# AN4866
# Application note

## Water resistant features

## Introduction

The aim of this document is to specify and describe the LPS35HW water resistant properties with respect to the applicable international standards, selected for similarity with the final application: *ISO 22810* and *IEC 60529 (IP code)*.

To compare the behavior of LPS35HW pressure sensor with the above reported international standards, dedicated tests have been performed by an ST accredited laboratory.

**Figure 1: External laboratory accreditation certificate**


For additional static and dynamic tests performed to characterize the water resistant capability of LPS35HW, please contact the local ST sales support.

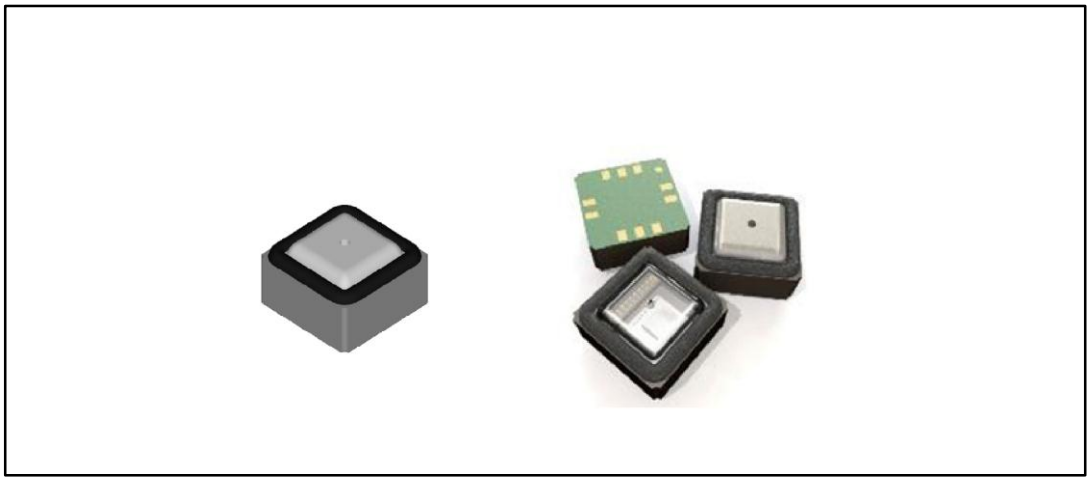
# Contents

# List of figures

# 1 LPS35HW package details

The LPS35HW is a digital output barometer that is available in a holed ceramic LGA package. Please refer to the LPS35HW datasheet for package outline and mechanical data.

**Figure 2: Package rendering**

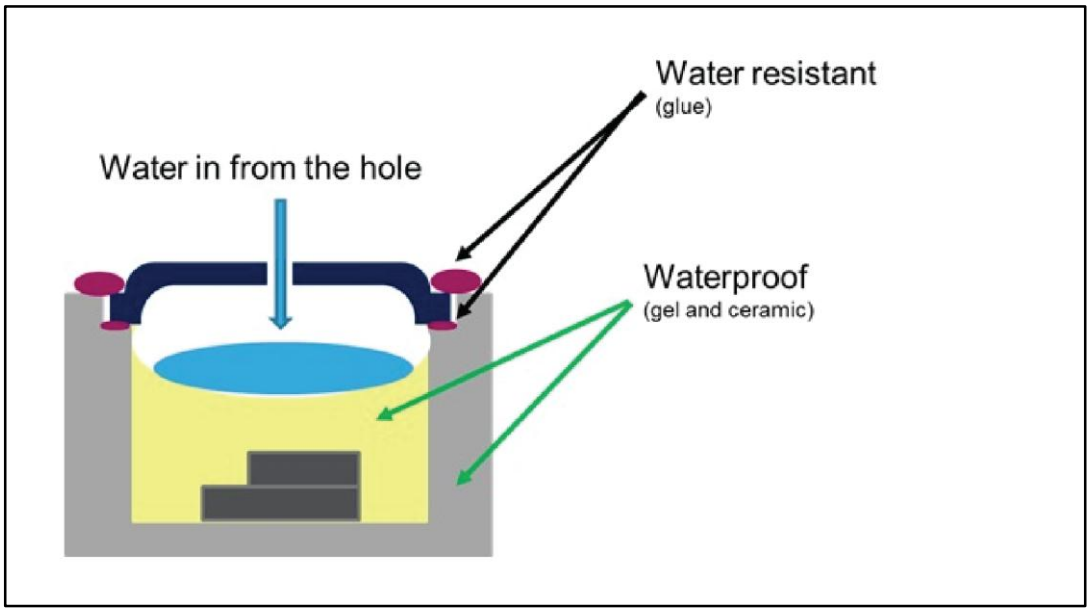


The LPS35HW is intrinsically waterproof thanks to the ceramic cavity base and the potting gel that covers the sensible element and the readout electronics.

The package is closed on the top with a holed metallic cap that is attached to the ceramic base through an epoxy glue. In this region the package is considered water resistant and not fully sealed against water.

Refer to *Figure 3: "CCLGA – 10L (3.5 x 3.5 x 1.85 mm) water resistance details"* for package sealing characteristics.

**Figure 3: CCLGA – 10L (3.5 x 3.5 x 1.85 mm) water resistance details**

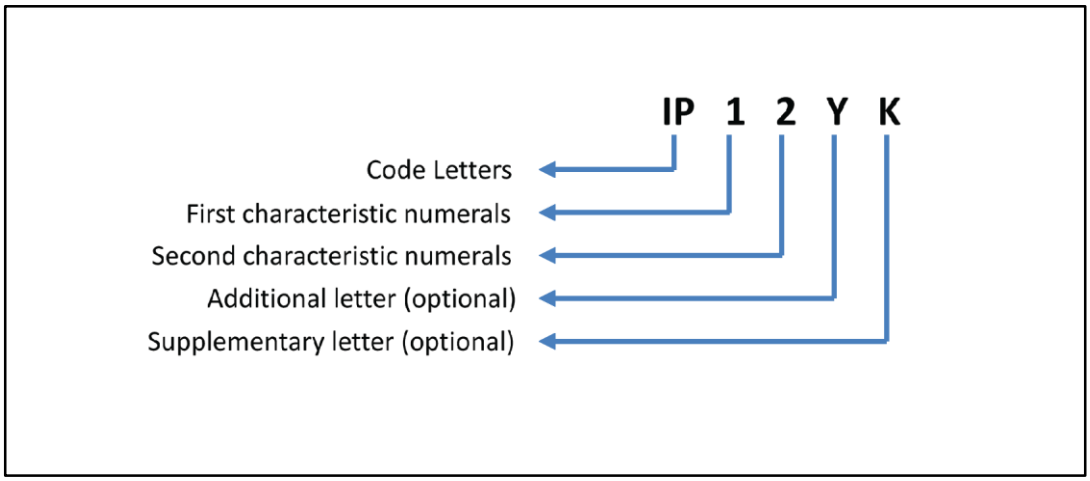


# 2 IEC 60529 (IP code) – Degrees of protection provided by enclosures

Depending on their potential exposure to foreign objects, electrical devices must, according to IEC 60529, belong to a specific type of protection. The types of protection are also called IP codes. The abbreviation IP stands for “ingress protection”.

The IP codes indicates the level of protection that the enclosure provides against the ingress of hazardous parts and solid foreign objects (marked by the first characteristic numeral of the IP code) and against harmful effects due to the ingress of water (marked by the second characteristic numeral of the IP code).

**Figure 4: IP standard description**




Where there is no data available to specify a protection rating with regard to one of the criteria, the digit is replaced with the letter “*X*”. The digit “*0*” is used where no protection is provided.

Please refer to the IEC 60529:2010 standard for the full description and definition of each degree of protection.

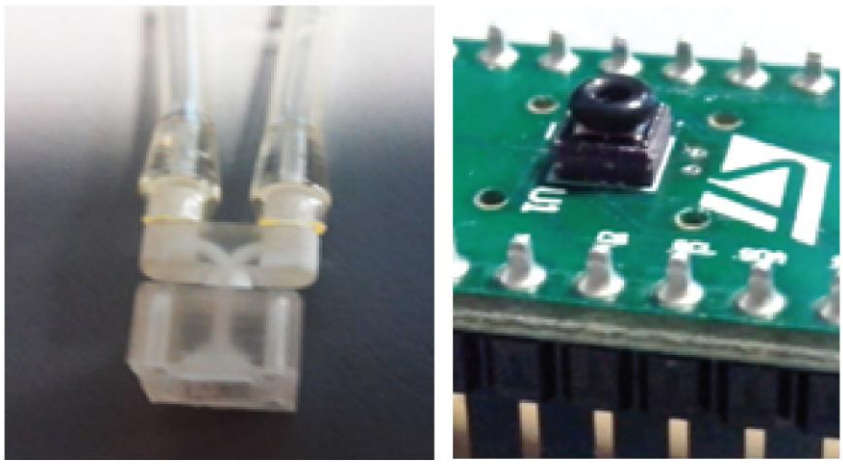
# 3 Test setup and process

Tests were performed on LPS35HW production parts that have been submitted to the following steps:

1. Preconditioning phase
   a. 24h at 125 °C
   b. 48h at 60 %/ 60 °C
2. two cycles of JEDEC compliant reflow process at 260 °C
3. soldering on adapter boards with a third JEDEC compliant process

Adapter boards of LPS35HW have been used together with plastic caps and commercial O-rings (1 mm diameter and 1 mm thickness – nitrile, 70 shore hardness) by the external laboratory to apply the requested testing condition. The test setup is shown in *Figure 6: "Plastic cap and standard o-ring mounted on the parts"*.

**Figure 5: Plastic cap and standard o-ring used for water stress tests**



The plastic cap is mounted on the LPS35HW evaluation board with the O-ring placed between the plastic cap itself and the device under test. Four screws allow the sealing of the system to emulate the vertical force induced on LPS35HW cap by a gasket/chassis system in the final application.

**Figure 6: Plastic cap and standard o-ring mounted on the parts**

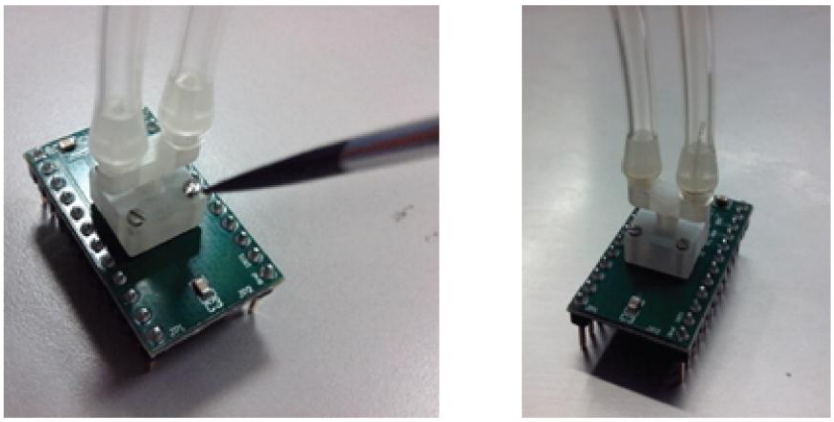
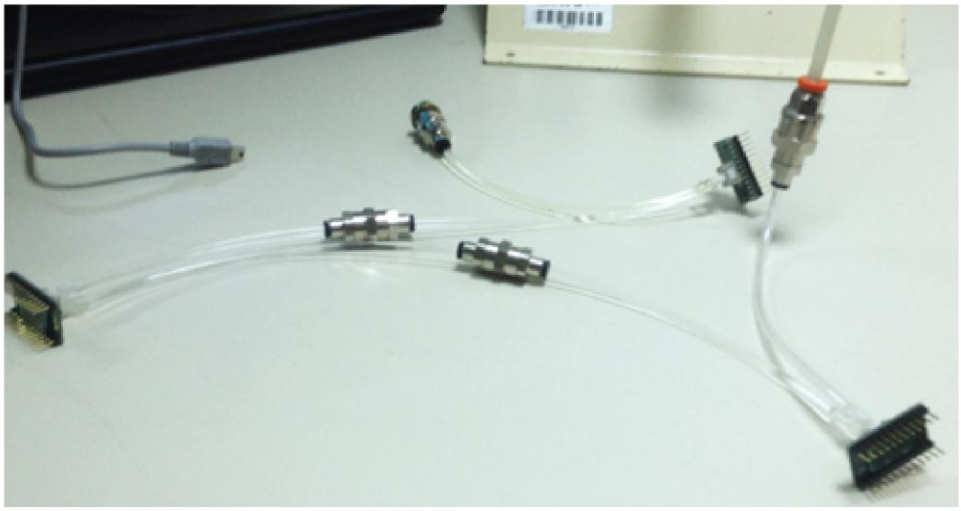


**Figure 7: Devices connected in series for IPx8 test**



The plastic cap has two plastic tubes on top of it: one connected to the inlet for water loading and the other one connected to other DUT in series, as described in *Figure 7: "Devices connected in series for IPx8 test"*. After the water is loaded into the package, overpressure is applied through the inlet, keeping the whole system perfectly closed.

For each test, 3 adapter boards with LPS35HW production parts have been tested.

The tests for IPx7– temporary immersion up to 1 m – were made by completely immersing the LPS35HW in water so that the following conditions are satisfied:

1. Tested with the lowest point of the enclosure 1000 mm below the surface of the water, or the highest point 150 mm below the surface, whichever is deeper
2. The duration of the test is 30 min

The test conditions for IPx8 – continuous immersion – are subjected to agreements between the manufacturer and user, but they shall be more severe than those prescribed in

IPx7 tests and they shall take account of the condition that the enclosure will be continuously immersed in water. In LPS35HW case, parts have been immersed in water at 20 °C and subjected to a pressure of 5bar for 60 minutes. After that, parts have been dried with Nitrogen before being tested.

# 4 Test outcomes

## 4.1 IPx7

Stress test for IPx7: 30 min at a pressure of 0.11 bar in water immersion (equivalent at ~1.1 m water depth).

**Figure 8: IPx7 test results**

| TEST IPX7 @1.8V, Pamb | Sheet | time FROM → | ← time TO | max | min | average | average rounded to 2 digits | Barometer reference FROM → | Barometer reference TO ← | Barometer reference Average | Delta P |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Samples for 1 min ≅ 1535 values | | | | | | | | | |
| **Sensor sn 5** | | | | [mbar a] | [mbar a] | [mbar a] | [mbar a] | [mbar a] | [mbar g] | [mbar a] | [mbar a] |
| Tnom=20°C Δh≈0cm **Before testing** | s5Bef | 2016/01/12 15:09:30,000 | 2016/01/12 15:10:30,000 | 1005.500 | 1005.440 | 1005.470 | 1005.47 | 1005.72 | 1005.70 | 1005.71 | -0.24 |
| Tnom=20°C Δh≈0cm **After testing** | s5Aft | 2016/01/12 16:09:30,000 | 2016/01/12 16:10:30,000 | 1007.470 | 1007.390 | 1007.433 | 1007.43 | 1006.02 | 1006.02 | 1006.02 | 1.41 |
| Tnom=20°C Δh≈0cm **After 41H** | s5Aft41H | 2016/01/14 09:22:00,000 | 2016/01/14 09:23:00,000 | 1016.130 | 1016.080 | 1016.108 | 1016.11 | 1016.67 | 1016.69 | 1016.68 | -0.57 |
| **Sensor sn 8** | | | | [mbar a] | [mbar a] | [mbar a] | [mbar a] | [mbar a] | [mbar g] | [mbar a] | [mbar a] |
| Tnom=20°C Δh≈0cm **Before testing** | s8Bef | 2016/01/12 15:09:30,000 | 2016/01/12 15:10:30,000 | 1006.020 | 1005.950 | 1005.984 | 1005.98 | 1005.72 | 1005.70 | 1005.71 | 0.27 |
| Tnom=20°C Δh≈0cm **After testing** | s8Aft | 2016/01/12 16:09:30,000 | 2016/01/12 16:10:30,000 | 1007.650 | 1007.580 | 1007.619 | 1007.62 | 1006.02 | 1006.02 | 1006.02 | 1.60 |
| Tnom=20°C Δh≈0cm **After 41H** | s8Aft41H | 2016/01/14 09:22:00,000 | 2016/01/14 09:23:00,000 | 1017.040 | 1016.990 | 1017.012 | 1017.01 | 1016.67 | 1016.69 | 1016.68 | 0.33 |
| **Sensor sn 18** | | | | [mbar a] | [mbar a] | [mbar a] | [mbar a] | [mbar a] | [mbar a] | [mbar a] | [mbar a] |
| Tnom=20°C Δh≈0cm **Before testing** | s18Bef | 2016/01/22 14:48:00,000 | 2016/01/22 14:49:00,000 | 1019.480 | 1019.420 | 1019.454 | 1019.45 | 1019.70 | 1019.68 | 1019.70 | -0.25 |
| Tnom=20°C Δh≈0cm **After testing** | s18Aft | 2016/01/22 15:35:00,000 | 2016/01/22 15:36:00,000 | 1019.950 | 1019.840 | 1019.907 | 1019.91 | 1020.00 | 1019.98 | 1020.00 | -0.09 |
| Tnom=20°C Δh≈0cm **After 41H** | s18RecWeek | 2016/01/24 08:36:00,000 | 2016/01/24 08:37:00,000 | 1023.640 | 1023.610 | 1023.623 | 1023.62 | 1023.92 | 1023.90 | 1023.91 | -0.29 |

## 4.2 IPx8

Stress test for IPx8: 1h at a pressure of 5 bar in water immersion (equivalent at ~50 m water depth).

**Figure 9: IPx8 test results**

| TEST IPX8 @1.8V, Pamb | | Sheet | time FROM → | ← time TO | max | min | average | average rounded to 2 digits | Sheet | Barometer reference FROM → | Barometer reference TO ← | Barometer reference Average | Delta P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Samples for 1 min ≅ 1535 values | | | | | | | | | | |
| **Sensor sn 9** | | | | | [mbar a] | [mbar a] | [mbar a] | [mbar a] | | [mbar a] | [mbar a] | [mbar a] | [mbar a] |
| Tnom=20°C Δh≈0cm | **Before testing** | s9Bef | 2016/01/14 15:16:00,000 | 2016/01/14 15:17:00,000 | 1012.830 | 1012.780 | 1012.802 | 1012.80 | | 1013.27 | 1013.25 | 1013.26 | -0.46 |
| Tnom=20°C Δh≈0cm | **After testing** | s9Aft | 2016/01/14 16:46:00,000 | 2016/01/14 16:47:00,000 | 1014.960 | 1014.780 | 1014.868 | 1014.87 | | 1012.76 | 1012.73 | 1012.75 | 2.12 |
| Tnom=20°C Δh≈0cm | **After 18H** | s9AftRec2 | 2016/01/15 10:46:00,000 | 2016/01/15 10:47:00,000 | 1006.100 | 1006.050 | 1006.075 | 1006.07 | BarRef1 | 1007.63 | 1007.60 | 1007.62 | -1.55 |
| **Sensor sn 11** | | | | | [mbar a] | [mbar a] | [mbar a] | [mbar a] | | [mbar a] | [mbar a] | [mbar a] | [mbar a] |
| Tnom=20°C Δh≈0cm | **Before testing** | s11Bef | 2016/01/14 15:16:00,000 | 2016/01/14 15:17:00,000 | 1013.160 | 1013.100 | 1013.130 | 1013.13 | | 1013.27 | 1013.25 | 1013.26 | -0.13 |
| Tnom=20°C Δh≈0cm | **After testing** | s11Aft | 2016/01/14 16:46:00,000 | 2016/01/14 16:47:00,000 | 1019.060 | 1018.530 | 1018.776 | 1018.78 | | 1012.76 | 1012.73 | 1012.75 | 6.03 |
| Tnom=20°C Δh≈0cm | **After 18H** | s11AftRec2 | 2016/01/15 10:46:00,000 | 2016/01/15 10:47:00,000 | 1010.590 | 1010.530 | 1010.559 | 1010.56 | BarRef1 | 1007.63 | 1007.60 | 1007.62 | 2.94 |
| **Sensor sn 17** | | | | | [mbar a] | [mbar a] | [mbar a] | [mbar a] | | [mbar a] | [mbar a] | [mbar a] | [mbar a] |
| Tnom=20°C Δh≈0cm | **Before testing** | s17Bef | 2016/01/14 15:16:00,000 | 2016/01/14 15:17:00,000 | 1013.050 | 1012.990 | 1013.020 | 1013.02 | | 1013.27 | 1013.25 | 1013.26 | -0.24 |
| Tnom=20°C Δh≈0cm | **After testing** | s17Aft | 2016/01/14 16:46:00,000 | 2016/01/14 16:47:00,000 | 1015.600 | 1014.800 | 1015.169 | 1015.17 | | 1012.76 | 1012.73 | 1012.75 | 2.42 |
| Tnom=20°C Δh≈0cm | **After 18H** | s17AftRec2 | 2016/01/15 10:46:00,000 | 2016/01/15 10:47:00,000 | 1007.190 | 1007.140 | 1007.167 | 1007.17 | BarRef1 | 1007.63 | 1007.60 | 1007.62 | -0.45 |

## 4.3 CEI/IEC 60529 (IP code) - results and remarks

The LPS35HW has been successfully tested for *IPx7* and *IPx8* standards. All the parts tested recovered properly after the stress conditions applied.

# 5 ISO 22810 horology– water-resistant watches

*ISO 22810 horology – water-resistant watches*, has been drawn up to meet a global demand for clear and unambiguous specifications in this area. It establishes the requirements and specifies the test methods used to verify the water resistance of watches.

Please refer to the standard Reference number ISO 22810:2010 for the full list of stress tests.

## 5.1 Applicable stress tests from ISO 22810

Three applicable tests have been selected to stress LPS35HW as follows.[a]

- 4.3.2 water resistance to overpressure:
  - Water immersion
  - Raise the pressure in the container in 1 minute to an overpressure of 5 bar[b]
  - Hold at the selected overpressure for 10 minutes
  - After 1 minute, reduce the pressure back down to ambient pressure
- 4.3.3 water resistance at shallow depth
  - Immerse the device in water to a depth of 10 cm ± 2 cm
  - Keep the device under water for 1 hour
- 4.3.5 water resistance on exposure to thermal shocks
  - Immerse the device in water to a depth of 10 cm ± 2 cm
  - Water at 40 °C for 5 minutes
  - 1 minute transfer to the next condition
  - Water at 20 °C for 5 minutes
  - 1 minute transfer to the next condition
  - Water at 40 °C for 5 minutes

## 5.2 Test setup and process

Tests were performed on LPS35HW production parts that have been submitted to the following steps:

1. Preconditioning phase
   a. 24h at 125 °C
   b. 48h at 60 % / 60 °C
2. Two cycles of JEDEC compliant reflow process at 260 °C
3. Soldering on adapter boards with a third JEDEC compliant process

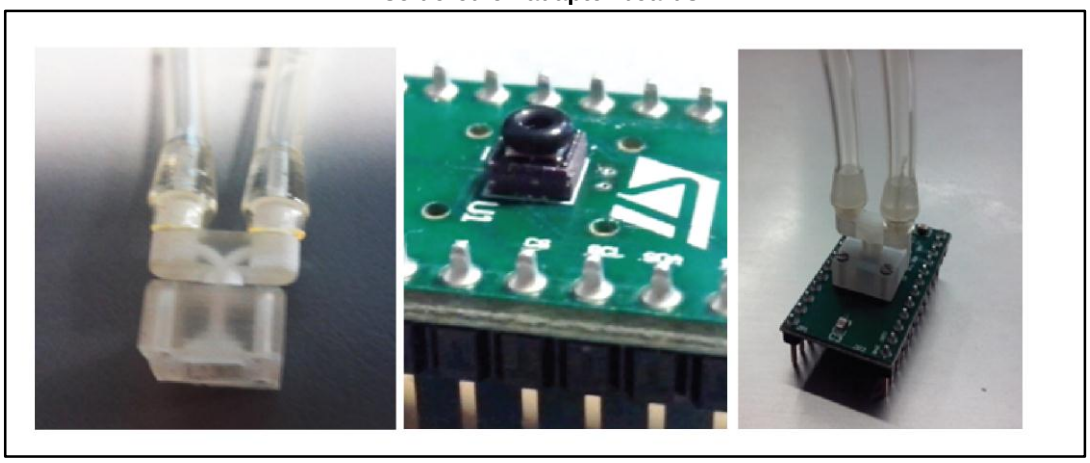
Adapter boards of LPS35HW have been used together with plastic caps and commercial O-rings (1 mm diameter and 1 mm thickness – nitrile, 70 shore hardness) by the external laboratory to apply the requested pressure condition. The test setup is shown in *Figure 10: "Plastic cap and standard o-ring used for water stress tests applied on parts soldered on adapter boards"*. The plastic cap is mounted on the LPS35HW evaluation board with the O-ring placed between the plastic cap itself and the device under test. Four screws allow the sealing of the system to emulate the vertical force induced on LPS35HW cap by a gasket/chassis system in the final application. The plastic cap has two plastic tubes on top

[a] According to Test 4.1, not reported here, the temperature must be under control and between 18 °C and 25 °C and water temperature equal to ambient temperature in all the test (except for Test 4.3.5)

[b] The device must be immersed completely in a suitable container filled with water. Raise the pressure in the container in 1 min to a minimum overpressure of 2 bar. Hold it at this pressure for 10 min. Then, in 1 min, reduce the pressure back down to ambient pressure. Higher overpressure values can be specified by the manufacturer, as per ST's indication of 5 bar.

of it: one connected to the inlet for water loading and the other one connected to the outlet as venting hole. After the water is loaded into the package, overpressure is applied through the inlet, keeping the outlet perfectly closed. For each applicable test, 3 adapter boards with LPS35HW production parts have been tested.

**Figure 10: Plastic cap and standard o-ring used for water stress tests applied on parts soldered on adapter boards**



## 5.3 Test outcomes

### 5.3.1 Results: water resistance to overpressure - Test 4.3.2

The device is put under strain according to the following procedure:

- Water immersion
- Raise the pressure in the container in 1 minute to an overpressure of 5 bar[a]
- Hold at the selected overpressure for 10 minutes
- After 1 minute, reduce the pressure back down to ambient pressure

The absolute accuracy is reported in the last column before and after the stress test.

**Figure 11: Test 4.3.2 results**

| TEST 4.3.2 @1.8V, Pamb | | Sheet | time FROM → | ← time TO | max | min | average | average rounded to 2 digits | Barometer reference FROM → | Barometer reference TO ← | Barometer reference Average | Delta P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Samples for 1 min ≅ 1535 values | | | | | | | | | |
| **Sensor sn 1** | | | | | [mbar a] | [mbar a] | [mbar a] | [mbar a] | [mbar a] | [mbar g] | [mbar a] | [mbar a] |
| Tnom=20°C Δh≈0cm | **Before testing** | s1Bef | 2016/01/12 10:35:40,000 | 2016/01/12 10:36:40,000 | 1006.320 | 1006.170 | 1006.252 | 1006.25 | 1006.57 | 1006.61 | 1006.59 | -0.34 |
| Tnom=20°C Δh≈0cm | **After testing** | s1Aft | 2016/01/12 11:39:20,000 | 2016/01/12 11:40:20,000 | 1009.900 | 1009.740 | 1009.814 | 1009.81 | 1006.45 | 1006.41 | 1006.43 | 3.38 |
| Tnom=20°C Δh≈0cm | **After 72H** | s1Aft72H | 2016/01/15 12:00:00,000 | 2016/01/15 12:01:00,000 | 1005.840 | 1005.700 | 1005.765 | 1005.76 | 1006.63 | 1006.61 | 1006.62 | -0.86 |
| **Sensor sn 3** | | | | | [mbar a] | [mbar a] | [mbar a] | [mbar a] | [mbar a] | [mbar g] | [mbar a] | [mbar a] |
| Tnom=20°C Δh≈0cm | **Before testing** | s3Bef | 2016/01/12 10:35:40,000 | 2016/01/12 10:36:40,000 | 1006.870 | 1006.730 | 1006.805 | 1006.80 | 1006.57 | 1006.61 | 1006.59 | 0.21 |
| Tnom=20°C Δh≈0cm | **After testing** | s3Aft | 2016/01/12 11:39:20,000 | 2016/01/12 11:40:20,000 | 1014.780 | 1014.380 | 1014.539 | 1014.54 | 1006.45 | 1006.41 | 1006.43 | 8.11 |
| Tnom=20°C Δh≈0cm | **After 72H** | s3Aft72H | 2016/01/15 12:00:00,000 | 2016/01/15 12:01:00,000 | 1006.360 | 1006.210 | 1006.278 | 1006.28 | 1006.63 | 1006.61 | 1006.62 | -0.34 |
| **Sensor sn 4** | | | | | [mbar a] | [mbar a] | [mbar a] | [mbar a] | [mbar a] | [mbar g] | [mbar a] | [mbar a] |
| Tnom=20°C Δh≈0cm | **Before testing** | s4Bef | 2016/01/12 10:35:40,000 | 2016/01/12 10:36:40,000 | 1006.480 | 1006.330 | 1006.412 | 1006.41 | 1006.57 | 1006.61 | 1006.59 | -0.18 |
| Tnom=20°C Δh≈0cm | **After testing** | s4Aft | 2016/01/12 11:39:20,000 | 2016/01/12 11:40:20,000 | 1015.680 | 1008.890 | 1012.246 | 1012.25 | 1006.45 | 1006.41 | 1006.43 | 5.82 |
| Tnom=20°C Δh≈0cm | **After 72H** | s4Aft72H | 2016/01/15 12:00:00,000 | 2016/01/15 12:01:00,000 | 1005.940 | 1005.770 | 1005.841 | 1005.84 | 1006.63 | 1006.61 | 1006.62 | -0.78 |

[a] The device must be immersed completely in a suitable container filled with water. Raise the pressure in the container in 1 min to a minimum overpressure of 2 bar. Hold it at this pressure for 10 min. Then, in 1 min, reduce the pressure back down to ambient pressure. Higher overpressure values can be specified by the manufacturer, as per ST's indication of 5 bar.

### 5.3.2 Results: water resistance at shallow depth - Test 4.3.3

The device is put under strain according to the following procedure:

- Immerse the device in water to a depth of 10 cm ± 2 cm
- Keep the device under water for 1 hour

The absolute accuracy is reported in the last column before and after the stress test.

**Figure 12: Test 4.3.3 results – DUT 1**

| TEST 4.3.3 @1.8V, Pamb | | Sheet | time FROM → | ← time TO | max | min | average | average rounded to 2 digits | Sheet | Barometer reference FROM → | Barometer reference TO ← | Barometer reference Average | Delta P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Samples for 1 min ≅ 1535 values | | | | | | | | | | |
| **Sensor sn 1** | | | | | [mbar a] | [mbar a] | [mbar a] | [mbar a] | | [mbar a] | [mbar a] | [mbar a] | [mbar a] |
| Tnom=20°C Δh≈0cm | **Before testing** | s1Bef | 2016/01/20 11:40:00,000 | 2016/01/20 11:41:00,000 | 1010.250 | 1010.180 | 1010.215 | 1010.22 | BarRef20 | 1011.35 | 1011.31 | 1011.33 | -1.11 |
| Tnom=20°C Δh≈0cm | **After testing** | s1Aft | 2016/01/20 13:02:00,000 | 2016/01/20 13:03:00,000 | 1009.580 | 1009.490 | 1009.550 | 1009.55 | BarRef20 | 1010.82 | 1010.79 | 1010.80 | -1.25 |
| Tnom=20°C Δh≈0cm | **After 22H** | s1Rec2 | 2016/01/21 11:02:00,000 | 2016/01/21 11:03:00,000 | 1013.160 | 1013.150 | 1013.155 | 1013.16 | BarRef20-21 | 1014.38 | 1014.36 | 1014.37 | -1.21 |
| **Sensor sn 3** | | | | | [mbar a] | [mbar a] | [mbar a] | [mbar a] | | [mbar a] | [mbar a] | [mbar a] | [mbar a] |
| Tnom=20°C Δh≈0cm | **Before testing** | s3Bef | 2016/01/20 11:40:00,000 | 2016/01/20 11:41:00,000 | 1010.020 | 1009.960 | 1009.989 | 1009.99 | BarRef20 | 1011.35 | 1011.31 | 1011.33 | -1.34 |
| Tnom=20°C Δh≈0cm | **After testing** | s3Aft | 2016/01/20 13:02:00,000 | 2016/01/20 13:03:00,000 | 1009.540 | 1009.450 | 1009.506 | 1009.51 | BarRef20 | 1010.82 | 1010.79 | 1010.80 | -1.29 |
| Tnom=20°C Δh≈0cm | **After 22H** | s3Rec2 | 2016/01/21 11:02:00,000 | 2016/01/21 11:03:00,000 | 1012.850 | 1012.830 | 1012.840 | 1012.84 | BarRef20-21 | 1014.38 | 1014.36 | 1014.37 | -1.53 |
| **Sensor sn 4** | | | | | [mbar a] | [mbar a] | [mbar a] | [mbar a] | | [mbar a] | [mbar a] | [mbar a] | [mbar a] |
| Tnom=20°C Δh≈0cm | **Before testing** | s4Bef | 2016/01/20 11:40:00,000 | 2016/01/20 11:41:00,000 | 1009.830 | 1009.770 | 1009.795 | 1009.79 | BarRef20 | 1011.35 | 1011.31 | 1011.33 | -1.54 |
| Tnom=20°C Δh≈0cm | **After testing** | s4Aft | 2016/01/20 13:02:00,000 | 2016/01/20 13:03:00,000 | 1009.490 | 1009.400 | 1009.450 | 1009.45 | BarRef20 | 1010.82 | 1010.79 | 1010.80 | -1.35 |
| Tnom=20°C Δh≈0cm | **After 22H** | s4Rec2 | 2016/01/21 11:02:00,000 | 2016/01/21 11:03:00,000 | 1012.760 | 1012.730 | 1012.746 | 1012.75 | BarRef20-21 | 1014.38 | 1014.36 | 1014.37 | -1.62 |

### 5.3.3 Results: water resistance at thermal shock - Test 4.3.5

The device is put under strain according to the following procedure:

- Immerse the device in water to a depth of 10 cm ± 2 cm
- Water at 40 °C for 5 minutes
- 1 minute transfer to the next condition
- Water at 20 °C for 5 minutes
- 1 minute transfer to the next condition
- Water at 40 °C for 5 minutes

The absolute accuracy is reported in the last column before and after the stress test.

**Figure 13: Test 4.3.5 results**

| TEST 4.3.5 @1.8V, Pamb | | Sheet | time FROM → | ← time TO | max | min | average | average rounded to 2 digits | Sheet | Barometer reference FROM → | Barometer reference TO ← | Barometer reference Average | Delta P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Samples for 1 min ≅ 1535 values | | | | | | | | | | |
| **Sensor sn 9** | | | | | [mbar a] | [mbar a] | [mbar a] | [mbar a] | | [mbar a] | [mbar a] | [mbar a] | [mbar a] |
| Tnom=20°C Δh≈0cm | **Before testing** | s9Bef | 2016/01/25 13:09:00,000 | 2016/01/25 13:10:00,000 | 1024.000 | 1023.870 | 1023.941 | 1023.94 | BarRef25 | 1025.22 | 1025.20 | 1025.21 | -1.27 |
| Tnom=20°C Δh≈0cm | **After testing** | s9Aft | 2016/01/25 13:52:00,000 | 2016/01/25 13:53:00,000 | 1023.800 | 1023.770 | 1023.783 | 1023.78 | BarRef25 | 1024.83 | 1024.79 | 1024.82 | -1.04 |
| Tnom=20°C Δh≈0cm | **After 10H** | s9Aft2 | 2016/01/25 23:52:00,000 | 2016/01/25 23:53:00,000 | 1024.120 | 1024.100 | 1024.111 | 1024.11 | BarRef25-26 | 1025.25 | 1025.23 | 1025.24 | -1.13 |
| **Sensor sn 11** | | | | | [mbar a] | [mbar a] | [mbar a] | [mbar a] | | [mbar a] | [mbar a] | [mbar a] | [mbar a] |
| Tnom=20°C Δh≈0cm | **Before testing** | s11Bef | 2016/01/25 13:09:00,000 | 2016/01/25 13:10:00,000 | 1024.640 | 1024.520 | 1024.584 | 1024.58 | BarRef25 | 1025.22 | 1025.20 | 1025.21 | -0.63 |
| Tnom=20°C Δh≈0cm | **After testing** | s11Aft | 2016/01/25 13:52:00,000 | 2016/01/25 13:53:00,000 | 1024.160 | 1024.110 | 1024.133 | 1024.13 | BarRef25 | 1024.83 | 1024.79 | 1024.82 | -0.69 |
| Tnom=20°C Δh≈0cm | **After 10H** | s11Aft2 | 2016/01/25 23:52:00,000 | 2016/01/25 23:53:00,000 | 1024.590 | 1024.570 | 1024.577 | 1024.58 | BarRef25-26 | 1025.25 | 1025.23 | 1025.24 | -0.66 |
| **Sensor sn 17** | | | | | [mbar a] | [mbar a] | [mbar a] | [mbar a] | | [mbar a] | [mbar a] | [mbar a] | [mbar a] |
| Tnom=20°C Δh≈0cm | **Before testing** | s17Bef | 2016/01/25 13:09:00,000 | 2016/01/25 13:10:00,000 | 1024.430 | 1024.280 | 1024.370 | 1024.37 | BarRef25 | 1025.22 | 1025.20 | 1025.21 | -0.84 |
| Tnom=20°C Δh≈0cm | **After testing** | s17Aft | 2016/01/25 13:52:00,000 | 2016/01/25 13:53:00,000 | 1023.150 | 1023.130 | 1023.138 | 1023.14 | BarRef25 | 1024.83 | 1024.79 | 1024.82 | -1.68 |
| Tnom=20°C Δh≈0cm | **After 10H** | s17Aft2 | 2016/01/25 23:52:00,000 | 2016/01/25 23:53:00,000 | 1023.390 | 1023.370 | 1023.380 | 1023.38 | BarRef25-26 | 1025.25 | 1025.23 | 1025.24 | -1.86 |

### 5.3.4 ISO 22810 - results and remarks

The LPS35HW has been successfully tested for all the applicable tests related to *ISO 22810 horology -- water-resistant watches*. All the parts tested recovered properly after the stress conditions applied.

## 5.4 Conclusions

LPS35HW has been successfully tested for:

- CEI IEC 60529 – IP Code IPx7 and IPx8
  - 30 min at a pressure of 0.11 bar in water immersion (equivalent at ~1.1 m water depth) and 1hour at a pressure of 5 bar in water immersion (equivalent at ~50 m water depth).
- ISO 22810 horology – water-resistant watches[a]
  - LPS35HW can be considered water resistant to overpressure, water resistant at shallow depth and water resistant to thermal shocks

It should be noted that LPS35HW package is intrinsically waterproof in the ceramic base and potting gel, while it is water resistant on the metal lid in the region of the sealing line.

Special care must be taken into account when designing the final application/product in order to proper seal the rest of the sensitive components (electronic components, pcb, connectors, displays, battery, etc…) through specific gasket/enclosures design.

The final product must be re-qualified to achieve the same applicable standards, even if less stringent (i.e. IPx6, etc…).

[a] Refer to *Section 4.1* for the applicable tests and conditions.

## 5.5 Conformity certificate

**Figure 14: Conformity certificate**

CALIBRATION LABORATORY
*Laboratorio di Taratura*

established by:
istituito da:

Officine Metrologiche Meridionali

METRA s.r.l. - Primo Ronco a via Tisia 11, 96100 Siracusa SR
sede operativa e laboratori metrologici: c/da Remingato, 96011 Augusta SR
tel:+39.0931513930 - fax:+39.0931993261
web site: www.metraofficine.it
email: info@metraofficine.it

CONFORMITY STATEMENT No. **0001 AC 16** Page 1 of 1
Attestato di Conformità n. *0001 AC 16* *Pagina 1 di 1*

We certify that the batch of LPS35HW sensors described below, submitted to conformity tests according ISO 22810: 2010, paragraphs 4.3.2, 4.3.3, 4.3.5, and according to IEC 60529: 2010, paragraphs 14.2.7 (degree of protection IPX7) and 14.2.8 (degree of protection IPX8, immersion equivalent 50m of water for 1 hour), in the Metrological Labs of Metra s.r.l.

*Si certifica che il lotto di sensori LPS35HW di seguito descritto, sottoposto ai test di conformità alla norma ISO 22810:2010, paragrafi 4.3.2, 4.3.3, 4.3.5, ed ai test di conformità alla norma IEC 60529:2010, paragrafi 14.2.7 (grado di protezione IPX7) e 14.2.8 (grado di protezione IPX8, immersione equivalente 50m d'acqua per 1 ora), presso i Laboratori Metrologici di Metra s.r.l.*

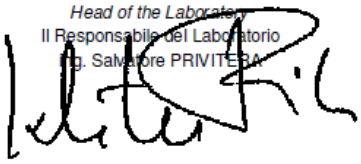
**is in compliance with the requirements above / *è conforme ai requisiti sopra descritti***

| | |
|---|---|
| -Date of issue<br>*data di emissione* | 2016/02/05 |
| -addressee<br>*destinatario* | STMicroelectronics s.r.l., Catania |
| -application<br>*richiesta* | 4000449135 |
| -date<br>*in data* | 2015/11/30 |

Referring to:
*si rifrisce a:*

| | |
|---|---|
| -item<br>*oggetto* | Barometric sensor (9 pcs.) |
| -manufacturer<br>*costruttore* | STMicroelectronics s.r.l. |
| -model<br>*modello* | LPS35HW - Lot number 22548NQJRR- Rev B |
| -serial number<br>*matricola* | 01/04/05/08/09/11/17/18/19 |
| -date of measurement<br>*data delle misure* | 2016/01/11 - 2016/02/02 |

*Head of the Laboratory*
Il Responsabile del Laboratorio
Ing. Salvatore PRIVITERA



# 6 Revision history

Table 1: Document revision history

| Date | Version | Changes |
|---|---|---|
| 21-Jul-2016 | 1 | Initial release. |

## IMPORTANT NOTICE – PLEASE READ CAREFULLY

STMicroelectronics NV and its subsidiaries (“ST”) reserve the right to make changes, corrections, enhancements, modifications, and improvements to ST products and/or to this document at any time without notice. Purchasers should obtain the latest relevant information on ST products before placing orders. ST products are sold pursuant to ST’s terms and conditions of sale in place at the time of order acknowledgement.

Purchasers are solely responsible for the choice, selection, and use of ST products and ST assumes no liability for application assistance or the design of Purchasers’ products.

No license, express or implied, to any intellectual property right is granted by ST herein.

Resale of ST products with provisions different from the information set forth herein shall void any warranty granted by ST for such product.

ST and the ST logo are trademarks of ST. All other product or service names are the property of their respective owners.

Information in this document supersedes and replaces information previously supplied in any prior versions of this document.