Over the past 70 years you’ve known us as Synchro-Start Products, but in May 2003 we became Woodward. With the resulting expansion in product lines, increased ability to provide customized system solutions, and strong quality and service initiatives, we are prepared to meet emerging trends in the global marketplace head on.

Those trends include:

- Strict adherence to tightening emission standards (especially for small engines)
- Consolidation among engine manufacturers
- Increased reliance upon suppliers to offset the high cost of meeting the next generation emission levels.

Woodward’s extensive line of on-engine control and fuel systems can help you maximize fuel economy, efficiency, and emissions control and minimize your system costs. Moreover, using a consultative approach, Woodward teams understand each customer’s unique challenges and deliver tightly integrated control systems for unmatched performance in engines of all sizes.

So, whether you’re looking for reliable engine control components such as solenoids, sensors, and electronic controls, or fully integrated control systems – intelligent “Networked Engines” – look to us.

WOODWARD

The world’s leading independent supplier of energy control solutions for engines, turbines, and power equipment.
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Solenoids

Solenoids

Solenoid Basics
From operating engine run/stop levers, throttles, chokes, valves and clutches to protecting expensive diesel engines from overspeed, low lube pressure and high temperature, you can rely on Woodward solenoids to meet the ever-changing technical demands of modern industry.

The Basic Single Coil Solenoid
A solenoid is a device that converts electrical energy into mechanical work. Solenoids are made up of a free moving steel plunger that sits within a wound coil of copper wire. When electric current is introduced, a magnetic field forms, which draws the plunger in. The exposed end of the plunger can be attached to equipment, and when the solenoid is activated, the plunger will move to open, close, turn on or turn off that equipment.

The Woodward Dual Coil Solenoid
To allow a solenoid to be held energized for long periods of time without overheating, Woodward uses two separate coil windings instead of one. The first wound coil operates at a high current level to provide maximum pull or push. The second wound coil simply holds the plunger in place after it has completed its stroke and “bottomed out.” Since the current required to hold the plunger in place is low, dual coil solenoids can be energized continuously without overheating. This unique design concept results in a highly efficient compact solenoid approximately one half the size of a comparable single coil unit.

![Diagram of solenoid components](image-url)
Three methods for turning off the pull coil

After energizing and pulling in the plunger, the pull coil in a dual coil solenoid must be turned off as soon as possible to prevent overheating. The three basic methods for switching off the pull coil are discussed below.

External Switching

The externally switched (3-wire) solenoid is used in applications where an operator/driver manually turns a key switch that temporarily energizes the pull coil to pull in the plunger. The most popular application is for start-stop control of engines in trucks and mobile equipment where moisture, dirt, dust, and high vibration are present. The sealed 3-wire solenoid is well suited for these harsh conditions.

External Switching with Timer Module

With the addition of a Woodward pull coil timer module, the externally switched (3-wire) solenoid can be used not only in operator/driver controlled vehicles, but also in unattended equipment, throttle, and choke controls. The timer ensures that the pull coil is turned off within approximately 1 1/2 seconds after energizing, which prevents overheating of the coil in situations such as abusive overcranking of an engine.

Internal Switching

The internally switched solenoid utilizes a mechanical double contact switch, mounted on the rear of the solenoid, to turn off the pull coil. Best suited for applications such as standby generator sets or other applications where vibration, dirt, moisture, and excessive cycling are not present.
Basics

Solenoid Selection Factors

- The pull or push force (Fp) required to move the plunger and load from a de-energized or non-voltage position to an energized or voltage induced position.
- The force required to hold (Fh) the plunger and load in its energized or voltage induced position.
- The total distance or stroke (S) the plunger travels when the solenoid is energized.
- All solenoids are affected by temperature. The hotter the solenoid, the less work it can do because of changes in the resistance of the copper coil wire.
- Low voltage also reduces the solenoid's work output.

Evaluating Solenoid Suitability

To evaluate a solenoid's work output, use the accompanying "pull vs. stroke," "voltage" and "temperature" graphs and follow this example:

Let's assume your application requires a maximum pull force of 7 pounds at a 1 inch stroke. After looking at the "pull vs. stroke" graph, the solenoid you're considering (Model 1502) has a 9 pound pull force at 1 inch stroke. We'll represent this pull force with the letters (Fo). You know the solenoid is operating at 100% of rated voltage. A quick look at the voltage correction graph, which corrects for any extreme voltages, provides a 1.0 factor. We'll represent the voltage correction factor with the letters (Fv). Your solenoid is located near the engine; therefore, the ambient temperature of 122˚F (50˚C) exceeds the normal 77˚F (25˚C) ambient. The temperature correction graph indicates a correction factor of .83 be used. We'll indicate the temperature correction factor with the letters (Ft).

Using the formula: 

\[ F = F_o \times F_v \times F_t \]

or

\[ F = 9 \times 1.0 \times 0.83 = 7.47 \text{ lbs} \]

Since the available solenoid force of 7.47 pounds is greater than your required pull force of 7 pounds, the solenoid is suitable for this particular application.

Measurements for above factors must be taken in operating conditions. For example: you must start the engine and measure the force to move the lever to the stop position. The engine governor often exerts force on the stop lever, which is not apparent on a stationary engine.
In some cases, an optional spring is attached to ensure that the solenoid's de-energized plunger returns to its original position. For these applications, when using the "F = Fo x fv x ft" formula to determine the appropriate solenoid, remember: As the "pull vs. stroke" graph illustrates, the addition of a return spring changes the force (Fo) characteristics. When determining (Fo) for a solenoid with a return spring, refer to the appropriate line on the graph illustrating the return spring value (S1). This value must be subtracted from the solenoid performance curve to assure adequate force is available under derated conditions. Using our original example, the solenoid pull force (Fo) for Model 1502 at full voltage, 122˚F (50˚C) and 1 inch stroke was calculated to be 7.47 lbs. This force must now be reduced by the 2 pounds required to begin compressing the optional return spring (S1) at one inch (see "Pull vs. Stroke" above). The available force has dropped to 5.47 lbs, far below the required 7 pounds for this application. Therefore, a solenoid model with a higher force rating such as the 1504 or 1753 would be required.
Basics

Solenoid Mounting

Location
Although the solenoid is designed to operate in harsh environments, locations with excessive heat build-up and constant exposure to liquid and particulate contaminants should be avoided.

Brackets
Must be sufficiently strong to handle solenoid pull forces, vibration and shock inherent in the application.

Alignment
The solenoid should be mounted to permit the plunger to be linked in a direct line to the load. Misalignment causes side loading and resulting friction reduces the solenoid’s available force. Increasing the distance between the solenoid and the lever-actuating mechanism will reduce the force lost due to side loading friction.

Solenoid position
The solenoid should be oriented with the plunger pointed vertically down or at some downward angle. If the plunger is pointed up, contaminants may collect in the plunger bore, affecting long term operation.

Solenoid Linkage
The connecting link between the solenoid and its intended application is known as the solenoid linkage. For the internal switch to automatically disconnect the high current pull coil, solenoid linkage systems must allow the plunger to move completely into the solenoid body and “bottom out” without binding. Failure to “bottom out” will cause an internally switched solenoid to burn out and an externally switched solenoid to “drop out.”

Solenoid linkage can take several forms: A rod threaded at both ends, a bead chain, a cable, etc.

Rod
When a connecting rod is employed, the stroke is adjusted by turning the rod on its threads and locking the rod in place with a lock washer and nut. The solenoid should be energized during adjustment. A swivel joint should be incorporated with this type of linkage system to compensate for possible misalignment between the connecting rod and solenoid plunger.

Bead chain or cable
When linkage is in either of these forms, the solenoid should be energized and the bead chain or cable length adjusted to give the desired lever position.

Plunger travel
Plunger travel must be checked, especially when a bead chain or cable is used in a connecting device. The plunger travel must be limited to the solenoid’s rated stroke when it is de-energized. An “L” bracket can be used to limit the plunger travel. (See diagram below.)
Solenoid Voltage

To minimize voltage loss and resulting solenoid force deration, this chart should be used to select the proper wire thickness based upon the total wire length from the battery to the solenoid and back to the battery.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>12 VDC</td>
<td>16 gauge or 1.5 mm²</td>
<td>21' (6.4 m)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>14 gauge or 2.5 mm²</td>
<td>12' (3.7 m) 40' (12.2 m)</td>
<td>9' (2.7 m) 34' (10.4 m)</td>
<td>5' (1.5 m) 9' (2.7 m)</td>
</tr>
<tr>
<td></td>
<td>12 gauge or 4.0 mm²</td>
<td>19' (5.8 m) 64' (19.5 m)</td>
<td>14' (4.3 m) 54' (16.5 m)</td>
<td>9' (2.7 m) 14' (4.3 m)</td>
</tr>
<tr>
<td></td>
<td>10 gauge or 6.0 mm²</td>
<td>20' (6.1 m) 102' (31.1 m)</td>
<td>23' (7 m) 86' (26.2 m)</td>
<td>14' (4.3 m) 23' (7 m)</td>
</tr>
</tbody>
</table>

Solenoid Current

To protect solenoids from permanent overload damage, a well-designed system will include an overload protection device. This chart indicates proper fuse and circuit breaker ratings to incorporate into the wiring system.

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Slow Blow Fuse Type 3AG</th>
<th>Breaker Amps Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 VDC</td>
<td>8A 6A</td>
<td>8A 6A</td>
</tr>
<tr>
<td>24 VDC</td>
<td>12A 7A</td>
<td>12A 7A</td>
</tr>
<tr>
<td>24 VDC</td>
<td>20A 10A</td>
<td>20A 10A</td>
</tr>
</tbody>
</table>

Solenoid Boots

Woodward solenoid boots are constructed of either epichlorohydrin (black boot) or silicone rubber (gray boot). Epichlorohydrin offers excellent resistance to oxygen, weather, fuels and oils. It is ideal for many automotive and off-road engine compartment applications. Silicone rubber is also resistant to most engine compartment chemicals with the advantage of retaining excellent flexibility at low temperatures and the ability to work well at high temperatures.

The boot type is either constant volume or bellows. Constant volume (CV) boots are designed so that the space inside the boot remains the same regardless of plunger position. With no change in volume there is no pressure buildup, which can reduce effective plunger force. A major benefit of the CV boot is that the boot can be totally sealed.

The bellows boot is necessary in longer stroke applications where the volume change is too great to be handled by a CV boot. The bellows boot typically has a small bleed hole in it so that air is not trapped on one side of the boot or the other, allowing the pressure to equalize. Therefore, the bellows boot is not a totally sealed design.
Solenoids
Selection Guide
A guide to help you in the selection of Woodward’s wide range of single and dual coil solenoids

Woodward’s innovative designs and advanced engineering technology provide distinct performance advantages:

• Dual coil design provides both a high and low resistance coil for continuous operation in the widest ambient temperature range
• Dual coil solenoids pack more power in a smaller space than single coil solenoids
• Coils are potted on select models, sealing the entire unit for long, reliable service under extreme dirt and moisture conditions
• Plated steel housings and mounting brackets are corrosion resistant
• High temperature magnet wire insulation
• Hard chrome plated plunger for smooth, reliable, wear-resistant operation
• Brass plunger bore sleeve
• 100% inspected and factory tested

The true tests of solenoid excellence:

<table>
<thead>
<tr>
<th>Test Type</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vibration test</td>
<td>15 to 2000 Hz @ 15 G’s, 3 planes</td>
</tr>
<tr>
<td>Thermal cycling test</td>
<td>-40°F to +250°F (-40°C to +121°C), 2 hours at each temperature with one hour transition, 25 cycles</td>
</tr>
<tr>
<td>Heat soak test</td>
<td>3 hours @ 250°F (121°C) at 120% rated voltage</td>
</tr>
<tr>
<td>Shock test</td>
<td>200 G’s peak @ 21 Hz for 300 hours</td>
</tr>
</tbody>
</table>
### Solenoid Overview Chart:

<table>
<thead>
<tr>
<th>Dual Coil</th>
<th>Model No.</th>
<th>Pull or Push Force</th>
<th>Hold Force</th>
<th>Stroke</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1502</td>
<td>√</td>
<td>10 lbs (44 N)</td>
<td>24 lbs (107 N)</td>
<td>1&quot; (25.4 mm)</td>
<td>12</td>
</tr>
<tr>
<td>1502ES</td>
<td>√</td>
<td>10 lbs (44 N)</td>
<td>28 lbs (125 N)</td>
<td>1&quot; (25.4 mm)</td>
<td>12</td>
</tr>
<tr>
<td>1504</td>
<td>√</td>
<td>12 lbs (53 N)</td>
<td>19 lbs (85 N)</td>
<td>1&quot; (25.4 mm)</td>
<td>12</td>
</tr>
<tr>
<td>1751</td>
<td>√</td>
<td>24 lbs (107 N)</td>
<td>38 lbs (169 N)</td>
<td>1&quot; (25.4 mm)</td>
<td>14</td>
</tr>
<tr>
<td>1751ES</td>
<td>√</td>
<td>25 lbs (111 N)</td>
<td>41 lbs (182 N)</td>
<td>1&quot; (25.4 mm)</td>
<td>14</td>
</tr>
<tr>
<td>1753</td>
<td>√</td>
<td>19 lbs (85 N)</td>
<td>42 lbs (187 N)</td>
<td>1&quot; (25.4 mm)</td>
<td>14</td>
</tr>
<tr>
<td>1753ES</td>
<td>√</td>
<td>20 lbs (89 N)</td>
<td>43 lbs (191 N)</td>
<td>1&quot; (25.4 mm)</td>
<td>14</td>
</tr>
<tr>
<td>1756</td>
<td>√</td>
<td>26 lbs (116 N)</td>
<td>35 lbs (156 N)</td>
<td>1&quot; (25.4 mm)</td>
<td>16</td>
</tr>
<tr>
<td>1756ESD</td>
<td>√</td>
<td>30 lbs (133 N)</td>
<td>53 lbs (236 N)</td>
<td>1&quot; (25.4 mm)</td>
<td>16</td>
</tr>
<tr>
<td>1757</td>
<td>√</td>
<td>20 lbs (89 N)</td>
<td>37 lbs (165 N)</td>
<td>1&quot; (25.4 mm)</td>
<td>16</td>
</tr>
<tr>
<td>1757ES</td>
<td>√</td>
<td>16 lbs (71 N)</td>
<td>57 lbs (254 N)</td>
<td>1&quot; (25.4 mm)</td>
<td>16</td>
</tr>
<tr>
<td>2001</td>
<td>√</td>
<td>21 lbs (93 N)</td>
<td>49 lbs (218 N)</td>
<td>1&quot; (25.4 mm)</td>
<td>18</td>
</tr>
<tr>
<td>2001ES</td>
<td>√</td>
<td>22 lbs (98 N)</td>
<td>43 lbs (191 N)</td>
<td>1&quot; (25.4 mm)</td>
<td>18</td>
</tr>
<tr>
<td>2003</td>
<td>√</td>
<td>26 lbs (116 N)</td>
<td>51 lbs (227 N)</td>
<td>1&quot; (25.4 mm)</td>
<td>18</td>
</tr>
<tr>
<td>2003ES</td>
<td>√</td>
<td>29 lbs (129 N)</td>
<td>41 lbs (182 N)</td>
<td>1&quot; (25.4 mm)</td>
<td>18</td>
</tr>
<tr>
<td>2370</td>
<td>√</td>
<td>37 lbs (165 N)</td>
<td>88 lbs (391 N)</td>
<td>1.5&quot; (38.1 mm)</td>
<td>20</td>
</tr>
<tr>
<td>2370ES</td>
<td>√</td>
<td>39 lbs (173 N)</td>
<td>92 lbs (409 N)</td>
<td>1.5&quot; (38.1 mm)</td>
<td>20</td>
</tr>
<tr>
<td>Cable</td>
<td>Solenoid</td>
<td>29 lbs (129 N)</td>
<td>41 lbs (182 N)</td>
<td>0.96&quot; (24.5 mm)</td>
<td>22</td>
</tr>
</tbody>
</table>

### Single Coil

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1000S</td>
<td>√</td>
<td>Against return spring with no side load on plunger pin</td>
<td>Against return spring with no side load on plunger pin</td>
<td>0.17&quot; (4.3 mm)</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>1503S</td>
<td>√</td>
<td>Must pull in against return spring at 9 VDC and 100°F (38°C) or 2.25 lbs min. (10 N) or 8 lbs (35.6 N) at rated voltage</td>
<td>Must hold return spring at 9 VDC and 100°F (38°C) or 8 lbs (35.6 N) at rated voltage</td>
<td>0.5&quot; (12.7 mm)</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>2370SP</td>
<td>√</td>
<td>12 lbs (53.4 N)</td>
<td>—</td>
<td>0.85&quot; (21.6 mm)</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>2370S</td>
<td>√</td>
<td>16 lbs (71.2 N)</td>
<td>—</td>
<td>0.85&quot; (21.6 mm)</td>
<td>28</td>
<td></td>
</tr>
</tbody>
</table>

*All 12 VDC/24 VDC except noted*
Dual Coil Solenoids

**Features:**
- Dual coil design for higher pull force in a smaller package than similar size single coil solenoid
- Customer-specified option to switch from high current “pull” operation to low current “hold” operation with internal mechanical switch or external electronic switch
- Hold coil provides continuous duty operation
- Hard chrome plated plunger and brass liner for smooth, reliable, wear-resistant operation, tested on one million cycles
- Corrosion resistant plated steel housing and mounting base/flange
- Choice of flange, threaded, or base mountings
- Electrical connections available with choice of screw or spade terminals, or wire/connectors
- Two different boot types available; bellows boot is tapered to eliminate expansion in tight spots; constant volume boot has no breather hole and so provides contaminant protection of the plunger and bore
**Solenoids**

**1500 Series**
Models 1502, 1502ES & 1504 dual coil solenoids

- **Pull Force Range:** 10-12 lbs (44-53 N)
- **Hold Force Range:** 19-28 lbs (85-125 N)

---

### Pull & Hold Rating Chart

<table>
<thead>
<tr>
<th>Model No.</th>
<th>Volts</th>
<th>Mounting Style</th>
<th>Plunger Type</th>
<th>Grounding Type</th>
<th>Termination Type</th>
<th>Boot Type</th>
<th>Return Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>1502</td>
<td>12</td>
<td>Flange</td>
<td>2 Ext. Thread</td>
<td>G Grounded</td>
<td>1 Screw</td>
<td>B1</td>
<td>S1 Light</td>
</tr>
<tr>
<td>1504</td>
<td>24</td>
<td>Base</td>
<td>6 Int. Thread</td>
<td>U Ungrounded 1504</td>
<td>3 Wire Leads</td>
<td>B4 Bel lows</td>
<td>B4 Bel lows</td>
</tr>
</tbody>
</table>

---

### Order Information:
Complete the following model descriptions to build your Order No.

1. **Model No.**
   - 1502
   - 1502ES
   - 1504
2. **Volts**
   - 12 VDC
   - 24 VDC
3. **Mounting Style**
   - Flange
   - Thread
   - Base
   - Flange
4. **Plunger Type**
   - Ext. Thread
   - Int. Thread
5. **Grounding Type**
   - G Grounded
   - U Ungrounded
6. **Termination Type**
   - 1 Screw
   - 2 Spade
   - 3 Wire Leads
7. **Boot Type**
   - B1 Constant Volume
   - B2 Bel lows
   - B4 Bel lows
8. **Return Spring**
   - S1 Light
   - S2 Medium

---

### When you order:
Add A to your order number for the Aux Terminal option available on internally switched models.

Certain combinations may not be standard models. Please contact factory to determine whether a custom-built model is required for your application.

---

*All rated voltage, 68ºF (20ºC), and 1” (25.4 mm) stroke*
1500 Series

Mounting Styles:

**MOUNTING STYLE A**

- Flange Mount
- Terminal Type 1 Screw #8-32 (2 places)
- Optional: Return Spring
- 1/4-28 Internal Thread
- Plunger Style 6 with Flange Mount
- Boot
- C.V. .5" [13 mm]
- 4.7" [120 mm]
- 1.3" [33 mm]
- 2.5" [64 mm]
- ø .28" [7.14 mm]
- ø 1.5" [38 mm]
- Thru Hole (2 places)

**MOUNTING STYLE B**

- Threaded Mount
- Terminal Type 2 Spade 1/4" (2 places)
- Plunger Style 2 with 1/4-28 External Thread (2 places)
- C.V. Boot
- .25" Female Quick Connect
- .375" [9.53 mm]
- 1.81" [45.9 mm]
- 2.58" [65.6 mm]
- 1.43" [36.2 mm]
- Wrench Flats
- 1.50" [38.1 mm]
- 5.25" [133.9 mm]
- 2.0" [50.8 mm]
- .13" [3.4 mm]
- 4.14" [105.0 mm]
- 1.81" [45.9 mm]
- 2.5" [63.5 mm]
- 1.00" [25.4 mm]

**MOUNTING STYLE C**

- Base Mount
- Coil Lead Color: Green
- Coil Lead Color: White
- .25" Female Quick Connect
- Plunger Style 2 with 1/4-28 External Thread
- C.V. Boot
- ø .27" [6.9 mm]
- .375" [9.53 mm]
- 1.50" [38.1 mm]
- ø 1.5" [38 mm]
- ø .96" [24.4 mm]

**MOUNTING STYLE D**

- Flange Mount
- Terminal Type 1 Screw #6-32 (2 places)
- Aux. Terminal Screw #6-32 (optional)
- Terminal Type 1 Screw #8-32 (2 places)
- Flange Mount
- Aux. Terminal Screw #6-32 (optional)
- Terminal Type 1 Screw #8-32 (2 places)
- Thru Hole (2 places)
- 4.7" [120 mm]
- ø 1.5" [38 mm]
- 1.3" [33 mm]
- 1.9" [48 mm]
- ø .25" [6.4 mm]
- .5" [13 mm]

Specifications:

- Temperature Range: -40°F to +250°F (-40˚C to +121˚C)
- Weight: 1.0 lbs (0.5 kg)

<table>
<thead>
<tr>
<th>Model</th>
<th>Rated Voltage</th>
<th>Rated Stroke</th>
<th>Pull Current</th>
<th>Hold Current</th>
<th>Pull Rating*</th>
<th>Hold Rating*</th>
<th>Coil Winding</th>
</tr>
</thead>
<tbody>
<tr>
<td>1502</td>
<td>12 VDC</td>
<td>1&quot; (25.4 mm)</td>
<td>30 A</td>
<td>0.7 A</td>
<td>10 lbs (44 N)</td>
<td>24 lbs (107 N)</td>
<td>Parallel</td>
</tr>
<tr>
<td>1502</td>
<td>24 VDC</td>
<td>1&quot; (25.4 mm)</td>
<td>16 A</td>
<td>0.24 A</td>
<td>10 lbs (44 N)</td>
<td>24 lbs (107 N)</td>
<td>Parallel</td>
</tr>
<tr>
<td>1502ES</td>
<td>12 VDC</td>
<td>1&quot; (25.4 mm)</td>
<td>30 A</td>
<td>0.7 A</td>
<td>10 lbs (44 N)</td>
<td>28 lbs (125 N)</td>
<td>Parallel</td>
</tr>
<tr>
<td>1502ES</td>
<td>24 VDC</td>
<td>1&quot; (25.4 mm)</td>
<td>16 A</td>
<td>0.24 A</td>
<td>10 lbs (44 N)</td>
<td>28 lbs (125 N)</td>
<td>Parallel</td>
</tr>
<tr>
<td>1504</td>
<td>12 VDC</td>
<td>1&quot; (25.4 mm)</td>
<td>41 A</td>
<td>0.76 A</td>
<td>12 lbs (53 N)</td>
<td>19 lbs (85 N)</td>
<td>Parallel</td>
</tr>
<tr>
<td>1504</td>
<td>24 VDC</td>
<td>1&quot; (25.4 mm)</td>
<td>22 A</td>
<td>0.37 A</td>
<td>12 lbs (53 N)</td>
<td>19 lbs (85 N)</td>
<td>Parallel</td>
</tr>
</tbody>
</table>

*At rated voltage, 68°F (20°C), and 1" (25.4 mm) stroke

Specifications are for reference only.
Solenoids

1750 Series
Models 1751, 1751ES, 1753 & 1753ES
dual coil solenoids
Pull Force Range: 19-25 lbs (85-111 N)
Hold Force Range: 38-43 lbs (169-191 N)

Order Information: Complete the following model descriptions to build your Order No.

Model No. – ( ) – ( ) – ( ) – ( ) – ( ) – ( ) – ( )

-1751
12 VDC
-24 VDC
1751ES
-24 VDC
1753
1753ES

Volts
Mounting Style
Plunger Type
Grounding Style (No. of Terminals)
Termination Type
Boot Type
Return Spring (Force @ 1”)

-2 Ext. Thread ½-28
-1 Screw (1751 and 1753 only)
B1 Constant Volume Silicone Rubber
S1 Light 4-6 lbs

-3 Ext. Thread M-6
2 Spade (1751 and 1753 only)
B2 Bellows Silicone Rubber
S5 Medium 7-11 lbs

-6 Int. Thread ½-28
L 3 Wire Leads
B4 Bellows Silicone Rubber
Available on 1751 and 1751ES only

-7 Int. Thread M-6
C Connector attached to 3 Wire Leads
Note: Contact factory for type and availability

When you order: Add A to your order number for the Aux Terminal option available on internally switched models. Certain combinations may not be standard models. Please contact factory to determine whether a custom-built model is required for your application.

Rated Voltage
Pull Rating
Hold Rating

<table>
<thead>
<tr>
<th>Model</th>
<th>Rated Voltage</th>
<th>Pull Rating</th>
<th>Hold Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1751</td>
<td>12/24 VDC</td>
<td>24 lbs (107 N)</td>
<td>38 lbs (169 N)</td>
</tr>
<tr>
<td>1751ES</td>
<td>12/24 VDC</td>
<td>25 lbs (111 N)</td>
<td>43 lbs (187 N)</td>
</tr>
<tr>
<td>1753</td>
<td>12/24 VDC</td>
<td>19 lbs (85 N)</td>
<td>42 lbs (187 N)</td>
</tr>
<tr>
<td>1753ES</td>
<td>12/24 VDC</td>
<td>20 lbs (89 N)</td>
<td>43 lbs (191 N)</td>
</tr>
</tbody>
</table>

*At rated voltage, 68ºF (20ºC), and 1” (25.4 mm) stroke
## Mounting Styles:

### MOUNTING STYLE A

- **Flange Mount**
- **Plunger Style 6** with 1/4-28 internal thread
- **C.V. Boot**
- **Specifications**
  - Temperature Range: -40°F to +250°F
  - Weight: 1.5 lbs (0.7 kg)

<table>
<thead>
<tr>
<th>Model</th>
<th>Rated Voltage</th>
<th>Rated Stroke</th>
<th>Pull Current</th>
<th>Hold Current</th>
<th>Pull Rating*</th>
<th>Hold Rating*</th>
<th>Winding</th>
</tr>
</thead>
<tbody>
<tr>
<td>1751</td>
<td>12 VDC</td>
<td>1” (25.4 mm)</td>
<td>46 A</td>
<td>1.3 A</td>
<td>24 lbs (107 N)</td>
<td>38 lbs (169 N)</td>
<td>Parallel</td>
</tr>
<tr>
<td>1751</td>
<td>24 VDC</td>
<td>1” (25.4 mm)</td>
<td>25 A</td>
<td>0.5 A</td>
<td>24 lbs (107 N)</td>
<td>38 lbs (169 N)</td>
<td>Parallel</td>
</tr>
<tr>
<td>1751ES</td>
<td>12 VDC</td>
<td>1” (25.4 mm)</td>
<td>46 A</td>
<td>1.1 A</td>
<td>25 lbs (111 N)</td>
<td>41 lbs (182 N)</td>
<td>Parallel</td>
</tr>
<tr>
<td>1751ES</td>
<td>24 VDC</td>
<td>1” (25.4 mm)</td>
<td>25 A</td>
<td>0.5 A</td>
<td>25 lbs (111 N)</td>
<td>41 lbs (182 N)</td>
<td>Parallel</td>
</tr>
<tr>
<td>1753</td>
<td>12 VDC</td>
<td>1” (25.4 mm)</td>
<td>33 A</td>
<td>0.8 A</td>
<td>19 lbs (85 N)</td>
<td>42 lbs (187 N)</td>
<td>Parallel</td>
</tr>
<tr>
<td>1753</td>
<td>24 VDC</td>
<td>1” (25.4 mm)</td>
<td>18 A</td>
<td>0.4 A</td>
<td>19 lbs (85 N)</td>
<td>42 lbs (187 N)</td>
<td>Parallel</td>
</tr>
<tr>
<td>1753ES</td>
<td>12 VDC</td>
<td>1” (25.4 mm)</td>
<td>33 A</td>
<td>0.8 A</td>
<td>20 lbs (89 N)</td>
<td>43 lbs (191 N)</td>
<td>Parallel</td>
</tr>
<tr>
<td>1753ES</td>
<td>24 VDC</td>
<td>1” (25.4 mm)</td>
<td>18 A</td>
<td>0.4 A</td>
<td>20 lbs (89 N)</td>
<td>43 lbs (191 N)</td>
<td>Parallel</td>
</tr>
</tbody>
</table>

*At rated voltage, 68°F (20°C), and 1” (25.4 mm) stroke

### MOUNTING STYLE E

- **Base Mount**
- **Plunger Style 2** with 1/4-28 external thread
- **Specifications**
  - Temperature Range: -40°F to +250°F
  - Weight: 1.5 lbs (0.7 kg)

### Specifications:

- **Temperature Range**: -40°F to +250°F (-40°C to +121°C)
- **Weight**: 1.5 lbs (0.7 kg)
**Solenoids**

**1750 Push Series**
Models 1756ES, 1756ESDB, 1757ES & 1757ESDB dual coil solenoids.
Externally switched push models available with double boot
Push Force Range: 16-26 lbs (71-116 N)
Hold Force Range: 35-56 lbs (156-249 N)

**Return Spring**

<table>
<thead>
<tr>
<th>Model</th>
<th>Rated Voltage</th>
<th>Push Rating 1 @ 1”</th>
<th>Hold Rating*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1756ES</td>
<td>12/24 VDC</td>
<td>26 lbs (116 N)</td>
<td>35 lbs (156 N)</td>
</tr>
<tr>
<td>1756ESDB</td>
<td>12/24 VDC</td>
<td>20 lbs (89 N)</td>
<td>37 lbs (165 N)</td>
</tr>
<tr>
<td>1757ES</td>
<td>12/24 VDC</td>
<td>22 lbs (99 N)</td>
<td>37 lbs (165 N)</td>
</tr>
<tr>
<td>1757ESDB</td>
<td>12/24 VDC</td>
<td>16 lbs (71 N)</td>
<td>56 lbs (249 N)</td>
</tr>
</tbody>
</table>

*All rated voltage, 68ºF (20ºC), and 1” (25.4 mm) stroke

**Order Information:** Complete the following model descriptions to build your Order No.

<table>
<thead>
<tr>
<th>Model No.</th>
<th>Volts</th>
<th>Mounting Style</th>
<th>Plunger Type</th>
<th>Grounding (No. of Terminals)</th>
<th>Termination Type</th>
<th>Boot Type</th>
<th>Return Spring (Force @ 1”)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1756ES</td>
<td>12</td>
<td>A Flange</td>
<td>2 Ext. Thread</td>
<td>U Ungrounded (3 Terminals or Wire Leads)</td>
<td>3 Wire Leads</td>
<td>B1 Constant Volume Silicone Rubber</td>
<td>B2 Bellows Silicone Rubber</td>
</tr>
<tr>
<td>1756ESDB</td>
<td>24</td>
<td>E Base</td>
<td>3 Ext. Thread</td>
<td>M-6 Ungrounded (3 Terminals or Wire Leads)</td>
<td>3 Wire Leads</td>
<td>B2 Bellows Silicone Rubber</td>
<td>B5 Medium (1.1 lb) Available on 1756ES and 1756ESDB only</td>
</tr>
<tr>
<td>1757ES</td>
<td>12</td>
<td>A Flange</td>
<td>2 Ext. Thread</td>
<td>M-6 Ungrounded (3 Terminals or Wire Leads)</td>
<td>3 Wire Leads</td>
<td>C Connector attached to 3 Wire Leads Note: Contact factory for type and availability</td>
<td>B4 Bellows Silicone Rubber</td>
</tr>
<tr>
<td>1757ESDB</td>
<td>24</td>
<td>E Base</td>
<td>3 Ext. Thread</td>
<td>M-6 Ungrounded (3 Terminals or Wire Leads)</td>
<td>3 Wire Leads</td>
<td>C Connector attached to 3 Wire Leads Note: Contact factory for type and availability</td>
<td>B4 Bellows Silicone Rubber</td>
</tr>
</tbody>
</table>

**When you order:** Certain combinations may not be standard models. Please contact factory to determine whether a custom-built model is required for your application.
1750 Push Series

Mounting Styles:

**MOUNTING STYLE A**

- **Flange Mount**: External Switch
  - Specifications:
    - Temperature Range: -40˚F to +250˚F (-40˚C to +121˚C)
    - Weight: 1.5 lbs (0.7 kg)
  - Models:
    |---------|---------------|--------------|--------------|--------------|--------------|--------------|--------------|
    | 1756ES  | 12 VDC        | 1" (25.4 mm) | 46 A         | 1.1 A        | 26 lbs (116 N) | 35 lbs (156 N) | Parallel     |
    | 1756ES  | 24 VDC        | 1" (25.4 mm) | 25 A         | 0.5 A        | 26 lbs (116 N) | 35 lbs (156 N) | Parallel     |
    | 1756ESDB| 12 VDC        | 1" (25.4 mm) | 46 A         | 1.1 A        | 20 lbs (89 N)  | 53 lbs (236 N) | Parallel     |
    | 1756ESDB| 24 VDC        | 1" (25.4 mm) | 25 A         | 0.5 A        | 20 lbs (89 N)  | 53 lbs (236 N) | Parallel     |
    | 1757ES  | 12 VDC        | 1" (25.4 mm) | 33 A         | 0.8 A        | 20 lbs (89 N)  | 37 lbs (165 N) | Parallel     |
    | 1757ES  | 24 VDC        | 1" (25.4 mm) | 18 A         | 0.4 A        | 20 lbs (89 N)  | 37 lbs (165 N) | Parallel     |
    | 1757ESDB| 12 VDC        | 1" (25.4 mm) | 33 A         | 0.8 A        | 16 lbs (71 N)  | 56 lbs (249 N) | Parallel     |
    | 1757ESDB| 24 VDC        | 1" (25.4 mm) | 18 A         | 0.4 A        | 16 lbs (71 N)  | 56 lbs (249 N) | Parallel     |

*At rated voltage, 68˚F (20˚C), and 1" (25.4 mm) stroke

Specifications are for reference only.
2000 Series
dual coil solenoids
Pull Force Range: 21-29 lbs (93-129 N)
Hold Force Range: 41-51 lbs (182-227 N)

Stroke – in (mm)
0.1 (2.54)
0.2 (5.08)
0.3 (7.62)
0.4 (10.16)
0.5 (12.70)
0.6 (15.24)
0.7 (17.78)
0.8 (20.32)
0.9 (22.86)
1.0 (25.4)

Force – lbs (N)
2003ES
2003
2001ES
2001
Spring 4
Spring 2
Spring 1

Order Information: Complete the following model descriptions to build your Order No.

Volts 12 24 12 24
Mounting Style E S Flange
Plunger Type 2 Ext. Thread 14-28
3 Ext. Thread M-6
6 Int. Thread M-6
7 Int. Thread M-6

Grounding (No. of Terminals) G Grounded (1 Terminal)
U Ungrounded 2001 and 2003
2001ES and 2003ES
(3 Terminals or Wire Leads)

Termination Type 1 Screw

Boot Type B1 Constant Volume Silicone Rubber
B2 Bellows Silicone Rubber
B3 Constant Volume Silicone Rubber
B4 Bellows Silicone Rubber
B5 Constant Volume Silicone Rubber

C Connector attached to 3 Wire Leads
Note: Contact factory for type and availability.
2001ES and 2003ES only

Return Spring (Force @ 1")
S1 Light 4-8 lbs
S2 Medium 8-14 lbs
S4 Heavy 14-17 lbs

*Flange mounting not available for ES models.

When you order: Add A to your order number for the Aux Terminal option or C for the Conduit Cover available on internally switched models. Certain combinations may not be standard models. Please contact factory to determine whether a custom-built model is required for your application.

Flange mounting not available for ES models.

*At rated voltage, 68ºF (20ºC), and 1" (25.4 mm) stroke

Rated Pull Hold
Model Voltage Rating* Rating*
2001 12/24 VDC 21 lbs (93N) 49 lbs (218 N)
2001ES 12/24 VDC 22 lbs (98 N) 43 lbs (191 N)
2003 12/24 VDC 26 lbs (116 N) 51 lbs (227 N)
2003ES 12/24 VDC 29 lbs (129 N) 41 lbs (182 N)

*All-rated voltage, 68ºF (20ºC), and 1" (25.4 mm) stroke

When you order: Add A to your order number for the Aux Terminal option or C for the Conduit Cover available on internally switched models. Certain combinations may not be standard models. Please contact factory to determine whether a custom-built model is required for your application.
Specifications:

<table>
<thead>
<tr>
<th>Model</th>
<th>Rated Voltage</th>
<th>Rated Stroke</th>
<th>Pull Current</th>
<th>Hold Current</th>
<th>Pull Rating*</th>
<th>Hold Rating*</th>
<th>Coil Winding</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>12 VDC</td>
<td>1&quot; (25.4 mm)</td>
<td>44 A</td>
<td>0.6 A</td>
<td>21 lbs (93 N)</td>
<td>49 lbs (218 N)</td>
<td>Series</td>
</tr>
<tr>
<td>2001</td>
<td>24 VDC</td>
<td>1&quot; (25.4 mm)</td>
<td>23 A</td>
<td>0.3 A</td>
<td>21 lbs (93 N)</td>
<td>49 lbs (218 N)</td>
<td>Series</td>
</tr>
<tr>
<td>2001ES</td>
<td>12 VDC</td>
<td>1&quot; (25.4 mm)</td>
<td>44 A</td>
<td>0.6 A</td>
<td>22 lbs (98 N)</td>
<td>43 lbs (191 N)</td>
<td>Parallel</td>
</tr>
<tr>
<td>2001ES</td>
<td>24 VDC</td>
<td>1&quot; (25.4 mm)</td>
<td>23 A</td>
<td>0.3 A</td>
<td>22 lbs (98 N)</td>
<td>43 lbs (191 N)</td>
<td>Parallel</td>
</tr>
<tr>
<td>2003</td>
<td>12 VDC</td>
<td>1&quot; (25.4 mm)</td>
<td>60 A</td>
<td>0.8 A</td>
<td>26 lbs (116 N)</td>
<td>51 lbs (227 N)</td>
<td>Series</td>
</tr>
<tr>
<td>2003</td>
<td>24 VDC</td>
<td>1&quot; (25.4 mm)</td>
<td>37 A</td>
<td>0.4 A</td>
<td>26 lbs (116 N)</td>
<td>51 lbs (227 N)</td>
<td>Series</td>
</tr>
<tr>
<td>2003ES</td>
<td>12 VDC</td>
<td>1&quot; (25.4 mm)</td>
<td>62 A</td>
<td>0.9 A</td>
<td>29 lbs (129 N)</td>
<td>41 lbs (182 N)</td>
<td>Parallel</td>
</tr>
<tr>
<td>2003ES</td>
<td>24 VDC</td>
<td>1&quot; (25.4 mm)</td>
<td>39 A</td>
<td>0.5 A</td>
<td>29 lbs (129 N)</td>
<td>41 lbs (182 N)</td>
<td>Parallel</td>
</tr>
</tbody>
</table>

*At rated voltage, 68°F (20°C), and 1" (25.4 mm) stroke

Specifications are for reference only.
2370 Series
Models 2370 and 2370ES dual coil solenoids
Pull Force Range: 37-39 lbs (165-173 N)
Hold Force Range: 88-92 lbs (391-409 N)

Solenoids 2370 Series

2370
2370ES

Model | Rated Voltage | Pull Rating* | Hold Rating*
-----|--------------|-------------|-------------
2370  | 12/24 VDC    | 37 lbs (165 N) | 38 lbs (391 N) |
2370ES| 12/24 VDC    | 39 lbs (173 N) | 88 lbs (391 N) |

*All rated voltage, 68ºF (20ºC) and 1.5” (38.1 mm) stroke

Return Spring
Model  | Force @ 1”
-------|-------------
23 Light  | 17.6-26.0 lbs

Order Information:
Complete the following model descriptions to build your Order No.

When you order: Add A to your order number for the Aux Terminal option available on internally switched models. Certain combinations may not be standard models. Please contact factory to determine whether a custom-built model is required for your application.
Mounting Styles:

**MOUNTING STYLE E**

- Base Mount
- Plunger Style 2 with 5/16-24 External Thread
- Return Spring
- Optional-
  - Terminal Type 1 Screw #8-32 (2 places)
  - Aux. Terminal Screw #6-32

**MOUNTING STYLE E**

- Base Mount / External Switch
- Plunger Style 2 with 5/16-24 External Thread
- Optional-
  - Terminal Type 1 Screw #8-32

Specifications:

<table>
<thead>
<tr>
<th>Model</th>
<th>Rated Voltage</th>
<th>Rated Stroke</th>
<th>Pull Current</th>
<th>Hold Current</th>
<th>Pull Rating*</th>
<th>Hold Rating*</th>
<th>Coil Winding</th>
</tr>
</thead>
<tbody>
<tr>
<td>2370</td>
<td>12 VDC</td>
<td>1.5&quot; (38.1 mm)</td>
<td>58 A</td>
<td>1.7 A</td>
<td>37 lbs (165 N)</td>
<td>88 lbs (391 N)</td>
<td>Series</td>
</tr>
<tr>
<td>2370</td>
<td>24 VDC</td>
<td>1.5&quot; (38.1 mm)</td>
<td>31 A</td>
<td>0.6 A</td>
<td>37 lbs (165 N)</td>
<td>88 lbs (391 N)</td>
<td>Series</td>
</tr>
<tr>
<td>2370ES</td>
<td>12 VDC</td>
<td>1.5&quot; (38.1 mm)</td>
<td>58 A</td>
<td>1.7 A</td>
<td>39 lbs (173 N)</td>
<td>92 lbs (409 N)</td>
<td>Parallel</td>
</tr>
<tr>
<td>2370ES</td>
<td>24 VDC</td>
<td>1.5&quot; (38.1 mm)</td>
<td>31 A</td>
<td>0.6 A</td>
<td>39 lbs (173 N)</td>
<td>92 lbs (409 N)</td>
<td>Parallel</td>
</tr>
</tbody>
</table>

*At rated voltage, 68°F (20°C) and 1.5" (38.1 mm) stroke

Specifications are for reference only.
Cable Solenoid
Patented, remote cable link solenoid can be used for throttle advance or shutdown requirements. Ideal for applications with space restrictions, extremely hot environments or excessive vibration.

Features:
- Remote mount for installation away from constrained or hostile environments
- Assembled with Model 2003ES high-force solenoid
- 8-14 pound return spring standard for start/stop applications.
- Heavy-duty cable withstands temperature ranges of -63°F to +250°F (-53°C to +121°C)
- Spherical rod end with 0.237” (6 mm) diameter hole
- Corrosion resistant plated steel housing and mounting
- Coils are potted to seal entire solenoid for reliable service under extreme vibration, temperature, dirt, and moisture conditions
- Options include connectors, flexible conduit over leads, and Coil Commander™ solenoid protection modules
- Patented

Solenoid Model 2003ES Features:
- 12 or 24 VDC
- Base mount
- Ungrounded 3-wire leads
- Return spring 8 lbs (3.6 kg) at rated voltage, 68°F (20°C) and 1” (25.4 mm) stroke

Order Information:

<table>
<thead>
<tr>
<th>ORDER NO.</th>
<th>Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA-4744-12</td>
<td>12 VDC</td>
</tr>
<tr>
<td>SA-4744-24</td>
<td>24 VDC</td>
</tr>
</tbody>
</table>

E.E.C. Directive Compliance: All parts supplied by Woodward are classified as components, and therefore are not “CE” marked. Please contact factory direct for details on specific product compliance with 89/336/EEC and 89/392/EEC directives.
Specifications:
At rated voltage, 68°F (20°C)
and .964" (24.5 mm) stroke

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Pull Current</th>
<th>Hold Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 VDC</td>
<td>61.8 A</td>
<td>0.85 A</td>
</tr>
<tr>
<td>24 VDC</td>
<td>39.0 A</td>
<td>0.46 A</td>
</tr>
</tbody>
</table>

| Pull Force | 29 lbs (129 N) |
| Hold Force | 41 lbs (182 N) |

| Cable Length | 41.08" (1043.4 mm) |
| Total Length | 50.4" (1280.1 mm) |

Specifications are for reference only.
Single Coil Solenoids

1000S Series
Locking Solenoid
Heavy-duty locks designed for side-load resistance in hydraulic or mechanical applications. Plunger can withstand 1500 pounds of side load in the de-energized position.

Features:
• Single coil construction for simple electrical interface
• Hardened, stainless steel pin resists high shear load and increases fatigue resistance
• Nickel plated plunger ensures smooth, reliable operation, as well as corrosion and wear resistance
• Protective brass liner plunger bore provides longer operating life
• Rugged construction allows for operation under the most severe temperature and vibration conditions
• Easy installation—no brackets or linkages necessary

Order Information:

<table>
<thead>
<tr>
<th>ORDER NO.</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA-4971</td>
<td>Continuous</td>
</tr>
<tr>
<td>SA-4972</td>
<td>PWM</td>
</tr>
</tbody>
</table>

E.E.C. Directive Compliance: All parts supplied by Woodward Products are classified as components, and therefore are not "CE" marked. Please contact factory direct for details on specific product compliance with 89/336/EEC and 89/392/EEC directives.
## 1000S Series Locking Solenoid

### Dimensions

- 3/4-16 UNF-2A External Thread
- Corners Rounded to ø1.094" [6 mm]
- O-Ring/O-Ring Groove Conform to SAE J1926/3 and SAE J515 for Thread Listed.
- 0.1917" [4.869 mm]
- 0.17" [4.3 mm]
- Travel Ref.: 0.50" [12.7 mm]
- 0.16" Ref: 0.487" [12.37 mm]
- (Energized) 0.657" [16.69 mm]
- (De-energized) 0.487" [12.37 mm]
- Ø1.00" [25.4 mm] Max
- 7.0" [178 mm] x 1.93"

### Specifications

#### Specifications:

<table>
<thead>
<tr>
<th></th>
<th>SA-4971</th>
<th>SA-4972</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Voltage</td>
<td>12 VDC</td>
<td>12 VDC</td>
</tr>
<tr>
<td>Rated Temperature</td>
<td>68°F (20°C)</td>
<td>68°F (20°C)</td>
</tr>
<tr>
<td>Temperature Range</td>
<td>-40°F to +185°F (-40°C to +85°C)</td>
<td>-40°F to +235°F (-40°C to +113°C)</td>
</tr>
<tr>
<td>Rated Stroke</td>
<td>0.17&quot; (4.32 mm)</td>
<td>0.17&quot; (4.32 mm)</td>
</tr>
<tr>
<td>Pull Current</td>
<td>100% duty @ 0.7 A</td>
<td>2 A max for 0.2 sec</td>
</tr>
<tr>
<td>Hold Current</td>
<td>100% duty @ 0.7 A</td>
<td>PWM 1.0 A average</td>
</tr>
<tr>
<td>Duty Cycle</td>
<td>100% @ 15.5 VDC max and 185°F (85°C)</td>
<td>15% @ 16 VDC</td>
</tr>
<tr>
<td>Pull Force</td>
<td>Solenoid must pull in plunger against return spring at 9.5 VDC and 320°F (160°C) coil temperature, with no side load on plunger pin</td>
<td>Solenoid must pull in plunger against return spring at 9.5 VDC and 235°F (113°C) within 200 msec, with no side load on plunger pin</td>
</tr>
<tr>
<td>Hold Force</td>
<td>Solenoid must hold in plunger against return spring at 9.5 VDC and 320°F (160°C) coil temperature</td>
<td>Solenoid must hold in plunger against return spring at 16 VDC, 15% duty cycle, 1000 Hz PWM signal, and 235°F (113°C)</td>
</tr>
<tr>
<td>Pull Coil Resistance</td>
<td>17.8 ohms ± 10%</td>
<td>5.55 ohms ± 5%</td>
</tr>
</tbody>
</table>

Specifications are for reference only.
1503S Series
Typically designed for continuous duty, with single coil performing both the pull and hold function for the solenoid.

Features:
• Continuous duty operation
• Hard chrome plated plunger for smooth, reliable, wear-resistant operation
• Brass liner plunger bore for long life
• Corrosion resistant plated steel housing and mounting base/flange
• Potted coil construction
• Variety of options for mounting bases/flanges, plungers, terminations, boots, and springs
• 100% inspected and factory tested

Order Information:

<table>
<thead>
<tr>
<th>ORDER NO.</th>
<th>Model</th>
<th>Termination</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA-4741</td>
<td>OT51</td>
<td>Leads</td>
</tr>
</tbody>
</table>

E.E.C. Directive Compliance: All parts supplied by Woodward Products are classified as components, and therefore are not "CE" marked. Please contact factory direct for details on specific product compliance with 89/336/EEC and 89/392/EEC directives.
1503S Series

Specifications:

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Voltage</td>
<td>12 VDC</td>
</tr>
<tr>
<td>Rated Current</td>
<td>4.7 A</td>
</tr>
<tr>
<td>Rated Temperature</td>
<td>68°F (20°C)</td>
</tr>
<tr>
<td>Temperature Range</td>
<td>-20°F to +250°F (-29°C to +121°C)</td>
</tr>
<tr>
<td>Nominal Rated Stroke</td>
<td>0.5&quot; (12.7 mm)</td>
</tr>
<tr>
<td>Pull Force</td>
<td>Must pull in against return spring at 9 VDC and 100°F (38°C) or 2.25 lbs min. (10 N) at rated voltage</td>
</tr>
<tr>
<td>Hold Force</td>
<td>Must hold return spring at 9 VDC and 100°F (38°C) or 8 lbs (35.6 N) at rated voltage</td>
</tr>
<tr>
<td>Nominal Spring Return</td>
<td>De-energized: 1.16 ± 0.16 lbs (5.16 ± 0.71 N)</td>
</tr>
<tr>
<td></td>
<td>Energized: 1.56 ± 0.25 lbs (6.94 ± 1.11 N)</td>
</tr>
<tr>
<td>Pull Coil Resistance</td>
<td>2.53 ohms ± 10%</td>
</tr>
<tr>
<td>Duty Cycle</td>
<td>Intermittent, 25% duty cycle, 5 minutes maximum ON time</td>
</tr>
<tr>
<td>Vibration</td>
<td>15 G’s @ 50-500 Hz</td>
</tr>
<tr>
<td>Shock</td>
<td>200 G’s, 0-peak @ 21 Hz</td>
</tr>
</tbody>
</table>

Specifications are for reference only.