> Introduction
Bronkhorst High-Tech B.V., the European market leader in low flow thermal and Coriolis Mass Flow Meters/Controllers, has many years experience in designing and manufacturing precise and reliable measurement and control devices. With a wide range of instruments, Bronkhorst offers innovative solutions for many different applications in many different markets. The instruments are made to customers’ specification, in various styles, suitable for use in laboratory, industrial and hazardous areas, in such diverse applications as semiconductor and analytical installations, to name but two.

> EL-FLOW® Select series
EL-FLOW® Select series Mass Flow Meters and Controllers for gas applications have a housing designed for laboratory and clean processing conditions. The instruments are truly unique in their capability to measure and control flow ranges between 0.014...0.7 ml/min and 8...1670 l/min with pressure rating between vacuum and 400 bar – all in one range of instruments. This versatility in flow ranges and in operating conditions has ensured that the EL-FLOW® Select series remains our most popular and field proven of instruments.

Today’s EL-FLOW® Select series are equipped with a digital pc-board, offering high accuracy, excellent temperature stability and fast response (settling times down to 500 msec). The main digital pc-board contains all of the general functions needed for measurement and control. In addition to the standard RS232 output the instruments also offer analog I/O. Furthermore, an integrated interface board provides DeviceNet™, PROFIBUS DP, Modbus, EtherCAT®, PROFINET or FLOW-BUS protocols.

> Selectable gases and flow ranges
The EL-FLOW® Select design features optional Multi-Gas / Multi Range functionality, providing (OEM-) customers with extra flexibility and process efficiency. Users of MFC’s in pilot plants or laboratories can rescale their instruments on site, saving time and money; substantial costs for stock keeping, (dis)mounting and also for service and recalibration are no longer applicable. Our free and easy-to-use software tool “FlowTune” enables the user to change the instrument’s configuration swiftly via the RS232 port of a lap-top.

> Mass Flow Controllers for every application
The control valve can be furnished as integral part of an EL-FLOW® Select MFC, or as separate component. It is a proportional, electro-magnetic control valve with extremely fast and smooth control characteristics. With reference to the specific field of application there are different series of control valves. There is a standard direct acting valve for common applications, a pilot operated valve for high flow rates, the so-called Vary-P valve that can cope with 6 up to 400 bar ΔP and a bellows valve for applications with very low differential pressure.

> General EL-FLOW® Select features
◆ fast response, excellent repeatability
◆ high accuracy
◆ virtually pressure and temperature independent
◆ pressure ratings up to 400 bar
◆ optional metal sealed and downported constructions

> Digital features
◆ DeviceNet™, PROFIBUS DP, Modbus-RTU/ASCII, EtherCAT®, PROFINET or FLOW-BUS slave; RS232 interface
◆ optional Multi Gas / Multi Range functionality up to 10 bar
◆ storage of max. 8 calibration curves
◆ alarm and counter functions
◆ control characteristics user-configurable
> Technical specifications

**Measurement / control system**

- **Accuracy (incl. linearity):**
  - Standard: ±0.5% Rd plus ±0.1% FS
  - Based on actual calibration: ±0.8% Rd plus ±2% FS for F-110C-005/F-200CV-005
  - ±2% FS for F-110C/F-200CV-002
- **Turndown:** 1:50 (in digital mode up to 1:187,5)
- **Repeatability:** <0.2% Rd
- **Settling time (controller):** Standard: 1...2 seconds
  - Option: down to 500 m/sec
- **Control stability:** <0.1% FS (typical for 1 l/min N₂)
- **Operating temperature:** -10...+70°C
- **Temperature sensitivity:**
  - Zero: <0.05% FS/°C; span: <0.05% Rd/°C
- **Pressure sensitivity:** 0.1% Rd/bar typical N₂, 0.01% Rd/bar typical H₂
- **Leak integrity, outboard:** Tested < 2 x 10⁻³ mbar l/s He
- **Attitude sensitivity:**
  - Max. error at 90° off horizontal: 0.2%
- **Warm-up time:** 30 min. for optimum accuracy
  - 2 min. for accuracy ±2% FS

**Mechanical parts**

- **Material (wetted parts):** Stainless steel 316L or comparable
- **Process connections:** Compression type or face seal couplings
- **Seals:**
  - Standard: Viton®
  - Options: EPDM, Kalrez® (FFKM)
- **Ingress protection (housing):** IP40

**Electrical properties**

- **Power supply:** +15...24 Vdc
- **Max. power consumption:**
  - Supply: at voltage I/O at current I/O
  - Meter: 15 V 95 mA 125 mA
  - 24 V 65 mA 85 mA
  - Controller: 15 V 290 mA 320 mA
  - 24 V 200 mA 215 mA
- **Extra for fieldbus:**
  - PROFIBUS DP: add 53 mA (at 15 V) or 30 mA (at 24 V)
  - EtherCAT®: add 66 mA (at 15 V) or 41 mA (at 24 V)
  - PROFINET: add 77 mA (15 V supply) or 48 mA (24 V supply)
  - DeviceNet®: add 48 mA (at 24 V)
- **Analog output/command:** 0...±(10) Vdc or 0 (6)...20 mA
  - (sourcing output)
- **Digital communication:** Standard: RS232
  - Options: PROFIBUS DP, DeviceNet®, EtherCAT®, Modbus-RTU/ASCII, PROFINET, FLOW-BUS

**Electrical**

- **Analog/RS232:** 9-pin D-connector (male);
- **PROFIBUS DP:** bus: 9-pin D-connector (female);
  - Power: 9-pin D-connector (male);
- **DeviceNet®:** 5-pin M12-connector (male);
- **EtherCAT®/PROFINET:** 2 x RJ45 modular jack (in/out)
- **FLOW-BUS/Modbus-RTU/ASCII:** RJ45 modular jack

Technical specifications and dimensions subject to change without notice.

> Models and flow ranges (based on Air)

**Mass Flow Meters (MFM); PN100 (pressure rating 100 bar)**

<table>
<thead>
<tr>
<th>Model</th>
<th>Min. flow</th>
<th>Max. flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-110C</td>
<td>0.014...0.7 ml/min</td>
<td>0.06...9 ml/min</td>
</tr>
<tr>
<td>F-111B</td>
<td>0.16...8 ml/min</td>
<td>0.16...25 l/min</td>
</tr>
<tr>
<td>F-111AC</td>
<td>0.4...20 l/min</td>
<td>0.6...100 l/min</td>
</tr>
<tr>
<td>F-112AC</td>
<td>0.8...40 l/min</td>
<td>1.4...250 l/min</td>
</tr>
<tr>
<td>F-113AC</td>
<td>4...200 l/min</td>
<td>8...1670 l/min</td>
</tr>
</tbody>
</table>

For ranges of 200 or 400 bar rated MFMs see model number identification.

**Mass Flow Controllers (MFC); PN64 / PN100**

<table>
<thead>
<tr>
<th>Model</th>
<th>Min. flow</th>
<th>Max. flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-200CV/F-210CV</td>
<td>0.014...0.7 ml/min</td>
<td>0.06...9 ml/min</td>
</tr>
<tr>
<td>F-201CV/F-211CV</td>
<td>0.16...8 ml/min</td>
<td>0.16...25 l/min</td>
</tr>
<tr>
<td>F-201AV/F-211AV</td>
<td>0.4...20 l/min</td>
<td>0.6...100 l/min</td>
</tr>
<tr>
<td>F-202AV/F-212AV</td>
<td>0.8...40 l/min</td>
<td>1.4...250 l/min</td>
</tr>
<tr>
<td>F-203AV/F-213AV</td>
<td>4...200 l/min</td>
<td>8...1670 l/min</td>
</tr>
</tbody>
</table>

**Mass Flow Controllers (MFC); PN200**

<table>
<thead>
<tr>
<th>Model</th>
<th>Min. flow</th>
<th>Max. flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-220M</td>
<td>0.2...10 ml/min</td>
<td>3...15 ml/min</td>
</tr>
<tr>
<td>F-221M</td>
<td>0.3...15 ml/min</td>
<td>0.4...20 l/min</td>
</tr>
</tbody>
</table>

For MFCs for high-pressure / high-AP applications; PN400

<table>
<thead>
<tr>
<th>Model</th>
<th>Min. flow</th>
<th>Max. flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-230M</td>
<td>0.2...10 ml/min</td>
<td>10...500 ml/min</td>
</tr>
<tr>
<td>F-231M</td>
<td>10...500 ml/min</td>
<td>0.2...10 l/min</td>
</tr>
<tr>
<td>F-232M</td>
<td>0.2...10 l/min</td>
<td>2...100 l/min</td>
</tr>
</tbody>
</table>

**MFCs for high-pressure / high-AP applications; PN400**

**Thermal mass flow measuring principle**

The heart of the thermal mass flow meter/controller is the sensor, that consists of a stainless steel capillary tube with resistance thermometer elements. A part of the gas flows through this bypass element consisting of a stainless steel disc stack with precision-etched flow channels. Thanks to the perfect flow split the sensor output is proportional to the total mass flow rate.
> Dimensions

**Mass Flow Meter**

<table>
<thead>
<tr>
<th>Model</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>H</th>
<th>K</th>
<th>Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-110C (1/8” OD)</td>
<td>47</td>
<td>98</td>
<td>47</td>
<td>111</td>
<td>25</td>
<td>0.4</td>
</tr>
<tr>
<td>F-111B (1/8” OD)</td>
<td>69</td>
<td>126</td>
<td>47</td>
<td>111</td>
<td>25</td>
<td>0.5</td>
</tr>
<tr>
<td>F-111AC (1/4” OD)</td>
<td>69</td>
<td>126</td>
<td>47</td>
<td>123</td>
<td>26</td>
<td>0.6</td>
</tr>
<tr>
<td>F-112AC (1/2” OD)</td>
<td>65</td>
<td>130</td>
<td>47</td>
<td>139</td>
<td>59</td>
<td>1.3</td>
</tr>
<tr>
<td>F-113AC (3/4” OD)</td>
<td>112</td>
<td>178</td>
<td>47</td>
<td>153</td>
<td>74</td>
<td>3.0</td>
</tr>
</tbody>
</table>

Dimensions in mm.

> Burner control

Burner control using Mass Flow Controllers brings many advantages compared to conventional systems, where flow is adjusted through needle valves. When burner orifices get clogged or when gas supply pressure varies, an MFC will automatically adapt to the changed conditions. For the control of relatively large flows with low differential pressure, which is typical for natural gas or CH₄, Bronkhorst offers mass flow meters with separate pressure compensated bellows valves.

> Making gas mixtures

MFC’s are often used to make precise and stable mixtures of two or more gases. A Bronkhorst® PS/Readout system can be applied to maintain the ratio of mixed gases by operating in master-slave mode. In the example above, the flow range of gas 1 is much smaller than the other. For this purpose Bronkhorst developed a gas mixer, to guarantee a homogeneous gas mixture.

> Fields of application

The EL-FLOW® Select series have been successfully applied in a wide variety of both OEM and laboratory applications in the following markets (typically):

- Semiconductor processing
- Analysis and environmental measurements
- Burner control
- Vacuum technology
- Surface treatment installations
- Process control in food, pharmaceutical and (petro-) chemical industries

To give an impression of the many varied applications, we hereby sketch some basic examples. In reality, these applications are commonly far more complex and with far more variations and adaptations.

> Feeding of reactors

Flow control is often combined with the control of reactor pressure, using an EL-PRESS back pressure controller, or as depicted, an EL-PRESS Pressure Meter with integrated PI-controller. Typical applications: high pressure hydrogenation systems and autoclave processes using a 400 bar rated Mass Flow Controller with Vary-P control valve.
### Table with minimum and maximum flow ranges for EL-FLOW

#### Multi Fluid / Multi Range functionality (valid for operating conditions from 0.8 to 10 bar abs and 0 to 70°C)

<table>
<thead>
<tr>
<th>EL-FLOW Select</th>
<th>MFM Model #</th>
<th>MFC Model #</th>
<th>Air flow ranges</th>
<th>Min/Max flow ranges for other gases</th>
<th>Min/Max flow ranges for other gases</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F-110C - 002</td>
<td>F-200CV - 002</td>
<td></td>
<td>CH4</td>
<td>Ar</td>
</tr>
<tr>
<td></td>
<td>F-110C - 003</td>
<td>F-200CV - 003</td>
<td></td>
<td>CO</td>
<td>CO</td>
</tr>
<tr>
<td></td>
<td>F-111B - 010</td>
<td>F-201CV - 100</td>
<td></td>
<td>H2</td>
<td>H2</td>
</tr>
<tr>
<td></td>
<td>F-111B - 011</td>
<td>F-201CV - 101</td>
<td></td>
<td>N2</td>
<td>N2</td>
</tr>
<tr>
<td></td>
<td>F-111B - 012</td>
<td>F-201CV - 102</td>
<td></td>
<td>O2</td>
<td>O2</td>
</tr>
</tbody>
</table>

#### Multi Gas / Multi Range features

- Rangeability up to 1875:1
- Flexible, user-programmable ranges and gas types
- Easy-to-use configuration software
- Multi Gas / Multi Range functionality up to 10 bar; pressure rating up to 100 bar
- High accuracy and repeatability

#### Notes

- Multi Gas / Multi Range is optional on the Select series and must be requested at the point of ordering
- Extended rangeability for digital communication only; turndown 50:1 when using analog I/O options
- The selected orifice of the control valve may limit the rangeability
- The selected orifice of the control valve may limit the rangeability
- Minimum range for gases not mentioned in this list; rule of thumb: nominal range for Ar x Conversion Factor; e.g. F-111B - 1K0: maximum range for SF6 = 1000 x 0.27 = 270 ml/min
- Minimum range for gases not mentioned in this list; rule of thumb: minimum range for Air x Conversion Factor; e.g. F-111B - 1K0: minimum range for SF6 = 400 x 0.27 = 108 ml/min

#### Conversion Factors

The Conversion Factors for these calculations can be extracted from Fluidat on the Net (www.fluidat.com): Go to ‘Flow calculations’ and select ‘Gas Conversion factor’. Select ‘Fluid from’ and make sure ‘Fluid to’ is Air. Select the applicable instrument model from the pull-down menu. Then press ‘Calculate’ and look up the conversion factor from the table.
### Model number identification

#### Base

<table>
<thead>
<tr>
<th>Base</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Valve only</td>
</tr>
<tr>
<td>1</td>
<td>Meter</td>
</tr>
<tr>
<td>2</td>
<td>Controller</td>
</tr>
</tbody>
</table>

#### Pressure rating

<table>
<thead>
<tr>
<th>Pressure</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>64 bar</td>
</tr>
<tr>
<td>1</td>
<td>100 bar</td>
</tr>
<tr>
<td>2</td>
<td>200 bar</td>
</tr>
<tr>
<td>3</td>
<td>400 bar</td>
</tr>
</tbody>
</table>

#### Ranges

**for PN64/PN100 Flow Meters/Controllers**

<table>
<thead>
<tr>
<th>Ranges</th>
<th>Flow Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>0C/0CV</td>
<td>0…0,7 / 0…9 ml/min</td>
</tr>
<tr>
<td>1B/1CV</td>
<td>0…8 / 0…25000 ml/min</td>
</tr>
<tr>
<td>1AC/1AV</td>
<td>0…20 / 0…100 l/min</td>
</tr>
<tr>
<td>2AC/2AV</td>
<td>0…40 / 0…250 l/min</td>
</tr>
<tr>
<td>3AC/3AV</td>
<td>0…200 / 0…1670 l/min</td>
</tr>
</tbody>
</table>

**for PN200/PN400 Flow Meters**

<table>
<thead>
<tr>
<th>Ranges</th>
<th>Flow Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>0M</td>
<td>0…10 / 0…15 ml/min</td>
</tr>
<tr>
<td>1M</td>
<td>0…15 / 0…20000 ml/min</td>
</tr>
<tr>
<td>2M</td>
<td>0…10 / 0…250 l/min</td>
</tr>
<tr>
<td>3M</td>
<td>0…200 / 0…1250 l/min</td>
</tr>
</tbody>
</table>

**for PN200 Flow Controllers**

<table>
<thead>
<tr>
<th>Ranges</th>
<th>Flow Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>0M</td>
<td>0…100 / 0…15 ml/min</td>
</tr>
<tr>
<td>1M</td>
<td>0…15 / 0…20000 ml/min</td>
</tr>
</tbody>
</table>

**for PN400 Flow Controllers**

<table>
<thead>
<tr>
<th>Ranges</th>
<th>Flow Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>0M</td>
<td>0…10 / 0…500 ml/min</td>
</tr>
<tr>
<td>1M</td>
<td>0…15 / 0…10 l/min</td>
</tr>
<tr>
<td>2M</td>
<td>0…10 / 0…100 l/min</td>
</tr>
</tbody>
</table>

#### Nominal range

Factory selected

#### Communication (I/O)

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>RS232 + analog (n/c control)</td>
</tr>
<tr>
<td>B</td>
<td>RS232 + analog (n/o control)</td>
</tr>
<tr>
<td>D</td>
<td>RS232 + DeviceNet® (n/c control)</td>
</tr>
<tr>
<td>E</td>
<td>RS232 + DeviceNet® (n/o control)</td>
</tr>
<tr>
<td>M</td>
<td>RS232 + Modbus (n/c control)</td>
</tr>
<tr>
<td>N</td>
<td>RS232 + Modbus (n/o control)</td>
</tr>
<tr>
<td>P</td>
<td>RS232 + PROFIBUS (n/c control)</td>
</tr>
<tr>
<td>Q</td>
<td>RS232 + PROFIBUS (n/o control)</td>
</tr>
<tr>
<td>R</td>
<td>RS232 + FLOW-BUS (n/c control)</td>
</tr>
<tr>
<td>S</td>
<td>RS232 + FLOW-BUS (n/o control)</td>
</tr>
<tr>
<td>T</td>
<td>RS232 + EtherCAT® (n/c control)</td>
</tr>
<tr>
<td>U</td>
<td>RS232 + EtherCAT® (n/o control)</td>
</tr>
<tr>
<td>V</td>
<td>RS232 + PROFINET (n/c control)</td>
</tr>
<tr>
<td>W</td>
<td>RS232 + PROFINET (n/o control)</td>
</tr>
</tbody>
</table>

#### Supply voltage

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>+15…24 Vdc</td>
</tr>
</tbody>
</table>

#### Connections (in/out)

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1/4” OD compression type</td>
</tr>
<tr>
<td>2</td>
<td>1/4” OD compression type</td>
</tr>
<tr>
<td>3</td>
<td>6 mm OD compression type</td>
</tr>
<tr>
<td>4</td>
<td>12 mm OD compression type</td>
</tr>
<tr>
<td>5</td>
<td>1/8” OD compression type</td>
</tr>
<tr>
<td>6</td>
<td>20 mm OD compression type</td>
</tr>
<tr>
<td>8</td>
<td>1/4” Face seal male</td>
</tr>
<tr>
<td>9</td>
<td>other</td>
</tr>
</tbody>
</table>

#### Analog output

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0…5 Vdc</td>
</tr>
<tr>
<td>B</td>
<td>0…10 Vdc</td>
</tr>
<tr>
<td>F</td>
<td>0…20 mA sourcing</td>
</tr>
<tr>
<td>G</td>
<td>4…20 mA sourcing</td>
</tr>
</tbody>
</table>

#### Internal seals

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>Viton® (factory standard)</td>
</tr>
<tr>
<td>E</td>
<td>EPDM</td>
</tr>
<tr>
<td>K</td>
<td>Kalrez® (FFKM)</td>
</tr>
</tbody>
</table>

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F-112AC Mass Flow Meter

F-231M Mass Flow Controller for high pressure applications

F-203AV Mass Flow Controller for high flow applications

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**Bronkhorst®**

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