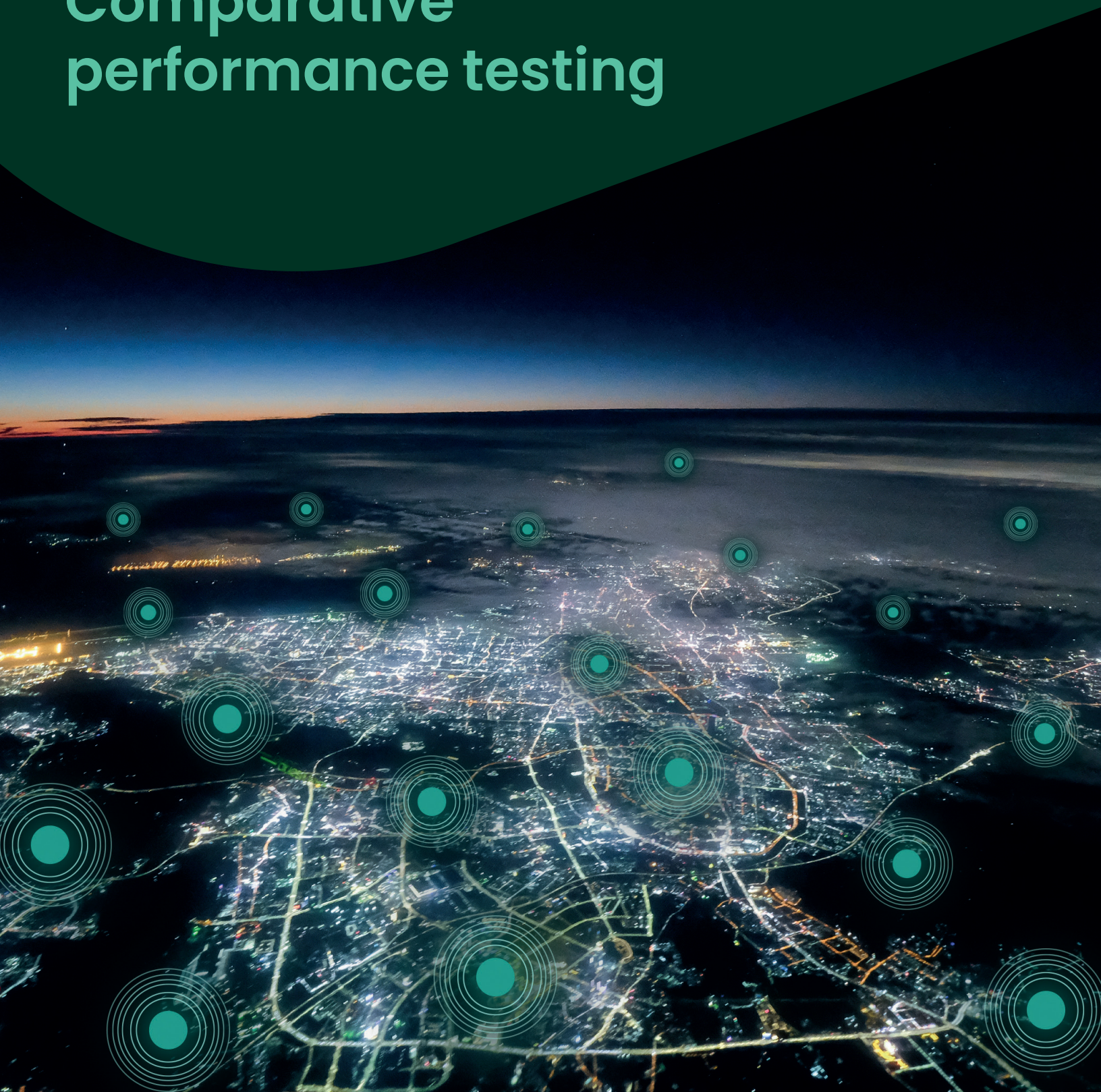
Druck
a Baker Hughes business

ADROIT6200

Comparative performance testing



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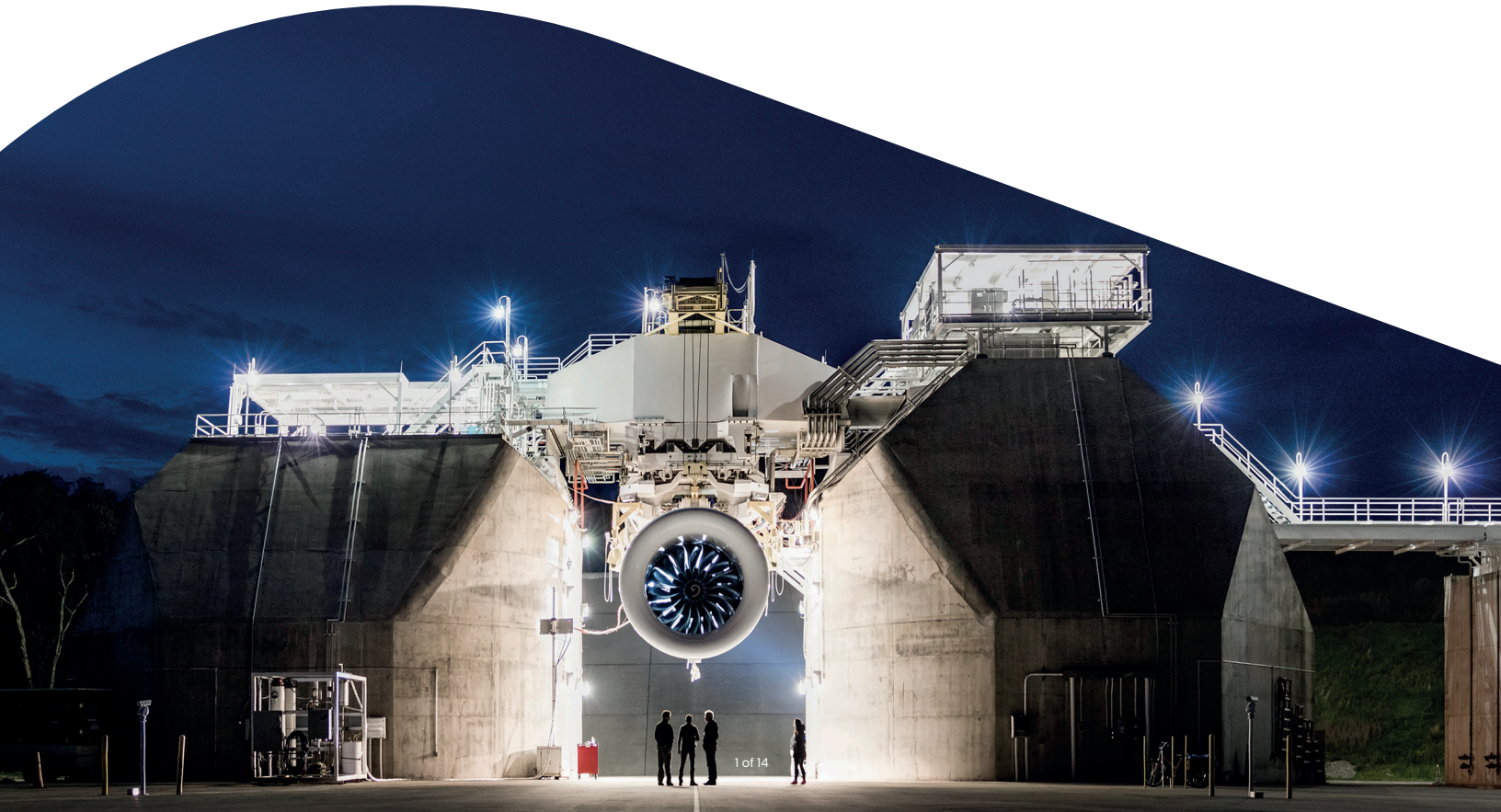
Druck, a Baker Hughes business, delivers world-class expertise, excellence, and reliability in the toughest environments. Druck's piezo-resistive pressure sensors and test and calibration instruments provide our customers with the highest performance, stability, quality, accuracy, and quickest response in any environment.

What began in 1972 as a small business in Leicester, UK has grown into a global pressure-measurement business recognized as a world leader serving a wide range of applications for customers in more than 70 countries.

Druck's high-quality products develop from the in-house, raw processing of silicon to delivering the final product.



2 Introduction to ADROIT6200

Druck, a Baker Hughes business, launched the ADROIT6200 pressure sensor in November 2020. It is a next generation digitally compensated piezo-resistive pressure sensor with high levels of accuracy across a wide operating temperature. It has a characteristically small package size and exhibits a rapid response to changes in pressure. This combination of features makes it an ideal product to be used in demanding test environments typical in Automotive and Aerospace development testing.

This paper discusses the results of comparative testing performed by Druck in laboratory conditions with products from other pressure sensor manufacturers with similar specifications and target applications.





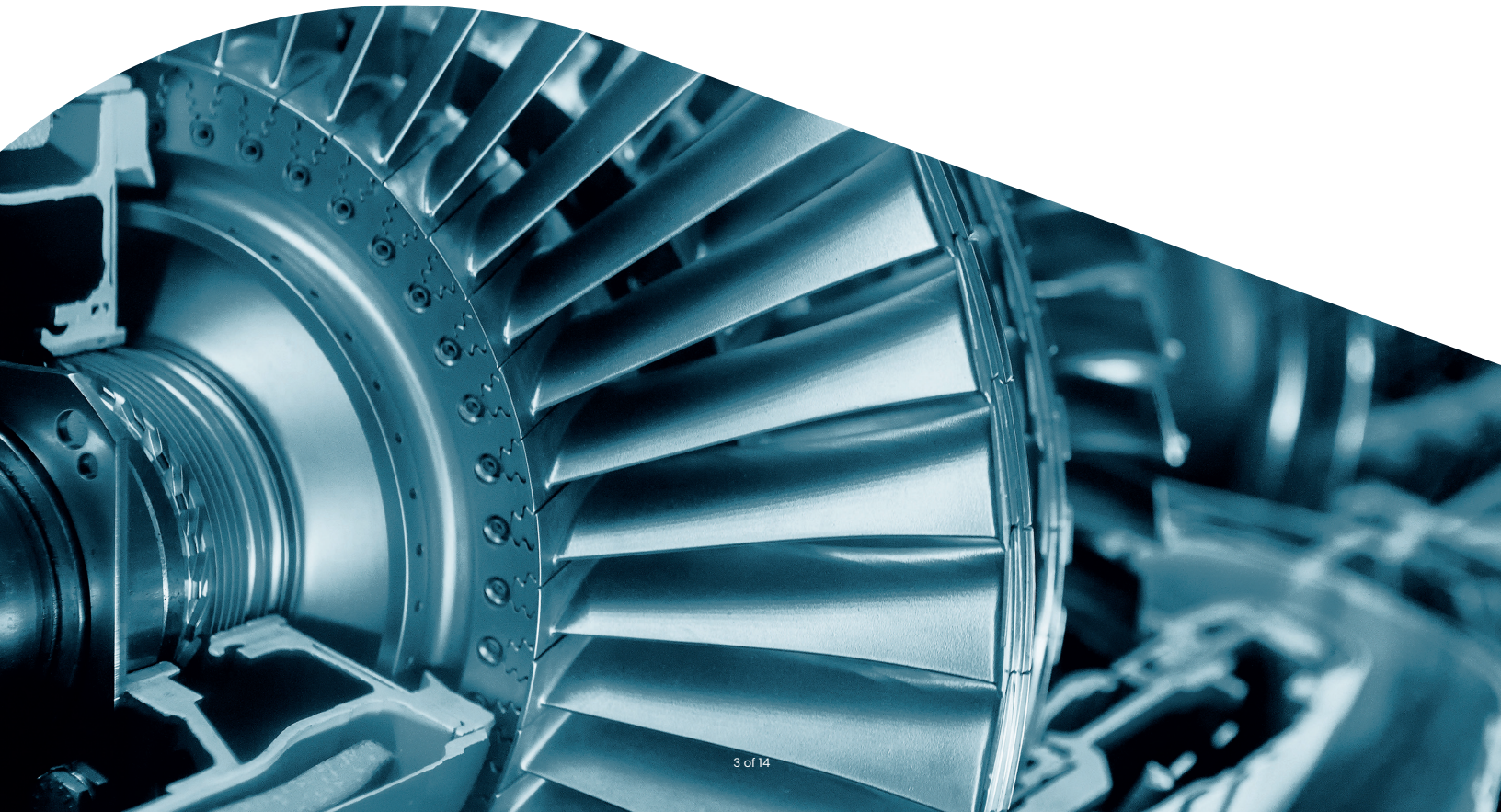

3 Units Under Test

The ADROIT6200 has been designed to be an ideal sensor for use in the automotive and aerospace test market. To determine the competitiveness of the ADROIT6200, units were tested against 3 market-leading competitors who claim similar performance specification. The details of these units are described in Table 2:

Name	Pressure range	Temperature range (°C)	Output	Output type	Quoted accuracy
Competitor A	150 psi G	-40 to +93	4 to 20 mA	Analogue	+/- 0.05 % accuracy, 0.0015 %FS/°F
Competitor B	10 bar G	-10 to +80	4 to 20 mA	Digitally Compensated Analogue	+/- 0.15% FS TEB
Competitor C	30 bar G	-20 to +80	4 to 20 mA	Digitally Compensated Analogue	+/- 0.1 % within 10 to 60 °C
Typical Analogue Sensor	200 mbar G	-40 to +80	4 to 20 mA	Analogue	+/- 2.25% FS TEB
ADROIT6200	10 bar G	-40 to +125	0.5 to 4.5 V	Digitally Compensated Analogue	+/- 0.2 %FS
ADROIT6200	350 bar A	-40 to +125	4 to 20 mA	Digitally Compensated Analogue	+/- 0.2 %FS

Table 2 - Sensors under test

Note: Quoted accuracy from product datasheet at time of purchase



3.1 Size comparison

The ADROIT has been designed to provide the best possible performance in the smallest possible package. From the scale drawing, Figure 1, the ADROIT is significantly smaller than all the competitors, with a smaller diameter as well as a shorter length.

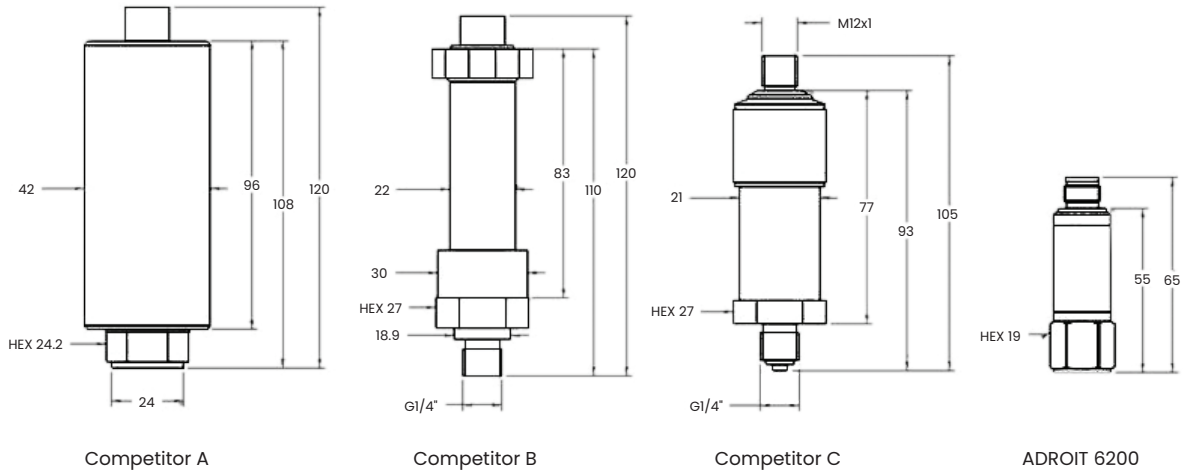


Figure 1 - Sensor size comparison

3.2 Unit performance

The units were all tested across pressure and temperature range to determine the performance level of the sensors.

The pressure was applied by a 20 bar G PACE pneumatic controller (±0.05 %FS), except for the 350 bar A ADROIT unit, which had pressure applied by a 350 bar A pressure controller with an accuracy of 0.01 %FS.

The temperature was controlled by an environmental chamber, with an operating temperature range of -55 to +155 °C.

3.2.1 Non-linearity, hysteresis and repeatability

From the performance over pressure at room temperature, the Non-Linearity, Hysteresis and Repeatability can be determined.

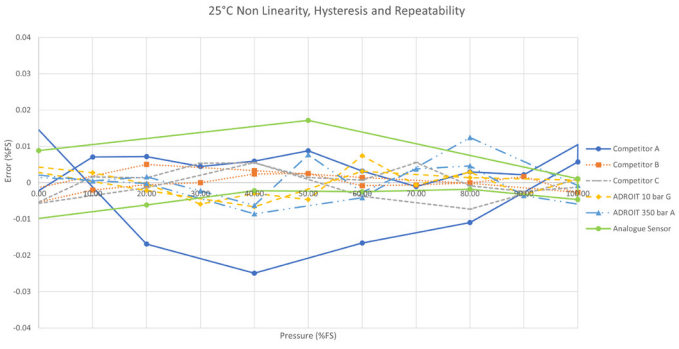


Figure 2 - Non-Linearity, Hysteresis and Repeatability

From this, the performance of the analogue only sensors cannot compare with digitally compensated output.

3.2.2 Total accuracy at room temperature

The ADROIT quotes accuracy to described output. By comparing the results to the calculated output from known pressure, the absolute error can be calculated.

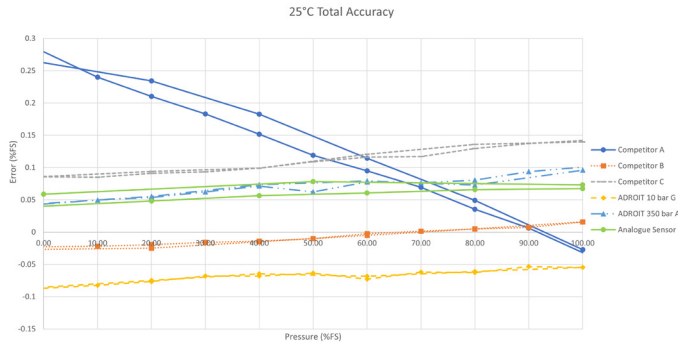


Figure 3 - Total accuracy at room temperature

Competitor B is very accurate at room temperature conditions. The ADROIT of a similar range exceeds its stated performance and is more accurate than all the remaining units under test.

3.2.3 Performance over temperature

The units were mounted on a manifold and pressurised to 10 bar gauge. The units were then thermally cycled down to -40 °C and up to 125 °C.

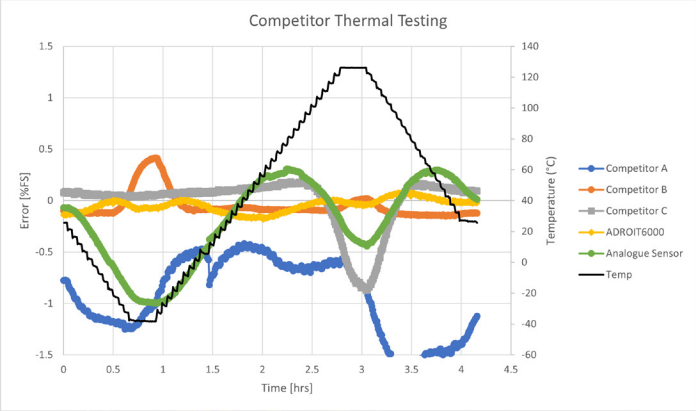


Figure 4 - Thermal performance

In rapidly changing temperature conditions the digitally compensated sensors performed much better than the analogue sensors. Competitor B and Competitor C exhibited errors at low and high temperature respectively. The ADROIT6200 sensor remained close to true value across the full temperature range, and was the sensor least affected by rapid temperature change in this test.

3.2.4 Thermal hysteresis

The units were fully verified, testing their performance across a range of temperatures within their operating temperature range. This information was used to determine the thermal hysteresis of each unit.

Sensor	Measured thermal hysteresis (%FS)
Competitor A	0.068
Competitor B	0.060
Competitor C	0.097
ADROIT 10 bar G	0.025
ADROIT 350 bar A	0.045

Table 3 - Thermal hysteresis

The thermal hysteresis figure varies with pressure range and temperature range, so the results shown in the above table will vary across different sensors. Despite having the widest temperature range and the smallest package, the ADROIT6200 demonstrated the best thermal hysteresis of all the sensors tested.

3.3 Response time

Digitally compensated sensors can show a slight delay in their power up and rise time, due to the calculations involved in compensating the output to achieve the highest levels of performance.

3.3.1 Power up time

The units were connected to an oscilloscope and the output recorded to determine the power up characteristics of each sensor.

Sensor	Power up time (ms)
Competitor A	0.1
Competitor B	25
Competitor C	740
ADROIT 10 bar G	5
Typical Analogue Sensor	0.1

Table 4 - Power up time

The ADROIT performs the power up significantly faster than the other digitally compensated sensors, reaching output in 5 ms.

3.3.2 Rise time

The units were connected to an oscilloscope, and the output was recorded as a vacuum was removed from the sensor. This showed the sensor responding to the sharp change in pressure, timed from the initial change in reading.

Sensor	Rise time (ms)
Competitor A	3
Competitor B	2.5
Competitor C	*
ADROIT 10 bar A	<1

Table 5 - Rise time

*As Competitor C is a 30 bar G sensor, the vacuum applied did not provide suitable resolution for the test to be performed successfully.

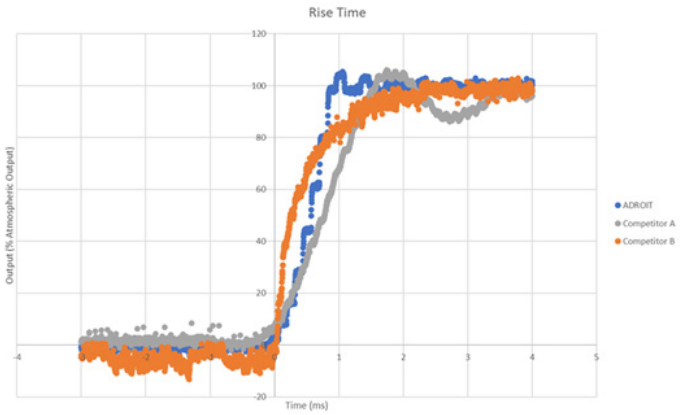


Figure 5 - Rise time testing

The rise times quoted are stated showing the time taken to respond to atmospheric pressure from the initial change in reading. The resonance shown in the output of some sensors is caused by the vibrations in the air of the pressure connections.

4 Conclusion

The ADROIT 6200 pressure sensor has many features, both physical and performance related, that make it an excellent product.

- The 19mm diameter package and short length of the ADROIT6200 allows installation in small spaces that cannot be matched by benchmark products in this test.
- The non-linearity, hysteresis, and repeatability of the ADROIT is comparable to the competitors.
- The unparalleled thermal performance of the ADROIT6200 makes it the standout pressure sensor for use in applications with wide temperature variations, providing unmatched performance from -40 to 125 C.
- The electronic design allows fast power up characteristics.