PCB - SafetyDevice

Document Version: 1.0

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1. Features

Feature	Description
Microcontroller	STM32F411CEU6 (ARM Cortex-M4, 100 MHz, 512 KB Flash, 128 KB SRAM)
Motion Sensing	MPU-6050 6-axis IMU (accelerometer + gyroscope) via I^2C
Gas Sensor	TGS822 with heater control and analog sensing input
Wireless Interface	UART interface with power supply for AG9 wireless communication module
Power Supply	Direct battery input (Li-ion/Li-Po), internally regulated to 3.3 V and 5 V
Push Button Input	User input via debounced button
Indicators	Two LED indicators: one controllable, one always on
Buzzer Output	Buzzer connected for alerts
Debugging	SWD header (SWCLK, SWDIO, GND)
USB Interface	USB available for data only (no USB VBUS power support)
Test Pads	All critical signals are broken out to the bottom layer for debugging

2. Electrical Characteristics

Parameter	Value
Input Voltage (VIN)	2.0 V – 6.0 V
Output Voltage (VOUT)	3.3 V and 5.0 V
Logic Voltage (VLOGIC)	3.3 V

3. Functional Overview

3.1 Microcontroller

- **Part Number**: STM32F411CEU6
- **Core**: ARM Cortex-M4
- **Clock**: Up to 100 MHz (24 MHz external crystal is used as high-speed clock source)
- **Memory**: 512 KB Flash / 128 KB SRAM
- **Peripherals**: I^2C, UART, SPI, ADC, PWM, USB FS

3.2 Motion Sensing (MPU-6050)

Communication with the microcontroller is via I^2C (bus 1), with an interrupt line also available.

MPU-6050 Datasheet

Signal	Pin	Description
SDA	PB6	I^2C1 Data
SCL	PB7	I^2C1 Clock
INT	PB8	Interrupt output from MPU-6050

3.3 Gas Sensor Interface (TGS822)

Sensor output is read by the microcontroller ADC. The heater enable pin (drive high to turn on) reduces power consumption.

TGS822 Datasheet

Signal	Pin	Description
HEATER_EN	PB15	Digital output for heater
ANALOG_OUT	PA4	Analog voltage input (ADC)

3.4 Interface for AG9 Wireless Module

Microcontroller communicates via UART and supplies power to the module.

AG9 Datasheet
Helpful Guide

Signal	Pin	Description

Signal	Pin	Description
TX	PB9	UART1 transmit
RX	PB10	UART1 receive
VCC	5 V	AG9 module power
GND	—	Ground

3.5 Indicators and Buzzer

LED1 is placed at the top-top-left corner and is software-controllable. LED2 is always on (connected to 3.3 V).

A push button is available and debounced in hardware.

Component	Pin	Notes
LED1	PA17	Software-controlled indicator
LED2	—	Always on (3.3 V connected)
Buzzer	PA2	Digital or PWM-controlled output
Push Button	PA5	Debounced user push button

4. USB and Debugging

- **USB Interface**: Standard USB FS (full-speed/12 Mbps) data lines (D+/D–)
- **Note**: USB power (VBUS) is not routed to the board supply – use battery input
- **Debug Port**: SWDIO, SWCLK, GND exposed for in-circuit programming/debugging

STM32CubeIDE is recommended for programming and firmware development.

5. Power Supply

- Designed for direct Li-ion cell input (3.7 V typical)
- Includes onboard switching regulators (external protection recommended)
- Capable of driving external 5 V modules such as AG9

6. Mechanical & Test Points

- **Mechanical**: See `mechanical.pdf` for mounting details and dimensions
- **Test Pads**: All critical signals are broken out on the bottom side for testing and debugging:

Test Pad	Description
T1	Power (3.3 V / GND)
T2	AG9 Module Interface
T3	IMU I^{2}C Interface
T4	Gas Sensor Signals