

# R-11, R-30, and R-120

## R-Series Electric Actuators with Integral Driver Service Tool Configurable

### Applications

Woodward's R-11, R-30, and R-120 electric actuators provide high torque rotary travel to precisely position various types of control valves and other mechanisms that operate in high-temperature, high-vibration locations. In reciprocating engine applications, these valves may include: fuel throttles, wastegates, exhaust gas recirculation (EGR), compressor recirculation (bypass), waste heat recovery (WHR), and exhaust. Additional applications on reciprocating engines include variable turbine geometry (VTG) turbocharger actuation.



### Description

The actuators accept a position command and use a brushless DC electric motor driving an integral gear box to move the output shaft through 73° of rotational output position for the R-11 and R-30 or 90° of rotational output position for the R-120. The cast metal modular design includes an electronic control module and integral motor housing that attach directly to the gearbox assembly. The 73° of travel enables the actuator to be connected directly to butterfly-type throttles, eliminating the need for failure-prone intermediate linkage. This larger rotary travel also provides more useful work output than actuators with the same torque output but with less rotary travel. (For more information on work vs torque, see Woodward application note 51214.)

All three actuators accept a position command signal from some other controlling device to position the actuator's output shaft. The actuators output shaft is moved to match the requested position. Internal electronic feedback assures the output shaft moves precisely to the requested position. These actuators accept either a 4 to 20 mA, 0 to 200 mA, J1939, or PWM (pulse width modulated) command signal while providing a 4 to 20 mA output shaft position signal that external devices can use as direct feedback of the output shaft's position.

Three major features were added to the original release of the R-Series. These include the addition of J1939 and demand redundancy, along with a service tool to support configuration and troubleshooting.

Greater operational reliability is achievable with redundant demand inputs. The demand redundancy has the ability to utilize two demand sources, a primary and a backup demand (e.g. PWM and J1939). It also includes functionality for fail-over, transferring to a backup input signal if primary input signal fails, and a fallback capability, transferring back to the primary input when it is restored, as well as a tracking error annunciation when the inputs signals are not tracking each other.

- High resolution
- High torque, low current electric actuator
- -40 °C to +105 °C operating range
- Up to +165 °C operating limit with active cooling
- Lower weight than LAT type actuators
- Accurate, non-contacting, position sensing
- J1939 Communications
- Redundant demand inputs
- On-board diagnostics
- Service tool for configuration and troubleshooting
- Custom cabling options

The J1939 functionality offers a long list of operational and diagnostic features, including flexible messaging, which enables users to build and define their own J1939 messages based on the application. This allows the J1939 compliant messages for a fuel valve to be different than those for an EGR valve. Additionally, it stores four independent sets of J1939 message configurations which are selected through harness coding using CAN ID discrete inputs. This harness code feature allows for up to four different J1939 applications to be preconfigured in a single Woodward part number.

The J1939 messaging provides numerous options including: Position Command, Run/Stop commands, Diagnostic Messaging (DM1, DM2, DM11), up to four J1939 devices harness code selected with CAN ID HI and LO discrete inputs, and up to 7 transmitted data messages each with configurable PGN, Rate, Start Bit, and Priority. DM1 provides active diagnostic trouble codes, DM2 is for previously active diagnostics, and DM11 is used to clear diagnostics. The optional data messages transmitted include: actual position (either 8-bit or 16-bit), desired position, operation status, diagnostic bit field, control mode status, electronics temperature, and prelim-FMI (Failure Mode Indicator)/temperature status.

Woodward's Toolkit software service tool enables unit configuration and device troubleshooting. It includes an event handler, which identifies all active and previously active diagnostics conditions as well as the fault type (alarm/shutdown), when they last occurred, and the number of occurrences detected.

An eleven point position demand curve allows a non-linear output position versus input signal with eleven breakpoints that interpolates between them.

The actuator travel auto setup feature uses a simple pushbutton command in the software service tool to automatically stroke the actuator from end-to-end to find the travel end points. The output travel is also configurable.

A configurable shutdown mode defines what action to take when a shutdown condition is detected. There are three different options: go limp on shutdown (zero actuator current), shutdown to position (e.g. 0%), or shutdown to position and then go limp. The shutdown position as well as the delay before going limp are configurable.

Two additional diagnostics are available for position error and a position sense deviation. Position error indicates a difference between command and actual position while the motor-to-shaft position deviation indicates a difference between the two internal position sensors (motor position and shaft position).

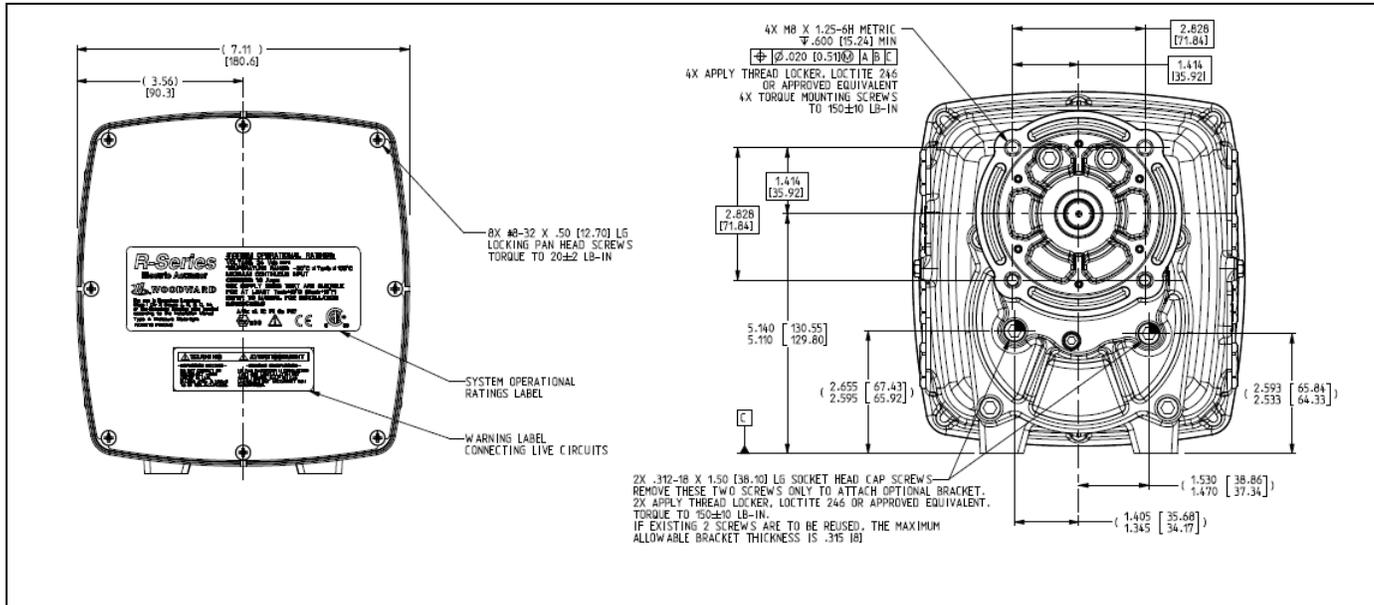
An access plate allows electrical connections to be made directly on the control module in the actuator housing and all wiring goes through gland nuts to maintain an ingress protection rating of IP67. The actuators are able to operate over a temperature range of  $-40\text{ }^{\circ}\text{C}$  to  $+105\text{ }^{\circ}\text{C}$  and up to  $+165\text{ }^{\circ}\text{C}$  with optional active liquid cooling. Some position accuracy is compromised from  $-40\text{ }^{\circ}\text{C}$  to  $-30\text{ }^{\circ}\text{C}$ .

## Installation

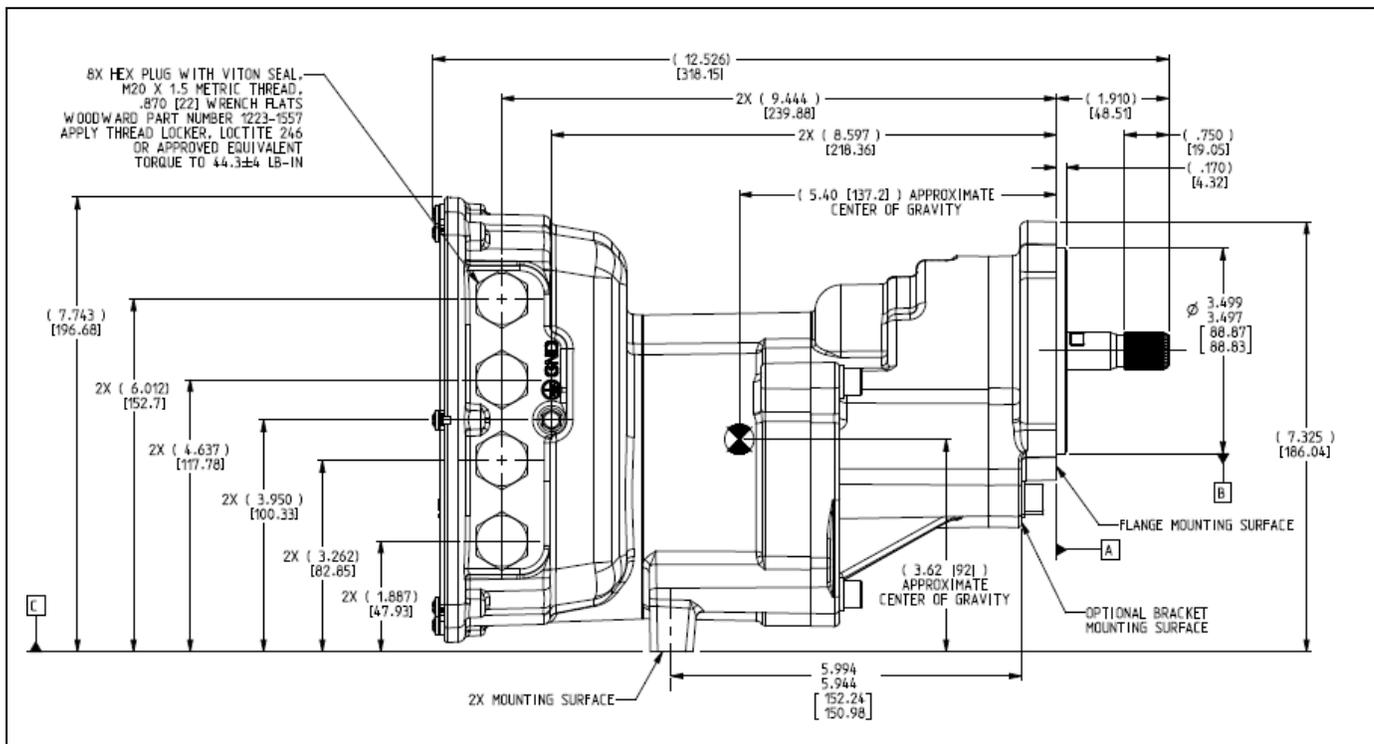
Both the R-11 and R-30 have the same physical dimensions, only the internal gearing is different. They can be mounted in any orientation and are completely self-contained.

All input and output signals run through two M20 threaded ports, using cable glands as needed to maintain the Class I, Division 2 / Zone 2 and Type 4 Enclosure Watertight. Field wiring is connected to internal screwless cage-clamp-style terminal blocks.

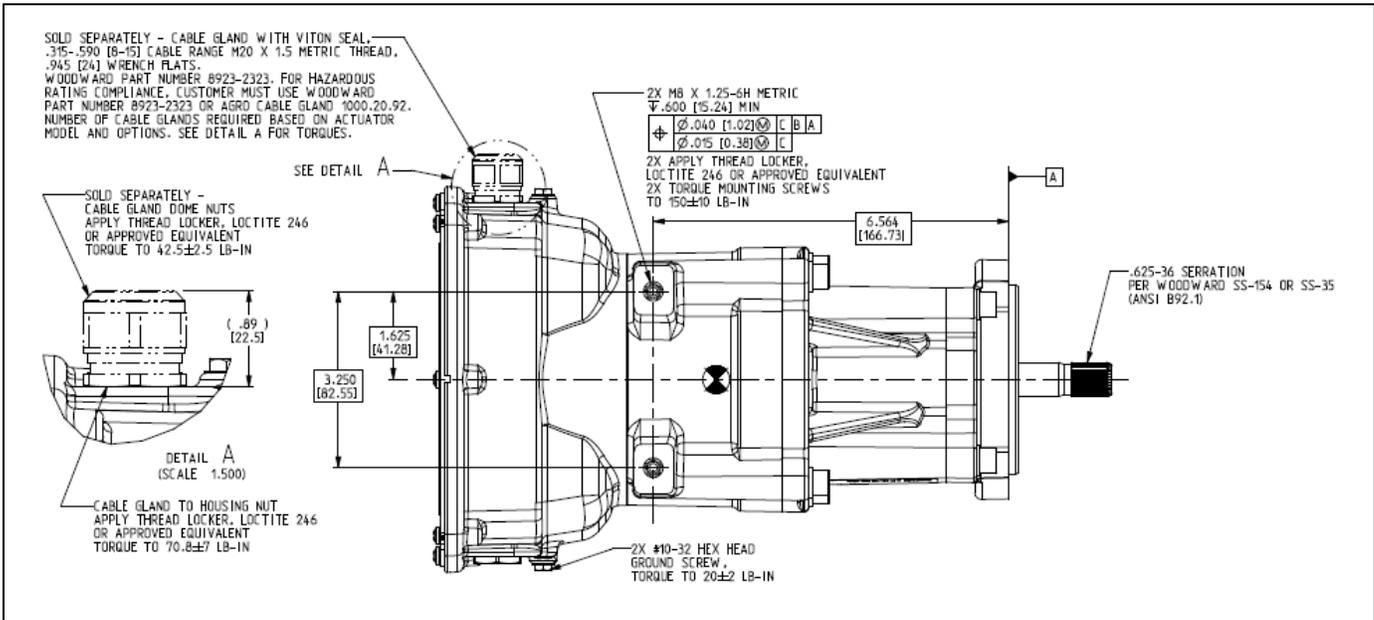
### R-11 and R-30 Series



R-11 and R-30 Dimensions  
(Do not use for construction)

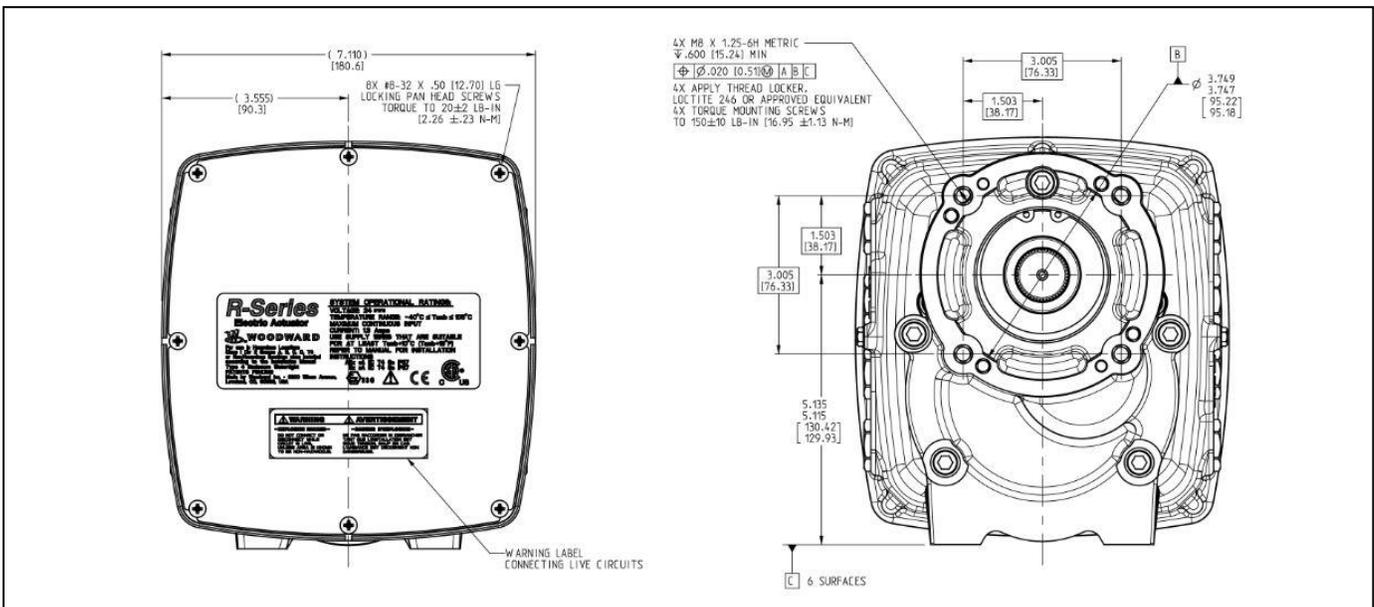


R-11 and R-30 Dimensions  
(Do not use for construction)

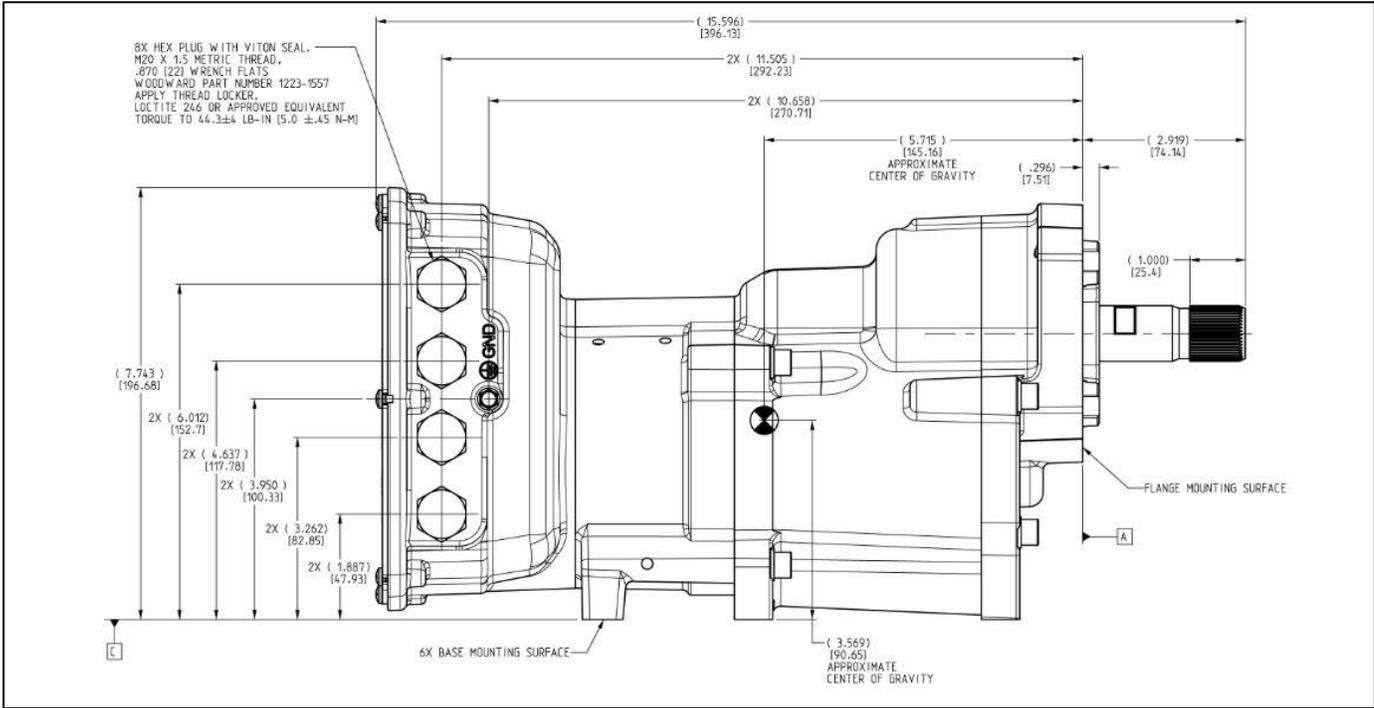


R-11 and R-30 Dimensions  
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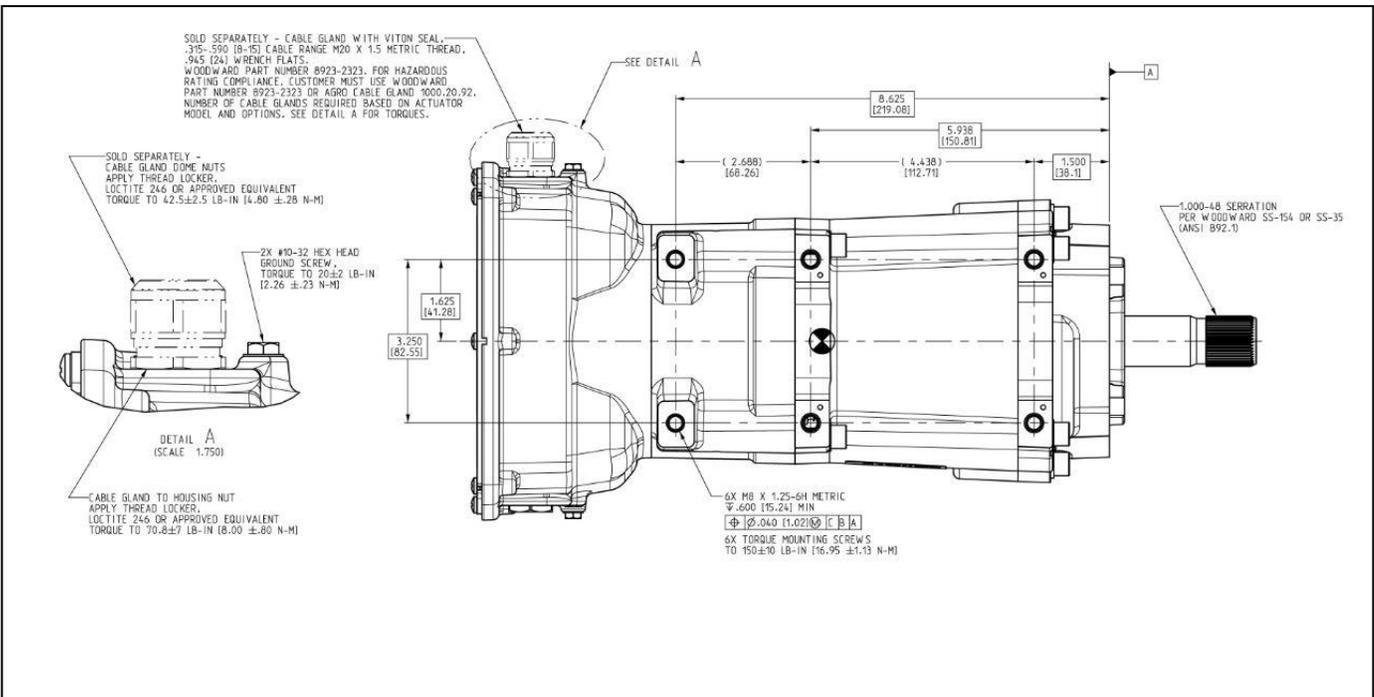
R-120 Series



R-120 Dimensions  
(Do not use for construction)



R-120 Dimensions  
(Do not use for construction)



R-120 Dimensions  
(Do not use for construction)

# Specifications

## General

| ***Model | *Work Output Continuous | Torque Output Transient | Torque Output Continuous | **Maximum Input Power Transient | **Maximum Input Power Continuous | **Maximum Current Transient | **Maximum Current Continuous | Weight             |
|----------|-------------------------|-------------------------|--------------------------|---------------------------------|----------------------------------|-----------------------------|------------------------------|--------------------|
| R-11     | 7.2 J<br>5.3 ft-lb      | 11 N-m<br>8.1 lb-ft     | 5.5 N-m<br>4 lb-ft       | 89 W                            | 24 W                             | 3.7 A                       | 1.0 A                        | 8.0 kg<br>17.6 lb  |
| R-11AC   |                         |                         |                          |                                 |                                  |                             |                              | 9.7 kg<br>21.3 lb  |
| R-30     | 19.6 J<br>14.5 ft-lb    | 30 N-m<br>22.1 lb-ft    | 15 N-m<br>11 lb-ft       | 89 W                            | 24 W                             | 3.7 A                       | 1.0 A                        | 8.3 kg<br>18.2 lb  |
| R-30AC   |                         |                         |                          |                                 |                                  |                             |                              | 9.9 kg<br>21.9 lb  |
| R-120    | 94.2 J<br>69.5 ft-lb    | 120 N-m<br>88.5 lb-ft   | 60 N-m<br>44.3 lb-ft     | 89 W                            | 24 W                             | 3.7 A                       | 1.0 A                        | 11.9 kg<br>26.3 lb |
| R-120AC  |                         |                         |                          |                                 |                                  |                             |                              | 13.6 kg<br>30 lb   |

(\*) Continuous Work Output is measured over 73° of rotation for R-11 and R-30 and 90° of rotation for the R-120. Good control of fuel racks requires the actuator to deliver a defined force over a defined distance, also known as *work*. Since *work* is the ultimate requirement, rotary actuators are best sized and compared based on continuous work rating: Continuous work (joules) = 0.01745 x continuous torque (N-m) x rotation angle (degrees)

(\*\*) at 24 Vdc nominal

(\*\*\*) AC refers to units provided with Active Fluid Cooling

## Inputs and Outputs

|                                 |                                                                                                                                                                                                                                                                   |
|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Power Input</b>              | 18–32 Vdc with out-of-range diagnostics                                                                                                                                                                                                                           |
| <b>Command Input</b>            | PWM: 8–32 Vdc, 100 to 2000 Hz (accepts push-pull and high-side or low-side open collector)<br>Analog: 0–200 mA, 4–20 mA, Digital J1939                                                                                                                            |
| <b>Output Shaft Rotation</b>    | R-11, R-30 = 73° ±2°<br>R-120 = 90° ±2°                                                                                                                                                                                                                           |
| <b>Position Feedback Output</b> | 4–20 mA corresponding to 0 % to 100 % travel                                                                                                                                                                                                                      |
| <b>Discrete Input</b>           | Key-switch low power standby mode. Applying input power to the key-switch input activates the actuator, making it ready to position in less than 300 ms. Removing the key-switch input power safely shuts down the actuator and its power draw is less than 2 mA. |
| <b>Discrete Output</b>          | Normally “ON” and turns “OFF” to indicate shutdown is active                                                                                                                                                                                                      |

## Performance

| Parameter                                           | Specification                                                                                                                                                                                           |
|-----------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Accuracy</b>                                     | ±1.36 % over the full rotational travel, from –30 to +105 °C, + input signal error. At < –30 °C, the position error can grow to ~ ±5%.                                                                  |
| <b>Maximum Slew Time †</b><br>(10 % to 90 % travel) | R-11 < 75 ms<br>R-30 < 105 ms<br>R-120 < 600 ms                                                                                                                                                         |
| <b>Small Signal Bandwidth †</b>                     | 6 Hz (minimum)                                                                                                                                                                                          |
| <b>Repeatability</b>                                | ≤1.0 % of full stroke at 25 °C                                                                                                                                                                          |
| <b>Gearbox Backlash</b>                             | < 0.5°                                                                                                                                                                                                  |
| <b>Maximum Side Load on Output Shaft</b>            | R-11, R-30 = 396 N / 89 lb<br>R-120 = 916 N / 206 lb                                                                                                                                                    |
| <b>Maximum Thrust Load on Output Shaft</b>          | R-11, R-30 = 67 N / 15 lb<br>R-120 = 175 N / 39 lb                                                                                                                                                      |
| <b>Maximum Load Inertia</b>                         | R-11 < 2.19E-3 kg-m <sup>2</sup> (1.94E-2 in-lb-s <sup>2</sup> )<br>R-30 < 5.26E-3 kg-m <sup>2</sup> (4.66E-2 in-lb-s <sup>2</sup> )<br>R-120 < 5.85E-2 kg-m <sup>2</sup> (0.518 in-lb-s <sup>2</sup> ) |

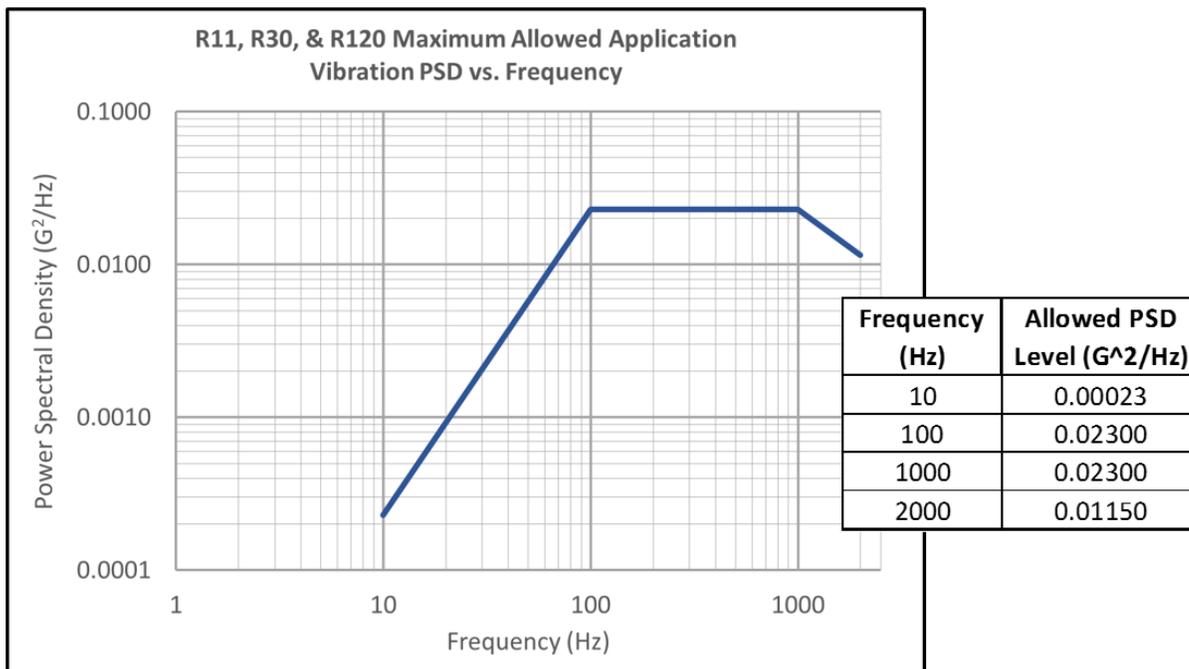
(†) with no external load

## Environmental

| Specification Item                  | Tested to the Following Specifications                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Operating Temperature Limits</b> | –40 °C to +105 °C (from –30 °C to –40 °C, position error can grow to ±5% of full travel)<br>Under all conditions, the Temperature Monitoring Zone must remain below 105 °C.<br>Active Liquid Cooling extends the upper ambient temperature range of the actuator up to a maximum of 165°C. Maximum cooling liquid temperatures and liquid type requirements must be followed per manual 26845.<br>See Mechanical Installation section of manual 26845 for discussion of this specification item. |
| <b>Storage Temperature</b>          | –40 °C to +125 °C, unpowered                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Mechanical Shock</b>             | US MIL-STD-810F, Method 516.5, Procedure 1, 40 G peak, 11 ms duration, saw-tooth pulse                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Ingress Protection</b>           | IP67 per IEC 60529, NEMA Type 4 enclosure                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Humidity</b>                     | 95 % Relative Humidity—12 hours at 60 °C and 7 hours at 25 °C with 5 hours of transition for 5 complete cycles                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Chemical Resistance</b>          | The actuator uses materials proven capable of withstanding normal engine environment chemicals per SAE J1455, such as diesel fuel, engine oil, and antifreeze.                                                                                                                                                                                                                                                                                                                                   |

## Mechanical Vibration

Power Spectral Density (PSD) must not exceed the level or frequency as shown in the curve below while the actuator is running, as measured at the actuator mounting surface.



## Regulatory Compliance

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### European Compliance for CE Mark:

- **EMC Directive:** 2014/30/EU
- **ATEX Directive:** 2014/34/EU Zone 2, Category 3, Group II G, Ex nA IIC T4 Gc IP67 (T3 for Active cooling modules)

### Other European Compliance:

- **Machinery Directive:** Compliant as a partly completed machinery per 2006/42/EC

### North American Compliance:

- **CSA Certified** for Class I, Division 2, Groups A, B, C, D, T4 at 105 °C Ambient  
For use in Canada and the United States (up to 165°C for Active Cooling)
- **CSA Certified** for Class I, Zone 2, Category 3, Group II G, AEx nA IIC T4 Gc IP67 (T3 for Active cooling modules) For use in Canada and the United States
- **CSA Certified** for Ordinary Locations

### Marine Compliance (pending):

- **DNV-GL** (Temp Class D, Humidity Class B, Vibration Class B, EMC Class A, Enclosure Class B)
- **Russian Maritime Register of Shipping**

Refer to manual 26845 for more detailed information.



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