Parker Hannifin Corporation

Parker Hannifin

Parker Hannifin is the world’s leading diversified manufacturer of motion and control technologies and systems, providing precision-engineered solutions for a wide variety of commercial, mobile, industrial, life science and aerospace markets.

The company’s products are vital to virtually everything that moves or requires control, including the manufacture and processing of raw materials, durable goods, infrastructure development and all forms of transport.

Automation Group

Parker Hannifin’s Automation Group is a market leader focused on the control and automation of fluids, compressed air, motion and drive technologies.

Our global divisions provide industry with a single point for solutions in multiple fluid media, pneumatics, drive and handling technologies.

Automation Group offer an extensive range of capabilities including, design and manufacture and assembly of complete integrated systems.

Fluidic Solutions Division

Parker Fluidic Solutions Division (PFS) is a global designer and manufacturer of bespoke integrated system solutions. Renowned globally for solutions in high technology, fluid and motion control utilising advanced design and manufacturing techniques. PFS is focused on incorporating the best of Parker products into solutions designed for you.

At PFS we constantly strive to provide outstanding design and ground-breaking innovation simultaneously. By developing partnerships with our customers we deliver solutions allowing you to accelerate your product development process, reduce your cost of acquisition and ownership.
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Product Development

With the increasing pressure to develop new products in shorter time frames, more and more companies are taking advantage of the benefits of PFS Rapid production capability.

Our suite of modelling tools provides the opportunity ‘to try before you buy’. Having physical models created from your ideas, developed into concepts and realised into prototypes demonstrates a unique Product Development offer from Parker Hannifin.

Our experience in performance enhancement is a benefit to the leading Formula 1 teams, medical device manufacturers and instrument designers. The suite of tools includes Selective Laser Sintering, Stereolithography and Fused Deposition Modelling among other Rapid technology tools which give you access to a host of capabilities without the on-site investment.

In addition to the tools we use, Parker also offer a variety of materials from which to choose. Different applications require a careful selection of materials, from polycarbonate or aluminium filled polyurethane to selected alloys. For either prototyping or production Parker have a wide range of solutions.

From a variety of CAD file extensions Parker translate your work into physical reality. Our design engineers will work with your ideas and develop components, interfaces and devices to meet your specifications.

Contact your local Parker Hannifin representative to request PFS Rapid.

Accelerate your time to market with Rapid!

Reduced product development time = Faster return on investment

Without Parker

£ $ €

Time

£ $ €

With Parker

£ $ €

Time
Integrated Solutions

In today’s demanding, evolving and rapidly changing environment, the need for a reduction in complexity and the efficient use of resource whilst maintaining technological and competitive edge ensures we stay alert to the challenges in product development. Failure to challenge the current state means our competition move ahead, gain market share and erode margins as we battle to retain business through pricing.

This brochure is designed to demonstrate the capability of Parker Hannifin in the reduction of hidden costs associated with your product, its development, assembly and time to market. Parker Hannifin systems provide increased efficiency, reliability and accuracy.

The philosophy of integrated systems is simple and demonstrated below and is the concept and innovation behind Fluidic Solutions Division, Parker Hannifin's low pressure multi-media system provider.

Problem

• Multiple component design considerations
• Multiple individual components to order
• Multiple different suppliers to source
• Multiple administrative tasks
• Component stock holding and handling
• Component assembly
• Assembly testing
• Rework

Solution

• Functional Optimisation
• Design Partnership
• One single part number
• Single source supply, single administration
• One handling and storage location or JIT
• Fully assembled and tested
• No Rework
• Reduced complexity and size

Together, we can reduce your manufacturing costs.
Clean Technology

Cleanroom

Parker Fluidic Solutions houses one of the largest cleanroom facilities to be found in the pneumatics and fluidics industry, a total floor area of 380 square metres (4092 sq.ft.)

It operates to ISO 14644-1, ISO Class 6 Standard, (FED Standard 209E, Class 1000) over the working areas and has its own dedicated material handling area and store.

The cleanroom contains over 24 square metres of Laminar Flow Cabients operating to ISO 14644-1, ISO Class 4 Standard (FED Standard 209E, Class 10).

Our engineering team has a wealth of experience in the design of electro-pneumatic and fluidic systems for OEM manufacturers in the semiconductor, medical and analytical sectors.

PFS systems are designed for optimum functionality and reliability and draw on well-proven products and components from the vast Parker Hannifin range.

These components are then skilfully integrated with control equipment into top level sub-systems that become an integral part of the OEM customer’s equipment. All system solutions are manufactured, tested and packed in a clean environment.

No organic sealants, adhesives or lubricants are used in the manufacturing process.

Component parts are lubricated with oxygen-compatible PFPE (perfluoropolyether) grease, as needed for assembly.

Each component is tested utilising compressed Nitrogen and ultraviolet light.

All products are double bagged in heat-sealed ESD packaging materials.

Oxygen Clean Capability

Components are ultrasonically cleaned, assembled, inspected and tested in a controlled area with a state-of-the-art positive pressure High Efficiency Particulate Air (HEPA) filtration system.

Both organic and inorganic contaminants such as particulate matter and hydrocarbon oils are removed.

Alternative Applications
Medical
Analytical
Bio Chemistry
Pharmaceutical
Clinical Chemistry
Aluminium Manifold Solutions

Life Science

Automation

Transportation

Power Generation

Semiconductor
Aluminium Manifold Solutions

A simple multi-technology manifold was designed for switching gas flow from N₂O to Air. The manifold has been designed specifically for the customer application and offers:

- Maximum flexibility
- Minimum components
- Ease of assembly
- Simple maintenance

This product design allows for a variety of technical specifications to be achieved through interchangeable components.

Media: Nitrous Oxide, Oxygen, Nitrogen, Air

Components: AC/DC solenoid valves, electronic pressure switches, barbed connections, fittings, oxygen clean.

Alternative Applications
Automation
Chromatography
Medical
Semiconductor
Transport
Aluminium Manifold Solutions

Door Control System

Fully automatic electro-pneumatic double door control system.

Adjustable obstacle detection on each door with adjustable pneumatic dwell time while door remains stationary and can be easily pushed back during dwell time.

Operator enabled:
- Emergency access
- Emergency egress
- Active lock-release control.
- Independent speed control of each door

Media: Compressed Air

Components: solenoid valves, flow controls, obstacle detection devices, logic elements, timers, fittings, electrical terminals and control valves.

- Easily identifiable port connections
- Compact design
- Ease of maintenance
- Reduced pipe work
- Potential for leaks reduced
- Modular approach
- Soft start

Alternative Applications
- Bus
- Truck
- Industrial Doors
- Safety Interlock Systems

Together, we can open doors.
Aluminium Manifold Solutions

Coupling Control System

The system controls the pneumatic actuators operating the coupling mechanism. It provides an adjustable time delay to give a time lapse in the coupling engagement cycle.

- Custom system for the control of automatic rail coupling.
- Material and component selection in line with the requirements of the rail industry.

The system offers:
- Design based on required performance conducted with dynamic simulation software package
- Adjustable duration of the coupling cycle
- Shock and vibration for EC61373:1999 Cat1

Media: Compressed Air

Components: ISO valves, shut-off valves, test points, gauges, solenoid valves, timers, flow controllers.

• Compact design
• 100% tested units
• Special port configuration
• Fail safe actuation
• High flow

Alternative Applications

Automation in control panels
Modular control panels

Media: Compressed Air

Components: ISO valves, shut-off valves, test points, gauges, solenoid valves, timers, flow controllers.
Door Control System

Our customer approached us to redesign a control that would offer more safety features in a reduced space envelope. PFS designed a fully pneumatic door system with double obstacle detection to fit within the existing space envelope. The design incorporated a number of Parker components which have been approved for demanding and arduous operations.

A solution designed to fit within the customer’s space restraints.

Media: Compressed Air

Components: control valves, in-line pneumatic valves, fittings, logic elements and silencers.

- Off-the-shelf components
- Custom-built and production tested solution improving reliability
- Single point of supply for all aspects reducing admin costs
- A fully integrated lightweight control system using polymer products

Alternative Applications
Bus
Truck
Industrial Doors
Safety Interlock Systems
Custom Manifold Solutions

Life Science

Automation

Transportation

Power Generation

Semiconductor
Custom Manifold Solutions

Where space and weight are considered as competitive advantages, advanced manufacturing techniques utilising CAD, materials and moulding technologies can provide you with an edge in size reduction and interfacing of your devices. The design of custom manifold shapes from lightweight materials specific to your requirements is a unique offer from Parker Hannifin.

Taking the lead from our Rapid Prototype capability, the development of Custom Solutions is born from talents in creative design and breaking convention with traditional manufacturing techniques. With limitless thinking and ‘What if’ ideology Parker Hannifin’s custom solutions in fluidic manifolds can offer you the next generation of machine design, component integration and functionality.

Custom solutions are virtually unlimited; Parker Hannifin design special components with unique characteristics, integrate standard components with custom electronics, construct complex shapes, combine and enable multiple media to be controlled and monitored in one compact and repeatable customer specific solution.

With the popularity of 3D CAD, the availability of materials and technologies such as SLA, SLS and FDM, the capability to simply translate CAD data into a physical 3D model is no longer a challenge.

These process technologies now allow the optimum design of new components using a ‘material on’ rather than a ‘material off’ process, removing the barriers of traditional manufacturing techniques.

Using this principle, PFS are able to supply complex sintered or moulded parts, in metal or plastic, directly from the 3D model, in a fraction of the time it would take to manufacture them using conventional techniques.

Utilising the range of in-house services, Parker support customers by getting their products to market, ahead of the competition.
Custom Manifold Solutions

Vacuum Generating Pneumatic System

Presented with the challenges of integrating two systems into one, reducing weight, profiling and optimization, the power of Parker is demonstrated.

In order to achieve our goal, PFS utilised its custom design and moulding capability to create a unique shape which maximised space and eliminated the need for pipework. The system is designed to generate and hold vacuum in a fall arrest system.

All components are surface-mounted onto the lightweight custom moulded reinforced manifold.

Media: Compressed Air - Vacuum

Components: Air operated pilot valves, filters, logic elements, test points, flow controllers, push button switch valves and fittings

- Compact design
- Custom built and production tested solution
- High reliability
- Lightweight
- Leak free
- Unique shape

Alternative Applications

Custom moulded manifolds are designed according to customer requirements. Parker’s unique ability to meet demanding engineering challenges delivers true competitive advantage.
Custom Manifold Solutions

Mixing Control Module

This control module is designed to regulate the oscillation of a blood handling table to ensure the continuous and consistent mixing of blood and blood products during both collection and dispensing.

The module is an aluminium filled polyurethane, designed specifically to integrate standard and bespoke circuit components into a single control module.

Valves are both surface-mounted and embedded as appropriate to incorporate a complex pneumatic circuit.

Media: Compressed Air, Nitrogen

Components: Cartridge fittings, valves, flow controllers, regulators and selector switches.

- Cost effective
- No pipework
- Leak free
- Compact
- Lightweight

Alternative Applications

- Diagnostics
- Wound therapy
- Bio Fluid
- Gas mixing
- Blending

Together, we can generate a technical advantage.
Gas Control Module

This gas control system is designed to give a step control of gas flow to a burner head in a Chromatography System.

The module is an aluminium filled polyurethane, designed specifically for a restricted space envelope.

The module is based around a combination of standard solenoid valves and bespoke pneumatic control valves, giving precise, controllable and reliable performance.

Valves are either surface mounted or embedded to incorporate a complex pneumatic circuit.

Media: Compressed Air, N₂O

Components: Pressure switches, custom manifold, solenoid valves and connectors.

- Supplied fully leak tested at very low leak rates - better than 3m bar min when using hydrogen
- Designed to integrate directly into the customer’s existing system
- Fully function-tested on customer specified, computer test equipment
Fluidic Manifold Solutions

Life Science

Automation

Transportation

Power Generation

Semiconductor
Fluidic Manifold Solutions

When your fluidic application requires transparency of flow, Parker Hannifin provide you with process visibility through our range of acrylic and engineered plastic manifolds.

Our manifold materials are precision CNC-machined and diffusion-bonded in a rigorous and proven process.

Parker produce a range of fluidic liquid and gas handling manifolds for use in the biotech, clinical chemistry, diagnostic and life science markets.

Material technology provides the opportunity to control multiple media regardless of concentration, toxicity and pressure.

Fluidic solutions are offered as individual chips or as complete modular systems incorporating miniature control elements and connectors.

Manifold, seal and component materials are selected according to chemical compatibility (see chart) and applications. From polycarbonate to polyetherimide, there is a fluidic manifold to satisfy most applications.

Track sizes vary. Parker offer down to 150 micron [0.006"] providing you with micro fluidic solutions.

‘Fluidic chips may utilise tracks down to 150 microns’

Our material selections are based upon your needs and address chemical compatibility, density, hardness, water absorption and flammability. Of course consideration is given to thermal, electrical, electromagnetic, mechanical and optical properties.

Utilising ISO, DIN, UL, IEC, NFP, FDA and ASTM ensure your system complies with the appropriate standard.

This enables us to provide you solutions specific to your application, the environment, industry standards and cost.

Our range of materials include:

PolyMethyl MethAcrylate
Polyethylene (PE)
PolyEtherImide (PEI - Ultem)

PolyCarbonate (PC)
PolyPropylene (PP)
Aluminium (AL)
PolyEther Ether Ketone (PEEK)

Polyester (PET)
PolyOxyMethylene (POM-Delrin)
PolySulphone (PSU)

PolyMethyl MethAcrylate (PMMA - Acrylic)
PolyEther Imide (PEI - Ultem)

With such a wide range of materials available the control of fluids has never been more accessible.

Parker Hannifin provide modular manifold fluid control solutions in food and medical technology, electrical engineering, electronics, mechanical and automotive engineering, vacuum technology, chemical industry, pump and instrument technology, transport, conveyor technology, precision engineering, jig construction, laboratory equipment, construction and many more.

Alternative Applications
Medical
Analytical
Instrumentation
Clinical Chemistry
Biotech
Fluidic Manifold Solutions

Assembled in a ISO Class 6 cleanroom, this manifold demonstrates the capability of PFS to develop and manufacture sophisticated high technology control systems.

This complex yet compact design highlights an ability to integrate electrical interfaces, with solid state electronic control, instrumentation, flow control, magnetic shielding and pneumatically operated solenoid technology.

The manifold material is PEEK which is particularly resistant to outgassing i.e. very resistant to molecular emission, which is critical in high technology cleanroom applications.

Pneumatic connections are kept to a minimum and the whole system operates with CDA at a dew point of -40ºC (40ºF).

This modular system is a plug-and-play system enabling rapid and easy access for maintenance and manual override during set up and calibration.

The lightweight construction of this module ensures that the device is suitable for high G-force applications without compromise or excessive loads being applied to guidance systems.

Alternative Applications
Robotics
Instrumentation
Analytical
Medical
Fluidic Manifold Solutions

Electromechanical Pump Control Systems

This system demonstrates the Power of Parker. This application is the heart of a biofluid management system.

The modular manifold system comprises surface-mounted Parker Hannifin solenoid valves for vacuum and pressure. The solenoid valves contain surge protection, low power latching and are interfaced with a specially designed pcb with connector for power and signals.

Using a profiled 3 layer acrylic substrate with multiple colours we have incorporated the vacuum and pressure connections into the manifold thus removing all the tubing and fittings which are potential leak paths. The profile design and rigidity of the material also reduced overall device weight by being part of the device chassis structure.

Media: Compressed Air

Components: solenoid valves, cartridge fittings, V3 electrical microswitches, pressure sensors, vacuum & pressure regulators, location pins and electronic stepper motors.

- Extremely compact
- Lightweight
- Multiple layer
- Multiple technology
- Multiple media
- Profiled
- Robust
- Electronic interface
- Electromechanical interface

Alternative Application
Clinical Chemistry
Analytical
Biotech
Changeover Valve

Designed for switching gas flow from N₂O to Air this valve offers:

- Maximum flexibility
- Minimum components
- Ease of assembly
- Simple maintenance

This solution combines engineering plastics, aluminium manifolds and basic components into a custom design.

This product design allows for a variety of technical specifications to be achieved through interchangeable components.

Media: Air, Nitrous Oxide.

Components: Rotary valve, barbed connections and electronic microswitches

- Compact design fits into small space envelope
- High flow – ø5.5mm orifice
- Flexible – manual/electrical options
- Special porting configuration in line with customer requirements

Alternative Applications

Medical
Analytical
Automation
Transportation
Conventional Systems

Life Science

Automation

Transportation

Power Generation

Semiconductor
**Conventional Systems**

**Pantograph System**

Pantograph systems provide direct contact with the wire of the Overhead Catenary Systems (OCS) and typically, this requires air cushioning and precision pressure regulation to maintain consistent power connection, with a variety of composite materials available for use in their construction.

PFS designed an integrated solution with each of the major functions incorporated on a control module mounted on a back plate i.e. pantograph raise/lower, carbon strip monitoring, compressor control, etc. This allowed the customer to order the system with all or any combination of functions.

**Media:** Compressed Air

**Components:** Shut-off valves, pressure switches, precision regulators, electro-pneumatic valves, air reservoirs, obstacle detectors, filters, quick release couplings, flow controllers, connections.

- Compact
- Rail industry approved
- Temperature and vibration tested
- Pneumatic cylinders
- Precision air regulators
- Carbon connector
- Wear monitoring

**Alternative Applications**
PFS develop a variety of electro-pneumatic systems in partnership with customers and their specifications.

Together, we can help you reach new heights.
Conventional Systems

Gas and Pneumatic Control System

The engineering team at PFS worked closely with the customer to design an electro-pneumatic circuit to operate within atex zones 1 or 2. Special attention was paid to low pressure points and the best positioning and connection to the final assembly.

Housed in a 316L cabinet, this system is delivered fully tested on a special mounting frame. As a safety-critical system operating in a challenging environment, Parker have designed new components and modified off-the-shelf products to surpass customer expectations.

Incorporated into the design are low pressure diaphragm valves [3 mbar and 15 mbar] which ensure this is a fully automated pressure management system, a 1” direct acting outlet valve that is actuated with minimal pilot pressure and a range of interchangeable jets were integrated into this System Solution for different sizes of machine.

Media: Compressed Air

Components: regulators, Atex solenoid valves, bulkheads, diaphragm valves, electrical terminal strips

- Atex approved
- 316L stainless
- Ip69 rated
- Fully integrated system solution
- Fully tested
- Can be scaled up or down depending Requirements

Alternative Applications

All Atex and non-Atex cabinet applications.
Conventional Systems

Air / Vacuum Conditioning Unit

The regulation system for the CDA (Clean Dry Air) System was designed using specially modified standard components.

To ensure the output was to the required standard of cleanliness the output was filtered. Both pressure and vacuum input and output pressures were monitored by pressure sensors providing balanced outputs using a bespoke printed circuit board.

All components were washed in a dedicated washer and assembled in an ISO 14644 class 6 cleanroom.

Media: Clean Dry Compressed Air (CDA)

Components: Ball, valves, regulators, flow controllers, valves, electronic interfaces, mass flow controllers, vacuum regulators, pressure sensors and transducers

- Compact
- Clean
- Controllable
- Multiple pressure

Alternative Applications

PFS provide solutions for high technology applications where control, size and performance are critical. Fluidic control in any environment is demonstrated by the Power of Parker Fluidic Solutions.
Core Components

X-Valve®

Universal Style Solenoid Valve

X-Valve® is a 2- or 3-way universal solenoid valve measuring just 8mm in width.

Ten-X®

Digital Solenoid Valve

Ten-X® is a 10mm solenoid valve with a 2- or 3-way NO/NC and distributor design. Ten-X delivers repeatable “energized” and “de-energized” response times, low power, and flow capability to meet the specific performance requirements of medical devices.

Kay Valve

Sub-base & Manifold Mounted Solenoid & Air Actuated Spool Valves

These have been developed for the widest use in general industrial applications as well as for specific use in industries such as Medical Automation and Instrumentation.

Logic Elements

Parker have a wide range of pneumatic logic elements which are ideal for purely pneumatic controlled circuits. Intrinsically safe.

BTC-IIS

Mini Pumps (air/gas)

Up to 11 LPM Free Flow

BTC-IIS Single Body Dual Head Miniature Diaphragm Pumps and Compressors are a series of brush and brushless DC motor driven pumps which are tailored to meet the specific performance requirements of your applications. These pumps are designed to handle both gases and liquids.

Mini Regulators

• Diaphragm operated for fast operation.
• Large diaphragm to valve area ratio for precise regulation and high flow capacity.
• Balanced valve design for precise regulation.
• Available in 2- or 4-port design.
• Available with a manifold mount to minimize plumbing.
• Suitable for low temperature applications.
• Non-rising adjusting knob.

Viking Extreme

High Performance Directional Control Valves

The Viking Xtreme series valve range is robust, versatile and combines high performance with compact installation dimensions. Large flow capacity, short change-over times and low change-over pressure are important characteristics of this valve.
T2-05

Micro Pumps (air/gas)
Up to 650 mLPM Free Flow

Designed to fit where other pumps can’t, the T2-05 DC motor-driven pump’s extra small size and high efficiency reduce footprints and extend battery life. The motor, pump head, and valve combination provide reliable, long life operation.

Our smallest pump was designed for applications where low power, small size, and light weight are critical.

Unique valve design minimizes leakage to maximize flow.

Ironless Core

Proportional Valves

Medical and analytical OEMs around the globe choose Parker Precision Fluidics’ patented thermal compensation miniature proportional valve technology for the most demanding precision gas flow applications. When performance, quality and reliability are critical to your instrument, go with the proportional valve professionals, Parker Precision Fluidics Division.

Isys Micro Valves

The Isys Micro Valve is a compact valve manifold offering high flow; Industrial communication with Fieldbus DeviceNet and Profibus DP protocols & Industrial Ethernet IP compatibility including Preferred Connectivity to Rockwell Logix™ Architecture.

Vacuum Products

Parker’s range of vacuum products includes a wide variety of conventional vacuum components, as well as more specialised items such as variable vacuum pumps, material transfer and air amplification units. Parker is also able to offer a comprehensive range of vacuum cups.

P3X Series Moduflex Lite

The Moduflex Lite FRL system is constructed from ultra light weigh technopolymers instead of the traditional aluminium or zinc die cast, this means that it is up to 45% lighter than conventional units. This non-metal construction also means that the Moduflex Lite is corrosion-free enabling it to be used in harsh industrial environments where anti freeze or aggressive synthetic oils are present.

Lucifer Valves

The functional construction of the solenoid valves is such that either DC or AC coils can be used with the same basic valve. The fact that the electrical components can be interchanged facilitates stock reduction.
### Chemical Compatibility Chart

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<th>ABS</th>
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- **Acid Resistant**: ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● •
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**Key:**

- ✓ Good
- ✓ Fair
- ✗ Poor

* Please note this is only a guide. Before ordering please check suitability and compatibility.
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