

# Direct Power Control

Temperature of sealing in-sync with machine motion

## SCOPE

Easy is Key, for the End User, the Packer, the OEM/ maintenance and the Supplier. In FFS machines the key to create the perfect seal each time and right from this start. For this Omron Sysmac is the solution to integrate temperature control and seal-jaw timing and pressure.

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## Executive Summary

### The need for speed in sealing packages.

Companies who pack goods, machine builders and automation suppliers are all working towards one goal: the best way to move vulnerable goods from producer to consumer. To extend the shelf life and to protect products is the main essence of packaging. We all want products to arrive at the consumer in a perfect state.

Form, Fill and Seal (FFS) machines are often used to pack large quantities of goods at high speed. Often these goods are food items, like nuts, chocolate bars and candy. There are different factors which can limit the speed of this type of primary packaging machine. They are: product feed, packaging material feed and seal-time. The flexible packaging material (e.g. foil) used in FFS machines is formed and sealed on the fly, often around the product while in motion.

Apart from *variation and quality*, producing *more packs per time* are the 3 fundamentals of an FFS packaging machine. With more consumers and the target to reduce cost, the need for more output is obvious. This can be reached not only by faster machines, but also with better quality sealing right from the first pack you produce.

In this paper the solutions provided are for seal quality, higher throughput and less waste at start-up.

Conclusion, the sealing of packaging needs to be fast, but most of all, good in all stages of machine transition.

### Constant seal jaw temperature; at start-up AND during production.

The packaging material requires an exact temperature at a given pressure to ensure a good seal. In the sealing process, the temperature, pressure and time are equally important as you can see in figure 1. The motion control is responsible for the timing and pressure of the sealing jaw. This is important, but not a subject discussed in this paper.

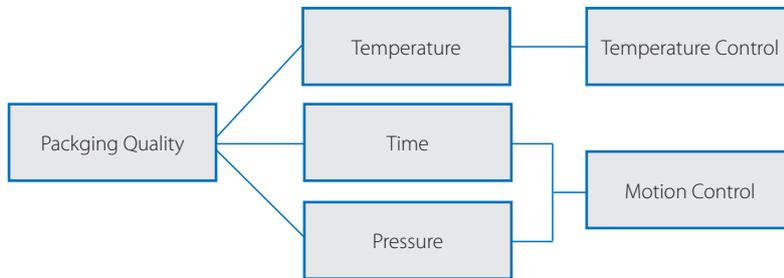


Figure 1. Packaging quality depends on 3 parameters.

Packaging seal quality is affected not only by the sealing temperature, but also the room temperature, packaging material temperature and the product temperature.

In many cases it comes down to only the sealing jaw to compensate for all of these factors. Pre-heating the foil can be an option, but is not always allowed or possible.

During operation, at each seal, the film absorbs heat from the seal-jaw causing it to drop in temperature. Before the next seal can be done, the seal-jaw needs to be at the right temperature again. Omron’s 2-PID algorithm and auto tuning (AT) is fully developed to recover fast when temperature drops after each seal.

Control is normally good when the machine is in production stage, but what when the production needs to start or stop? When moving from the idle stage to production stage, the balance in the PID control loop is disturbed heavily. The big drop in temperature at startup results often in a few or even many bad packages (fig.2). When the machine is paused the Seal jaw temperature is rising unnecessary high.



Figure 2. bad seal at startup

Especially with fast running machines like Flow Wrappers, you want to run at full speed from the start, packing all products with an equally good seal.

Here is the solution; we know when the machine is going to start, the operator gives that signal! Knowing this start moment, we can “prepare” the seal-jaw temperature for the soon-coming-drop and pre-compensate for that. The technology Omron is using to achieve this is called Direct Power Control (DPC). It provides heating output feed forward control in conjunction with Omron’s unique 2-PID temperature algorithm AND is in-sync with the motion of the machine.

### Easy to implement technology

To improve machine performance one should consider all parameters of influence and apply an integrated way of controlling them. Omron Sysmac machine controller series NJ has the capability to achieve this. As mentioned before, the integration of timing, motion and temperature control is mandatory for good seals at high speed.

To stay focused on the temperature control part, three steps are needed to apply DPC to a FFS packaging machine. First set-up and tune the PID control loop, then from the PID values a few parameters need to be derived and finally, load all these parameters into the matrix which is used by the DPC function block in the controller.

### Set up the PID loop

Omron's unique 2-PID temperature control is a big advantage over standard PID control. The build-in Auto-Tune will optimize the system for fast-disturbance-response. Sealing is such a fast-disturbance process. Set value (SV) is fixed, but each sealing makes the temperature of the sealing jaw (PV) drop. The faster the controller recovers the PV to SV, the faster the next seal can be made. Omron 2PID and AT available in on-panel and in-panel stand-alone TC and in PLC and Machine controller FB's

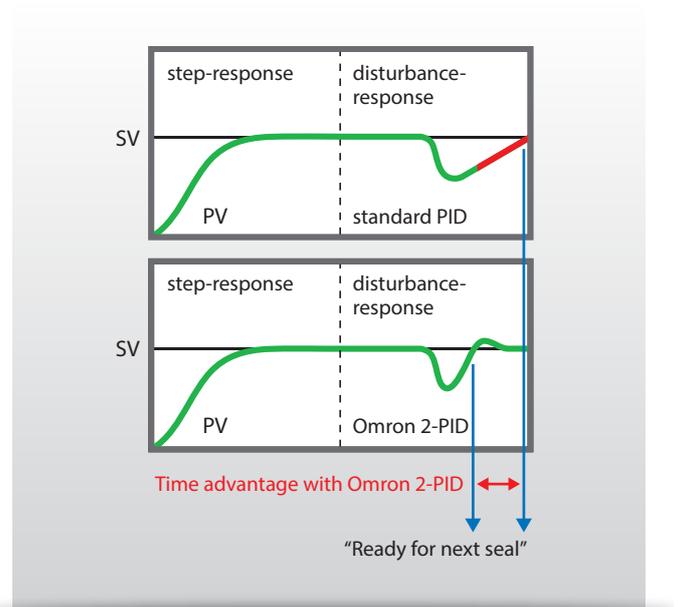


Figure 3.

### Calculate the parameters for DPC

From the PID parameters that the Auto Tuning (AT) found, the dead time can be calculated. The DPC function block also need to be fed with information which easily can be found from the temperature trend chart or with a simple manual test. Mainly this values are power levels of the temperature controller output when the jaw is open and when it is closed with the foil clamped. From these calculations a seal temperature profile and a seal timing profile can be composed. The DPC function block comes with a easy to use instruction, divided in clear steps, to perform this fine tuning calculation task.



Figure 4. Functional diagram of DPC interaction with PID

### The DPC function block

With the parameters found and the DPC operation matrix filled, all can be merged together. PID algorithm, DPC data matrix and the DPC function block are now ready to produce. The Result will be that the seal jaw temperature will show less deviation from the set point (SP) as before, especially during machine transitions from idle to production.

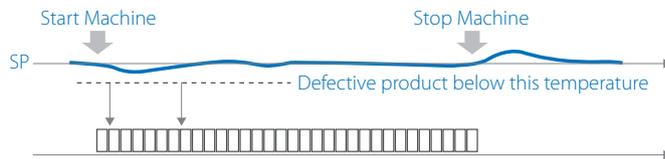


Figure 5. result when using DPC, no bad sealing so good packs right from the start.

### Business benefits

The benefits for using DPC technology is mainly in FFS machines like Flow wrappers, HFFS and VFFS machine. Slower moving intermitted (stroke) machines like tray sealers or bulk-bag-sealers, are less likely to benefit from this technology.

With most flexible material, especially when they exist of laminated layers of barrier and carries foils, the applied temperature is critical. 2°C too high could lead to a burned seal and 2°C too low is badly or not sealed at all. For example easy-to-open packaging is made of foil with complex layer structure and is very sensitive to heat deviation. The goods which are packed could also influence the sealing. For example if the product is wet, frozen or very cold. This product will cool down the film and sealing can fail. Tight control is the only way to automatic compensate for this. Another application would be pharmaceutical. Packing medication is very temperature sensitive and with DPC just enough heat to seal is applied.

The heat loss compensation is done by the controller, so there is no need for bigger sealing jaw which hold more heat inertia. The machine can operate with lighter and cheaper jaws. Smaller sealing jaws also means less energy use. For the OEM/SI the trick of feed-forward and pre-compensate sounds logical, but who is the expert to implement it? Omron created a machine controller FB and documented the workflow.

### SUMMARY

Easy is Key, for the End User, the Packer, the OEM/maintenance and the Supplier.

In FFS machines the key to create the perfect seal each time and right from this start. For this Omron Sysmac is the solution to integrate temperature control and seal-jaw timing and pressure. Sysmac machine controllers integrate logic and motion as well with some clever analogue and application specific function blocks. The DPC function block integrates the temperature control with the flow of the machine motion.

Omron has almost 40 years of experience in making temperature controllers and our algorithm has been developed and evolved in one of the best for disturbance based processes like sealing. The Omron staff can and is willing always to help you further.

### Omron Corporation

- 50 years in industrial automation
- Over 35.000 employees
- Support in every European country
- Over 1.800 employees in 19 European countries
- 800 Specialised field engineers
- 7% of turnover invested in R&D
- More than 200.000 products
- More than 6.950 patents registered to date

### Omron Industrial Automation

Headquartered in Kyoto, Japan, OMRON Corporation is a global leader in the field of automation. Established in 1933 and headed by President Hisao Sakuta, Omron has more than 35,000 employees in over 35 countries working to provide products and services to customers in a variety of fields including industrial automation, electronic components industries, and healthcare. The company is divided into five regions and head offices are in Japan (Kyoto), Asia Pacific (Singapore), China (Hong Kong), Europe (Amsterdam) and US (Chicago). The European organisation has its own development and manufacturing facilities, and provides local customer support in all European countries. For more information, visit Omron's Web site at [www.omron.com](http://www.omron.com).

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Educated as Applied Physics Engineer, Stanley Neilen started his career as first as commissioning and later as application design engineer in the thermal processing industry.

He joined Omron in 2002 as Product Marketing Manager for Temperature Control products, first the stand-alone controllers but later also took responsibility for the Omron integrated solutions for temperature.

From this his specialization expanded and started to market the integrated solutions for machine automation.

Sealing is a complex art of pressure, timing and temperature, all of which Omron masters. In this whitepaper Stanley is focusing on the temperature control solution.