

*Sensi*THING

SIBAS-WPR32-REVB

Version 1.0.0

*Sensi***THING1.0** – Combining Certified BLE Module, Sensors and Wireless Charger.

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1 Overview

1.1 General Information

SensiTHING 1.0 is a ARM-based high performance System on Module. *SensiTHING1.0* integrates the microcontroller (MCU), variety of sensor, Bluetooth connectivity and wireless charging technology. Also, the device comprises smoke detector sensor enabling stand-alone applications of environment control.

Low-power design provides operation of SensiTHING 1.0 during months without charging. *SensiTHING 1.0* enables wireless connectivity, not requiring any RF experience or expertise. The on-board module is already certified for wide global markets.

1.1.1 Base Part numbers

Development Kit Part number:

SIBAS-WC-DKL (SIBAS-WPR32 + SEDA-10 + SIRWPT-A48)

Included Products in the Development Kit :

SIBAS-WPR32	:SensiTHING module
SEDA-10	:ConnectorBoard for a programmer
SIRWPT-A48	:Wireless Charger

1.1.2 Software:

Features

- Demo project to kick-start development
- Single firmware to work with all sensors installed on SensiTHING 1.0
- In real time, you can get information about the relative humidity and temperature, presence of smoke, battery level and charging status, recognition of active and inactive state using an accelerometer, manage external IO / ADC / DAC
- Streaming data over BLE communication profile, and Serial Flash data logging
- The firmware is adapted for maximum energy saving and disables sensors that are not used
- Windows application is available to test sensors and to display information from sensors in real time
- FOTA update using normal BLE-enabled smartphone/tablet/PC (no special hardware needed) with Blue Gecko Bluetooth® Smart iOS or Android App

Tools

- Simplicity Studio v4 - an integrated development environment (IDE) based on Eclipse 4.5.
- Windows BLE SDK – <https://github.com/SensiEDGE/SensiBleWindows> open source SDK to develop application on windows desktop.
- The Silicon Labs Blue Gecko App utilizes the Bluetooth adapter on your phone/tablet to scan for, connect to BLE devices and update firmware (FOTA).

Contact SensiEDGE support services for further information:

<mailto:Support@SensiEDGE.com>.

1.2 Feature's Summary

Product Type	Module
Dimension	Ø32 x 9 mm
RF Communication	Bluetooth Low Energy (Bluetooth 5)
Bluetooth Certified Module	
Technology	Bluetooth 2.4 GHz
Antenna	Internal
RF Conn/ Antenna	Chip Antenna
Modulation schemes:	2-GFSK
Internal High Speed Clock	38.4MHZ crystal oscillator
Internal Low Power Clock	32.768KHZ
output power	8 dBm
Receiver sensitivity	-103 dBm (@125 kbps)
link budget	96dB
Data Rate	up to 2Mbps
Certification	FCC, CE, IC/ISED, MIC/Telec Certified
BQE Qualified	BQE qualified (in progress)
Processor	ARM® 32-bit Cortex®-M4 CPU with FPU
Microcontroller	EFR32BG13
Sensors	
Accelerometer	ADXL362
Smoke Detector	ADPD188BI
Relative humidity & temperature	Si7006-A20
Temperature Sensor	ADT7420
Extra IO/ADC/DAC	AD5592R
User Input/Output	
RG LED	LTST-C195KGJRKT
User Button	KMR221NG LFS

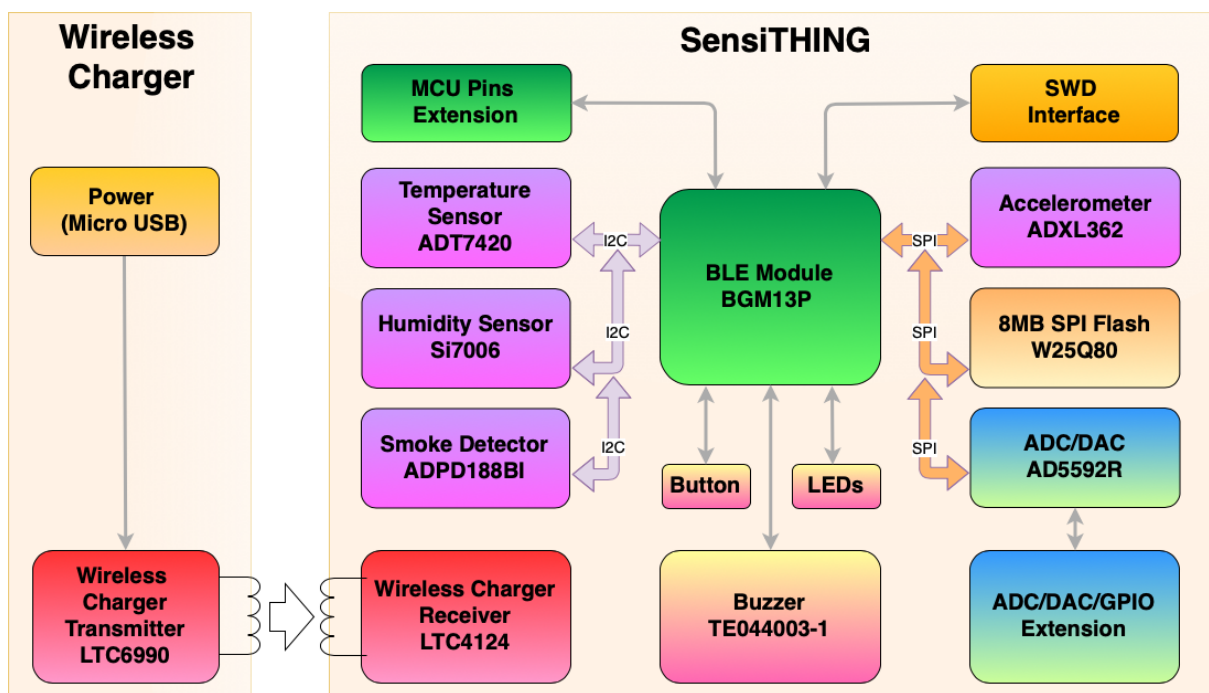
Buzzer	TE044003-1
Data Logger	8Mbit SPI_Flash
Serial Flash	W25Q80DVUXIE
Extension Interface	
MCU GPIO	4
Extra GPIO/ADC/DAC	6
Power Interface	
Lilon Rechargeable Battery	3.6V 100mAh
Wireless Charger Receiver IC	LTC4124
Battery Gas Gauge	LTC2942

1.3 Block Diagram

The system based on 6 main block's:

- Connectivity
- Micro Controller
- Extensions & Power
- Sensors
- Data Logger
- User Interface

Figure 1 SensiTHING Block Diagram

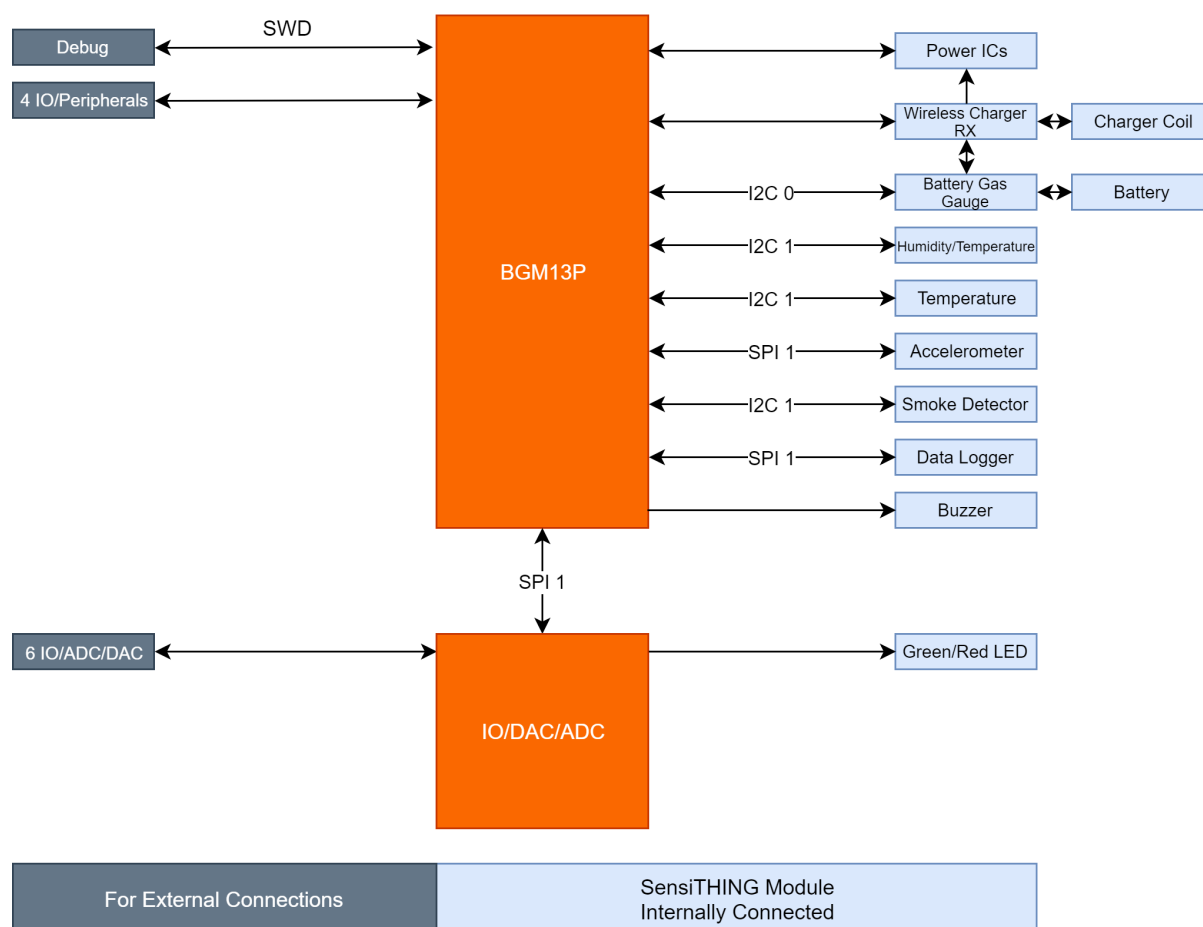


2 Main Hardware Components

SensiTHING hardware building blocks are described in this section.

BGM13P has the extension connector. It can be used as I/O or any BGM13P's peripherals may be assigned to these pins. Additionally, the configurable ADC/DAC/IO pins are tied to another extension connector.

Figure 2 SensiTHING 1.0 Internal & External Connections Diagram



List of peripheral available on the BGM13P's extension connector:

- 4 I/O
- PWM
- UART
- SPI
- ADC
- DAC
- Operational Amplifier
- Low-Energy Sensor Interface
- Analog Comparator

2.1 BGM13P Module

2.1.1 EFR32BG13

The *SensiTHING* module contains Silicon Labs Blue Gecko Bluetooth Low Energy System-on-Chip (SoC). The EFR32BG13 device is the single-die solution providing industry-leading energy efficiency, ultra-fast wake-up times, a scalable power amplifier, an integrated balun. The SoC integrates ARM® Cortex®-M4 core with DSP instructions and floating-point unit (FPU) for efficient signal processing. The core operates at a frequency of up to 40 MHz. The EFR32 product family combines an energy-friendly MCU with a highly integrated radio transceiver implementing Bluetooth 5 and Bluetooth Mesh connectivity.

2.2 IO/ADC/DAC

2.2.1 AD5592R

The AD5592R have eight I/Ox pins (I/O0 to I/O7) that can be independently configured as digital-to-analog converter (DAC) outputs, analog-to-digital converter (ADC) inputs, digital outputs, or digital inputs. The device is controlled thru SPI interface.

The AD5592R have an integrated 2.5 V, 25 ppm/°C reference, which is turned off by default, and an integrated temperature indicator, which gives an indication of the die temperature. The temperature value is read back as part of an ADC read sequence.

2.3 Sensors

The *SensiTHING* module contains the following sensors :

- AD's 3D accelerometer
- AD's temperature
- AD's smoke detection
- SILABS's humidity and temperature

2.3.1 ADXL362: 3D Accelerometer

The ADXL362 is an ultralow power, 3-axis MEMS accelerometer that consumes less than 2 µA at a 100 Hz output data rate and 270 nA when in motion triggered wake-up mode. It samples full bandwidth of the sensor at all data rate unlike other accelerometer using power duty cycling to achieve low power consumption.

2.3.2 ADT7420: ±0.25°C Accurate Temperature Sensor

The ADT7420 is a high accuracy digital temperature sensor offering breakthrough performance over a wide industrial range. It is suitable for low-power application with excellent long-term stability and reliability without calibration or correction required.

2.3.3 APDP188BI: Optical Module for Smoke Detection

The ADPD188BI is a complete photometric system for smoke detection utilizing dual-wavelength technology. The module integrates a highly efficient photometric front end, two LEDs, and a photodiode (PD). All of these items are housed in a custom package that prevents light from going directly from the LED to the photodiode without first entering the smoke detection chamber.

2.3.4 Si7006-A20: Humidity and Temperature Sensor

The Si7006 I2C Humidity and Temperature Sensor is a monolithic CMOS IC integrating humidity and temperature sensor elements, an analog-to-digital converter, signal processing, calibration data, and an I2C Interface. The patented use of industry-standard, low-K polymeric dielectrics for sensing humidity enables the construction of low-power, monolithic CMOS Sensor ICs with low drift and hysteresis, and excellent long term stability.

2.4 Data Logger

2.4.1 W25Q80

The *Sensi*THING module contains Winbond W25Q80. Winbond's W25Q80 is a serial flash memory device. It can be used for storing configurations, gathered sensor data for a long period.

2.5 User Interface

The *Sensi*THING module contains variety of user interfaces :

- DB Unlimited's Buzzer (PF6)
- C&K's Button (PF2)
- Lite-On's RG-LED (Led G @ I/O6 of IO/DAC/ADC, Led R @ I/O7 of IO/DAC/ADC)

2.5.1 TE044003-1 Magnetic Buzzer

DB Unlimited's Buzzer based on Electro-Magnetic Acoustic Transducer for non-contact sound generation and reception using electromagnetic mechanisms.

2.5.2 KMR221NG Button

C&K's is a push operating button. It is used for Bluetooth connectivity and power control.

2.5.3 LTST-C195KGJRKT Dual color chip LED

Lite-On's SMD Red/Green LED based 2 separate LED's in a package, allows two colors (red and green), while only having 4 pins (Dual set cathode and anode) miniature sizes and special configurations for space-sensitive applications.

3 External Connectors

The *SensiTHING 1.0* comprises two extension connectors and one debugging connector. J1 provides SWD connectivity to debug the BGM13P SoC.

The extension connectors are CN2 and CN3, where CN2 exposes BGM13P's GPIOs and CN3 provides access to IO/ADC/DAC's pins.

Both connectors have 8-pin 1.27mm-pitch 2-row footprint.

Pin #:	Pin Number
Schematic Name:	Device name description
Type:	Pin type & direction
	S – Power Pin and/or Ground Pin
	I/O – GPIO

Description:	Description of the Pin
--------------	------------------------

3.1 Pin Mux

Table 1 and Table 2 explain function of connectivity pins in *SensiTHING 1.0* module

Table 1 CN2 SensiTHING1.0 Module

Pin #	Schematic Name	Type	Description
1	+3V3	S	+3.3V from voltage regulator
2	GND	S	Ground pin
3	PD14	I/O	
4	PD15	I/O	
5	PA0	I/O	
6	PA1	I/O	
7	NC		Not used
8	NC		Not used

Table 2 CN3 SensiTHING 1.0 Module

	Schematic Name	Type	Description
1	+3V3	S	+3.3V from voltage regulator
2	GND	S	Ground pin
3	I/O0	I/O	IO/ADC/DAC
4	I/O1	I/O	IO/ADC/DAC
5	I/O2	I/O	IO/ADC/DAC
6	I/O3	I/O	IO/ADC/DAC
7	I/O4	I/O	IO/ADC/DAC
8	I/O5	I/O	IO/ADC/DAC

4 SoC

4.1 BGM13P

4.1.1 General Description

The EFR32 product family combines an energy-friendly MCU with a highly integrated radio transceiver. The devices are well suited for any battery operated application as well as other systems requiring high performance and low energy consumption. The single-die solution provides industry-leading energy efficiency, ultra-fast wakeup times, a scalable power amplifier, an integrated balun and no-compromise MCU features.

The BGM13P are based on the high performance ARM Cortex-M4, 32-bit RISC core operating at a frequency of up to 40 MHz.

The Cortex-M4 core features a Floating-point unit (FPU) single precision, which supports all ARM single-precision data-processing instructions and data types. It also implements a full set of DSP instructions and a memory protection unit (MPU) which enhances application security.

SensiTHING 1.0 integrates the BGM13P32F512GA module. The module's SoC includes 512 kB of flash and 64 kB of RAM, I/O which may be connected to any SoC's peripherals. Also, it features a radio transceiver supporting Bluetooth Low Energy® and proprietary short range wireless protocols..

BGM13P's module provides Bluetooth 5 connecting other devices at ranges of up to 200 meter. The ARM Cortex-M4 RISC processor comprise the Linked Direct Memory Access (LDMA) controller allowing the system to perform memory operations independently of software. This reduces both the energy consumption and software workload. The LDMA allows operations to be linked together and staged, enabling sophisticated operations to be implemented.

On-chip rich security module provides CRC calculating block, true random number generator and two hardware cryptographic accelerators for AES 128/256, SHA-1, SHA-2 (SHA-224 and SHA-256) and ECC.

The SoC includes analog peripherals such as

- 12-bit 1 Msps SAR analog to digital converter (ADC)
- two analog comparators
- two digital to analog converters
- three operational amplifiers
- digital to analog current converter

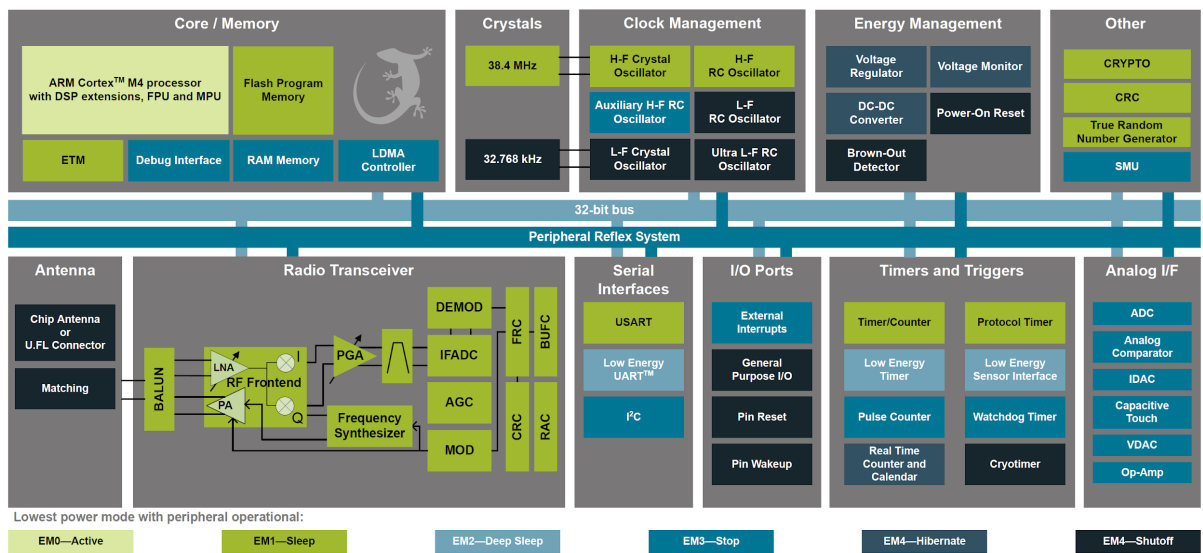
The digital peripherals encompass

- eight DMA Controllers
- twelve-channel peripheral reflex system
- two 16-bit timer/counters with compare/capture/PWM channels
- one 32-bit timer/counter, 32-bit real time counter and calendar
- 16-bit low energy timer for waveform generation
- two watchdog timers
- 16-bit pulse counters
- three universal synchronous/asynchronous receiver/transmitter
- two I²C interfaces

The BGM13P32F512GA is capable to operate in wide range of temperature from -40 to +85 C° and voltages from 1.8 to 3.8V

4.1.2 Block Diagram

Figure 3 SensiTHING’s MCU Block Diagram



(*) Some of the peripherals are connected internally on-board sensors, others are available at extension connector (list).

5 Bluetooth 5

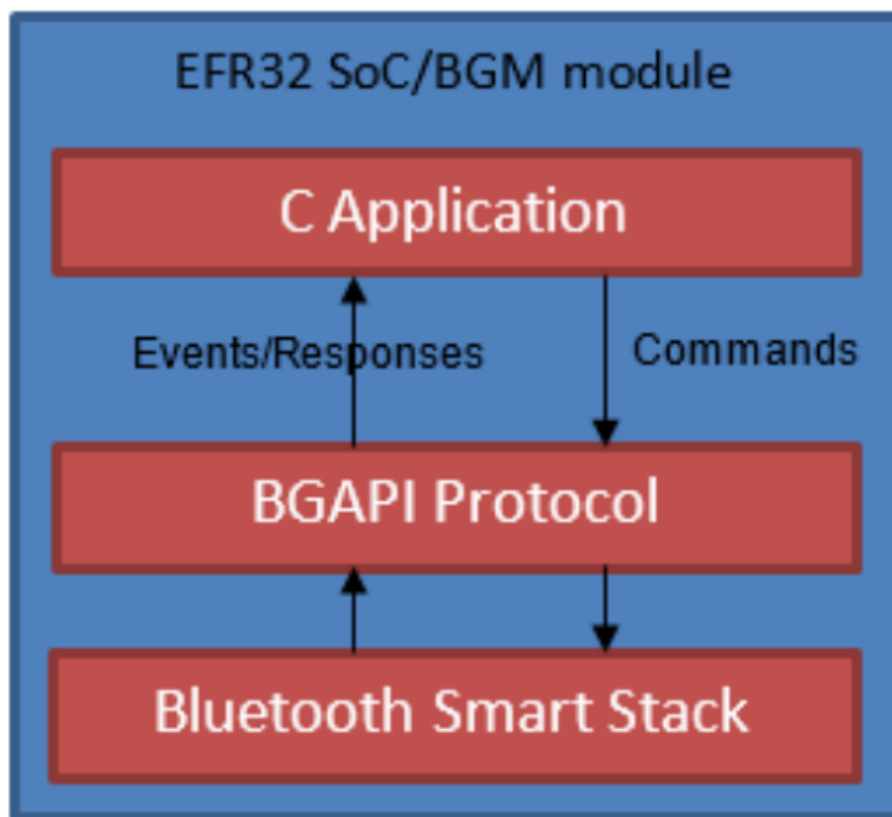
5.1 On-Chip Radio

5.1.1 General Description

The BGM13P's radio enables support for Bluetooth Low Energy (BLE). The size of on-chip memory is enough to meet Bluetooth Mesh networking memory requirements effectively.

The Bluetooth SDK allows you to develop System-On-Chip (SoC) firmware in C on a single microcontroller. On an SoC system the Application code, the Bluetooth Host, and Controller code run on the same Wireless MCU.

Figure 4 Embedded BLE Protocol Stack



5.1.2 Features

- Bluetooth Radio features
 - Modulation schemes: GFSK
 - Air data rate up to 2 Mbps
 - On-board antenna
 - Operating temperature range from -40 °C to 85 °C
- RF features
 - Receiver sensitivity: -103,2dBm at 125 kbit/s
 - Programmable RF output power up to +8dBm

6 Configurable

6.1 ADC/DAC/IO

6.1.1 Functional Description

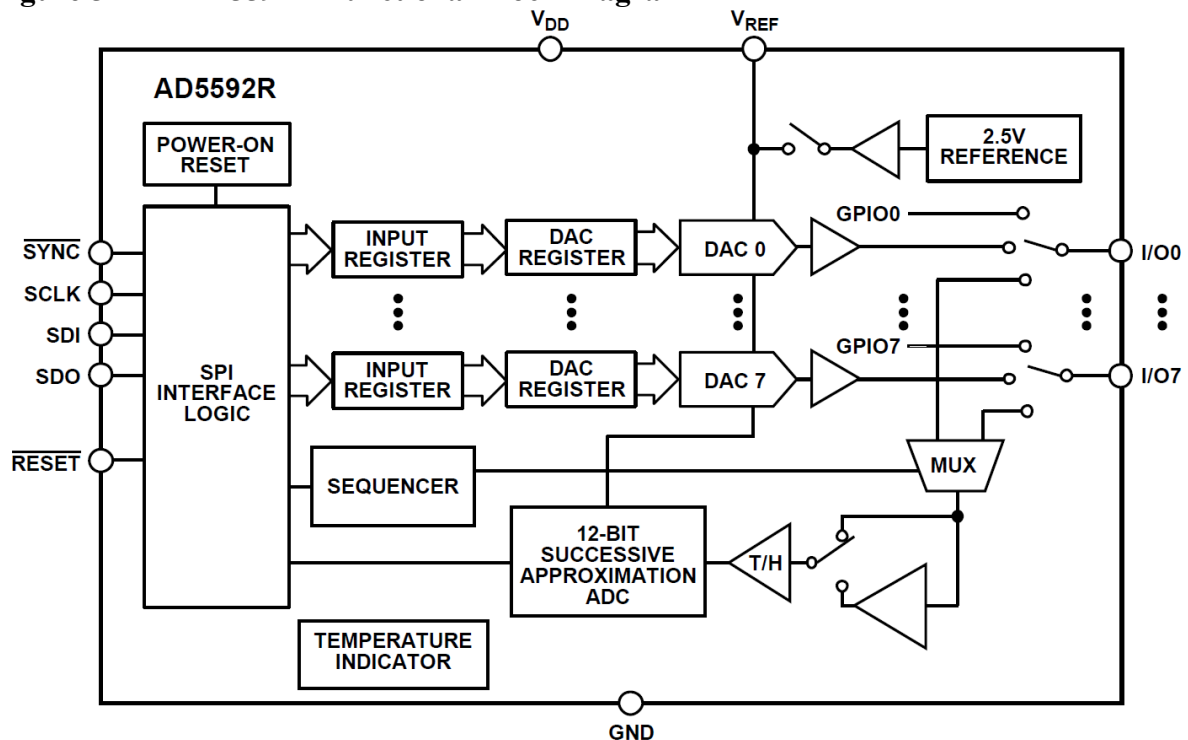
The *SensiTHING 1.0* comprise the pin extension unit with analog capabilities. The AD5592R have eight I/Ox pins (I/O0 to I/O7) that can be independently configured as DAC outputs, ADC inputs, digital outputs, or digital inputs.

When an I/Ox pin is configured as an analog output, it is driven by a 12-bit DAC. The output range of the DAC is 0 V to V_{REF} or 0 V to $2 \times V_{REF}$. The AD5592R have an integrated 2.5V, 25 ppm/°C reference, which is turned off by default, and an integrated temperature indicator, which gives an indication of the die temperature.

When an I/Ox pin is configured as an analog input, it is connected to a 12-bit ADC via an analog multiplexer. The input range of the ADC is 0 V to V_{REF} or 0 V to $2 \times V_{REF}$. The ADC has a total throughput rate of 400 kSPS. The I/Ox pins can also be configured as digital, general-purpose input or output (GPIO) pins. The state of the GPIO pins can be set or read back by accessing the GPIO write data register or the GPIO read configuration register, respectively, via a serial peripheral interface (SPI) write or read operation.

6.1.2 Block Diagram

Figure 5 AD5592R Functional Block Diagram



Two I/O pins are connected to control the two-color Red/Green LED. The rest pins are connected to the CN3 extension connector.

Figure 6 AD5592R Schematic Connection

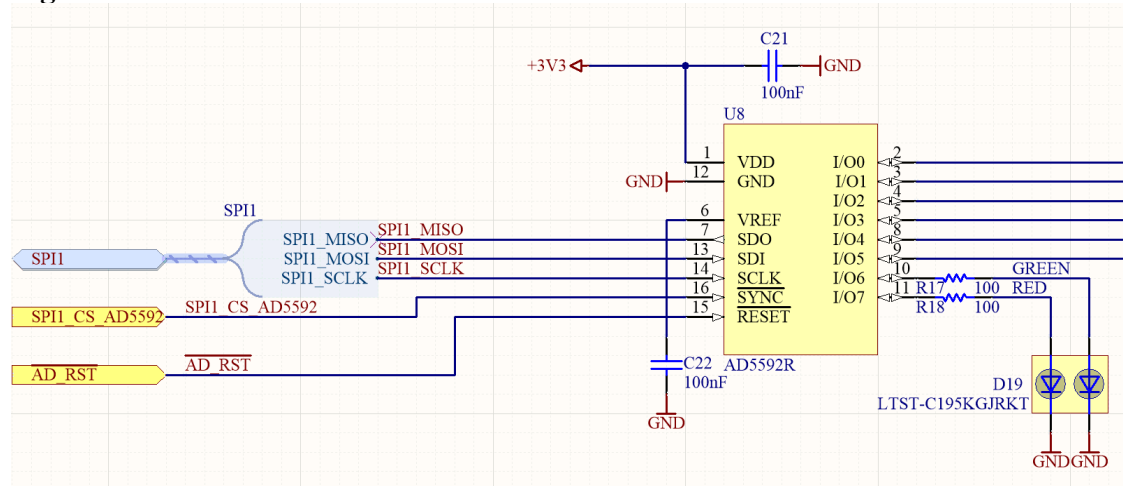


Table 3 AD5592R Pin Assignment

Pin#	Name	Function
1	VDD	Power Supply Input. The AD5592R operates from 2.7 V to 5.5 V, and this pin must be decoupled with a 0.1 μ F capacitor to GND
2-5, 8-10	I/O0	These pins can be independently configured as DACs, ADCs, or general-purpose digital inputs or outputs. The function of each pin is determined by programming the I/Ox pin configuration registers
6	VREF	Reference Input/Output. When the internal reference is enabled, the 2.5 V reference voltage is available on this pin. A 0.1 μ F capacitor connected from the VREF pin to GND is recommended to achieve the specified performance from the AD5592R. When the internal reference is disabled, an external reference must be applied to this pin. The voltage range for the external reference is 1 V to VDD
7	SDO	Data Out. Logic output. The conversion results from the ADC, register reads, and temperature sensor information are provided on this output as a serial data stream. The bits are clocked out on the rising edge of the SCLK input. The MSB is placed on the SDO pin on the falling edge of SYNC. Because the SCLK can idle high or low, the next bit is clocked out on the first rising edge of SCLK that follows a falling edge SCLK while SYNC is low
11	I/O7	Input/Output 7. This pin can be configured as a DAC, ADC, or general-purpose digital input or output. I/O7 can also be configured as a BUSY signal to indicate when an ADC conversion is taking place
12	GND	Ground Reference Point for All Circuitry on the AD5592R
13	SDI	Data In. Logic input. Data that is to be written to the DACs and

		control registers is provided on this input and is clocked into the register on the falling edge of SCLK
14	SCLK	Serial Clock Input. Data is clocked into the input shift register on the falling edge of the serial clock input. Data can be transferred at rates of up to 50 MHz when writing to the DACs. SCLK has a maximum speed of 20 MHz when performing a conversion or clocking data from the AD5592R
15	RESET	Asynchronous Reset Pin. Tie this pin high for normal operation. When this pin is brought low, the AD5592R is reset to its default configuration
16	SYNC	Synchronization. Active low control input. SYNC is the frame synchronization signal for the input data. When SYNC goes low, data is transferred in on the falling edges of the next 16 clocks

7 Sensors

7.1 Smoke Detector

7.1.1 General Description

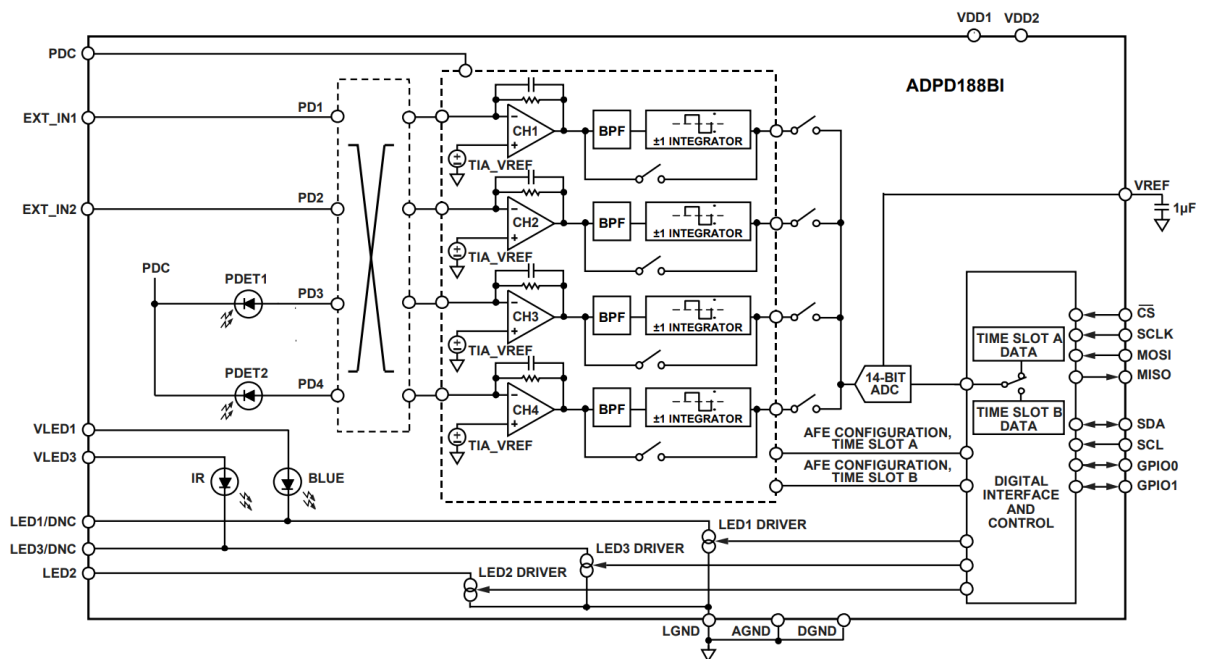
The ADPD188BI is a complete photometric system for smoke detection using optical dual wavelength technology. The module integrates a highly efficient photometric front end, two light emitting diodes (LEDs), and two photodiodes (PDs). These items are housed in a custom package that prevents light from going directly from the LED to the photodiode without first entering the smoke detection chamber.

7.1.2 Features

- 1 blue LED, 1 IR LED, and 2 photodiodes
- 2 external inputs for other sensors (for example, CO and temperature)
- three 370 mA LED drivers
- 20-bit burst accumulator enabling 20 bits per sample period
- On-board sample to sample accumulator enabling up to 27 bits per data read
- Optimized SNR for signal limited cases
- I²C or SPI communication

7.1.3 Block Diagram

Figure 7 ADPD188BI Functional Block Diagram



The ADPD188BI is a complete, integrated optical module designed for smoke detection measurements. The module contains two optical detectors. Photodetector 1 (PDET1) has 0.4mm² of active area and is connected to Channel 3 of the ASIC. Photodetector 2 (PDET2)

has 0.8mm² of active area and is connected to Channel 4 of the ASIC. The two photodiodes can be combined into a single detector with 1.2 mm² of active area. The module combines the dual photodetector with two separate LEDs, and a mixed-signal photometric front-end ASIC into a single compact device for optical measurements. The dual wavelength ADPD188BI uses a 470 nm blue LED and an 850 nm IR LED. The combination of the different wavelengths in a scattering measurement allows particle size discrimination between different types of smoke, dust, and water vapor. The on-board ASIC includes an analog signal processing block, an ADC, a digital signal processing block, an I²C and SPI communication interface, and three independently programmable pulsed LED current sources.

7.1.4 Connections and Signals

Figure 8 ADPD188BI Schematic Connections

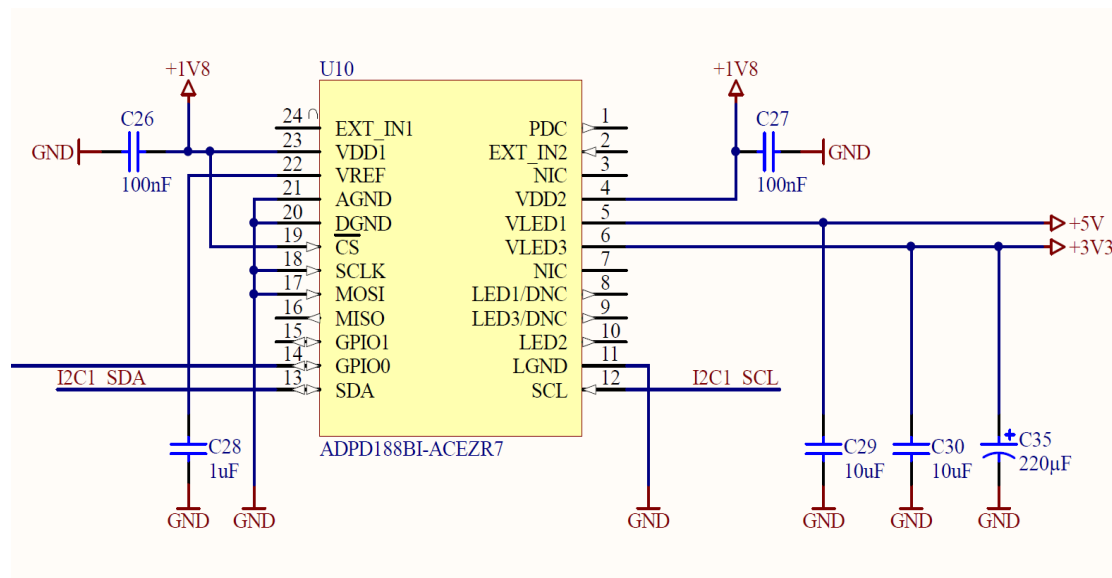


Table 4 ADPD188BI Pin Assignment

Pin#	Name	Function
1	PDC	Photodiode Common Cathode Bias
2	EXT_IN2	EXT_IN2 Current Input
3	NIC	No Internal Connection. This pin is not internally connected
4	VDD2	1.8V Supply
5	VLED1	Blue LED Anode Supply Voltage
6	VLED3	IR LED Anode Supply Voltage
7	NIC	No Internal Connection. This pin is not internally connected
8	LED1/DNC	LED1 Driver Current Sink/Do Not Connect (DNC). Do not connect to this pin when using internal LEDs
9	LED3/DNC	LED3 Driver Current Sink/Do Not Connect (DNC). Do

		not connect to this pin when using internal LEDs
10	LED2	LED2 Driver Current Sink. If not in use, leave this pin floating
11	LGND	LED Driver Ground
12	SCL	I ² C serial clock (SCL)
13	SDA	I ² C serial data (SDA)
14	GPIO0	General-Purpose Input/Output 0
15	GPIO1	General-Purpose Input/Output 1
16	MISO	SPI Master Input, Slave Output
17	MOSI	SPI Master Output, Slave Input
18	SCLK	SPI Clock Input
19	CS	SPI Chip Select (Active Low)
20	DGND	Digital Ground
21	AGND	Analog Ground
22	VREF	Internally Generated ADC Voltage Reference. Connect a 1 μ F ceramic capacitor from VREF to ground
23	VDD1	1.8 V Supply
24	EXT_IN1	EXT_IN1 Current Input

7.2 Accelerometer

7.2.1 General Description

The *SensiTHING 1.0* contains the ADXL362 accelerometer. The ADXL362 is an ultralow power, 3-axis MEMS accelerometer that consumes less than 2 μA at a 100 Hz output data rate and 270 nA when in motion triggered wake-up mode. Unlike accelerometers that use power duty cycling to achieve low power consumption, the ADXL362 does not alias input signals by undersampling; it samples the full bandwidth of the sensor at all data rates.

The ADXL362 always provides 12-bit output resolution; 8-bit formatted data is also provided for more efficient single-byte transfers when a lower resolution is sufficient. Measurement ranges of $\pm 2\text{ g}$, $\pm 4\text{ g}$, and $\pm 8\text{ g}$ are available, with a resolution of 1 mg/LSB on the $\pm 2\text{ g}$ range. For applications where a noise level lower than the normal 550 $\mu\text{g}/\sqrt{\text{Hz}}$ of the ADXL362 is desired, either of two lower noise modes (down to 175 $\mu\text{g}/\sqrt{\text{Hz}}$ typical) can be selected at minimal increase in supply current.

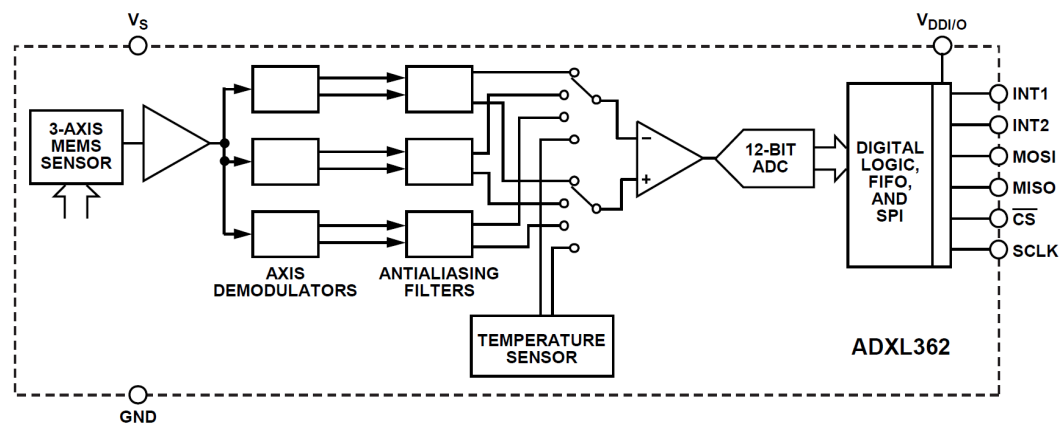
In addition to its ultralow power consumption, the ADXL362 has many features to enable true system level power reduction. It includes a deep multimode output FIFO, a built-in micropower temperature sensor, and several activity detection modes including adjustable threshold sleep and wake-up operation that can run as low as 270 nA at a 6 Hz (approximate) measurement rate. A pin output is provided to directly control an external switch when activity is detected, if desired. In addition, the ADXL362 has provisions for external control of sampling time and/or an external clock.

7.2.2 Features

- Ultralow power
 - Power can be derived from coin cell battery
 - 1.8 μA at 100 Hz ODR, 2.0 V supply
 - 3.0 μA at 400 Hz ODR, 2.0 V supply
 - 270 nA motion activated wake-up mode
 - 10 nA standby current
- High resolution: 1 mg/LSB
- Built-in features for system-level power savings:
 - Adjustable threshold sleep/wake modes for motion activation
 - Autonomous interrupt processing, without need for microcontroller intervention, to allow the rest of the system to be turned off completely
 - Deep embedded FIFO minimizes host processor load
 - Awake state output enables implementation of standalone, motion activated switch
- Low noise down to 175 $\mu\text{g}/\sqrt{\text{Hz}}$
- Wide supply and I/O voltage ranges: 1.6 V to 3.5 V
 - Operates off 1.8 V to 3.3 V rails
- Acceleration sample synchronization via external trigger
- On-chip temperature sensor
- SPI digital interface
- Measurement ranges selectable via SPI command
- Small and thin 3 mm \times 3.25 mm \times 1.06 mm package

7.2.3 Block Diagram

Figure 9 ADXL362 Functional Block Diagram



7.2.4 Connections and Signals

Figure 10 ADXL362 Schematic Connections

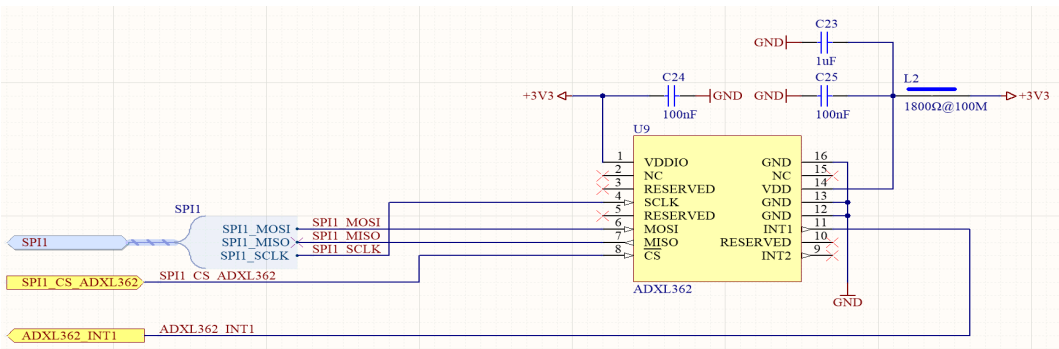


Table 5 ADXL362 Pin Assignment

Pin#	Name	Function
1	VDDIO	Supply Voltage for Digital I/O
2	NC	No Connect
3	Reserved	Reserved. Can be left unconnected or connected to GND
4	SCLK	SPI Communications Clock
5	Reserved	Reserved. Can be left unconnected or connected to GND
6	MOSI	Master Output, Slave Input. SPI serial data input
7	MISO	Master Input, Slave Output. SPI serial data output
8	CS	SPI Chip Select, Active Low. Must be low during SPI communications
9	INT2	Interrupt 2 Output. INT2 also serves as an input for synchronized sampling
10	Reserved	Reserved. Can be left unconnected, or connected to GND

11	INT1	Interrupt 1 Output. INT1 also serves as an input for external clocking
12	GND	Ground. This pin must be grounded
13	GND	Ground. This pin must be grounded
14	VS	Supply Voltage
15	NC	No Connect. Not internally connected
16	GND	Ground. This pin must be grounded

7.3 Temperature Sensor

7.3.1 General Description

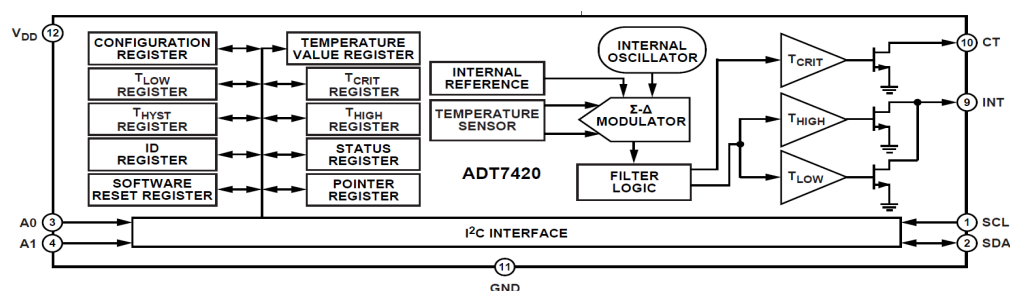
The *SensiTHING 1.0* module contains AD's ADT7420. The ADT7420 is a high accuracy digital temperature sensor offering breakthrough performance over a wide industrial range, housed in a 4 mm × 4 mm LFCSP package. It contains an internal band gap reference, a temperature sensor, and a 16-bit ADC to monitor and digitize the temperature to 0.0078°C resolution. The ADC resolution, by default, is set to 13 bits (0.0625°C). The ADC resolution is a user programmable mode that can be changed through the serial interface.

7.3.2 Features

- High performance
 - Temperature accuracy
 - $\pm 0.20^{\circ}\text{C}$ from -10°C to $+85^{\circ}\text{C}$ at 3.0 V
 - $\pm 0.25^{\circ}\text{C}$ from -20°C to $+105^{\circ}\text{C}$ from 2.7 V to 3.3 V
 - 16-bit resolution: 0.0078°C
- Ultralow temperature drift: 0.0073°C
 - NIST traceable or equivalent
 - Fast first temperature conversion on power-up of 6 ms
- Easy implementation
 - No temperature calibration/correction required by user
 - No linearity correction required
- Low power
 - Power-saving 1 sample per second (SPS) mode
 - 700 μW typical at 3.3 V in normal mode
 - 7 μW typical at 3.3 V in shutdown mode
- Wide operating ranges
 - Temperature range: -40°C to $+150^{\circ}\text{C}$
 - Voltage range: 2.7 V to 5.5 V
- Programmable interrupts
 - Critical overtemperature interrupt
 - Overtemperature/undertemperature interrupt
- I2C-compatible interface
- 16-lead, 4 mm × 4 mm LFCSP RoHS-compliant package

7.3.3 Block Diagram

Figure 11 ADT7420 Functional Block Diagram



7.3.4 Connections and Signals

Figure 12 ADT7420 Schematic Connections

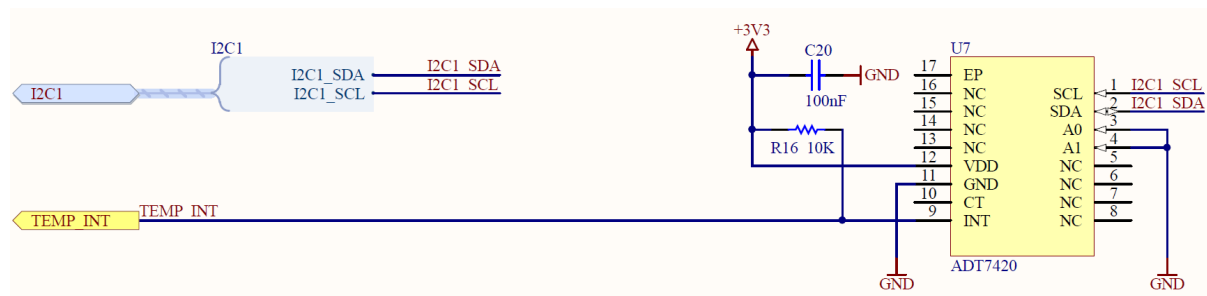


Table 6 ADT7420 Pin Assignment

Pin #	Name	Function
1	SCL	I2C Serial Clock Input. The serial clock is used to clock in and clock out data to and from any register of the ADT7420. Open-drain configuration. A pull-up resistor is required, typically 10 kΩ
2	SDA	I2C Serial Data Input/Output. Serial data to and from the part is provided on this pin. Open-drain configuration. A pull-up resistor is required, typically 10 kΩ
3	A0	I2C Serial Bus Address Selection Pin. Logic input. Connect to GND or VDD to set an I2C address
4	A1	I2C Serial Bus Address Selection Pin. Logic input. Connect to GND or VDD to set an I2C address
5	NC	No Connect. The NC pin is not bonded to the die internally
6	NC	No Connect. The NC pin is not bonded to the die internally
7	NC	No Connect. The NC pin is not bonded to the die internally
8	NC	No Connect. The NC pin is not bonded to the die internally
9	INT	Overtemperature and Undertemperature Indicator. Logic output. Power-up default setting is as an active low comparator interrupt. Open-drain configuration. A pull-up resistor is required, typically 10 kΩ
10	CT	Critical Overtemperature Indicator. Logic output. Power-up default

		polarity is active low. Open-drain configuration. A pull-up resistor is required, typically 10 k Ω
11	GND	Analog and Digital Ground
12	VDD	Positive Supply Voltage (2.7 V to 5.5 V). The supply be decoupled with a 0.1 μ F ceramic capacitor to ground
13	NC	No Connect. The NC pin is not bonded to the die internally
14	NC	No Connect. The NC pin is not bonded to the die internally
15	NC	No Connect. The NC pin is not bonded to the die internally
16	NC	No Connect. The NC pin is not bonded to the die internally
17	EP	Exposed Pad. To ensure correct operation, the exposed pad should either be left floating or connected to ground

7.4 Humidity and Temperature Sensor

7.4.1 General Description

The *SensiTHING 1.0* module comprises Silabs's Si7006-A20. The Si7006 I2C Humidity and Temperature Sensor is a monolithic CMOS IC integrating humidity and temperature sensor elements, an analog-to-digital converter, signal processing, calibration data, and an I2C Interface. The patented use of industry-standard, low-K polymeric dielectrics for sensing humidity enables the construction of low-power, monolithic CMOS Sensor ICs with low drift and hysteresis, and excellent long term stability.

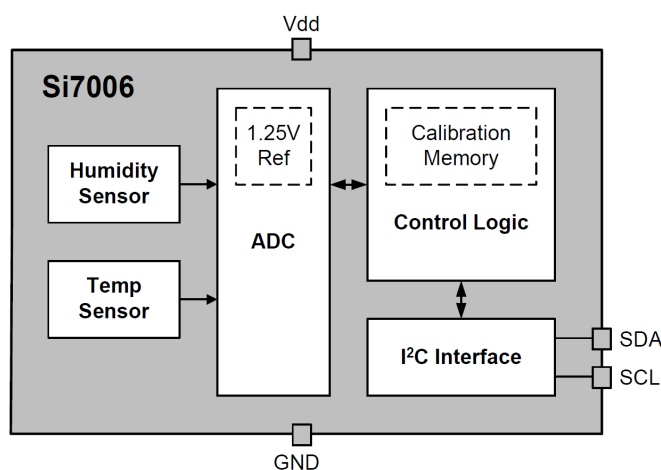
The humidity and temperature sensors are factory-calibrated and the calibration data is stored in the on-chip non-volatile memory. This ensures that the sensors are fully interchangeable, with no recalibration or software changes required.

7.4.2 Features

- Precision Relative Humidity Sensor
 - $\pm 5\%$ RH (max), 0–90% RH
- High Accuracy Temperature Sensor
 - $\pm 1\text{ }^{\circ}\text{C}$ (max), -10 to $85\text{ }^{\circ}\text{C}$
- 0 to 100% RH operating range
- -40 to $+125\text{ }^{\circ}\text{C}$ operating range
- Wide operating voltage
 - (1.9 to 3.6 V)
- Low Power Consumption
 - 150 μA active current
 - 60 nA standby current
- Factory-calibrated
- I2C Interface
- Integrated on-chip heater
- 3x3 mm DFN Package
- Excellent long term stability

7.4.3 Block Diagram

Figure 13 Si7006 Functional Block Diagram



7.4.4 Connections and Signals

Figure 14 Si7006-A20 Schematic Connections

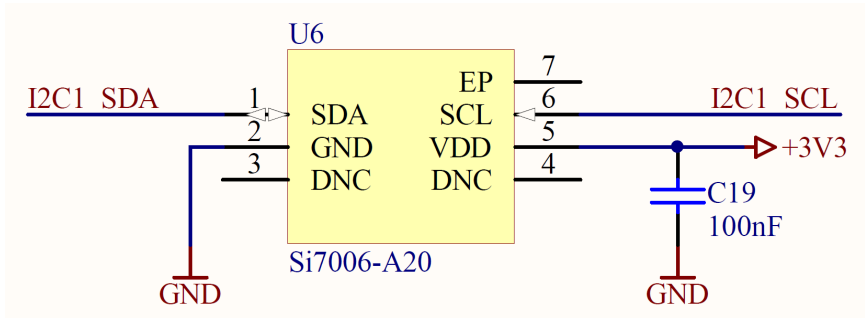


Table 7 Si7006-A20 Pin Assignment

Pin Number	Name	Function
1	SDA	I ² C data
2	GND	Ground. This pin is connected to ground on the circuit board through a trace. Do not connect directly to GND plane
5	VDD	Power. This pin is connected to power on the circuit board
6	SCL	I ² C clock
3, 4	SDO SA0	4-wire SPI serial data output (SDO) Least significant bit of the device address (SA0)
6	CS	These pins should be soldered to pads on the PCB for mechanical stability; they can be electrically floating or tied to VDD (do not tie to GND)
Tgnd	Paddle	This pad is connected to GND internally. This pad is the main thermal input to the onchip temperature sensor. The paddle should be soldered to a floating pad

8 Wireless Charger

8.1 General Description

Wireless charging is implemented in *SensiTHING 1.0*. It is compatible with *SensiTHING Wireless Charger*. The charging device is based on the LTC4124.

The LTC4124 is a simple high performance wireless Li-Ion charger with low battery disconnect. The pinselectable charge current (up to 100mA) and charge voltage ensure versatility while minimizing the number of required external components.

Wireless charging with the LTC4124 allows devices to be charged while sealed within enclosures and eliminates bulky connectors in space-constrained applications. Elimination of exposed conductive connectors also creates more robust devices while ensuring an effortless end-user experience.

The LTC4124 includes an NTC input for safe temperature qualified charging as well as a battery disconnect feature that prevents damage to a battery due to over-discharging.

The charging current set on *SensiTHING 1.0* is 25 mA. The D1 blue LED indicates charging status.

8.1.1 Features

- Complete Wireless Power Receiver, Li-Ion Charger and PowerPath™ Controller
- Wireless Input Power Control and Rectification
- Wideband Wireless Power Frequency:
 - DC to >10MHz
- Pin-Selectable Charge Current:
 - 10mA/25mA/50mA/ 100mA
- Pin-Selectable Charge Voltage:
 - 4.0V/4.1V/4.2V/4.35V
- Pin-Selectable Low Battery Disconnect:
 - 2.7V/3.2V
- Zero Battery Drain Current in Disconnect/Ship Mode
- Pin-Selectable Low Battery Pre-Charge Current Enable
- NTC Input for Temperature Qualified Charging
- Safety Charge Termination Timer
- Tiny Total Solution Size with Few Externals
- Small Thermally Enhanced 12-lead
 - 2mm × 2mm LQFN

8.1.2 Block Diagram

TBD

9 Battery Gas Gauge

9.1 General Description

The *SensiTHING 1.0* contains current measuring circuits based on the LTC2942 Battery Gas Gauge.

The LTC®2942 measures battery charge state, battery voltage and chip temperature in handheld PC and portable product applications. Its operating range is perfectly suited for single-cell Li-Ion batteries. A precision coulomb counter integrates current through a sense resistor between the battery's positive terminal and the load or charger. Battery voltage and on-chip temperature are measured with an internal 14-bit No Latency $\Delta\Sigma^{\text{TM}}$ ADC. The three measured quantities (charge, voltage and temperature) are stored in internal registers accessible via the onboard SMBus/I2C interface.

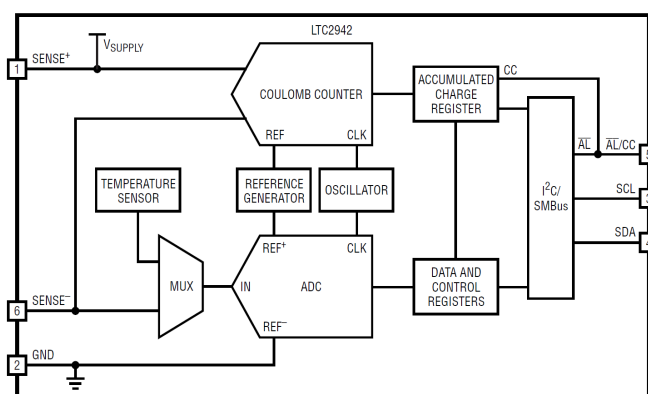
The LTC2942 features programmable high and low thresholds for all three measured quantities. If a programmed threshold is exceeded, the device communicates an alert using either the SMBus alert protocol or by setting a flag in the internal status register.

9.1.1 Features

- Indicates Accumulated Battery Charge and Discharge
- High Accuracy Analog Integration
- ADC Measures Battery Voltage and Temperature
- Integrated Temperature Sensor
- High Side Sense
- 1% Voltage and Charge Accuracy
- $\pm 50\text{mV}$ Sense Voltage Range
- SMBus/I2C Interface
- Configurable Alert Output/Charge Complete Input
- 2.7V to 5.5V Operating Range
- Quiescent Current Less than $100\mu\text{A}$
- Small 6-Pin 2mm \times 3mm DFN package

9.1.2 Block Diagram

Figure 15 LTC2942 Functional Block Diagram



9.1.3 Connections and Signals

Figure 16 LTC2942 Schematic Connections

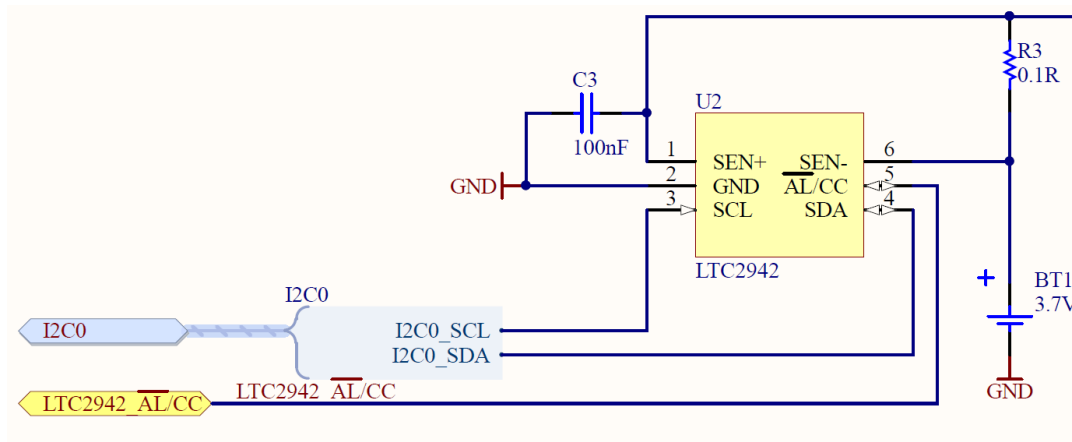


Table 8 LTC2942 Pin Assignment

Pin Number	Name	Function
1	SENSE+	Positive Current Sense Input and Power Supply. Connect to the load/charger side of the sense resistor. VSENSE+ operating range is 2.7V to 5.5V
2	GND	Device Ground. Connect directly to the negative battery terminal
3	SCL	Serial Bus Clock Input
4	SDA	Serial Bus Data Input and Output
5	AL/CC	Alert Output or Charge Complete Input. Configured either as an SMBus alert output or charge complete input by control register bits B[2:1]. At power-up, the pin defaults to alert mode conforming to the SMBus alert response protocol. It behaves as an open-drain logic output that pulls to GND when any threshold register value is exceeded. When configured as a charge complete input, connect to the charge complete output from the battery charger circuit. A high level at CC sets the value of the accumulated charge (registers C, D) to FFFFh
6	SENSE-	Negative Current Sense Input. Connect SENSE- to the positive battery terminal side of the sense resistor. The voltage between SENSE- and SENSE+ must remain within $\pm 50\text{mV}$ in normal operation. SENSE- is also the input for the ADC in voltage measurement mode
7	Exposed Pad	Do Not Connect

10 Serial Flash W25Q80DV

10.1 Description

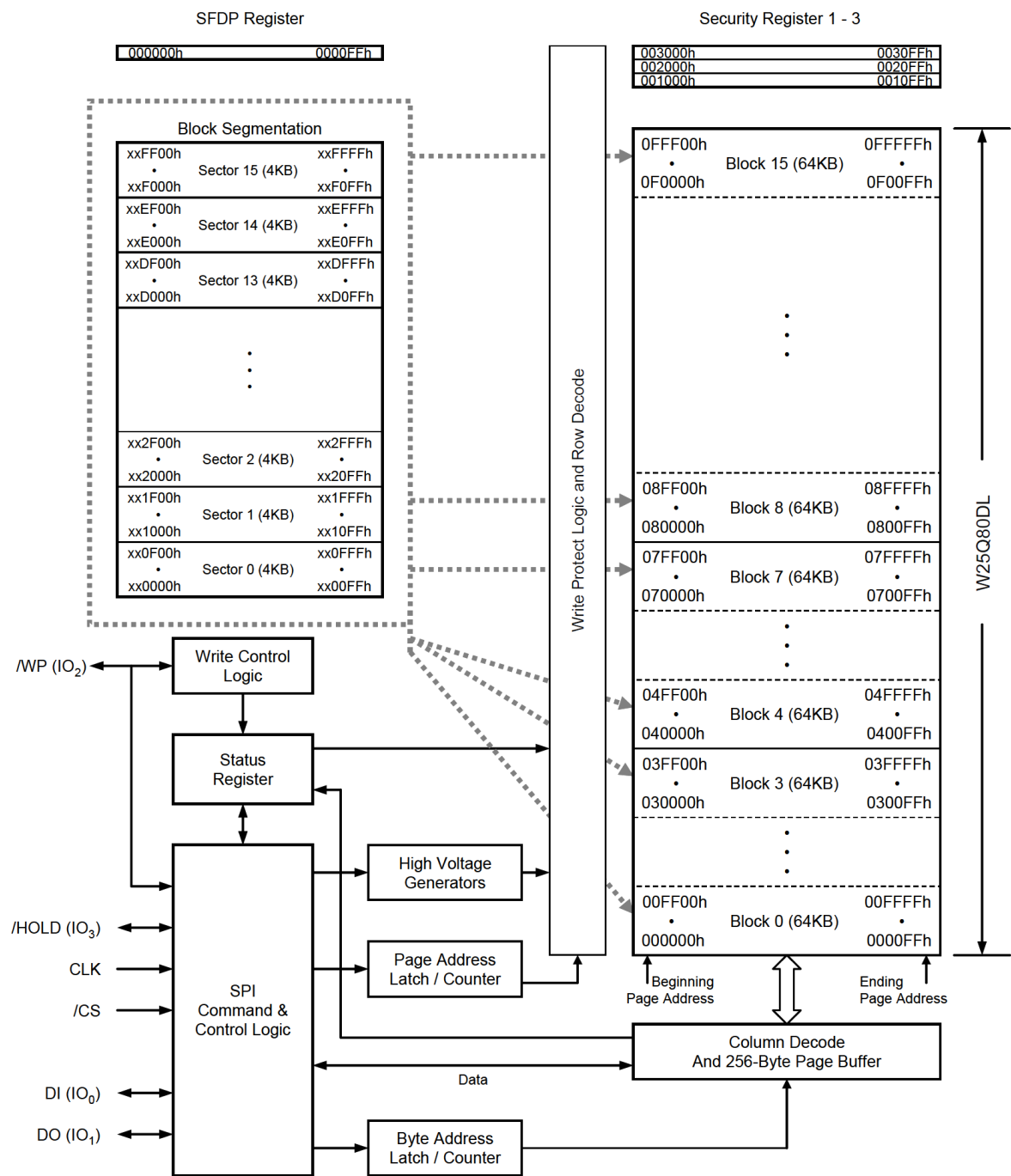
The W25Q80DV (8M-bit) Serial Flash memory provides a storage solution for systems with limited space, pins and power. The 25Q series offers flexibility and performance well beyond ordinary Serial Flash devices. They are ideal for code shadowing to RAM, executing code directly from Dual/Quad SPI (XIP) and storing voice, text and data. The device operates on a single 2.7V to 3.6V power supply with current consumption as low as 1µA for power-down. All devices are offered in space-saving packages.

10.1.1 Features

- Family of SpiFlash Memories
 - W25Q80DV: 8M-bit/1M-byte (1,048,576)
 - 256-byte per programmable page
 - Standard SPI: CLK, /CS, DI, DO, /WP, /Hold
 - Dual SPI: CLK, /CS, IO0, IO1, /WP, /Hold
 - Quad SPI: CLK, /CS, IO0, IO1, IO2, IO3
 - Uniform 4 KB Sectors, 32KB & 64KB Blocks
- Highest Performance Serial Flash
 - 104 MHz Dual/Quad SPI clocks
 - 208/416 MHz equivalent Dual/Quad SPI
 - 50 MB/s continuous data transfer rate
- Software and Hardware Write Protection
 - Write-Protect all or portion of memory
 - Enable/Disable protection with /WP pin
 - Top or bottom array protection
- Flexible Architecture with 4KB sectors
 - Uniform Sector/Block Erase (4/32/64-kbytes)
 - Program one to 256 bytes < 0.8 ms
 - Erase/Program Suspend & Resume
 - More than 100,000 erase/write cycles
 - More than 20-year data retention
- Low Power, Wide Temperature Range
 - Single 2.7 to 3.6V supply
 - < 1 µA Power-down (typ.)
- Space Efficient Packaging
 - 8-pin SOIC 150-mil/208-mil, VSOP 150-mil
 - 8-pad WSON 6x5-mm, USON 2x3-mm
 - 8-pin PDIP 300-mil
 - 8-ball WLCSP

10.1.2 Block Diagram

Figure 17 W25Q80DV Block Diagram



10.1.3 Connections and Signals

Figure 18 APDS-9250 Schematic Connections

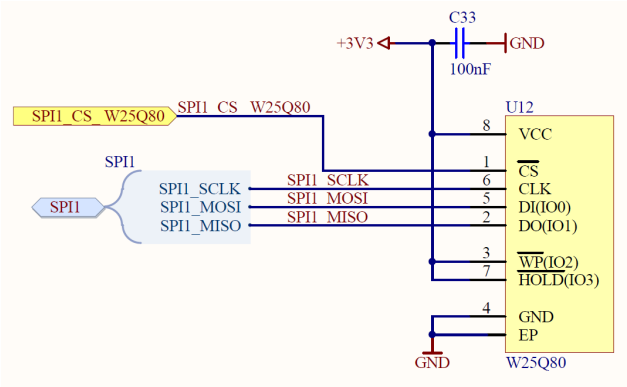


Table 9 W25Q80DV Pin Assignment

Pin Number	Name	Function
1	/CS	Chip Select Input
2	DO (IO1)	Data Output (Data Input Output 1)
3	/WP (IO2)	Write Protect Input (Data Input Output 2)
4	GND	Ground
5	DI (IO0)	Data Input (Data Input Output 0)
6	CLK	Serial Clock Input
7	/HOLD (IO3)	Hold Input (Data Input Output 3)
8	VCC	Power Supply

11 Absolute Maximum Characteristics

TBD

12 Operational Characteristics

12.1 Power supplies

TBD

12.2 Power Consumption

TBD

13 DC Electrical Characteristics

TBD

14 Environmental Specifications

TBD

15 Mechanical Drawings

Figure 19 SensiTHING 1.0 Top and Down View [mm]

