Applications

The F-Series ITB is designed to throttle air or air/fuel mixtures for gaseous engines in industrial and on-highway service. This system is designed for direct replacement of traditional throttle valves, and requires no linkage between valve and actuator. The ITB contains a return spring to fully comply with US DOT 571.124 specifications. The three sizes are designed to cover a wide range of engines, and should be selected using the sizing procedure described in this specification.

The F-Series ITB actuator software must be properly set up for the application. Refer to manual 26355 for detailed instructions.

Description

The F-Series Integrated Throttle Bodies (ITB) are butterfly valves electrically actuated by an F-Series actuator to control flow output. Flow is a function of inlet and outlet pressure, throttle size, and throttle position. Throttle position is proportional to the position demand. The actuator drives the 0–70 degree output shaft to the demanded position based on an internal shaft position sensor.

There are two ITB actuator types:
- F-Series Throttle (FST)
- F-Series Throttle Plus (FSTP)

Both the FST and FSTP actuators accept a PWM position demand signal while the FSTP can also accept a J1939 CAN, 4–20 mA or 0–5 Vdc position demand. An optional non-linear position demand curve can be configured for a non-linear actuator response versus the position demand input signal.

The CANbus protocol is SAE J1939.

A 0–5 Vdc configurable position feedback signal provides for monitoring throttle position and for possible feed-forward control. A sight cover is provided over the slotted throttle shaft end to view the actual throttle position. Note that the throttle plate is 15° off horizontal (flange plane) when the valve is fully closed.

The FSTP version includes a relay driver output that changes state whenever the controller detects a configured fault or error condition.

The FSTP version includes discrete inputs for a Run Enable/Key Switch and to set the CAN ID.

The F-Series actuator operates on 10–32 Vdc. The ambient operating temperature range is −40 to +105 °C (−40 to +221 °F).

The F-Series ITB is available in 48, 60, and 68 mm bore sizes. The throttle bodies provide maximum flow rates equivalent to standard throttle bodies of equal diameter. The ITB is designed to operate on air and gases ranging from pipeline quality natural gas to specialty gas (such as landfill, digester, or other biogases). The ITB alleviates the problems associated with linkages on gas engines (such as setup, non-linearity, and wear).

The direct combination of throttle and actuator results in excellent transient response and stability, and requires no hydraulics, pneumatics, or gear train. Therefore, you end up with an efficient, long lasting, and easily installed throttle option.
Determining the Proper Valve Size

The proper size valve can be determined using the equation below. The required Cv (flow coefficient) should be calculated for both the minimum and maximum flows expected on the application. This design allows for a nominal travel of 70 degrees of rotation.

Using the graph and table below, select the closest valve that has a Cv equal to or greater than the calculated maximum flow value at approximately 80% opening (55 degrees) to ensure reasonable flow margin. Also, check that the particular valve’s minimum Cv listed below is less than the minimum calculated Cv for good low idle performance. For further assistance, consult the Woodward engineering department.

\[ Cv = Q \times 0.00978 \times \left( \frac{G \times T}{(P_1-P_2) \times K} \right)^{0.5} \]

Where:
- \( Cv \) = Valve Flow Coefficient
- \( Q \) = Flow (lb/h) (1 lb = 0.4536 kg)
- \( G \) = Specific gravity of fluid (use 1.0 for air & 0.6 for Nat Gas)
- \( T \) = Absolute inlet temperature (460 + °F)
- \( P_1 \) = Inlet pressure (psia)
- \( P_2 \) = Discharge pressure (psia)
- \( K \) = \( P_2 \) if \( P_1-P_2 \) is less than 10% of \( P_1 \)
  = \( P_1 \) if \( P_1-P_2 \) is 25% or more of \( P_1 \)
  = \( (P_1+P_2)/2 \) if \( P_1-P_2 \) is in between 10 and 25%

Note—\( P_2 \) must be Greater than 0.528 \( P_1 \) (or flow becomes choked). If \( P_2 \) is less than 0.528 \( P_1 \), then use \( P_2= 0.528 \times P_1 \)

### F-Series Cv Curves

<table>
<thead>
<tr>
<th>Position (Deg)</th>
<th>48 mm Cv</th>
<th>60 mm Cv</th>
<th>68 mm Cv</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.65</td>
<td>1.08</td>
<td>1.08</td>
</tr>
<tr>
<td>2</td>
<td>1.54</td>
<td>2.43</td>
<td>2.51</td>
</tr>
<tr>
<td>10</td>
<td>5.15</td>
<td>8.16</td>
<td>10.20</td>
</tr>
<tr>
<td>15</td>
<td>8.18</td>
<td>12.99</td>
<td>16.94</td>
</tr>
<tr>
<td>20</td>
<td>12.00</td>
<td>18.77</td>
<td>25.11</td>
</tr>
<tr>
<td>30</td>
<td>21.95</td>
<td>34.67</td>
<td>48.31</td>
</tr>
<tr>
<td>40</td>
<td>34.82</td>
<td>58.62</td>
<td>87.71</td>
</tr>
<tr>
<td>50</td>
<td>52.76</td>
<td>95.19</td>
<td>138.93</td>
</tr>
<tr>
<td>55</td>
<td>65.75</td>
<td>118.06</td>
<td>172.42</td>
</tr>
<tr>
<td>60</td>
<td>80.12</td>
<td>144.36</td>
<td>210.18</td>
</tr>
<tr>
<td>70</td>
<td>108.50</td>
<td>202.19</td>
<td>272.55</td>
</tr>
</tbody>
</table>

**Note**—These flow coefficients were determined using the test setup described in ANSI/ISA-S75.02-1996 “Control Valve Capacity Test Procedure”

Electrical Connector Orientation Options
Specifications

Power Supply 12/24 V systems (10–32 Vdc), reverse polarity protection
Power Consumption 24 W steady-state, 98 W instantaneous during transient
   Travel 70 ±2 degrees
Torque Steady State: 1.4 N⋅m (1.0 lb-ft) at 105 °C, 12 Vdc
   Transient: 2.7 N⋅m (2.0 lb-ft) at 105 °C, 12 Vdc
Mass/Weight 48 mm ITB = 4.9 kg (10.8 lb)
   60 mm ITB = 4.7 kg (10.4 lb)
   68 mm ITB = 4.5 kg (10.0 lb)
Command Input PWM (4–32 V, 300–2000 Hz) or J1939 CAN (FSTP Only), Analog (FSTP Only) (4–20 mA or
   0–5 Vdc)
Position Feedback Output 0.5 to 4.5 Vdc, configurable in software
Programming Port Programmable with Service Tool software (9927-1419) and 14-pin harness 8923-1254 (FST) or
   23-pin harness 8923-1255 (FSTP)

Performance
Positioning Accuracy ±4% full stroke for all input types after effects from –40 to +85 °C board temperature
10%–90% Step Slew Time = 10 Hz at –3 db, ±0.5% of full scale
   Bandwidth = 14 Hz at –3 db, ±2% of full scale

Environmental
Ambient Operating Temp. –40 to +105 °C (–40 to +221 °F)
ITB Flowing Medium Temp. –40 to +105 °C (–40 to +221 °F)
Storage Temperature –40 to +125 °C (–40 to +257 °F)
EMC EN61000-6-2 (2005): Immunity for Industrial Environments
   EN61000-6-4 (2001): Emissions for Industrial Environments
   ISO 10605 (2001): ESD Immunity for Packaging and Handling, ±4 kV contact discharge
   ISO 11452-2,4: RF Immunity, 1 MHz – 2 GHz
   CISPR 25 (2002): Radiated RF Emissions, 30 MHz – 1 GHz, 2004/104/EC and ECE Regulation
   10 limits
   ISO 7637-2 (2004): Conducted Transient Immunity, Pulse 1c, 2a, 3a, 3b, 4, and 5a
Humidity US MIL-STD 810D, 507.2, Procedure III (60 °C, 95% RH); Lloyd’s Register of Shipping Humidity
   Test 1; Det Norske Veritas Damp Heat per Woodward Procedure 4-04-6230
Chemical Resistance SAE J1455, 4.4.3 (except water immersion testing)
Shock 40 G, 11 ms duration saw-tooth pulse per Woodward Procedure 3-04-6231, MS1
Vibration Random: 0.3 G²/Hz, 10–2000 Hz (22.1 Grms ) 3 h/axis per Woodward Procedure 3-04-6231, RV3
Thermal Shock SAE J1455, 4.1.3.2. Modified, –40 to +105 °C and 20 cycles
Ingress Protection IP56 per IEC 60529, (dust ingress, water ingress)
   SAE J1455, sections 4.3, 4.4.3, 4.5, 4.7, 4.10.3.1

Regulatory Compliance
CSA Certified Class I, Division 2, Groups A, B, C, & D, T3
CE Marking Stationary industrial markets only
EMC Directive 2004/108/EC
Other European Directives (non-CE marking):
   Machinery Directive 98/37/EC (compliant as a component)
   Pressure Equipment Directive 97/23/EC (Exempt per Article 1-3.10)
Other International Compliance (vehicular markets only):
   UNECE Regulations 67 and 110

Technical Manual 26355