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 practice. 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.

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**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>S</th>
<th>SV</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sprue bushings (thermal gate)</td>
<td>Single axis valve gate nozzles (pneumatic / hydraulic)</td>
<td>Threaded nozzles (thermal gate / valve gate)</td>
<td></td>
</tr>
<tr>
<td>Nozzle size</td>
<td>06</td>
<td>09</td>
<td>12</td>
</tr>
<tr>
<td>J=Ø6</td>
<td>06 S</td>
<td>06 E</td>
<td>09 S</td>
</tr>
<tr>
<td>J=Ø9</td>
<td>09 SVP pneumatic</td>
<td>09 E01</td>
<td>12 SVP pneumatic</td>
</tr>
<tr>
<td>J=Ø12</td>
<td>12 S</td>
<td>12 E</td>
<td>12 SVH hydraulic</td>
</tr>
<tr>
<td>J=Ø16</td>
<td>16 S</td>
<td>16 E</td>
<td>16 SVH hydraulic</td>
</tr>
<tr>
<td>J=Ø22</td>
<td>22 S</td>
<td>22 E</td>
<td>22 E</td>
</tr>
</tbody>
</table>
# Key Nozzle Data

**Key nozzle data**

- **Nozzle style**
  - S
  - SV
  - E

- **Nozzle series**
  - 06 S
  - 09 S
  - 12 S
  - 16 S
  - 22 S
  - 09 SVP
  - 12 SVP
  - 12 SVH
  - 16 SVP
  - 16 SVH
  - 09 E
  - 12 E
  - 12 E-05
  - 16 E
  - 12 EX 16-01
  - 12 EX 16-02
  - 22 E-04
  - 16 EX 22-01
  - 16 EX 22-02

## Max. shot weight per nozzle (g)

<table>
<thead>
<tr>
<th>Nozzle</th>
<th>Thermal Gate</th>
<th>Valve Gate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>J</td>
<td>L</td>
<td>D</td>
</tr>
<tr>
<td>30</td>
<td>70</td>
<td>120</td>
</tr>
<tr>
<td>70</td>
<td>120</td>
<td>250</td>
</tr>
<tr>
<td>500</td>
<td>800</td>
<td>1500</td>
</tr>
<tr>
<td>1000</td>
<td>1500</td>
<td>2000</td>
</tr>
<tr>
<td>1500</td>
<td>2500</td>
<td>5000</td>
</tr>
</tbody>
</table>

## Major Dimensions

<table>
<thead>
<tr>
<th>Nozzle</th>
<th>Thermal Gate</th>
<th>Valve Gate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>J</td>
<td>L</td>
<td>D</td>
</tr>
<tr>
<td>06</td>
<td>60...200</td>
<td>Ø20</td>
</tr>
<tr>
<td>09</td>
<td>60...400</td>
<td>Ø27</td>
</tr>
<tr>
<td>09</td>
<td>50...400</td>
<td>Ø35</td>
</tr>
<tr>
<td>09</td>
<td>50...400</td>
<td>Ø35</td>
</tr>
<tr>
<td>09</td>
<td>50...400</td>
<td>Ø35</td>
</tr>
<tr>
<td>10</td>
<td>100...395</td>
<td>Ø50</td>
</tr>
<tr>
<td>10</td>
<td>100...395</td>
<td>Ø50</td>
</tr>
<tr>
<td>10</td>
<td>100...395</td>
<td>Ø50</td>
</tr>
</tbody>
</table>

## *Thermal Gate*

- Xn: minimal distance between nozzles
- Xc: minimal distance between nozzle and center support

### Shot weight based on gating type and viscosity of melt

- **> 150 Pa s**
  - a) high
    - PC, PMMA, PEEK, PES, PSU, PEI, POM
  - 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

- **Viscosity of melt**
  - (at medium melt temperature and at a shear rate of 1000 1/s)

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### Basic Manifold Dimensions

<table>
<thead>
<tr>
<th>Nozzle series</th>
<th>Nozzle size</th>
<th>M</th>
<th>M1</th>
</tr>
</thead>
<tbody>
<tr>
<td>V-37</td>
<td>06 E</td>
<td>37</td>
<td>36</td>
</tr>
<tr>
<td>V-42</td>
<td>09 E</td>
<td>42</td>
<td>50</td>
</tr>
<tr>
<td>V-45</td>
<td>12 E</td>
<td>45</td>
<td>50</td>
</tr>
<tr>
<td>V-50</td>
<td>16 E</td>
<td>50</td>
<td>60</td>
</tr>
<tr>
<td>V-55</td>
<td>22 E</td>
<td>55</td>
<td>70</td>
</tr>
<tr>
<td>V-65</td>
<td>16 EX 16</td>
<td>65</td>
<td>80</td>
</tr>
</tbody>
</table>

**Available manifold series**

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

<table>
<thead>
<tr>
<th>Minor dimensions</th>
<th>A</th>
<th>B</th>
<th>J2</th>
<th>NT</th>
</tr>
</thead>
<tbody>
<tr>
<td>06 E</td>
<td>16</td>
<td>10</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>09 E</td>
<td>10</td>
<td>10</td>
<td>15</td>
<td>12</td>
</tr>
<tr>
<td>12 E</td>
<td>12</td>
<td>12</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>16 E</td>
<td>16</td>
<td>16</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>16 EX 16</td>
<td>16</td>
<td>16</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>22 E</td>
<td>26</td>
<td>26</td>
<td>20</td>
<td>20</td>
</tr>
</tbody>
</table>

1. Major dimensions
**Actuators**

- **HYC4500M**
- **HB250**
- **HB4016**
- **HY2308**
- **QCVG16**
- **PNC3008B**
- **PNC4508B**
- **PNC6018B**
- **PBC4008**
- **PBC6016**
- **PBC8016**
- **VP4008P**
- **VP8016P**
- **ELA4308P**
- **ELA5708P**
- **ELA8708P**
- **ELA7616M**

**Nozzle sizes**

<table>
<thead>
<tr>
<th>Nozzle series</th>
<th>Actuator bolted to the manifold</th>
<th>Actuator in mold plate</th>
<th>Actuator with backing plate</th>
<th>Electric actuator in mold plate</th>
</tr>
</thead>
<tbody>
<tr>
<td>06</td>
<td>HB Series</td>
<td>HYZ Series</td>
<td>PNC####B Series</td>
<td>ELA P Series</td>
</tr>
<tr>
<td>09</td>
<td>HB Series</td>
<td>QCVG Series</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>PB Series</td>
<td>VP Series</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>ELA M Series</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>PNC####B Series</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Reference: eGate 2.0 For Medium-to-Large Part Molding, Catalog CAT-16-0039_EN-Rev##
Nozzle Tip Description - VTP

Nozzle Tip Selection

From the nozzle tip descriptions, individual configurations can be selection 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**

Most effective solution for color change applications

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

Unsuitable for cosmetic gating and amorphous plastics when direct gating on part
Non-homogeneous cavity surface temperature
No significant effect with slow needle opening (activeGate)

VSP-SC

For color change applications
Flame retardant resins
Slightly hotter tip surface than VSP

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
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
For use on color change applications, when a straight and blind tip is requested
- 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
For use on color change applications, when a blind tip is requested
- 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
For color change applications, if thermal gate is requested
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
Most effective solution for color change applications, if thermal gate and blind tip is requested
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**

- Best solution for color change applications, if valve gate is not necessary and gating at cold runner
- Slightly hotter tip surface than TFP
- Flame retardant resins
Hot Runner Guide

Tip Modifications 12E, 16E, 22E Series

Illustrations simplified, schematically drawn and not to scale.

VSP

- **Standard**
- **Alternate Cutout**

Space Restrictions, Contoured or Angled Parting Line

- **Angled Gating**
  - Option 1: Angle max 10° (recom.)
  - Option 2: Angle max 25° (recom.)
  - Option 3: Angle >25°

Extended land tip orifice with Valve Pin to accommodate

Needle modification NOT applicable

VSW

- **Angled Gating**
  - Option 1: Angle max 10° (recom.)
  - Option 2: Angle max 10° (recom.)
  - Option 3: Angle >10°

Valve pin +1,5 mm

Consult Synventive

Preferred (✓) Available (✓) Not Available
**Hot Runner Guide**

**Tip Modifications 12E, 16E, 22E Series**

Illustrations simplified, schematically drawn and not to scale.

### VTP

**Standard**

![Standard Diagram](image1)

- Space Restrictions, Contoured or Angled Parting Line

**Alternate Cutout**

![Alternate Cutout Diagram](image2)

- Space Restrictions, Contoured or Angled Parting Line

**Angled Gating**

- Option 1: Angle max 10° (recom.)
- Option 2: Angle max 25° (recom.)

Extended land tip orifice with reduced orifice and Valve Pin to accommodate. Tapered pin extended = special part

### VTW

**Angled Gating**

- Angle to part

**Angled Gating**

- Option 1: Angle max 10° (recom.)
- Option 2: Angle max 10° (recom.)

Tapered pin extended = special part

**Angled Gating**

- Option 2: Angle max 10° (recom.)

Tapered pin extended = special part

- Preferred

- Available

- Not Available
HOT RUNNER TECHNOLOGY

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Tip Modifications 12E, 16E, 22E Series

Illustrations simplified, schematically drawn and not to scale.

TTP

- Standard
- Alternate Cutout
- Dimple

Space Restrictions, Contoured or Angled Parting Line
According to customer specification depth max. 1 mm

Angle to part
Option 1
Angle max 10° (recom.)

TTW

- Angled Gating
- Angled Gating

- Angle to part
Option 1
Angle max 10° (recom)

TFP

- Standard
- Alternate Cutout
- Dimple
- Angled Gating
- Angled Gating

Space Restrictions, Contoured or Angled Parting Line
According to customer specification depth max. 1 mm

Angle to part
Option 1
Angle max 10° (recom.)

Preferred  (✓) Available  (✓) Not Available
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

12E min. length is 102 mm
16E & 22E min. length is 110 mm
12E, 16E & 22E max. length 650 mm

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

Suitable pitch dimensions for
12E Nozzles only