

Solenoid Basics

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

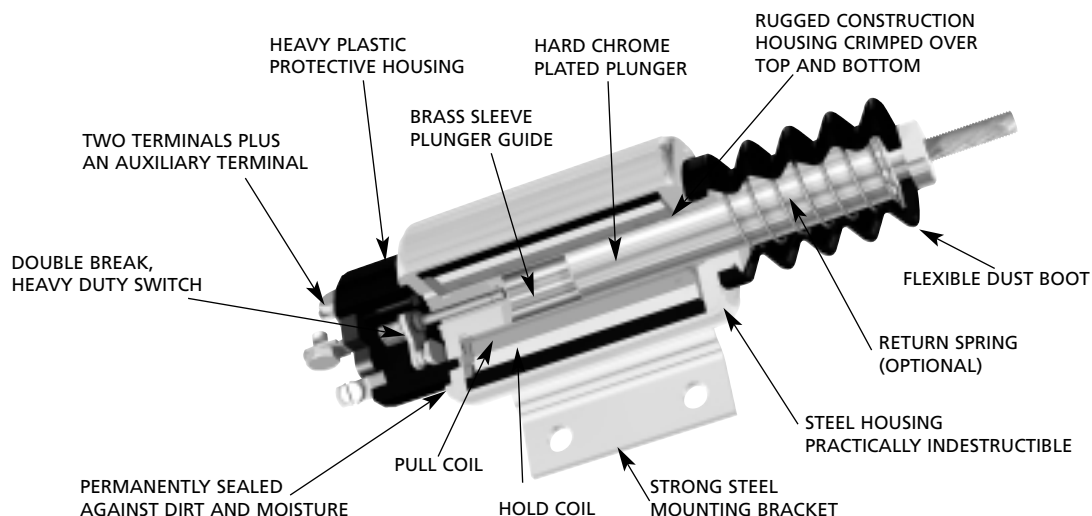


The Basic Single Coil Solenoid

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.

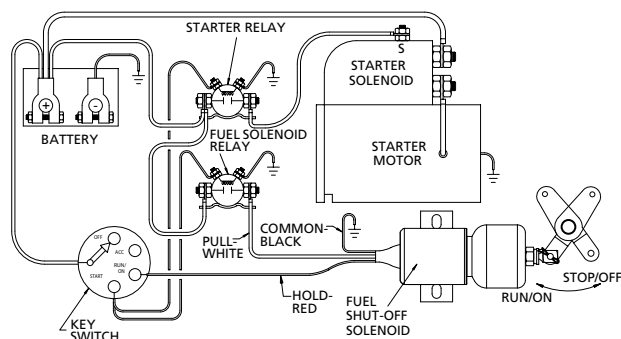
The Woodward Dual Coil Solenoid

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.



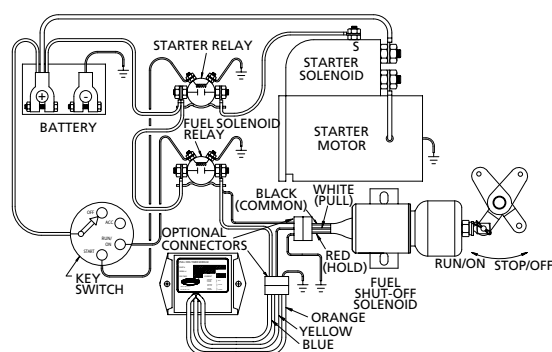
Three methods for turning off the pull coil

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.



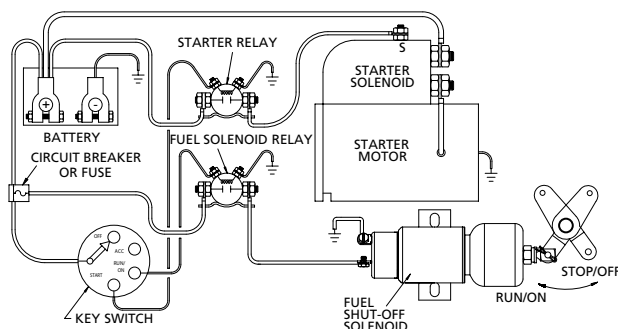
External Switching

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 1/2 seconds after energizing, which prevents overheating of the coil in situations such as abusive overcranking of an engine.

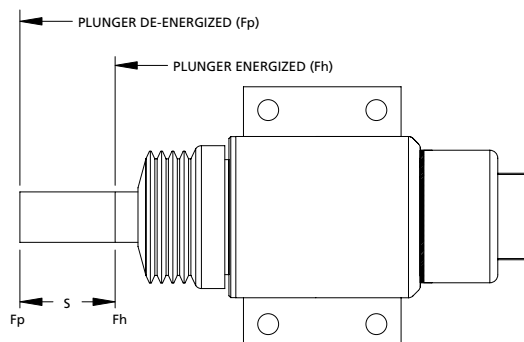


Internal Switching

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).

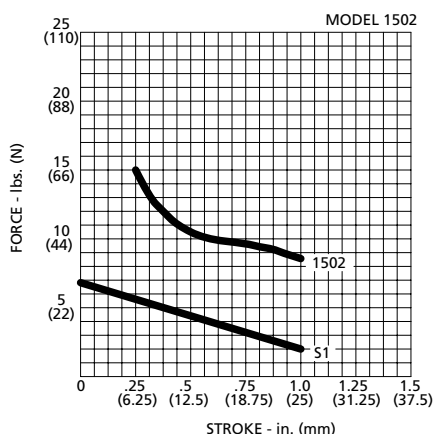
Using the formula: $F = F_o \times f_v \times f_t$ or $F = 9 \times 1.0 \times .83 = 7.47$ lbs

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.

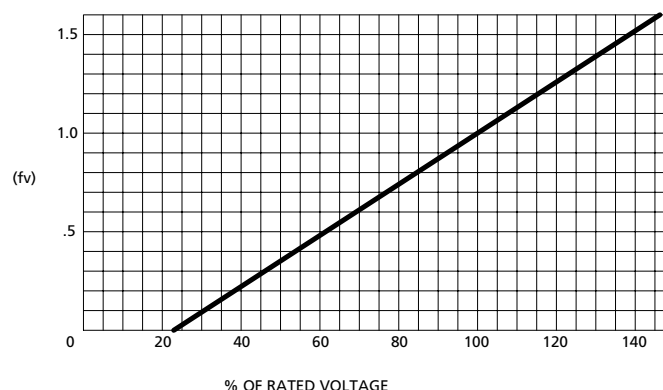
Measurements for above factors must be taken in operating conditions. For example: you must start the engine and measure the force to move the lever to the stop position. The engine governor often exerts force on the stop lever, which is not apparent on a stationary engine.

Solenoid Deration Graphs

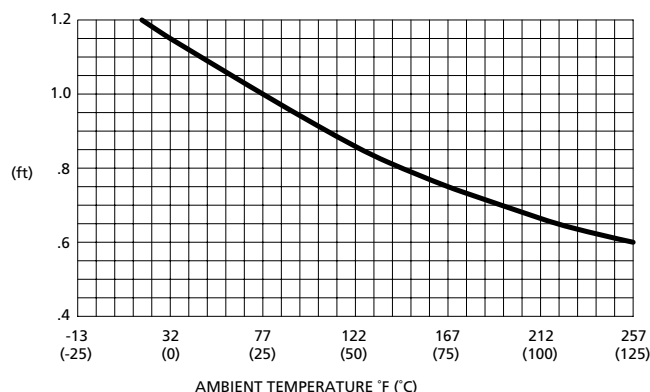
Pull vs Stroke



Voltage Correction (fv)



Temperature Correction (ft)



Return Spring Deration

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 " $F = F_o \times f_v \times f_t$ " formula to determine the appropriate solenoid, remember: As the "pull vs. stroke" graph illustrates, the addition of a return spring changes the force (F_o) characteristics. When determining (F_o) 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 (F_o) 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

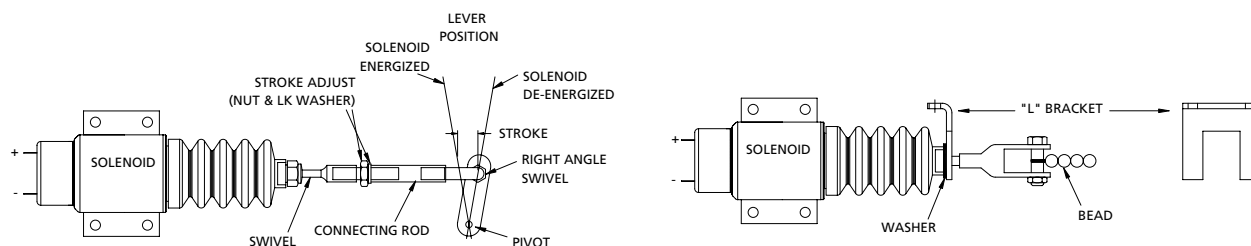
Solenoid Mounting

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.

	Solenoid Series 1502/1753/1757		Solenoid Series 1504/1751/1756/2001		Solenoid Series 2003/2370	
	Wire Length		Wire Length		Wire Length	
Voltage	12 VDC	24 VDC	12 VDC	24 VDC	12 VDC	24 VDC
Wire Thickness						
16 gauge or 1.5 mm ²	–	–	–	21' (6.4 m)	–	–
14 gauge or 2.5 mm ²	12' (3.7 m)	40' (12.2 m)	9' (2.7 m)	34' (10.4 m)	5' (1.5 m)	9' (2.7 m)
12 gauge or 4.0 mm ²	19' (5.8 m)	64' (19.5 m)	14' (4.3 m)	54' (16.5 m)	9' (2.7 m)	14' (4.3 m)
10 gauge or 6.0 mm ²	20' (6.1 m)	102' (31.1 m)	23' (7 m)	86' (26.2 m)	14' (4.3 m)	23' (7 m)

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.

	Solenoid Series 1502/1753/1757		Solenoid Series 1504/1751/1756/2001		Solenoid Series 2003/2370	
	12 VDC	24 VDC	12 VDC	24 VDC	24 VDC	24 VDC
Slow Blow Fuse Type 3AG	8A	6A	12A	7A	20A	10A
Breaker Amps Max	8A	6A	12A	7A	20A	10A

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 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:

Vibration test:	15 to 2000 Hz @ 15 G's, 3 planes
Thermal cycling test:	-40°F to +250°F (-40°C to +121°C), 2 hours at each temperature with one hour transition, 25 cycles
Heat soak test:	3 hours @ 250°F (121°C) at 120% rated voltage
Shock test:	200 G's peak @ 21 Hz for 300 hours

Solenoid Selection Guide

Solenoid Overview Chart:

Dual Coil Model No.*	Direction		Pull or Push Force	Hold Force	Stroke	Page No.
	Pull	Push				
1502	✓		10 lbs (44 N)	24 lbs (107 N)	1" (25.4 mm)	12
1502ES	✓		10 lbs (44 N)	28 lbs (125 N)	1" (25.4 mm)	12
1504	✓		12 lbs (53 N)	19 lbs (85 N)	1" (25.4 mm)	12
1751	✓		24 lbs (107 N)	38 lbs (169 N)	1" (25.4 mm)	14
1751ES	✓		25 lbs (111 N)	41 lbs (182 N)	1" (25.4 mm)	14
1753	✓		19 lbs (85 N)	42 lbs (187 N)	1" (25.4 mm)	14
1753ES	✓		20 lbs (89 N)	43 lbs (191 N)	1" (25.4 mm)	14
1756ES		✓	26 lbs (116 N)	35 lbs (156 N)	1" (25.4 mm)	16
1765ESDB		✓	30 lbs (133 N)	53 lbs (236 N)	1" (25.4 mm)	16
1757ES		✓	20 lbs (89 N)	37 lbs (165 N)	1" (25.4 mm)	16
1757ESDB		✓	16 lbs (71 N)	57 lbs (254 N)	1" (25.4 mm)	16
2001	✓		21 lbs (93 N)	49 lbs (218 N)	1" (25.4 mm)	18
2001ES	✓		22 lbs (98 N)	43 lbs (191 N)	1" (25.4 mm)	18
2003	✓		26 lbs (116 N)	51 lbs (227 N)	1" (25.4 mm)	18
2003ES	✓		29 lbs (129 N)	41 lbs (182 N)	1" (25.4 mm)	18
2370	✓		37 lbs (165 N)	88 lbs (391 N)	1.5" (38.1 mm)	20
2370ES	✓		39 lbs (173 N)	92 lbs (409 N)	1.5" (38.1 mm)	20
Cable Solenoid	✓		29 lbs (129 N)	41 lbs (182 N)	0.96" (24.5 mm)	22

Single Coil Model No.*	Direction		Pull or Push Force	Hold Force	Stroke	Page No.
	Pull	Push				
1000S 12 VDC	✓		Against return spring with no side load on plunger pin	Against return spring with no side load on plunger pin	0.17" (4.3 mm)	24
1503S 12 VDC	✓		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	Must hold return spring at 9 VDC and 100°F (38°C) or 8 lbs (35.6 N) at rated voltage	0.5" (12.7 mm)	26
2370SP 12 VDC 24 VDC		✓ ✓	12 lbs (53.4 N) 16 lbs (71.2 N)	—	0.85" (21.6 mm) 0.85" (21.6 mm)	28 28
2370S 24 VDC	✓		16 lbs (71.2 N)		0.85" (21.6 mm)	28

*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)

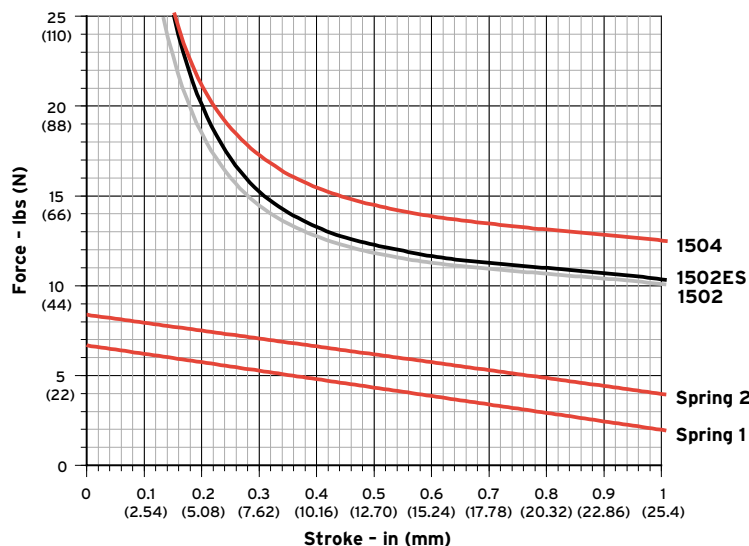


Model	Rated Voltage	Pull Rating*	Hold Rating*
1502	12/24 VDC	10 lbs (44 N)	24 lbs (107 N)
1502ES	12/24 VDC	10 lbs (44 N)	28 lbs (125 N)
1504	12/24 VDC	12 lbs (53 N)	19 lbs (85 N)

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

Return Spring

Model	Force @ 1"
S1 Light	2.0-6.7 lbs
S2 Medium	4.0-8.4 lbs



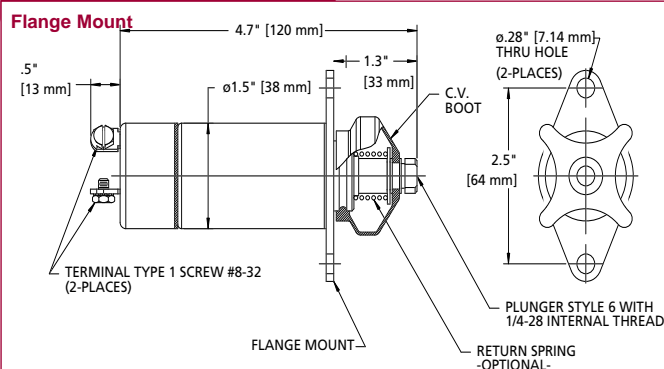
Order Information: Complete the following model descriptions to build your Order No.

()	()	()	()	()	()	()	()
Model No.	Volts	Mounting Style	Plunger Type	Grounding (No. of Terminals)	Termination Type	Boot Type	Return Spring (Force @ 1")
1502	12 12 VDC	A Flange	2 Ext. Thread ¼-28	G Grounded (1 Terminal)	1 Screw	B1 Constant Volume Epichlorohydrin	S1 Light (2.0-6.7 lbs)
1502ES Note: 1502ES offers Base Mounting, Ungrounded Terminals and Screw Type Termination only	24 24 VDC	B Thread	3 Ext. Thread M-6	U Ungrounded 1502 and 1504: (2 Terminals) 1502ES: (3 Terminals or Wire Leads)	2 Spade	B2 Bellows Silicone Rubber	S2 Medium (4.0-8.4 lbs)
1504		C Base	6 Int. Thread ¼-28		L 3 Wire Leads	B4 Bellows Silicone Rubber	
		D Flange	7 Int. Thread M-6			B5 Constant Volume Silicone Rubber	

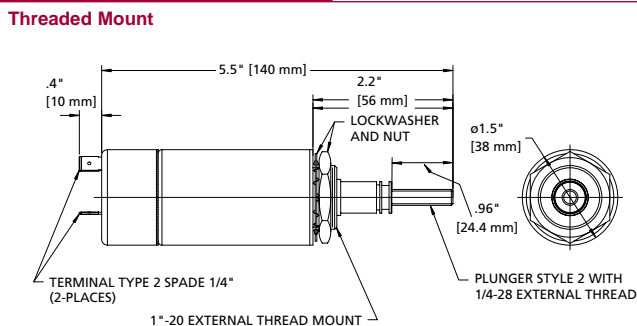
When you order: Add A to your order number for the Aux Terminal option available on internally switched models. Certain combinations may not be standard models. Please contact factory to determine whether a custom-built model is required for your application.

Mounting Styles:

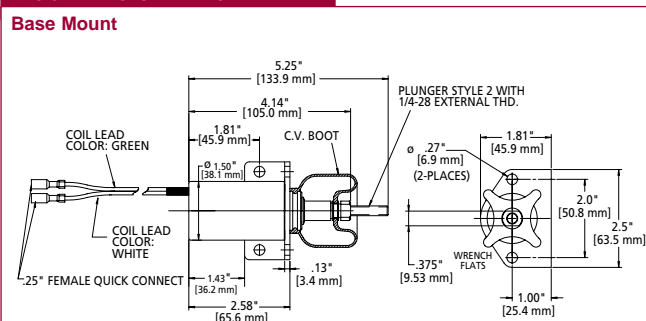
MOUNTING STYLE A



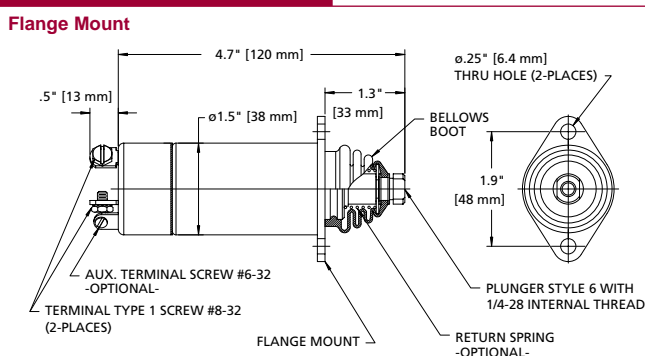
MOUNTING STYLE B



MOUNTING STYLE C



MOUNTING STYLE D



Specifications:

Temperature Range

-40°F to +250°F
(-40°C to +121°C)

Weight

1.0 lbs (0.5 kg)

Model	Rated Voltage	Rated Stroke	Pull Current	Hold Current	Pull Rating*	Hold Rating*	Coil Winding
1502	12 VDC	1" (25.4 mm)	30 A	0.7 A	10 lbs (44 N)	24 lbs (107 N)	Parallel
1502	24 VDC	1" (25.4 mm)	16 A	0.24 A	10 lbs (44 N)	24 lbs (107 N)	Parallel
1502ES	12 VDC	1" (25.4 mm)	30 A	0.7 A	10 lbs (44 N)	28 lbs (125 N)	Parallel
1502ES	24 VDC	1" (25.4 mm)	16 A	0.24 A	10 lbs (44 N)	28 lbs (125 N)	Parallel
1504	12 VDC	1" (25.4 mm)	41 A	0.76 A	12 lbs (53 N)	19 lbs (85 N)	Parallel
1504	24 VDC	1" (25.4 mm)	22 A	0.37 A	12 lbs (53 N)	19 lbs (85 N)	Parallel

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

Specifications are for reference only.

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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)

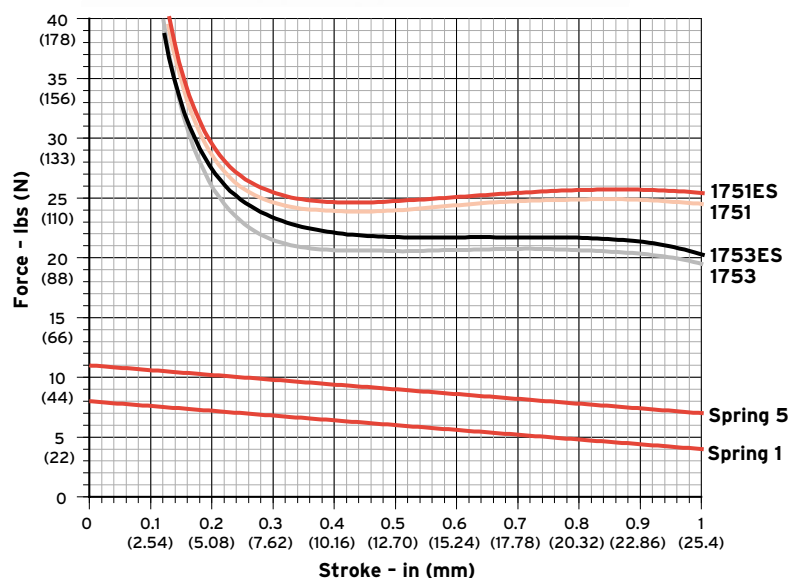


Model	Rated Voltage	Pull Rating*	Hold Rating*
1751	12/24 VDC	24 lbs (107 N)	38 lbs (169 N)
1751ES	12/24 VDC	25 lbs (111 N)	41 lbs (182 N)
1753	12/24 VDC	19 lbs (85 N)	42 lbs (187 N)
1753ES	12/24 VDC	20 lbs (89 N)	43 lbs (191 N)

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

Return Spring

Model	Force @ 1"
S1 Light	4-8 lbs
S5 Medium	7-11 lbs



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

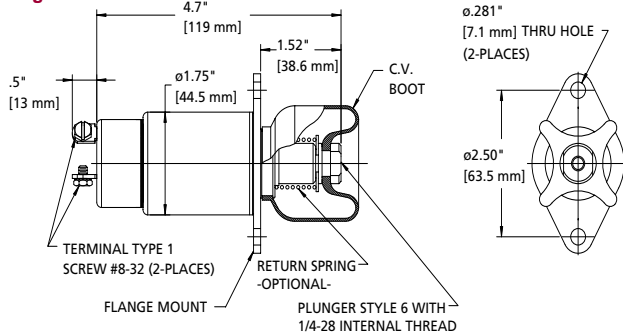
()	-	()	()	()	()	()	()
Model No.	Volts	Mounting Style	Plunger Type	Grounding (No. of Terminals)	Termination Type	Boot Type	Return Spring (Force @ 1")
1751	12 12 VDC	A Flange	2 Ext. Thread ¼-28	U Ungrounded 1751 and 1751ES: (3 Terminals or Wire Leads) 1751, 1753 and 1753ES: (2 Terminals)	1 Screw (1751 and 1753 only)	B1 Constant Volume Silicone Rubber	S1 Light (4-8 lbs)
1751ES	24 24 VDC	E Base	3 Ext. Thread M-6		2 Spade (1751 and 1753 only)	B2 Bellows Silicone Rubber	S5 Medium (7-11 lbs) Available on 1751 and 1751ES only
1753			6 Int. Thread ¼-28		L 3 Wire Leads	B4 Bellows Silicone Rubber	
1753ES			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.

Mounting Styles:

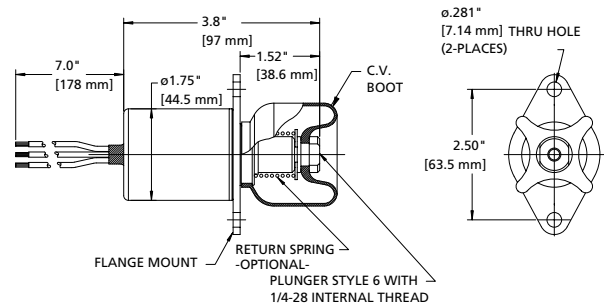
MOUNTING STYLE A

Flange Mount



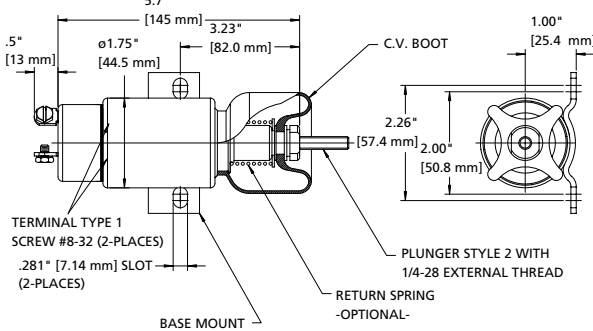
MOUNTING STYLE A

Flange Mount / External Switch



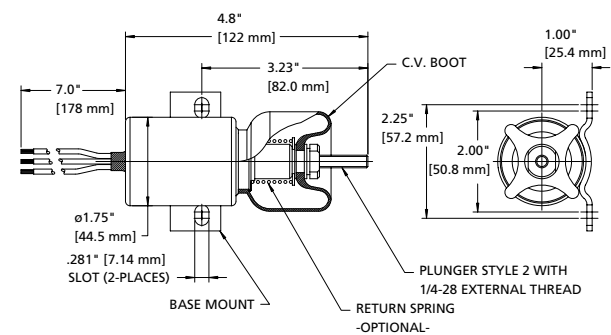
MOUNTING STYLE E

Base Mount



MOUNTING STYLE E

Base Mount / External Switch



Specifications:

Temperature Range

-40°F to +250°F
(-40°C to +121°C)

Weight

1.5 lbs (0.7 kg)

Model	Rated Voltage	Rated Stroke	Pull Current	Hold Current	Pull Rating*	Hold Rating*	Coil Winding
1751	12 VDC	1" (25.4 mm)	46 A	1.1 A	24 lbs (107 N)	38 lbs (169 N)	Parallel
1751	24 VDC	1" (25.4 mm)	25 A	0.5 A	24 lbs (107 N)	38 lbs (169 N)	Parallel
1751ES	12 VDC	1" (25.4 mm)	46 A	1.1 A	25 lbs (111 N)	41 lbs (182 N)	Parallel
1751ES	24 VDC	1" (25.4 mm)	25 A	0.5 A	25 lbs (111 N)	41 lbs (182 N)	Parallel
1753	12 VDC	1" (25.4 mm)	33 A	0.8 A	19 lbs (85 N)	42 lbs (187 N)	Parallel
1753	24 VDC	1" (25.4 mm)	18 A	0.4 A	19 lbs (85 N)	42 lbs (187 N)	Parallel
1753ES	12 VDC	1" (25.4 mm)	33 A	0.8 A	20 lbs (89 N)	43 lbs (191 N)	Parallel
1753ES	24 VDC	1" (25.4 mm)	18 A	0.4 A	20 lbs (89 N)	43 lbs (191 N)	Parallel

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

Specifications are for reference only.

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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)

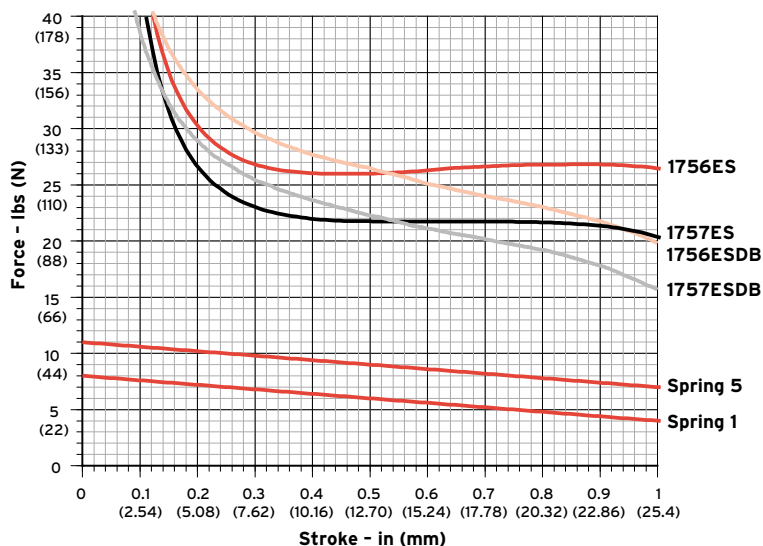


Model	Rated Voltage	Push Rating*	Hold Rating*
1756ES	12/24 VDC	26 lbs (116 N)	35 lbs (156 N)
1756ESDB	12/24 VDC	20 lbs (89 N)	53 lbs (236 N)
1757ES	12/24 VDC	20 lbs (89 N)	37 lbs (165 N)
1757 ESDB	12/24 VDC	16 lbs (71 N)	56 lbs (249 N)

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

Return Spring

Model	Force @ 1"
S1 Light	4-8 lbs
S5 Medium	7-11 lbs



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")
1756ES	12 12 VDC	A Flange	2 Ext. Thread ¼-28	U Ungrounded (3 Terminals or Wire Leads)	L 3 Wire Leads	B1 Constant Volume Silicone Rubber Not available on ESDB models	S1 Light (4-8 lbs)
1756 ESDB	24 24 VDC	E Base	3 Ext. Thread M-6		C Connector attached to 3 Wire Leads Note: Contact factory for type and availability	B2 Bellows Silicone Rubber	S5 Medium (7-11 lbs) Available on 1756ES and 1756ESDB only
1757ES						B4 Bellows Silicone Rubber	
1757 ESDB							

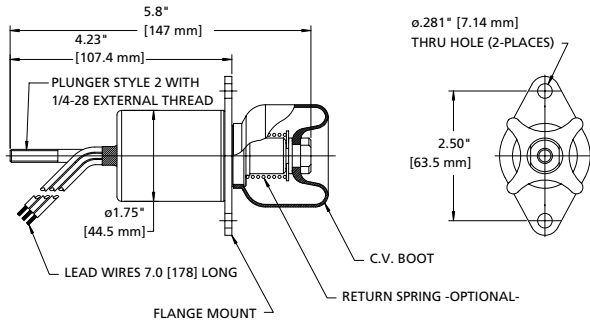
When you order: Certain combinations may not be standard models. Please contact factory to determine whether a custom-built model is required for your application.

1750 Push Series

Mounting Styles:

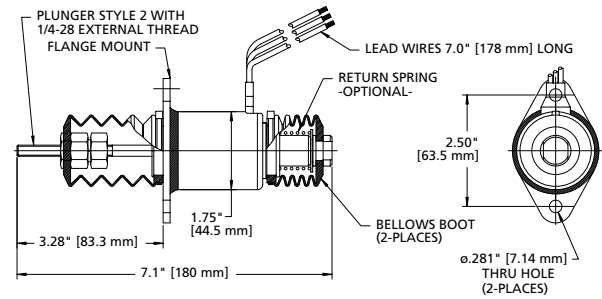
MOUNTING STYLE A

Flange Mount / External Switch



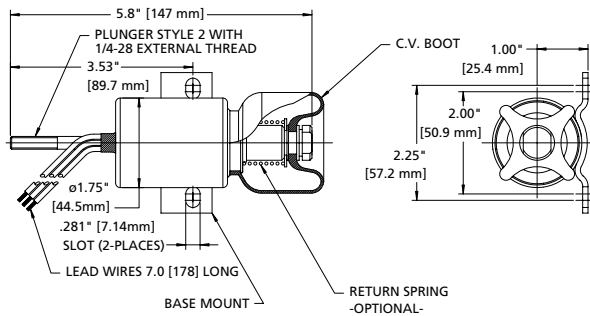
MOUNTING STYLE A

Flange Mount / External Switch, Double Boot



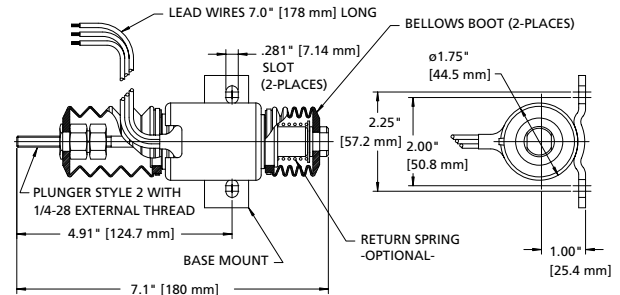
MOUNTING STYLE E

Base Mount / External Switch



MOUNTING STYLE E

Base Mount / External Switch, Double Boot



Specifications:

Temperature Range

-40°F to +250°F
(-40°C to +121°C)

Weight

1.5 lbs (0.7 kg)

Model	Rated Voltage	Rated Stroke	Push Current	Hold Current	Push Rating*	Hold Rating*	Coil Winding
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.

e-mail: info_niles@woodward.com

2000 Series

Models 2001, 2001ES, 2003, 2003ES
dual coil solenoids

Pull Force Range: 21-29 lbs (93-129 N)

Hold Force Range: 41-51 lbs (182-227 N)

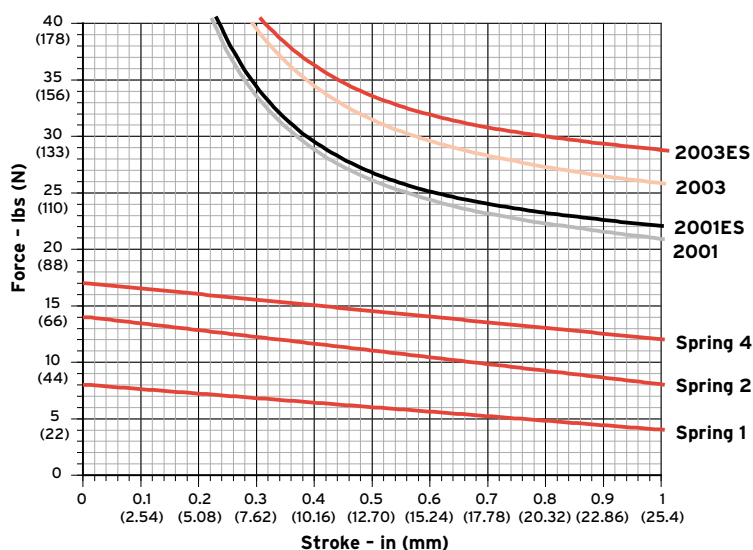


Model	Rated Voltage	Pull Rating*	Hold Rating*
2001	12/24 VDC	21 lbs (93N)	49 lbs (218 N)
2001ES	12/24 VDC	22 lbs (98 N)	43 lbs (191 N)
2003	12/24 VDC	26 lbs (116 N)	51 lbs (227 N)
2003ES	12/24 VDC	29 lbs (129 N)	41 lbs (182 N)

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

Return Spring

Model	Force @ 1"
S1 Light	4-8 lbs
S2 Medium	8-14 lbs
S4 Heavy	14-17 lbs



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 12 VDC	E Base	2 Ext. Thread 1/4-28	G Grounded (1 Terminal)	1 Screw	B1 Constant Volume Silicone Rubber	S1 Light (4-8 lbs)
2003	24 24 VDC	S* Flange	3 Ext. Thread M-6	U Ungrounded 2001 and 2003: (2 Terminals) 2001ES and 2003ES: (3 Terminals or Wire Leads)	L 3 Wire Leads Note: 2001ES and 2003ES only	B2 Bellows Silicone Rubber	S2 Medium (8-14 lbs)
2001ES			6 Int. Thread 1/4-28			B3 Constant Volume Silicone Rubber Red	S4 Heavy (12-17 lbs) Available on 2003 and 2003ES only
2003ES			7 Int. Thread M-6		C Connector attached to 3 Wire Leads Note: Contact factory for type and availability. 2001ES and 2003ES only	B4 Bellows Silicone Rubber	
						B5 Constant Volume Silicone Rubber	

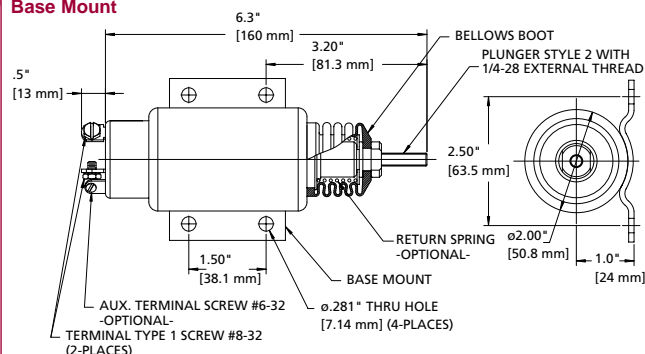
*Flange mounting not available for ES models.

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:

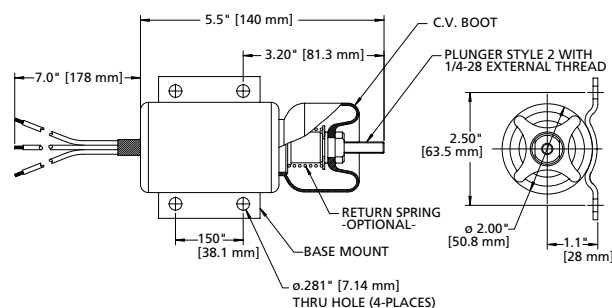
MOUNTING STYLE E

Base Mount



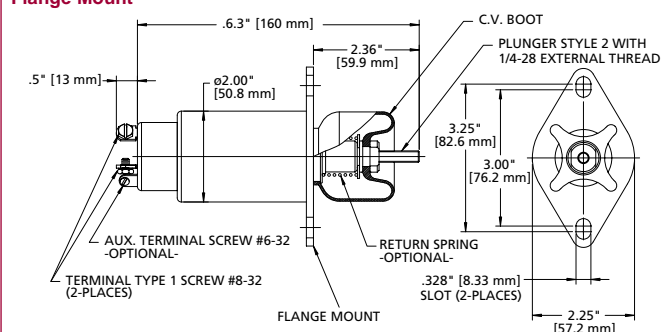
MOUNTING STYLE E

Base Mount / External Switch



MOUNTING STYLE S

Flange Mount



Specifications:

Temperature Range

-40°F to +250°F
(-40°C to +121°C)

Weight

2.5 lbs (1.2 kg)

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

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

Specifications are for reference only.

e-mail: info_niles@woodward.com

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)

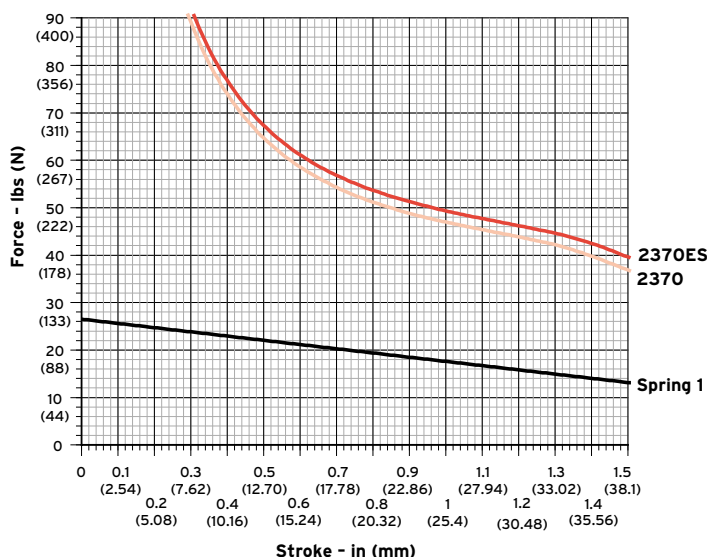


Model	Rated Voltage	Pull Rating*	Hold Rating*
2370	12/24 VDC	37 lbs (165N)	38 lbs (391 N)
2370ES	12/24 VDC	39 lbs (173 N)	88 lbs (391 N)

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

Return Spring

Model	Force @ 1"
S1 Light	17.6-26.0 lbs



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

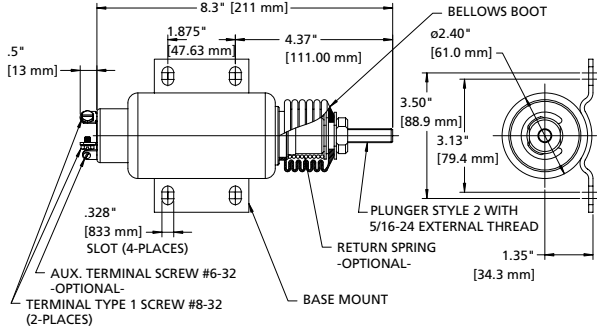
()	()	()	()	()	()	()	()
Model No.	Volts	Mounting Style	Plunger Type	Grounding (No. of Terminals)	Termination Type	Boot Type	Return Spring (Force @ 1")
2370	12 12 VDC	E Base	2 Ext. Thread 5/16-24	G Grounded (1 Terminal)	1 #8 Screw	B2 Bellows Epichlorohydrin	S1 Light (17.6-26.0 lbs)
2370ES	24 24 VDC		3 Ext. Thread M-8 x 1.25	U Ungrounded 2370: (2 Terminals) 2370ES: (3 Terminals or Wire Leads)	3 #8 Stud	B5 Constant Volume Silicone Rubber	
			6 Int. Thread 5/16-24		6 #10 Stud		
			7 Int. Thread M-8 x 1.25		L 3 Wire Leads		
					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.

Mounting Styles:

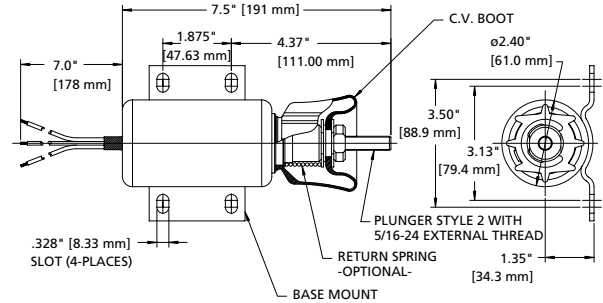
MOUNTING STYLE E

Base Mount



MOUNTING STYLE E

Base Mount / External Switch



Specifications:

Temperature Range

-40°F to +250°F
(-40°C to +121°C)

Weight

5 lbs (2.3 kg)

Model	Rated Voltage	Rated Stroke	Pull Current	Hold Current	Pull Rating*	Hold Rating*	Coil Winding
2370	12 VDC	1.5" (38.1 mm)	58 A	1.7 A	37 lbs (165 N)	88 lbs (391 N)	Series
2370	24 VDC	1.5" (38.1 mm)	31 A	0.6 A	37 lbs (165 N)	88 lbs (391 N)	Series
2370ES	12 VDC	1.5" (38.1 mm)	58 A	1.7 A	39 lbs (173 N)	92 lbs (409 N)	Parallel
2370ES	24 VDC	1.5" (38.1 mm)	31 A	0.6 A	39 lbs (173 N)	92 lbs (409 N)	Parallel

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

Specifications are for reference only.

e-mail: info_niles@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:

ORDER NO.	Voltage
SA-4744-12	12 VDC
SA-4744-24	24 VDC

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.

Technical drawing of the Cable Bulkhead Assembly (Model 378-513) showing side and end views with dimensions in inches and millimeters.

Side View Dimensions:

- .964" PLUNGER STROKE [24.5 mm]
- 5.10" REF [129.5 mm]
- 3.13" REF [79.5 mm]
- 50.40" [1280.1 mm]
- 41.08" REF [1043.4 mm]
- 4.21" REF [106.9 mm]
- 12.0" [305 mm]
- .91" REF [22.9 mm]
- 1.500" [38.10 mm]
- 2.25" [57.2 mm]
- 1.375" HEX REF [34.93 mm]
- 9/16-18 NUT
- 1.179" [29.95 mm]
- .135" [3.42 mm]
- 2.756" [70.00 mm]
- 3.39" [86.1 mm]
- 1.179" [29.95 mm]
- .135" [3.42 mm]
- 2.756" [70.00 mm]
- 3.39" [86.1 mm]

End View Dimensions:

- 1.179" [29.95 mm]
- .135" [3.42 mm]
- 2.756" [70.00 mm]
- 3.39" [86.1 mm]
- 1.179" [29.95 mm]
- .135" [3.42 mm]
- 2.756" [70.00 mm]
- 3.39" [86.1 mm]

Other Labels:

- NOMINAL SUPPORT BRACKET LOCATION FOR CABLE BULKHEAD. BRACKET LOCATION TO BE ADJUSTED BY CUSTOMER. (BRACKET NOT SUPPLIED)
- ø.237" [6.02 mm]
- ø.47" REF [11.9 mm]
- ø.41" REF [10.4 mm]
- ø.345" HOLE THRU [8.76 mm] (4-PLACES)
- PAT.#378,513
- "E-BASE"
- ø.203" MAX [51.6 mm]

23

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:

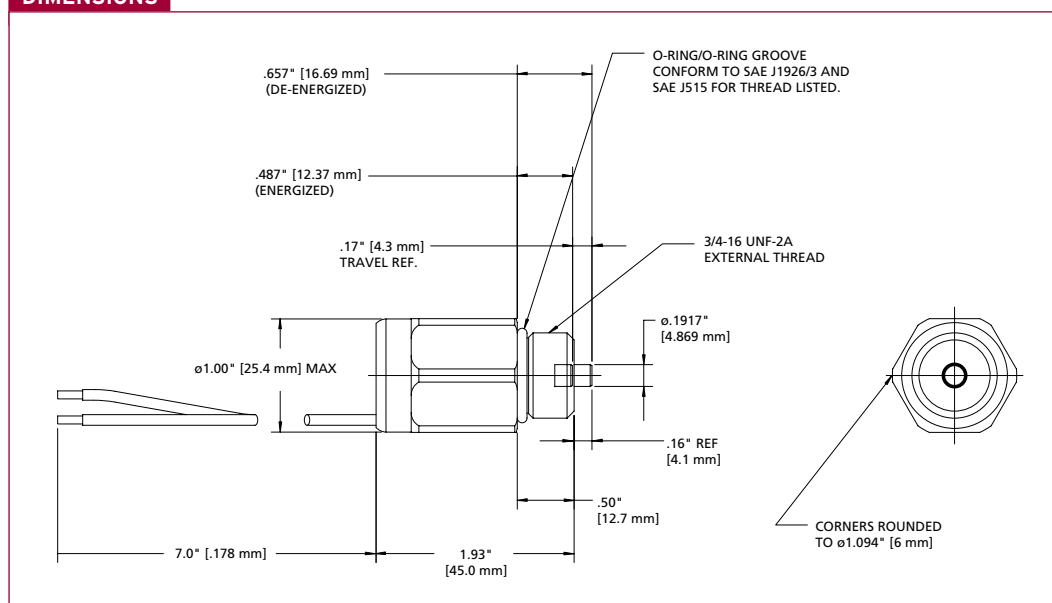
- Single coil construction for simple electrical interface
- Hardened, stainless steel pin resists high shear load and increases fatigue resistance
- Nickel plated plunger ensures smooth, reliable operation, as well as corrosion and wear resistance
- Protective brass liner plunger bore provides longer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

Order Information:

ORDER NO.	Model
SA-4971	Continuous
SA-4972	PWM

1000S Series Locking Solenoid

DIMENSIONS



Specifications:

SA-4971

SA-4972

Rated Voltage	12 VDC	12 VDC
Rated Temperature	68 °F (20 °C)	68 °F (20 °C)
Temperature Range	-40 °F to +185 °F (-40 °C to +85 °C)	-40 °F to +235 °F (-40 °C to +113 °C)
Rated Stroke	0.17" (4.32 mm)	0.17" (4.32 mm)
Pull Current	100% duty @ 0.7 A	2 A max for 0.2 sec
Hold Current	100% duty @ 0.7 A	PWM 1.0 A average
Duty Cycle	100% @ 15.5 VDC max and 185 °F (85 °C)	15% @ 16 VDC
Pull Force	Solenoid must pull in plunger against return spring at 9.5 VDC and 320 °F (160 °C) coil tem- perature, with no side load on plunger pin	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
Hold Force	Solenoid must hold in plunger against return spring at 9.5 VDC and 320 °F (160 °C) coil temperature	Solenoid must hold in plunger against return spring at 16 VDC, 15% duty cycle, 1000 Hz PWM signal, and 235 °F (113 °C)
Pull Coil Resistance	17.8 ohms ± 10%	5.55 ohms ± 5%

Specifications are for reference only.

e-mail: info_niles@woodward.com

1503S Series

Typically designed for continuous duty, with single coil performing both the pull and hold function for the solenoid.



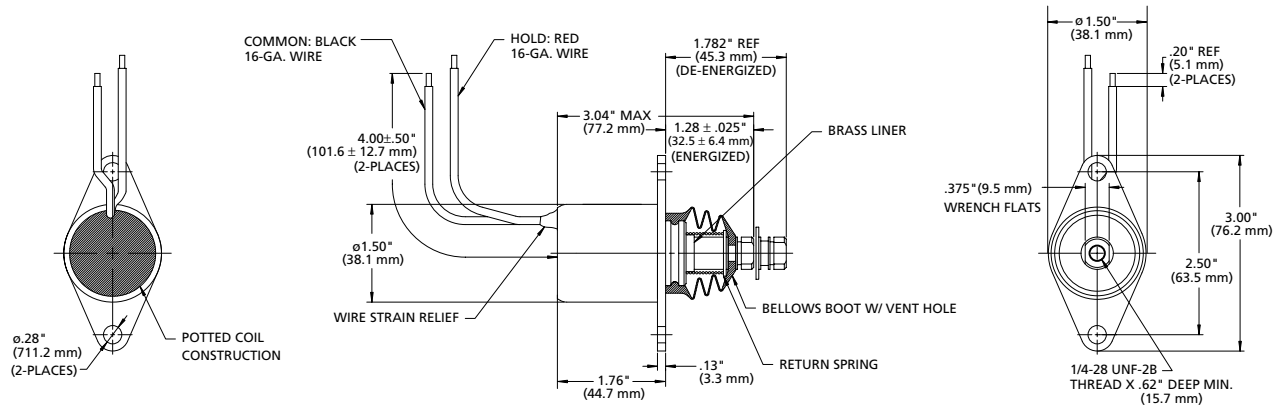
Features:

- 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:

ORDER NO.	Model	Termination
SA-4741	0151	Leads

SA-4741



Specifications:

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

Specifications are for reference only.

e-mail: info_niles@woodward.com

2370S Series

Typically designed for continuous duty, with single coil performing both the pull and hold function for the solenoid.



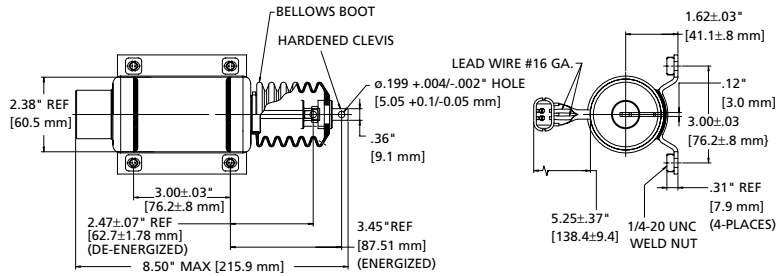
Features:

- 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:

ORDER NO.	Model	Voltage	Termination
SA-4973	0237P	24 VDC	Packard Metri-Pack 280 Series
SA-4974	0237	24 VDC	Leads
SA-4975	0237P	12 VDC	Packard Metri-Pack 280 Series

DIMENSIONS



Specifications:

SA-4973

SA-4974

SA-4975

Rated Voltage	24 VDC	24 VDC	12 VDC
Rated Current	3.3 A	3.3 A	4.3 A
Rated Temperature	68°F (20°C)	68°F (20°C)	68°F (20°C)
Nominal Rated Stroke	0.85" (21.6 mm)	0.85" (21.6 mm)	0.85" (21.6 mm)
Temperature Range	-40°F to 250°F (-40°C to 121°C)	-40°F to 250°F (-40°C to 121°C)	-40°F to 250°F (-40°C to 121°C)
Vibration	2 G's @ 11-100 Hz	2 G's @ 11-100 Hz	2 G's @ 11-100 Hz
Shock	20 G's for 20 msec	20 G's for 20 msec	20 G's for 20 msec
Duty Cycle	Continuous up to 28 VDC & 220°F (104°C)	Continuous up to 28 VDC & 220°F (104°C)	Continuous up to 14 VDC & 220°F (104°C)
Pull Force*	N/A	16 lbs (71.2 N)	N/A
Push Force*	16 lbs (71.2 N)	N/A	12 lbs (53.4 N)
Pull Coil Resistance	7.25 ohms ± 10%	7.25 ohms ± 10%	7.25 ohms ± 10%

* At rated voltage, rated stroke and 68°F (20°C)

Timer Module Basics

- 5-Wire Coil Commander®
- 6-Wire Coil Commander®
- 7-Wire SSR Coil Commander®
- Pull Coil Timer Modules



Timer Modules

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.

Timer modules protect Woodward solenoids from burnout caused by engine over cranking or the misadjustment of linkages. The protective modules energize and de-energize the solenoid pull coil within approximately 1½ seconds.

Woodward makes two types of 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 1½ 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)

	Continuous	Intermittent
12 VDC	2 cycles/minute	4 cycles/minute for 5 minutes
24 VDC	1 cycle/minute	3 cycles/minute for 5 minutes

PCTM Modules

These timers protect externally switched solenoids by limiting the pull coil ON time to ½ second. Use of the PCTM provides enhanced solenoid performance, as an externally switched unit performs like 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 ½ 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

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

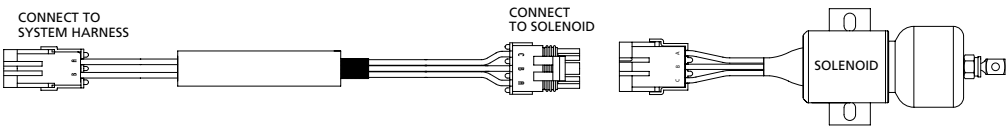
Built-in Modules

Contact Woodward for factory assembled units

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

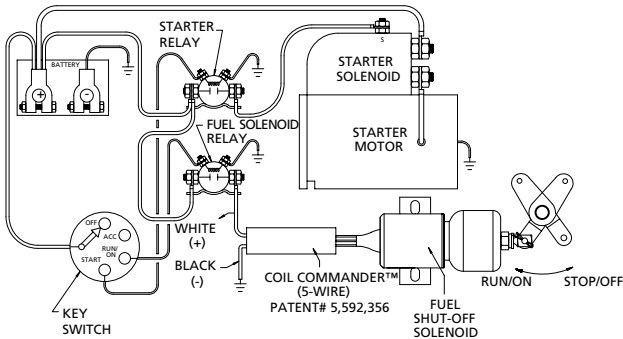
5-Wire Coil Commander®

TERMINATION CONNECTIONS



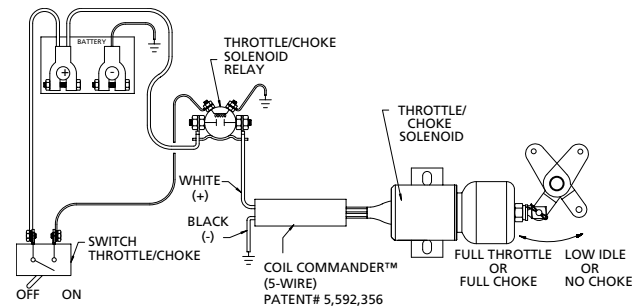
ELECTRIC SHUTOFF

Electric shutoff with dedicated relay for fuel solenoid

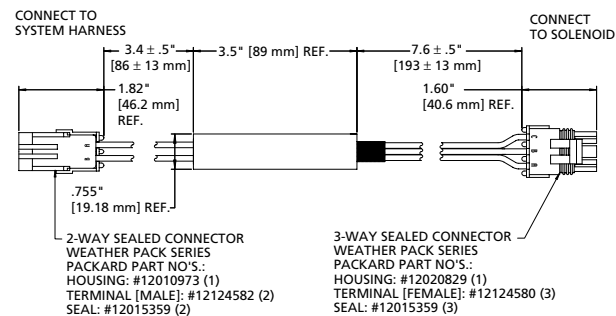


THROTTLE/CHOKE SOLENOID

Throttle/choke solenoid with dedicated relay for fuel solenoid



DIMENSIONS



Note: Coil Commanders will reduce the available pull coil voltage by approximately ½ to 1 volt.

Specifications:

Temperature	-40°F to +250°F (-40°C to +121°C)	
Vibration	15 G's @ 15-2000 Hz	
Rated Voltage	12 Volt	24 Volt
Minimum Input Voltage @ 68° F (20°C)	9 VDC	18 VDC
Rated Jump Start Voltage (<5 min)	24 VDC	48 VDC
Reverse Polarity Protection	None	
Weight	Approx. 4 oz. (113 g)	

Specifications are for reference only.

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®

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

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

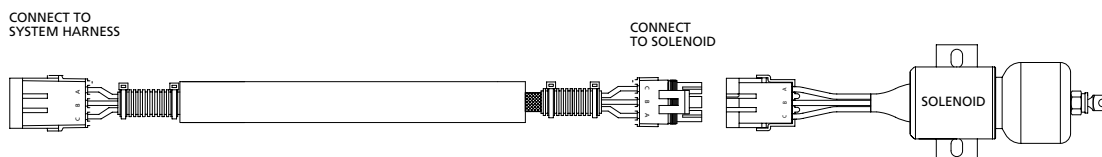
*For use with Kubota 1503ES solenoids

Built-in Modules

Contact Woodward for factory assembled units

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

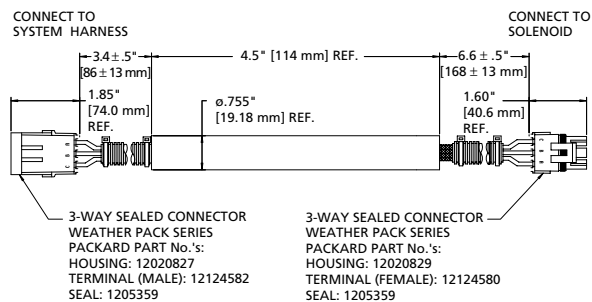
TERMINATION CONNECTIONS



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.

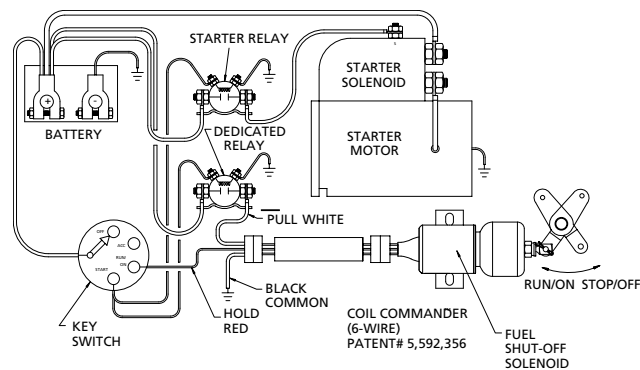
6-Wire Coil Commander®

DIMENSIONS



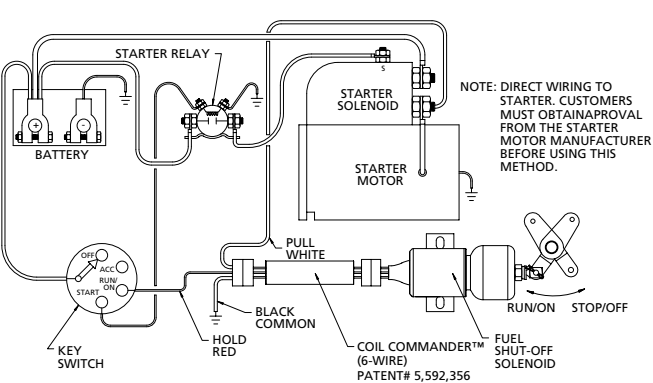
ELECTRIC SHUTOFF

Electric shutoff with dedicated relay for fuel solenoid



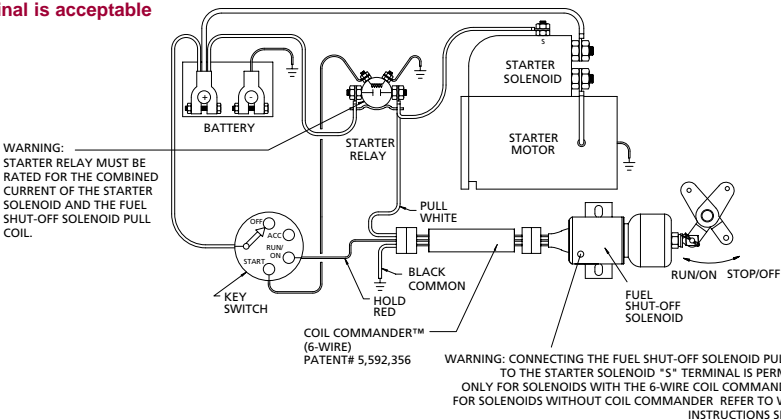
THROTTLE/CHOKE SOLENOID

Throttle/choke solenoid shown with Coil Commander wired to starter. This method requires approval from the starter motor manufacturer.



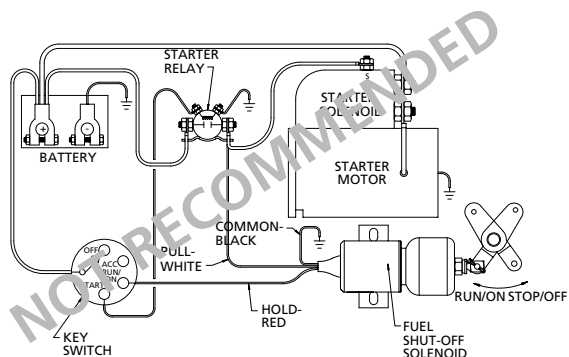
RECOMMENDED CONNECTION

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



NON-RECOMMENDED CONNECTION

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



Note: Coil Commanders will reduce the available pull coil voltage by approximately ½ to 1 volt.

Specifications:

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

Specifications are for reference only.

e-mail: info_niles@woodward.com

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

ORDER NO.	Rated Voltage	Max. Current @ 68°F (20°C)	Terminations To System Harness	Terminations To Solenoid
SA-4690-12	12 VDC	70 A	Leads	Leads
SA-4690-24	24 VDC	40 A	Leads	Leads
SA-4691-24	24 VDC	60 A	Leads	Leads
SA-4727-12	12 VDC	86 A	Packard Weather Pack Housing No. 12020827	Packard Weather Pack Housing No. 12020832
SA-4727-24	24 VDC	56 A	Packard Weather Pack Housing No. 12020827	Packard Weather Pack Housing No. 12020832

Built-in Modules

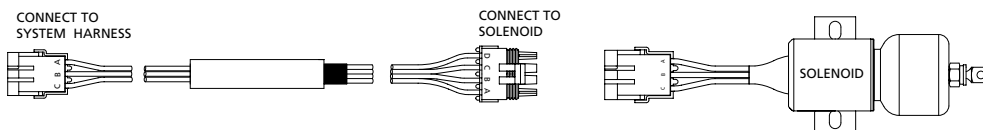
Contact Woodward for factory assembled units.

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.

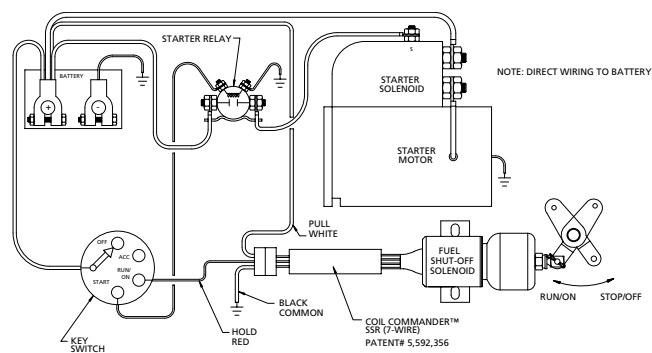
7-Wire SSR Coil Commander®

TERMINATION CONNECTIONS



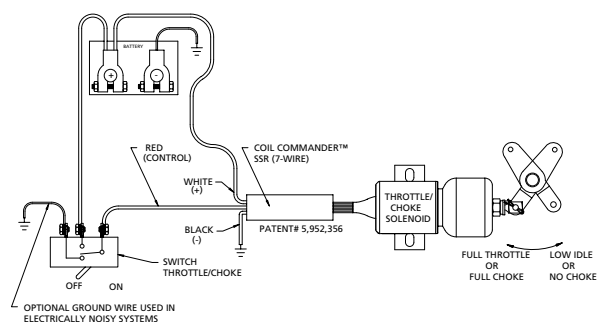
SSR ELECTRIC SHUTOFF

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

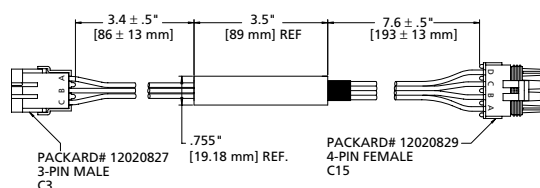


SSR THROTTLE/CHOKE SOLENOID

SSR throttle/choke solenoid eliminates need for mechanical relay



DIMENSIONS



Note: Coil Commanders® will reduce the available pull coil voltage by approximately ½ to 1 volt.

Specifications:

Temperature	-40°F to +250°F (-40°C to +121°C)	
Vibration	15 G's @ 15-2000 Hz	
Rated Voltage	12 Volt	24 Volt
Minimum Input Voltage @ 68°F (20°C)	9 VDC	18 VDC
Rated Jump Start Voltage (<5 min)	24 VDC	48 VDC
Reverse Polarity Protection	None	
Weight	Approx. 4 oz. (113 g)	

Specifications are for reference only.

e-mail: info_niles@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:

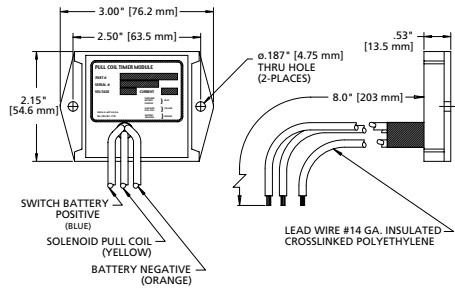
ORDER NO.	Wire Configuration	Rated Voltage	Terminations To System Harness	Terminations To Solenoid
SA-4092-12	3-Wire	12 VDC	Leads	Leads
SA-4092-24	3-Wire	24 VDC	Leads	Leads
SA-4094-12	3-Wire	12 VDC	Packard Weather Pack Housing No. 12020827	Packard Weather Pack Housing No. 12020827
SA-4094-24	3-Wire	24 VDC	Packard Weather Pack Housing No. 12020827	Packard Weather Pack Housing No. 12020827
SA-4220-12	6-Wire	12 VDC	Leads	Leads
SA-4220-24	6-Wire	24 VDC	Leads	Leads
SA-4222-12	6-Wire	12 VDC	Packard Weather Pack Housing No. 12010717	Packard Weather Pack Housing No. 12015793
SA-4222-24	6-Wire	24 VDC	Packard Weather Pack Housing No. 12010717	Packard Weather Pack Housing No. 12015793
SA-4224-12	6-Wire	12 VDC	Leads	Packard Weather Pack Housing No. 12020827
SA-4224-24	6-Wire	24 VDC	Leads	Packard Weather Pack Housing No. 12020827

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

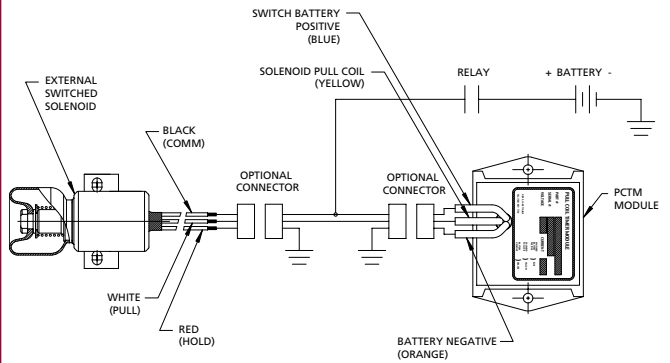
E.E.C. Directive Compliance: All parts supplied by Woodward are classified as components, and therefore are not "CE" marked. Please contact factory direct for details on specific product compliance with 89/336/EEC and 89/392/EEC directives.

3-Wire Pull Coil Timer Module

DIMENSIONS

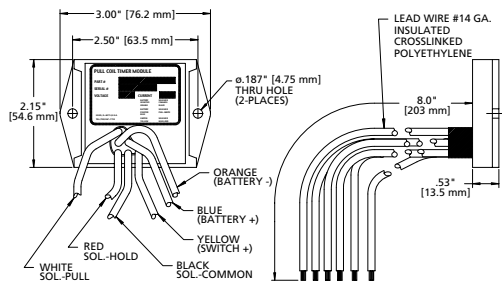


WIRING DIAGRAM

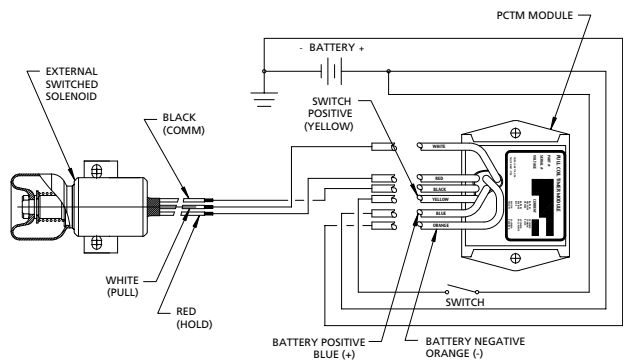


6-Wire SSR Pull Coil Timer Module

DIMENSIONS



WIRING DIAGRAM



Note: PCTM's will reduce the available pull coil voltage by approximately ½ to 1 volt.

Specifications:

Temperature	-40°F to +185°F (-40°C to +85°C)
Input Voltage	12 VDC (30 VDC jump start) 24 VDC (57 VDC jump start)
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

Specifications are for reference only.

e-mail: info_niles@woodward.com

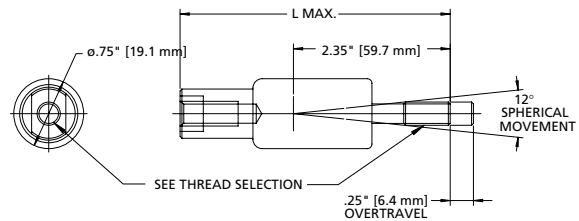
Hardware

- 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 1/4-28 or M6 male; 3.25" when using 5/16-24 male



ORDER NO.	Solenoid Model No.	Optional Return Spring
SA-3157 - () ()	1502-1504-1753	No
SA-3158 - () ()	1502-1504-1753	Yes
SA-3159 - () ()	1751-2001-2003	No
SA-3160 - () ()	1751-2001-2003	Yes

Male End of Swivel
Thread Selection

A
1/4-28

C
5/16-24

E
M6

Female End of Swivel
Thread Selection

B
1/4-28

D
5/16-24

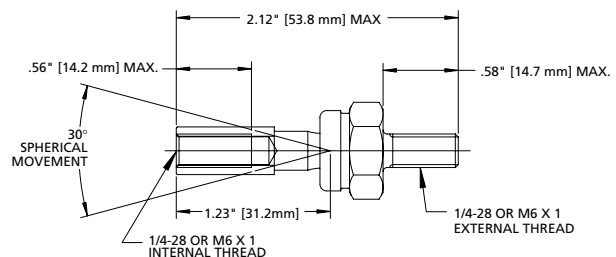
F
M6

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

ORDER NO.	Mounting Thread
SA-4049	1/4-28
SA-4050	M6 x 1



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.

ORDER NO.	Solenoid Model No.
SE-5601	1500 Series
SE-5614	1750 Series
SE-5559	2000 Series