

**ControlLinks™ Fuel Air Ratio**  
Commercial/Industrial Combustion Controls

**Honeywell**



**Capable. Flexible. Efficient. Safe.**

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The Honeywell ControlLinks™ Fuel Air Ratio Control System helps you realize real Energy Savings, Increased Turndown, Reduced Emissions and System Reliability all in an easy to install, powerful and cost effective package. With traditional mechanical linkage systems, compromised fuel and burner efficiency is the reality. So Go Linkageless with Honeywell's ControlLinks and start reaping the benefits to your bottom line. You have Everything to Gain and Inefficiencies to Lose!



## Go Linkageless with ControlLinks and get Ahead of the Curve

### Energy Savings

- Prevents burner short cycling
- Reduces fuel usage from 2 to 6% and beyond
- Many utility companies offer rebates if linkageless fuel air systems are installed

### Maximize Burner Efficiency

- Match load to appliance firing rate
- Combustion efficiency maximized throughout the curve instead of at only 1 point
- Up to 24 points on the Fuel/Air Curve

### Reduced Emissions and Reduced Excess Air

- Reduce Thermal NOx (Nitrous Oxide) by employing the Flue Gas Recirculation (FGR) damper function
- Reduce unburned fuel & products of combustion with 4th channel FGR

### Increased Equipment Life

- Equipment cycles less frequently, reducing wear and tear and extending its useful life
- Integrated Thermal Shock Protection Algorithms offer advanced capability to extend equipment life

### System Reliability

- No Fuel/Air Ratio curve erosion over time due to component wear and shifting as with mechanical linkage systems

### Flexibility

- Flexible use 4th Channel, which may be used for FGR, Secondary Air Control or Secondary Modulating Fuel Valve
- Dual fuel flexibility, with two independent fuel curves, allowing maximum efficiency for both fuels

### Safety

- Dynamic safety checks: Fail Safe Potentiometer Test, Anti-Swap of Actuators, Curve Tracking Verification & Safety Relay Test

### Affordable

- Payback typically less than 1 year versus the expense of O<sub>2</sub> trim with marginal fuel efficiency gain over Linkageless Fuel Air Ratio Controls. Generally, O<sub>2</sub> trim provides some additional fuel savings, but is usually cost prohibitive.

# ControlLinks Fuel Air Control System: The Linkageless Advantage



## Typical Applications

Replaces traditional single point modulation of a mechanical cam and linkage assembly, which controls the relationship between fuel, airflow and flue gas recirculation (if used) on a power burner. Up to 4 independently controlled universal parallel positioning actuators (UPPAs) are commanded by the ControlLinks™ Controller, which responds to load and firing rate demands. Honeywell's ControlLinks linkageless fuel air ratio control provides more accuracy and efficiency in actuator positioning and burner firing, which equates to less service and downtime.

May be used on single or combination fuel single burner applications, including power burners, boilers, process furnaces, ovens, smelting, kilns, paint drying booths, VOC burn-off, ceramics, make-up air heaters or any full modulating burner as part of a retrofit or new burner application where increased efficiency is desired. Particularly suited for hospitals, schools, universities, office complexes, commercial retail complexes, multi-unit housing dwellings and industrial process production facilities.

## Key Features

- Stand Alone Parallel Positioning Control System that is Designed for Easy Retrofit
- Dynamic Safety Checks including Fail Safe Potentiometer Checks, Anti Swap of Actuators & Curve Verification Algorithms
- Dynamic Safety Relay Test for LCI-LCO (Limit Control Input/Output) Contact Set
- Integrated Shock Protection Algorithms: Water or Stack Temperature Low Fire Hold, FGR Hold, FGR & Low Fire Hold
- Controller LEDs: Power, Alarm, Motor 1, 2, 3, 4 for Status and Fault Code Annunciation (60 Possible)
- 2 Independent Fuel Profiles with or without Flue Gas Recirculation (FGR)
- Programmable Positioning for Non-Selected Fuel Actuator, Standby, Purge, Light-Off, Minimum & Maximum Modulation
- Up to 4 Universal Parallel Positioning Actuators: Combustion Air, Fuel 1, Fuel 2, FGR/Flexible Usage
- 4th Channel Actuator Flexible Usage: FGR, Secondary Air Control, Secondary Modulating Fuel Valve
- 7 to 24 Points Per Profile Curve with Quick Set-up Feature Providing Minimum 3-Point Profile Curve
- Auto/Manual Firing Rate Input
- External Indication of Actuator Position via Large Arrow
- Actuator CW & CCW Switches for Manually Driving Hub — Useful for Installation & Service
- Actuator LED Annunciation for Unconfigured, Configured and On-Line or Faulty Actuator States
- Actuator Direct Coupled Output

## Product Overview

The ControlLinks Fuel Air Ratio Control System is a microprocessor-based control that simultaneously controls from two to four actuators associated with a full modulation power burner. Actuators control the position of primary and secondary fuel valves, the combustion air damper and the FGR (Flue Gas Return) damper, if used. The system consists of the R7999 master controller and its Q7999A wiring subbase and the ML7999A actuators.

Two controller models, 100 – 120Vac and 200 – 240Vac, cover global applications. Controller non-volatile memory stores operating history and current lockout and alarm status and has 6 LEDs for Power, Alarm and 4 Actuator Status Lights. Fault annunciation via blinking power light, with 60 possible fault codes. Floating control output to UPPAs, auto/manual firing rate input, remote reset capability, 4 – 20mA stack or water temperature input and dual fuel input. Control from 2 to 4 UPPAs. Password required for parameter adjustment to prevent unauthorized access.

UPPAs have universal power input of 100 to 240 Vac, providing flexibility in application with direct coupled output. A large arrow on the actuator face provides instant visual indication of actuator position. Floating control input with 950 possible actuator positions, output hub position accuracy of  $\pm 0.1$  angular degrees and CW and CCW switches for manually driving hub. A mechanical stop with a magnetic coupling between stepper drive motor and the gear train assures gears will not strip or burn out the motor in an overload condition. Actuator LED Annunciation for Unconfigured, Configured and On-Line or Faulty Actuator States.



## Go Linkageless and Say Goodbye to the Jackshaft Forever

Mechanical cam and linkage systems used to control the fuel-air ratio of a fully modulating power burner represent a great disadvantage to the equipment operator in regard to fuel usage, burner efficiency, dual fuel usage and burner turndown. Because mechanical linkage systems have one foot-mounted actuator to position both the combustion air and the fuel at the same time, the result is compromised fuel-air ratio and dual fuel efficiency to obtain reliable combustion throughout the fuel-air curve. Typically mechanically linked systems utilize the same point for light-off and low fire, which reduces fuel efficiency because many burners are capable of operating at a lower firing rate than light-off. As with any mechanical system, what happens over time is loss of precision due to component wear and shifting, equating to erosion of the fuel-air curve and non-optimal performance as well as unnecessary fuel costs.

With the ever increasing price of fuel and emphasis on emissions, achieving optimal burner efficiency has never been more critical and requires a cost-effective and enduring solution. Enter Honeywell's ControlLinks Linkageless Fuel Air Control System, which provides consistent and reliable fuel-air ratio control thanks to precision microprocessor control and integral actuator position feedback potentiometers. Four separate Universal Parallel Positioning Actuators (UPPAs) replace the single actuator used with mechanical cam and linkage systems, providing independent control of the combustion air damper, the primary fuel, the secondary fuel and the FGR damper (if used). The UPPAs are commanded by the ControlLinks Controller, which responds to load and firing rate demands. Further, ControlLinks offers dual fuel flexibility, allowing two independent fuel curves, providing maximum efficiency for both fuels. Because the burner fuel to air ratio is adjusted independently, the result is maximized burner efficiency and reduced fuel consumption that typically pays for the ControlLinks system within a year. See your ControlLinks Authorized Representative to estimate your potential saving today!

One controller, four actuators and optimal burner efficiency. It all adds up to monumental savings you can't afford to ignore! So go linkageless with Honeywell's ControlLinks and reap the benefits. You have everything to gain and inefficiencies to lose!

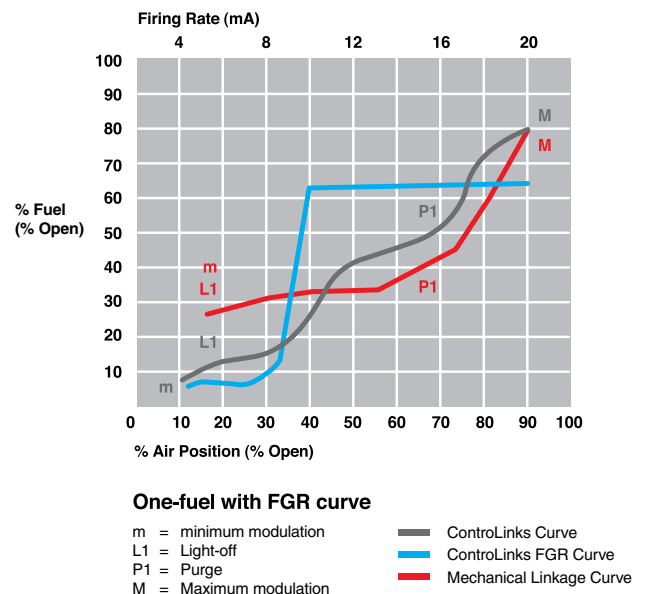
### Reduced Emissions and FGR

Reducing emissions has become a spotlight issue for many facilities. Thermal NOx (Nitrous Oxide) is produced from the oxidation of nitrogen (N<sub>2</sub>) at temperatures above 1500° F when burning natural gas and distillate oils.

Thermal NOx can be reduced by dropping the flame temperature, which can be accomplished by lowering the amount of oxygen in the combustion air. Such a task is achieved by utilizing Flue Gas Recirculation (FGR), in which a damper is placed in the flue gas piping, allowing recirculation of a portion of the flue gas.

FGR significantly reduces NOx emissions in industrial boilers by recirculating a portion of the flue gas into the main combustion chamber, thereby reducing the peak combustion temperature. The use of FGR also reduces emissions of unburned fuel and products of combustion.

### Fuel/Air Profile Graph





## Capable. Flexible. Efficient. Safe.

The ControlLinks Fuel Air Ratio Control System provides value, flexibility and efficiency in an easy to install, capable package while ensuring equipment safety. It is compatible with competitive and legacy full modulation burner primary safety controls. A step-by-step menu driven commissioning process with step-size enforcement via the S7999B System Display or the ZM7999A Configuration Software provides quick and effective system commissioning.

**Capable** of controlling from 2 to 4 UPPAs for Combustion Air, a Primary Fuel, a Secondary Fuel and a 4th Flexible Usage actuator.

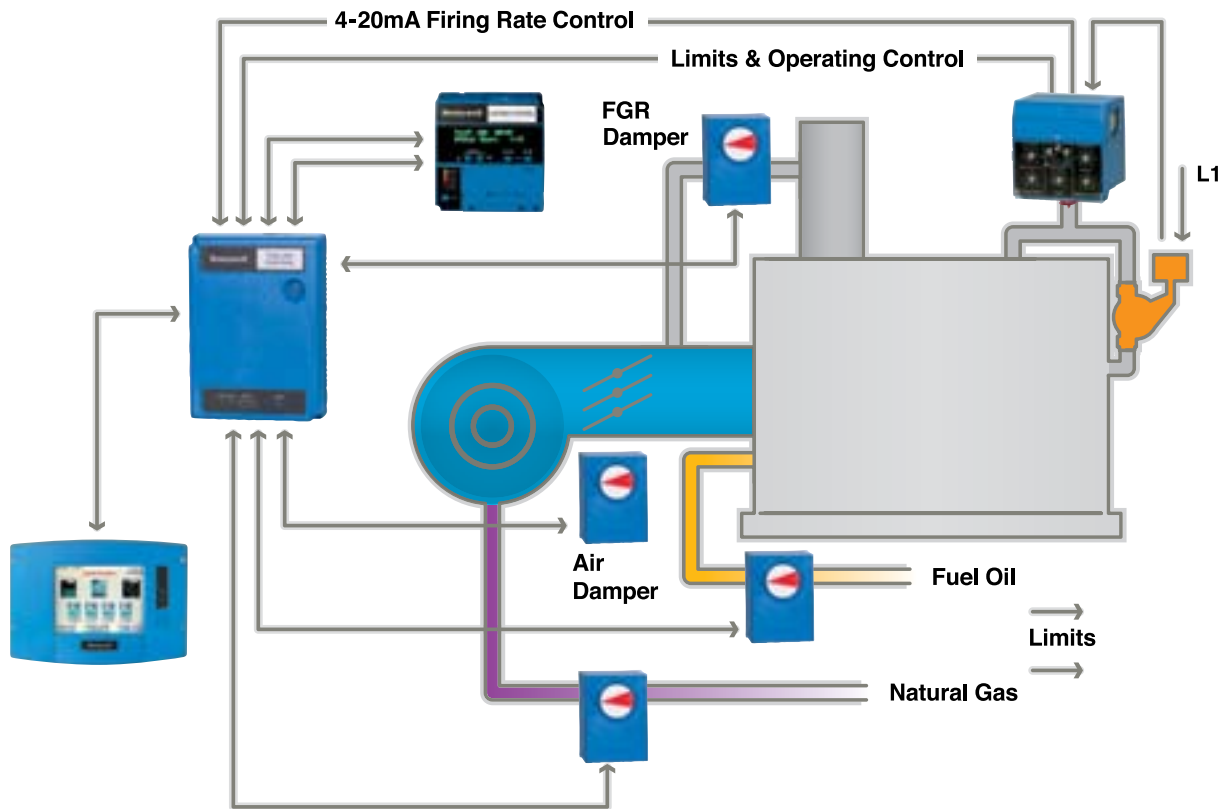
Allows two independent fuel air profiles with or without FGR. The ControlLinks controller has the capability to prevent equipment thermal shock. The Integrated Thermal Shock Protection Algorithms include Water or Stack Temperature Low Fire Hold, FGR Hold or FGR and Low Fire Hold combined. Utilizing a scaleable 4-20mA stack/water temperature sensor input, the Water or Stack Temperature Low Fire Hold keeps the burner at light-off until the programmed temperature limit is exceeded. FGR Hold keeps the FGR damper closed until the stack temperature has reached its programmed threshold. FGR and Low Fire Hold combines both hold features, providing maximum equipment protection. The controller also has Fuel-Air-FGR profile download capability from a PC or the S7999B System Display via File Transfer Protocol (FTP). Other features include programmable behaviors for all actuators during Purge and Standby, a configurable Differential (reaction time) of 0.12 to 3.0mA and a configurable Dead Band of 0.1 to 0.5 angular degrees.

**Flexible** 4th channel Flexible Use Function, which may be used for Flue Gas Recirculation (FGR) damper actuation, Secondary Air Control or a Secondary Modulating Fuel Valve. The 4th channel operates in conjunction with the selected primary fuel and is hard programmed to drive fully closed at light-off, regardless of its selected function. The 4th channel may be programmed to follow the Fuel/Air curve or be configured flat or negative versus the Fuel/Air curve. Further 4th channel special operating functions can be selected via the System Parameters option during commissioning, invoking the Integrated Thermal Shock Protection Algorithms, which respond to the 4-20mA stack or water temperature sensor input.

**Efficient** operation is obtained by replacing old mechanical single point linkage systems with the ControlLinks Fuel Air Ratio System, reducing fuel usage from 2% to 6% and beyond. By decoupling the fuel curves, maximum efficiency is achieved for both fuels. Further, there is no erosion over time of the Fuel Air Profile as with the inherent wear and tear of mechanical linkage systems, saving valuable fuel and maintenance costs. ControlLinks allows optimization of the fuel/air mixture, which maximizes combustion efficiency throughout the curve. And with the ability to program up to 24 points per fuel/air curve, closer and more precise firing rate control is obtained over the entire firing rate of the burner for each fuel. Due to the inherent energy usage impact, many utility companies offer energy rebates if linkageless fuel air systems are installed. Inquire with your local utility.

**Safe** operation assured with built-in Self-Test and Safety Relay Circuits. Dynamic safety checks including Fail Safe Potentiometer Checks, Anti-Swap of Actuators and Curve Tracking Verification. At commissioning, the 8-digit hexadecimal actuator ID is entered for its respective channel and is tracked to ensure it is not swapped with an adjacent actuator, providing consistent operation. The curve tracking algorithm verifies the curve profile is within its programmed Dead Band of between 0.1 to 0.5 angular degrees and will lockout if the Dead Band is exceeded. Further safety is provided via the Dynamic Safety Relay Test for the LCI-LCO (Limit Control Input/Output) Contact Set, which verifies the contact integrity of devices installed in the limit string. Password protection for parameter changes, assuring no unauthorized re-adjustment of system occurs.

## Boiler Application — ControlLinks Fuel Air Ratio Control System











### More Reasons to Go Linkageless with ControlLinks

|                           |  |
|---------------------------|--|
| Increased Turndown        | <ul style="list-style-type: none"> <li>• Increase turndown up to 6:1 vs. a typical mechanically linked optimal turndown of 3:1</li> <li>• Separate points for light-off and low-fire vs. a mechanically linked system</li> </ul> |
| Commissioning Time & Cost | <ul style="list-style-type: none"> <li>• Burner commissioning time reduced by 30% to build the fuel/air curves</li> <li>• Fast burner setup via S7999B Display or PC/Laptop</li> </ul>   |
| Design Considerations     | <ul style="list-style-type: none"> <li>• Choose modulating component placement without consideration of common jackshaft linkage</li> </ul>  |

| Information/Options   | Installation Instructions   | Product Data    | Guide Spec | Technical Brochure | Sell Sheet |
|---|---|-----------------|------------|--------------------|------------|
| R7999A, B Controller, Q7999A Subbase  | —   | 65-0238/65-0240 | 65-0248    | 63-9489            | 63-9165    |
| ML7999A Parallel Positioning Actuator   | 66-1121   | 65-0239         | 65-0248    | 63-9489            | 63-9165    |
| S7999B System Display   | 65-0283   | —               | 65-0293    | 63-9488            | 63-9165    |
| V5197A Firing Rate Gas Valve, C6097 Pressure Switches, P7810C PressureTrol Controller, Flame Safeguard Controls |   |                 |            |                    |            |
| Download from: <a href="http://customer.honeywell.com">http://customer.honeywell.com</a>                        |   |                 |            |                    |            |
| UDC2500/3200 Controls   | <a href="http://content.honeywell.com/imc/pi/">http://content.honeywell.com/imc/pi/</a> |                 |            |                    |            |

## The Honeywell Solution

Get the 4-20mA control advantage by using Honeywell's V5197A Firing Rate Valve, the P7810C combination Firing Rate/Limit/On-Off Control and/or the UDC2500/3200 Control for Firing Rate or On/Off Control in conjunction with ControlLinks for a powerful and accurate combination. ControlLinks also accepts a scaled 4-20mA auxiliary sensor input as the tool to drive the Integrated Boiler Shock Protection Algorithms.

| Component  | Purpose   |
|--|---|
| R7999A, B<br>ControlLinks<br>Controller                 | Linkageless Fuel Air Controller, which controls 2 to 4 UPPAs for Combustion Air, Fuel 1, Fuel 2 & a 4th Channel Flexible Use. Directs UPPAs based on input from Firing Rate Control, Limit & Operating Controls, Primary Flame Safeguard Control and/or S7999B System Display. Maintains optimal burner Fuel Air Ratio to maximize burner efficiency and minimize fuel usage and emissions.   |
| ML7999A<br>ControlLinks<br>Actuator                     | Universal Parallel Positioning Actuator (UPPA) with direct coupled output and universal 100 to 240 Vac power input. Controls % open of Combustion Air Damper, Fuel 1 Valve, Fuel 2 Valve & FGR damper (if used). Floating control input with 950 possible actuator positions, output hub position accuracy of $\pm 0.1$ angular degrees.  |
| S7999B<br>System<br>Display                             | Commission <ul style="list-style-type: none"> <li>ControlLinks Fuel/Air Ratio Control System. Password protected.</li> </ul>  |
|  | Configure <ul style="list-style-type: none"> <li>S7830 Expanded Annunciator Terminal Names (Global Feature)</li> <li>Modbus Network (up to 99 nodes) &amp; Assign Names</li> </ul>  |
|  | Monitor <ul style="list-style-type: none"> <li>Local Burner/Boiler System or up to 99 Systems/Nodes</li> <li>Device status, fault codes &amp; history, diagnostic information and key process variables for each 7800 SERIES &amp; R7140 Burner Control, ControlLinks Fuel/Air Ratio Control, Expanded Annunciator and/or UDC controller.</li> </ul>  |
|  | Control <ul style="list-style-type: none"> <li>Single (Local) Burner/Boiler System or up to 99 Systems/Nodes</li> <li>Remote reset for each 7800 SERIES &amp; R7140 Burner Control. UDC device security password, control, demand &amp; alarm setpoints. Password protected.</li> </ul>   |
| V5197A<br>Firing<br>Rate Valve                        | Modulating valve comes with ML7999 mounting bracket and direct couple drive stem to facilitate set-up. Driven by ML7999A, which responds to firing rate commands provided to the R7999 Controller, the valve expertly helps you match the appliance load.<br><br>15psi maximum rating, visual position indicator. Accepts C6097 flange mounted pressure switch. Several pipe adapters are available for valve train installation. Provides turndown of up to 40:1 via its flow limiting adjustment. |
| C6097<br>Gas/Air<br>Pressure<br>Switch                | Diaphragm-actuated Gas Pressure Limit Switch. Available in 1/4 inch NPT or flange mount models, which mount directly to the V5197A Firing Rate Valve. IP54 enclosure standard. Other variations include additive or subtractive differential, operating pressure range, maximum pressure, manual reset and break on pressure fall or rise.  |
| P7810C<br>PressureTrol®<br>Controller                 | Combination Firing Rate/Limit/On-Off Control. Two separate sensors for Limit and On/Off/Firing Rate Control. Provides 4-20mA Firing Rate commands based on pressure to the ControlLinks Controller for effective load matching.<br><br>For use with steam, air or noncombustible gases. Various operating pressure and differential ranges available. Break on pressure rise. LED indicators for power, call for heat and lockout status. Manual reset and electronic maximum fixed stop limit.     |
| RM7800 SERIES<br>Primary Flame<br>Safeguard Controls  | Primary flame safeguard control family. Several variations available for standing, intermittent or interrupted pilots, on/off or programming, modulation, pre purge, post purge, proof of closure, valve proving system (VPS), and lockout or recycle modulation as well as many other options.   |
| UDC2500 or<br>UDC3200<br>Control                      | For Firing Rate and/or On/Off operation based on pressure or temperature, the UDC2500 or UDC3200 Controls are just the ticket, providing accurate command for your burner application.<br><br>For Firing Rate, controls provide a 4-20mA output for the ControlLinks Controller.  |

## Condensed Specifications

|  |   |
|--|---|
| <b>Application</b>                         | <ul style="list-style-type: none"> <li>• Linkageless Fuel Air Ratio Control System</li> <li>• 4 Channel Output Control: Combustion Air, Fuel 1, Fuel 2, Flexible Usage</li> <li>• 4th Channel Usage: FGR, Secondary Air Control, Secondary Modulating Fuel Valve</li> <li>• Integrated Thermal Shock Protection Algorithms for Low Fire Hold and/or FGR Hold</li> </ul> |
| <b>LED Indicators</b>                      | Power / Alarm / 4 Motor Channels for Status and Fault Codes (60 Possible)   |
| <b>Protection Category</b>                 | R7999: NEMA 1 (IP40)<br>ML7999: NEMA 2 (IP31) or NEMA 3 (IP54) with Optional Weatherproof Kit   |
| <b>Hysteresis and Dead Band</b>            | Configurable from 0.12 mA to 3.0 mA and 0.1 to 0.5 Angular Degrees  |
| <b>Required Components</b>                 | ML7999A Universal Parallel Positioning Actuator (quantity 2 to 4), R7999A,B Controller, Q7999A Wiring Subbase and S7999B System Display or ZM7999A Configuration Software (for commissioning and/or monitoring)   |
| <b>Optional Components and Accessories</b> | Weatherproof Kit (NEMA 3 / IP54) for ML7999A, Shaft Adapters, A7999A Portable Combustion Analyzer & Port Expander RS-232/RS-485 (for commissioning) & ControlLinks Demo Tool: DSP3548   |
| <b>Honeywell Compatible Components</b>     | V5197A Firing Rate Valve, with ML7999 Actuator Mounting Bracket & Drive Stem<br>P7810C PressureTrol® 4-20mA combination Firing Rate/Limit/On-Off Control<br>UDC2500/3200 Control for Firing Rate/On-Off Control<br>RM7800 SERIES, R7140, R4140 Legacy & Other Primary Flame Safeguard Controls  |
| <b>Electrical Ratings</b>                  | R7999A: 100 to 120 Vac (+10%, -15%), 50/60 Hz (±10%), 10VA maximum<br>R7999B: 200 to 240 Vac (+10%, -15%), 50/60 Hz (±10%), 10VA maximum<br>ML7999A: 100 to 240 Vac (+10%, -15%), 50/60 Hz (±10%), 15VA maximum   |
| <b>Vibration</b>                           | 0.0 to 0.5 G continuous environment   |
| <b>Actuator Stroke</b>                     | 95° nominal ±3°, mechanically limited   |
| <b>Actuator Timing</b>                     | 24 to 30 seconds for 90° Travel   |
| <b>Actuator Torque</b>                     | 100 lb-in (11.3 Nm) Lift and Hold Minimum, Breakaway Minimum, Stall Minimum   |
| <b>Actuator Accuracy</b>                   | Output Hub Position Accuracy ±0.1 Angular Degrees.  |
| <b>Ambient Temperature Range</b>           | -40° F to +140° F (-40° C to +60° C)  |
| <b>Humidity Range</b>                      | 5% to 95% Relative Humidity, Non-condensing   |
| <b>Dimensions</b>                          | R7999A,B: 5-3/16 in. W x 7-3/16 in. H x 3 in. D installed (131mm W x 182mm H x 76mm D)<br>ML7999B: 4 in. W x 6 in. H x 3-1/2 in. D (102mm W x 153mm H x 89mm D)   |
| <b>Approvals</b>                           | R7999A,B: UL/cUL Component Recognized (A only), CE Approved, CSD-1 & NFPA Acceptable, AGA Certified Product (Australian Gas Association)<br>ML7999A: UL/cUL Listed, CE Approved, AGA Certified Product  |

### To Learn More

For more information please contact your Honeywell Distributor. Or visit <http://customer.honeywell.com>.

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