

ABMD ALARM

BLUETOOTH MOTION DETECTOR WITH ACOUSTIC WARNING

POLITECNICO DI TORINO

ELECTRONIC SYSTEMS ENGINEERING - PROF. PASERO EROS

BONONI ANDREA 287628

s287628@studenti.polito.it

SPECIFICATIONS

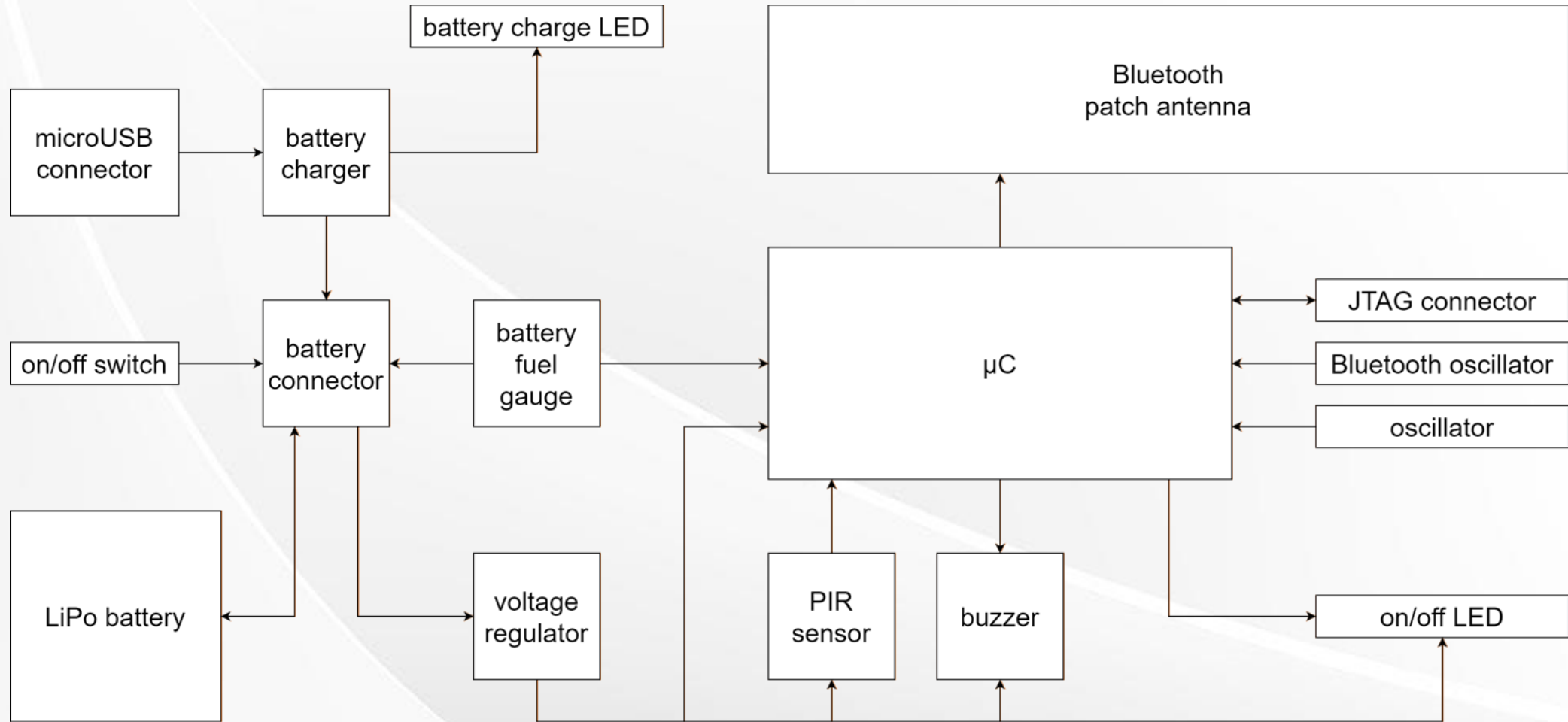
Low power motion detector to be used as intruder alarm in a surveillance security system.

When the presence of an intruder is detected, an acoustic alarm is immediately activated and a notice is sent via Bluetooth to an Android application, from which it is possible to deactivate it (otherwise it will last 5 minutes once activated).

The detector can be activated and deactivated from the Androi application. It can also be configured to automatically send an alert to a police station or to a specific phone number when an intrusion is detected.

The system is rechargeable by means of a commun micro-USB connector and the battery status can be visualized in the Android application. A notification is sent when the battery charge level falls under a minimum threshold.

BLOCK DIAGRAM



PASSIVE INFRARED SENSOR

Manufacturer product number: **USEQMSEA011680**

Manufacturer: KEMET

Mounting style: SMD

Supply voltage: 1.75V to 3.6V

Communication: I²C

Operating current consumption (3.3V): 23 µA

Power down current consumption (3.3V): 2 µA

Main vendor: Mouser

- Part number: 80-USEQMSEA011680
- Unit price (per 1000 units): 15.52€
- Estimated shipping time: 28 weeks

Secondary vendor: Digi-Key

- Part number: 399-USEQMSEA011680CT-ND
- Unit price (per 1000 units): 16.16524€
- Estimated shipping time: 28 weeks

Manufacturer product number: **EKMB1307111K**

Manufacturer: Panasonic Industrial Devices

Mounting style: THD

Supply voltage: 2.3 to 4V

Communication: digital

Maximum current consumption: 12 µA

Maximum output current: 100 µA

Distance: 7m (field of view 90°)

Secondary vendor: Mouser

- Part number: 769-EKMB1307111K
- Unit price (per 1000 units): 8.61€
- Estimated shipping time: 28 weeks

Main vendor: Digi-Key

- Part number: 255-6554-ND
- Unit price (per 1000 units): 8.73617€
- Estimated shipping time: 12 weeks

Manufacturer product number: **EKMC1607112**

Manufacturer: Panasonic Industrial Devices

Mounting style: THD

Supply voltage: 3V to 6V

Communication: digital

Maximum current consumption: 300 µA

Maximum output current: 100 µA

Distance: 7m (field of view 90°)

Main vendor: Digi-Key

- Part number: 255-6546-ND
- Unit price (per 1000 units): 6.71293€
- Estimated shipping time: 12 weeks

Secondary vendor: Mouser

- Part number: 769-EKMC1607112
- Unit price (per 1000 units): 6.81€
- Estimated shipping time: 28 weeks

An SMD mounting style would be better, but the cost is not worth the benefit. The two THD sensors can both be employed and they work in a similar way (the current consumption is different, but in any case it is negligible with respect to the consumption introduced by the other components of our system). Since it comes with a quite lower price, the **EKMC1607112** sensor will be employed in our project.

BUZZER

Manufacturer product number: AI-1223-TWT-3V-2-R

Manufacturer: PUI Audio, Inc.

Mounting style: THD

Type: electromechanical, internally driven

Supply voltage: 2V to 4V

Size: 12.2 mm diameter

Maximum current consumption (3V): 30 mA

Sound Pressure Level (3V, 10 cm): 82 dB

Main vendor: Mouser

- Part number: 665-AI1223TWT3V2R
- Unit price (per 1000 units): 0.676€
- Estimated shipping time: 2 weeks

Secondary vendor: Digi-Key

- Part number: 668-1456-ND
- Unit price (per 1000 units): 0.68533€
- Estimated shipping time: 12 weeks

Manufacturer product number: AI-3035-TWT-3V-R

Manufacturer: PUI Audio, Inc.

Mounting style: THD

Type: piezoelectric, internally driven

Supply voltage: 2V to 5V

Size: 30 mm diameter

Maximum current consumption (3V): 9 mA

Sound Pressure Level (3V, 10 cm): 100 dB

Main vendor: Digi-Key

- Part number: 668-1204-ND
- Unit price (per 1000 units): 1.65494€
- Estimated shipping time: 12 weeks

Secondary vendor: Mouser

- Part number: 665-AI3035TWT3VR
- Unit price (per 1000 units): 1.77€
- Estimated shipping time: 3 weeks

The piezoelectric sensor leads to an inferior power consumption but the electromechanical sensor has a lower price. Since the buzzer will be turned off the most of the time, the power consumption is not as important as the price (as long as it is manageable), therefore the **AI-1223-TWT-3V-2-R** will be employed in our project.

MICROCONTROLLER

Manufacturer product number: **CC2640F128RHBR**

Manufacturer: Texas Instruments

Mounting style: SMD

Package: VQFN 32-pin 5mm x 5mm

Supply voltage: 1.8V to 3.8V

Internal Bluetooth Low Energy (BLE) 4.2

128 kB programmable flash, 8 kB of SRAM for cache

Current consumption in active state (3V): $1.45 \text{ mA} + F_{\text{CLK}} \cdot 31 \text{ } \mu\text{A/MHz}$

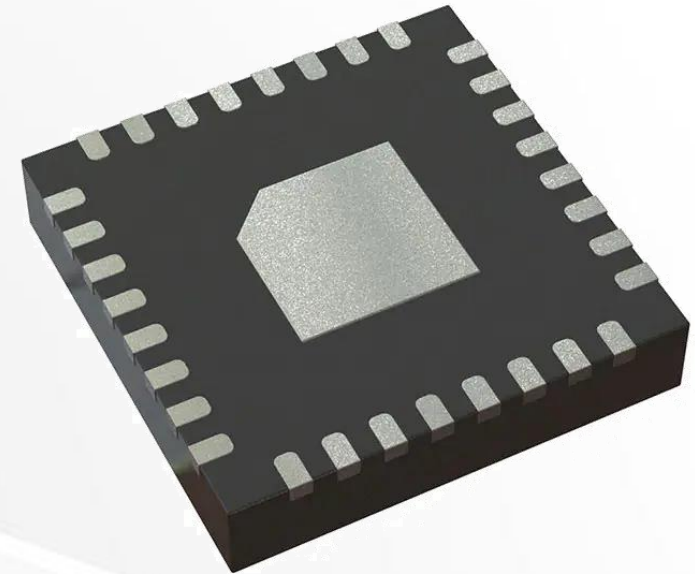
Current consumption in RF state (3V): up to 6.1 mA

Main vendor (due to shipping time): Digi-Key

- Part number: 296-43634-1-ND
- Unit price (per 1000 units): 3.98204€
- Estimated shipping time: 5800 parts in stock, otherwise 35 weeks

Secondary vendor: Mouser

- Part number: 595-CC2640F128RHBR
- Unit price (per 1000 units): 3.68€
- Estimated shipping time: 4800 in stock, otherwise 65 weeks



BATTERY

LiPo battery (3.7V)

Manufacturer product number: LP-523450-IS-3

Manufacturer: BAK

Vendor: Farnell

Vendor part number: 2077888

Capacity: 980 mAh

Terminal type: 5264 connector (3 positions)

Price per unit: 13.6884€

Battery Charger

Manufacturer product number: MCP73832T-2ATI/MC

Manufacturer: Microchip Technology

Output current: 15 mA to 500 mA

Mounting style: SMD

Leakage current: 2 µA

Main vendor: Mouser

- Part number: 579-MCP73832T-2ATIMC
- Unit price (per 1000 units): 0.645€
- Estimated shipping time: 27 weeks

Secondary vendor: Digikey

- Part number: MCP73832T-2ATI/MCCT-ND
- Unit price (per 1000 units): 0.6722€
- Estimated shipping time: 4 weeks

Fuel Gauge

Manufacturer product number: BQ27411DRZT-G1A

Manufacturer: Texas Instruments

Current consumption: 93 µA

Mounting style: SMD

Communication: I²C

Main vendor: Mouser

- Part number: 595-BQ27411DRZT-G1A
- Unit price (per 1000 units): 1.65€
- Estimated shipping time: 21 weeks

Secondary vendor: Digikey

- Part number: 296-39941-1-ND
- Unit price (per 1000 units): 1.794€
- Estimated shipping time: 6 weeks

VOLTAGE REGULATOR

Manufacturer product number: TPS62824DMQR

Manufacturer: Texas Instruments

Topology: buck

Output voltage: 2V to 5.5V

Input voltage: 0.6V to 4V

Maximum output current: 1A

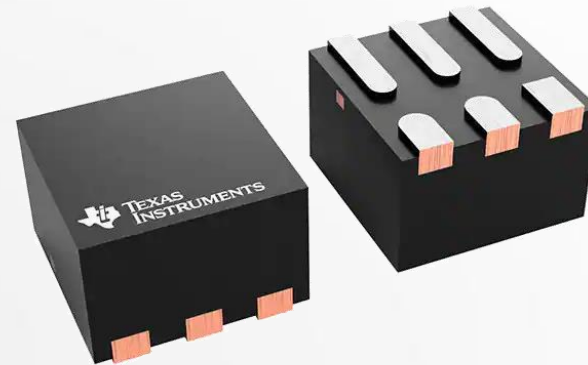
Switching frequency: 2.2 MHz

Main vendor: Mouser

- Part number: 595-TPS62824DMQR
- Unit price (per 1000 units): 0.635€
- Estimated shipping time: 31 weeks

Secondary vendor: Digikey

- Part number: 296-TPS62824DMQRCT-ND
- Unit price (per 1000 units): 0.66534€
- Estimated shipping time: 6 weeks



SECONDARY COMPONENTS

- ON/OFF mechanical switch:
 - Manufacturer product number: SK-12F17-G7
 - Manufacturer: C&K
 - Mounting style: THD
 - Circuit: SPDT
 - Main vendor: Mouser (0.551€ per 1000 units, 2900 units in stock otherwise 9 weeks of shipping time, part number 611-SK-12F17-G7)
 - Secondary vendor: Digikey (0.56984€ per 1000 units, 27000 units in stock otherwise 8 weeks shipping time, part number CKN10393-ND)
- Micro-USB connector:
 - Manufacturer product number: 105164-0001
 - Manufacturer: MOLEX
 - Main vendor: Mouser (0.632€ per 1000 units, 21700 units in stock otherwise 28 weeks of shipping time, part number 538-105164-0001)
 - Secondary vendor: Digikey (0.7389€ per 1000 units, 27133 units in stock otherwise 26 weeks shipping time, part number WM11263CT-ND)
- POWER ON/OFF and BATTERY CHARGE/DISCHARGE leds:
 - Manufacturer product number: HLMP-K150
 - Manufacturer: Broadcom / Avago
 - Mounting style: THD
 - 1.7V, 1mA
 - Main vendor: Digikey (0.08345€ per 1000 units, 4400 units in stock otherwise 15 weeks of shipping time, part number 1080-1067-ND)
 - Secondary vendor: Mouser (0.18€ per 1000 units, 80600 units in stock otherwise 28 weeks shipping time, part number 630-HLMP-K150)
- JTAG connector (header, pin strip):
 - Manufacturer product number: M20-9720546
 - Manufacturer: Harwin
 - Number of positions: 10
 - Contact plating: tin
 - Main vendor: Digikey (0.25705€ per 1000 units, 1500 units in stock otherwise 18 weeks shipping time, part number M20-9720546-ND)
 - Secondary vendor: Mouser (0.325€ per 1000 units, 28000 units in stock otherwise 24 weeks of shipping time, part number 855-M20-9720546)

SECONDARY COMPONENTS

- Quartz oscillator 24 MHz:
 - Manufacturer product number: ECS-240-8-33-AGN-TR3
 - Manufacturer: ECS
 - Load capacitance: 8 pF
 - Frequency tolerance: 25 ppm
 - ESR: 40Ω
 - Main vendor: Mouser (0.224€ per 1000 units, 7200 units in stock otherwise 13 weeks shipping time, part number ECS-240-8-33-AGN-TR3)
 - Secondary vendor: Digikey (0.23579€ per 1000 units, 13300 units in stock otherwise 13 weeks shipping time, part number 50-ECS-240-8-33-AGN-TR3CT-ND)
- Quartz oscillator 32.768 kHz:
 - Manufacturer product number: SC32S-7PF20PPM
 - Manufacturer: Seiko Semiconductors
 - Load capacitance: 7 pF
 - Frequency tolerance: 20 ppm
 - ESR: 70kΩ
 - Main vendor: Digikey (0.21469€ per 1000 units, 148500 units in stock otherwise 25 weeks shipping time, part number 728-1074-1-ND)
 - Secondary vendor: Mouser (0.221€ per 1000 units, 141500 units in stock otherwise 24 weeks shipping time, part number 628-SC32S-7PF20PPM)
- Battery connector (rectangular header, male):
 - Manufacturer product number: 22-03-5035
 - Manufacturer: MOLEX
 - Mounting style: THD
 - Number of positions: 3
 - Pitch: 2.5mm
 - Main vendor: Mouser (0.133€ per 1000 units, 32000 units in stock otherwise 36 weeks shipping time, part number 538-22-03-5035)
 - Secondary vendor: Farnell (0.1586€ per 1000 units, 200000 units in stock, part number 9979620)
- Several passive components and some transistors (drivers)

POWER ESTIMATION

Normal mode current consumption (the buzzer does not sound since no intrusion is detected):

- The voltage regulator provides 3.3V and drives the μC , the sensor and the power LED:
 - μC (3.3V): up to 5.6 mA in RF state
 - Sensor: 300 μA
 - LED: 1 mA while active, therefore 0.5 mA blinking it with a 50% duty cycle (at a frequency so that the human eye cannot perceive the blinking)
 - The voltage regulator efficiency is approximately 90% therefore the maximum input current is about 5.77 mA
- Battery charger: 2 μA
- Battery fuel gauge: 93 μA
- **Total estimated power:** 5.86 mA (the 980 mAh battery should last approximately 167 hours, i.e. about 7 days)

Current consumption supposing to detect 4 intrusions per day (the buzzer sounds intermittently for 5 minutes when an intrusion is detected):

- The voltage regulator drives the μC , the sensor, the buzzer and the power LED:
 - μC (3.3V): up to 5.6 mA in RF state
 - Sensor: 300 μA
 - Buzzer: 30 mA while active, therefore 0.21 mA average
 - LED: 1mA while active, therefore 0.5mA blinking it with a 50% duty cycle (at a frequency so that the human eye cannot perceive the blinking)
 - The voltage regulator efficiency is approximately 90% therefore the input current is about 5.96 mA
- Battery charger: 2 μA
- Battery fuel gauge: 93 μA
- **Total estimated power:** 6.05 mA (the 980 mAh battery should last approximately 162 hours)

As we can see, the buzzer activation (which is theoretically not predictable) probably does not affect too much the battery duration.

COST ESTIMATION

- Microcontroller: 3.98€
- PIR sensor: 6.71€
- Buzzer: 0.676€
- Battery: 13.70€
- Battery charger: 0.645€
- Battery fuel gauge: 1.65€
- Voltage regulator: 0.635€
- Switch: 0.551€
- LEDs: 0.167€
- Oscillators:
 - 24 MHz: 0.224€
 - 32.768 kHz: 0.215€
- Connectors:
 - Micro-USB connector: 0.632€
 - Battery connector: 0.133€
 - JTAG connector: 0.257€
- Passive components: about 2€

Total production cost per unit (considering at least 1000 units produced): 32.20€

Considering the manufacturing of the case and the board, the development of the mobile application and the HW design cost, the final price per unit could be less than 40€.

MARKET ANALYSIS



TIWEE TWX4MSA03V2 wireless motion detector with remote controller (no mobile app) and pill batteries (not rechargeable): 37€



RISWOND P6 wireless motion detector with remote controller (no mobile app) and pill batteries (not rechargeable): 28€



RISWOND P7 wireless motion detector with remote controller (no mobile app) and pill batteries (not rechargeable): 30€

The cost of our system is a bit higher than the products listed above but its battery is rechargeable and it includes a dedicated mobile application instead of a simple remote controller, therefore the price range is acceptable.

GANTT DIAGRAM

