Druck
a Baker Hughes business

The need for speed

Optimising Druck's PACE5000 E & 6000 E Pressure Controllers

Introduction

Druck, a Baker Hughes business, has been developing and delivering pressure measurement solutions to customers for more than 50 Years. Our expertise spans across many of the harshest applications, including in Aerospace, Oil & Gas, Industrial, Metrological Laboratories and many others.

One of Druck's main areas of technical expertise is Pressure Controllers, with customers using Druck's solution across many different industrial applications and by metrological laboratories as calibration standards around the world.

Druck's PACE Pressure Controllers are widely regarded as the fastest, most stable and accurate controllers on the market, across a wide variety of applications.

In the past, we have written about the accuracy and stability of the PACE portfolio, producing a whitepaper (available to download here) that discusses aspects to consider when accuracy and stability are key to your application.

In this paper, we are focusing on how to optimise your PACE controller set up to achieve the best result when speed is the most critical factor.

In reality, applications often require a blend of all three aspects of speed, accuracy and stability. We see competing suppliers heavily promoting one aspect of performance, but customers are often not aware that their pressure controller sacrifices one of the other two key areas to achieve this.

The versatility and flexibility of Druck's PACE Pressure Controllers portfolio allows for fine tuning to find the best possible set up to meet your application needs.

In this paper, we are going to focus on three main areas to consider when optimising your PACE Pressure Controller setup to maximise speed:

- Controller settings
- Pneumatic connections
- Maintenance

Controller settings

One of the easiest, quickest and cost-effective ways to improve the PACE control performance is to optimise the settings within the controller to match the application. All control settings can be found within the "control setup" menu.

Slew rate

For the majority of applications, the optimum setting is to configure PACE for "Max rate". This will ensure the PACE controls as fast as possible.

However, for configurations that contain complex loads/volumes it may be necessary to find a slew rate that hits the sweet spot for that application by configuring the slew rate as "linear" with a defined value in mbar/second (example) that can be tuned to match the application.

This setting is also useful should maximum speed not be a requirement, but where a slower and precisely controlled ramp might be more desirable

Overshoot

In order to guarantee the fastest control speed, it is necessary to enable the overshoot setting. This does not guarantee that the controller will overshoot, but allows it to if necessary.

If the user requires the controller not to overshoot then the "no overshoot" setting can be enabled.

In-limits

PACE Pressure Controllers are considered the most stable on the market, guaranteeing a control stability of 10ppmFS (0.001%FS) minimum. Typically, figures of 5ppm or even 1ppm are possible.

When compared to the closest competitor product, achieving 30ppm, you can see the gap in performance. However, if the user wishes to sacrifice control stability for enhanced speed-to-setpoint then the "in-limit" settings can be adjusted to higher values e.g. 50ppm. This will reduce the time it takes for PACE to report back via remote communication (or on-screen) that it has settled at the desired setpoint. In this case PACE can reach most setpoints in as little as 1-2 seconds. This setting can be found within the supervisor setup menu.

PACE also provides feedback that you are within these specified control stability limits for a user defined period of time. This feedback can be provided on-screen or via the remote communication interface.

Active/passive/gauge mode

Although not related to control speed, this setting allows the user to potentially improve their uncertainty budget in a leak-free or low leak system.

In active mode, the PACE controller is always responding to pressure fluctuations and so the 10ppm pressure stability figure must be included within the uncertainty budget. The reason for not including this term as standard is because the PACE often achieves 1-2ppm control stability and is therefore negligible in these situations.

If the user has a setup whereby the system has a very small leak, then PACE can be switched to passive mode whereby the controller turns off when reaching setpoint. This allows for the uncertainty budget to be improved. It's extremely important to consider this uncertainty budget if using a competitor product with reduced control stability.

Often, claims of very fast control speed are offset by control stability specifications of >=250ppmFS. Consider this against a sensor uncertainty in the region of 50-100ppmFS and the excellent sensor performance is completely negated by the poor control stability.

In addition to this, it is worth mentioning gauge mode, this allows the user to control PACE without the use of a vacuum pump by venting the controlled pressure when close to atmospheric conditions, should a 0barg setpoint be required.

Pneumatic settings

This area can often be one of the most overlooked, yet crucial aspects to pressure control. In order to optimise pressure control the following areas must be considered:

Source pressure

It is imperative for fast and precise pressure control that source pressure is accurately maintained during a pressure ramp. If the source providing the pneumatic pressure to the PACE is not capable of providing enough air into the PACE to pressurise the load volume to the required pressure, then the source pressure will 'droop' during a ramp and this will impact control performance. For this reason, Druck recommends using hoses as short as possible, of 6mm or greater internal diameter and if necessary installing a volume several times bigger than the load volume in the source line.

This has the benefit of being "charged up" by the source pressure in between pressure ramps and the volume then supports the source pressure during pressure ramps with a buffer of air (comparisons can be drawn with a decoupling capacitor in an electrical circuit).

Similarly, the vacuum supply, if used, provides for faster control around atmospheric pressure. This should have 6mm, or greater, hosing and have the power to draw a strong vacuum during negative pressure ramps. A volume in the vacuum line will also benefit control speed. All volumes should be multiple times larger than the load volume where possible in order to maximise the benefits of installing a source volume. This will give the added benefit of providing enough surplus air in the event of several pressure ramps in quick succession.

It is recommended to install Druck accessory IO-VAC-SYS for optimum performance also. This is a 'check' valve that allows internal manifold pressure to be quickly exhausted to atmosphere during a negative pressure ramp as opposed to going into the vacuum volume and causing a potential pressure rise.

The source pressure itself should be set to approximately 120% full-scale to give the largest differential pressure with respect to vacuum whilst also staying within the pneumatic limits of the control module being used.

Hose connections

As previously mentioned, Druck recommends all those connections to be 6mm or greater internal diameter so as to reduce the possible number of flow restrictors in the overall system. For this reason, it is important to also ensure that any pressure adaptors between hoses/volumes/equipment are not restricting the flow more than necessary.

Barometric influence

On any gauge or pseudo-gauge pressure controller, the atmospheric pressure will have small influences on the pressure reading. This is due to disturbances in the environment the controller is operating in, such as doors opening/closing or air conditioning for example. For this reason, Druck recommends utilising the reference port snubber provided with all PACE pressure controllers.

The controller will still be able to reliably measure barometric pressure, but the snubber prevents any short-term disturbances from possibly affecting the PACE controller during a pressure ramp or whilst maintaining its industry leading control stability.

Maintenance

In order to guarantee the industry leading pressure control performance, the Druck PACE controllers should be serviced at regular intervals (for example, during yearly calibrations) and this service can be provided in-house or at dedicated service centres around the globe.

This is one of the main advantages of returning your Druck pressure controller to a recommended service centre rather than a 3rd party. Returning the whole control module as opposed to just a sensor module ensures that your control performance is always optimised

Controller performance

1. Test and set-up description

As is widely known in the market the PACE controllers offer industry leading speed-to-setpoint, but how much faster can be hard to quantify based on datasheet figures. Examples that you may see are:

– Competitor A quotes 15 seconds for a 10%FS pressure increase into a 50ml volume

– Competitor B quotes 20 seconds settling time (typical)

The following graphs show a side by side comparison of a PACE6000 E controller against competitor A & B into variously sized volumes and for different sized pressure ramps.

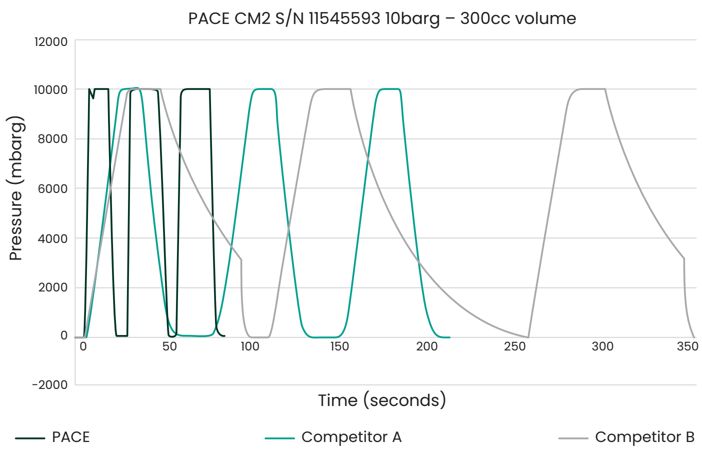
Three pressure profile cycles were used as this accounts for any pressure ramp variability. In practice, each individual ramp will never take exactly the same time. However, as you can see from the graphs the PACE repeatability is extremely good

As can be seen the PACE is **up to 7.5x faster** for a given pressure profile and this difference is even more pronounced on larger volumes with larger ramps (due to the superior ramp rate of the PACE controller). It is also crucial to consider that PACE is settling to setpoints of 10ppm rather than 30ppm of most competition.

Remember also to consider speed vs stability when analysing any potential claims made regarding a fast controller.

All tests were performed with PACE set to maximum ramp rate, overshoot enabled and with a 1 litre source volume installed. An external sensor was used to log the pressure independently and all setpoint changes were applied via remote communications once a response from the controllers were received indicating that pressure was stable.

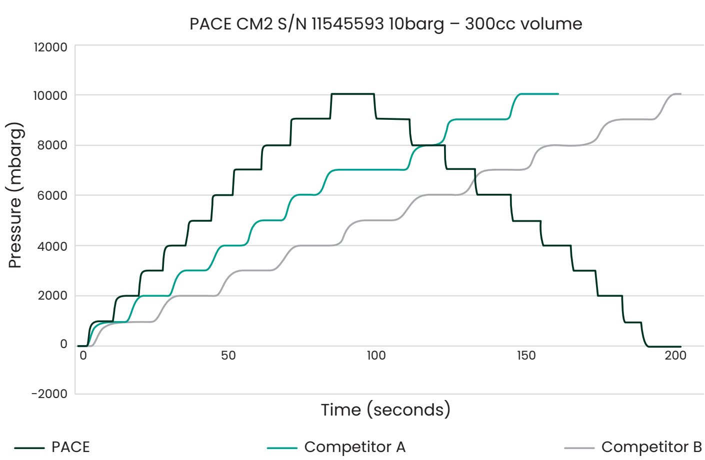
2. Presentation of results and observations



Observations:

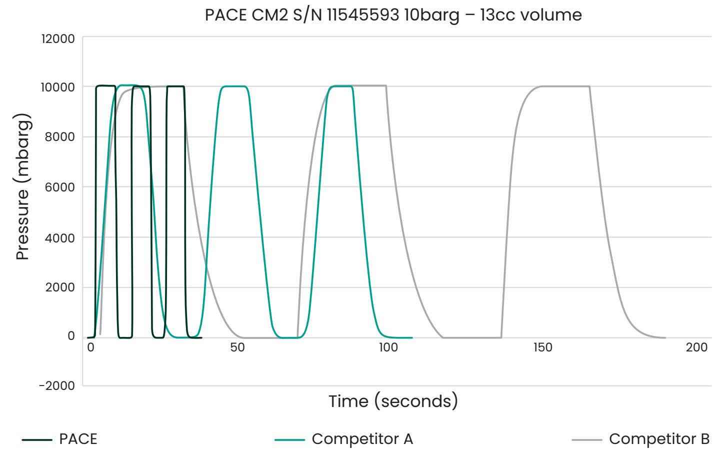
– PACE 82s typical (72s best case), A = 212s, B = 353s (can be improved to 303s if uncontrolled vent is used like in ramps 1 & 3).

– NB: If no-overshoot selected for the PACE then the time taken increased to 101s, still significantly faster than competitor products. Competitor products were both configured to use their standard 'fast' settings.



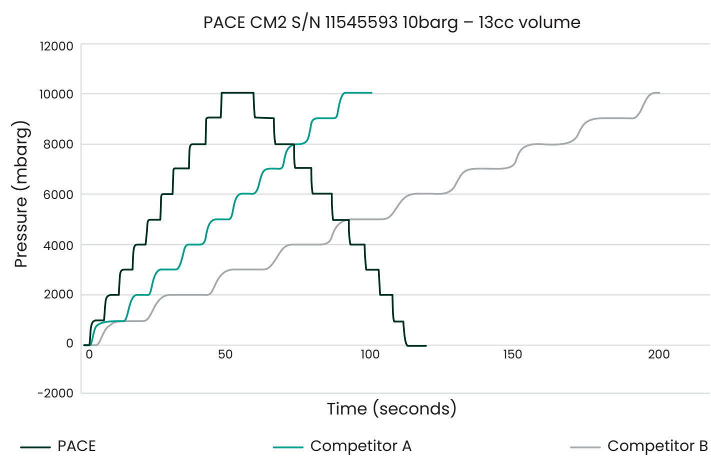
Observations:

– PACE 99s typical to 100%FS (75s best case), A = 158s, B = 202s



Observations:

– PACE 37s typical (27s best case), A = 106s, B = 204s



Observations:

– PACE 59s typical to 100%FS (38s best case), A = 102s, B = 217s

3. Conclusions

As can be seen in the controller performance section the PACE6000 E Pressure Controller performs very favorably compared to its main competitors in the market. These performances also hold true when control stability specifications are relaxed in favour of increased speed. If we equate these savings in production line operating time to monetary savings, then it is clear to see the savings that can be made.

For a typical volume (50ml) on a production line running 5 days a week 24 hours per day and based on the performance data measured for this whitepaper it can be seen that typical year 1 running costs would be approximately 293% greater for competitor A and 656% greater for competitor B.

Summary

As presented in this paper it is clear that PACE is by far the fastest pressure controller available on the market.

From other whitepapers we have presented it can be seen that the PACE product line also has the market leading accuracy and stability.

In reality, a varying blend of speed, accuracy and stability are required to optimise controller performance to meet the needs of different applications. The excellence that PACE demonstrates in these three key areas make it versatile enough to optimise performance in numerous applications across many different industries and applications without compromising on performance. From Automotive to Aviation, from medical to metrological.

The benefits that this performance and versatility brings from a profitability perspective as well as metrological perspective are self-evident.

Support and contact

For all enquiries please visit **Druck.com/Contact** or find out more at **Druck.com/PACE**.

Baker Hughes

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