Switching Unit for Varithermal Temperature Control

Product Catalogue 2013-10
Applications of variothermal temperature control in injection moulding

• Elimination of weld lines
• Contour accuracy in the moulding of the finest structures
• Optimal surface quality
• Reduction of high injection pressures
• Reduction of sink marks

Reference: Schorm GmbH, St. Valentin
Reference: Niko, Sint-Niklaas
Reference: Key Plastics, Janovice nad Úhlavou
Switching Unit Vario-5

A variothermal system consists of two temperature control units Thermo-5 and a switching unit. One of the temperature control units feeds the hot water circuit and the other the cold water circuit.

Benefits
• Silent switching unit for water up to 180 °C
• Maintenance-free, pressure shock-free
• No steam, scaling or corrosion
• Cycle time reduction by using Wizards
• Fully automatic process monitoring
• Buffer volume for energy-saving operation
• Small footprint due to compact design

Services
Optional services for variothermal applications on a time and material basis:

• Assessment of variothermal application (approx. 1 day)
  The current injection moulding application is assessed in terms of variothermal temperature control. This gives an assessment of whether the desired objectives can be met and with which equipment.

• Moulding support of the variothermal process (approx. 1 day)
  Planning and documentation of trial series, running trials, production support and optimisation
Technical Data
- Closed hydraulic system without oxygen contact
- Hydraulic circuit made of non-corroding materials
- Electrically operated valves (no compressed air)
- Digital inputs and outputs for switchover commands
- Connection for external sensor

Control
The switching unit is controlled by a temperature control unit Thermo-5 or a control module Panel-5 with the following amendments:
- Wizard for determining process parameters (delay times, switching times, setpoint temperatures)
- Fully-automated process monitoring
- Large choice of display windows and values
- Automatic limit value settings for temperatures and flow
- Selectable control mode (pulse or continuous contact)
- Storage of specific variothermal parameters
- Recording of actual values to USB memory

Interfaces and Power Supply

<table>
<thead>
<tr>
<th>Interfaces and Power Supply</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>HB (IN/OUT) *</td>
<td>HB-Therm specific serial data interface CAN for connection to a temperature control unit Thermo-5 or control module Panel-5</td>
</tr>
<tr>
<td>2 Sub-D 15 pin female connectors</td>
<td></td>
</tr>
<tr>
<td>Typ J, K, T, Pt 100</td>
<td>External sensor connector (thermocouple or Pt 100 in 3-wire circuit)</td>
</tr>
<tr>
<td>Connector Audio 5 pin (female)</td>
<td></td>
</tr>
<tr>
<td>0–10 V, 4–20 mA</td>
<td>External sensor connector (standard signals)</td>
</tr>
<tr>
<td>4 pin M12 socket</td>
<td></td>
</tr>
<tr>
<td>Ext. Control *</td>
<td>2 digital inputs and 2 digital outputs for switchover commands via potential-free contact</td>
</tr>
<tr>
<td>Harting Han 12Q female connector</td>
<td></td>
</tr>
<tr>
<td>24 VDC</td>
<td>Power supply with supplied mains adapter 100–240 VAC, 50/60 Hz, &lt;65 W</td>
</tr>
<tr>
<td>Harting Han 4A male connector</td>
<td></td>
</tr>
</tbody>
</table>

* Communication (→P. 6, Fig. 2)
## Technical Specifications

### Switching unit
- **Heat transfer medium**: Water
- **Maximum main line temperature**: °C 180

### Type
- **Buffer volume**: Volume 0.9 L US1, Volume 1.8 L US2

### Accessories
1. Connection set (hydr.) Vario-5/Thermo-5, size 1 or 2 O/ID 26847-X
2. Connection set (hydr.) Vario-5/Thermo-5, size 3 O/ID 26848-X
3. Connection set (hydr.) Vario-5/mould O/ID 26841-X
4. Cable HB O/ID 24858-X
5. Cable HB/CAN O/ID 26825-X
6. Cable ZC O/ID 22571-X
7. Proximity switch with magnetic base O/ID 26821-X
8. IR temperature sensor with magnetic base O/ID 26819-X
9. Emission level stickers 25 mm (70 per sheet) O/ID 26843

### Services
- Assessment of variothermal application from mould data
- Moulding support of the variothermal process

### Order Example: HB-VS180-US1, English

### Dimensions
- **Height**: mm 484
- **Width**: mm 240
- **Depth**: mm 675
- **Weight**: kg 38

### Environment
- **Temperature**: 5–40 °C
- **Humidity**: 35–85 % RH (non-condensing)

### Colour
- **Cover**: RAL 7035 (light grey gloss), RAL 5012 (light blue gloss)
- **Door**: RAL 7021 (black-grey gloss)

### Protection class
- **Standards**: EN ISO 13732-1, EN 61010-1, EN 61326-1
- **Certification/Approval**: CE (compliance with relevant CE directives)

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### Recommendation for Unit Type Thermo-5 (Fig. 1)
- **Hot water circuit**: Thermo-5, HB-160 or HB-180, pump 4M, heating and cooling power depends on application
- **Cold water circuit**: Thermo-5, HB-140, pump 4M, heating and cooling power depends on application (if the unit for the hot water circuit is run at over 160 °C, the unit for the cold water circuit must be equipped with a 17 bar safety valve and a manometer 25 bar)

### Communication
- Interface equipment for single units: ZI, ZC

**Note**: In order to ensure compatibility, detailed clarification must be obtained for equipment that differs from this recommendation.

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1) Recommended for mould circuits of 0.9 L and larger
2) For detailed information see accessories programme (D8064-D)
Communication (Fig. 2)
Switching unit (VS) with two single units (EG), controlled by single unit

Switching unit (VS) with two single units (EG), controlled by control module (FB)

Switching unit (VS) with 1 single unit (EG) and 1 modular unit (MG), controlled by single unit

Switching unit (VS) with 2 modular units (MG), controlled by control module (FB)

ZD, ZC, ZP For information on these interfaces, see product catalogue Thermo-5 (D8090-E)
1) HB interface protocol setting required
2) Assignment dependent on machine control unit

Dimensions (Fig. 3)
HB-VS180, scale 1:10
**Variothermal Temperature Control**

In injection moulding some typical problems cannot be solved by traditional temperature control:

- visible weld lines in optically critical areas.
- incomplete moulding of the finest structures and lacking contour accuracy (e.g. for optical lenses, micro- or nano-structures, piano lacquer)
- insufficient surface quality of foamed and fibre-reinforced parts
- excessively high injection pressures for extremely small cross-sections
- sink marks at extreme wall thickness ratios

Reasons: In injection moulding the hot plastic melt meets a relatively cool mould surface in the injection phase. The latter needs to be cool in order to dissipate the heat out of the melt to solidify the part. The mould temperature depends not only on the material, but also on the demands of the component quality and the cycle time. At high temperatures the quality of the component increases, thus longer cycle times are necessary. This negatively affects the unit costs. Therefore, the choice of the mould temperature is always a compromise between quality and cost effectiveness.

If no optimum quality is achieved with a compromise or impermissible process parameters would be needed, an alternative temperature control strategy is necessary. A high temperature during injection followed by a cold temperature in the cooling phase can be a solution. It is called a variothermal temperature control. Two temperature control units, one operating at a higher and one at a lower temperature combined with a switching unit will solve such demanding tasks.

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**Process procedure in injection moulding with variothermal temperature control**
The Process
The fluid-fluid technique sends alternatingly hot and cold temperature control medium through the temperature control channel immediately below the cavity surface, controlled by the machine cycle. The temperatures are set on the two temperature control units. If there is a temperature sensor available at a suitable position in the mould, the switch-over or the start of injection can also be made depending on the mould temperature to increase process reliability.

Operating mode: Heating

Operating mode: Cooling
Frame Conditions
In variothermal temperature control the temperature at the surface of the cavity will be actively changed within the injection cycle. The area around the cavity is thus cyclically heated and cooled. Depending on the configuration of the temperature control channels the temperature at the surface of the cavity reacts stronger or weaker and the area is larger or smaller. To efficiently achieve the largest temperature gradients possible the following is recommended:

Distance of the temperature control channel from the surface of the cavity
The distances between the temperature control channel and the cavity must be kept as small as possible.

Variothermal mass
Keep the variothermal area as small as possible:
• Run only those circuits on variothermal process which have an influence on the critical mould area
• As possible, create inserts that are small and can be thermally isolated from the rest of the mould.

Isolation
Isolate the variothermal areas with isolating materials or clearances from the rest of the mould.

Connections
Connect the variothermal areas (inserts) directly with specific pipes not in contact with the rest of the mould (clearance) to the temperature control system. Avoid supply via the mould plates or frames as well as heavy distribution and measuring systems, as they will unnecessarily increase the variothermal mass.

Material
In critical cases, inserts of copper alloy or other materials with good thermal conductivity are to be used for the variothermal areas (The thermal conductivity of copper is more than five times greater than that of steel).

Temperature control channel cross section
Large channel diameters or several channels increase the surface and thereby the transfer of heat.

Flow rate
The temperature control channels should be designed to achieve the best possible flow rate. This improves the transfer of heat between the temperature control medium and the mould and results in shorter response times or quicker temperature gradients in the mould.

Note: Variothermally controlled circuits can come up to the temperature of the hot unit. Seals, couplings, hoses need to be selected accordingly. The cyclical temperature changes can cause moveable inserts such as sliders to jam.

Example for the design of a mould-insert for variothermal temperature control
Control
The cyclical heating and cooling is actuated in sync with the machine cycle. The highest temperature is reached in the injection phase, the lowest at the time of demoulding. For this purpose, the signals for the switch-over have to precede by the amount of the system delay.

The parameters relevant to the injection moulding process such as injection, holding pressure or cooling time are set via the machine controls. Therefore it suggests itself that the signals for controlling the switch-over should also be set via the machine controls. For this, digital output signals of the machine can be used. Depending on the machine type, values for the variothermal process can be set more or less comfortably.

If only one signal is available for the synchronisation with the injection moulding process the respective delay times in relation to the machine signal must be set on the variothermal equipment. Although the machine interface thus is much simpler it has the distinct disadvantage of having to adjust the settings on the variothermal equipment as well when changing the machine settings.

The timer signals for heating and cooling are independent from the actual temperature in the mould. A separate temperature sensor is not necessary. Software wizards help to determine the necessary delays in a simple way.
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Since 1967 HB-Therm AG has been developing and producing innovative „Swiss-made“ temperature control technology to the highest quality standards. With its comprehensive know-how and motivated workforce, the company has succeeded in becoming the technology leader in its sector.

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Customer service. Included.
With our sales and marketing network service we can offer comprehensive expert advice and assistance in:

• Optimum temperature control process
• Determination of the specification of the product and advice regarding functionality
• Electrical and hydraulic connections
• Data interfaces
• Heat transfer medium
• Servicing of the equipment

Our experts are always available for support when questions of specialist requirements or applications arise or when putting the equipment into operation, or for the operational training of your staff.
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