Hot Runner Guide
Layout and Design

Stabilize your Process
The purpose of this Hot Runner Guide

The Hot Runner Guide - Layout and Design is intended to help everyone who designs feed systems for injection molds or simply wants to find out about designing feed systems in the following way:

- Overview of the Synventive hot runner product range
- Insight into the layout of feed systems with hot runner technology
- Help to select suitable hot runner components

Important note

All the information contained in these pages is based upon our current knowledge and experience gained from both theory and practise. However because of many factors outside our control they do not guarantee the suitability of our products for any particular application. Always consult Synventive for your specific application.

Table of Contents

**Introduction**

Page 3 ..................................................

- The Custom Hot Runner Solution from Modular Components

**Hot Runner Components**

Page 4 ..................................................
- Nozzles
  - Overview of Nozzles Series

Page 5 ..................................................
- Key Nozzle Data

Page 6 ..................................................
- Manifolds
  - Basic manifold Dimensions

Page 7 ..................................................
- Flow Control
  - Actuators

**Material Suitability**

Page 8 ..................................................
- Nozzle Tip Description VTP Series
Page 9 ..................................................
- Nozzle Tip Description VSP Series
Page 10 ............................................... 
- Nozzle Tip Description VTW Series
Page 11 ............................................... 
- Nozzle Tip Description TTP, TTW Series
Page 12 ............................................... 
- Nozzle Tip Description TFW Series

**Hot Runner Design**

Page 13 ..................................................
- Shot Weight per Nozzle

Page 14 ..................................................
- Thermal Expansion Guidelines
**Hot Runner Guide**

**Hot Runner Components**

**Product Range Structure**

Hot runner systems may comprise of many subsets, each customized for a specific application.

- **a) Nozzles**
  Wide range of nozzles to suit most applications.

- **b) Hot Runner Systems**
  Available in standard shapes - I, H, X, Y - and in any realisable custom shape, the ranges of manifolds cover all possible injection configurations and mold concepts.

- **c) Melt Flow Control Technology**
  Utilizing valve gate technologies, Synventive provides solutions from traditional SVG to activeGate® technology to meet the needs of the most challenging applications.

- **d) Connections**
  To customer specification or Synventive standard, Synventive hot runner systems are available pre-wired, pre-plumbed and pre-tested.

- **e) Hot Halves**
  Hot runner systems are supplied completely mounted in mold plates, pre-wired, pre-piped if required and fully adjusted.
# Overview of Nozzle Series

<table>
<thead>
<tr>
<th>Nozzle Style</th>
<th>Nozzle Size</th>
<th>Sprue Bushings</th>
<th>Single Axis Valve Gate Nozzles</th>
<th>Threaded Nozzles</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>06 J=Ø6</td>
<td>Sprue bushings (thermal gate)</td>
<td>Single axis valve gate nozzles (pneumatic / hydraulic)</td>
<td>Threaded nozzles (thermal gate / valve gate)</td>
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<td>09 SVP pneumatic</td>
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<td>12SVP pneumatic</td>
<td>12 E</td>
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<td>12 SVH hydraulic</td>
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<td>16SVP pneumatic</td>
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<td>16 SVH hydraulic</td>
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<td>22 J=Ø22</td>
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<td>16 EX 22</td>
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</tr>
</tbody>
</table>

Master Language is English

For a specific application, please consult Synventive

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## Key Nozzle Data

### Key nozzle data
- **Nozzle style**: Thermal gate, Valve Gate
- **Nozzle series**: high, medium, low
- **Nozzle type**: pneumatic, hydraulic

<table>
<thead>
<tr>
<th>Nozzle series</th>
<th>Nozzle type</th>
<th>Key Nozzle Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>06 S</td>
<td>pneumatic</td>
<td>Max. shot weight per nozzle (g)</td>
</tr>
<tr>
<td>09 S</td>
<td>pneumatic</td>
<td>Thermal gate: high: 30, 70, 120</td>
</tr>
<tr>
<td>12 S</td>
<td>pneumatic</td>
<td>low: 10, 50, 80</td>
</tr>
<tr>
<td>16 S</td>
<td>pneumatic</td>
<td>Valve Gate: high: 06, 20, 30</td>
</tr>
<tr>
<td>22 S</td>
<td>pneumatic</td>
<td>medium: 09, 40, 70</td>
</tr>
<tr>
<td>09 SVP</td>
<td>hydraulic</td>
<td>low: 15, 80, 150</td>
</tr>
<tr>
<td>12 SVH</td>
<td>hydraulic</td>
<td>Valve Gate: high: 06, 20, 30</td>
</tr>
<tr>
<td>16 SVP</td>
<td>hydraulic</td>
<td>medium: 09, 40, 70</td>
</tr>
<tr>
<td>16 SVH</td>
<td>hydraulic</td>
<td>low: 15, 80, 150</td>
</tr>
</tbody>
</table>

**Viscosity of melt**
- (at medium melt temperature and at a shear rate of 1000 1/s)
  - > 150 Pa s
    - a) high: PC, PMMA, PEEK, PES, PSU, PEI, POM
  - = 60...150 Pa s
    - b) medium: ABS, SAN, ASA, PBT, PET, POM (Copo), PA, PPE, PPO, PPS, PC/ABS, PC/PBT
  - < 60 Pa s
    - c) low: PP, PE, PS, LCP, TPE

**Major Dimensions and Heater Zones**

1. Shot weight based on gating type and viscosity of melt
   - > 150 Pa s
     - a) high
   - = 60...150 Pa s
     - b) medium
   - < 60 Pa s
     - c) low
2. Major dimensions and heater zones

**Thermal Gate nozzle related minimal distance (theoretical)**
- Xn: minimal distance between nozzles
- Xc: minimal distance between nozzle and center support
### Available manifold series

<table>
<thead>
<tr>
<th>Nozzle size</th>
<th>Nozzle series</th>
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<tbody>
<tr>
<td>M=</td>
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<tr>
<td>M1=</td>
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<tr>
<td>V-37</td>
<td>M= 37, M1= 36</td>
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<tr>
<td>V-42</td>
<td>M= 42, M1= 50</td>
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<tr>
<td>V-45</td>
<td>M= 45, M1= 50</td>
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<td>V-50</td>
<td>M= 50, M1= 60</td>
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<td>V-55</td>
<td>M= 55, M1= 70</td>
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<tr>
<td>V-65</td>
<td>M= 65, M1= 80</td>
</tr>
</tbody>
</table>

### Basic Manifold Dimensions

<table>
<thead>
<tr>
<th>M= 37, M1= 36</th>
<th>J2 max. NT</th>
<th>A</th>
<th>B</th>
<th>J2 max. NT</th>
<th>A</th>
<th>B</th>
<th>J2 max. NT</th>
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</table>

**NT:** Open nozzles  **V:** Valve gate nozzles

1. **Major dimensions**

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For a specific application, please consult Synventive
# Hot Runner Guide

## Actuators

| Nozzle size | Nozzle series | Xc | Xc | Xc | Xc | Xc | Xc | Xc | Xc | Xc | Xc | Xc | Xc | Xc | Xc | Xc | Xc | Xc | Xc | Xc | Xc | Xc |
|-------------|---------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 06          | 06 E          | -  | 38 | -  | 42 | -  | # | -  | 57 | -  | 55 | -  | 45 | 60 | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |
| 09          | 09 E          | -  | 38 | 61 | 53 | -  | 61 | 61 | 77 | 97 | -  | 57 | -  | 55 | -  | -  | -  | -  | -  | -  | -  | -  | -  | 90 | 90 |
| 12          | 12 E          | 96 | 61 | 100 | - | - | 77 | 97 | -  | -  | 90 | 97 | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |
| 16          | 16 E          | 140 | 61 | 100 | - | - | 97 | -  | -  | -  | 90 | 97 | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |
|             | 12 EX 16      | 140 | 61 | 100 | - | - | 97 | -  | -  | -  | 90 | 97 | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |
| 22          | 22 E          | 140 | 61 | 100 | - | - | 97 | -  | -  | -  | 90 | 97 | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |
|             | 16 EX 22      | 140 | 61 | 100 | - | - | 97 | -  | -  | -  | 90 | 97 | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  |

1. Actuator bolted to the manifold
   - HB Series
   - PB Series

2. Actuator in mold plate
   - HYZ Series
   - QCVG Series
   - VP Series

3. Actuator with backing plate
   - PNC####B Series

4. Electric actuator in mold plate
   - ELA Series

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CAT-14-0001_EN-REV06  
For a specific application, please consult Synventive

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7 / 15  
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Nozzle Tip Description - VTP

Nozzle Tip Selection

From the nozzle tip descriptions, individual configurations can be selected to suit a specific application.

**VTP**

Valve Gate - Tapered Pin - Plunged Through

F=0, F=30, F=0-30 MOD

Universal tip

For direct gating or cold runner applications

Recommended for all common polyolefin and amorphous resins

Talc filled resins

GF not recommended

Inner part made of heat conductive material

Melt is covered and controlled until gate

Tip face must always be against plastic to avoid heat loss and mechanical loads when closing mold

Wall thickness in gating area >= Gate-diameter

Industrial standard for head and rear lamp applications

Gate quality lower than straight needle, risk of flash

Unsuitable for cosmetic gating and amorphous plastics when direct gating on part

Non-homogeneous cavity surface temperature

Significant effect with slow needle opening, strongly recommended for activeGate®

**VTP-SC Seal cap**

Most effective solution for color change applications

Gap between inner and outer part is closed with a seal cap

Slightly hotter tip surface than VTP

Flame retardant resins
**VSP**

Valve Gate - Straight Pin - Plunged Through

- F=0, F=30, F= 0-30 MOD
- Universal tip
- For direct gating or cold runner applications.
- For all common resins
- Talc filled resins
- GF< 30% crystalline; PA6.6 GF<20%
- Inner part made of heat conductive material
- Melt is covered and controlled until gate
- Tip face must always be against plastic to avoid heat loss and mechanical loads when closing mold
- Wall thickness in gating area >= Gate-diameter
- Gate quality better than tapered needle

**VSP-SC Seal cap**

- For color change applications
- Gap between inner and outer part is closed with a seal cap
- Flame retardant resins
- Slightly hotter tip surface than VSP

**VSP-WA Wear A**

- Internal and external component - best possible wear resistance (abrasion and corrosion) with a standard heat transfer rate
- Barium sulfate *
- Work around for bad mold cooling and sticking

**VSP-WC Wear C**

- External component – best possible wear resistance (abrasion and corrosion) with a standard heat transfer rate
- Internal component – high heat transfer rate
- GF>30% crystalline; PA6.6 GF>20%; LGF

* For a specific application, please consult Synventive
**VSW**

Valve Gate - Straight Pin - Blind

- Inner part made of heat conductive material
- Melt is covered and controlled until gate
- For direct gating and cold runner applications
- Recommended for most common resins
- Wear and/or Cooling insert strongly recommended
- Talc filled resins
- GF < 20% (crystalline materials) GF < 30% (amorphous and polyolefin materials)
- Wall thickness in gating area min 0.7 – 1.0 x Gate-diameter recommended
- Gate quality better than tapered needle
- Unsuitable for crystalline resins with narrow process windows (PA 4.6, …)
- If not using separate wear inserts, hardened gate area to greater than 54 HRC

**VSW-SC Seal cap**

- For use on color change applications, when a straight and blind tip is requested
- Gap between inner part and mold is closed with a seal cap
- Slightly hotter cavity surface than VSW
- Flame retardant resins

**VTW**

Valve Gate - Tapered Pin - Blind

- Inner part made of heat conductive material
- Melt is covered and controlled until gate
- For direct gating and cold runner applications
- For most common amorphous resins recommended
- Wear and/or Cooling insert strongly recommended
- Talc filled resins
- Wall thickness in gating area min 0.7 – 1.0 x Gate-diameter recommended
- Industrial standard for head and rear lamp applications
- Unsuitable for crystalline resins with narrow process windows (PA 4.6, …)
- If not using separate wear inserts, hardened gate area to greater than 54 HRC
- Unsuitable for glass fiber resins

**VTW-SC Seal cap**

- For use on color change applications, when a blind tip is requested
- Gap between inner part and mold is closed with a seal cap
- Slightly hotter cavity surface than VSW
- Flame retardant resins
**TTP**

Thermal Gate - Torpedo – Plunged Through

- All Tips F=0, F=30, F=0-30 MOD
- Inner part made of heat conductive material
- Melt is covered and controlled until gate
- Tip face must always be against plastic to avoid heat loss and mechanical loads when closing mold
- For direct gating and cold runner applications
- For most common resins recommended
- Sprue as short as possible
- Talc filled resins
- GF < 20% (crystalline materials) GF<30% (amorphous and polyolefin materials)
- Unsuitable for cosmetic gating and amorphous plastics when direct gating on part
- Processing with polyolefins and amorphous plastics the front tends to stick if the mold cooling is not optimal (W-Tip)
- Non-homogeneous cavity surface temperature
- Unsuitable for highly filled resins (>30%) full flow or valve gate recommended

**TTP-SC Seal cap**

For color change applications, if thermal gate is requested
- Gap between inner and outer part is closed with a seal cap
- Slightly hotter tip surface than TTP
- Flame retardant resins

**TTW**

Thermal Gate - Torpedo - Blind

- Inner component made of heat conductive material
- Melt is covered and controlled until gate
- For direct gating and cold runner applications
- For most common resins recommended
- Talc filled resins
- GF < 20% (crystalline materials) GF<30% (amorphous and polyolefin materials)
- Unsuitable for crystalline resins with narrow process windows (PA 4.6, ...)
- If not using separate wear inserts, harden gate area to greater than 54 HRC
- Unsuitable for highly filled resins (>30%) full flow or valve gate recommended

**TTW-SC Seal cap**

Most effective solution for color change applications, if thermal gate and blind tip is requested
- Gap between inner part and mold is closed with a seal cap
- Slightly hotter cavity surface than TTW
- Flame retardant resins
TFP

Thermal Gate – Full Flow – Plunged Through

All Tips F=0, F=30, F=0-30 MOD
Inner part made of heat conductive material
Melt is covered and controlled until gate
Tip face must always be against plastic to avoid heat loss and mechanical loads when closing mold
For shear sensitive resins, with do not tend to string
For cold runner applications
Suitable for highly filled resins
Talc filled resins
Limited for direct gating because of possible gate vestige
Sprue as short as possible
Unsuitable for cosmetic gating
Gate tends to string
Gate vestige not defined
Non-homogeneous cavity surface temperature

TFP-SC Seal cap

Best solution for color change applications, if valve gate is not necessary and gating at cold runner
Gap between inner and outer part is closed with a seal cap
Slightly hotter tip surface than TFP
Flame retardant resins
The term "maximum shot size per nozzle" denotes the performance capacity of a hot runner nozzle, that is, the maximum quantity of plastic melt that can pass through the nozzle during operation without damaging the nozzle or plastic material.

The reason performance capacity is specified in terms of weight rather than volume flow is that it is more readily understandable to the user, who has usually received information on the weight of the molded parts to be produced.

How to find the shot weight per nozzle (W) is shown on the right for three different applications.

1. **Several parts per nozzle**
   - Multi cavity mold with sprue bushing
   - Gating on cold sub runner
   - Shot weight per nozzle = Parts + runner

2. **One part per nozzle**
   - Multi cavity mold with manifold system
   - Direct gating on to the part
   - Shot weight per nozzle = part

3. **Several nozzles per part**
   - Single cavity mold with manifold system
   - Direct gating on to the part
   - Shot weight per nozzle = Section of the cavity which is filled by one nozzle

The maximum shot size that can be achieved depends on several factors:

- Injection time
- Type of plastic: viscosity, additives, etc.
- Runner length/diameter
- Maximum permitted pressure loss
- Residence time

When the above factors are taken into consideration, conflicting requirements may arise in some cases.

**Flow channel as big as possible:**

- low pressure loss
- low shear rate

**Flow channel as small as possible:**

- low residence time
- good melt exchange

The values for the maximum shot weight of a Synventive nozzle have been derived from practical experience as well as theoretical studies. They are valid for non-filled materials. For a specific application, please always consult Synventive.
Ratio of Pitch Dimension to Nozzle length for threaded Nozzles

The thermal expansion of the manifold makes the nozzle move while the nozzle tip is fixed inside the mold cutout. In order to allow the nozzle to bend without being damaged the nozzle must adhere to a minimum length. These graphs show the minimum length of threaded nozzles in relation to its pitch dimension.

**NOTICE**

06E max length is 200 mm
09E max length is 400 mm
06E & 09E min. length 60 mm

Suitable pitch dimensions for
06E & 09E Nozzles

Suitable pitch dimensions for
09E Nozzles only

**NOTICE**

12E04 min. length is 60 mm
16E & 22E min. length is 110 mm
12E04, 16E & 22E max. length 650 mm

Suitable pitch dimensions for
12E04, 16E & 22E Nozzles

Suitable pitch dimensions for
12E04 Nozzles only