WOODWARD

PRODUCT CATALOG 2004

SOLENOIDS | ACTUATORS | ENGINE CONTROLS

ELECTROMAGNETIC CONTROLS AND SYSTEMS

The diesel and gas engine industry worldwide is changing...and so are we.

Synchro-Start® PRODUCTS, INC.

WOODWARD™

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

Those trends include:

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

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

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

WOODWARD™

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









TABLE OF CONTENTS

Solenoid Basics

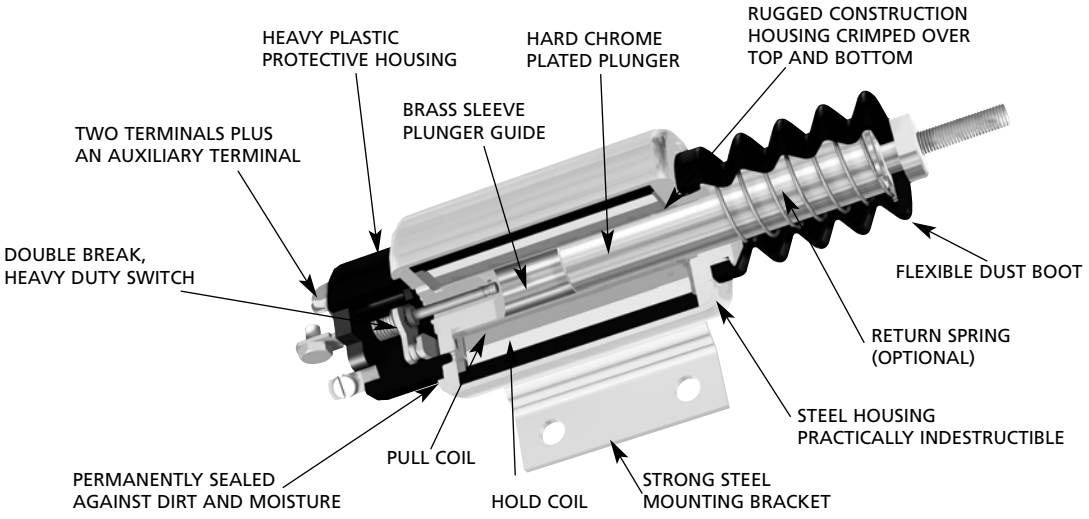
From operating engine run/stop levers, throttles, chokes, valves and clutches to protecting expensive diesel engines from overspeed, low lube pressure and high temperature, you can rely on Woodward solenoids to meet the ever-changing technical demands of modern industry.

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.

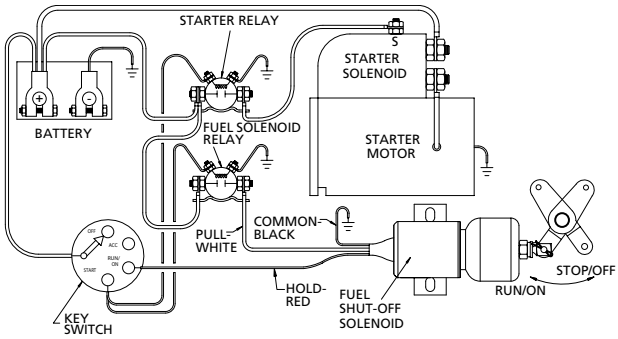
The Woodward Dual Coil Solenoid

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.



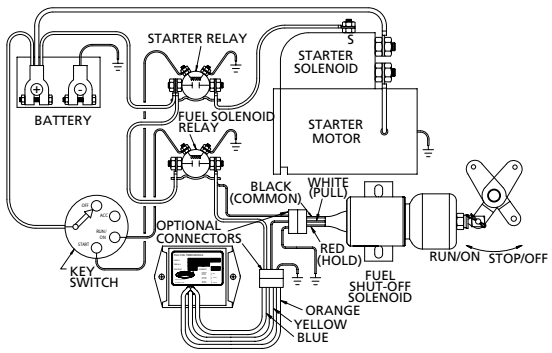
Three methods for turning off the pull coil

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.



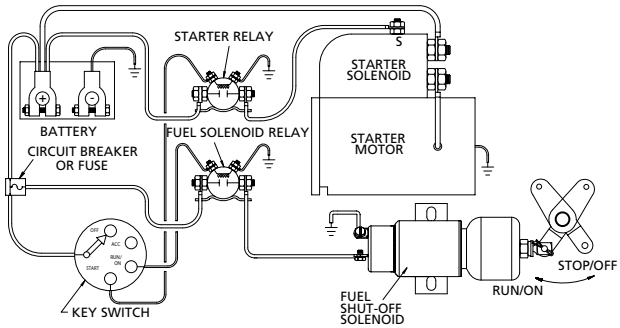
External Switching

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 ½ seconds after energizing, which prevents overheating of the coil in situations such as abusive overcranking of an engine.

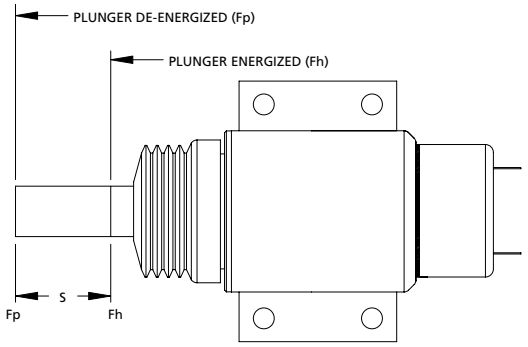


Internal Switching

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).

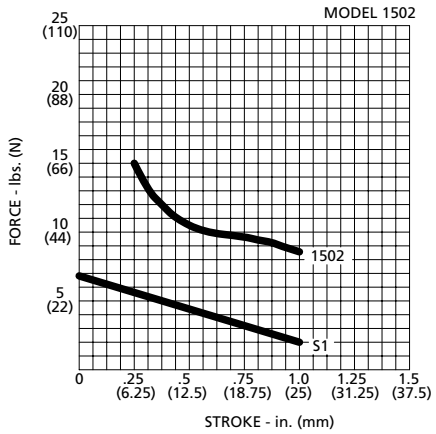
Using the formula: F = Fo x fv x ft *or* F = 9 x 1.0 x .83 = 7.47 lbs

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.

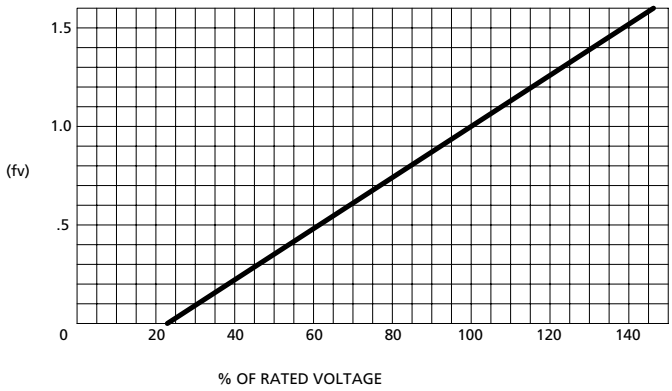
Measurements for above factors must be taken in operating conditions. For example: you must start the engine and measure the force to move the lever to the stop position. The engine governor often exerts force on the stop lever, which is not apparent on a stationary engine.

Solenoid Deration Graphs

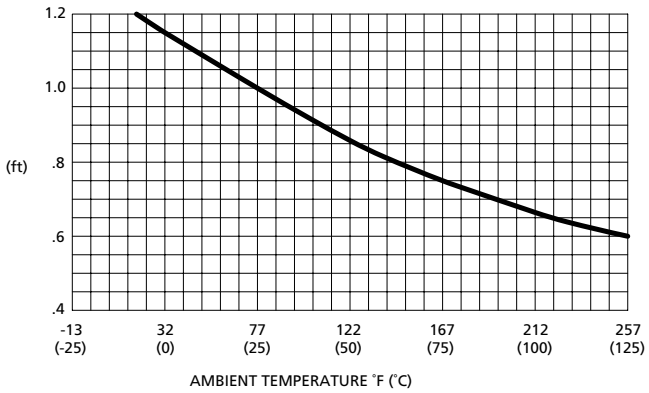
Pull vs Stroke



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 = 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

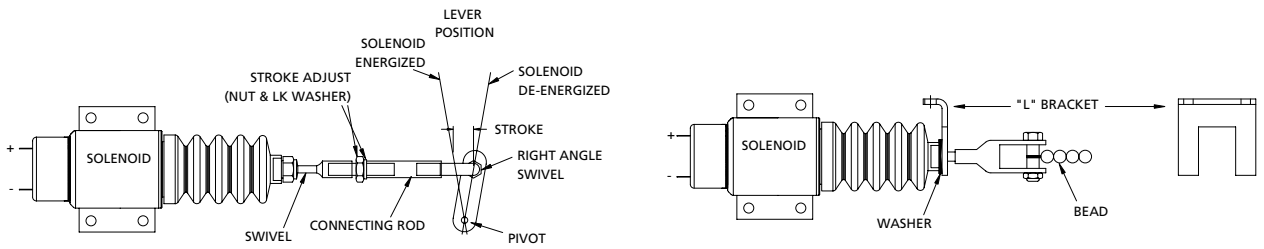
Solenoid Mounting

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.

	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	
Voltage	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	Direction Push	Pull or Push Force	Hold Force	Stroke	Page No.
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	Direction Push	Pull or Push Force	Hold Force	Stroke	Page No.
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

Notes

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

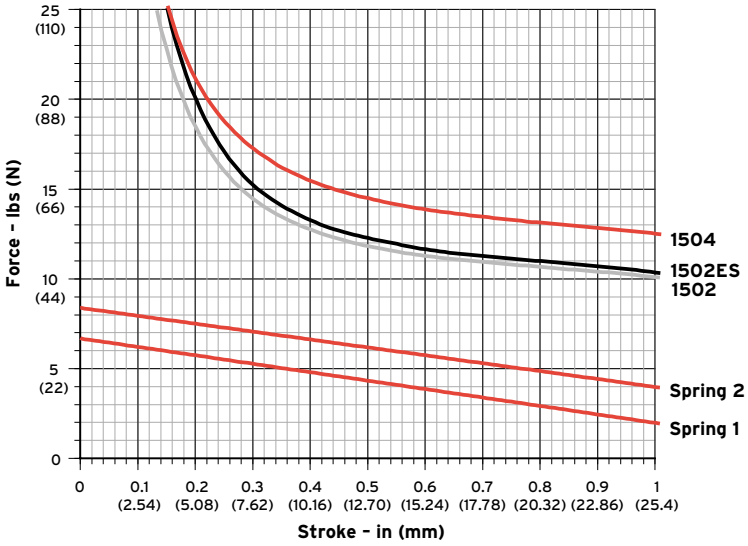
Models 1502, 1502ES & 1504 dual coil solenoids

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.
- **1502**
- **1502ES** Note: 1502ES offers Base Mounting, Ungrounded Terminals and Screw Type Termination only
- **1504**

Volts
- **12** 12 VDC
- **24** 24 VDC

Mounting Style
- **A** Flange
- **B** Thread
- **C** Base
- **D** Flange

Plunger Type
- **2** Ext. Thread ¼-28
- **3** Ext. Thread M-6
- **6** Int. Thread ¼-28
- **7** Int. Thread M-6

Grounding (No. of Terminals)
- **G** Grounded (1 Terminal)
- **U** Ungrounded 1502 and 1504: (2 Terminals) 1502ES: (3 Terminals or Wire Leads)

Termination Type
- **1** Screw
- **2** Spade
- **L** 3 Wire Leads

Boot Type
- **B1** Constant Volume Epichlorohydrin
- **B2** Bellows Silicone Rubber
- **B4** Bellows Silicone Rubber
- **B5** Constant Volume Silicone Rubber

Return Spring (Force @ 1")
- **S1** Light (2.0-6.7 lbs)
- **S2** Medium (4.0-8.4 lbs)

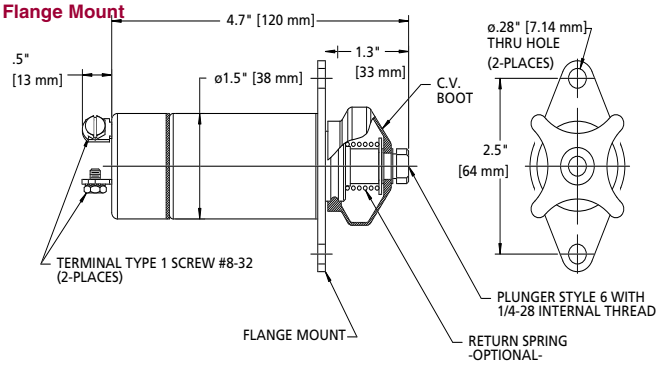
When you order: Add A to your order number for the Aux Terminal option available on internally switched models. Certain combinations may not be standard models. Please contact factory to determine whether a custom-built model is required for your application.

1500 Series

Mounting Styles:

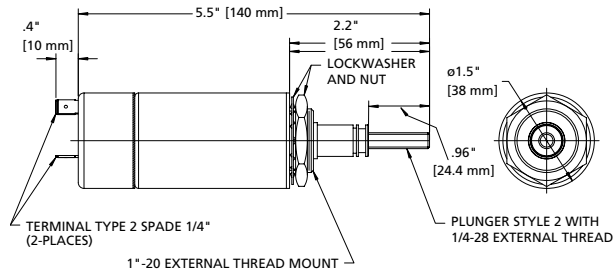
MOUNTING STYLE A

Flange Mount



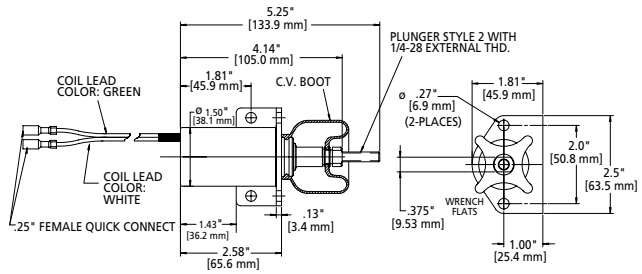
MOUNTING STYLE B

Threaded Mount



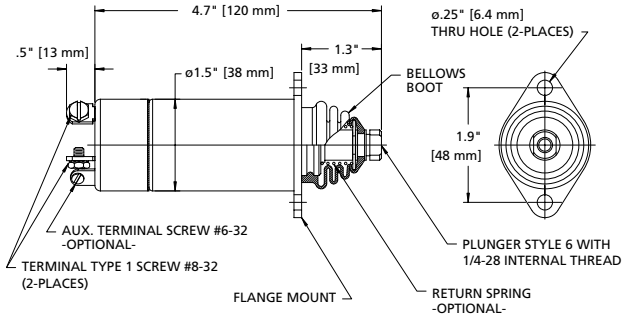
MOUNTING STYLE C

Base Mount



MOUNTING STYLE D

Flange Mount



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

Specifications are for reference only.

1750 Series

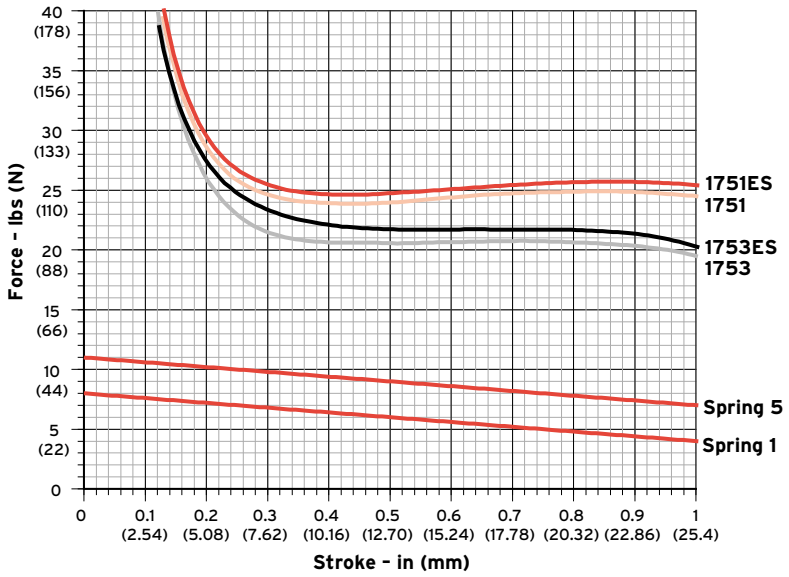
Models 1751, 1751ES, 1753 & 1753ES dual coil solenoids

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.
- **1751**
- **1751ES**
- **1753**
- **1753ES**

Volts
- **12** 12 VDC
- **24** 24 VDC

Mounting Style
- **A** Flange
- **E** Base

Plunger Type
- **2** Ext. Thread ¼-28
- **3** Ext. Thread M-6
- **6** Int. Thread ¼-28
- **7** Int. Thread M-6

Grounding (No. of Terminals)
- **U** Ungrounded
  1751 and 1751ES: (3 Terminals or Wire Leads)
  1751, 1753 and 1753ES: (2 Terminals)

Termination Type
- **1** Screw (1751 and 1753 only)
- **2** Spade (1751 and 1753 only)
- **L** 3 Wire Leads
- **C** Connector attached to 3 Wire Leads

  Note: Contact factory for type and availability

Boot Type
- **B1** Constant Volume Silicone Rubber
- **B2** Bellows Silicone Rubber
- **B4** Bellows Silicone Rubber

Return Spring (Force @ 1")
- **S1** Light (4-8 lbs)
- **S5** Medium (7-11 lbs) Available on 1751 and 1751ES only

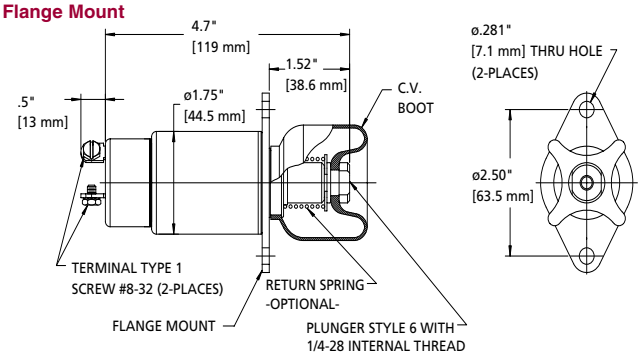
When you order: Add A to your order number for the Aux Terminal option available on internally switched models. Certain combinations may not be standard models. Please contact factory to determine whether a custom-built model is required for your application.

1750 Series

Mounting Styles:

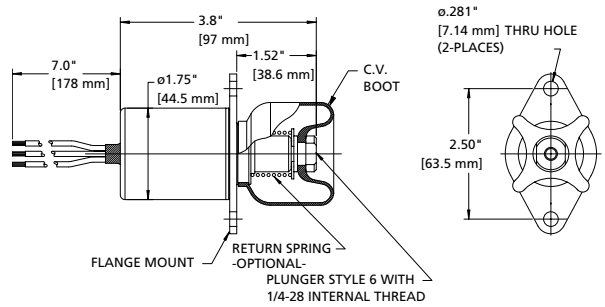
MOUNTING STYLE A

Flange Mount



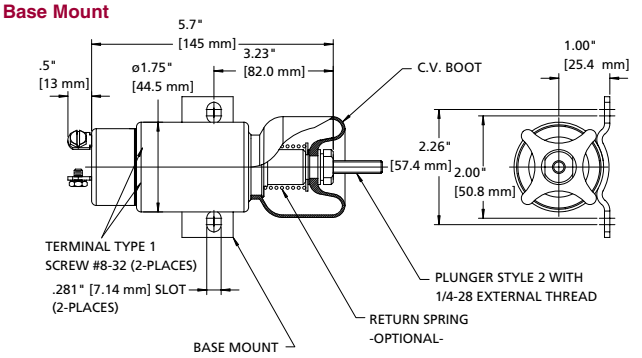
MOUNTING STYLE A

Flange Mount / External Switch



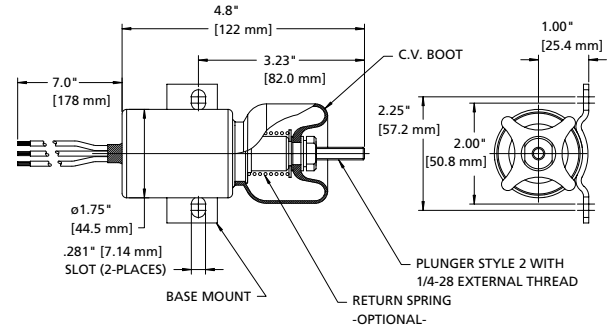
MOUNTING STYLE E

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.

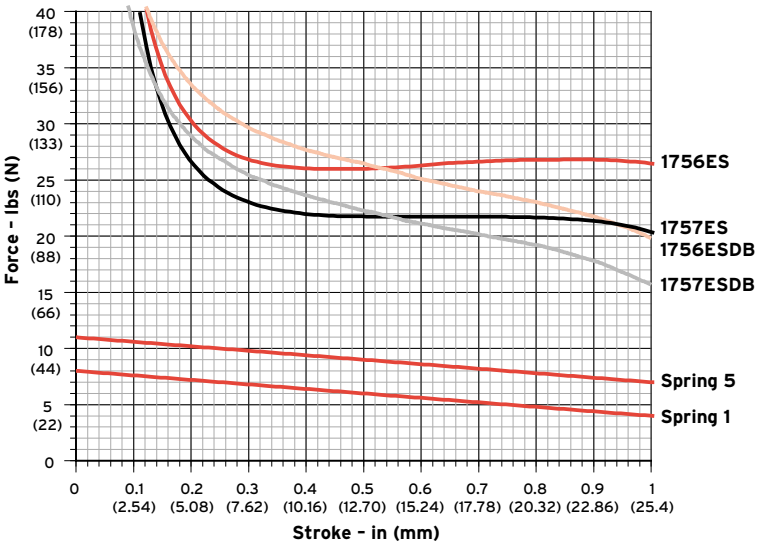
1750 Push Series

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.
- **1756ES**
- **1756 ESDB**
- **1757ES**
- **1757 ESDB**

Volts
- **12** 12 VDC
- **24** 24 VDC

Mounting Style
- **A** Flange
- **E** Base

Plunger Type
- **2** Ext. Thread ¼-28
- **3** Ext. Thread M-6

Grounding (No. of Terminals)
- **U** Ungrounded (3 Terminals or Wire Leads)

Termination Type
- **L** 3 Wire Leads
- **C** Connector attached to 3 Wire Leads
  Note: Contact factory for type and availability

Boot Type
- **B1** Constant Volume Silicone Rubber
  Not available on ESDB models
- **B2** Bellows Silicone Rubber
- **B4** Bellows Silicone Rubber

Return Spring (Force @ 1")
- **S1** Light (4-8 lbs)
- **S5** Medium (7-11 lbs)
  Available on 1756ES and 1756ESDB only

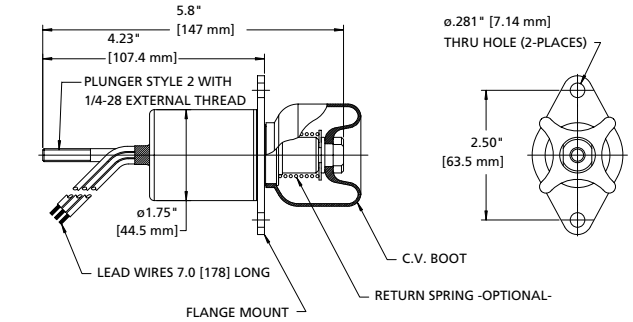
When you order: Certain combinations may not be standard models. Please contact factory to determine whether a custom-built model is required for your application.

1750 Push Series

Mounting Styles:

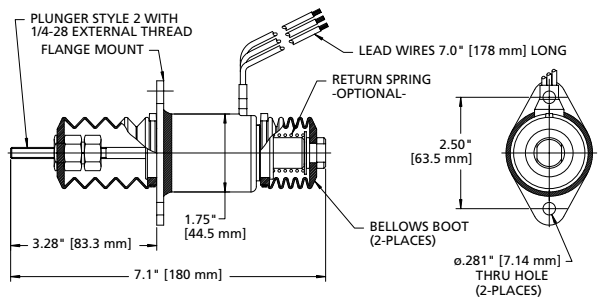
MOUNTING STYLE A

Flange Mount / External Switch



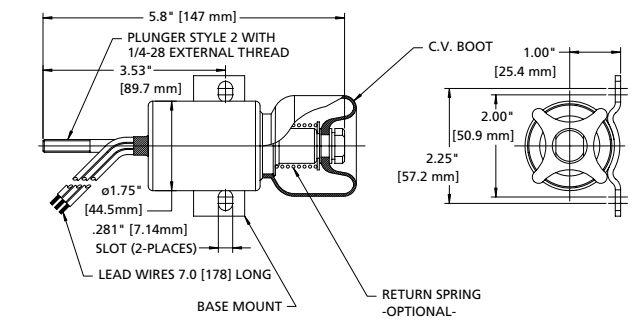
MOUNTING STYLE A

Flange Mount / External Switch, Double Boot



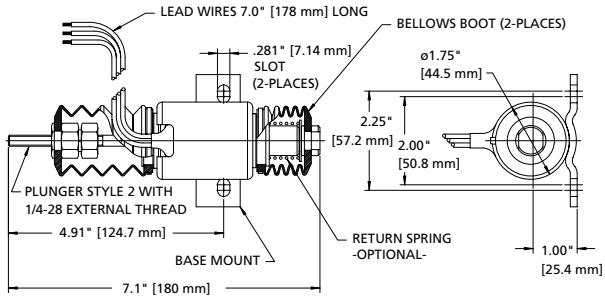
MOUNTING STYLE E

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.

2000 Series

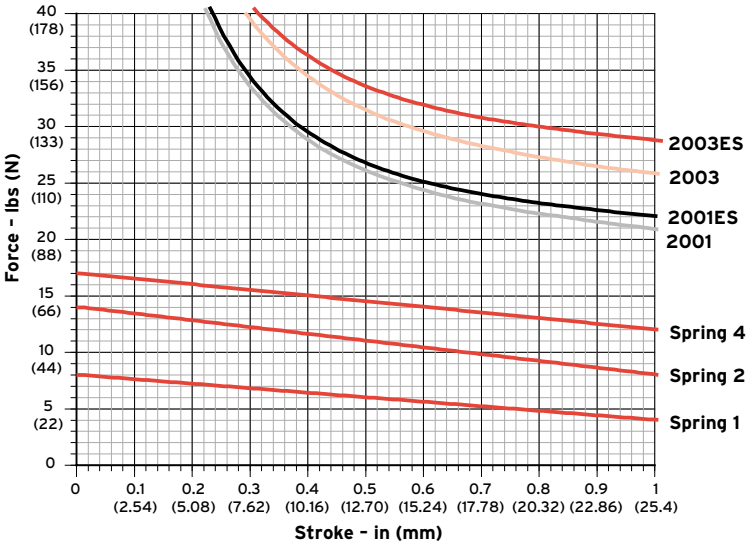
Models 2001, 2001ES, 2003, 2003ES dual coil solenoids

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.
- **2001**
- **2003**
- **2001ES**
- **2003ES**

Volts
- **12** 12 VDC
- **24** 24 VDC

Mounting Style
- **E** Base
- **S*** Flange

Plunger Type
- **2** Ext. Thread 1/4-28
- **3** Ext. Thread M-6
- **6** Int. Thread 1/4-28
- **7** Int. Thread M-6

Grounding (No. of Terminals)
- **G** Grounded (1 Terminal)
- **U** Ungrounded
  2001 and 2003: (2 Terminals)
  2001ES and 2003ES: (3 Terminals or Wire Leads)

Termination Type
- **1** Screw
- **L** 3 Wire Leads
  Note: 2001ES and 2003ES only
- **C** Connector attached to 3 Wire Leads
  Note: Contact factory for type and availability. 2001ES and 2003ES only

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

Return Spring (Force @ 1")
- **S1** Light (4-8 lbs)
- **S2** Medium (8-14 lbs)
- **S4** Heavy (12-17 lbs) Available on 2003 and 2003ES only

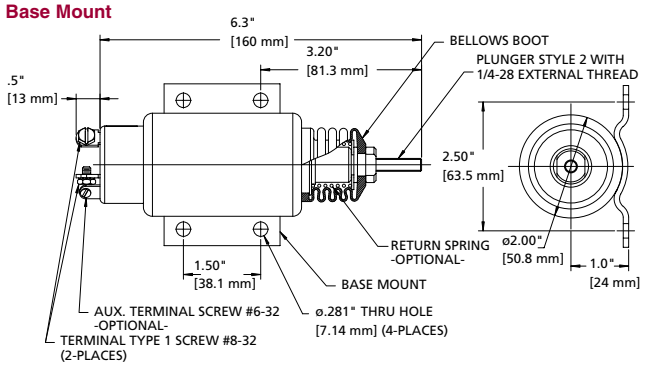
***Flange mounting not available for ES models.**

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:

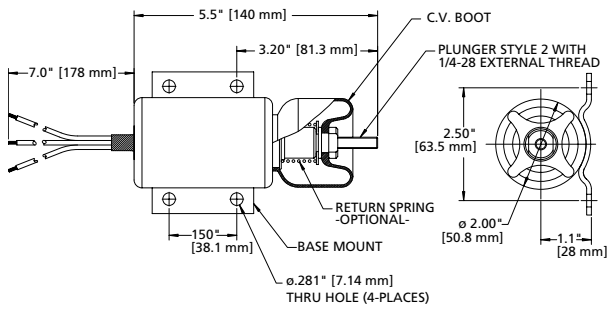
MOUNTING STYLE E

Base Mount



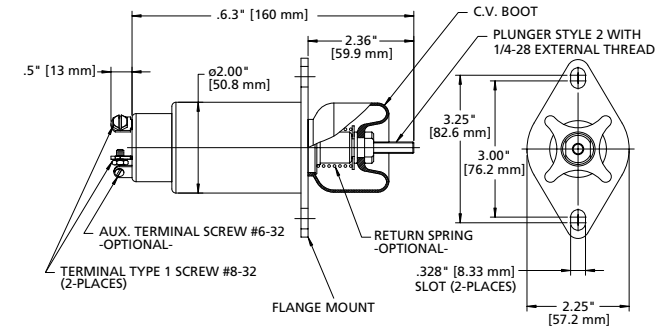
MOUNTING STYLE E

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.

2370 Series

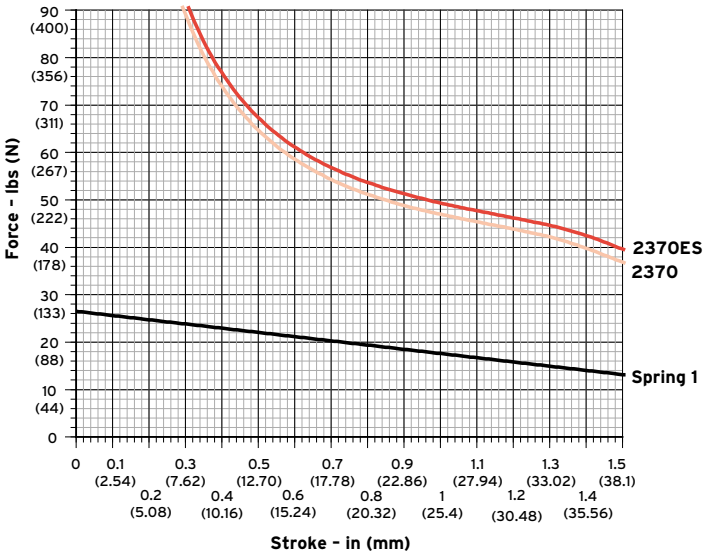
Models 2370 and 2370ES dual coil solenoids

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.
- **2370**
- **2370ES**

Volts
- **12** 12 VDC
- **24** 24 VDC

Mounting Style
- **E** Base

Plunger Type
- **2** Ext. Thread 5/16-24
- **3** Ext. Thread M-8 x 1.25
- **6** Int. Thread 5/16-24
- **7** Int. Thread M-8 x 1.25

Grounding (No. of Terminals)
- **G** Grounded (1 Terminal)
- **U** Ungrounded
  2370: (2 Terminals)
  2370ES: (3 Terminals or Wire Leads)

Termination Type
- **1** #8 Screw
- **3** #8 Stud
- **6** #10 Stud
- **L** 3 Wire Leads
- **C** Connector attached to 3 Wire Leads
  Note: Contact factory for type and availability

Boot Type
- **B2** Bellows
  Epichlorohydrin
- **B5** Constant Volume
  Silicone Rubber

Return Spring (Force @ 1")
- **S1** Light
  (17.6-26.0 lbs)

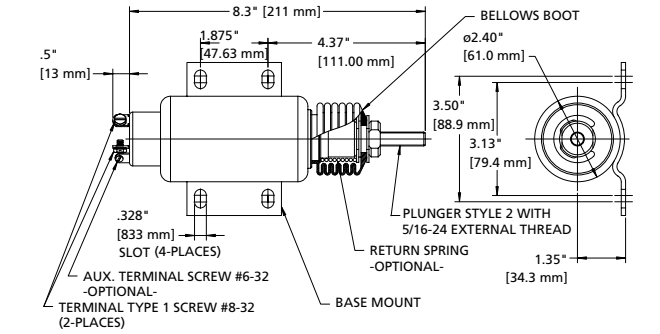
When you order: Add A to your order number for the Aux Terminal option available on internally switched models. Certain combinations may not be standard models. Please contact factory to determine whether a custom-built model is required for your application.

2370 Series

Mounting Styles:

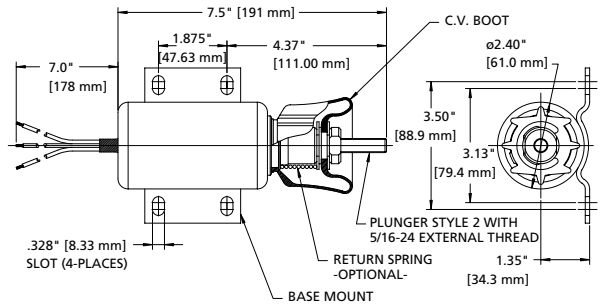
MOUNTING STYLE E

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.

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

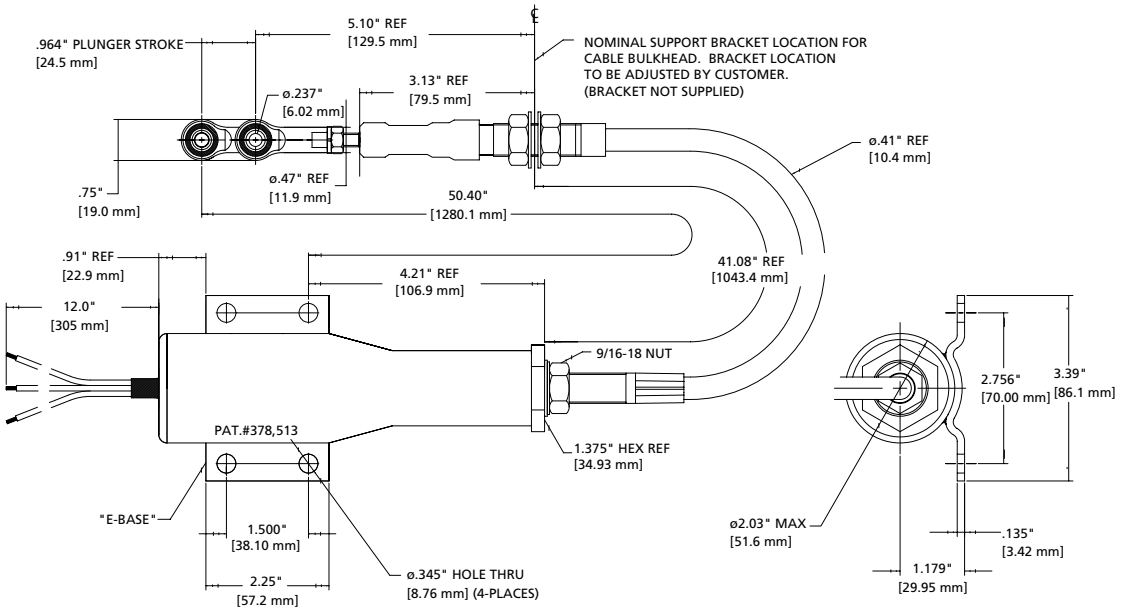
Order Information:

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.

Cable Solenoid

DIMENSIONS



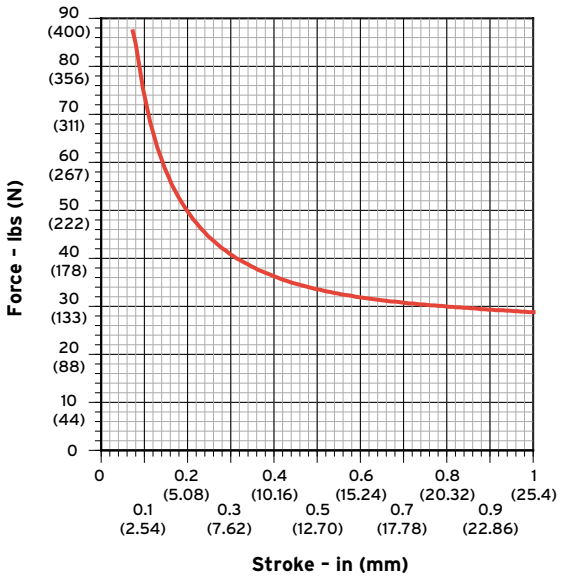
NOTE: Minimum bend radius for optimum cable life is 5" (127 mm)

Specifications:

At rated voltage, 68˚F (20˚C)
and .964" (24.5 mm) stroke

Voltage	12 VDC	24 VDC
Pull Current	61.8 A	39.0 A
Hold Current	0.85 A	0.46 A
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)	

Force vs. Stroke



Specifications are for reference only.

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

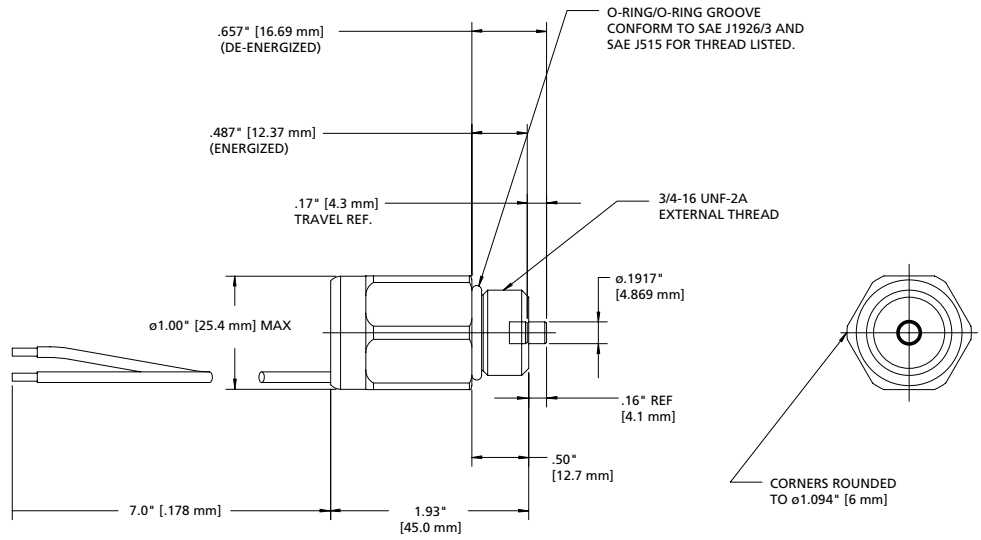
Order Information:

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

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



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 temperature, 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.

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

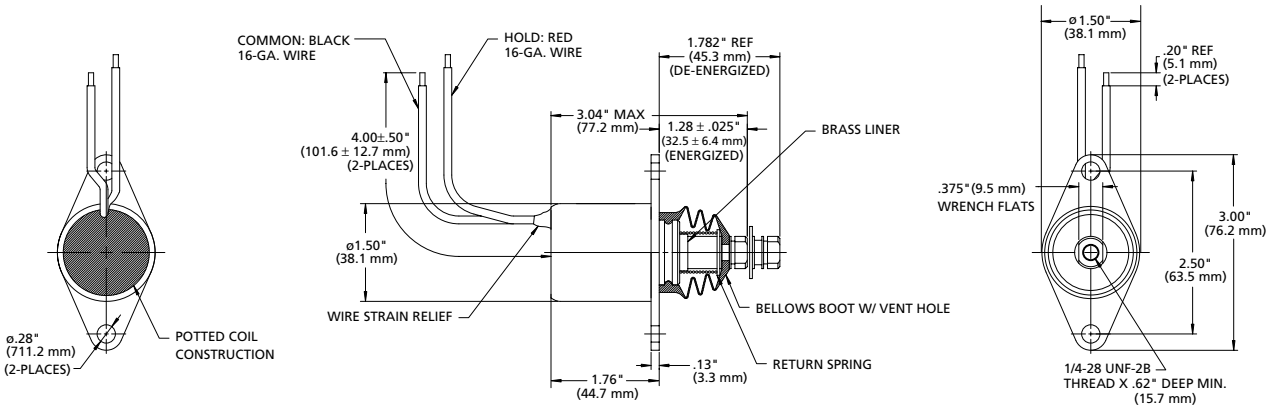
Order Information:

ORDER NO.	Model	Termination
SA-4741	0151	Leads

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

1503S Series

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.

2370S Series

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

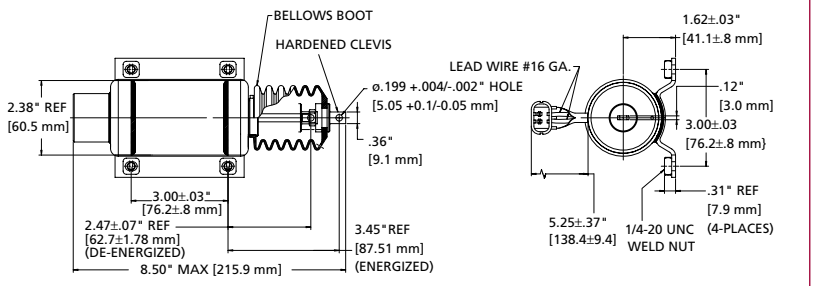
Features:

- 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 68ºF (20ºC)**

Specifications are for reference only.

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).

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

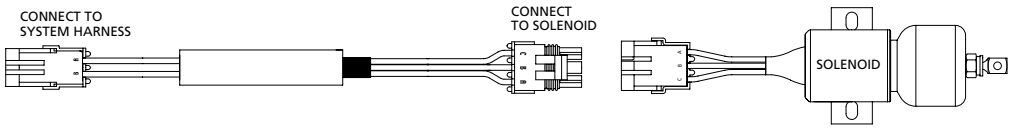
Built-in Modules

Contact Woodward for factory assembled units

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

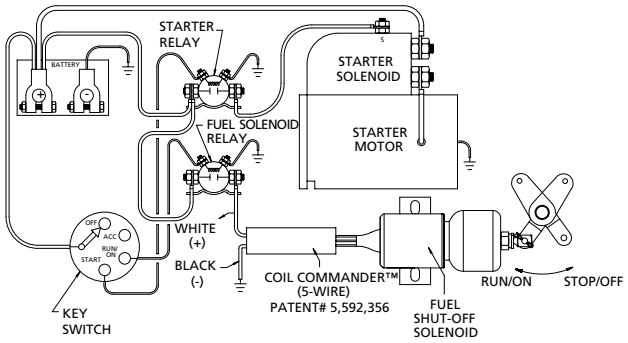
5-Wire Coil Commander®

TERMINATION CONNECTIONS



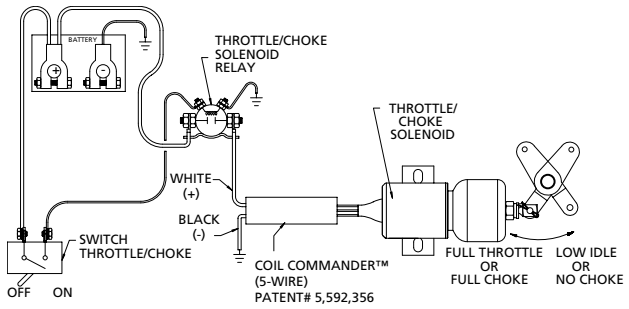
ELECTRIC SHUTOFF

Electric shutoff with dedicated relay for fuel solenoid

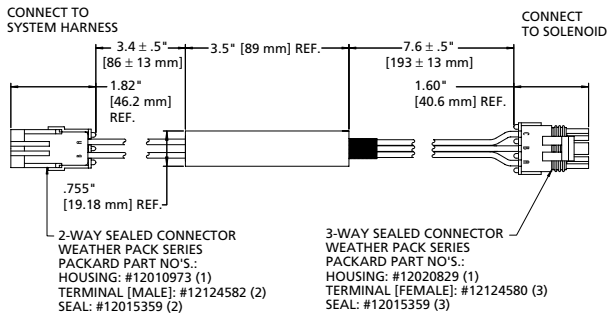


THROTTLE/CHOKE SOLENOID

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

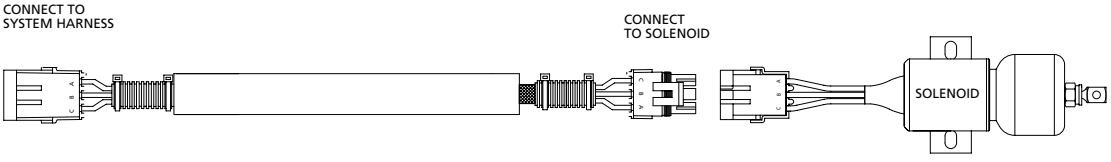
*For use with Kubota 1503ES solenoids

Built-in Modules

Contact Woodward for factory assembled units

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

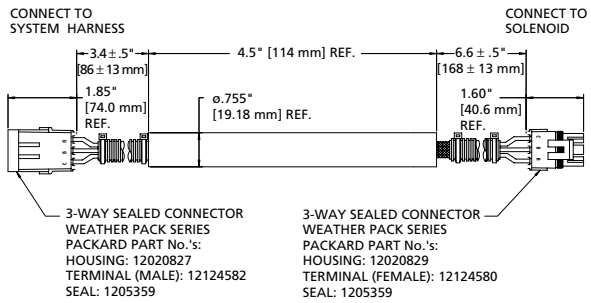
TERMINATION CONNECTIONS



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.

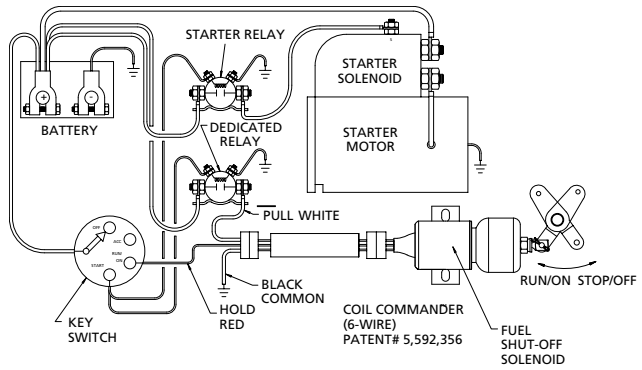
6-Wire Coil Commander®

DIMENSIONS



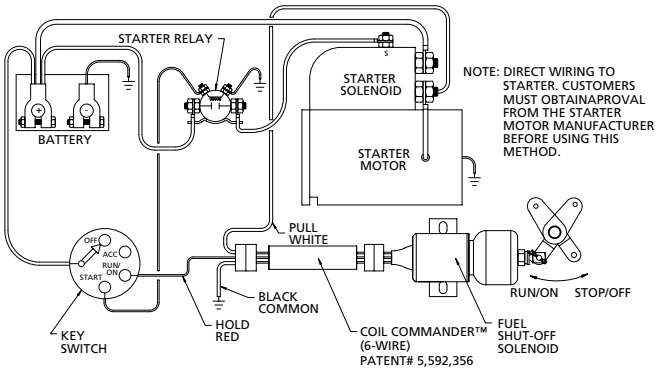
ELECTRIC SHUTOFF

Electric shutoff with dedicated relay for fuel solenoid



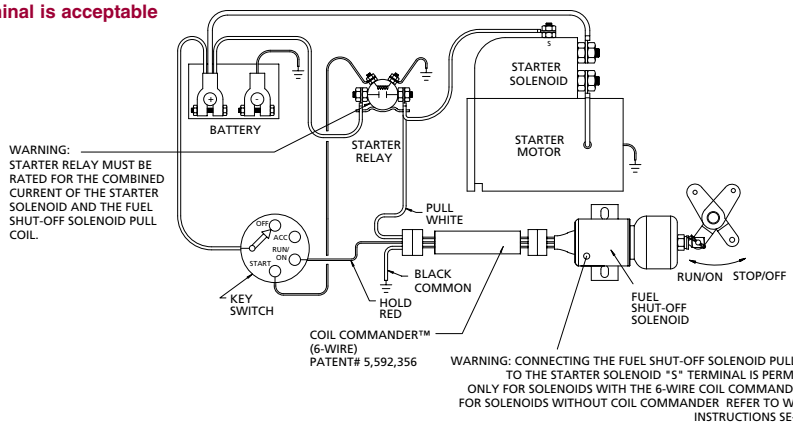
THROTTLE/CHOKE SOLENOID

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



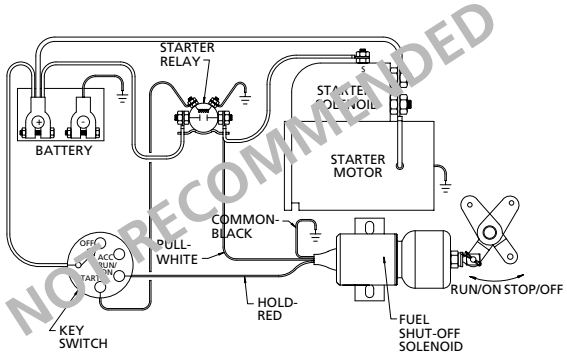
RECOMMENDED CONNECTION

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.



Specifications are for reference only.

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)	

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

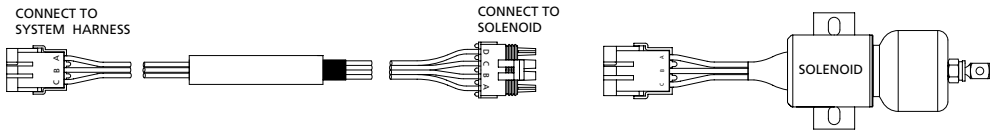
Built-in Modules

Contact Woodward for factory assembled units.

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

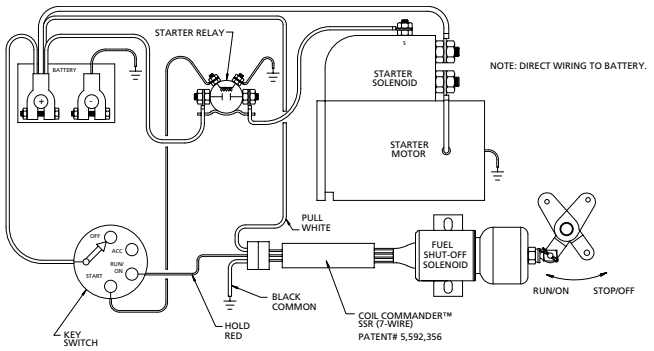
7-Wire SSR Coil Commander®

TERMINATION CONNECTIONS



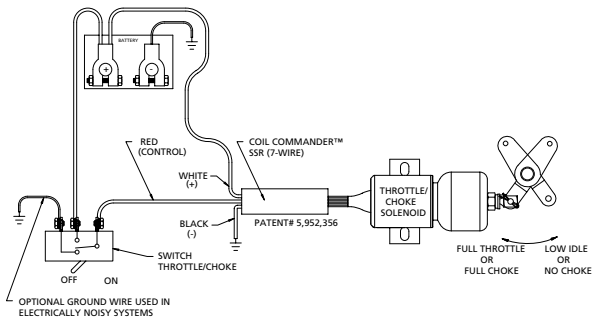
SSR ELECTRIC SHUTOFF

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

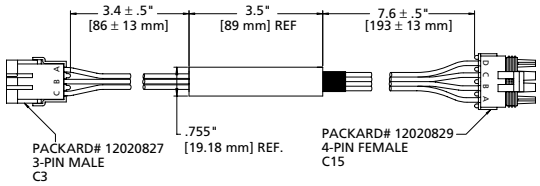


SSR THROTTLE/CHOKE SOLENOID

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.

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:

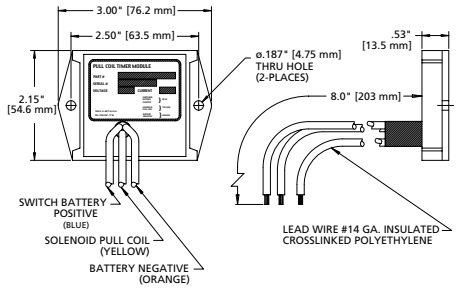
ORDER NO.	Wire Configuration	Rated Voltage	Terminations To System Harness	Terminations To Solenoid
SA-4092-12	3-Wire	12 VDC	Leads	Leads
SA-4092-24	3-Wire	24 VDC	Leads	Leads
SA-4094-12	3-Wire	12 VDC	Packard Weather Pack Housing No. 12020827	Packard Weather Pack Housing No. 12020827
SA-4094-24	3-Wire	24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

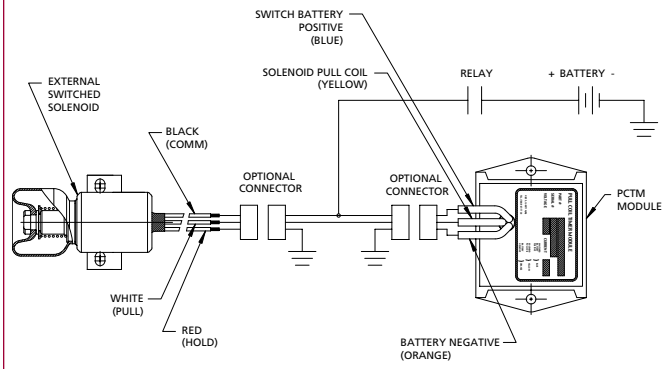
E.E.C. Directive Compliance: All parts supplied by Woodward are classified as components, and therefore are not "CE" marked. Please contact factory direct for details on specific product compliance with 89/336/EEC and 89/392/EEC directives.

3-Wire Pull Coil Timer Module

DIMENSIONS

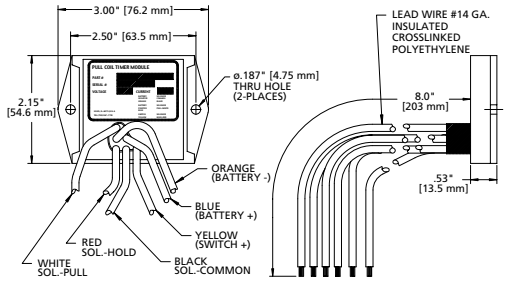


WIRING DIAGRAM

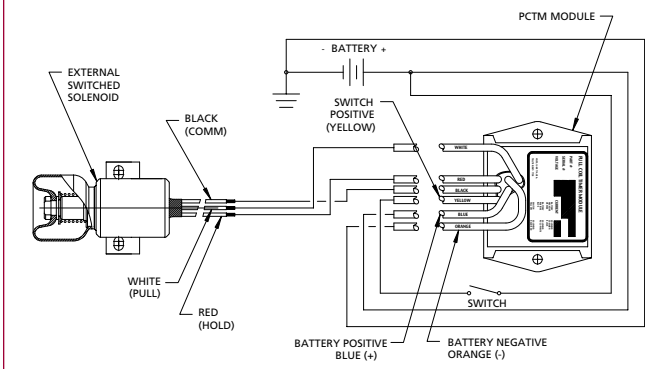


6-Wire SSR Pull Coil Timer Module

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

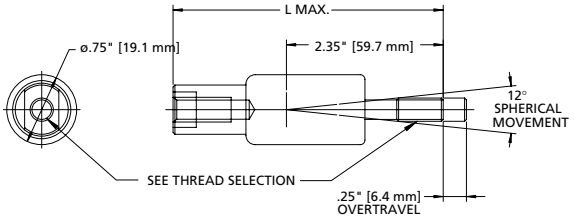
Specifications are for reference only.

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 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** ¼–28, **C** 5/16–24, **E** M6

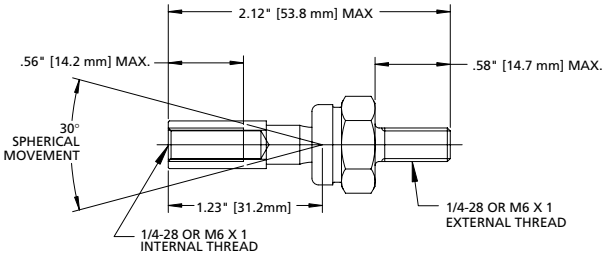
Female End of Swivel Thread Selection: **B** ¼–28, **D** 5/16–24, **F** M6

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	¼–28
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

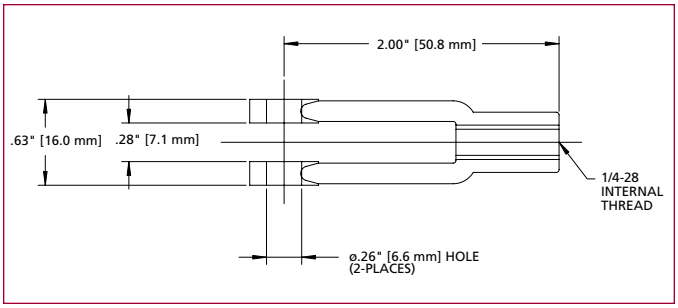
ORDER NO.	Solenoid Model No.
SE-5601	1500 Series
SE-5614	1750 Series
SE-5559	2000 Series

®Hypalon is a registered trademark of DuPont Dow Elastomers.

Clevis Yoke

For use in customer designed linkage assemblies

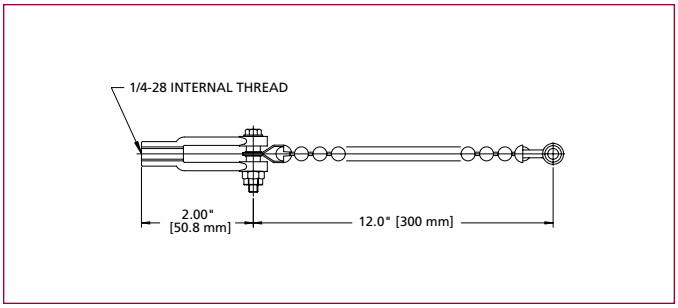
ORDER NO.	Mounting Thread
SA-0008-A	¼–28



Clevis Yoke Bead Chain Assemblies

Used whenever a flexible connection is required, such as pulling a throttle lever on a gasoline engine

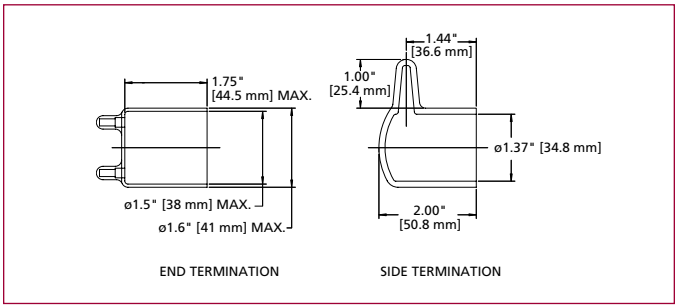
ORDER NO.	Mounting Thread
SA-0293-B	¼–28



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

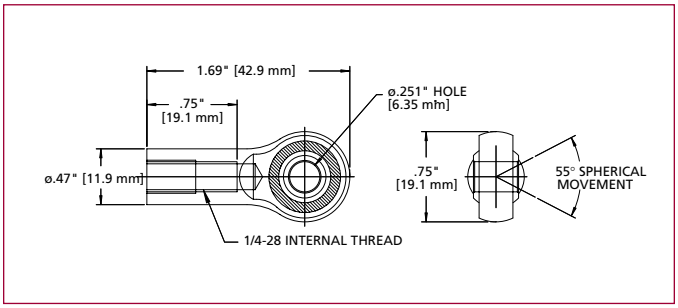
ORDER NO.	Termination
SA-2968	End
SA-2968-UK	Side



Spherical Rod End

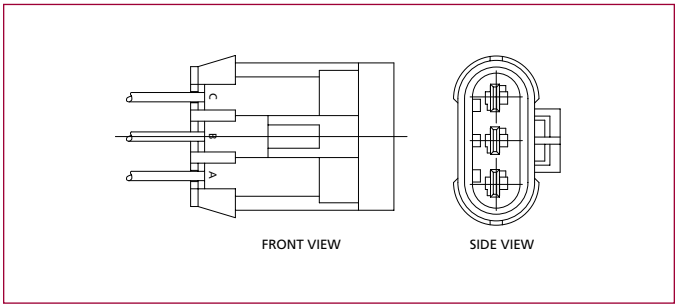
- Heavy duty, low friction, nylon race ball joints for connecting solenoid linkage to fuel pump levers
- Available in male and female options

ORDER NO.	Body	Stud
SA-4280	Internal ¼–28	None
SA-4188	Internal ¼–28	External ¼–28
SA-4232	External ¼–28	External ¼–28



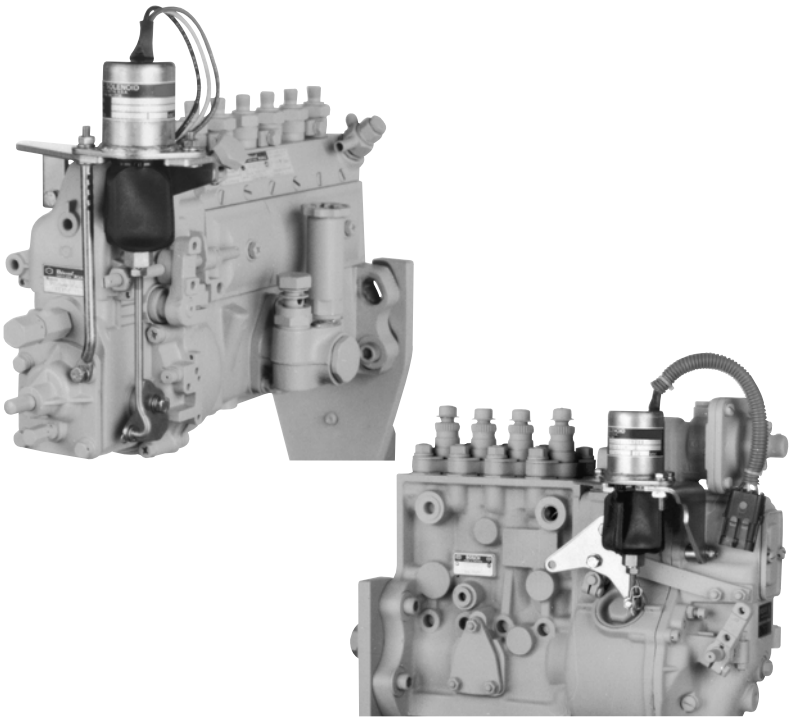
Connectors

- 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

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)

Engine Series	Voltage	Pull Current	Hold Current
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

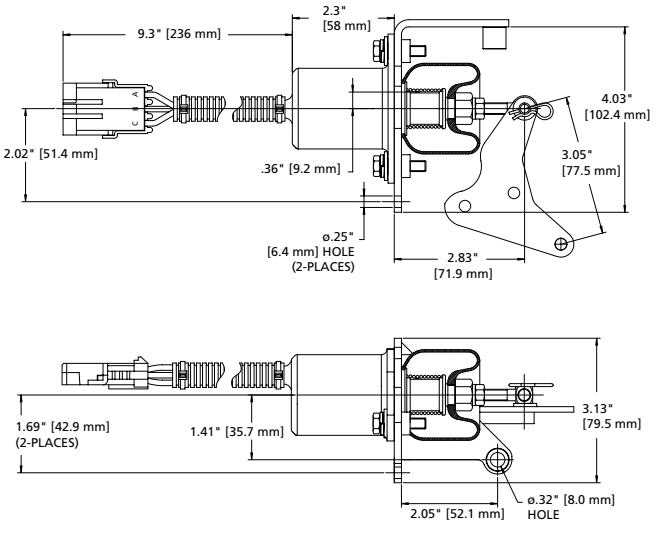
Specifications are for reference only.

Shutdown Kits

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)

ORDER NO.	Solenoid Model	Voltage
SA-4026-12	1752ES	12 VDC
SA-4026-24	1752ES	24 VDC



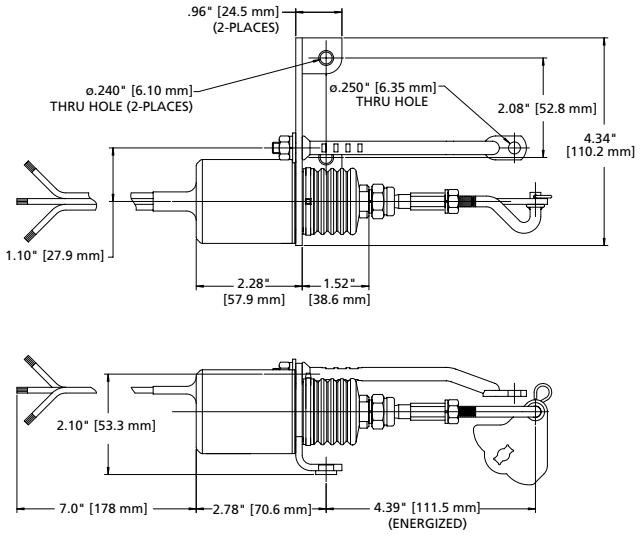
NOTE: Left-Hand Kit with 1752ES solenoid

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

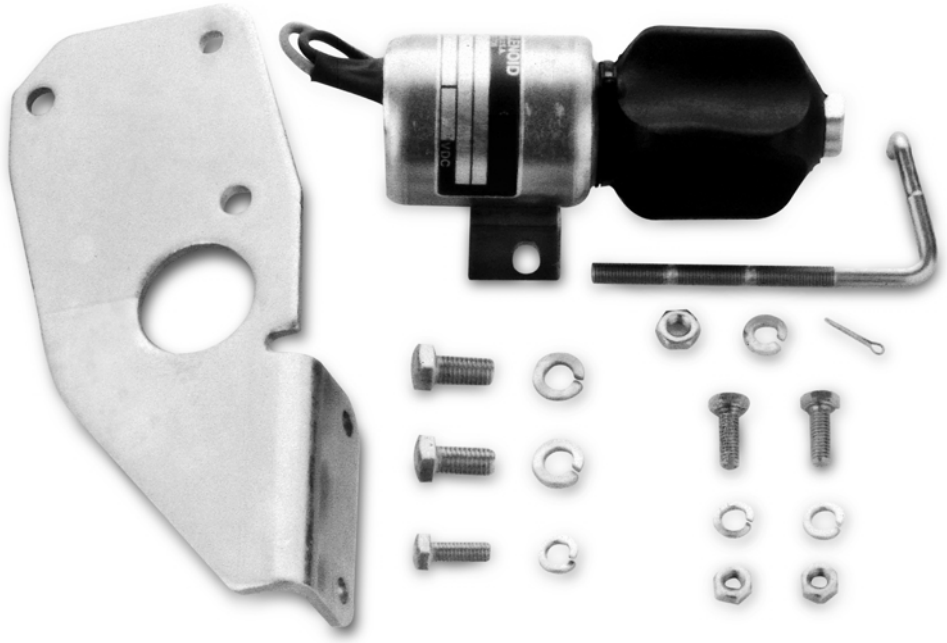
ORDER NO. Right-Hand	Solenoid Model	Voltage
SA-3799-12	1751ES	12 VDC
SA-3799-24	1751ES	24 VDC
SA-3800-12	1751	12 VDC
SA-3800-24	1751	24 VDC

ORDER NO. Left-Hand	Solenoid Model	Voltage
SA-3742-12	1751ES	12 VDC
SA-3742-24	1751ES	24 VDC
SA-3765-12	1751	12 VDC
SA-3765-24	1751	24 VDC



NOTE: Left-Hand Kit with 1751ES solenoid

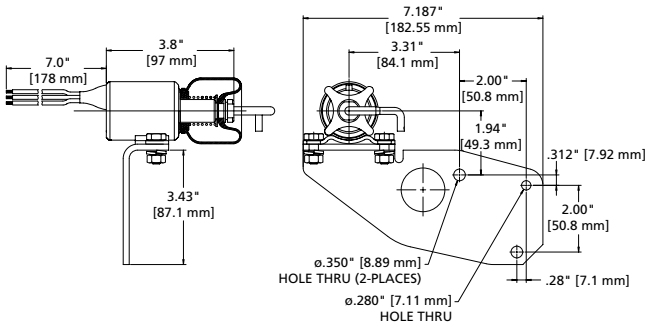
Shutdown Kits

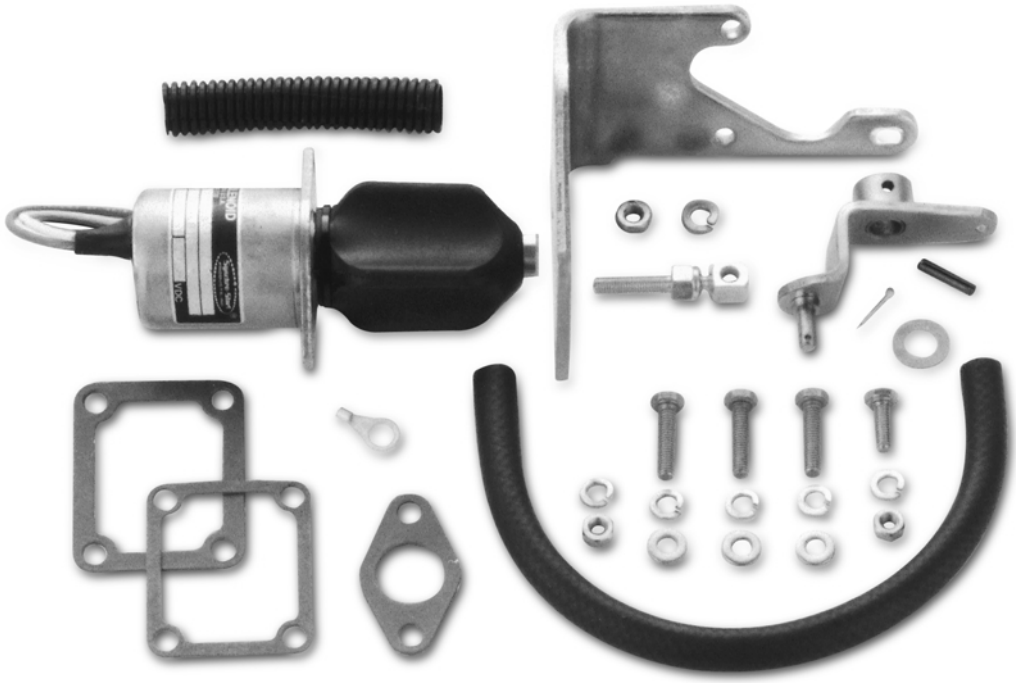


Kubota 1A Kit (62.2 mm series engines)

- Installs on Kubota 62.2 mm series engines
- Also available as hardware kit without 1753 solenoid

ORDER NO.	Solenoid Model	Voltage
SA-4268-12	1753	12 VDC
SA-4269-12	1753ES	12 VDC
SA-4270 (Hardware only)	—	—

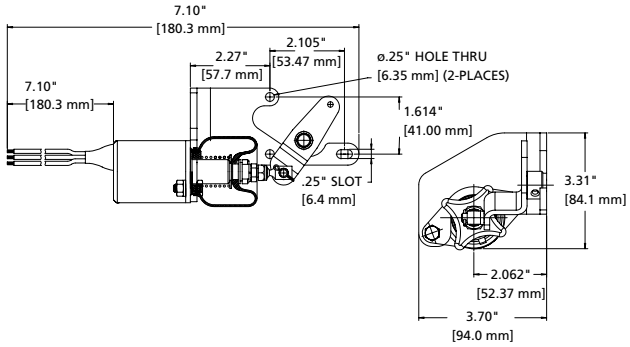




Kubota 3A Kit (70 & 82 mm series engines)

- Installs on Kubota 70 and 82 mm series engines
- Also available as hardware kit without 1751 solenoid

ORDER NO.	Solenoid Model	Voltage
SA-4259-12	1751	12 VDC
SA-4260-12	1751ES	12 VDC
SA-4260-24	1751ES	24 VDC
SA-4264 (Hardware only)	—	—

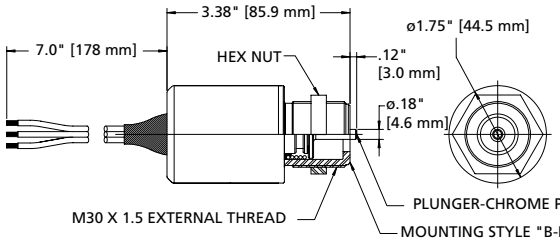


Shutdown Kits

Mitsubishi L Kit

- Installs on Mitsubishi "L" Series engines directly into pump with no external linkage

ORDER NO.	Solenoid Model	Voltage
SA-3725	1751ES	12 VDC



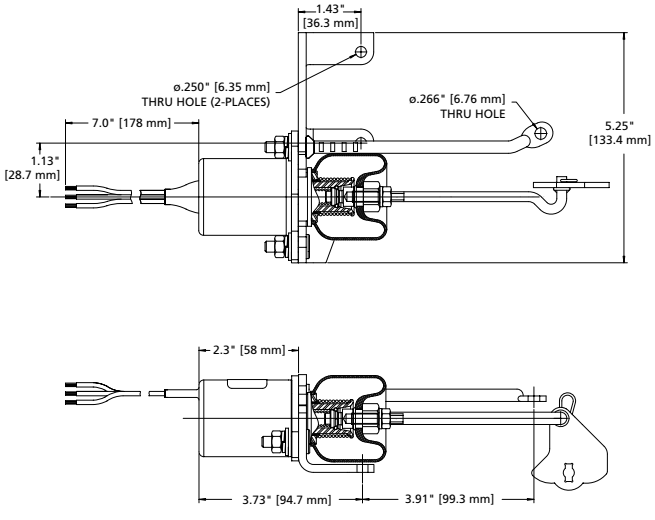
NOTE: 1751ES threaded solenoid with 30mm lock nut screws into back of pump

RSV Zexel Nippondenso

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

ORDER NO. Right-Hand	Solenoid Model	Voltage
SA-3999-12	1752ES	12 VDC
SA-3999-24	1752ES	24 VDC

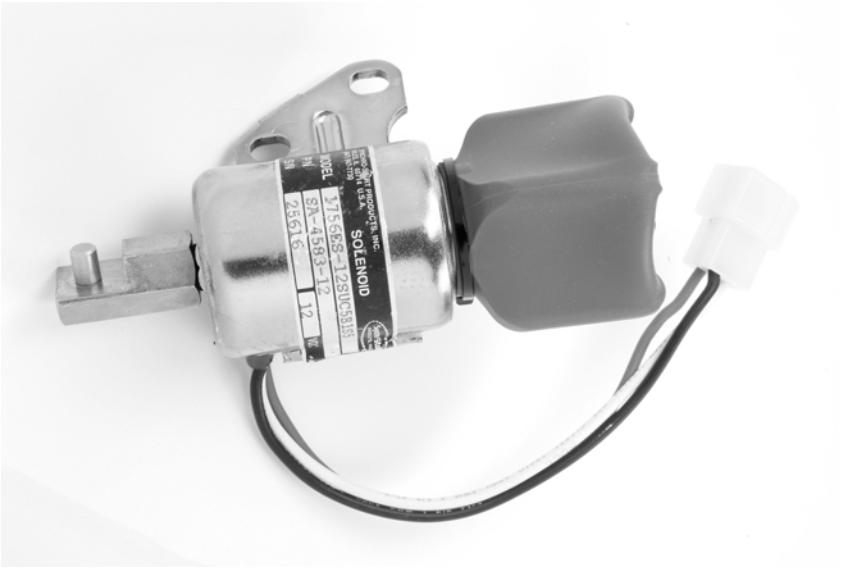
ORDER NO. Left-Hand	Solenoid Model	Voltage
SA-4014-12	1752ES	12 VDC
SA-4014-24	1752ES	24 VDC



NOTE: Left-Hand Kit with 1752ES solenoid

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
- Mounting hardware included for fast, easy installation

Order Information:

ORDER NO.	Solenoid	Voltage
SA-4899-12	1756ES	12 VDC
SA-4899-24	1756ES	24 VDC

Kubota Shutdown Lever:

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

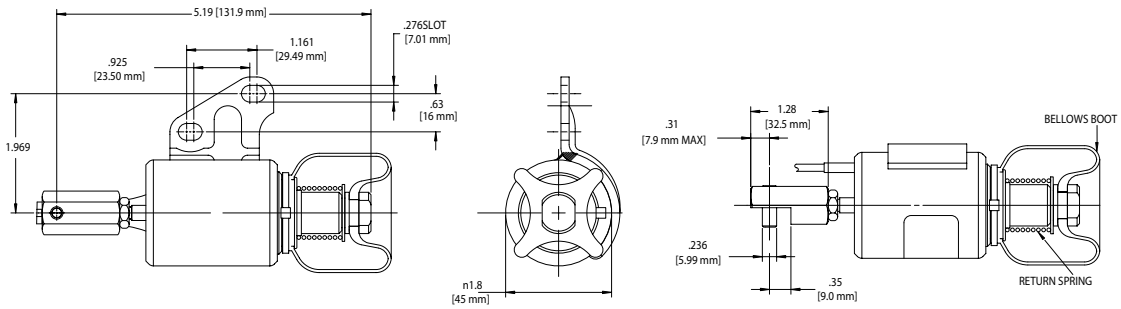
PART NO.	Engine Production Date*
16851-57720	Before April, 2001
16851-57723	After April, 2001

***Contact Kubota with engine serial number**

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.

Shutdown Solenoid

KUBOTA D722 & Z482



Specifications:

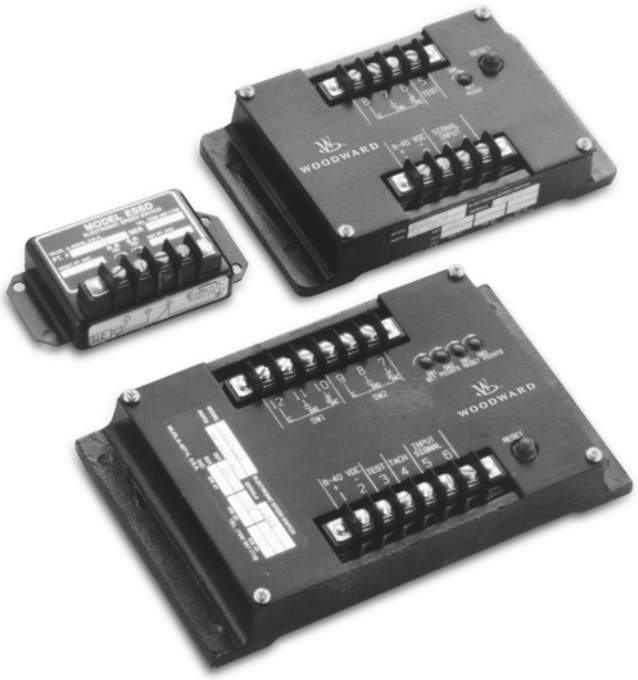
Rated Voltage	12 or 24 VDC
Ambient Temperature	-40˚F to +250˚F (-40˚C to +121˚C)
Weight	Approx. 1.8 lbs (0.8 kg)

Engine Type	Voltage	Pull Current	Hold Current
Kubota D722 & Z482	12	46 A	1.1 A
	24	25 A	0.5 A

Specifications are for reference only.

ESS Basics

In 1932, Woodward introduced the first system to monitor speed. Over the years, our line of speed switches has broadened to include a wide range of electronic systems for many different markets.



Typical electronic speed switch applications include:

Generator Sets	Speed switches commonly used for crank disconnect and engine overspeed protection, which also protects the generator.
Starter Motors	A speed switch can detect starting speed and disengage the cranking motor to prevent damage.
Engines	The speed switch detects the critical speed above which engines should not be operated. Engines and motors suffer damage if operated at excessive speeds. By preventing the engine from developing excessive RPM's, the speed switch protects gears, transmissions, pumps, power takeoffs, etc.
Conveyors	Underspeed can also be a source of danger. It is often desirable to shut down a motor, an engine or a piece of equipment if the speed falls below a predetermined RPM. For example, conveyors may jam, compressors freeze, belts and drives break, lugging motors stall at critical times, motor windings overheat.
Bus Doors	Should an operator of buses require positive control to prevent the rear door from opening before the bus comes to stop, a Woodward speed system combined with a Mini-Gen® signal generator would provide the control automatically.
PTO Protection	Vehicles equipped with hydraulic power take-offs protect their systems by using a Woodward speed switch to control the activation speed.
Magnetic Brake Retarders	A Woodward speed switch and Mini-Gen® signal generator are used to monitor road speed and control the retarder activation and deactivation to save the battery.
Transmissions	A Woodward speed switch can be used as a shift inhibitor to assure the proper transmission shifting.

Understanding the Electronic Speed Switch

What is a Speed Switch?	• Electronic device that senses rotational motion and speed • Can be set to switch a load or control device
How Does it Work?	• Obtains signal from sensor device (magnetic pickup, Mini-Gen signal generator, alternator or ignition coil) in the form of a frequency • Frequency is monitored electronically within the switch • When the speed or frequency reaches the desired setting or set point, the output relay tied into the control circuit is energized or switched

Selecting a Speed Switch

In selecting the best speed switch for controlling a particular application, the following factors should be considered:

Number of Switch Points	Most applications require only 1 or 2 switch points, some models offer 3-4 points.
Frequency Range of Application, Setpoints, and Signal Source	The frequency range of the application and setpoints are dependent upon the selection of the signal source, which in turn depends upon the operating speed and physical mounting limitations.

Signal Source Options

The variety of signal sources which may be used with most SSPI switches include:

Magnetic Pickup Commonly used for higher speed applications. The output is a function of the "gap" between the pickup and the gear tooth and the peripheral velocity of the gear.	Setpoint Frequency In Hertz = $\frac{\text{No. of Gear Teeth} \times \text{Engine RPM Setpoint}}{60}$
Mini-Gen® Signal Generator Designed to provide outstanding signal output at speeds as low as 20 RPM.	Setpoint Frequency In Hertz = $\frac{\text{Mini-Gen RPM at Engine RPM Setpoint}}{2}$
Alternator Output Used in applications unable to accommodate a magnetic pickup or Mini-Gen signal generator.	Setpoint Frequency In Hertz = $\frac{\text{Pulley Ratio} \times \text{No. of Alt. Poles} \times \text{Engine RPM Setpoint}}{120}$
Ignition Output Commonly used as a source for gasoline and natural gas type engines.	Setpoint Frequency In Hertz = $\frac{\text{No. of Cylinders} \times \text{Engine RPM Setpoint}}{120}$

Basics

Setpoint Frequency

Each signal source produces a different Hertz setpoint frequency for identical engine RPM setpoints.

Example:

Required crank disconnect 300 RPM and overspeed of 2500 RPM. This 8-cylinder gas engine has an 80-tooth flywheel and an 8-pole alternator with a 2:1 pulley ratio.

Signal Source	Crank Disconnect 300 RPM	Overspeed 2500 RPM
Magnetic Pickup	$\frac{80 \times 300}{60}$ = 400 Hz	$\frac{80 \times 2500}{60}$ = 3333 Hz
Mini-Gen®	$\frac{300}{2}$ = 150 Hz	$\frac{2500}{2}$ = 1250 Hz
Alternator	$\frac{2 \times 8 \times 300}{120}$ = 40 Hz	$\frac{2 \times 8 \times 2500}{120}$ = 333 Hz
Ignition	$\frac{8 \times 300}{120}$ = 20 Hz	$\frac{8 \times 2500}{120}$ = 166 Hz

Reset Requirements

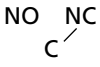
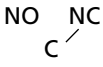
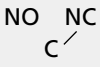
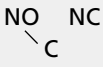
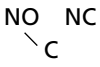
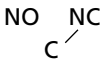
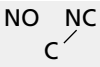
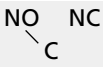
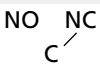
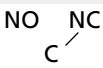
There are four reset options available for resetting the speed switch:

Automatic Reset	With the automatic reset option, the switch will automatically reset if the frequency of the input signal is lowered by 80% to 90% of the setpoint.
Electrical Latch	With the electrical latch option, the relay will energize (after the setpoint has been reached) and remain energized even if the input signal frequency has been lowered to 0 Hertz. The only way to reset the unit is to remove power.
Manual Reset	With the manual reset option, the switch is supplied with a reset button. By depressing this button, the unit will be reset.
Adjustable Reset	With the adjustable (automatic) reset option, the switch will automatically reset at the frequency determined by the setting of the supplied reset pot. By adjusting the potentiometer, the reset can be selected anywhere between 25% and 95% of the setpoint on the majority of models.

Relay Operation

Standard Relay Logic	With power applied and a signal below the setpoint, the relay will remain de-energized until the setpoint is reached. At setpoint, the relay will be energized and remain energized until reset.
Reverse Relay Logic	With power applied and a signal below the setpoint, the relay will be energized and remain energized until the setpoint is reached. At setpoint or interruption of power, the relay will de-energize and remain de-energized until reset or power is reapplied. Reverse relay logic is commonly used as part of a fail-safe system to assure power is applied to the relay during operation.

Typical Relay Operation

Condition	Standard Relay Logic	Reverse Relay Logic
Power Off		
Power On		
At Setpoint		
At Reset		
Loss of Power to Switch		

Power Requirements

Identify the power source variations. Determine the maximum and minimum voltage as well as transients of the power source.

Load Requirements

Determine the voltage and current switching requirements of the external control circuit. Consider the inductive or resistive nature of the load. If load currents in excess of 10 amps are expected, interface relays should be used.

Environmental Conditions

Identify the environmental conditions. Determine the maximum and minimum ambient temperatures. Also consider vibration and shock.

Standard Features and Options

Verify or Test Circuit	Standard on many models, which enables the testing of the complete system while the engine is operating at a safe speed. When used, the switch will trip at approximately 67% of the setpoint.
Signal Loss	If protection from possible loss of signal is desired, the ESSB offers optional broken signal lead protection by continuously monitoring for an open or high resistance in the signal source circuit.
Power Loss	If protection from "loss of power" to the electronic unit is desired, specify the reverse relay logic option.
Terminal Protection	Conduit covers and terminal protectors are available to eliminate exposed connections and danger from high voltage on select models.

ESSB

Model ESSB electronic speed switch has many years of proven service. It is engineered to provide a wide variety of features and options including up to four switch points, adjustable reset, a selection of voltage inputs and tachometer output.

Features:

- Adjustable switch points
- Sealed NEMA 4 enclosure
- Transient and reverse polarity protection
- Precise repetitive speed switch points
- Automatic, manual or remote manual reset
- Power loss protection
- DC output for Model 30 Tach (1 mA)
- 8–40 VDC; 64 VDC; 100–140 VDC; or 100–130 VAC power
- Broken signal lead protection
- Standard or reverse relay logic
- Lockwire seal
- Conduit cover
- Vibration isolation kit accessory

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

ESS — Electronic Speed Switch

B — Switch model

( ) — **1, 2, 3 or 4**
Number of switch points
Note: for each switch point, specify set and reset frequency:
a) Hertz and increasing or decreasing speed direction
b) Standard or reverse relay logic
c) Optional special reset differential adjustment
d) Optional broken signal lead protection

( )
A — Automatic reset
M — Manual reset on one switch point
R — Remote manual switch

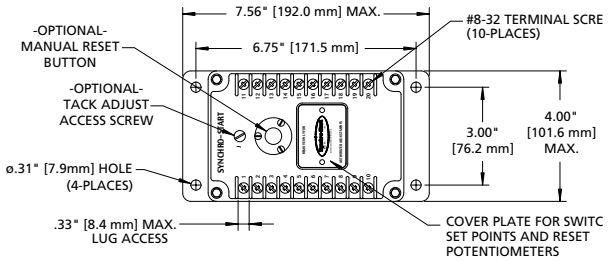
( )
T — Tachometer Model 30 option
Note: specify scale and rated speed

( )
C — Conduit cover option

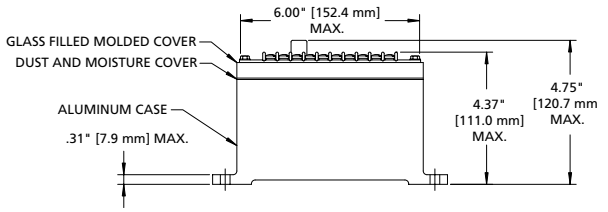
When you order: You will need to provide the power supply voltage

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.

FRONT VIEW



SIDE VIEW



Electrical Specifications:

Power Input	8-40 VDC 64 VDC 100-140 VDC 100-130 VAC
Reverse Polarity Protection	1000 VDC
Maximum Current (2 ch. 80-40 VDC)	12 Volt / 24 Volt
Operating	200 mA / 220 mA
Standby	50 mA / 60 mA
Signal Input	Minimum: 1.2 VRMS Impedance: 2K ohms
Relay Contact Ratings	
Resistive Load:	0.1 to 10 A 28 VDC
Inductive Load:	0.1 to 8 A 28 VDC
Overspeed Response Time	100 milliseconds typical
Setpoint Reset	
Automatic:	80% to 90% of setpoint
Automatic Adjustable:	50% to 98% of setpoint
Setpoint Stability	0.8% over voltage range and 0.01% per °F typical

Mechanical Specifications:

Operating Temperature	-40°F to + 185°F (-40°C to + 85°C)
Vibration	4 G's from 9 to 200 Hz
Shock	4 foot drop test
Case	NEMA 4 high impact molded enclosure
Weight	4.5 lbs (2 kg)

Accessories

Vibration Isolator

The vibration isolator kit is recommended for mounting ESSB speed switches on or near engines wherever vibration exceeds 5 G's 20 to 500 Hertz. Proper installation will reduce vibration by as much as 80%.

Mounting studs are ¼-20 x ⅝" permitting mounting on ¼" thick plate.

ORDER NO.	Mounting Studs
SA-2214	¼-20 x ⅝"

Specifications are for reference only.

DISCONTINUED
Effective 09.01.03

ESSD

The ESSD speed switch is designed to provide overspeed or underspeed protection, crank disconnect, shift inhibiting on diesel engines, and brake retarding on trucks and buses.

Features:

- Economical single channel speed switch
- Compact, rugged construction
- Potted, solid state components
- Normally open or normally closed switch
- Adjustable reset
- Wide speed range from 20 RPM up to 10 kHz

Order Information: Indicate switch action to complete your Order No.

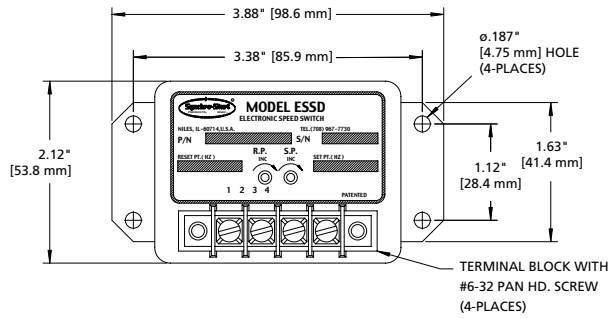
ORDER NO.	Set Point Frequency Range Hertz	Signal Source Mini-Gen 44 Gauge	Signal Source Mini-Gen 37 Gauge	Signal Source Magnetic Pickup
SA-2657-( )	>10	X		
SA-2658-( )	12.5 to 68	X		
SA-2659-( )	69 to 357		X	
SA-2660-( )	358 to 1330		X	X
SA-3316-( )	1331 to 3200			X
SA-3317-( )	3201 to 8000			X

Switch Action

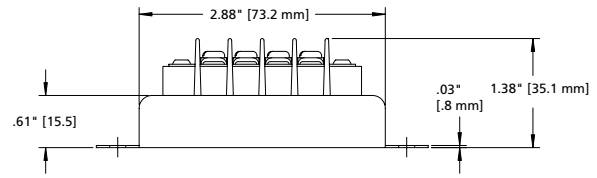
NO	NC	OA	CA
Normally open	Normally closed	Normally open w/ adjustable reset	Normally closed w/ adjustable reset

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.

FRONT VIEW



SIDE VIEW



Electrical Specifications:

Power Input	10–30 VDC
Maximum Current (2 ch.8–40 VDC)	12 Volt / 24 Volt
Standby	3 mA / 6 mA
Signal Input	Minimum: 1.2 VRMS Impedance: 22K ohms (Nominal)
Switching Capability	Maximum: 1 A DC continuous
External Load Resistance	12 VDC: 14 to 330 ohms 24 VDC: 28 to 1200 ohms
Setpoint Reset	
Automatic:	70% to 90% of setpoint
Automatic Adjustable:	50% to 98% of setpoint

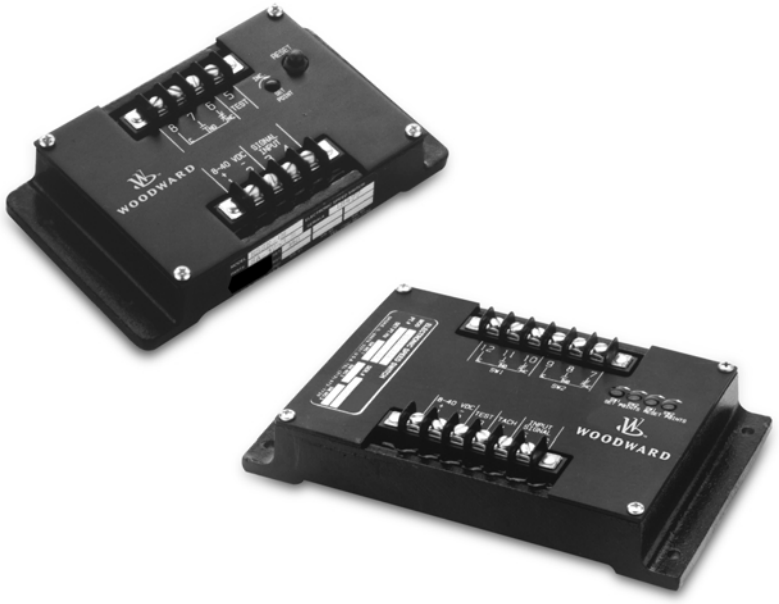
Mechanical Specifications:

Operating Temperature	-40˚F to + 185˚F (-40˚C to + 85˚C)
Vibration	5 G's from 20 to 500 Hz
Shock	4 foot drop test
Case	Metal drawn Potted electronics for environmental protection Nickel-plated terminals – humidity and salt spray resistant
Weight	.27 lbs (.12 kg)

Specifications are for reference only.

ESSE Series

Single or dual switches to monitor and control critical speed functions. Applications include crank disconnect or overspeed protection on diesel engines, transmission shift inhibiting, and PTO protection.



Features:

- Standard or reverse relay operation
- Field adjustable set and reset switch points
- High noise immunity
- Latch, automatic, manual or adjustable resets (automatic or latch are field selectable)
- Reverse polarity protection
- Mini-Gen® signal generator, magnetic pickup, alternator or ignition coil for signal input
- Test circuit (trips at 67% ± 10% of setpoint)
- Potted for in-field reliability, exposed applications, and hostile environments
- Field selectable setpoint range

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

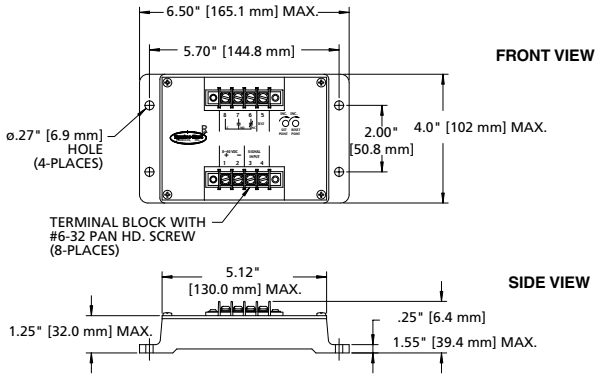
ESS	E	( )	( )	( )
Electronic Speed Switch	Switch model	**1** Single setpoint **2** Dual setpoints Note: for each setpoint, specify setpoint frequency (see "Basics") and signal source (Mini-Gen® signal generator, magnetic pickup, alternator, or ignition coil on gas engines).	Setpoint #1 reset option (Options for single set point) **L** Latch-up **A** Automatic reset **P** Automatic adjustable reset **M** Manual reset	Setpoint #2 reset option (leave blank for single set point) **L** Latch-up **A** Automatic reset **P** Automatic adjustable reset **M** Manual reset

When you order: Also specify speed range 1 or 2 from the chart below.

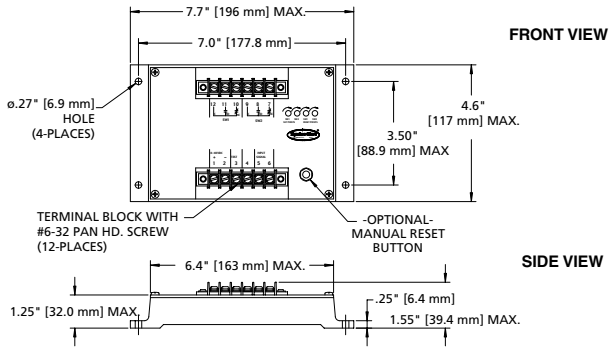
	Standard Inputs	Ignition Input
1	80-2500 Hz	10-250 Hz
2	325-10,000 Hz	20-500 Hz

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.

ESSE-1



ESSE-2



Electrical Specifications:

Power Input	8-40 VDC (40-80 VDC optional on ESSE-2)	
Power Supply Transient Protection	900 volts for 100 microseconds (exponential decay)	
Reverse Polarity Protection	1000 VDC	
Maximum Current for ESSE-1	<u>12 Volt</u>	<u>24 Volt</u>
Operating:	125 mA	140 mA
Standby:	30 mA	45 mA
for ESSE-2	<u>12 Volt</u>	<u>24 Volt</u>
Operating:	200 mA	220 mA
Standby:	30 mA	45 mA
Signal Input Minimum:	1.2 VRMS	
Maximum:	130 VRMS	
Impedance:	33K ohms (nominal)	
Relay Contact Ratings		
Resistive Load:	0.1 to 10 A 28 VDC	
Inductive Load:	0.1 to 8 A 28 VDC	
Overspeed Response Time	100 milliseconds (typical)	
Setpoint Reset	Automatic (80% to 90% of setpoint) Automatic Adjustable (25% to 95% of setpoint) Electrical Latch Manual Reset	
Setpoint Stability	For an input voltage range of 9V to 40V and for a temperature range of +14˚F to +185˚F (-10˚C to +85˚C), the ESSE Series shall typically be less than 1% or 8 Hz, whichever is greater. The unit performs to -40˚F (-40˚C).	

Mechanical Specifications:

Operating Temperature	-40˚F to +185˚F (-40˚C to +85˚C)	
Vibration	4 G's from 20 to 500 Hz	
Shock	4 foot drop test	
Case	Cast aluminum ¼" wall thickness Potted electronics for environmental protection Nickel-plated terminals – humidity and salt spray resistant	
Weight of ESSE-1	1.4 lbs (.5 kg)	
of ESSE-2	1.9 lbs (0.9 kg)	

Specifications are for reference only.

EPS 1000

The EPS 1000 is a programmable, three-channel equipment protection module designed to perform a variety of functions simultaneously. It is especially suited for engine protection, sequenced operations, and critical timing applications. It can also be used for unattended engine starting using autocrank and glow plug functions.

Features:

- PC programmable, microprocessor based for accurate and stable set points
- Two-piece enclosure allows either recessed panel mounting or base mounting (Patent applied for)
- Front panel LED's provide instant visual data on operational status
- Three output channels for independent configuration of various actions
- Each channel can be configured in one of three modes:
    1. Speed Switch
    2. Autocrank Controller
    3. Glow Plug Controller
- Speed signal input is user selectable for magnetic pickup, ignition, or Hall Effect sensor
- Autocrank mode allows programming for crank time, rest time, and maximum crank attempts
- Glow plug mode controls glow plug ON time
- Test verify function permits testing of relay at 70% of set point (programmable 0 to 99% of set point)
- Normal or reverse relay logic is configurable by user
- Six switch inputs plus engine speed input provide versatile programming
- Protection switch inputs (EP) can be enabled at preset (programmable) RPM after preset time delay
- Two auxiliary outputs indicate status and fault codes
- Engine status indicator displays engine failure codes to aid in troubleshooting engine problems

Order Information:

ORDER No.	Description
SA-4478	EPS 1000 Module
SA-4479	EPS Calibration Tool Kit Includes interface module, program diskette, RS-232 cable, and Operator's Manual

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.

EPS 1000

Electrical Specifications:

Power Input	9-30 VDC, reverse polarity protected
Electromagnetic Compatibility	ISO 14982:1998/E
EMI Immunity (ISO 14982:1998/E)	30 V/M 20 MHz to 1000 MHz
Nominal Operating Current	12 Volt / 24 Volt
Operating:	140 mA / 120 mA
Standby:	25 mA / 40 mA
Relay Contact Ratings	
Resistive Load:	0.1 to 10 A @ 28 VDC
Inductive Load:	0.1 to 8 A @ 28 VDC
Auxiliary Outputs	Aux 1 and Aux 2: 200 mA maximum

Mechanical Specifications:

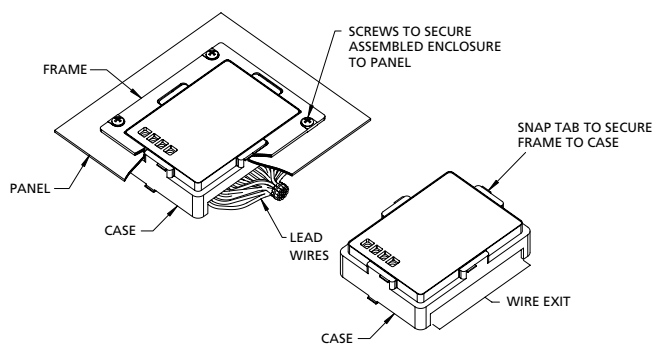
Operating Temperature	-40˚F to +185˚F (-40˚C to +85˚C)
Vibration	4 G's from 40 to 2000 Hz
Shock	10 G's @ 45 Hz
Case	UV, chemical resistant, and UL 94 V-0 flame retardant. Encapsulated for reliability against harsh environments
Calibration	Requires interface adapter and software for calibration setup.
Terminations	Euro style terminal block
Weight	.85 lbs (.386 kg)

Unique, Patented Enclosure:

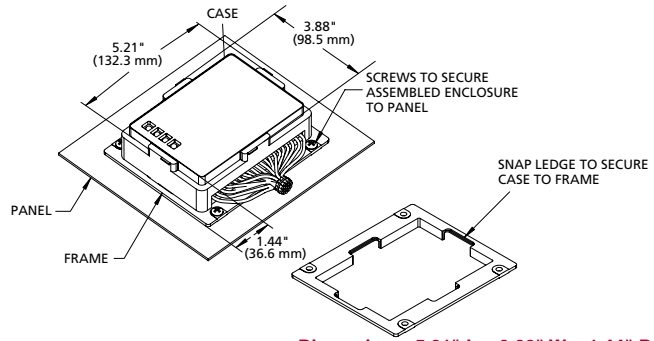
Two-part enclosure accommodates either panel or base mounting for convenient, clutter-free installation.

Case	• Lead wires to 21 terminals exit unobtrusively from bottom of case • Terminal descriptions easily identified on side of case • LED's and engine failure codes prominently displayed on front panel
Reversible Frame	• Snap ledges secure case to frame • When attached to top of case, assembly can be installed below the surface in a cutout in the panel (panel mount) • When attached to bottom of case, assembly can be mounted on top of panel surface (base mount). Built-in aperture allows a convenient exit for wires and/or connections.

PANEL MOUNT



BASE MOUNT



Dimensions: 5.21" L x 3.88" W x 1.44" D (132.3 mm L x 98.5 mm W x 36.6 mm D)

Specifications are for reference only.

Magnetic Pickups

Convert engine speed to an AC voltage. Compatible with Woodward electronic governing systems and speed switches

Features:

- No moving parts
- Self powered
- 5/8 and 3/4 thread sizes
- Withstands extreme temperature range
- Endures shock and vibration
- Choice of wire leads or cable connectors

Order Information:

Without Cable Assembly*

ORDER NO.	Mounting Thread	Overall Length (mm)	Coil Resistance ohms @ 78˚F	Inductance mH @ 1 Khz	Output Voltage Peak-to-Peak	Output Voltage VRMS
SA-2170	5/8–18	2.62" (66.6)	144 to 230	85	17	6
SA-2171A	5/8–18	3.63" (92.2)	144 to 198	85	17	6

With Cable Assembly

ORDER NO.	Mounting Thread	Overall Length (mm)	Coil Resistance Ohms @ 78˚F	Inductance mH @ 1 KHZ	Output Voltage Peak-to-Peak	Output Voltage VRMS
SA-4423	3/4–16	3.00" (76.2)	360 to 540	25	15	5.3
SA-4424	5/8–18	3.00" (76.2)	40 to 85	25	8	2.8

Operating Temperature: -65˚F to 225˚F (-54˚C to 107˚C)

Storage Temperature: -100˚F to 225˚F (-73˚C to 107˚C)

Test Conditions: Airgap: 0.015, Surface speed: 300 in/sec, Test wheel gear: 8 pitch, Load: 2.2k ohms.

***See facing page for ordering information**

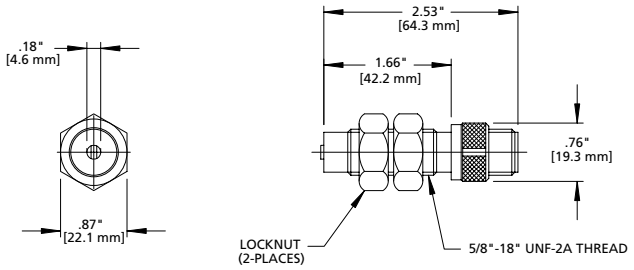
Specifications are for reference only.

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.

phone: 847-967-7730

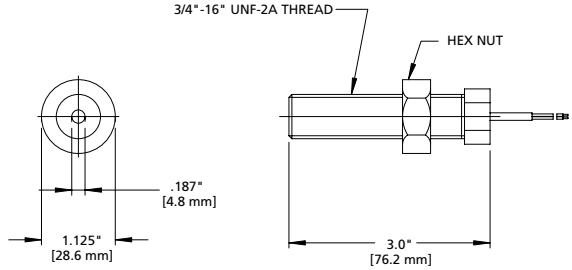
Magnetic Pickups

SA-2170



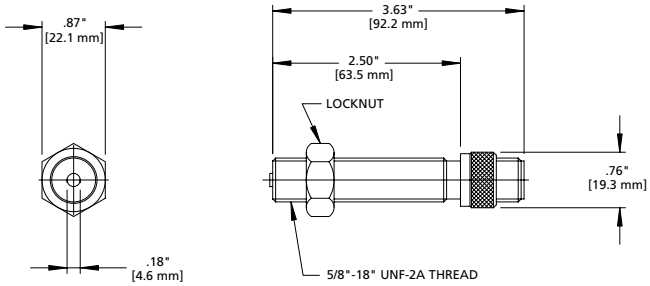
NOTE: Chisel Tip SA-2170 is suggested for flywheel teeth with very fine pitch

SA-4423

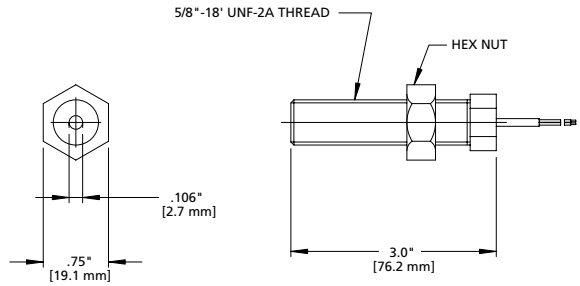


Two wires, open lead

SA-2171A



SA-4424



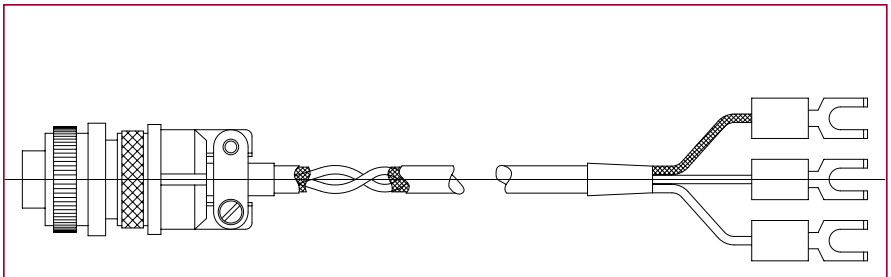
Two wires, open lead

Use Woodward magnetic pickups with electronic speed switches for the input signal normally obtained from a gear tooth. Models SA-4423 and SA-4424 come with cable assembly for connection to the speed switch. For connection of Models SA-2170 and SA-2171A, cable lengths from 3 to 50 feet are available.

Accessories

Connector and Cable Assembly

Used with SA-2170 and SA-2171A only.
Order separately.



CONNECTOR AND CABLE ASSEMBLY

ORDER NO.	Cable Length
SA-1707-003	3' (0.9m)
SA-1707-008	8' (2.4m)
SA-1707-010	10' (3.1m)
SA-1707-014	14' (4.3m)
SA-1707-015	15' (4.6m)
SA-1707-020	20' (6.1m)
SA-1707-030	30' (9.2m)
SA-1707-035	35' (10.7m)
SA-1707-050	50' (15.3m)

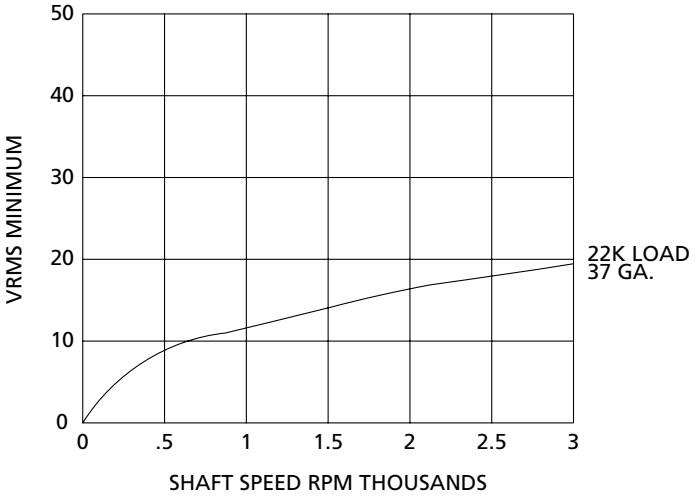
Mini-Gen® Signal Generator

The Mini-Gen® signal generator mounts on the transmissions of buses and trucks to measure road speed or on diesel engines to measure engine speed.

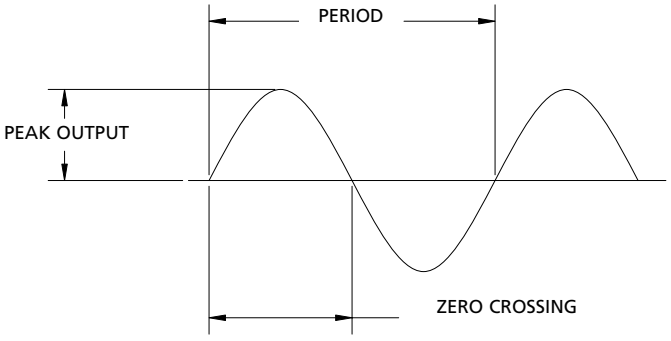
Features:

- Mounts on standard SAE ⅞-18, General Motors, and E1 & E2 DIN 75 532 tachometer outputs
- Non-feed thru models come standard with ¼" male tab
- Compact, only 1¾" in diameter
- Long, reliable life under continuous speeds as high as 4000 RPM
- Usable signal at speeds below 20 RPM (10 Hz)
- Output signal frequency ½ of shaft RPM
- Rugged zinc die cast construction
- Heavy duty, two-conductor cable on feed-thru models
- Plated for protection against moisture, salt and dirt
- Environmentally sealed
- Optional connectors available
- Patented design

Signal Generator Output:



Mini-Gen Timing:



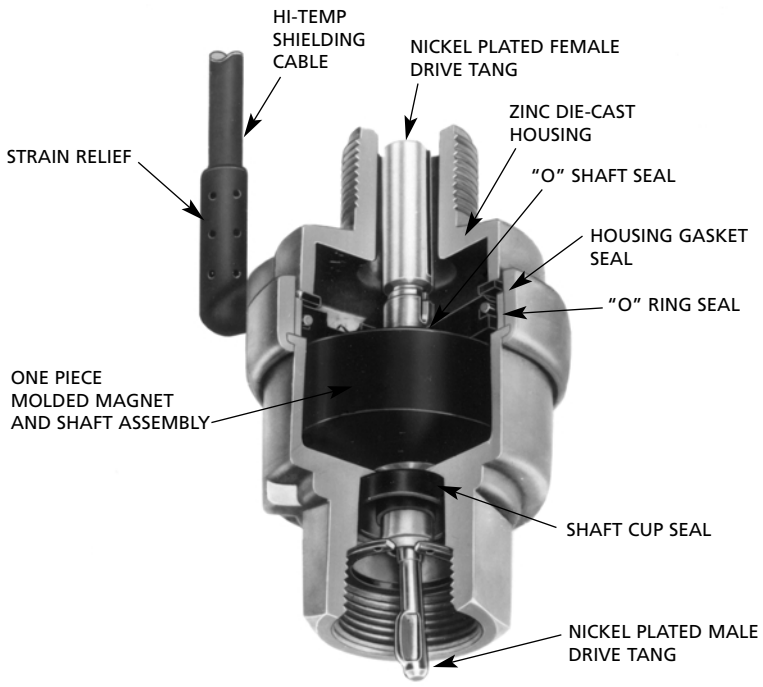
Sinusoidal Output @ 1000 RPM
(Mini-Gen shaft speed) = 500 Hz

1. Voltage output = 25 V peak (RMS = 17.7 volts)
2. Timing between zeroes = 1 millisecond
3. Timing between periods = 2 milliseconds

Timing variation between zero crossing = 7%

Mini-Gen® Signal Generator

RUGGED CONSTRUCTION



Electrical Specifications:

Output (37 GA) (No Load) Minimum Maximum Resistance (37 GA)	 1750 RPM 25 VRMS 55 VRMS 210 ohms +15%
Hi Pot	600 VDC
60 Pole Magnet	4000 RPM maximum

Consult factory for high RPM applications and alternate coil construction for higher output.

Mechanical Specifications:

Operating Temperature	-40˚F to + 225˚F (-40˚C to +107˚C)
Thread Torque	15 ft. lbs (20.3 Nm) maximum
Lead Pull Test (feed-thru)	10 lbs (44.5 N) maximum
Vibration	20 G's at 5-2000 Hz
Mechanical Shock	Withstands 3 drops to concrete from 3 feet
Environmental	Exposure to moisture, salt, fuel oil, lubricants, or transmission fluid will not degrade performance or shorten life

Specifications are for reference only.

Mini-Gen® Signal Generator

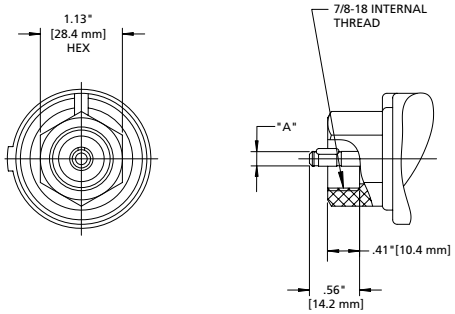
Three Mounting Drives

The Mini-Gen's non-feed thru or feed thru mounting styles permit its use with practically any engine, transmission, tachometer or speedometer manufactured throughout the world.

1. SAE Mounting

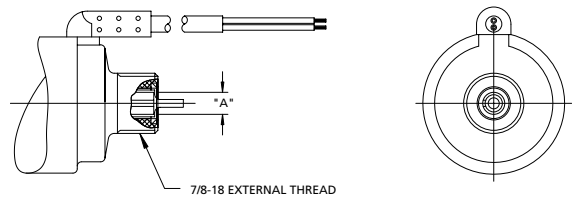
MGO

Non-feed Thru Mounting End
SA-2650A



MGO-1

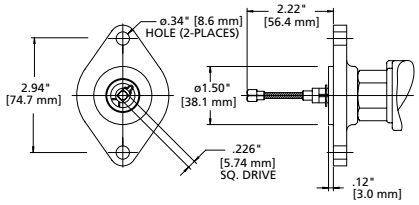
Feed Thru Mounting End
SA-2652A



2. General Motors Engine Mounting

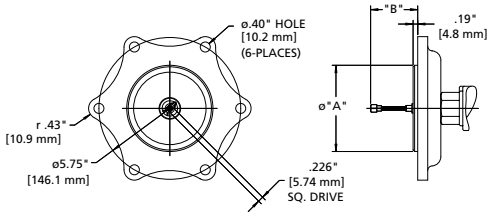
MGY

Non-feed Thru Mounting End
SA-2731A



MGW

Non-feed Thru Mounting End
SA-2772A

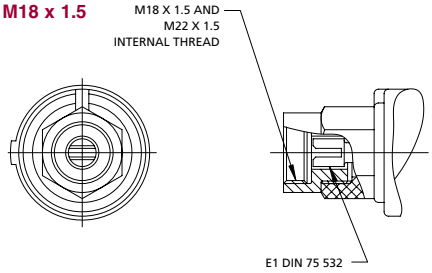


DIM.	INCHES	MM
A	4.56 DIA.	11.5 DIA.
B	1.25	31.7

3. Metric Mounting

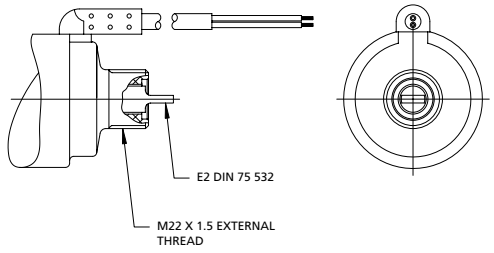
MGJ

Non-feed Thru Mounting End
SA-2685A – M22 x 1.5
SA-2888A – M18 x 1.5



MGJ-1

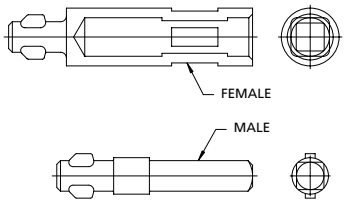
Feed Thru Mounting End
SA-2763A – M22 x 1.5



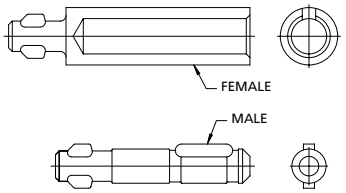
Mini-Gen® Signal Generator

Drive Tangs Nickel plated, round or square drive tangs for use with SAE mounting Mini-Gens. To select appropriate drive tang, match Dimension "A" from mounting drive diagram with Part No. from charts below.

SQUARE DRIVE TANG



ROUND DRIVE TANG



Order Information:

	Mounting Drive	Drive Designation	Mounting Style
SA-2650A	SAE ⅞-18	MGO	Non-feed thru
SA-2652A	SAE ⅞-18	MGO-1	Feed thru
SA-2731A	General Motors	MGY	Non-feed thru
SA-2772A	General Motors	MGW	Non-feed thru (large ring)
SA-2685A	Metric (M22x1.5)	MGJ	Non-feed thru
SA-2888A	Metric (M18x1.5)	MGJ	Non-feed thru
SA-2763A	Metric (M22x1.5)	MGJ-1	Feed thru

Drive Tang Option: For use on SAE mounting drives only (MGO, MGO-1)

Square Drive Tangs

ORDER NO. Male	ORDER NO. Female	Dimensions "A" (mm)
SA-2676	SA-2635	.104" (2.64)
SA-2633	SA-2639	.150" (3.81)
SA-2634	SA-2640	.193" (4.90)

Round Drive Tangs

ORDER NO. Male	ORDER NO. Female	Dimensions "A" (mm)
SA-2677	SA-2636	.152" (3.86)
SA-2678	SA-2637	.187" (4.75)
SA-2679	SA-2638	.203" (5.16)
SA-2672		.187" (4.75) Extended

Metric Drive Tangs

ORDER NO.	Termination	Specifications
SA-2962	Male	E2 DIN 75 532
SA-2961	Female	E2 DIN 75 532

Note: Non-feed thru models come standard with ¼" male tab. Lead wire with connector is available as an option.

APECS® Basics

A guide to help in the selection of your electronic engine governing system

Understanding APECS®

The Advanced Proportional Engine Control System (APECS) provides isochronous engine governing through a wide speed range. The system consists of a powerful microprocessor-based controller driving a precision proportional actuator that is connected to the engine's throttle. The APECS controller product line is comprised of the 2000, 3000, 4000, 4500, and 5000 Series models.

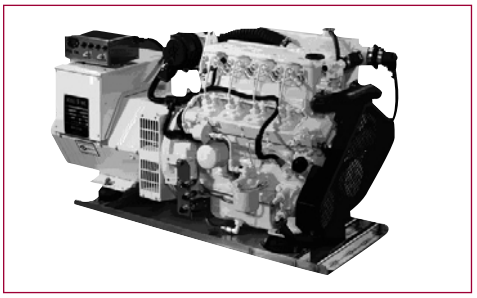
Applications

APECS engine governing systems expand speed control functions in diverse applications:

- Power Generation
- Industrial
- Marine
- Automotive
- Construction
- Agriculture/Forestry

Aerial Work Platforms

- Multi-speed control from operator's position



Gensets/Compressors

- Isochronous governing
- Single or two-speed control

Construction Equipment

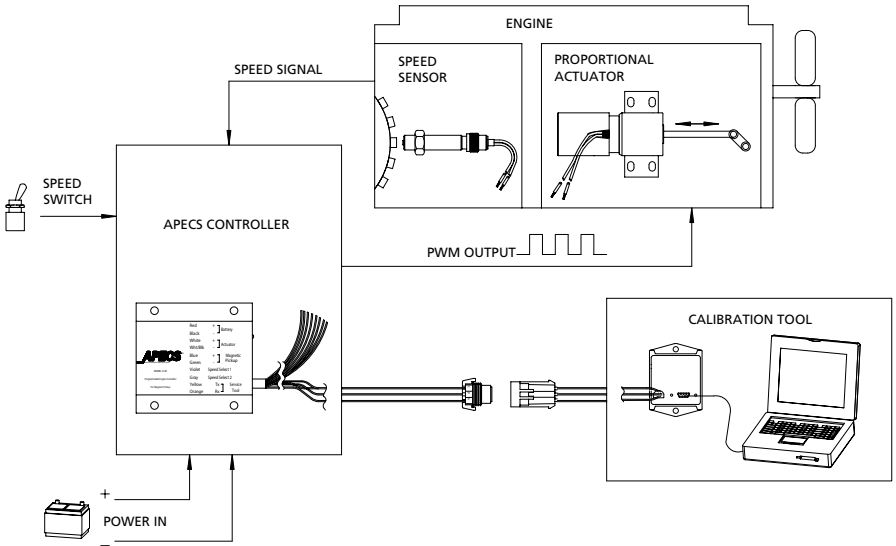
- Single or multi-speed control
- Design flexibility

APECS® Components and Functions

Understanding APECS®

State-of-the-art APECS digital electronic governor system provides the flexibility to solve the most complex engine control applications. Here's how it works:

APECS WITHIN CLOSED LOOP SYSTEM



Note: See component definitions below

APECS® Components

Speed Sensor	The controller processes the speed signal received from the speed sensor, usually a magnetic pickup, and compares it to the desired speed setting.
APECS Controller	The powerful microprocessor-based controller is the brain of APECS.
Speed Select Switch (optional)	More than one speed can be selected by attaching an external switch (external pot on Series 2000).
APECS Calibration Tool (Series 3000, 4000, 4500, & 5000)	The calibration tool is used to configure and adjust your system. It allows interactive, real-time display of engine speed on your computer.
Proportional Actuator*	The output of the controller is a pulse width modulated signal to the actuator. The actuator converts the signal to an output shaft position, proportional to the amount of current in the coil.

***Actuator must be ordered separately. See Linear Proportional Actuators, pages 84-89, for ordering information.**

APECS® Features

APECS Series Feature Comparison

	APECS 2000	APECS 3000	APECS 4000
Type of speed control	Isochronous	Isochronous	User selectable isochronous or droop governing
Speed signal input options	Magnetic pickup	Magnetic pickup, Hall effect, coil-type ignition, magneto ignition	Magnetic pickup, Hall effect, coil-type ignition, magneto ignition
Electrical connections	Screw type	Open lead	Connector
External speed command	Analog with external pot	Digital: 2 switch inputs for 4 discrete set speeds or increase/ decrease set speed	Analog and Digital: Can select analog (external pot), digital (2 switch inputs) or combination of both
Overspeed shutdown, underspeed shutdown	25% overspeed Shutdown only	All programmable	All programmable
Gain setting method	Potentiometer	Computer	Computer with external remote master gain pot
Gain adjustments	Proportional, Integral, Derivative, (PID)	PID	PID and Master
PC interface	–	On-screen calibration, interactive real time	On-screen calibration, interactive real time
Programmable engine speed responses	–	Ramp rates, warm-up time	Ramp rates, warm-up time
Drive-by-wire	–	–	Pedal position sensor input with optional idle verification switch input
PTO enable switch	–	–	Yes
Programmable auxiliary outputs	–	–	Autocrank, crank disable, engine shutdown, remote status lamp, PTO enabled lamp

APECS® Accessories

APECS Calibration Tool

The calibration tool provides the means of configuring and adjusting your system through software. An interface module connects the controller to your computer.

- Calibration wizard makes set-up easy
- Graphs engine speed on screen, in real time, during calibration
- Last settings are retained in controller, even after shutdown

Please see Controllers, pages 74-83, (APECS 3000, 4000, 4500, & 5000) for ordering information.

Magnetic Pickups

Magnetic pickup speed sensor converts mechanical motion to an AC voltage without external power. It transmits a signal each time a gear tooth passes near the center pole piece.

- 5/8 and 3/4 UNF sizes
- Endures shock and vibration and extreme temperature range
- Choice of wire leads or sealed connector

Please see Speed Sensors, pages 64-69, for ordering information.

Linkage and Mounting Hardware

Linkage connects the actuator shaft to the engine control lever. A good linkage contributes to accurate, stable, and responsive performance with minimal play and friction.

- Allows for minor misalignments
- Minimal friction, binding and backlash
- Hardware for longer and shorter linkages

Please see Actuator Accessories, pages 100-101, for ordering information.

WARNING: An overspeed shutdown device, independent of the APECS system, should be provided to prevent loss of engine control that may cause personal injury or equipment damage.

APECS® 2000

The powerful microprocessor-based controller of the APECS (Advanced Proportional Engine Control System) monitors the actual speed of the engine through a speed sensor, compares the actual speed with the desired speed, then sends a pulse width modulated signal to the precision proportional actuator to maintain the desired speed.

Features:

- Proportional, Integral and Derivative control (PID)
- Isochronous governing ± 0.25% (20 turn setpoint)
- Remote speed setpoint (± 10% speed change or 0–100% of internal setpoint)
- Surface mount technology
- Signal source: magnetic pickup
- Electrostatic discharge protection
- Reverse polarity protection
- Protection against miswiring
- Diagnostics for broken wire, overspeed, and internal component check
- Engine compartment mountable and can be used with all sizes of APECS actuators
- Rugged case potted for environmental protection

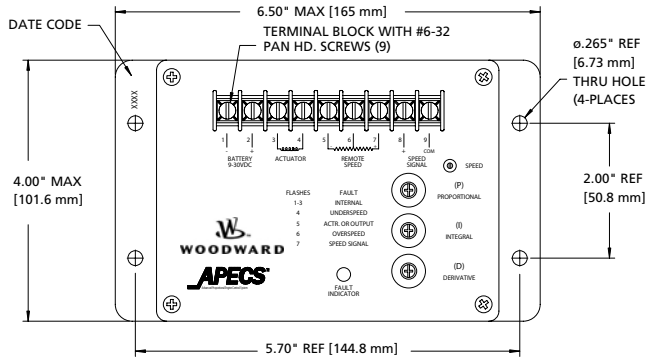
Order Information:

ORDER NO.	Model
SA-4389	2000

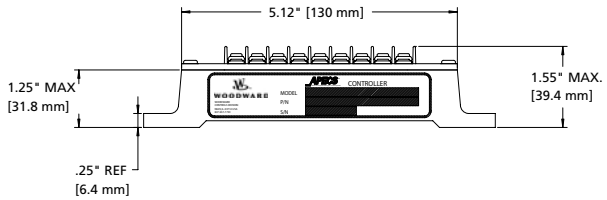
E.E.C. Directive Compliance: All parts supplied by Woodward are classified as components, and therefore are not "CE" marked. Please contact factory direct for details on specific product compliance with 89/336/EEC and 89/392/EEC directives.

Dimensions:

FRONT VIEW



SIDE VIEW



Electrical Specifications:

Operating Voltage	9–30 VDC (wide range)
Overspeed Protection	Automatic shutdown at 125% of setpoint speed
Speed Input Signal	250 Hz to 10,000 Hz (5 ranges)
Signal Input Minimum	2 VRMS at cranking
Output	PWM up to 8 A

Mechanical Specifications:

Operating Temperature	-40˚F to 185˚F (-40˚C to 85˚C)
Vibration	6 G's from 20 to 500 Hz
Shock	4 foot drop test
Protection	Potted electronics for environmental protection
Terminals	Nickel plated, humidity and salt spray resistant
Weight	1.4 lbs (0.6 kg)

Specifications are for reference only.

WARNING: An overspeed shutdown device, independent of the APECS system, should be provided to prevent loss of engine control that may cause personal injury or equipment damage.

APECS® 3000

APECS (Advanced Proportional Engine Control System) governs engine speed and is computer calibrated using all-digital electronic technology.

Features:

- Isochronous engine control
- All-digital electronic technology
- Calibrations set with a personal computer
- Easy to calibrate with APECS start-up wizard
- Calibration tool graphs engine speed on screen, in real time, during calibration process
- All settings remain in memory during shutdown
- Remote speed control available with external switches:
  - -Preprogram up to four discrete speeds and set ramp rates between speeds, or
  - -Manually increase/decrease engine speed at preset rates
- Compatible with all Woodward proportional actuators
- Operates on both 12 volt and 24 volt systems

Order Information:

APECS 3000

ORDER NO.	Model	Speed Signal Input	External Switch Connection
SA-4450	3100	Magnetic Pickup	Switch Activated to Battery Positive
SA-4451	3100	Magnetic Pickup	Switch Activated to Ground
SA-4452	3200	Spark Ignition	Switch Activated to Ground
SA-4453	3300	Magneto Ignition	Switch Activated to Ground
SA-4471	3400	Hall Effect Sensor	Switch Activated to Ground

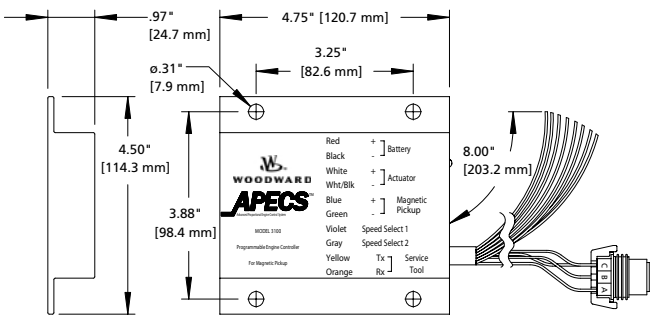
APECS Calibration Tool

ORDER NO.	Model	Description
SA-4455	ACT	For all Series 3000 controllers, includes interface module, program diskette, RS-232 cable, and User's Manual. (Computer not included)

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.

Dimensions:

FRONT VIEW



Electrical Specifications:

Supply Voltage	9-30 VDC, negative ground. Reverse polarity protected
Magnetic Pickup	2 VRMS minimum (during cranking) required signal
Switch Inputs	Two switch inputs, pre-programmable to select up to four speeds Switch activated to ground or to battery positive must be specified
Output to Actuator	Pulse width modulated, 8 A maximum
Calibration Tool Interface	Requires interface adapter and DOS based software for initial calibration setup

Mechanical Specifications:

Connections	Sealed connector to interface module All other electrical connections are open lead
Operating Temperature	-40˚F to +185˚F (40˚C to +85˚C)
Vibration	6 G's from 40 to 2000 Hz
Electronic Interface (EMI)	10 V/m 27-1000 MHz
Shock	20 G's peak @ 35 Hz
Mounting	4 holes
Weight	1.18 lb (0.54 kg)
Drop Test	1 m on concrete surface

Specifications are for reference only.

WARNING: An overspeed shutdown device, independent of the APECS system, should be provided to prevent loss of engine control that may cause personal injury or equipment damage.

APECS® 4000

APECS 4000 expands Woodward's line of programmable engine governors to address the needs of the stationary and mobile equipment industry. Enhanced input and output capability, combined with a flexible configuration, permits APECS 4000 to easily adapt to a wide variety of engine governing applications.

Features:

- User selectable isochronous or droop governing
- Analog input suitable for many uses:
  - -Pedal position sensor with idle verification switch
  - -Remote speed adjustments
  - -Trim potentiometer
- Two switched inputs allow user to:
  - -Program up to four discrete speeds and set ramp rates between speeds, or
  - -Manually increase or decrease speed at preset rates with variable speed control
- PTO enable switch to select between pedal input and speed switches in mobile applications
- User selectable engine protection switch input (high coolant temperature, low oil pressure)
- Compatible with Woodward proportional actuators
- Auxiliary output configurable in several ways:
  - -Engine shutdown
  - -Crank disable
  - -Remote status lamp
  - -Autocrank
  - -PTO enabled lamp
- User-friendly calibration tool:
  - -Programmable PID gains
  - -Programmable speed setpoints, ramp rates
  - -Easy to calibrate using APECS start-up wizard
  - -Graphical or numerical real time display
- Current protection limits current to the actuator to protect from overheating
- Status lamp (LED) signals normal engine running condition and diagnostics including overspeed and underspeed
- Sealed, tamper-resistant enclosure, chemical resistant to most automotive oils and liquids

Order Information:

APECS 4000

ORDER NO.	Model	Speed Signal Input	External Switch Connection
SA-4467	4100	Magnetic Pickup	Switch Activated to Battery Positive
SA-4468	4200	Spark Ignition	Switch Activated to Battery Positive
SA-4469	4300	Magneto Ignition	Switch Activated to Battery Positive
SA-4470	4400	Hall Effect Sensor	Switch Activated to Battery Positive

APECS Calibration Tool

ORDER NO.	Model	Description
SA-4475	ACT Kit	For all Series 4000 controllers, includes interface module, program diskette, RS-232 cable, and User's Manual. (Computer not included)
SA-4473	Connector Kit*	For all controllers

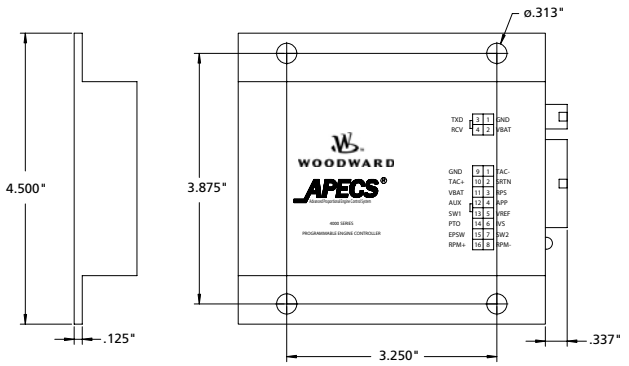
*Connector kit contains Molex mating connector shell and terminals.

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.

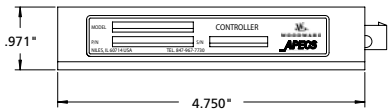
APECS® 4000

Dimensions:

FRONT VIEW



SIDE VIEW



Electrical Specifications:

Supply Voltage	9–30 VDC, negative ground. Reverse polarity protected
Switch Inputs	Two switch inputs, pre-programmable to select up to four speeds PTO switch Engine protection switch
Speed Sensing	Magnetic pickup input, Ignition input, Magneto input, Hall effect sensor
Shock	20 G's peak @ 45 Hz
Vibration	6 G's from 40-2000 Hz
Electromagnetic Interface (EMI)	30V/m 20-1000M Hz

Mechanical Specifications:

Connector	Molex part no. 39-30-1160 Mates with Molex part no. 39-01-2160 (not supplied with controller) Terminals required 16 AWG part no. 39-00-0078 18-24 AWG part no. 39-00-0039
External Analog Input	Trim, set speed with pot and drive-by-wire with IVS option
Output to Actuator	Pulse width modulated 8 A maximum
Temperature	-40˚F to 185˚F (-40˚C to 85˚C)
Weight	1.18 lb (0.54 kg)
Calibration	Requires interface adapter and software for calibration setup

Typical Applications

- Power Generation
- Automotive
- Marine
- Construction
- Industrial
- Agriculture/Forestry

Specifications are for reference only.

WARNING: An overspeed shutdown device, independent of the APECS system, should be provided to prevent loss of engine control that may cause personal injury or equipment damage.

NEW

APECS® 4500

The APECS 4500 electronic controller provides maximum control and optimal engine performance. By adjusting the fuel control lever with a Woodward proportional actuator the 4500 system controls and limits engine speed. By adjusting to load, temperature and fuel quality it optimizes your engine's operating efficiency.

Features:

- Control capabilities include engine/ ground speed control, rate of acceleration control, drive-by-wire operation, variable speed operation, and power take-off operation.
- Two user-selectable auxiliary outputs can be configured for glow plug control, autocrank control, engine shutdown, remote diagnosis, and mode lamp.
- Calibration is simple using ACT, Woodward's proprietary software. The controller can be calibrated on any IBM-compatible PC, allowing for easy customization and re-programmability.
- Universal speed input permits use with magnetic pickups, coil-type spark ignition systems, magneto spark ignition systems, and Hall Effect sensors.
- Internal diagnostics monitor engine operation and the status LED indicates malfunctions through coded flashing. Built-in engine protection capability can monitor engine coolant and oil pressure.
- Sealed, waterproof connectors assure reliability in harsh environments.

Order Information:

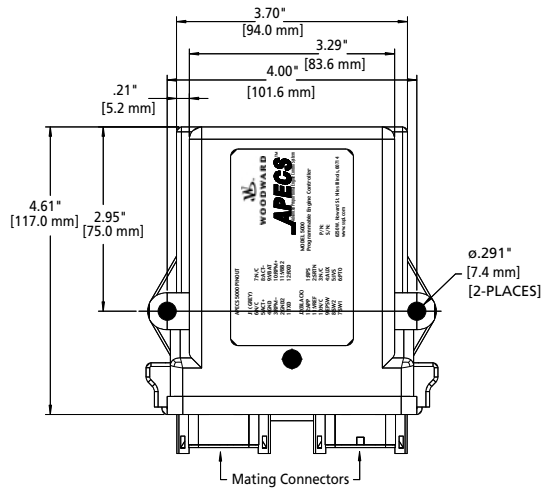
SA-4489	APECS 4500 Controller
SA-4490	Deutsch Connector Kit
SA-4488	ACT Kit (All-purpose Calibration Tool)

Dimensions:

APECS 4500 has two 12-pin Deutsch connectors labeled J1 (grey) and J2 (black). Deutsch part numbers are DTM06-12SA (J1 grey) and DTM06-12SB (J2 black).

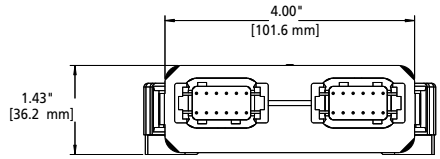
DIMENSIONS

Integral connection



TWO 12-PIN RECEPTACLES

Integral connection



Programmable Features:

- Analog speed setpoint input is suitable for use with a potentiometer or an accelerator pedal position sensor (idle verification available).
- Actuator current protection protects actuator from burning out.
- Autocrank permits remote operation of engines.
- Two auxiliary outputs drive a lamp or relay.
- Glow plug control
- Droop governing allows non-isochronous speed governing.
- Engine protection input protects against adverse conditions such as loss of engine oil pressure or excessive coolant temperature.
- Engine start calibration expedites special startup operations such as warm-up speed, reduced governor gains, missing speed signal
- Overspeed/underspeed protection
- PID gain adjustment allows governor response to be adjusted by user.
- PTO switch input permits selection between analog speed setpoint input and switched speed setpoint inputs in mobile applications.
- Switched speed setpoint inputs allow multiple speed settings using switches. This feature can be configured together with the analog input (speed pot) for a variety of speed select options.

Specifications:

Power Input	9-32 VDC, reverse polarity protected
EMI Immunity	(ISO 14982:1998/E) 30 V/M 20 MHz to 1000 MHz
Output to Actuator	Pulse width modulated, 6 amps max.
Auxiliary Outputs	200 mA maximum (sinking)
Operating Temperature	-40° F to +185° F (-40° C to+85° C)
Vibration	6 G's from 40 Hz to 2000 Hz
Calibration	Requires interface adapter and software for calibration
Enclosure	Deutsch PCB enclosure EEC-325X4 with two 12-pin receptacles
Weight	Approx. 0.6 lb (0.27 kg)

NEW

APECS® 5000

This newest addition to the APECS series of programmable engine controllers applies Woodward's advanced digital governing technology to stepper motors. Designed as an economical means of throttle actuation in small spark ignition engines, the APECS 5000 is also an excellent engine protection system.

Features:

- User-selectable isochronous or droop governing
- Actuator output tailored to Woodward bi-polar stepper motor. Position control to one-quarter degree accuracy
- Easily programmed with software calibration tool:
  - Adjustable PID gains
  - Programmed speed setpoints, ramp rates
  - Simplified calibration with software wizard
  - Graphic or numeric real-time display
- Universal speed input for either magnetic pickup, coil-type spark ignition system, magneto spark ignition system, or Hall Effect sensor.
- External analog speed setpoint input may be configured for trim mode or full authority mode.
- Two switched inputs allow for either multi-speed or variable speed operation.
- PTO switch input enables selection between analog and speed setpoint switch inputs. Also used to initiate an autocrank sequence when auxiliary output is configured for this purpose.
- Idle verification switch input can detect pedal position sensor faults.
- Engine protection switch input connects to one or more user-selected engine protection switches (e.g. engine coolant, engine oil pressure).
- Status lamp (LED) signals normal engine running condition and diagnostics including overspeed and underspeed.
- Auxiliary output configurable in several ways:
  - Engine shutdown
  - Crank disable
  - Autocrank sequence
  - Remote fault lamp or remote status lamp
- Ideal for mobile or stationary applications.

Order Information:

SA-4486	APECS 5000 Controller
SA-4490	Deutsch Connector Kit
SA-4488	ACT Kit (All-purpose Calibration Tool)

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.

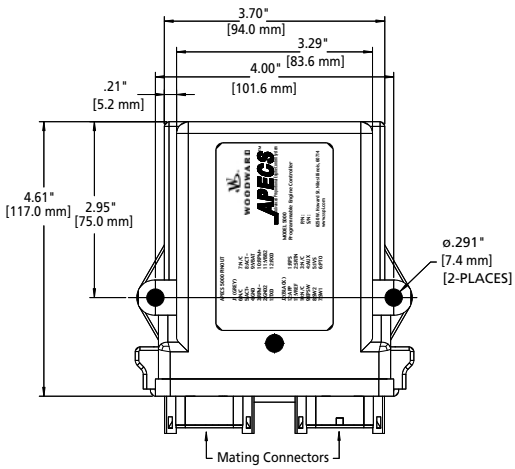
Electrical Specifications:

Power Input	9-32 VDC, reverse polarity protected
EMI Immunity (ISO 14982:1988/E)	30 V/M 20 MHz to 1000 MHz
Operating Current	12 Volt / 24 Volt
Operating:	1.25 A / 1.25 A
Standby:	25 mA / 25 mA
Auxiliary Outputs	200 mA maximum

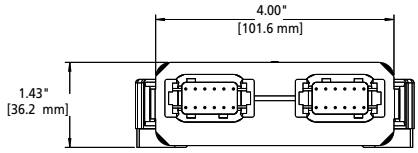
Mechanical Specifications:

Operating Temperature	-40˚F to +185˚F (-40˚C to +85˚C)
Vibration	6 G's from 40 to 2000 Hz
Calibration	Requires interface adapter and software for calibration setup
Enclosure	Deutsch PCB enclosure EEC-325X4 with two 12-pin receptacles
Weight	Approx. 0.6 lbs (0.27 kg)

DIMENSIONS



TWO 12-PIN RECEPTACLES



Specifications and dimensions are for reference only.

APECS® 0175 Series Actuators

Provides proportional fuel control for construction, industrial and agricultural equipment. 1.75" diameter spring-return actuator, pull or push models, three spring types available.

Features:

- Pull or push actuation (Model 0175 pull, Model 0175P push)
- Flange or base mount
- Failsafe operation using spring to return actuator to minimum fuel position
- Corrosion resistant, plated steel housing and mounting base/flange
- Precise engine speed control when used with APECS electronic controllers. (See Controllers section, pages 74-83, for ordering information.)
- Variety of mounting styles, plungers, terminations, and springs available

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

( ) – ( ) ( ) ( ) ( ) ( )

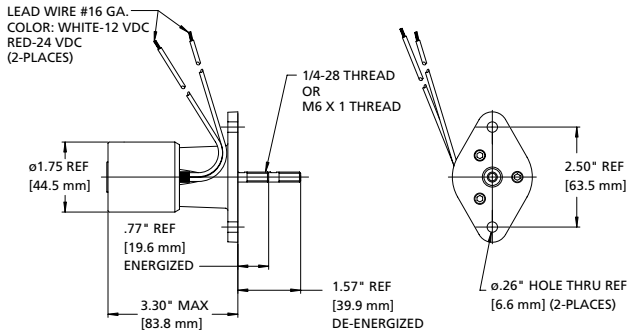
Model No.	Voltage	Mounting Style	Plunger Type	Termination Type	Return Spring*
0175 Pull	**12** 12 VDC	**A** Flange	**2** Ext. ¼-28 thread	**L** Lead wire	**S1**
0175P Push	**24** 24 VDC	**E** Base	**3** Ext. M-6 thread	**C** Connector	**S2**
					S3

*Spring Chart

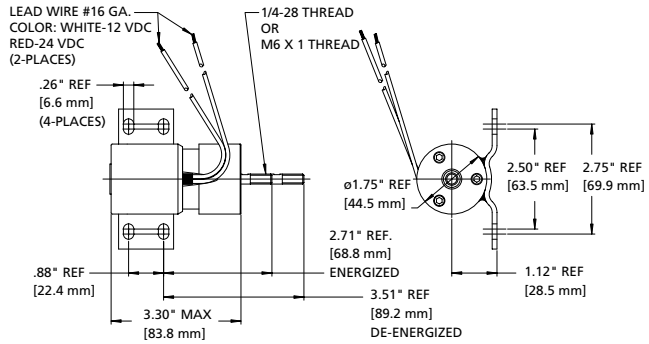
Spring Type	PART NO.	De-energized Spring Force	Energized Spring Force	Spring Rate
S1	SA-4703	0.50 lbs (2.2 N)	5.25 lbs (23.4 N)	5.94 lbs/in (0.16 kg/mm)
S2	SA-4704	0.25 lbs (1.1 N)	6.00 lbs (26.7 N)	7.20 lbs/in (0.13 kg/mm)
S3	SA-4472	0.40 lbs (1.8 N)	1.60 lbs (7.1 N)	1.53 lbs/in (0.03 kg/mm)

0175 / Pull Actuation

FLANGE MOUNT

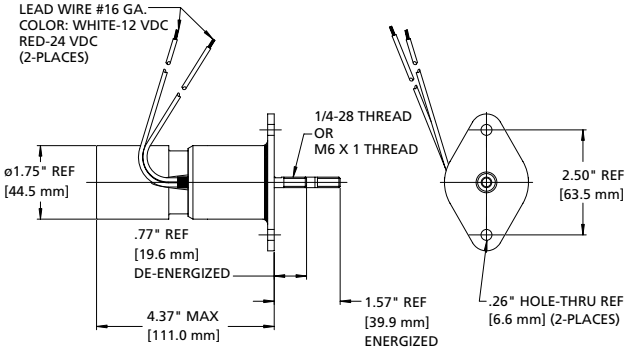


BASE MOUNT

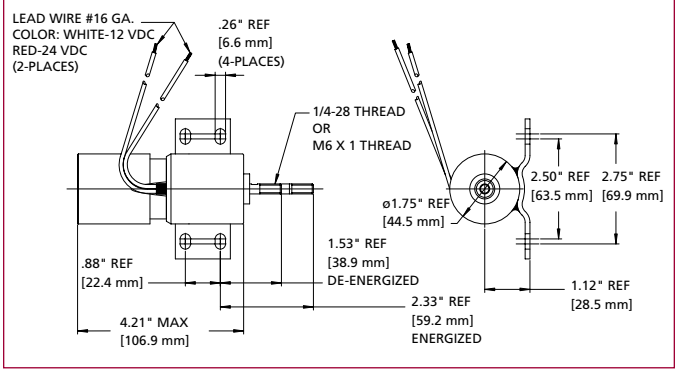


0175P / Push Actuation

FLANGE MOUNT



BASE MOUNT



Electrical Specifications:

Stroke	0.8" Maximum (20.3 mm)
Net Force	4.0 lbs (17.8 N)
Work Rating	0.3 ft. lbs (0.41 Nm)
Nominal Rated Current	4.3 A (12 VDC) 2.3 A (24 VDC)
Response Time	30 milliseconds for 10%–90% of stroke
Resistance* (nominal)	2.80 Ohms (12 Volt) 10.63 Ohms (24 Volt)

Mechanical Specifications:

Operating Temperature	-40˚F to + 250˚F (-40˚C to + 121˚C)
Vibration	15 G's
Shock	200 G's
Weight	Approx. 1.5 lbs (0.7 kg)

Specifications are for reference only.

***At ambient temperature**

WARNING: An overspeed shutdown device, independent of the APECS system, should be provided to prevent loss of engine control that may cause personal injury or equipment damage.

APECS® 0250 Series Actuators

Provides proportional fuel control for construction, industrial and agricultural equipment. 2.50" diameter spring-return actuator, pull or push models, four spring types available.

Features:

- Pull or push actuation (Model 0250 pull, Model 0250P push)
- Flange or base mount
- Failsafe operation using spring to return actuator to minimum fuel position
- Corrosion resistant, plated steel housing and mounting base/flange
- Precise engine speed control when used with APECS electronic controllers. (See Controllers section, pages 74-83, for ordering information.)
- Variety of mounting styles, plungers, terminations, and springs available

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

( ) – ( ) ( ) ( ) ( ) ( )

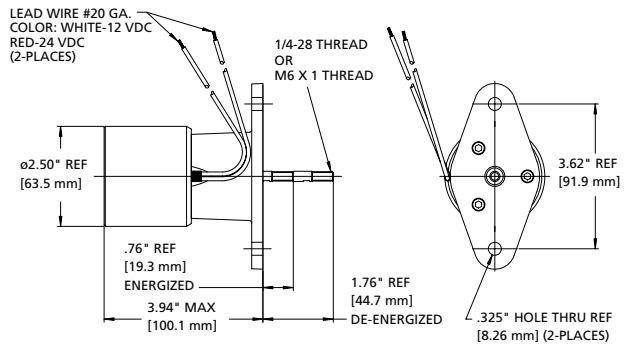
Model No.	Voltage	Mounting Style	Plunger Type	Termination Type	Return Spring*
0250 Pull	**12** 12 VDC	**A** Flange	**2** Ext. ¼-28 thread	**L** Lead wire	**S1**
0250P Push	**24** 24 VDC	**E** Base	**3** Ext. M-6 thread	**C** Connector	**S2**
					S3
					S4

*Spring Chart

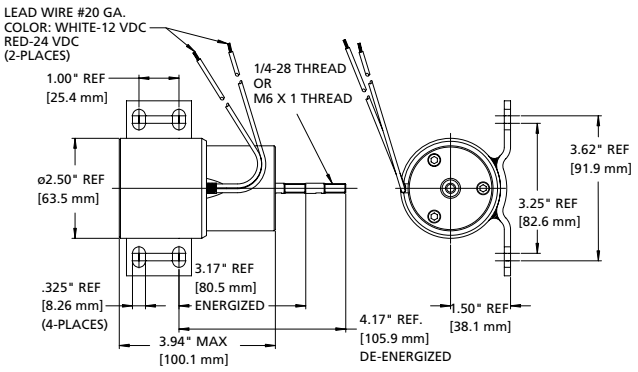
Spring Type	PART NO.	De-energized Spring Force	Energized Spring Force	Spring Rate
S1	SA-4684	1.60 lbs (7.1 N)	11.40 lbs (50.7 N)	9.80 lbs/in (0.17 kg/mm)
S2	SA-4685	0.75 lbs (3.3 N)	14.00 lbs (62.3 N)	13.25 lbs/in (0.24 kg/mm)
S3	SA-4728	0.75 lbs (3.3 N)	8.80 lbs (39.1 N)	8.05 lbs/in (0.14 kg/mm)
S4	SA-4729	0.75 lbs (3.3 N)	14.55 lbs (64.7 N)	13.80 lbs/in (0.25 kg/mm)

0250 / Pull Actuation

FLANGE MOUNT

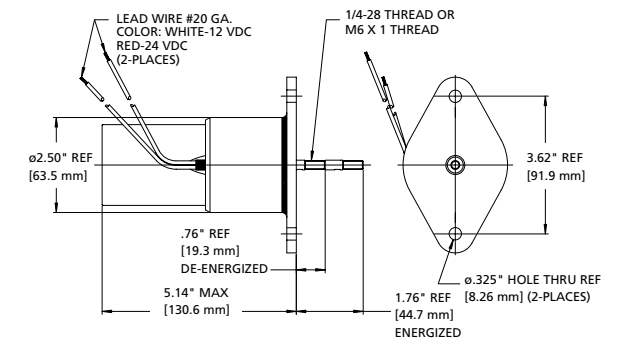


BASE MOUNT

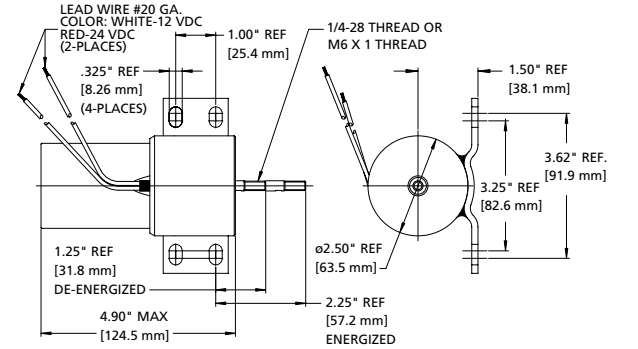


0250P / Push Actuation

FLANGE MOUNT



BASE MOUNT



Electrical Specifications:

Stroke	1.0" Maximum (25.4 mm)
Net Force	6.0 lbs (26.7 N)
Work Rating	0.7 ft. lbs (0.95 Nm)
Nominal Rated Current	6.8 A (12 VDC) 3.5 A (24 VDC)
Response Time	65 milliseconds for 10%–90% of stroke
Resistance* (nominal)	1.76 Ohms (12 Volt) 6.84 Ohms (24 Volt)

Mechanical Specifications:

Operating Temperature	-40˚F to + 250˚F (-40˚C to + 121˚C)
Vibration	15 G's
Shock	200 G's
Weight	Approx. 3.0 lbs (1.4 kg)

Specifications are for reference only.

***At ambient temperature**

WARNING: An overspeed shutdown device, independent of the APECS system, should be provided to prevent loss of engine control that may cause personal injury or equipment damage.

APECS® 0300 Series Actuators

Provides proportional fuel control for construction, industrial and agricultural equipment. 3.00" diameter spring-return actuator, pull or push models, three spring types available.

Features:

- Pull or push actuation (Model 0300 pull, Model 0300P push)
- Flange or base mount
- Failsafe operation using spring to return actuator to minimum fuel position
- Corrosion resistant, plated steel housing and mounting base/flange
- Precise engine speed control when used with APECS electronic controllers. (See Controllers section, pages 74-83, for ordering information.)
- Variety of mounting styles, plungers, terminations, and springs available

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

( ) – ( ) ( ) ( ) ( ) ( )

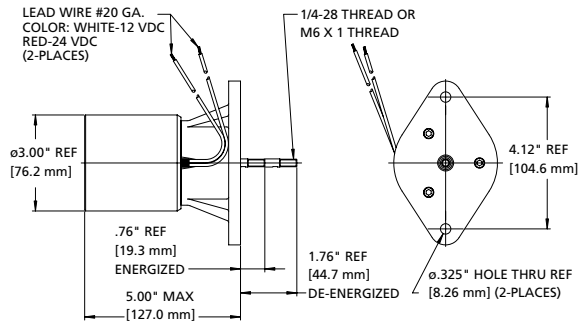
Model No.	Voltage	Mounting Style	Plunger Type	Termination Type	Return Spring*
0300 Pull	**12** 12 VDC	**A** Flange	**2** Ext. ¼-28 thread	**L** Lead wire	**S1**
0300P Push	**24** 24 VDC	**E** Base	**3** Ext. M-6 thread	**C** Connector	**S2**
					S3

*Spring Chart

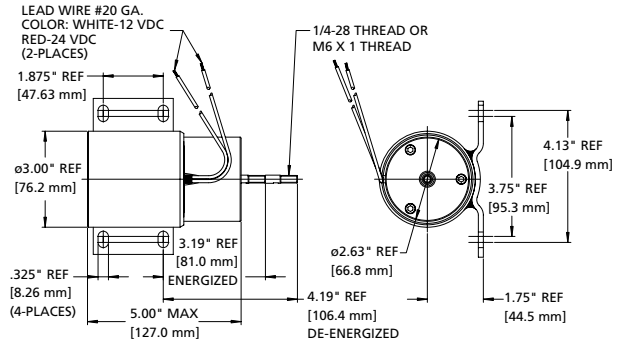
Spring Type	PART NO.	De-energized Spring Force	Energized Spring Force	Spring Rate
S1	SA-4713	4.25 lbs (18.9 N)	19.50 lbs (86.7 N)	15.25 lbs/in (0.27 kg/mm)
S2	SA-4714	1.00 lbs (4.4 N)	22.00 lbs (97.9 N)	21.00 lbs/in (0.37 kg/mm)
S3	SA-4829	2.13 lbs (9.5 N)	9.75 lbs (43.4 N)	7.62 lbs/in (0.14 kg/mm)

0300 / Pull Actuation

FLANGE MOUNT

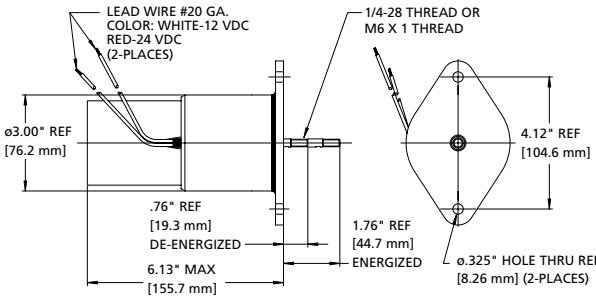


BASE MOUNT

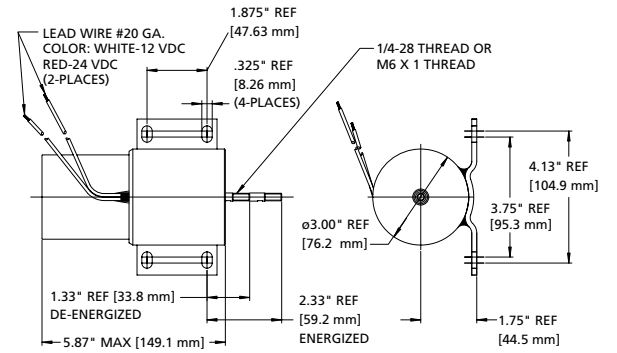


0300P / Push Actuation

FLANGE MOUNT



BASE MOUNT



Electrical Specifications:

Stroke	1.0" Maximum (25.5 mm)
Net Force	15.0 lbs (66.7 N)
Work Rating	1.3 ft. lbs (1.76 Nm)
Nominal Rated Current	6.9 A (12 VDC) 3.6 A (24 VDC)
Response Time	80 milliseconds for 10%–90% of stroke
Resistance* (nominal)	1.72 Ohms (12 Volt) 6.57 Ohms (24 Volt)

Mechanical Specifications:

Operating Temperature	-40˚F to + 250˚F (-40˚C to + 121˚C)
Vibration	15 G's
Shock	200 G's
Weight	Approx. 6.5 lbs (3.0 kg)

Specifications are for reference only.

***At ambient temperature**

WARNING: An overspeed shutdown device, independent of the APECS system, should be provided to prevent loss of engine control that may cause personal injury or equipment damage.

Linkage Free Integral-Type

Actuators provide proportional fuel control for construction, industrial, and agricultural equipment. For direct mounting to specific engines.

Features:

- Direct replacement for integral mount fuel shutoff solenoid
- Fuel pump shutoff force built into actuator
- Responds in milliseconds to changes in current from a pulse width modulated signal generated by the controller
- Precise engine speed control when used with APECS electronic controllers (See Controllers section, pages 74-83, for ordering information)
- Simple installation, no brackets or linkages necessary

Available for:

- Kubota Super 5 Series
- Kubota 3300 Series
- Mitsubishi SL Series
- Perkins 700 Series
- Yanmar TNE Series
- Yanmar 2V78 Series

Order Information:

ORDER NO.	Engine Series	Model	Voltage
SA-4573-12	Kubota Super 5	0175-12 A5LS Kubota	12 VDC
SA-4573-24	Kubota Super 5	0175-24 A5LS Kubota	24 VDC
SA-4828-12	Kubota 3300	0175-12 A6LS Kubota	12 VDC
SA-4828-24	Kubota 3300	0175-24 A6LS Kubota	24 VDC
SA-4837-12*	Mitsubishi SL	0175-12 B7LS Mitsubishi	12 VDC
SA-4837-24*	Mitsubishi SL	0175-24 B7LS Mitsubishi	24 VDC
SA-4777-12	Perkins 700	0175-12 A6LS Perkins	12 VDC
SA-4777-24	Perkins 700	0175-24 A6LS Perkins	24 VDC
SA-4574-12	Yanmar TNE	0175-12 S5LS Yanmar	12 VDC
SA-4574-24	Yanmar TNE	0175-24 S5LS Yanmar	24 VDC
SA-4848-12	Yanmar 2V78	0175-12 S6LS Yanmar	12 VDC
SA-4848-24	Yanmar 2V78	0175-24 S6LS Yanmar	24 VDC

***Threaded-mount unit, locknut supplied**

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.

Linkage Free Integral-Type

Electrical Specifications:

Rated Voltage	12 or 24 VDC
Rated Current	4.3 A (12 VDC) 2.3 A (24 VDC)
Input Signal	Pulse width modulated
Connections	Two wires, open lead

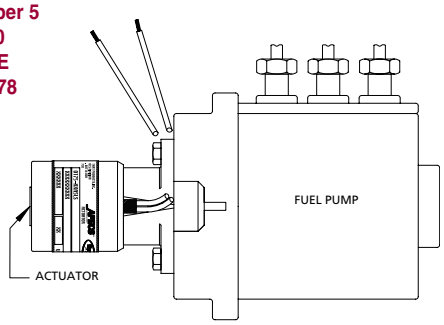
Mechanical Specifications:

Temperature Range	-40˚F to + 250˚F (-40˚C to + 121˚C)
Vibration	15 G's from 50 to 500 Hz sinusoidal, 3-planes
Shock	200 G's, 0-Peak @ 21 Hz
Housing	Anodized aluminum, sealed up to 3 psi for environmental protection

Engine Series	Stroke	Weight
Kubota Super 5	0.47" (12 mm)	1.16 lbs (0.53 kg)
Kubota 3300	0.47" (12 mm)	1.16 lbs (0.53 kg)
Mitsubishi SL	0.53" (13.5 mm)	1.28 lbs (0.58 kg)
Perkins 700	0.63" (16.0 mm)	1.19 lbs (0.54 kg)
Yanmar TNE	0.29" (7.4 mm)	1.19 lbs (0.54 kg)
Yanmar 2V78	0.29" (7.4 mm)	1.19 lbs (0.54 kg)

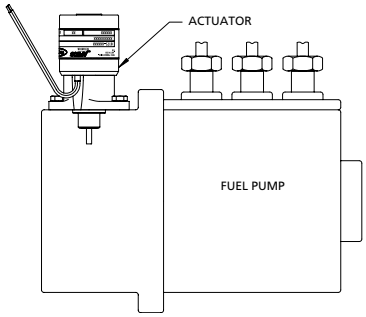
SIDE MOUNTING

Actuator mounts directly to fuel pump in place of the fuel shutoff solenoid
Kubota Super 5
Perkins 700
Yanmar TNE
Yanmar 2V78



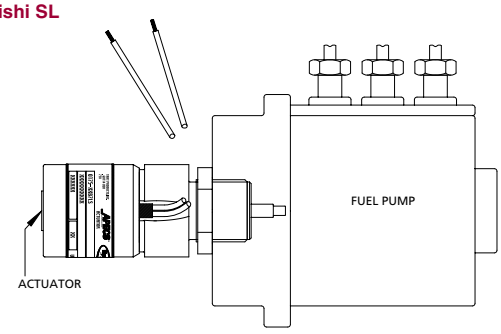
TOP MOUNTING

Kubota 3330



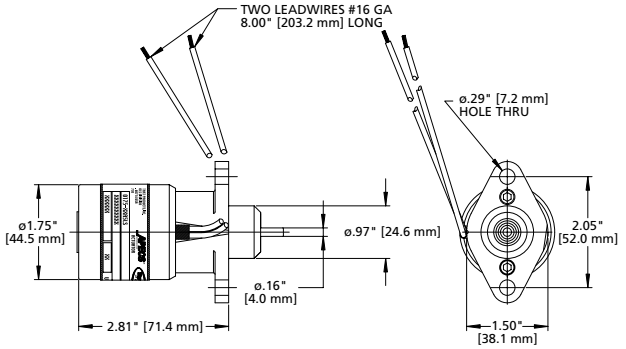
THREAD MOUNTING

Mitsubishi SL

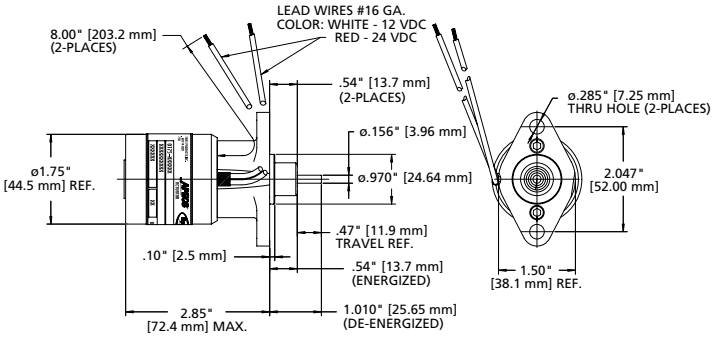


Linkage Free Integral-Type

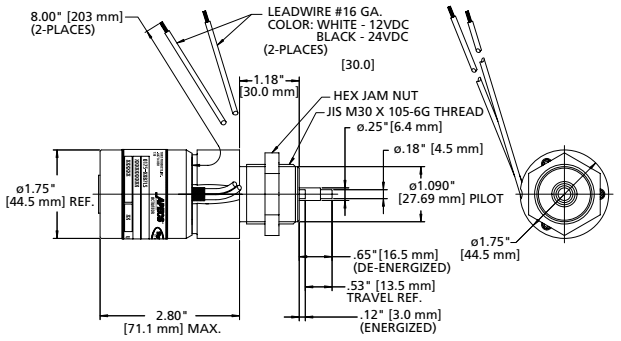
KUBOTA SUPER 5 SERIES



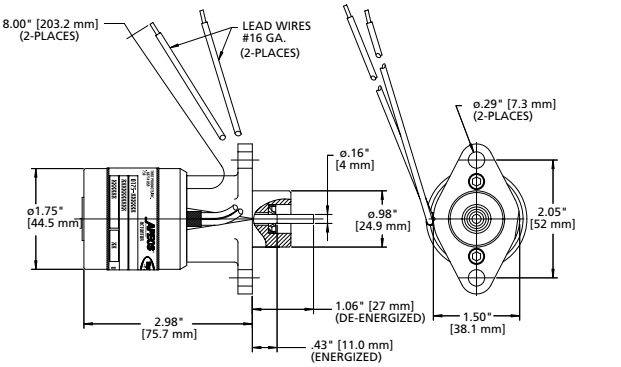
KUBOTA 3300 SERIES



MITSUBISHI SL SERIES

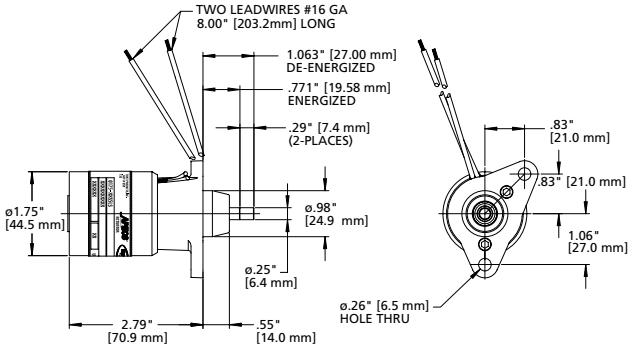


PERKINS 700 SERIES

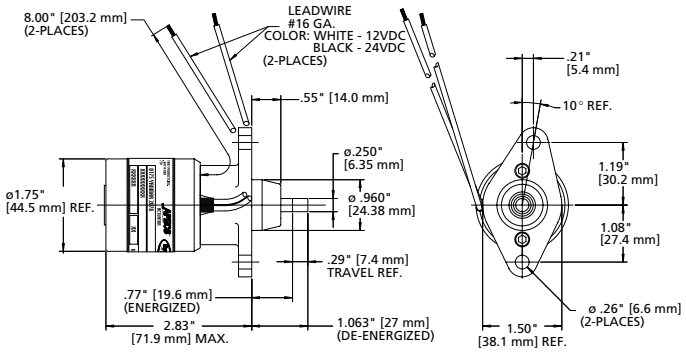


Linkage Free Integral-Type

YANMAR TNE SERIES



YANMAR 2V78 SERIES



Specifications are for reference only.

WARNING: An overspeed shutdown device, independent of the APECS system, should be provided to prevent loss of engine control that may cause personal injury or equipment damage.

APECS® 0200R Rotary Actuator

Versatile rotary actuator is suitable for a variety of stationary and off-road engine applications. Direct connection eliminates the need for any external linkage.

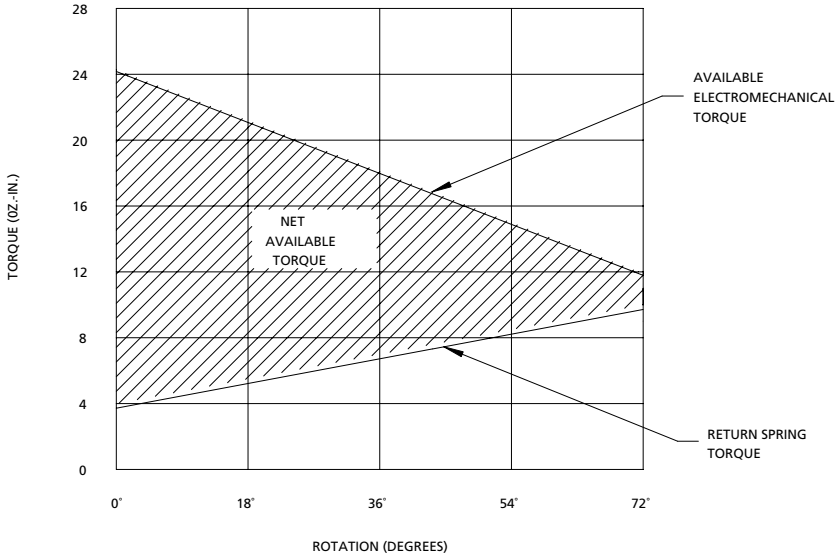
Features:

- Angular position proportional to input coil current
- Direct interface between actuator and shut-off lever
- Multiple terminal connections available
- Spring return to minimum position
- Precise engine speed control when used with APECS electronic controllers (See Controllers section, pages 74-83, for ordering information)
- Withstands harsh temperature and vibration conditions
- Corrosion resistant housing with sealed plastic cover

Order Information:

ORDER NO.	Voltage
SA-4928-12	12 VDC
SA-4928-24	24 VDC

Torque vs. Rotation*



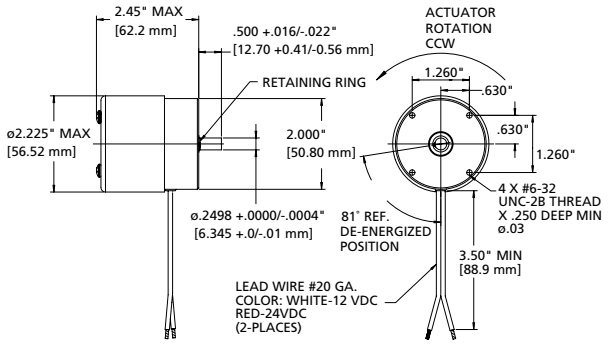
*At 68˚F (20˚C) and rated voltage

WARNING: An overspeed shutdown device, independent of the APECS system, should be provided to prevent loss of engine control that may cause personal injury or equipment damage.

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.

APECS® 0200R Rotary Actuator

DIMENSIONS



Electrical Specifications:

Rated Voltage	12 or 24 VDC
Rated Current	68°F(20°C)
Nominal Steady State Nominal Intermittent at Stall	12 Volt 24 Volt 3.0 A 1.6 A 6.0 A 3.1 A
Response Time	0.05 sec nominal ON time for 63% stroke 0.05 sec nominal OFF time for 63% stroke

Mechanical Specifications:

Temperature Range	-40°F to + 221°F (-40°C to + 105°C)
Rotation	72° (±2°)
Vibration	15 G's
Shock	200 G's
Sealing	Oil, water and dust resistant
Weight	1.2 lbs (0.54 kg)

Specifications are for reference only.

Engine Mounting Kits

Proportional fuel control for construction, industrial, and agricultural equipment. Maintains isochronous engine speed for demanding applications such as gensets, eliminating droop inherent in mechanical governors. Includes mounting hardware and control linkage for electronic engine governing systems.

Features:

- Fast, easy installation
- Corrosion resistant, plated steel bracket, linkage and hardware
- For use with APECS proportional actuators. (Vanguard kit includes 0175 actuator)
- Precise engine speed control when used with APECS electronic controllers (See APECS Controllers section, pages 74-83, for ordering information)

Kits Available

- Cummins C Series
- Kubota V2203-E
- Vanguard 3/LC
  DM-700D, DM-850D & DM-950D

WARNING: An overspeed shutdown device, independent of the APECS system, should be provided to prevent loss of engine control that may cause personal injury or equipment damage.

Engine Mounting Kits

Specifications:

Actuator Rated Voltage	12 or 24 VDC
Temperature Range	-40˚F to +250˚F (-40˚C to +121˚C)
Input Signal	Pulse width modulated
Housing	Anodized aluminum
Connections	Two wires, open lead

	Rated Current	Stroke	Weight (excluding actuator)	Kit Contents
Cummins	6.8 A–12 VDC 3.5 A–24 VDC	1.00" (25.4 mm)	1.4 lbs (0.64 kg)	Adapter plate, linkage, reinforcing bar for A & MW pump mounting hardware
Kubota	6.8 A–12 VDC 3.5 A–24 VDC	1.00" (25.4 mm)	2.7 lbs (1.2 kg)	Mounting bracket, linkage, lever extension, mounting hardware
Vanguard	4.3 A–12 VDC 2.3 A–24 VDC	0.80" (20 mm)	1.7 lbs (0.78 kg)	Actuator with welded bracket, linkage and mounting hardware

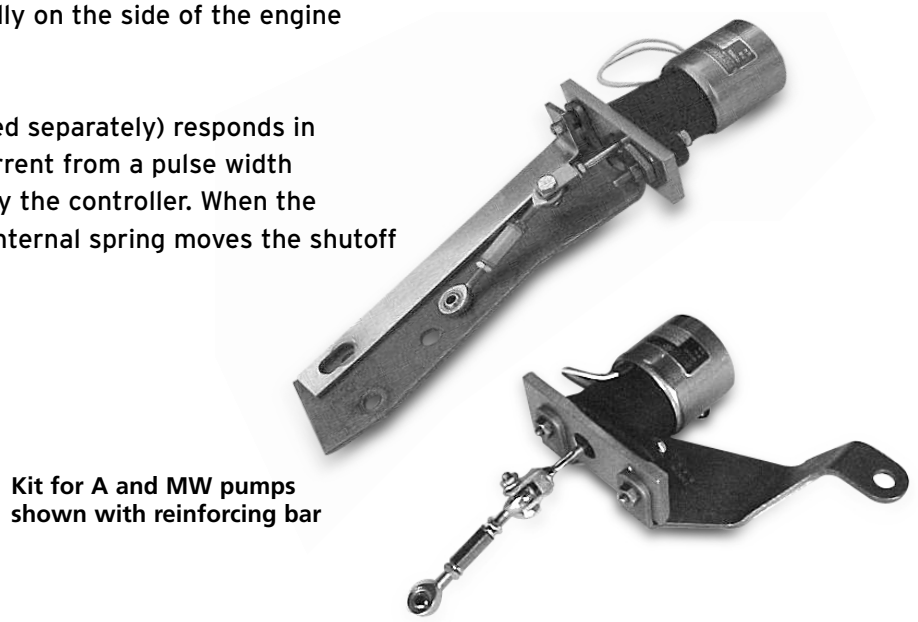
Specifications are for reference only.

Engine Mounting Kits

Cummins C Series Kit

Kits are custom fit for Cummins C series engines that are equipped with an RSV governor on Bosch A, MW and P fuel pumps. Kit mounts horizontally on the side of the engine block behind the pump.

APECS linear actuator (ordered separately) responds in milliseconds to changes in current from a pulse width modulated signal generated by the controller. When the actuator is de-energized, an internal spring moves the shutoff lever to shutdown.



Kit for A and MW pumps shown with reinforcing bar

Kit for P Pump

Order Information:

Mounting Kit

ORDER NO.	Application
SA-4598	Cummins C Series (A, MW & P pumps)

APECS Proportional Actuators

ORDER NO.	Model	Spring	Voltage
SA-4506-12	0250	SA-4684 (S1)	12 VDC
SA-4506-24	0250	SA-4684 (S1)	24 VDC

When you order: Order bracket from Cummins if it is not already on the engine:

PUMP MODEL	Bracket
A	No. 3923254
MW	No. 3923255
P	No. 3930290

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.

Engine Mounting Kits

Kubota V2203-E Kit

The Kubota V2203-E kit mounts closely behind the fuel pump.

APECS linear proportional actuator (ordered separately) responds in milliseconds to changes in current from a pulse width modulated signal generated by the controller. When the actuator is de-energized, an internal spring moves the shutoff lever to shutdown.

Order Information:

Mounting Kit

ORDER NO.	Application
SA-4457	Kubota V2203-E

APECS Proportional Actuators

ORDER NO.	Model	Spring	Voltage
SA-4502-12	0251	SA-4684 (S1)	12 VDC
SA-4502-24	0251	SA-4684 (S1)	24 VDC

Vanguard 3/LC DM-700D, DM-850D & DM-950D Kit

The Vanguard 3/LC kit mounts closely above the front gear housing, behind the fan, to minimize interference with other components or housing.

APECS linear proportional actuator responds in milliseconds to changes in current from a pulse width modulated signal generated by the controller. When the actuator is de-energized, an internal spring moves the shutoff lever to shutdown.

Order Information:

Mounting Kit

ORDER NO.	Application
SA-4779-12	Vanguard 3/LC (all models)
SA-4779-24	Vanguard 3/LC (all models)

APECS Proportional Actuators

ORDER NO.	Model	Spring	Voltage
Included in Kit	0175	Included	12 VDC
Included in Kit	0175	Included	24 VDC

Note: The throttle lever with an extra hole must be ordered from Briggs and Stratton Daihatsu in the U.S.

Linkage Hardware

Linkage components connect the actuator shaft to the engine control lever. A good linkage contributes to accurate, stable and responsive performance with minimal play or friction.

Features:

- Allows for minor misalignments
- Minimal friction, binding and backlash
- Threaded rod for longer linkages
- Spherical male and female rod-end bearings for shorter linkages
- Built to withstand extreme conditions
- Corrosion resistant

Kit Contents:

Long Linkage Kit includes:

(1) Threaded rod
(4) Hex nuts
(4) Split lockwashers
(1) Hex screw
(2) Rod ends, female
(1) Clevis

Short Linkage Kit includes:

(3) Hex nuts
(3) Split lockwashers
(1) Hex screw
(1) Rod end, female
(1) Rod end, male
(1) Clevis

Order Information:

APECS Linkage Kits

ORDER NO.	Description	Thread Size	Center to center of spherical rod ends Minimum Length	Maximum Length
SA-4661	Long Linkage Kit	¼-28	3.3"	7.9"
SA-4845	Long Linkage Kit	M6	83.8 mm	200.6 mm
SA-4742	Short Linkage Kit	¼-28	2.2"	2.6"
SA-4844	Short Linkage Kit	M6	55.8 mm	66.0 mm

Individual APECS Kit Components

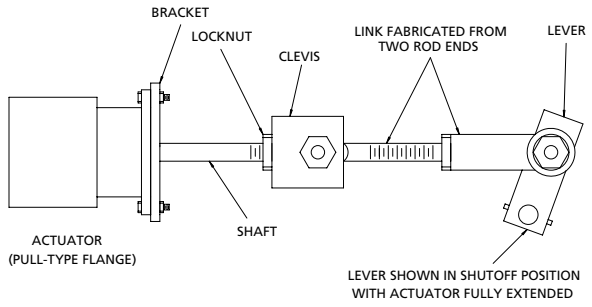
ORDER NO. for Thread Size: ¼-28	M6	Description
SA-4599	SA-4804	Clevis (fits actuators to the rod ends sold below)
SA-4619	SA-4843	Spherical rod end, female
SA-4600	SA-4842	Spherical rod end, male
SA-4602	SA-4846	Long threaded rod

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.

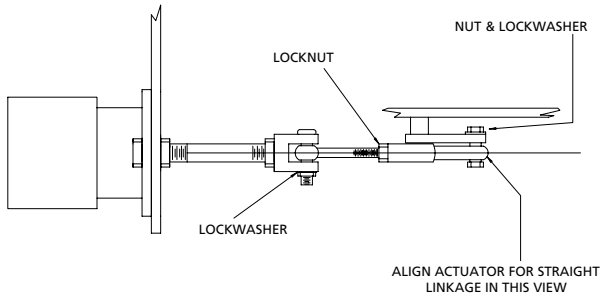
Linkage Hardware

Assembled Kits:

SIDE VIEW



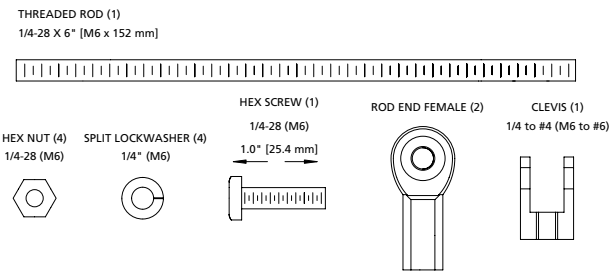
TOP VIEW



NOTE: Actuator and control lever are not part of the linkage kit.

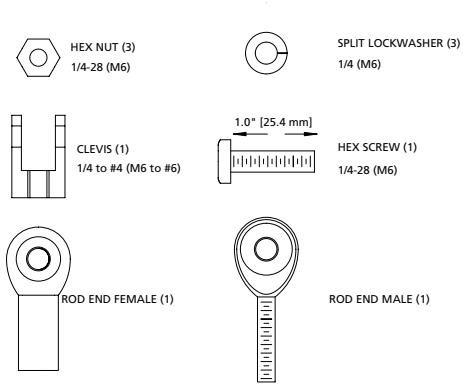
Kit Components:

LONG LINKAGE KIT



NOTE: Kit components are bagged, not assembled.

SHORT LINKAGE KIT



NOTE: Kit components are bagged, not assembled.

WARNING: An overspeed shutdown device, independent of the APECS system, should be provided to prevent loss of engine control that may cause personal injury or equipment damage.

Part No. Index

Part No. Index

Product Index

phone: 847-967-7730

WORLDWIDE SALES OFFICES & DISTRIBUTORS

AUSTRALIA
Distributor:
Micromax Pty., Ltd.
Carlo Foligni
Wollongong, Australia
Telephone: +61 (0) 2 4271 1300
Fax: +61 (0) 2 4271 8091
E-mail: carlo@micromax.com.au

BRAZIL
Representative:
Werner Nopper
Sao Paulo
Brazil
Telephone: +55 (0) 115 181 7474
Fax: +55 (0) 115 181 7474
E-mail: wnopper@uol.com.br

CANADA
Distributor:
Traycana Inc.
Rick Gledhill
Quebec, Canada
Telephone: 450 424-6464
Fax: 450 424 4768
E-mail: traycana@total.net

CHINA
Woodward Controls Suzhou Co., Ltd.
Susan Zhang
Suzhou, China
Telephone: +86 (0) 512 6762 6727
Fax: +86 (0) 512 6761 7765
E-mail: infosuzhou@woodward.com

FRANCE
Distributor:
DSF Technologies S.A.
Alain Ferrando
Biot, France
Telephone: +33 (0) 4 92 38 88 20
Fax: +33 (0) 4 92 38 98 89
E-mail: alain.ferrando@dsf-tech.com

GERMANY
Woodward Controls UK Ltd.
Sales Engineer
Steven Phillips
Aachener Str. 295
Cologne, Germany
Telephone: +49 (0) 172 6106 733
Fax: +49 (0) 221 282 4053
E-mail: sphill@woodward.com

Distributor:
Motortech GmbH
Christian Thielbahr
Celle, Germany
Telephone: +49 (0) 5141 9399-16
Fax: +49 (0) 5141 9399-99
E-mail: cthielbahr@motortech.de

ITALY
Distributor:
DSF Technologia S.R.L.
Giorgio Cavagnera
Milan, Italy
Telephone: +39 (0) 291 080 209
Fax: +39 (0) 291 080 397
E-mail: info@dsftecnologia.com

JAPAN
Distributor:
Kimura Corporation
Frank Kimura
Tokyo, Japan
Telephone: +81 (0) 3 3213 0251
Fax: +81 (0) 3 3213 0470
E-mail: div3@kimuracorporation.co.jp

KOREA
Distributor:
Shinil Engineering Corp., Ltd.
Yong Ho Hur
Ulsan, Korea
Telephone: +82 (0) 52 289 9977
Fax: +82 (0) 52 288 4398
E-mail: shinil82@kornet.net

MEXICO
Distributor:
Idimex
Gonzalo Munoz
Mexico City, Mexico
Telephone: +52 (0) 55 5588 9479/9466
Fax: +52 (0) 55 5588 9549
E-mail: idimex@prodigy.net.mx

MIDDLE EAST
Distributor:
Fox for Engineering and Trading
Maher Ibrahim
4 El-Shorta Towers, 10th Floor, Flat 58
Cairo, Egypt
Telephone: (20) 2 48 20 441
Fax: (20) 2 48 20 441
E-mail: fox1eng@link.net

THE NETHERLANDS
Distributor:
Coltrading
Frans Colombon
Heemstede, The Netherlands
Telephone: +31 (0) 235 484 400
Fax: +31 (0) 235 484 408
E-mail: coltrading@cte-group.com

SINGAPORE
Distributor:
Pan-Halcyon Marketing Pte., Ltd.
Bob Moh
Singapore
Telephone: +65 (0) 6268 0860
Fax: +65 (0) 6383 0803
E-mail: bobmoh@starhub.net.sg

Distributor:
CCH/Chop Hock Hong
EE Boon Kwee
Singapore
Telephone: (65) 6294 9564
Fax: (65) 6293 8678
E-mail: hockhong@singnet.com.sq

SPAIN
Distributor:
DSF Technologies S.A. – Suc. En Espana
Andres Salgado
Madrid, Spain
Telephone: (34) 918 082 003
Fax: (34) 918 952 993
E-mail: andres.salgado@dsf-technologias.com

SWITZERLAND
Distributor:
Energotech AG
Albert Iten
Steinhausen, Switzerland
Telephone: +41 (0) 417 400 030
Fax: +41 (0) 417 400 035
E-mail: info@energotech.ch

TAIWAN
Distributor:
SanChin Industrial Co., Ltd.
Michael Sheu
Taiwan
Telephone: +866 2 2551 9251
Fax: +866 2 2563 8083
E-mail: mikepass@pchome.com.tw

THAILAND
Distributor:
Daven Co., Ltd.
Pote Pasoog
Nontaburi, Thailand
Telephone: +662 964 0877
Fax: +662 964 0879
E-mail: daven@ji-net.com

Distributor:
Diamond Brothers Ltd.
Komsan Pacharawanich
Bangkok, Thailand
Telephone: +662 868 6688
Fax: +662 868 6600
E-mail: komsanpat@diamond-brothers.com

UNITED KINGDOM
Woodward Controls UK Ltd.
Bob Beaumont
West Sussex, United Kingdom
Telephone: +44 (0) 1444 872836
Fax: +44 (0) 1444 239226
E-mail: info_uk@woodward.com

Distributor:
BSC (Contracts) Ltd.
Detlef Rademacher
West Midlands, United Kingdom
Telephone: +44 (0) 1215 574651
Fax: +44 (0) 1215 577375
E-mail: detlef@bsc-contracts.co.uk

WOODWARD

Formerly Synchro-Start Products, Inc.

6250 West Howard Street
Niles, IL 60714-3433
telephone: 847.967.7730
fax: 847.967.7832
e-mail: info_niles@woodward.com
www.woodward.com

GPC 2004: REV B 12/03