Solenoid Components for Control Systems

Solenoids • Solenoid Accessories • Solenoid Shutdown Kits
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- Mitsubishi L
- RSV Zexel Nippondenso
Custom Solutions

Engines run in hot, dirty places. In hazardous environments. In submerged conditions. For long continuous hours or for very intense intermittent times.

Woodward knows that your engine’s control system has to work perfectly—no matter where that engine is running or what it is running. That’s why OEMs team up with Woodward engineers when solenoids are key components of their control systems.

This collaboration results in components uniquely tailored for the job at hand.

Typical Custom Solutions for...

...Engine Control Systems

**Woodward Air Valve Shutoff Solenoid**

Diesel engine runaway, caused by the presence of combustible gases in engine intake air, can result in serious consequence. Woodward designed and manufactured a diesel engine air shutoff valve solenoid to eliminate intake air. The solenoid, built for an engine OEM, allows the safe operation of engines in hazardous environments.

**Woodward Air Vent Control Solenoid**

Railroad cars and refrigerated trucks hauling produce must combat the buildup of carbon dioxide in order to prevent the cargo from rot. Woodward designed and manufactured an air vent control solenoid that allows fresh air to flow over produce while being transported by train or truck.
Typical Custom Solutions for...

...Engine Brake Systems

**Woodward Integrated Solenoid Valve**

A compression release engine brake system reduces vehicle speed via an exhaust valve that allows pressure to escape instead of returning energy back to the piston. Woodward designed and manufactured a solenoid valve that opens and closes the brake system exhaust valve for an Asian OEM’s new line of 224 kW to 299 kW (300 hp to 400 hp) on-highway diesel engines.

...Switchgear Controls

**Woodward Bi-directional Solenoid**

Electrical power switchgear requires a high force (445 N [100 lbf]), low stroke (6.35mm [1/4”]) motion to push a spring loaded switch over center to make and break a circuit. Woodward designed and manufactured a bi-directional solenoid to open or close the voltage switch on a vacuum capacitor switch.

...Locking Assemblies

**Woodward Spool Lock Solenoid**

Construction equipment runs in hot, dirty, high-vibration environments and needs rugged components as locking mechanisms. Woodward designed and manufactured a spool lock solenoid for a skid steer loader OEM that withstands 1500 lbs of side load resistance.

When solenoids are key components of your control systems, put Woodward on your design team. Contact your Woodward representative to learn more about our engine control solutions.
Woodward’s new MagAssist™ solenoid delivers high return force with low power input, using less energy than typical dual-coil solenoids. Its patented, single-coil design uses a permanent magnet with bi-directional assist to achieve both pull and hold functions.

While de-energized, the solenoid plunger remains attracted to the permanent magnet to maintain position. When energized, the permanent magnet enhances the pull-in force.

By eliminating the need for high current switching or electronic switch assemblies, the MagAssist can significantly reduce system costs.

The MagAssist would be an ideal choice for an industrial, under-the-hood application where voltage is 12 Vdc; rated current is 2.6 A; stroke is approx 6mm (1/4”); and return force requirements are up to 20 N (4.5 lbf).

To see if the MagAssist would be ideal for your engine, contact Woodward with your specific requirements.
MagAssist Reduces Cost of Control Systems by Simplifying Components and Connections

This fuel system uses a dual-coil solenoid with electronics for switching the pull and hold coils. It requires a dedicated relay for the fuel solenoid, a timing module with associated connections, and a dual-coil fuel shutoff solenoid.

This fuel system uses a MagAssist solenoid which eliminates the need for switching electronics. The MagAssist will result in a reduction of total system costs and improved reliability.
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.
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 second 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.
Solenoid Selection Factors

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: $F = Fo \times fv \times ft$  or  $F = 9 \times 1.0 \times .83 = 7.47$ 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>Voltage</th>
<th>Wire Thickness</th>
<th>12 VDC</th>
<th>24 VDC</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 AWG/1.5 mm²</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>14 AWG/2.5 mm²</td>
<td>12' (3.7 m)</td>
<td>40' (12.2 m)</td>
<td>9' (2.7 m)</td>
</tr>
<tr>
<td>12 AWG/4.0 mm²</td>
<td>19' (5.8 m)</td>
<td>64' (19.5 m)</td>
<td>14' (4.3 m)</td>
</tr>
<tr>
<td>10 AWG/6.0 mm²</td>
<td>20' (6.1 m)</td>
<td>102' (31.1 m)</td>
<td>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</td>
<td>6A</td>
</tr>
<tr>
<td>24 VDC</td>
<td>8A</td>
<td>6A</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.
Solenoid Selection Guide
A guide to help you in the selection of Woodward’s wide range of 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 Selection Guide

## Solenoid Overview Chart:

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

*All 12 Vdc/24 Vdc except where 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
**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)

<table>
<thead>
<tr>
<th>Model</th>
<th>Rated Voltage</th>
<th>Pull Rating*</th>
<th>Hold Rating*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1502</td>
<td>12/24 Vdc</td>
<td>10 lbs (44 N)</td>
<td>24 lbs (107 N)</td>
</tr>
<tr>
<td>1502ES</td>
<td>12/24 Vdc</td>
<td>10 lbs (44 N)</td>
<td>28 lbs (125 N)</td>
</tr>
<tr>
<td>1504</td>
<td>12/24 Vdc</td>
<td>12 lbs (53 N)</td>
<td>19 lbs (85 N)</td>
</tr>
</tbody>
</table>

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

**Return Spring**

<table>
<thead>
<tr>
<th>Model</th>
<th>Force @ 1”</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1 Light</td>
<td>2.0-6.7 lbs (8.9-29.8 N)</td>
</tr>
<tr>
<td>S2 Medium</td>
<td>4.0-8.4 lbs (17.8-37.4 N)</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>( ) -</th>
<th>( )</th>
<th>( )</th>
<th>( )</th>
<th>( )</th>
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<th>( )</th>
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<th>( )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model No.</td>
<td>Volts</td>
<td>Mounting Style</td>
<td>Plunger Type</td>
<td>Grounding (No. of Terminals)</td>
<td>Termination Type</td>
<td>Boot Type</td>
<td>Return Spring (Force @ 1”)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1502</td>
<td>12</td>
<td>A Flange</td>
<td>2 Ext. Thread M-6</td>
<td>G Grounded (1 Terminal)</td>
<td>1 Screw</td>
<td>B1 Constant Volume</td>
<td>S1 Light (2.0-6.7 lbs)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1504</td>
<td>24</td>
<td>C Base</td>
<td>7 Int. Thread M-6</td>
<td>3 Wire Leads</td>
<td>2 Spade</td>
<td>B2 Bellows</td>
<td>S2 Medium (4.0-8.4 lbs)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1502ES</td>
<td>24</td>
<td>B Thread</td>
<td>3 Ext. Thread M-6</td>
<td>U Ungrounded 1502 and 1504: (2 Terminals) 1502ES: (3 Terminals or Wire Leads)</td>
<td>1 Screw</td>
<td>B3 Bellows</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6 Int. Thread M-6</td>
<td>3 Wire Leads</td>
<td>2 Spade</td>
<td>B4 Bellows</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**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.
1500 Series

Mounting Styles:

**MOUNTING STYLE A**

Flange Mount

- TERMINAL TYPE 1 SCREW #8-32 (2-PLACES)
- FLANGE MOUNT
- RETURN SPRING -OPTIONAL-
- PLUNGER STYLE 6 WITH 1/4-28 INTERNAL THREAD
- ø.28” [7.14 mm]
- ø1.5” [38 mm]
- 4.7” [120 mm]
- ø1.3” [33 mm]
- C.V. BOOT

**MOUNTING STYLE B**

Threaded Mount

- TERMINAL TYPE 2 SPADE 1/4” (2-PLACES)
- 1”-20 EXTERNAL THREAD MOUNT
- ø1.5” [38 mm]
- 5.5” [140 mm]
- ø.25” [6.4 mm]
- ø1.9” [48 mm]

**MOUNTING STYLE C**

Base Mount

- 25° Female Quick Connect
- ø0.96” [24.4 mm]
- ø1.5” [38 mm]
- ø1.3” [33 mm]
- ø1.9” [48 mm]
- ø0.25” [6.4 mm]

**MOUNTING STYLE D**

Flange Mount

- TERMINAL TYPE 1 SCREW #8-32 (2-PLACES)
- FLANGE MOUNT
- RETURN SPRING -OPTIONAL-
- ø1.5” [38 mm]
- ø2.5” [63.5 mm]
- ø.28” [7.14 mm]
- ø1.3” [33 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” (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” (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” (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” (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” (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” (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.

e-mail: icinfo@woodward.com
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)

<table>
<thead>
<tr>
<th>Model</th>
<th>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>41 lbs (182 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, 68°F (20°C), and 1" (25.4 mm) stroke

Return Spring
Model | Force @ 1"
---|---
S1 Light | 4-8 lbs (17.8-35.6 N)
S5 Medium | 7-11 lbs (31.1-48.9 N)

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

( ) - ( ) ( ) ( ) ( ) ( ) ( ) ( ) ( )
Model No. Volts Mounting Style Plunger Type Grounding (No. of Terminals) Termination Type Boot Type Return Spring (Force @ 1")
1751 12/24 Vdc A Ext. Thread ¼-28 Ungrounded
1751ES 24/24 Vdc E Ext. Thread M-6
1753 M-6
1753ES M-6

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 A

**Flange Mount**

- Flange Mount
- RETURN SPRING -OPTIONAL-
- PLUNGER STYLE 6 WITH 1/4-28 INTERNAL THREAD
- C.V. BOOT
- ø2.50" [63.5 mm]
- ø1.75" [44.5 mm]
- .5" [13 mm]
- 7.0" [178 mm]
- ø1.75" [44.5 mm]
- 4.7" [119 mm]
- 5.0" [127 mm]
- ø.281" [7.14 mm] SLOT (2-PLACES)

### MOUNTING STYLE A

**Flange Mount / External Switch**

- Flange Mount / External Switch
- RETURN SPRING -OPTIONAL-
- PLUNGER STYLE 6 WITH 1/4-28 INTERNAL THREAD
- C.V. BOOT
- ø2.50" [63.5 mm]
- ø1.75" [44.5 mm]
- .5" [13 mm]
- 7.0" [178 mm]
- ø1.75" [44.5 mm]
- 4.7" [119 mm]
- 5.0" [127 mm]
- ø.281" [7.14 mm] SLOT (2-PLACES)

### MOUNTING STYLE E

**Base Mount**

- Base Mount
- RETURN SPRING -OPTIONAL-
- PLUNGER STYLE 2 WITH 1/4-28 EXTERNAL THREAD
- C.V. BOOT
- ø2.50" [63.5 mm]
- ø1.75" [44.5 mm]
- .5" [13 mm]
- 5.7" [145 mm]
- ø1.75" [44.5 mm]
- 3.22" [82.0 mm]
- 2.00" [50.8 mm]

### MOUNTING STYLE E

**Base Mount / External Switch**

- Base Mount / External Switch
- RETURN SPRING -OPTIONAL-
- PLUNGER STYLE 2 WITH 1/4-28 EXTERNAL THREAD
- C.V. BOOT
- ø2.50" [63.5 mm]
- ø1.75" [44.5 mm]
- .5" [13 mm]
- 7.0" [178 mm]
- ø1.75" [44.5 mm]
- 4.8" [122 mm]
- 2.25" [57.2 mm]
- 2.00" [50.8 mm]

---

## Specifications:

- **Temperature Range**: -40°F to +250°F (-40°C to +121°C)
- **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>Coil Winding</th>
</tr>
</thead>
<tbody>
<tr>
<td>1751</td>
<td>12 Vdc</td>
<td>1&quot; (25.4 mm)</td>
<td>46 A</td>
<td>1.1 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&quot; (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&quot; (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&quot; (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&quot; (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&quot; (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&quot; (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&quot; (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

Specifications are for reference only.
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: 35-37 lbs (156-165 N)

Return Spring
Model Force @ 1"
S1 Light 4-8 lbs (17.8-35.6 N)
S5 Medium 7-11 lbs (31.1-48.9 N)

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

Model No. Volts Mounting Style Plunger Type Grounding Type Termination Type Boot Type Return Spring
1756ES 12/24 Vdc A 2 U L B1 S1
1756ESDB 24 24 Vdc E 3 U C L B2 S5
1757ES 12/24 Vdc A 2 U L B2
1757ESDB 24 24 Vdc E 3 U C L B4

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

**MOUNTING STYLE A**
Flange Mount / External Switch, Double Boot

**MOUNTING STYLE E**
Base Mount / External Switch

**MOUNTING STYLE E**
Base Mount / External Switch, Double Boot

Specifications:

<table>
<thead>
<tr>
<th>Temperature Range</th>
<th>-40°F to +250°F (-40°C to +121°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>1.5 lbs (0.7 kg)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1756ES</td>
<td>12 Vdc</td>
<td>1&quot; (25.4 mm)</td>
<td>46 A</td>
<td>1.1 A</td>
<td>26 lbs (116 N)</td>
<td>35 lbs (156 N)</td>
<td>Parallel</td>
</tr>
<tr>
<td>1756ES</td>
<td>24 Vdc</td>
<td>1&quot; (25.4 mm)</td>
<td>25 A</td>
<td>0.5 A</td>
<td>26 lbs (116 N)</td>
<td>35 lbs (156 N)</td>
<td>Parallel</td>
</tr>
<tr>
<td>1756ESDB</td>
<td>12 Vdc</td>
<td>1&quot; (25.4 mm)</td>
<td>46 A</td>
<td>1.1 A</td>
<td>20 lbs (89 N)</td>
<td>35 lbs (156 N)</td>
<td>Parallel</td>
</tr>
<tr>
<td>1756ESDB</td>
<td>24 Vdc</td>
<td>1&quot; (25.4 mm)</td>
<td>25 A</td>
<td>0.5 A</td>
<td>20 lbs (89 N)</td>
<td>35 lbs (156 N)</td>
<td>Parallel</td>
</tr>
<tr>
<td>1757ES</td>
<td>12 Vdc</td>
<td>1&quot; (25.4 mm)</td>
<td>33 A</td>
<td>0.8 A</td>
<td>20 lbs (89 N)</td>
<td>37 lbs (165 N)</td>
<td>Parallel</td>
</tr>
<tr>
<td>1757ES</td>
<td>24 Vdc</td>
<td>1&quot; (25.4 mm)</td>
<td>18 A</td>
<td>0.4 A</td>
<td>20 lbs (89 N)</td>
<td>37 lbs (165 N)</td>
<td>Parallel</td>
</tr>
<tr>
<td>1757ESDB</td>
<td>12 Vdc</td>
<td>1&quot; (25.4 mm)</td>
<td>33 A</td>
<td>0.8 A</td>
<td>16 lbs (71 N)</td>
<td>37 lbs (165 N)</td>
<td>Parallel</td>
</tr>
<tr>
<td>1757ESDB</td>
<td>24 Vdc</td>
<td>1&quot; (25.4 mm)</td>
<td>18 A</td>
<td>0.4 A</td>
<td>16 lbs (71 N)</td>
<td>37 lbs (165 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.

e-mail: icinfo@woodward.com
2000 Series
dual coil solenoids

Pull Force Range: 21-29 lbs (93-129 N)
Hold Force Range: 41-51 lbs (182-227 N)

Return Spring
Model | Force @ 1"
------|-----------------
S1 Light | 4-8 lbs (17.8-35.6 N)
S2 Medium | 8-14 lbs (35.6-62.3 N)
S4 Heavy | 14-17 lbs (62.3-75.6 N)

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

- Model No. | Volts | Mounting Style | Plunger Type | Grounding (No. of Terminals) | Termination Type | Boot Type | Return Spring (Force @ 1"")
--- | --- | --- | --- | --- | --- | --- | ---
2001 | 12 | E Base | 2 | G Grounded (1 Terminal) | 1 Screw | B1 Constant Volume Silicone Rubber | S1 Light (4-8 lbs)
2001ES | 2003 | 2003ES

*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.
## Mounting Styles:

### MOUNTING STYLE E

**Base Mount**

- BELLOWS BOOT
- PLUNGERS STYLE 2 WITH 1/4-28 EXTERNAL THREAD
- RETURN SPRING -OPTIONAL-
- AUX. TERMINAL SCREW #6-32 (2-PLACES)
- TERMINAL TYPE 1 SCREW #8-32

**Specifications**

- **Temperature Range:** -40°F to +250°F (-40˚C to +121˚C)
- **Weight:** 2.5 lbs (1.2 kg)

### MOUNTING STYLE E

**Base Mount / External Switch**

- BELLOWS BOOT
- PLUNGERS STYLE 2 WITH 1/4-28 EXTERNAL THREAD
- RETURN SPRING -OPTIONAL-
- AUX. TERMINAL SCREW #6-32 (2-PLACES)
- TERMINAL TYPE 1 SCREW #8-32

### MOUNTING STYLE S

**Flange Mount**

- C.V. BOOT
- PLUNGERS STYLE 2 WITH 1/4-28 EXTERNAL THREAD
- RETURN SPRING -OPTIONAL-
- AUX. TERMINAL SCREW #6-32 (4-PLACES)
- TERMINAL TYPE 1 SCREW #8-32

### Specifications:

- **Temperature Range:** -40°F to +250°F (-40˚C to +121˚C)
- **Weight:** 2.5 lbs (1.2 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>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*
**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)

<table>
<thead>
<tr>
<th>Model</th>
<th>Rated Voltage</th>
<th>Pull Rating*</th>
<th>Hold Rating*</th>
</tr>
</thead>
<tbody>
<tr>
<td>2370</td>
<td>12/24 Vdc</td>
<td>37 lbs (165 N)</td>
<td>88 lbs (391 N)</td>
</tr>
<tr>
<td>2370ES</td>
<td>12/24 Vdc</td>
<td>39 lbs (173 N)</td>
<td>92 lbs (409 N)</td>
</tr>
</tbody>
</table>

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

**Return Spring**

Model | Force @ 1”
---|---
S1 Light | 17.6-26.0 lbs (78.3-115.7 N)

**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>2370</td>
<td>12</td>
<td>E Base</td>
<td>2 Ext. Thread</td>
<td>Grounded (1 Terminal)</td>
<td>#8 Screw</td>
<td>B2 Bellows</td>
<td>S1 Light (17.6-26.0 lbs)</td>
</tr>
<tr>
<td>2370ES</td>
<td>24</td>
<td>24 Vdc</td>
<td>3 Ext. Thread</td>
<td>Ungrounded 2370: (2 Terminals)</td>
<td>#8 Stud</td>
<td>B5 Constant Volume Silicone Rubber</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3 Int. Thread</td>
<td>2370ES: (3 Terminals or Wire Leads)</td>
<td>#10 Stud</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6 Int. Thread</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>7 Int. Thread</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**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.
Specifications:

Temperature Range: -40°F to +250°F (-40°C to +121°C)

Weight: 5 lbs (2.3 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>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.

e-mail: icinfo@woodward.com
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 and dimensions are for reference only.

NOTE: Minimum bend radius for optimum cable life is 5" (127 mm)
Single Coil Solenoids

Features:
Single coil solenoids are typically designed for continuous duty, with single coil performing both the pull and hold function for the solenoid.

Solenoid Selection Guide

<table>
<thead>
<tr>
<th>Single Coil Model No.</th>
<th>Direction</th>
<th>Pull</th>
<th>Push</th>
<th>Start Force</th>
<th>Hold Force</th>
<th>Stroke</th>
<th>Current</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1000S</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 Vdc</td>
<td>✓</td>
<td></td>
<td></td>
<td>0.6 lbs (2.7 N)</td>
<td>4.0 lbs (17.8 N)</td>
<td>0.17&quot; (4.3 mm)</td>
<td>0.7 A</td>
</tr>
<tr>
<td>24 Vdc</td>
<td>✓</td>
<td></td>
<td></td>
<td>1.4 lbs (6.2 N)</td>
<td>5.0 lbs (22.2 N)</td>
<td>0.17&quot; (4.3 mm)</td>
<td>2 A</td>
</tr>
<tr>
<td><strong>1510S</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 Vdc</td>
<td>✓</td>
<td></td>
<td></td>
<td>3.6 lbs (16.0 N)</td>
<td>9.8 lbs (43.6 N)</td>
<td>0.5&quot; (12.7 mm)</td>
<td>4.7 A</td>
</tr>
<tr>
<td>24 Vdc</td>
<td>✓</td>
<td></td>
<td></td>
<td>3.6 lbs (16.0 N)</td>
<td>9.8 lbs (43.6 N)</td>
<td>0.5&quot; (12.7 mm)</td>
<td>2.4 A</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ø1.00&quot; MAX</td>
<td>25.4 mm</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>
</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>
</tr>
<tr>
<td>Pull Coil Resistance</td>
<td>17.8 ohms ± 10%</td>
</tr>
</tbody>
</table>

## Specifications:

<table>
<thead>
<tr>
<th>Specification</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></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></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.

e-mail: icinfo@woodward.com
1510S 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>0151</td>
<td>Leads</td>
</tr>
</tbody>
</table>

**1510S Standard Force Curve**

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.
Specifications:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</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></td>
</tr>
<tr>
<td>De-energized</td>
<td>1.16 ± 0.16 lbs (5.16 ± 0.71 N)</td>
</tr>
<tr>
<td>Energized</td>
<td>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.
Woodward’s extensive line of solenoid protection products feature either external or internal electronics. Coil Commanders™ and pull coil timer modules (PCTMs) are externally attached to the solenoid to prevent overheating of the pull coil. ICE (Integrated Coil Electronics) and AICE (Advanced ICE) solenoids have built-in electronics that prevent overheating of the pull coil.
External Electronic Solenoid Controls

Coil Commanders™ and PCTM Protection Systems
Dual coil solenoids are constructed of two wound coils. The pull coil operates at high currents in order to provide maximum pull or push force. The hold coil retains the plunger in place after it has completed its stroke. After energizing, the pull coil must be turned off as soon as possible to prevent burnout. The protection modules energize the solenoid pull coil for approximately 1.0 second.

Woodward makes two types of externally controlled solenoid protection systems: Coil Commander™ modules and pull coil timer modules (PCTM).
Timer Module Basics

Coil Commander™ Modules

Coil Commanders time out a solenoid’s high amperage pull coil within approximately 1.5 seconds. The in-line cylindrical tube design comes in 5-, 6-, and 7-wire SSR configurations:

| 5-Wire Module | When used with a 3-wire externally switched solenoid, the combined unit functions similarly to an internally switched solenoid without modification to existing wiring harness. |
| 6-Wire Module | Provides a quick, easy fix to prevent burnout for externally switched installations that are connected to the “S” terminal on the starter. |
| 7-Wire SSR Module | When used with a 4-wire externally switched solenoid, the combined unit functions similarly to an internally switched solenoid and eliminates the need for a separate solenoid relay. |

Stand-alone units are lightweight and need no mounting brackets. Modules are also available with solenoid attached.

Maximum ON/OFF Duty Cycles for Coil Commander™ Modules

At de-rated conditions: 125% of rated voltage and 250°F (121°C)

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Continuous</th>
<th>Intermittent</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 Vdc</td>
<td>2 cycles/minute</td>
<td>4 cycles/minute for 5 minutes</td>
</tr>
<tr>
<td>24 Vdc</td>
<td>1 cycle/minute</td>
<td>3 cycles/minute for 5 minutes</td>
</tr>
</tbody>
</table>

PCTM Modules

These timers protect externally switched solenoids by limiting the pull coil ON time to 0.5 second. Use of a PCTM enhances solenoid performance by providing functionality of an internally switched solenoid but with greater durability and reliability.

Note: Coil Commanders and PCTM’s will reduce the available pull coil voltage by approximately 0.5 to 1 volt.
5-Wire Coil Commander™

Provides the functionality of an internally switched solenoid when used with a 3-wire externally switched solenoid.

Features:

- Prevents solenoid burnout due to engine over cranking or misadjustment of linkage by limiting the pull coil ON time
- Potted and sealed solid-state electronics
- Separate mounting bracket not required
- Stand alone plug-in or factory assembled to solenoid
- Patented

Order Information:

Stand Alone Modules

<table>
<thead>
<tr>
<th>ORDER NO.</th>
<th>Rated Voltage</th>
<th>Max. Current at 68°F (20°C)</th>
<th>Terminations To System Harness</th>
<th>Terminations To Solenoid</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA-4624-12</td>
<td>12 Vdc</td>
<td>70 A</td>
<td>Leads</td>
<td>Packard Weather Pack Housing No. 12020829</td>
</tr>
<tr>
<td>SA-4624-24</td>
<td>24 Vdc</td>
<td>40 A</td>
<td>Leads</td>
<td>Packard Weather Pack Housing No. 12020829</td>
</tr>
<tr>
<td>SA-4626-12</td>
<td>12 Vdc</td>
<td>70 A</td>
<td>Packard Weather Pack Housing No. 12020827</td>
<td>Packard Weather Pack Housing No. 12020829</td>
</tr>
<tr>
<td>SA-4626-24</td>
<td>24 Vdc</td>
<td>40 A</td>
<td>Packard Weather Pack Housing No. 12020827</td>
<td>Packard Weather Pack Housing No. 12020829</td>
</tr>
<tr>
<td>SA-4630-12</td>
<td>12 Vdc</td>
<td>70 A</td>
<td>Packard Weather Pack Housing No. 12010973</td>
<td>Yazaki Housing No. 7123-2137</td>
</tr>
<tr>
<td>SA-4630-24</td>
<td>24 Vdc</td>
<td>60 A</td>
<td>Packard Weather Pack Housing No. 12010973</td>
<td>Packard Weather Pack Housing No. 12020829</td>
</tr>
<tr>
<td>SA-4634-12</td>
<td>12 Vdc</td>
<td>90 A</td>
<td>Packard Weather Pack Housing No. 12010973</td>
<td>Packard Weather Pack Housing No. 12020829</td>
</tr>
<tr>
<td>SA-4634-24</td>
<td>24 Vdc</td>
<td>60 A</td>
<td>Packard Weather Pack Housing No. 12010973</td>
<td>Packard Weather Pack Housing No. 12020829</td>
</tr>
<tr>
<td>SA-4686-12</td>
<td>12 Vdc</td>
<td>70 A</td>
<td>Leads</td>
<td>Leads</td>
</tr>
<tr>
<td>SA-4686-24</td>
<td>24 Vdc</td>
<td>40 A</td>
<td>Leads</td>
<td>Leads</td>
</tr>
<tr>
<td>SA-4687-12</td>
<td>12 Vdc</td>
<td>90 A</td>
<td>Leads</td>
<td>Leads</td>
</tr>
<tr>
<td>SA-4687-24</td>
<td>24 Vdc</td>
<td>60 A</td>
<td>Leads</td>
<td>Leads</td>
</tr>
<tr>
<td>SA-4822-12</td>
<td>12 Vdc</td>
<td>90 A</td>
<td>Metri-Pack 280 Series Housing No. 15300002</td>
<td>Packard Weather Pack Housing No. 12020829</td>
</tr>
</tbody>
</table>

Built-in Modules

Contact Woodward for factory assembled units

Minimum quantities required for non-standard configurations. Contact factory for details.
**5-Wire Coil Commander™**

**Termination Connections**

**Electric Shutoff**

Electric shutoff with dedicated relay for fuel solenoid

**Throttle/Choke Solenoid**

Throttle/choke solenoid with dedicated relay for fuel solenoid

**Dimensions**

- **Temperature**: -40°F to +250°F (-40°C to +121°C)
- **Vibration**: 15 G’s @ 15-2000 Hz
- **Rated Voltage**
  - Minimum Input Voltage @ 68°F (20°C)
  - Rated Jump Start Voltage (<5 min)
- **Reverse Polarity Protection**: None
- **Weight**: Approx. 4 oz. (113 g)

**Specifications**

Note: Coil Commanders will reduce the available pull coil voltage by approximately 0.5 to 1 volt.

Specifications are for reference only.

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E-mail: icinfo@woodward.com
6-Wire Coil Commander™

Plugs into existing externally switched solenoid installations without wiring modification when used with optional connectors. Works with installations connected to “S” terminal on starter.

Features:
- Prevents solenoid burnout due to engine over crank or misadjustment of linkage by limiting the pull coil ON time
- Potted and sealed solid-state electronics
- Separate mounting bracket not required
- Stand alone plug-in or factory assembled to solenoid
- Patented

Order Information:

Stand Alone Modules

<table>
<thead>
<tr>
<th>ORDER NO.</th>
<th>Rated Voltage</th>
<th>Max. Current at 68°F (20°C)</th>
<th>Terminations To System Harness</th>
<th>Terminations To Solenoid</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA-4751</td>
<td>9-36 Vdc</td>
<td>86 A</td>
<td>Packard Weather Pack Housing No. 12020827</td>
<td>Packard Weather Pack Housing No. 12020829</td>
</tr>
<tr>
<td>SA-4759</td>
<td>9-36 Vdc</td>
<td>86 A</td>
<td>Leads</td>
<td>Leads</td>
</tr>
<tr>
<td>SA-4945*</td>
<td>9-36 Vdc</td>
<td>86 A</td>
<td>Yazaki Housing-Male No. 7122-2237-00</td>
<td>Yazaki Housing-Female No. 7123-2137</td>
</tr>
<tr>
<td>SA-5028</td>
<td>9-36 Vdc</td>
<td>86 A</td>
<td>Packard Metri-Pack 280 Housing No. 1530003</td>
<td>Packard Metri-Pack 280 Housing No. 12040977</td>
</tr>
<tr>
<td>SA-5160</td>
<td>9-36 Vdc</td>
<td>86 A</td>
<td>Yazaki Housing-Male No. 7122-2237-00</td>
<td>Yazaki Housing-Female No. 7123-2137</td>
</tr>
</tbody>
</table>

*For use with Kubota 1503ES solenoids

Built-in Modules
Contact Woodward for factory assembled units

Minimum quantities required for non-standard configurations. Contact factory for details.

TERMINATION CONNECTIONS

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.
6-Wire Coil Commander™

**DIMENSIONS**

- 3.4 ± 0.5" (86 ± 13 mm) REF.
- 1.85" (47.0 mm) REF.
- ø 0.755" (19.18 mm) REF.
- 4.5" (114 mm) REF.
- 6.6 ± 0.5" (168 ± 13 mm) REF.

**CONNECT TO SYSTEM HARNESS**

**CONNECT TO SOLENOID**

**ELECTRIC SHUTOFF**

Electric shutoff with dedicated relay for fuel solenoid

- **CONNECT TO SOLENOID**
- **CONNECT TO SYSTEM HARNESS**
- **3-WAY SEALED CONNECTOR**
- **WEATHER PACK SERIES**
- **PACKARD PART No.**
  - HOUSING: 12020827
  - TERMINAL (MALE): 12124582
  - SEAL: 1205359

**3-WAY SEALED CONNECTOR**

**WEATHER PACK SERIES**

**PACKARD PART No.**

- HOUSING: 12020829
- TERMINAL (FEMALE): 12124580
- SEAL: 1205359

**ELECTRIC SHUTOFF W/ STARTER MOTOR**

Solenoid shown with Coil Commander wired to starter. This method requires approval from the starter motor manufacturer.

**RECOMMENDED CONNECTION**

Connection of solenoid to "S" terminal is acceptable with 6-wire Coil Commander.

**WARNING:**

- Starter relay must be rated for the combined current of the starter solenoid and the fuel shut-off solenoid pull coil.

**NON-RECOMMENDED CONNECTION**

Connection of solenoid to "S" terminal is not recommended.

**Note:** Coil Commanders will reduce the available pull coil voltage by approximately 0.5 to 1 volt.

**Specifications:**

- Temperature
  - -40°F to +250°F
  - (-40°C to +121°C)
- Vibration
  - 15 G's @ 15-2000 Hz
- Rated Voltage
  - Minimum Input Voltage @ 68°F (20°C)
  - 12 Volt 9 Vdc 18 Vdc
  - 24 Volt 36 Vdc
- Rated Jump Start Voltage
  - (1 cycle/min for 10 min)
- Reverse Polarity Protection
  - None
- Weight
  - Approx. 4 oz. (113 g)

Specifications are for reference only.

E-mail: icinfo@woodward.com
Solenoid Control Electronics

7-Wire SSR Coil Commander™
Provides the functionality of an internally switched solenoid when used with a 4-wire externally switched solenoid. Eliminates the need for a separate solenoid relay.

Features:
- Prevents solenoid burnout due to engine over cranking or misadjustment of linkage by limiting the pull coil ON time
- Potted and sealed solid-state electronics
- Separate mounting bracket not required
- Stand alone plug-in or factory assembled to solenoid
- Patented

Order Information:

Stand Alone Modules

<table>
<thead>
<tr>
<th>ORDER NO.</th>
<th>Rated Voltage</th>
<th>Max. Current @ 68°F (20°C)</th>
<th>Terminations To System Harness</th>
<th>Terminations To Solenoid</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA-4690-12</td>
<td>12 Vdc</td>
<td>70 A</td>
<td>Leads</td>
<td>Leads</td>
</tr>
<tr>
<td>SA-4690-24</td>
<td>24 Vdc</td>
<td>40 A</td>
<td>Leads</td>
<td>Leads</td>
</tr>
<tr>
<td>SA-4691-24</td>
<td>24 Vdc</td>
<td>60 A</td>
<td>Leads</td>
<td>Leads</td>
</tr>
<tr>
<td>SA-4727-12</td>
<td>12 Vdc</td>
<td>86 A</td>
<td>Packard Weather Pack Housing No. 12020827</td>
<td>Packard Weather Pack Housing No. 12020832</td>
</tr>
<tr>
<td>SA-4727-24</td>
<td>24 Vdc</td>
<td>56 A</td>
<td>Packard Weather Pack Housing No. 12020827</td>
<td>Packard Weather Pack Housing No. 12020832</td>
</tr>
</tbody>
</table>

Built-in Modules
Contact Woodward for factory assembled units.

Minimum quantities required for non-standard configurations. Contact factory for details.

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.
7-Wire SSR Coil Commander™

**TERMINATION CONNECTIONS**

**SSR ELECTRIC SHUTOFF**
SSR electric shutoff for use with externally switched solenoids and to replace or eliminate a second solenoid relay

**SSR THROTTLE/CHOKE SOLENOID**
SSR throttle/choke solenoid eliminates need for mechanical relay

**DIMENSIONS**

Note: Coil Commanders will reduce the available pull coil voltage by approximately 0.5 to 1 volt.

**Specifications:**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>-40°F to +250°F (-40°C to +121°C)</td>
</tr>
<tr>
<td>Vibration</td>
<td>15 G's @ 15-2000 Hz</td>
</tr>
<tr>
<td>Rated Voltage</td>
<td></td>
</tr>
<tr>
<td>Minimum Input Voltage @ 68°F (20°C)</td>
<td>12 Volt 9 Vdc 24 Volt 18 Vdc</td>
</tr>
<tr>
<td>Rated Jump Start Voltage (≤5 min)</td>
<td>24 Vdc 48 Vdc</td>
</tr>
<tr>
<td>Reverse Polarity Protection</td>
<td>None</td>
</tr>
<tr>
<td>Weight</td>
<td>Approx. 4 oz. (113 g)</td>
</tr>
</tbody>
</table>

Specifications are for reference only.

e-mail: icinfo@woodward.com
### PCTM Modules

Pull coil timer modules protect externally switched solenoids by limiting the pull coil ON time. Use of a PCTM enhances solenoid performance by providing functionality of an internally switched solenoid but with greater durability and reliability.

### Features:
- 3- and 6-wire configurations for externally switched solenoids
- Can be mounted in any orientation or location
- Potted and sealed solid-state electronics
- Corrosion resistant

### Order Information:

<table>
<thead>
<tr>
<th>ORDER NO.</th>
<th>Wire Configuration</th>
<th>Rated Voltage</th>
<th>Terminations To System Harness</th>
<th>Terminations To Solenoid</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA-4092-12</td>
<td>3-Wire</td>
<td>12 Vdc</td>
<td>Leads</td>
<td>Leads</td>
</tr>
<tr>
<td>SA-4092-24</td>
<td>3-Wire</td>
<td>24 Vdc</td>
<td>Leads</td>
<td>Leads</td>
</tr>
<tr>
<td>SA-4094-12</td>
<td>3-Wire</td>
<td>12 Vdc</td>
<td>Packard Weather Pack Housing No. 12020827</td>
<td>Packard Weather Pack Housing No. 12020827</td>
</tr>
<tr>
<td>SA-4094-24</td>
<td>3-Wire</td>
<td>24 Vdc</td>
<td>Packard Weather Pack Housing No. 12020827</td>
<td>Packard Weather Pack Housing No. 12020827</td>
</tr>
<tr>
<td>SA-4220-12</td>
<td>6-Wire</td>
<td>12 Vdc</td>
<td>Leads</td>
<td>Leads</td>
</tr>
<tr>
<td>SA-4220-24</td>
<td>6-Wire</td>
<td>24 Vdc</td>
<td>Leads</td>
<td>Leads</td>
</tr>
<tr>
<td>SA-4222-12</td>
<td>6-Wire</td>
<td>12 Vdc</td>
<td>Packard Weather Pack Housing No. 12010717</td>
<td>Packard Weather Pack Housing No. 12015793</td>
</tr>
<tr>
<td>SA-4224-12</td>
<td>6-Wire</td>
<td>12 Vdc</td>
<td>Leads</td>
<td>Packard Weather Pack Housing No. 12020827</td>
</tr>
<tr>
<td>SA-4224-24</td>
<td>6-Wire</td>
<td>24 Vdc</td>
<td>Leads</td>
<td>Packard Weather Pack Housing No. 12020827</td>
</tr>
</tbody>
</table>

Minimum quantities required for non-standard configurations. Contact factory for details.

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3-Wire Pull Coil Timer Module

Specifications:
- Temperature: -40˚F to +185˚F (-40˚C to +85˚C)
- Input Voltage:
  - 12 Vdc
  - 24 Vdc
- Pull Current:
  - 70 A @ 12 Vdc
  - 56 A @ 24 Vdc
- Vibration: 15 G’s @ 15-2000 Hz
- Maximum Cycles: 3 cycles/minute continuous
- Energized Time: 0.5 seconds

Note: PCTM’s will reduce the available pull coil voltage by approximately 0.5 to 1 volt.

6-Wire SSR Pull Coil Timer Module

Specifications:
- Temperature: -40˚F to +185˚F (-40˚C to +85˚C)
- Input Voltage:
  - 12 Vdc
  - 24 Vdc
- Pull Current:
  - 70 A @ 12 Vdc
  - 56 A @ 24 Vdc
- Vibration: 15 G’s @ 15-2000 Hz
- Maximum Cycles: 3 cycles/minute continuous
- Energized Time: 0.5 seconds

Note: PCTM’s will reduce the available pull coil voltage by approximately 0.5 to 1 volt.

Specifications are for reference only.
e-mail: icinfo@woodward.com
Internal Electronic Solenoid Controls

Integrated Coil Electronic Solenoids
Ideal for custom applications, Woodward’s Integrated Coil Electronics (ICE and Advanced ICE) solenoids have built-in electronics that prevent overheating of the pull coil. The electronics on both products are totally encapsulated onto the solenoid to ensure reliability in the harshest environments. And, both feature reverse polarity protection.
Integrated Coil Electronics (ICE)
For Dual Coil Solenoids

A printed circuit board mounted onto a dual coil solenoid provides a timer circuit for the pull coil. The PCB functions as an internal timer that switches the pull coil ON and OFF so that the solenoid does not burn itself out.

Features:
- Totally encapsulated PCB ensures reliability in the harshest environments
- Compact design for usage in tight spaces
- Reverse polarity protected

Dimensions in brackets are millimeters.
Advanced Integrated Coil Electronics (AICE)
For Single Coil Solenoids

Electronics integrated into a single coil solenoid control the solenoid's current to provide high initial starting force and a constant hold force. The microprocessor encapsulated onto the solenoid calculates the pull time and then generates a pulse width modulated signal to create the hold coil function for single coil solenoids. Under this reduced current, the hold force of the plunger is held constant over input voltage and temperature ranges.

Features:
- Totally encapsulated electronics operate on PWM signals to regulate current
- Compact design for usage in tight spaces
- Reverse polarity protected

Dimensions in brackets are millimeters.
Solenoid Control Electronics

Hardware
- Solenoid spring swivel
- In-line swivel
- Solenoid end cap
- Clevis yoke
- Clevis yoke bead chain assemblies
- PVC terminal protector
- Spherical rod end
- Connectors

Solenoid Spring Swivel
- Provides a 12° rotational movement to compensate for minor misalignment between solenoid and linkage, and allows up to .25” overtravel
- Male and female connectors rotate 360° for easy installation
- “L” dimension 3.0” when using ¼-28 or M6 male; 3.25” when using ⅝-24 male

<table>
<thead>
<tr>
<th>ORDER NO.</th>
<th>Male End of Swivel Thread Selection</th>
<th>Female End of Swivel Thread Selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>A  ¼–28</td>
<td>C  ⅝–24</td>
<td>E  M6</td>
</tr>
<tr>
<td>B  ¼–28</td>
<td>D  ⅝–24</td>
<td>F  M6</td>
</tr>
</tbody>
</table>

When you order: You will need to provide the male and female swivel thread selection

In-line Swivel
Compensates for possible misalignment between rigid linkage and solenoid plunger

<table>
<thead>
<tr>
<th>ORDER NO.</th>
<th>Mounting Thread</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA-4049</td>
<td>¼–28</td>
</tr>
<tr>
<td>SA-4050</td>
<td>M6 x 1</td>
</tr>
</tbody>
</table>

Solenoid End Cap
- Hypalon® rubber end cap thoroughly seals solenoid from contaminants such as water, oil, chemicals and salts
- Sized for 1500, 1750, and 2000 series solenoids

*Hypalon is a registered trademark of DuPont Dow Elastomers.
Clevis Yoke
For use in customer designed linkage assemblies

<table>
<thead>
<tr>
<th>ORDER NO.</th>
<th>Mounting Thread</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA-0008-A</td>
<td>1/4–28</td>
</tr>
</tbody>
</table>

Clevis Yoke Bead Chain Assemblies
Used whenever a flexible connection is required, such as pulling a throttle lever on a gasoline engine

<table>
<thead>
<tr>
<th>ORDER NO.</th>
<th>Mounting Thread</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA-0293-B</td>
<td>1/4–28</td>
</tr>
</tbody>
</table>

PVC Terminal Protector
- For internally switched solenoids with terminals
- Fits over solenoid cap to protect terminals from accidental shorting
- Available in end or side termination

<table>
<thead>
<tr>
<th>ORDER NO.</th>
<th>Termination</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA-2968</td>
<td>End</td>
</tr>
<tr>
<td>SA-2968-UK</td>
<td>Side</td>
</tr>
</tbody>
</table>

Spherical Rod End
- Heavy duty, low friction, nylon race ball joints for connecting solenoid linkage to fuel pump levers
- Available in male and female options

<table>
<thead>
<tr>
<th>ORDER NO.</th>
<th>Body</th>
<th>Stud</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA-4280</td>
<td>Internal 1/4–28</td>
<td>None</td>
</tr>
<tr>
<td>SA-4188</td>
<td>Internal 1/4–28</td>
<td>External 1/4–28</td>
</tr>
<tr>
<td>SA-4232</td>
<td>External 1/4–28</td>
<td>External 1/4–28</td>
</tr>
</tbody>
</table>

Connectors
- For externally switched solenoids with leads
- Special materials and seals are used to allow the connector to withstand extreme temperature and moisture conditions
- For ordering information contact Woodward
Shutdown Kits

Safe, dependable shutdown systems fit a range of engines and fuel injection pump governors. Designed for ease of installation and maintenance, kits contain solenoid and all mounting hardware for attachment to the governor housing.

Features:
- Hold coil designed for continuous duty operation under the most severe temperature and vibration conditions
- Brass liner plunger bore for long life
- Plunger hard chrome plated for smooth, reliable, wear-resistant operation
- Plated steel solenoid, bracket, linkage, lever and hardware for corrosion resistance
- Available in 12 and 24 volt models
- Optional Packard Weather Pack, or Metri-Pack sealed connectors (RQV-K Bosch Kit includes Packard Weather Pack connector)
- Mounting hardware included for fast, easy installation
- Kits contain the properly selected solenoid and return spring for running and stopping engines under all conditions
- Solenoids are sized according to deration for hot temperature and low voltage

Kits Available:
- RQV-K Type Bosch Kit
- RSV Type Bosch Kit
- Kubota Kit 1A (62.2 mm series engines)
- Kubota Kit 3A (70 and 82 mm series engines)
- Mitsubishi L Series Kit
- RSV Type Zexel Nippondenso Kit

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**Specifications:**

| Solenoid | 3-wire externally switched (ES) solenoid  
| Internally switched solenoid also available on Kubota and RSV-Bosch kits |
|---|---|
| Rated Voltage | 12 or 24 Vdc |
| Ambient Temperature | -40°F to +250°F  
(-40°C to +121°C) |
| Weight | Approx. 3.0 lbs (1.4 kg) |

<table>
<thead>
<tr>
<th>Engine Series</th>
<th>Voltage</th>
<th>Pull Current</th>
<th>Hold Current</th>
</tr>
</thead>
</table>
| RQV-K Bosch | 12  
24 | 55 A  
29 A | 1.1 A  
0.6 A |
| RSV Bosch | 12  
24 | 46 A  
25 A | 1.1 A  
0.5 A |
| Kubota 1A  
(62.2 mm series) | 12  
24 | 33 A  
18 A | 0.8 A  
0.4 A |
| Kubota 3A  
(70 & 82 mm series) | 12  
24 | 46 A  
25 A | 1.1 A  
0.5 A |
| Mitsubishi L | 12 | 46 A | 1.1 A |
| RSV Zexel Nippondenso | 12  
24 | 55 A  
29 A | 1.1 A  
0.6 A |

Specifications are for reference only.
**RQV-K Bosch Kit**

- Installs on a variety of engines using Bosch pumps with RQV-K governor
- 1752ES solenoid has built-in Packard Weather Pack connector (Housing No. 12020827)

<table>
<thead>
<tr>
<th>ORDER NO.</th>
<th>Solenoid Model</th>
<th>Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA-4026-12</td>
<td>1752ES</td>
<td>12 Vdc</td>
</tr>
<tr>
<td>SA-4026-24</td>
<td>1752ES</td>
<td>24 Vdc</td>
</tr>
</tbody>
</table>

**NOTE:** Left-Hand Kit with 1752ES solenoid
RSV Bosch Kit
• Installs on a variety of engines and Bosch Models A, MW, and P pumps with RSV governor
• Right- or left-hand mounting styles

<table>
<thead>
<tr>
<th>ORDER NO.</th>
<th>Right-Hand</th>
<th>Solenoid Model</th>
<th>Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA-3799-12</td>
<td>1751ES</td>
<td>12 Vdc</td>
<td></td>
</tr>
<tr>
<td>SA-3799-24</td>
<td>1751ES</td>
<td>24 Vdc</td>
<td></td>
</tr>
<tr>
<td>SA-3800-12</td>
<td>1751</td>
<td>12 Vdc</td>
<td></td>
</tr>
<tr>
<td>SA-3800-24</td>
<td>1751</td>
<td>24 Vdc</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ORDER NO.</th>
<th>Left-Hand</th>
<th>Solenoid Model</th>
<th>Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA-3742-12</td>
<td>1751ES</td>
<td>12 Vdc</td>
<td></td>
</tr>
<tr>
<td>SA-3742-24</td>
<td>1751ES</td>
<td>24 Vdc</td>
<td></td>
</tr>
<tr>
<td>SA-3765-12</td>
<td>1751</td>
<td>12 Vdc</td>
<td></td>
</tr>
<tr>
<td>SA-3765-24</td>
<td>1751</td>
<td>24 Vdc</td>
<td></td>
</tr>
</tbody>
</table>

NOTE: Left-Hand Kit with 1751ES solenoid
## Kubota 1A Kit (62.2 mm series engines)
- Installs on Kubota 62.2 mm series engines
- Also available as hardware kit without 1753 solenoid

<table>
<thead>
<tr>
<th>ORDER NO.</th>
<th>Solenoid Model</th>
<th>Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA-4268-12</td>
<td>1753</td>
<td>12 Vdc</td>
</tr>
<tr>
<td>SA-4269-12</td>
<td>1753ES</td>
<td>12 Vdc</td>
</tr>
<tr>
<td>SA-4270</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

(Hardware only)
Shutdown Kits

Kubota 3A Kit (70 & 82 mm series engines)
- Installs on Kubota 70 and 82 mm series engines
- Also available as hardware kit without 1751 solenoid

<table>
<thead>
<tr>
<th>ORDER NO.</th>
<th>Solenoid Model</th>
<th>Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA-4259-12</td>
<td>1751</td>
<td>12 Vdc</td>
</tr>
<tr>
<td>SA-4260-12</td>
<td>1751ES</td>
<td>12 Vdc</td>
</tr>
<tr>
<td>SA-4260-24</td>
<td>1751ES</td>
<td>24 Vdc</td>
</tr>
<tr>
<td>SA-4264</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

(Hardware only)

e-mail: icinfo@woodward.com
Shutdown Kits

Mitsubishi L Kit
• Installs on Mitsubishi “L” Series engines directly into pump with no external linkage

<table>
<thead>
<tr>
<th>ORDER NO.</th>
<th>Solenoid Model</th>
<th>Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA-3725</td>
<td>1751ES</td>
<td>12 Vdc</td>
</tr>
</tbody>
</table>

NOTE: 1751ES threaded solenoid with 30mm lock nut screws into back of pump
RSV Zexel Nippondenso

- Installs on a variety of engines using Zexel or Nippondenso pumps with RSV governor
- Right- or left-hand mounting styles

<table>
<thead>
<tr>
<th>ORDER NO.</th>
<th>Solenoid Model</th>
<th>Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right-Hand</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SA-3999-12</td>
<td>1752ES</td>
<td>12 Vdc</td>
</tr>
<tr>
<td>SA-3999-24</td>
<td>1752ES</td>
<td>24 Vdc</td>
</tr>
<tr>
<td>Left-Hand</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SA-4014-12</td>
<td>1752ES</td>
<td>12 Vdc</td>
</tr>
<tr>
<td>SA-4014-24</td>
<td>1752ES</td>
<td>24 Vdc</td>
</tr>
</tbody>
</table>

NOTE: Left-Hand Kit with 1752ES solenoid
**Solenoid Shutdown Kits**

**Shutdown Solenoid Kit**

Fuel shutdown solenoid mounts closely above the front gear housing behind the fan on Kubota D722 & Z482 engines.

**Features:**
- Energized to run, fail-safe operation
- Hold coil designed for continuous duty operation under the most severe temperature and vibration conditions
- Brass liner plunger bore for long life
- Plunger hard chrome plated for smooth, reliable, wear-resistant operation
- Plated steel solenoid, bracket, linkage, lever and hardware for corrosion resistance
- Available in 12 and 24 volt models

**Order Information:**

<table>
<thead>
<tr>
<th>ORDER NO.</th>
<th>Solenoid</th>
<th>Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA-4899-12</td>
<td>1756ES</td>
<td>12 Vdc</td>
</tr>
<tr>
<td>SA-4899-24</td>
<td>1756ES</td>
<td>24 Vdc</td>
</tr>
</tbody>
</table>

**Kubota Shutdown Lever:**

Engine must be equipped with proper shutdown lever in order to install the shutdown solenoid. Order appropriate part number from Kubota.

<table>
<thead>
<tr>
<th>PART NO.</th>
<th>Engine Production Date*</th>
</tr>
</thead>
<tbody>
<tr>
<td>16851-57720</td>
<td>Before April, 2001</td>
</tr>
<tr>
<td>16851-57723</td>
<td>After April, 2001</td>
</tr>
</tbody>
</table>

*Contact Kubota with engine serial number

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