THALES

Air Data Pressure sensor
Thales In-service experience

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Thales Product Range

A range of products for pressure measurements

- Pressure sensor
- Air data processors (ADM, ADC)
- Standby Instrument fitted with standalone pressure sensor

2 generations of pressure sensor

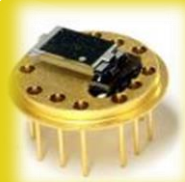
- High accuracy and maturity
- Excellent in-service reliability and stability
- More than 100,000 sensors in-service for Commercial Aircraft use

Pressure sensor product range

2 generations of pressure sensors

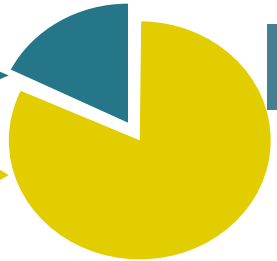
Piezzo Electric Sensor

1992 → 2011



Silicon Chip Sensor

1997 → *Currently in production*



20,000 sensors produced

85,000 sensor produced

Product performance

Product performance

- Down to **+/-0,25 hPa** for the operational pressure range (from **100 hPa** up to **1400 hPa)**

Corresponds to :

- **+/- 7 ft** at sea level
- **+/- 27 ft** at FL400

High accuracy pressure manometer used for acceptance test in production and repair shop

Focus on measurement errors

- Measurements performed using a « Primary pressure standard »
- Schwien pressure generators considered as « Primary pressure standards » (COFRAC : French Accreditation Organisation)
- Used for: Initial performance, stabilisation process, final calibration
- Accuracy of Schwien pressure generator is pressure dependant
  - From 0,03 hPa @ low pressure, up to 0,07 hPa for high pressure

Product performance (+/- 0,25 hPa) close to the performance of the highest manometer standard

Sensors long term stablity

As pressure sensors long term stability is a key player in ASE, it is a main driver in Thales pressure sensor design and production process

Design

- From piezzo-electric to various silicon chip sensors, design targets long term stability with root cause analysis in design as well as in process
- Accelerated ageing testing on sensors sets are used to validate the design
- In service results are compared to accelerated ageing tests results

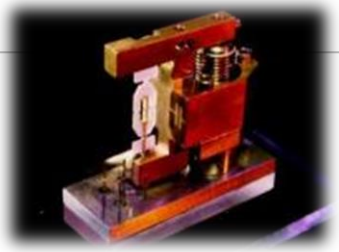
Production process

- Stability monitored during production process for each sensor
- Final acceptance test in production highlights the stability

In service experience : Piezzo Electric Sensor

- THALES collects in-service data from its worldwide repair network
- These data give an overview of the behavior of suspected ADM, removed from the A/C following a maintenance action

In service experience : Piezzo Electric Sensor



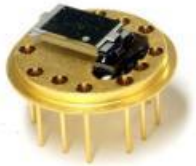
For ADM fitted with Piezzo Electric sensor

- Very good in-service reliability observed
- Some units affected by drift phenomenon
- One of the known root cause responsible for a negative drift of the sensor :
  - loss of vacuum inside the reference cavity
  - reference pressure increases
  - causes a negative misreading (pressure underestimated)
  - can explain A/C flying below the assigned altitude

Most of these drifts occur during the first years of operation : typical value 5 years

- Phenomenon stabilizes with time
- Mean drift value : -0,9 hPa (-90ft at FL400)

In service experience : Silicon Chip Sensor



For ADM fitted with Silicon chip sensors

- Reliability greatly enhanced compared to former generations
- Regular design and manufacturing process improvement leading to excellent stability and accuracy
- These sensors are not affected by drift effect
  - Fail safe concept : decrease of vaccuum quality inside the cavity leads to sensor failure (loss of ADM output)
- Common failure modes observed :
  - Very seldom case of slight decalibration can be observed, not correlated to unit age
  - Decalibration equally distributed between positive and negative values
  - Average decalibration value :
    - Negative : -0,5 hPa (50ft at FL 400)
    - Positive : +0,7 hPa (70ft at FL 400)

Conclusion

- For A/C fitted with last ADM generation, limited number of altimetry system error
- For older A/C, some ADM may need to be removed from the A/C for recalibration in Thales shop
- Once recalibrated, ADM recover its nominal performance and a high level of stability, no other drift is expected