Temperature control is moving into the era of AI.
The adjustments made by skilled workers are automated using AI.
The innovation of production sites has begun.

Optimal and automatic temperature control without human intervention easily achieves both productivity and quality.

Previous temperature controllers have not only required a long time for start-up settings and variation adjustments, it has also been difficult to make the optimal adjustments without having experience and intuition. There were therefore some effects on quality.

In response to this situation, OMRON developed temperature controllers that includes "adaptive control technology."

This makes it possible to detect the changes in the status which will have an effect on quality and to automatically control the temperature so that the optimal state is always maintained, in the same way as a skilled worker would.

This frees production sites from troublesome start-up and adjustment work.
Causes of temperature variations on production lines

Workpiece changes
- Materials, dimensions, etc.

Machine and infrastructure changes
- Cooling water, gas, etc.

Environment changes
- Outside air temperature, etc.

It is possible to continue producing good products without making set point changes or PID adjustments

Previously
- Production speed: Slow
- Failure rate: High
- Adjustment by workers: Necessary

The answer was

the industry's first inclusion\(^*\) of "adaptive control technology"

With the "adaptive control" incorporated into this product, the optimal PID value is calculated automatically for both the time of the start-up and for during stable production. Furthermore, it is possible to monitor the temperature control status of the machine to automatically adjust the PID value to obtain the optimal temperature control in response to changes such as workpiece changes and machine changes.

Previously
- There is one type of PID and after failures occur due to reasons such as machine changes, PID adjustment is performed with AT or manually.

ES/D NX-TC
- Higher speeds become possible with the PID during start-up and also the optimal temperature control status is maintained with automatic adjustment of the PID value following changes such as machine changes.

\(^*\) According to an investigation by OMRON of general-purpose temperature controllers for FA as of March 2017.
Empower your semiconductor equipment to maximize quality deviations caused by disturbance.

**Issues at production sites**

- The miniaturization and integration of semiconductors have made stringent temperature control a must; temperature variations caused by routine disturbance impact quality.

- Wait time until temperature variations caused by routine disturbances stabilize hampers improvements in production capacity.

**Disturbance examples**

**deposition equipment**

Chamber temperature falls when doors are opened/closed or when gas is injected.

**Prober**

Current application generates heat in the wafer, causing the stage temperature to rise.

**Molding system**

Mold temperature falls upon resin injection.

**Solution: NX-TC**

Automatically suppresses temperature variations caused by routine disturbances.

Provides stable automatic control against foreseeable temperature variations, e.g. those caused by outside air infiltration when doors are opened and closed.

Contributes to quality improvement and helps boost production capacity by reducing the wait time until temperature stabilization.

*This function is available only with NX-TC.

**Helps boost production capacity**

By suppressing temperature variations, reduces wait time until temperature stabilizes by 80%.

*Data measured by OMRON.
Control performance that achieves new value

**Disruption Suppression Feature minimizes temperature deviations**

The Disturbance Suppression Function is a control function that automatically suppresses temperature variations that are expected to be caused by foreseeable disturbances. Trigger signals input to the temperature controller before these disturbances occur turn the function on, which adds to or subtracts from the manipulated variable (MV). Disturbance autotuning automatically adjusts the FF (feedforward) MV, FF operation time, and FF waiting time.

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**Temperature falls by routine disturbances**

- **PID only**
- **Disturbance Suppression Function + PID**

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**Temperature rises by routine disturbances**

- **PID only**
- **Disturbance Suppression Function + PID**

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New value that supports advances in packaging machines

Packaging machines that can maintain quality even at higher speeds.

**Issues at production sites**

- Faster packaging to respond to the demand for foodstuffs arising due to the population increases in emerging nations
- Increase in speed even when performing multiple-product production using a wide variety of packaging materials
- At higher speeds, the temperature difference between the sealing surface and the control temperature widens, so the failure rate rises...

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**The temperature of the sealing surface is stably controlled automatically with measurement of the sealing surface temperature and algorithms to suppress variations.**

"Temperature sensors for packaging machines" to measure the temperature of the sealing surface

The temperature of the heating bar surface is measured accurately and there is no effect from factors causing temperature variations, such as the speed of the packaging machine and changes to the packaging materials.

On a conventional sealing machine, temperature sensors can often be located too far away from the sealing surface, so a difference occurred between the temperature of the sealing surface and the temperature that was actually being controlled. This temperature difference and resulting sealing failures increase as the packaging speed increases.

"Automatic filter adjustment function" to suppress the instability in surface temperature measurements

By using the temperature sensor for packaging machines and the automatic filter adjustment function, it becomes possible to control the quality with the sealing temperature while also suppressing variation in the temperature with just a temperature controller, without relying on adjustments by workers.

When a temperature sensor for a packaging machines is used, there is sometimes periodic temperature variation generated when there is a marked effect from the heat on the packaging materials side.

* Data measured by OMRON on a vertical flow packer.
New value that supports advances in molding machines

Molding machines that can maximize production capacity.

**Issues at production sites**

- Increased productivity to respond to demand expansion related to infrastructure as a result of the economic development of the emerging nations and the transfer of production bases overseas.
- At higher speeds, adjustments by the workers become necessary to respond to temperature variations arising due to factors such as the materials compounding and cooling water...
- It is difficult to achieve high speed production while also maintaining the quality...

**Temperature variations due to speed changes and changes in the status of machines are suppressed without adjustments by the workers.**

On a water-cooled extrusion molding machine, increased speed leads to temperature variations due to various causes and it was previously necessary for the workers to repeatedly make valve adjustments to stabilize the quality. With the E5□D/NX-TC, the water-cooling output adjustment function suppresses the temperature variations to a minimum and raises the production capacity with the quality maintained.

**"Water-cooling output adjustment function" to simultaneously suppress the causes of temperature variations and maintain stable performance**

It is possible to suppress the temperature variations that occur due to the cooling output by using the auto-tuning (water cooling) before the materials are input to gain an understanding of the cooling characteristics.

**Causes of temperature variations**

**Nonlinear characteristics of water cooling**

In the type of cooling that uses the heat of evaporation, the cooling performance is nonlinear, so temperature variation occurs.

**Variations in cooling water**

When there are variations in the cooling water system, temperature variations occur with the conventional auto-tuning because it is not possible to respond to changes in the status during operations.

*Data measured by OMRON on a water-cooled twin screw extrusion molding machine.*
**Push-In Plus Technology for Easy Wiring**

**E5□D-B/NX-TC**

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**Greatly Reduce Wiring Work**

Conventional screw terminal blocks  OMRON Push-In Plus terminal blocks

*Information for Push-In Plus and screw terminal blocks is based on OMRON’s actual measurement value data.

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**Easy to Insert**

OMRON’s Push-In Plus technology are as easy as inserting to an earphone jack. They help reduce the workload and improve wiring quality.

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**Main specifications**

**E5□D/E5□D-B**

<table>
<thead>
<tr>
<th>Model</th>
<th>E5CD</th>
<th>E5CD-B</th>
<th>E5ED</th>
<th>E5ED-B</th>
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</thead>
<tbody>
<tr>
<td>Size (mm)</td>
<td>Front panel: 48 x 48, Depth: 60</td>
<td>Front panel: 48 x 48, Depth: 67.4</td>
<td>Front panel: 48 x 96, Depth: 60</td>
<td>Front panel: 48 x 96, Depth: 67.4</td>
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<tr>
<td>Sensor input</td>
<td>Thermocouple, platinum resistance thermometer, infrared temperature sensor (E51B), or analog input (voltage/current).</td>
<td>Thermocouple: (±0.3% of indication value or ±1°C, whichever is greater) ±1 digit max. Platinum resistance thermometer: (±0.2% of indication value or ±0.8°C, whichever is greater) ±1 digit max. Analog input: ±0.2% FS ±1 digit max.</td>
<td>CT input: ±5% FS ±1 digit max.</td>
<td>CT input: ±5% FS ±1 digit max.</td>
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<tr>
<td>Indication accuracy (at the ambient temperature of 23°C)</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Input sampling period</td>
<td>50 ms</td>
<td>50 ms</td>
<td>50 ms</td>
<td>50 ms</td>
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<tr>
<td>Control output</td>
<td>Relay output, voltage output (for driving SSR), Linear current output</td>
<td>Relay output, voltage output (for driving SSR), Linear current output</td>
<td>Relay output, voltage output (for driving SSR), Linear current output</td>
<td>Relay output, voltage output (for driving SSR), Linear current output</td>
</tr>
<tr>
<td>Terminal type</td>
<td>M3 screw terminal block</td>
<td>Push-In Plus terminal block</td>
<td>M3 screw terminal block</td>
<td>Push-In Plus terminal block</td>
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<tr>
<td>Approved standards</td>
<td>UL, KC, CE</td>
<td>UL, KC, CE</td>
<td>UL, KC, CE</td>
<td>UL, KC, CE</td>
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</table>

**NX-TC**

<table>
<thead>
<tr>
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<th>NX-TC24</th>
<th>NX-TC34</th>
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<tbody>
<tr>
<td>Size (mm)</td>
<td>Front panel: 12 x 100, Depth: 71</td>
<td>Front panel: 24 x 100, Depth: 71</td>
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<tr>
<td>Sensor input</td>
<td>Thermocouple, platinum resistance thermometer</td>
<td>Thermocouple, platinum resistance thermometer</td>
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<tr>
<td>Reference Accuracy</td>
<td>For details, refer to the &quot;NX-series Temperature Control Units User’s Manual (Man.No. H228)&quot;.</td>
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</tr>
<tr>
<td>Input sampling period</td>
<td>50 ms</td>
<td>50 ms</td>
</tr>
<tr>
<td>Control output</td>
<td>Voltage output (for driving SSR), Linear current output</td>
<td>Voltage output (for driving SSR), Linear current output</td>
</tr>
<tr>
<td>Terminal type</td>
<td>Push-In Plus terminal block (Screwless clamping terminal block)</td>
<td>Push-In Plus terminal block (Screwless clamping terminal block)</td>
</tr>
<tr>
<td>Approved standards</td>
<td>cULus, CE, RCM, KC, EAC, NK, LR, BV, DNV-GL</td>
<td>cULus, CE, RCM, KC, EAC, NK, LR, BV, DNV-GL</td>
</tr>
</tbody>
</table>

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