OSX – Open-SDI12-Blue

Version Pressure Level Transmitter (Piezo), Type 31x

1 Quick setup

OSX PiezoPressure (IP68 for permanent immersion until max. over pressure)

The **OSX PiezoPressure** is a SDI12 Pressure Level Transmitter, based on a digital Piezo Transducer sensor element.

By default the OSX is configured as:

- Pressure range 0..1 bar (equivalent to ca. 10 mtr. Water level)
- Optionally the sensor can be configured to Water level in meters
- 10 mtr. cable (ventilated for atmospheric compensation)
- Ultra-Low-Power operation of the sensor
- Sensor size ca. 100 mm x 25 mm
- Accuracy: max. ± 0.15 %FS (Linearity best straight line@RT, hysteresis, repeatability)
- Overpressure: 4 x pressure range
- Long Term Stability: typ. ± 0.1 %FS, max. ± 0.2 %FS (for pressure ranges < 1.5 bar: ± 3 mbar)
- Type 310: Standard Temperature Sensor: ± 2 °C (typ.)
  Type 311: High Precision Temperature Sensor: ± 0.1 °C (-20 °C – +50 °C)
  Type 312: as Typ 311, but with additional 3-axis orientation sensor.

SDI-12-Cable (core cable ends or optionally with Connector (AKL-169-04 (RIA CONNECT, RM 3.5mm)):

YELLOW:	GND
WHITE:	3.6V-16V Supply
GREEN:	SDI-12 Signal

The command set is based on standard SDI12 (V1.3) command set. Most important commands:

aAn! : Change Address from ‘a’ to ‘n’. (a might be always be a ‘?’ as wild card).

aI! : Identify Node (should identify as ‘a13TT_KLD_A_0310_OSXxxxxxxxx’ for Type 310 or as ‘a13TT_KLDHA_0311_OSXxxxxxxxx’ for Type 311)

aM! : Start measure (also ‘aMC!’). This will start the measure. After finishing all measured values are available in an internal cache. Up to 2 data may be read with the „D“- command: a.) Pressure and b.) Temperature

aM1! : Only for Type 312;
Start measure (also ‘aMC1!’). This will start the measure including Supply Voltage. After finishing all measured values are available in an internal cache. Up to 6 data may be read with the „D“- command:
a.) Pressure, b.) Temperature and c.) Voltage

aM9! : Start measure (also ‘aMC9!’). This will start the measure including Supply Voltage. After finishing all measured values are available in an internal cache. Up to 4/7 data may be read with the „D“- command:
a.) Pressure, b.) Temperature and c.) (optionally Orientation) and d.) Voltage

aD0! : This will read the 1 to max. 3/6 measures from the preceding „M“- command;
Index 0: Pressure value (default ‘Bar)
Index 1: Temperature (default °C)
Index 2,3,4: Orientation X,Y,Z (mg) (only for Type 312)
Index 5: Supply-Voltage (mV)

Note: The basic measurement commands (‘aM!’ and ‘aM1!’ and ‘aM9!’) are designed for command line use and omit a CRC. For integration with external systems (e.g. data loggers), use the CRC-including versions (‘aMC!’ and ‘aMC1! And ‘aMC9!’).

Error codes (all values lower than -1000):

-1101: Sensor internal error (‘No Reply1’) probably sensor or internal connection broken.
-1102: Sensor internal error (‘No Reply2’) probably sensor or internal connection broken.
-1103: Sensor internal error (‘Timeout’) probably sensor or internal connection broken.
-1104: Sensor internal error (‘Busy’) probably sensor or internal connection broken.
-1105: Sensor internal error (‘MemoryError’) probably sensor or internal connection broken.
-1106: Sensor internal error (‘No Coefficients’) probably sensor or internal connection broken.
-2000: High Precision Temperature Sensor error (only Type 311)
others: Displayed as text in BLX.JS or BlueShell

2 The Open-SDI12-Blue platform

OSX Sensors are based on an open platform:

Link: https://github.com/joembedded/Open-SDI12-Blue

Important: the range of the Bluetooth-Signal is limited to ca. < 1 meter (in air) and the Bluetooth signal is very strongly attenuated by water. Therefore, communication via Bluetooth is only possible when the sensor is outside of water or very close to the surface.

3 Software

3.1.1 Software to access the sensor

OSX Sensors can accessed by SDI12 (V1.3) or Bluetooth BLE or SDI12 via Bluetooth.

- BlueShell for PC (Windows 10 / 11)
- BLX.JS (PC (Browsers: Chrome, Edge, Opera, …) or Android). No APP required!

Link: Download Link BlueShell or BLX.JS

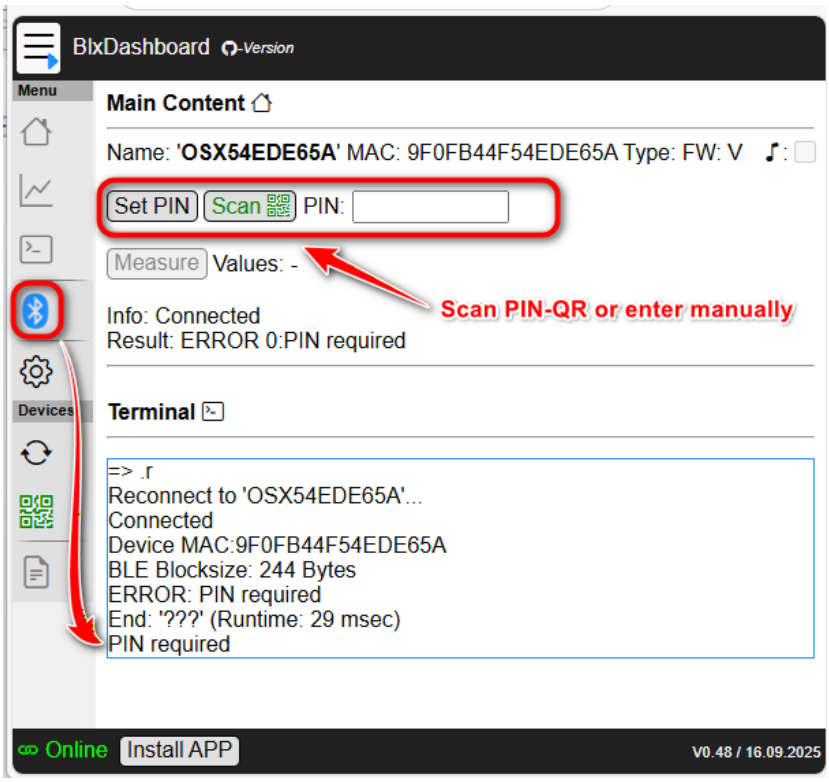
3.1.2 Software for SDI12

- A simple SDI12Term for PC (Windows) (connect SDI12 sensors via RS232)

Link: https://github.com/joembedded/SDI12Term

4 Sample session BLX.JS

The sensors are locked with a 6 digit PIN (Authentification method: Challenge-Response)



5 Commands

A selection of commands for setup (enter via BLX.JS or BlueShell Terminal)

5.1.1 Commands for this type (Type 31x):

Measure:

- M or MC or M1 or MC1 or M9 or MC9 starts the measure, measure takes < 1 sec (optionally the Warm-Up Time can be changed, see below)
- D replies the values

5.1.2 Standard commands for Open-SDI12-Blue (SDI12 via BLE):

All „SDI12 via BLE“ commands are preceded by ‚z‘:

```
> z?I!                                                    SDI12 via BLE: Identify
Reply: '013TT_KLD_A_0312_OSX7740B474<CR><LF>'
End: 'OK' (Runtime: 229 msec)
> z?M!                                                    SDI12: Measure
Reply: '00012<CR><LF>'
Reply: '0<CR><LF>'
End: 'OK' (Runtime: 358 msec)
> z?D0!                                                   SDI12: Values
Reply: '0+0.00032+26.36<CR><LF>'
End: 'OK' (Runtime: 302 msec)
> z?MC!                                                   SDI12: Measure+CRC
Reply: '00012<CR><LF>'
Reply: '0<CR><LF>'
End: 'OK' (Runtime: 387 msec)
> z?D0!                                                   SDI12: ‚@|‘ is CRC
Reply: "0+0.00025+30.8@C|<CR><LF>'
End: 'OK' (Runtime: 290 msec)
> k                                                       ‘k’: Show Coefficients
Reply: 'K0: 1.000000 Press.Multi(f) (Def: 1.0)'
Reply: 'K1: 0.000000 Press.Offset(f) (Def: 0.0)'
Reply: 'K2: 1.000000 Temp.Multi(f) (Def: 1.0)'
Reply: 'K3: 0.000000 Temp.Offset(f) (Def: 0.0)'
Reply: 'K4: 0.000000 Units(nr) See Manual: Bar,mWs,.. (Def: 0)'
Reply: 'K5: 1.000000 LiveSpeed(nr) 0:Off (Def: 1(=max, 16400(=1sec))'
End: 'OK' (Runtime: 613 msec)
> z?XDevice!                                              SDI12: XDevice
Reply: '0M:2299983A7740B474,T:310,V1.0, P:321144!<CR><LF>' SDI12: Red: Device.PIN
End: 'OK' (Runtime: 299 msec)
> z?XSensor!                                              SDI12: Get Sensor Settings
Reply: '0LD,P:0.0;3.0,PA!<CR><LF>!                        SDI12: Type ‘LD, 0.0-3.0 bar’
End: 'OK' (Runtime: 100 msec)                             SDI12: ‘PR’,‘PA’ or ‘PAA’
> z?XFactoryReset!                                        SDI12: Factors Reset:
Disconnected while Busy('z?XFactoryReset!')               SDI12: New setup
ERROR: Disconnected ('z?XFactoryReset!')                  SDI12: required!
```

5.1.3 Some standard commands for BLX.JS (not available with BlueShell):

(Remark: BLX.JS is our BLE driver written in JavaScript, it could easily be used with other HTML too).

```
> .a                                                      .a or .audio: „Finder♪“
Audio: RSSI: OFF, Term: ON
> .audio 1 1                                              Audio & Finder♪ ‚ON‘
Audio: RSSI: ON, Term: ON
```

> .firmware Secure firmware update
Select new firmware (*.sec)...

5.1.4 Special commands for Open-SDI12-Blue (SDI12 via BLE):

Sensor setup / scan commands:

Important: our sensors are are delivered “ready-2-run” and normally no special setup is required (except e.g. after Factory Reset or if sensor configuration was changed). The following commands are only listed for technical completeness or for changed setup (e.g. output in Water Level)

- Each channel has 2 coefficients for (optional) user calibration.
  By default these coefficients are 1.0 (Multi) and 0.0 (Offset), this means the values of the sensor are not changed. The sensor elements are internally factory calibrated to Bar and °C (units may be changed).
- It is possible to set the sensor to Water Level. Because Water Level depends on the weight of the water, this calibration is dependant to water salinity and geographical gravity:
  - Sweet / drinking water (with a salinity of <0.1%) has a density of 1.00 kg per liter
  - The geographical gravity varies from ca. 9.83 m/s^2 (equator) tp 9.79 m/s^2 (earth poles). For Central Europe 9.806 m/s² is a good average, hence 1 Bar is equal to 10.19711 mtr. Water level with a salinity of <0.1%.
- The 4 Coefficients (see above, command ‘k’):
  Formula is (BLX standard): Formula: VALUE = (MEASURED * Multi) – Offset.
  K0: Pressure Multi (Default: 1.0)
  K1: Pressure Offset (Default: 0.0)
  K2: Temperature Multi (Default: 1.0)
  K3: Temperature Offset (Default: 0.0)
  K4: Units for Pressure: 0: Bar, 1: mWS, 2: mH2O
  Optionally (only sensor Type 312):
  K5: Speed for orientation data (0: Off, ca. 16400 equals 1 per sec, Default: 1)
- Example how to change the Coefficients to Water Level (for sweet / drinking water (with a salinity of <0.1%):
  - Set K0 to 10.19711 (see above)
  - Set Unit of pressure channel from “Bar” to “mWs” or “mH2O”
  (The unit is only used for the APP, since SDI-12 can only transmit numbers).
- Only for sensor Type 310, 311): The coefficient ‘P’ is the Level Transmitter's Warm-Up Time. Default is 250 msec. However it can be set to 1..9999 msec with the “P”-Command. If the P is set to 0, the Level Transmitter is constantly powered (Higher Power consumption!).
- The “Write” command writes changed parameters to Flash.

In this example the sensor is set to Water Level:

> e	Measure
Measure (2 Channels in 750 msec) (0)0.53222 Bar (1)25.8 oC	
> z?XK0!	Check K0 (Multi)
Reply: '0K0=1.000000<CR><LF>' End: 'OK' (Runtime: 389 msec)	
> z?XK0=10.19711!	Set K0 to Water Level
Reply: '0K0=10.197112<CR><LF>' End: 'OK' (Runtime: 246 msec)	
> z?XK4!	Check Unit Pressure
Reply: '0K4=0<CR><LF>' End: 'OK' (Runtime: 206 msec)	
> z?XK4=2!	Set Unit 0 to ‘mH2O’
Reply: '0K4=2<CR><LF>' End: 'OK' (Runtime: 269 msec)	
> e	Check results
Measure (2 Channels in 750 msec) (0)5.42333 mtr (1)25.8 oC	
> z?XWrite!	Save Settings to Flash
Reply: '0<CR><LF>' End: 'OK' (Runtime: 162 msec)	

In this example K3 (Offset for Temperature) is ‘adjusted’ to display 1.23°C less:

> e	Measure
Measure (2 Channels in 300 msec) (0)0.0003 Bar (1)26.47 oC End: 'OK' (Runtime: 564 msec)	
> z?XK3!	Coefficient for Temperature
Reply: '0K3=0.000000<CR><LF>' End: 'OK' (Runtime: 271 msec)	
> z?XK3=1.23!	Decrease Temp. by 1.23°C
Reply: '0K3=1.230000<CR><LF>' End: 'OK' (Runtime: 191 msec)	
> e	And check result
Measure (2 Channels in 300 msec) (0)0.0003 Bar (1)25.24 oC	

> z?XWrite! Save Settings to Flash
Reply: '0<CR><LF>'
End: 'OK' (Runtime: 162 msec)

Set Pressure Zero Point:

> e Sensor has Offset
Measure (2 Channels in 300 msec)
(0)0.0372 Bar
(1)24.17 oC
> z?XZeroP! Now Set Pressure Zero Point
Reply: '0<CR><LF>'
End: 'OK' (Runtime: 79 msec)
> e And check result
Measure (2 Channels in 300 msec)
(0)0.0001 Bar OK
(1)24.16 oC

5.2 Orientation data (only sensor Type 312)

This type is equipped with an orientation sensor, that delivers the gravitation in x,y,z-direction in ‘mg’ (normally the total sum of all 3 components should be arround 1000 mg). Z is the direction to the ground.

A small HTML page can be used to display a ‘live view’:

https://joembedded.github.io/viewer3d/index2.html (the APP)

https://github.com/joembedded/viewer3d (the project (Open Source))

6 Power Supply

The OSX Sensor works from 3.6V to 16V (see Open-SDI12-Blue documentation).

Measure: < 4mA for ca. 300 msec (Default, if Warm-Up Time is set to 0, the sensor element is constantly powered).

Operating Temperature: -40°C - +85°C
Medium Temperature: -10°C - +80°C for best performance

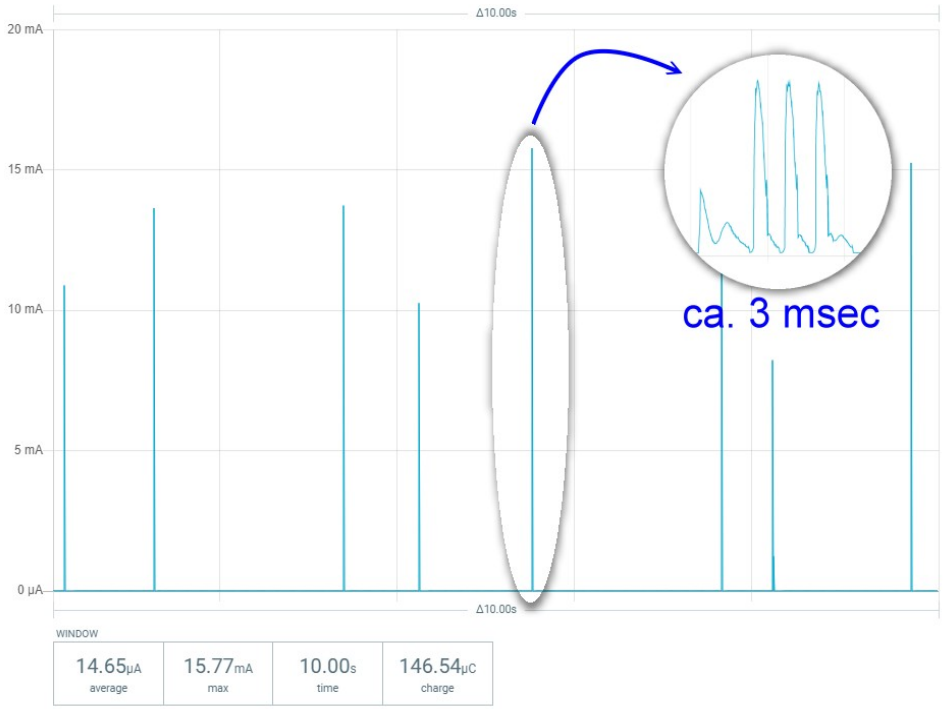
6.1 Power Profile

6.1.1 Power Up Sequence

The Sensor is ready after ca. 250 msec.

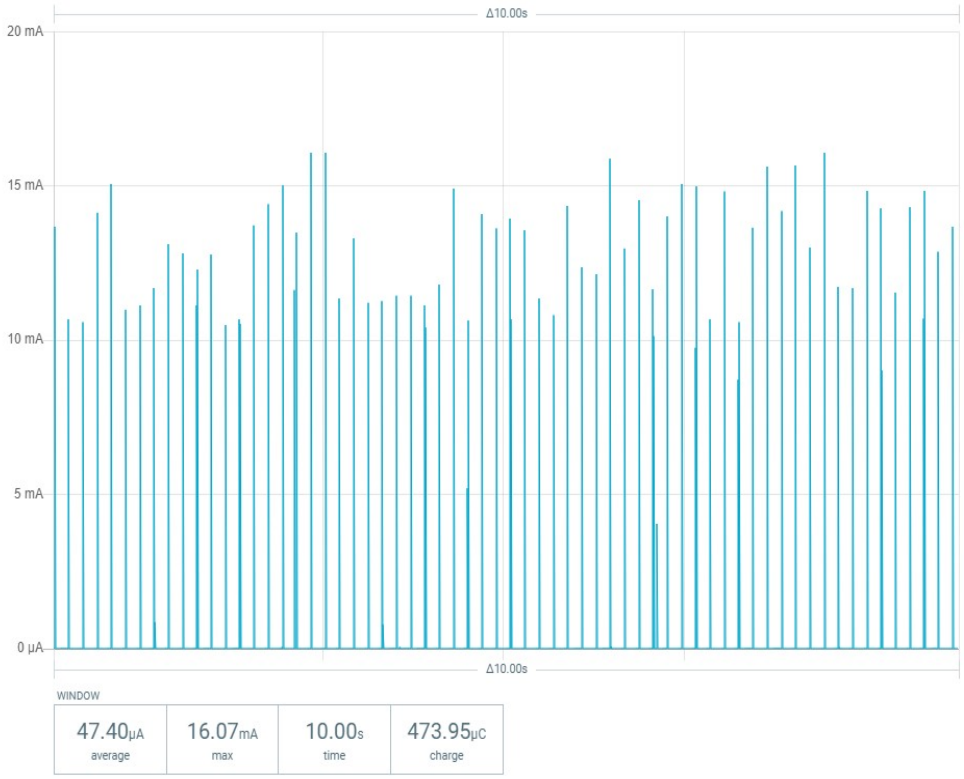
6.1.2 Advertising (in deep sleep)

Average power consumption in deep sleep is <15 µA @ 5V



Advertising power consumption (one peak zoomed)

6.2 Connected Mode



Connected power consumption

In Connected Mode (active BLE connection) the average power consumption is <50 µA @ 4V

7 Compliance (Version: PiezoPressure, Type 31x)

7.1 Compliance: CE, RoHS

- EN 55022 Emission, class B < 30 dBµV/m (0.03...1 GHz)
- EN 61000-4-2 Electrostatic discharge 4 kV contact / 8 kV air
- EN 61000-4-3 Irradiated RF 10V/m (0.1...1 GHz)
- EN 61000-4-4 Transients (burst) 4 kV
- EN 301 489-1 V2.1.1 and EN 301 489-17 V3.1.1 EMC
- EN 300 328 V2.1.1 EN 300 330 V2.1.1 Radio Emission
- Bluetooth SIG listed: ID 138612

The sensor OSX – Version PiezoPressure, Type 31x complies with the essential requirements of Radio Equipment Directive (RED) 2014/53/EU and with the Directive 2011/65/EU (EU RoHS 2) and its amendment Directive (EU) 2015/863 (EU RoHS 3).

Manufacturers:

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29.11.2023

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