Example building automation applications

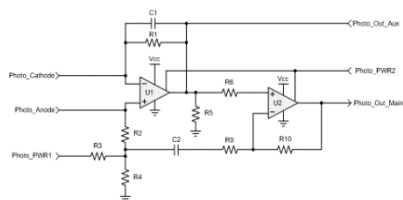
End equipment	Application requirements
Video Doorbell	<ul style="list-style-type: none"><li>• Keep camera asleep, only wakeup when motion is detected to save power</li><li>• Low-noise reduces false-triggers and wakeups from outdoor environment</li></ul>
IP Network Camera	<ul style="list-style-type: none"><li>• Robust motion sensing over long range</li><li>• High efficiency for battery powered systems</li><li>• Generally limited space, ideal for MSPM0L</li></ul>
Motion Detector	<ul style="list-style-type: none"><li>• Very long battery life</li><li>• Extremely low-noise signal chain for long detection range</li></ul>
Smart Thermostat	<ul style="list-style-type: none"><li>• Limit AC when room is unoccupied</li><li>• Configurable sensitivity and timeout period</li></ul>

# TI smoke alarm solutions

**UL217 8<sup>th</sup> edition in effect June 2024, 9<sup>th</sup> edition as of June 2025 (UL268 for commercial variants)**

- Detection of smoldering Polyurethane fires, hotter and faster fires leading to a reduction in escape time from 17 to 4 minutes
- Distinguish between real fire and false alarms (cooking, dust, etc.), added go-no-go test in 9<sup>th</sup> edition

## Discrete analog sensing



**Target subfamily:** General purpose amplifiers, MSPM0 / MSP430 / CCxxxx MCUs

**Collateral:**

- [TIDA-010014](#): Photoelectric IR LED driver
- [Transimpedance amplifier](#) blog series
- [TIDA-00756](#): CO detector
- [MSPM0 Arm-based micro controllers](#)
- [MSP430™ ultra-low-power sensing & measurement](#) MCUs

## Integrated analog sensing

Photo Amp	Regulator	CO Amp
MCU	IR LED Driver	Boost
	Blue LED Driver	Horn Driver

TPS880x

**Target subfamily:** Custom, MSPM0 / MSP430 / CCxxxx MCUs

**Collateral:**

- TPS8802 + MSPM0/MSP430 reference hardware
- Residential Smoke alarm AFE
- Commercial Smoke detector AFE
- MSPM0 Arm-based micro controllers
- MSP430™ ultra-low-power sensing & measurement MCUs

## Integrated analog sensing and digital

Photo Amp	Regulator	CO Amp
MCU	IR LED Driver	Boost
	Blue LED Driver	Horn Driver

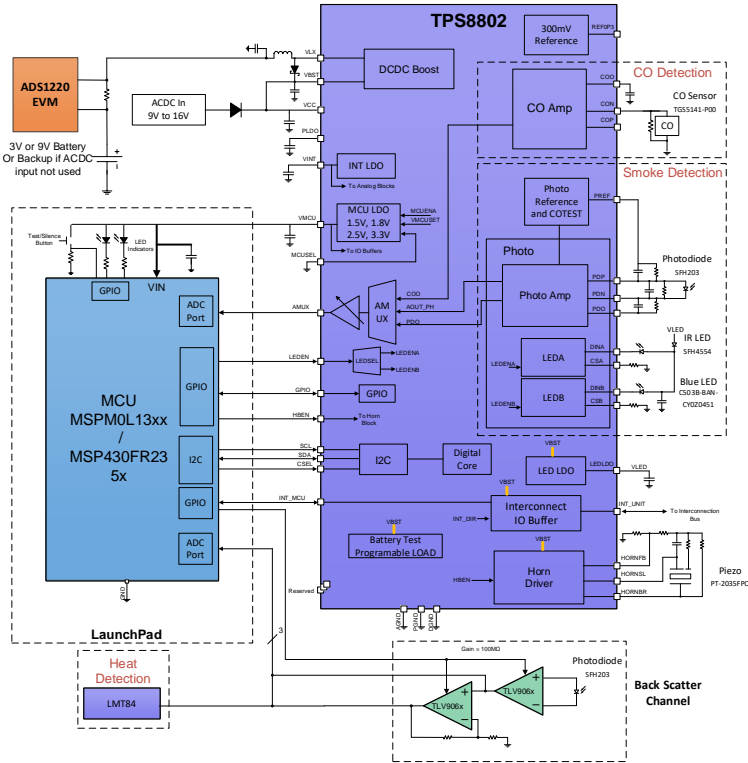
MSPM0 / MSP430FR2355

**Target subfamily:** MSPM0 / MSP430 MCUs

## Collateral

- [TIDA-010941: Smoke Detection with Ambient Light Cancellation using M0](#)
- [Streamlining Smoke Detector Designs With Highly Integrated MSPM0 MCUs](#)
- [MSP430FR2355 Integrated Analog Microcontroller](#)

# Dual wave combo smoke / CO alarm demo platform



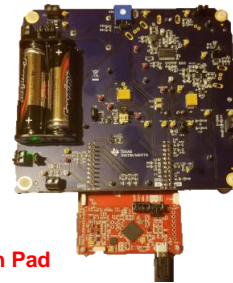
## TI system value proposition

Demo platform pairs MSP430/MSPM0 with TPS8802 AFE to realize full signal chain for dual-wave photoelectric smoke detector for applications **targeting compliance to latest-generation UL 217/268 standards**

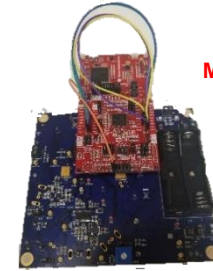
Support for **2-terminal or 3-terminal piezo sounder** for audible alarm

**Smoke chamber** supporting multiple configurations (forward scatter only or forward & back scatter)

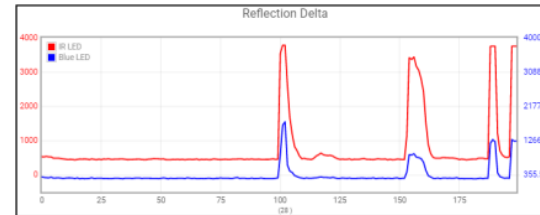
USB connection to PC enables GUI for **device set-up and real-time data visualization**



MSP430 Launch Pad



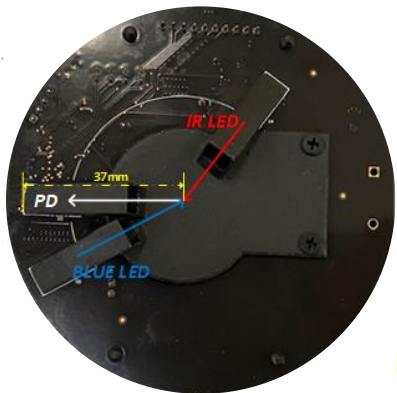
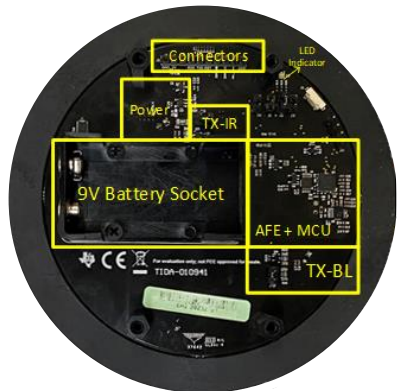
MSPM0L Launch Pad



App Note: "Dual-Ray Smoke Detector with the TPS8802 and MSPM0 MCUs"

# Smoke detection reference design using MSPM0L1306

## UL217 9<sup>th</sup> ed., Smoke Detector



- Smoke sensing scheme and algorithm to reduce false alarms
  - 70dB sensing SNR
  - Passes UL217 9<sup>th</sup> edition sensitivity and Fire room tests
- Modulated-based sensing architecture for ambient light rejection
  - >60dB rejection; DC, 120Hz + Harmonics
  - No complex chamber design required → enables platform for chamber-less solution
- Dual-beam sensing with air quality indication capability
  - Particle size estimation: 300nm - 10 $\mu$ m ( $\pm$ 0.2 $\mu$ m)
  - Mass concentration: 1+ mg/m<sup>3</sup> ( $\pm$ 30%)
- 10+ years battery life on 9V battery

# TIDA-010941

Smart analog sensor interface for smoke detection with ambient light cancellation reference design | Design status: In-design

## Features

- **Modulation-based sensing signal-chain with ambient light rejection**
  - DC, 120 Hz + harmonics: >60dB attenuation
  - Signal Chain SNR: 70dB (128 pulses)
- **Advanced compressive sensing technique for low power operation**
  - Total Current Consumption: 5 $\mu$ A (single pulse, 1Hz ODR)
  - >3x lower power compared to 128 pulse averaging
- **Dual-beam air quality sensing**
  - Particle size: 300nm – 10 $\mu$ m ( $\pm$ 0.2 $\mu$ m)
  - Mass concentration: 1+ mg/m<sup>3</sup> ( $\pm$ 30%)

## Applications

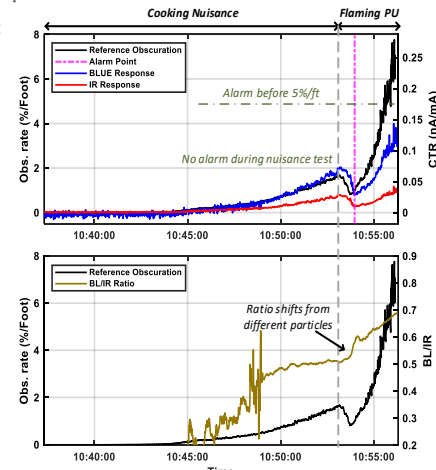
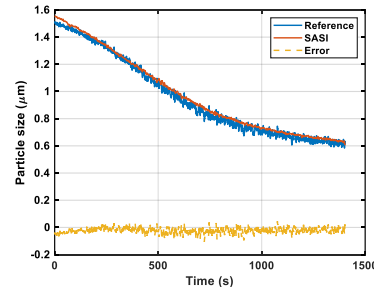
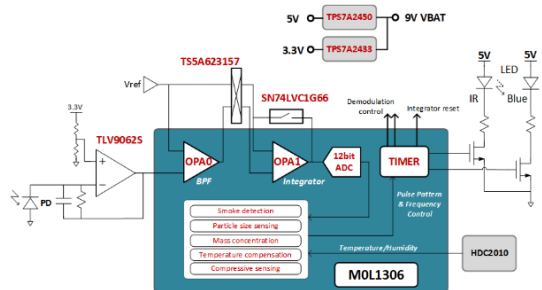
- Chambered or chamber-less smoke detector
- Air quality sensing

## Tools & resources

- **TIDA-010941 Tools Folder**
- **Design Guide**
- **Design Files:** Schematics, BOM, Gerbers, etc.
- **Device Datasheets:**
  - [MSPMOL1306](#)
  - [TLV9062S](#)
  - [HDC2010](#)
  - [TPS7A24xx](#)
  - [TS5A623157](#)
  - [SN74LVC1G66](#)

## Benefits

- Low optical chamber and manufacture complexity
- Adjustable signal chain gain through N pulse integration (13MQ w/ N=2)
- Smoke + Air Quality sensing with the same optical and analog front end
- 10+ years battery life with 9V battery

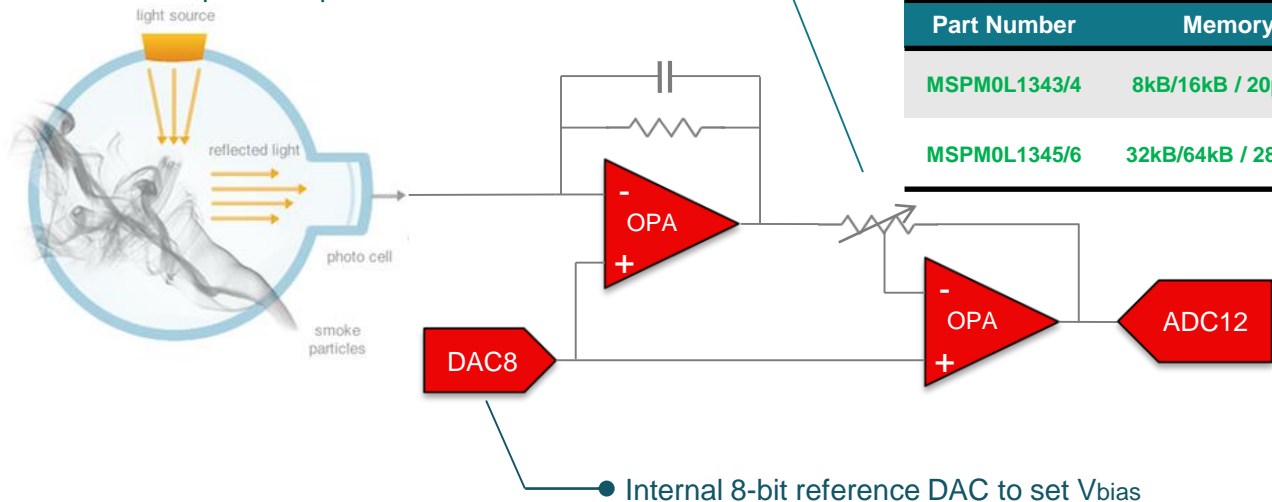




# MSPM0L134x smoke detector concept

## Optical sensing

- 2x OPA with low input bias current (10pA) for 2-channel or cascaded trans-impedance amplification
- Internal programmable gain up to 32x
- 6MHz gain bandwidth with 2 $\mu$ s settling time
- Rail-to-rail input & output



## Key Features in MSPM0L134x

- Low-cost MCU solution with rich analog integration
- 2x OPA (TIA) with 10pA Input Bias current
- Internal connection between OPA - PGA & OPAs - ADC to ease PCB layout for lower noise
- 1 $\mu$ A STANDBY current to reduce system supply current consumption
- Scalable pin-to-pin compatible upgrade path for 8K-to-16K and 32K-to-64K memory

Part Number	Memory / Pin	Analog	Timers
MSPM0L1343/4	8kB/16kB / 20pin VSSOP	2x OPA, DAC8, ADC12, COMP, GPAMP	4x GP, 1x SysTick
MSPM0L1345/6	32kB/64kB / 28pin VSSOP	2x OPA, DAC8, ADC12, COMP, GPAMP	4x GP, 1x SysTick

## Data Acquisition

- 1MSPs 12-bit ADC with 11.2 ENOB
- Programmable internal reference (1.4V or 2.5V)
- Up to 9 external input channels



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