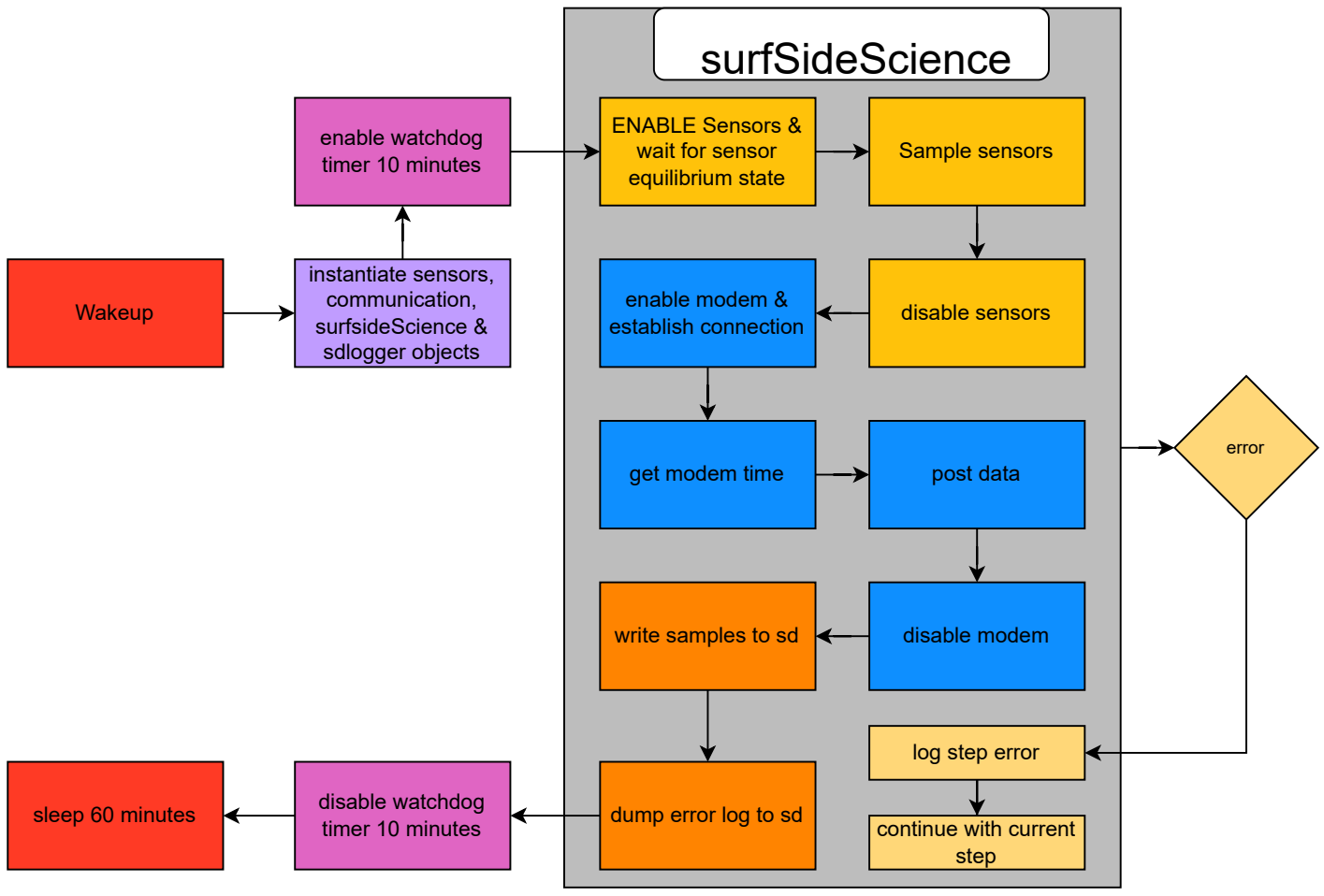
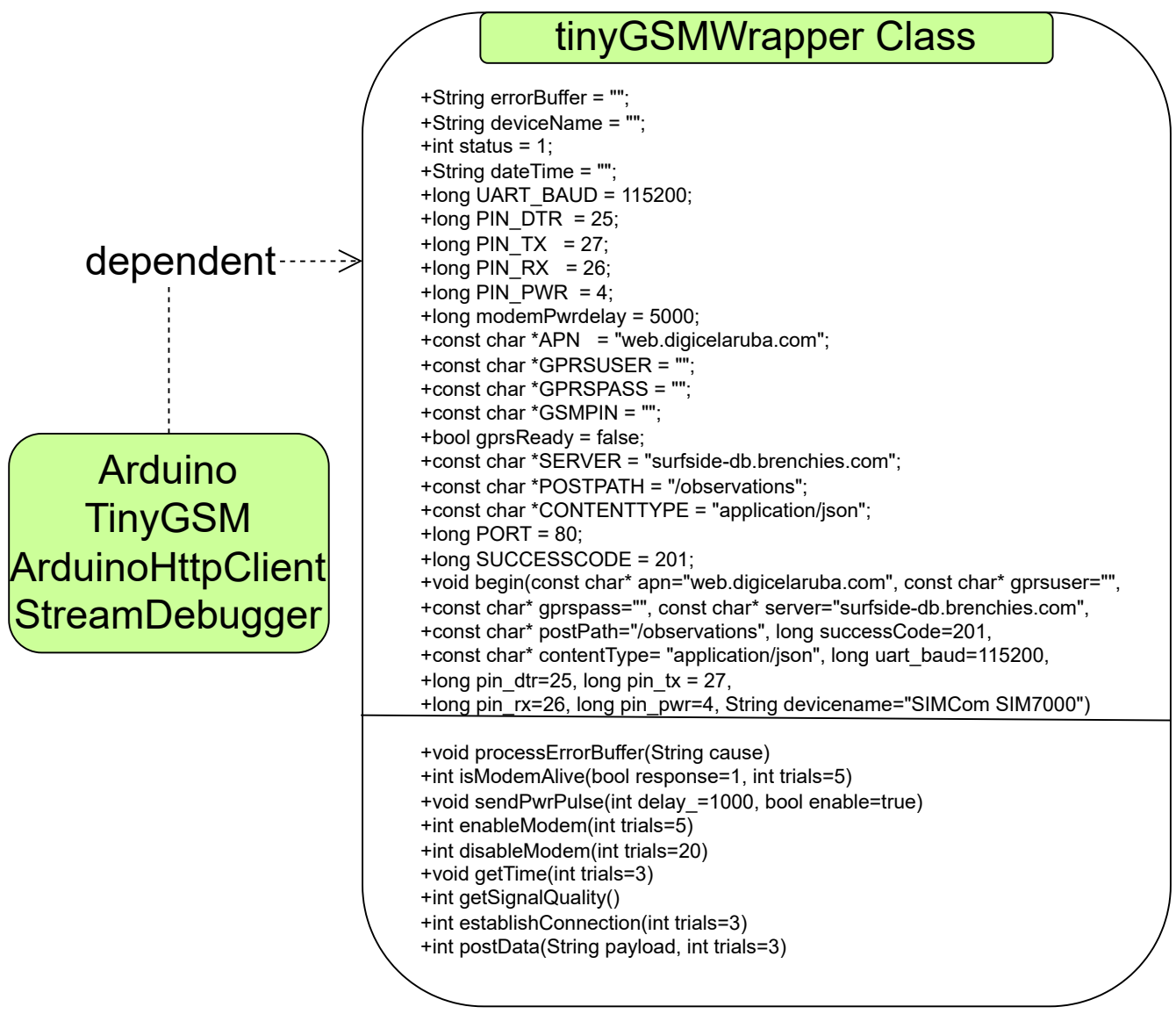

surfSideScience
enable watchdog timer 10 minutes
ENABLE Sensors & wait for sensor equilibrium state
Sample sensors
Wakeup
instantiate sensors, communication, surfsideScience & sdlogger objects
enable modem & establish connection
disable sensors
get modem time
post data
error
write samples to sd
disable modem
log step error
sleep 60 minutes
disable watchdog timer 10 minutes
dump error log to sd
continue with current step

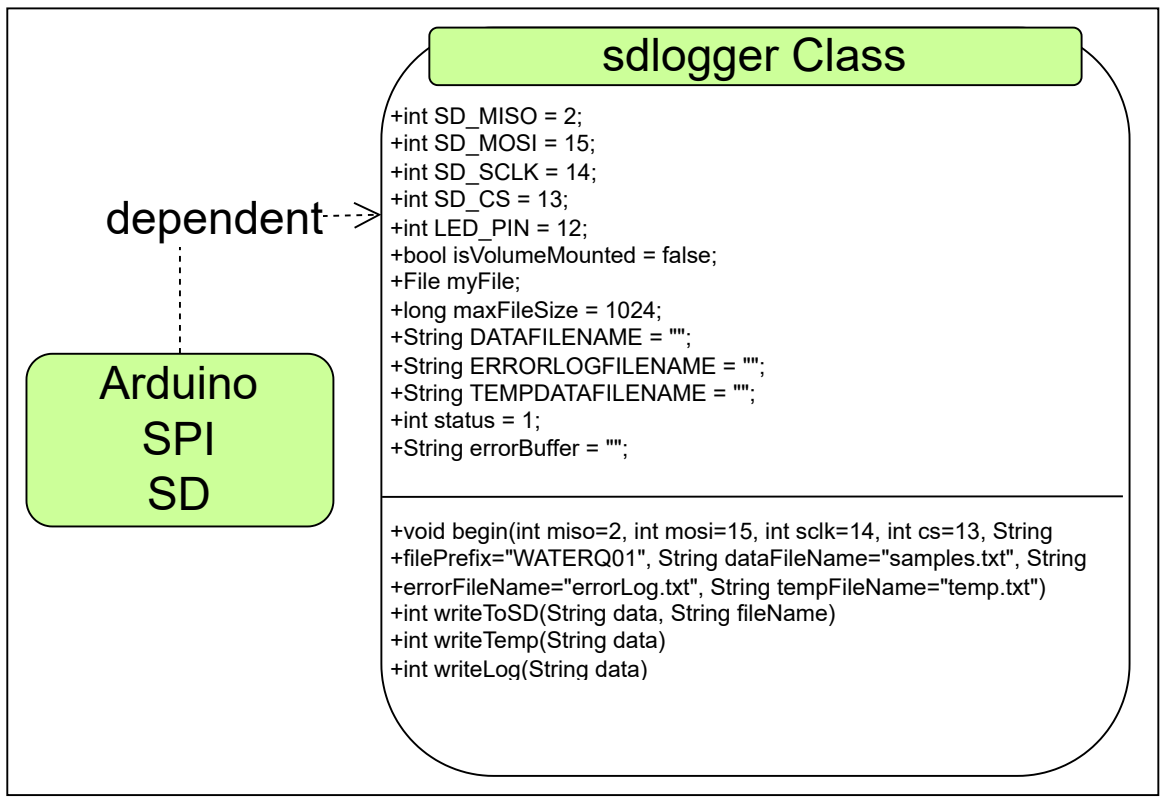
DATA PAYLOAD JSON FORMAT

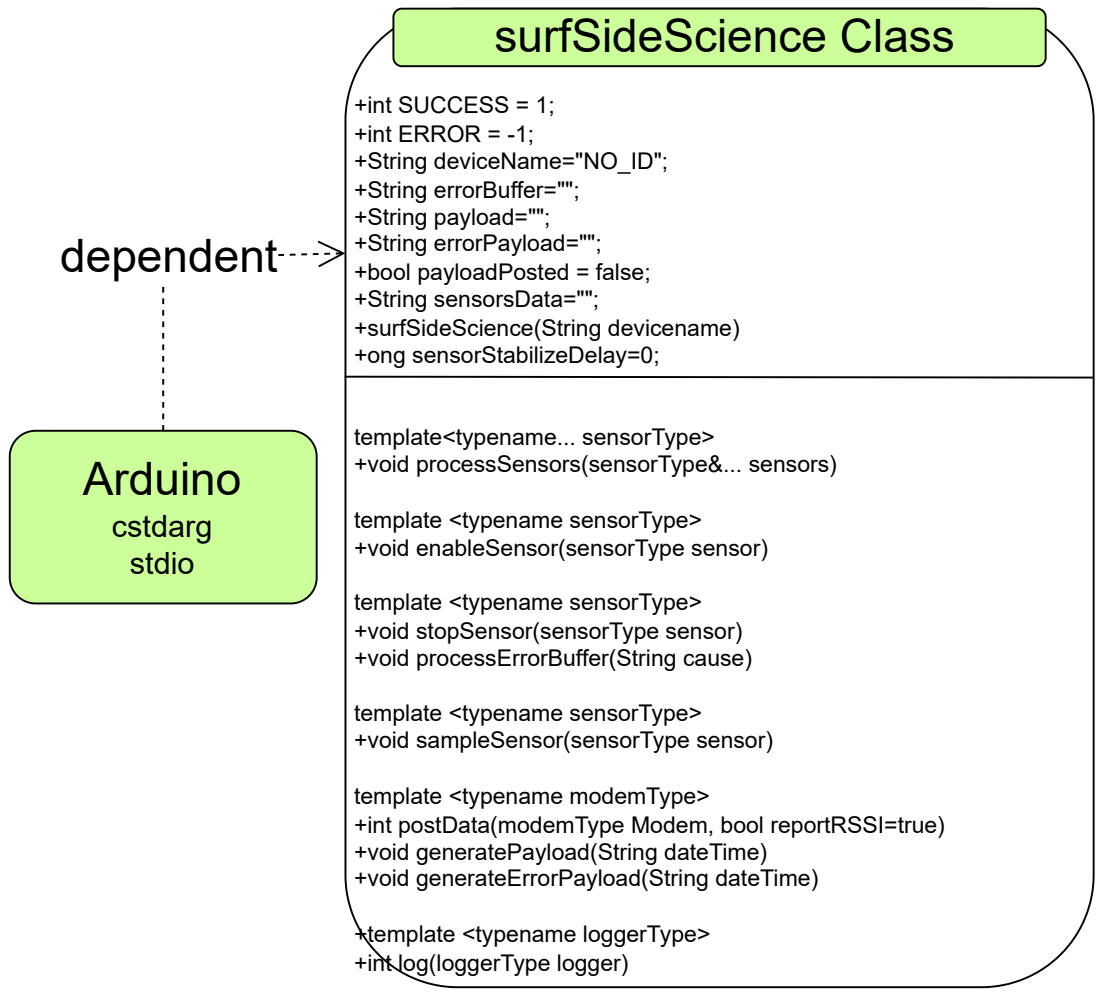
```
{"deviceName": "string", "timestamp": "dateTime",
 "sesnors": [
                {"sensorName": "string", "value": float, "unit": "string"},
                {...},
                {"sensorName": "string", "value": float, "unit": "string"}
            ]
}
```

ERROR PAYLOAD JSON FORMAT

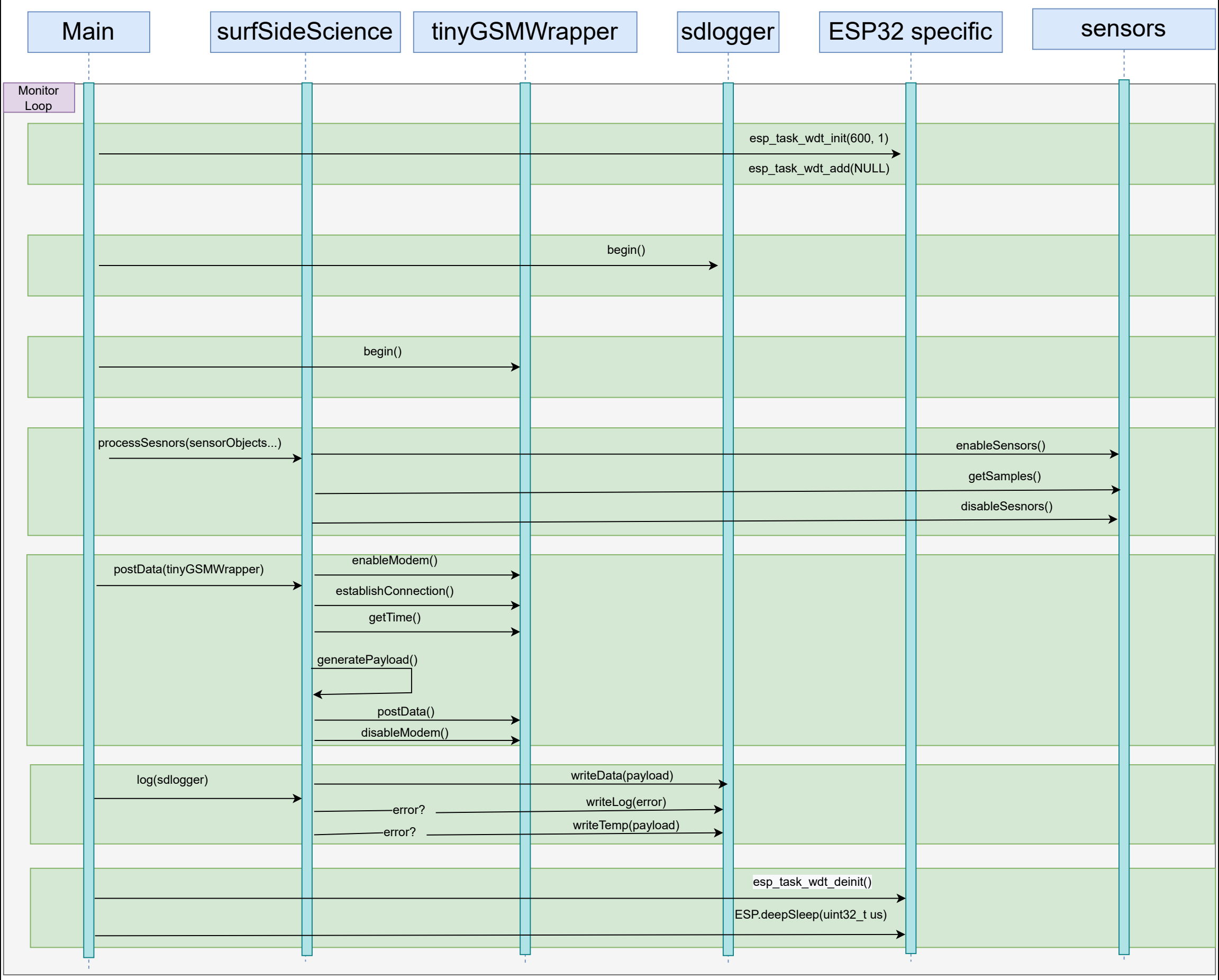
```
{"deviceName": "string", "timestamp": "dateTime",
 "errors": [
            {"sensorName": "string", "error": "String"},
            {...},
            {"sensorName": "string", "error": "String"},
        ]
}
```


tinyGSMWrapper Class
+String errorBuffer = "";
+String deviceName = "";
+int status = 1;
+String dateTime = "";
+long UART_BAUD = 115200;
+long PIN_DTR = 25;
+long PIN_TX = 27;
+long PIN_RX = 26;
+long PIN_PWR = 4;
+long modemPwrdelay = 5000;
+const char *APN = "web.digicelaruba.com";
+const char *GPRSUSER = "";
+const char *GPRSPASS = "";
+const char *GSMPIN = "";
+bool gprsReady = false;
+const char *SERVER = "surfside-db.brenchies.com";
+const char *POSTPATH = "/observations";
+const char *CONTENTTYPE = "application/json";
+long PORT = 80;
+long SUCCESSCODE = 201;
+void begin(const char* apn="web.digicelaruba.com", const char* gprsuser="",
+const char* gprspass="", const char* server="surfside-db.brenchies.com",
+const char* postPath="/observations", long successCode=201,
+const char* contentType= "application/json", long uart_baud=115200,
+long pin_dtr=25, long pin_tx = 27,
+long pin_rx=26, long pin_pwr=4, String devicename="SIMCom SIM7000")
+void processErrorBuffer(String cause)
+int isModemAlive(bool response=1, int trials=5)
+void sendPwrPulse(int delay_=1000, bool enable=true)
+int enableModem(int trials=5)
+int disableModem(int trials=20)
+void getTime(int trials=3)
+int getSignalQuality()
+int establishConnection(int trials=3)
+int postData(String payload, int trials=3)
dependent
Arduino
TinyGSM
ArduinoHttpClient
StreamDebugger


sdlogger Class
+int SD_MISO = 2;
+int SD_MOSI = 15;
+int SD_SCLK = 14;
+int SD_CS = 13;
+int LED_PIN = 12;
+bool isVolumeMounted = false;
+File myFile;
+long maxFileSize = 1024;
+String DATAFILENAME = "";
+String ERRORLOGFILENAME = "";
+String TEMPDATAFILENAME = "";
+int status = 1;
+String errorBuffer = "";
+void begin(int miso=2, int mosi=15, int sclk=14, int cs=13, String
+filePrefix="WATERQ01", String dataFileName="samples.txt", String
+errorFileName="errorLog.txt", String tempFileName="temp.txt")
+int writeToSD(String data, String fileName)
+int writeTemp(String data)
+int writeLog(String data)
dependent
Arduino
SPI
SD


surfSideScience Class
+int SUCCESS = 1;
+int ERROR = -1;
+String deviceName="NO_ID";
+String errorBuffer="";
+String payload="";
+String errorPayload="";
+bool payloadPosted = false;
+String sensorsData="";
+surfSideScience(String devicename)
+ong sensorStabilizeDelay=0;
dependent
Arduino
cstdarg
stdio
template<typename... sensorType>
+void processSensors(sensorType&... sensors)
template <typename sensorType>
+void enableSensor(sensorType sensor)
template <typename sensorType>
+void stopSensor(sensorType sensor)
+void processErrorBuffer(String cause)
template <typename sensorType>
+void sampleSensor(sensorType sensor)
template <typename modemType>
+int postData(modemType Modem, bool reportRSSI=true)
+void generatePayload(String dateTime)
+void generateErrorPayload(String dateTime)
+template <typename loggerType>
+int log(loggerType logger)

Sequence diagram



Ezo_board

+enum errors {SUCCESS, FAIL, NOT_READY, NO_DATA,NOT_READ_CMD};

#uint8_t i2c_address;
#const char* name = 0;
#float reading = 0;
#bool issued_read = false;
#enum errors error;
#const static uint8_t bufferlen = 32;
#TwoWire* wire = &Wire;

+Ezo_board(uint8_t address);
+Ezo_board(uint8_t address, const char* name);
+Ezo_board(uint8_t address, TwoWire* wire);
+void send_cmd(const char* command);
+void send_read_cmd();
+void send_cmd_with_num(const char* cmd, float num, uint8_t decimal_amount = 3);
+void send_read_with_temp_comp(float temperature);
+enum errors receive_cmd(char* sensordata_buffer, uint8_t buffer_len);
+enum errors receive_read_cmd();
+bool is_read_poll();
+float get_last_received_reading();
+const char* get_name();
+enum errors get_error();
+uint8_t get_address();

sensorBase Class

+int numberOfreadings = 0;
+int SENSOR_BASE_SUCCESS = 1;
+int SENSOR_BASE_FAIL = -1;
+String sensorName[BASE_SENSORS_DEFAULT_NR_READINGS];
+String samplesBuffer[BASE_SENSORS_DEFAULT_NR_READINGS];
+float samplesBufferTemp[BASE_SENSORS_DEFAULT_NR_READINGS];
+String units[BASE_SENSORS_DEFAULT_NR_READINGS];
+unsigned long sensorStabilizeDelay[BASE_SENSORS_DEFAULT_NR_READINGS];
+String errorBuffer[BASE_SENSORS_DEFAULT_NR_READINGS];
+int status;
+int sensorStatus[BASE_SENSORS_DEFAULT_NR_READINGS];
+long sampleReadDelay = 1000;
+bool SENSOR_ENABLE_STATE = HIGH;
+float EXPECTED_VALUE_MIN[BASE_SENSORS_DEFAULT_NR_READINGS];
+float EXPECTED_VALUE_MAX[BASE_SENSORS_DEFAULT_NR_READINGS];
+bool checkValueInRange = true;
+long sensorPwrDelay = 2000;
+int ENABLEPIN = 0;
+float averagingSamples = 1;
+int sensorReadingDecimals[BASE_SENSORS_DEFAULT_NR_READINGS] = {3};
+float samplesTemp[BASE_SENSORS_DEFAULT_NR_READINGS];

+bool valueInrange(float val, int index)
*+virtual int readSesnorImpl(float *buffer, int *sensorStatus, long delay_)*
+void processErrorBuffer(int bufferNr, String cause)
+int getSamples()
+virtual int enableSensorImpl(int *sensorstatus)
+int enableSensors(int trials=3)
*+virtual int enableSensorImpl(int *sensorstatus)*
*+virtual int disableSensorImpl(int *sensorstatus)*
+int disableSensors(int trials=3)
*+virtual int calibrateSesnorsImpl(int statusLed, int *sensorstatus)*
+int calibrate(int statusLedPin=0)

ezo_do_rtd Class

+ezo_rtd_i2c(int enablePin=13, uint8_t address=0x66, float oversamples=5,
String sensorname="TEMPERATURE", String unit="°C") : Ezo_board(address,
sensorname.c_str())

+int readSesnorImpl(float *buffer, int *sensorStatus, long delay_)
+int enableSensorImpl(int *sensorstatus)
+int enableSensorImpl(int *sensorstatus)
+int disableSensorImpl(int *sensorstatus)
+int calibrateSesnorsImpl(int statusLed, int *sensorstatus)

Ezo_board

+enum errors {SUCCESS, FAIL, NOT_READY, NO_DATA,NOT_READ_CMD};

#uint8_t i2c_address;
#const char* name = 0;
#float reading = 0;
#bool issued_read = false;
#enum errors error;
#const static uint8_t bufferlen = 32;
#TwoWire* wire = &Wire;

+Ezo_board(uint8_t address);
+Ezo_board(uint8_t address, const char* name);
+Ezo_board(uint8_t address, TwoWire* wire);
+void send_cmd(const char* command);
+void send_read_cmd();
+void send_cmd_with_num(const char* cmd, float num, uint8_t decimal_amount = 3);
+void send_read_with_temp_comp(float temperature);
+enum errors receive_cmd(char* sensordata_buffer, uint8_t buffer_len);
+enum errors receive_read_cmd();
+bool is_read_poll();
+float get_last_received_reading();
+const char* get_name();
+enum errors get_error();
+uint8_t get_address();

sensorBase Class

+int numberOfreadings = 0;
+int SENSOR_BASE_SUCCESS = 1;
+int SENSOR_BASE_FAIL = -1;
+String sensorName[BASE_SENSORS_DEFAULT_NR_READINGS];
+String samplesBuffer[BASE_SENSORS_DEFAULT_NR_READINGS];
+float samplesBufferTemp[BASE_SENSORS_DEFAULT_NR_READINGS];
+String units[BASE_SENSORS_DEFAULT_NR_READINGS];
+unsigned long sensorStabilizeDelay[BASE_SENSORS_DEFAULT_NR_READINGS];
+String errorBuffer[BASE_SENSORS_DEFAULT_NR_READINGS];
+int status;
+int sensorStatus[BASE_SENSORS_DEFAULT_NR_READINGS];
+long sampleReadDelay = 1000;
+bool SENSOR_ENABLE_STATE = HIGH;
+float EXPECTED_VALUE_MIN[BASE_SENSORS_DEFAULT_NR_READINGS];
+float EXPECTED_VALUE_MAX[BASE_SENSORS_DEFAULT_NR_READINGS];
+bool checkValueInRange = true;
+long sensorPwrDelay = 2000;
+int ENABLEPIN = 0;
+float averagingSamples = 1;
+int sensorReadingDecimals[BASE_SENSORS_DEFAULT_NR_READINGS] = {3};
+float samplesTemp[BASE_SENSORS_DEFAULT_NR_READINGS];

+bool valueInrange(float val, int index)
*+virtual int readSesnorImpl(float *buffer, int *sensorStatus, long delay_)*
+void processErrorBuffer(int bufferNr, String cause)
+int getSamples()
+virtual int enableSensorImpl(int *sensorstatus)
+int enableSensors(int trials=3)
*+virtual int enableSensorImpl(int *sensorstatus)*
*+virtual int disableSensorImpl(int *sensorstatus)*
+int disableSensors(int trials=3)
*+virtual int calibrateSesnorsImpl(int statusLed, int *sensorstatus)*
+int calibrate(int statusLedPin=0)

ezo_do_i2c Class

+ezo_do_i2c(int enablePin=13, uint8_t address=0x61,
+float oversamples=5,
+String sensorname="DISSOLVED_OXYGEN",
+String unit="mg/L") : Ezo_board(address, sensorname.c_str())

+int readSesnorImpl(float *buffer, int *sensorStatus, long delay_)
+int enableSensorImpl(int *sensorstatus)
+int enableSensorImpl(int *sensorstatus)
+int disableSensorImpl(int *sensorstatus)
+int calibrateSesnorsImpl(int statusLed, int *sensorstatus)

Ezo_board

+enum errors {SUCCESS, FAIL, NOT_READY, NO_DATA,NOT_READ_CMD};

#uint8_t i2c_address;
#const char* name = 0;
#float reading = 0;
#bool issued_read = false;
#enum errors error;
#const static uint8_t bufferlen = 32;
#TwoWire* wire = &Wire;

+Ezo_board(uint8_t address);
+Ezo_board(uint8_t address, const char* name);
+Ezo_board(uint8_t address, TwoWire* wire);
+void send_cmd(const char* command);
+void send_read_cmd();
+void send_cmd_with_num(const char* cmd, float num, uint8_t decimal_amount = 3);
+void send_read_with_temp_comp(float temperature);
+enum errors receive_cmd(char* sensordata_buffer, uint8_t buffer_len);
+enum errors receive_read_cmd();
+bool is_read_poll();
+float get_last_received_reading();
+const char* get_name();
+enum errors get_error();
+uint8_t get_address();

sensorBase Class

+int numberOfreadings = 0;
+int SENSOR_BASE_SUCCESS = 1;
+int SENSOR_BASE_FAIL = -1;
+String sensorName[BASE_SENSORS_DEFAULT_NR_READINGS];
+String samplesBuffer[BASE_SENSORS_DEFAULT_NR_READINGS];
+float samplesBufferTemp[BASE_SENSORS_DEFAULT_NR_READINGS];
+String units[BASE_SENSORS_DEFAULT_NR_READINGS];
+unsigned long sensorStabilizeDelay[BASE_SENSORS_DEFAULT_NR_READINGS];
+String errorBuffer[BASE_SENSORS_DEFAULT_NR_READINGS];
+int status;
+int sensorStatus[BASE_SENSORS_DEFAULT_NR_READINGS];
+long sampleReadDelay = 1000;
+bool SENSOR_ENABLE_STATE = HIGH;
+float EXPECTED_VALUE_MIN[BASE_SENSORS_DEFAULT_NR_READINGS];
+float EXPECTED_VALUE_MAX[BASE_SENSORS_DEFAULT_NR_READINGS];
+bool checkValueInRange = true;
+long sensorPwrDelay = 2000;
+int ENABLEPIN = 0;
+float averagingSamples = 1;
+int sensorReadingDecimals[BASE_SENSORS_DEFAULT_NR_READINGS] = {3};
+float samplesTemp[BASE_SENSORS_DEFAULT_NR_READINGS];

+bool valueInrange(float val, int index)
*+virtual int readSesnorImpl(float *buffer, int *sensorStatus, long delay_)*
+void processErrorBuffer(int bufferNr, String cause)
+int getSamples()
+virtual int enableSensorImpl(int *sensorstatus)
+int enableSensors(int trials=3)
*+virtual int enableSensorImpl(int *sensorstatus)*
*+virtual int disableSensorImpl(int *sensorstatus)*
+int disableSensors(int trials=3)
*+virtual int calibrateSesnorsImpl(int statusLed, int *sensorstatus)*
+int calibrate(int statusLedPin=0)

ezo_ec_rtd Class

+ezo_ec_i2c(int enablePin=13, uint8_t address=0x64, float oversamples=5, String sensorname="CONDUCTIVITY", String unit="µS/cm") : Ezo_board(address, sensorname.c_str())

+int readSesnorImpl(float *buffer, int *sensorStatus, long delay_)
+int enableSensorImpl(int *sensorstatus)
+int enableSensorImpl(int *sensorstatus)
+int disableSensorImpl(int *sensorstatus)
+int calibrateSesnorsImpl(int statusLed, int *sensorstatus)

Ezo_board

+enum errors {SUCCESS, FAIL, NOT_READY, NO_DATA,NOT_READ_CMD};

#uint8_t i2c_address;
#const char* name = 0;
#float reading = 0;
#bool issued_read = false;
#enum errors error;
#const static uint8_t bufferlen = 32;
#TwoWire* wire = &Wire;

+Ezo_board(uint8_t address);
+Ezo_board(uint8_t address, const char* name);
+Ezo_board(uint8_t address, TwoWire* wire);
+void send_cmd(const char* command);
+void send_read_cmd();
+void send_cmd_with_num(const char* cmd, float num, uint8_t decimal_amount = 3);
+void send_read_with_temp_comp(float temperature);
+enum errors receive_cmd(char* sensordata_buffer, uint8_t buffer_len);
+enum errors receive_read_cmd();
+bool is_read_poll();
+float get_last_received_reading();
+const char* get_name();
+enum errors get_error();
+uint8_t get_address();

sensorBase Class

+int numberOfreadings = 0;
+int SENSOR_BASE_SUCCESS = 1;
+int SENSOR_BASE_FAIL = -1;
+String sensorName[BASE_SENSORS_DEFAULT_NR_READINGS];
+String samplesBuffer[BASE_SENSORS_DEFAULT_NR_READINGS];
+float samplesBufferTemp[BASE_SENSORS_DEFAULT_NR_READINGS];
+String units[BASE_SENSORS_DEFAULT_NR_READINGS];
+unsigned long sensorStabilizeDelay[BASE_SENSORS_DEFAULT_NR_READINGS];
+String errorBuffer[BASE_SENSORS_DEFAULT_NR_READINGS];
+int status;
+int sensorStatus[BASE_SENSORS_DEFAULT_NR_READINGS];
+long sampleReadDelay = 1000;
+bool SENSOR_ENABLE_STATE = HIGH;
+float EXPECTED_VALUE_MIN[BASE_SENSORS_DEFAULT_NR_READINGS];
+float EXPECTED_VALUE_MAX[BASE_SENSORS_DEFAULT_NR_READINGS];
+bool checkValueInRange = true;
+long sensorPwrDelay = 2000;
+int ENABLEPIN = 0;
+float averagingSamples = 1;
+int sensorReadingDecimals[BASE_SENSORS_DEFAULT_NR_READINGS] = {3};
+float samplesTemp[BASE_SENSORS_DEFAULT_NR_READINGS];

+bool valueInrange(float val, int index)
+*virtual int readSesnorImpl(float *buffer, int *sensorStatus, long delay_)*
+void processErrorBuffer(int bufferNr, String cause)
+int getSamples()
+virtual int enableSensorImpl(int *sensorstatus)
+int enableSensors(int trials=3)
*+virtual int enableSensorImpl(int *sensorstatus)*
*+virtual int disableSensorImpl(int *sensorstatus)*
+int disableSensors(int trials=3)
*+virtual int calibrateSesnorsImpl(int statusLed, int *sensorstatus)*
+int calibrate(int statusLedPin=0)

ezo_ph_i2c Class

+ezo_ph_i2c(int enablePin=13, uint8_t address=0x63, float
oversamples=5, String sensorname="PH", String unit="NAN") :
Ezo_board(address, sensorname.c_str())

+int readSesnorImpl(float *buffer, int *sensorStatus, long delay_)
+int enableSensorImpl(int *sensorstatus)
+int enableSensorImpl(int *sensorstatus)
+int disableSensorImpl(int *sensorstatus)
+int calibrateSesnorsImpl(int statusLed, int *sensorstatus)

+bool ph_temperature_compensation
+uint8_t ezo_rtd_i2c_addesss = 0x66
+ezo_rtd_i2c RTD_TEMP_COMPENSATION

AQS V1.0 Code UML Diagram

For working version with two PMS5003 sensors and one SHT31, below you can see the class structures.

sensorbase

+int numberOfreadings = 0;
+int SENSOR_BASE_SUCCESS = 1;
+int SENSOR_BASE_FAIL = -1;
+String sensorName[BASE_SENSORS_DEFAULT_NR_READINGS];
+String samplesBuffer[BASE_SENSORS_DEFAULT_NR_READINGS];
+float samplesBufferTemp[BASE_SENSORS_DEFAULT_NR_READINGS];
+String units[BASE_SENSORS_DEFAULT_NR_READINGS];
+unsigned long sensorStabilizeDelay[BASE_SENSORS_DEFAULT_NR_READINGS];
+String errorBuffer[BASE_SENSORS_DEFAULT_NR_READINGS];
+int status;
+int sensorStatus[BASE_SENSORS_DEFAULT_NR_READINGS];
+long sampleReadDelay = 1000;
+bool SENSOR_ENABLE_STATE = HIGH;
+float EXPECTED_VALUE_MIN[BASE_SENSORS_DEFAULT_NR_READINGS];
+float EXPECTED_VALUE_MAX[BASE_SENSORS_DEFAULT_NR_READINGS];
+bool checkValueInRange = true;
+long sensorPwrDelay = 2000;
+int ENABLEPIN = 0;
+float averagingSamples = 1;
+int sensorReadingDecimals[BASE_SENSORS_DEFAULT_NR_READINGS] = {3};
+float samplesTemp[BASE_SENSORS_DEFAULT_NR_READINGS];

+bool valueInrange(float val, int index)
*+virtual int readSesnorImpl(float *buffer, int *sensorStatus, long delay_)*
+void processErrorBuffer(int bufferNr, String cause)
+int getSamples()
*+virtual int enableSensorImpl(int *sensorstatus)*
+int enableSensors(int trials=3)
*+virtual int enableSensorImpl(int *sensorstatus)*
*+virtual int disableSensorImpl(int *sensorstatus)*
+int disableSensors(int trials=3)
*+virtual int calibrateSesnorsImpl(int statusLed, int *sensorstatus)*
+int calibrate(int statusLedPin=0)

SHT31

-TwoWire* _wire
-uint8_t _address
-uint8_t _heatTimeout
-uint32_t _lastRead
-uint32_t _lastRequest
-uint32_t _heaterStart
-uint32_t _heaterStop
-bool _heaterOn
-uint16_t _rawHumidity
-uint16_t _rawTemperature
-uint8_t _error

+SHT31()
+bool begin(const uint8_t address, uint8_t, uint8_t)
+bool begin(const uint8_t, const uint8_t)
+bool begin(const uint8_t address, TwoWire *wire = &Wire)
+bool begin(TwoWire *wire = &Wire)
+bool read(bool fast = true)
+bool isConnected()
+uint16_t readStatus()
+uint32_t lastRead()
+bool reset(bool hard = false)
+void setHeatTimeout(uint8_t)
+uint8_t getHeatTimeout()
+bool heatOn()
+bool heatOff()
+bool isHeaterOn()
+bool heatUp()
+float getHumidity()
+float getTemperature()
+float getFahrenheit()
+uint16_t getRawHumidity()
+uint16_t getRawTemperature()
+bool requestData()
+bool dataReady()
+bool readData(bool fast = true)
+int getError()

PMS *pms

PMS *pms

PMS

+static const uint16_t SINGLE_RESPONSE_TIME
+static const uint16_t TOTAL_RESPONSE_TIME
+static const uint16_t STEADY_RESPONSE_TIME
+static const uint16_t BAUD_RATE
+struct DATA
-enum STATUS
-enum MODE
-uint8_t _payload[12]
-Stream* _stream
-DATA* _data
-STATUS _status
-MODE _mode = MODE_ACTIVE
-uint8_t _index
-uint16_t _frameLen
-uint16_t _checksum
-uint16_t _calculatedChecksum

-PMS(Stream&);
-void sleep();
-void wakeUp();
-void activeMode();
-void passiveMode();
-void requestRead();
-bool read(DATA& data);
-bool readUntil(DATA& data,
uint16_t timeout = SINGLE_RESPONSE_TIME);

PMS_SS

+enum Particulates
+SoftwareSerial serial
+PMS::DATA pms_data

+void begin(int,int,String[],String[],int,long,int)
+int readSesnorImpl(float *, int *, long)
+int enableSensorImpl(int *)
+int disableSensorImpl(int *)

PMS_SSS

+enum Particulates
+SoftwareSerial serial2
+PMS::DATA pms_data

+void begin(int,int,String[],String[],int,long,int)
+int readSesnorImpl(float *, int *, long)
+int enableSensorImpl(int *)
+int disableSensorImpl(int *)

SHT31_S

+enum Sensors

+SHT31_S(int, String[], String[],int,long,int):SHT31()
begin(int,int,String[],String[],int,long,int)
+int readSesnorImpl(float *, int *, long)
+int enableSensorImpl(int *)
+int disableSensorImpl(int *)