Actuator control by Profibus

Profibus DP module - serial communication unit
World leaders in valve control

In the 40 years since the company was founded, Rotork Actuation has become a byword for excellence in the field of valve, sluice gate and damper actuation products for the oil, gas, power, water and waste treatment industries - worldwide.

We owe our success to an uncompromising focus on quality at every stage - and at every level - of the company’s operations.

From initial site survey, specification and design, through to materials, manufacturing and testing processes, installation, commissioning and after-sales service we accept nothing but the best.

At the heart of the company is an exceptional workforce - the highly trained, forward-thinking engineers, fitters and support staff who each have a crucial role to play in maintaining Rotork Actuation’s unrivalled reputation for innovation, reliability and first class customer support.

Rotork. Established leaders in actuation technology.
Open fieldbus systems

Profibus compatible actuators from Rotork follow the international standard for Profibus DP serial communications. The Rotork IQ, IQM, AQ, AQM and Q range of electric actuator products may be interrogated and controlled over 2 wires using the Profibus DP fieldbus system when they are fitted with the Profibus DP option module.

**Profibus DP**
- International Open Fieldbus Standard EN 50170
- RS485 2 wire communication
- High speed data transfer (up to 1.5Mbit/s)
- 126 devices per highway
- Standardised communications
- Simplified connectivity

**Rotork Profibus DP Module**
- Independently Certified
- Compatible with IQ, IQM, AQ, AQM and Q range electric actuators
- Reduced design engineering costs
- Reduced installation costs
- Greater control system flexibility
- Simple plant expansion
- Supports DP V0 cyclic communication
Profibus DP Standard Fieldbus

Introduction to Profibus

Profibus allows a cost effective integrated communication and control system to be assembled using standard parts and open fieldbus components. Profibus actually comprises three different levels for the communications, each directed at satisfying the specific needs of each part of the overall network.

- Profibus FMS network is used for the movement of relatively large amounts of data between the plant controllers
- Profibus DP network is used for the primary control network on the process
- Profibus PA network allows the DP network to be extended with an Intrinsically Safe segment.

The Profibus DP network is performance optimised for time critical communication between the various components connected. The data packets transmitted are small and the data rate can be quite high. The result of the design is to have a deterministic response time for all the elements.

Each Profibus DP segment has an address range that can support up to 126 devices. Each device needs a unique address on the highway. The physical media used for Profibus DP is either RS485, as is used by Rotork actuators, or fibre optic cable. In the case of RS485 care must be taken not to exceed the physical limitations of 32 nodes on a segment of the highway. If more devices need to be connected then the highway needs a repeater to connect between the segments. Only 9 repeaters can be connected on a single highway.

The Rotork actuators reside on the Profibus DP network highway. Heavy duty electric actuators are best suited to this highway as there is no requirement to carry the power to the device over the 2 wires, an impossible task for most of these actuators. The actuator may be either explosion proof or suitable for safe area location. Wherever the actuator is mounted there is a need to bring power to it. In a hazardous area explosion proof wiring standards are used. These standards extend to the DP network cables as well. Other field monitoring equipment such as level sensors can also be connected to the DP network, or placed on an intrinsically safe PA segment coupled to the DP network.
**Profibus-FMS**

This is the universal solution for the communications tasks at the upper level (cell level) and the Field Level of the industrial communication hierarchy. In order to carry out the extensive communication tasks with acyclic or cyclic data transfers at medium speed, the Fieldbus Message Specification (FMS) services offer a wide range of functionality and flexibility. Profibus-FMS is included into the European Fieldbus Standard EN 50170.

**Profibus-DP**

This is the performance optimised version of Profibus, specifically dedicated to time-critical communication between automation systems and distributed peripherals. It is suitable as a replacement for the costly parallel wiring of 24 V and 4(0) to 20 mA measurement signals. Profibus-DP is included into the European Fieldbus Standard EN 50170.

Profibus DP includes three versions, allowing optimisation of the data communication for differing equipment requirements.

Profibus DP V0 is the original specification and all DP hardware must comply to this standard. Specifically V0 supports master-slave cyclic communication over the network.

Profibus DP V1 is an extension to DP V0 that adds acyclic master-slave data exchange.

Profibus DP V2 adds a further level of communication by including slave to slave and acyclic data exchange to the basic DP V0 cyclic communication.

**Profibus-PA**

Profibus-PA is the solution for process automation, connecting automation systems and decentralised field devices. Profibus-PA is based on Profibus-DP (according to EN 50170) and permits a transparent communication from general purpose automation to process automation.

The Profibus-PA profile defines the behaviour of the field devices and ensures full interoperability and interchangeability of the field devices from different manufacturers.

Profibus-PA operates either with intrinsic safe transmission technology (according to IEC 61158-2) or standard transmission technology (according to RS485). PA fulfils the special requirements of the process automation industry e.g. chemical or petrochemical applications.
Rotork Profibus actuators

Electric actuators

● Plug in option board
The Profibus Module is available with the complete range of Rotork IQ, IQM, AQ, AQM, and Q electric actuators. It is fitted inside the actuator electrical housing, normally when the actuator is manufactured. Once present, all of the actuator control functions and feedback data, plus some additional data - with IQ and IQM actuators, become available at the actuator terminals on the Profibus DP data highway. All communication related parameters can be configured by a Profibus DP Class 2 Master via this highway. The IQ can also be configured via the Infrared interface.

● State of the Art technology
The processor employed in the Profibus Module is a state of the art One-Time-Programmable device that includes the operating programme. This in turn interfaces to an SPC3 chip which controls the Profibus communications with the Master. All user settings are stored in a non-volatile EEPROM.

● Independent Certification
The Profibus DP Module has been independently tested and is certified as conforming to EN 50170 for Profibus DP slave devices, by the Profibus Nutzerorganisation e.V. in Karlsruhe, Germany.
Feedback and Control

The addition of a remote input board to the IQ and IQM actuators increases the input signals available.

### AQ, Q, IQ/IQM, (without remote board) I/O

<table>
<thead>
<tr>
<th>Digital Inputs:</th>
<th>Digital Outputs:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actuator moving</td>
<td>Open</td>
</tr>
<tr>
<td>Close limit switch</td>
<td>Close</td>
</tr>
<tr>
<td>Open limit switch</td>
<td>Stop/maintain</td>
</tr>
<tr>
<td>Thermostat tripped</td>
<td>ESD</td>
</tr>
<tr>
<td>Monitor relay</td>
<td></td>
</tr>
<tr>
<td>Local control selected</td>
<td>Analog Inputs:</td>
</tr>
<tr>
<td>Remote control selected</td>
<td>Measured actuator position</td>
</tr>
<tr>
<td>Battery low - IQ only</td>
<td>Current torque value - IQ only</td>
</tr>
<tr>
<td>Motion inhibit timer active</td>
<td></td>
</tr>
<tr>
<td>Clockwise contactor on - IQ only</td>
<td>Analog Outputs:</td>
</tr>
<tr>
<td>Anticlockwise contactor on - IQ only</td>
<td>Desired actuator position</td>
</tr>
<tr>
<td>Position control enabled</td>
<td></td>
</tr>
<tr>
<td>Error</td>
<td></td>
</tr>
<tr>
<td>S1 - IQ only</td>
<td></td>
</tr>
<tr>
<td>S2 - IQ only</td>
<td></td>
</tr>
<tr>
<td>S3 - IQ only</td>
<td></td>
</tr>
<tr>
<td>S4 - IQ only</td>
<td></td>
</tr>
</tbody>
</table>

### Additional I/O when remote input board added to IQ/IQM:

<table>
<thead>
<tr>
<th>Digital Inputs:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open interlock</td>
</tr>
<tr>
<td>Close interlock</td>
</tr>
<tr>
<td>Aux input 1</td>
</tr>
<tr>
<td>Aux input 2</td>
</tr>
<tr>
<td>Aux input 3</td>
</tr>
<tr>
<td>Aux input 4</td>
</tr>
</tbody>
</table>

Note: The Aux inputs 1-4 may be used for direct actuator remote control and indication.
Profibus performance

Distance and speed

The permitted length of each segment within a Profibus highway depends primarily on the speed of the communications. At 9600 baud and using type A cable a segment length can be up to 1200 metres. If the segment is restricted to 30 devices then a repeater can be placed on the end and a further 1200 metres obtained for segment 2 of the highway and another 31 devices.

Up to 9 repeaters can be added in this way until the maximum permitted is reached. So the effective cable length can reach 10 km at 9.6k baud. Profibus does not permit more than 9 repeaters to be fitted to the network. Even if repeaters are used there is still a limit of 126 addresses on the highway, meaning 125 actuators and one PLC.

The speed at which the system will actually run can be determined automatically by the network during configuration, each speed is checked in turn and once all the configured devices have been parameterised the system speed is set.

Highway redundancy

The Profibus Module caters for two fully independent data highways by having two RS485 ports. This allows two Profibus highways to be connected to the actuator for those critical systems demanding redundant communication paths. The two independent communication routes to the module fully duplicates the controller and communications enabling the actuator to be accessed by a second independent network in the case of a failure in the first. The option of remote input signals to control the actuator directly is still available. Changeover between the channels occurs automatically. If one becomes silent for too long then the other takes over. In addition, operation on one channel inhibits communication on the other.
Profibus data highway

Profibus DP RS485 highway

The data highway comprises a single twisted pair cable that connects all the devices together on the RS485 network. The Profibus Organisation produces extensive guidelines concerning the type of cable and the methods that must be employed for the cabling and termination of the system if the optimum performance is to be achieved.

Bus cable

The Profibus standard defines two variations of the bus cable for Profibus DP. Type A is for all new installations and for high transmission speeds (> 500 kBAud) and permits doubling of the network distance in comparison to Type B. Type B should only be used in existing systems and at low baud rates and low requirements on the network distances. Therefore it is recommended to use cable Type A.

Cable termination network

Termination networks should be enabled on the two ends of the highway, which will usually be at the PLC and the furthest actuator. If the termination networks are not fitted there is a possibility that the network communications will be unsatisfactory.

Connection stubs

The use of stub connections is not recommended by the standard. These tend to cause local reflections on the cable and must always be kept to an absolute minimum. If they cannot be eliminated they must not exceed a total of 6 metres on a 1.5Mbit/sec system.

The actuator provides two sets of terminals per highway so as to ensure the internal wiring of the actuator itself does not constitute a stub.

Cable specification Type A for PROFIBUS - DP – All new installations

- Impedence: 135 up to 165 Ohm at a frequency of 3 to 20 MHz
- Cable capacity: <30 pF per Metre
- Core diameter: >0.34mm² (corresponds to AWG 22)
- Cable type: twisted pair cable 1x2 or 2x2 or 1x4 lines
- Resistance: <110 Ohm per km
- Signal attenuation: max. 9dB over total length of line section
- Shielding: Copper shielding braid or shielding braid and shielding foil

Cable specification Type B for PROFIBUS - DP

- Impedence: 135 up to 165 Ohm at a frequency of >100 kHZ
- Cable capacity: typ. <60 pF per Metre
- Core diameter: >0.22mm² (corresponds to AWG 24)
- Cable type: twisted pair cable 1x2 or 2x2 or 1x4 lines
- Signal attenuation: max. 9dB over total length of line section
- Shielding: Copper shielding braid or shielding braid and shielding foil
Rotork protection

Lightning protection

The Rotork Profibus Module features full optical isolation between the communications driver circuits and the internal actuator processors to ensure that no unwanted communication errors occur due to poor system integration or earth loop currents.

In addition the unit has extensive protection against high induced voltages on the communication cables such as those produced by lightning strikes or large current switching operations. This protection includes the use of gas discharge tube arresters as well as varistor semiconductor protection devices.

This protection restricts the number of actuators that may be fitted on a segment if high transmission speeds are to be used. Removal of the protection components lifts this restriction.

Network termination

In order to avoid signal reflections on the RS485 highway, both ends must be correctly terminated. The Profibus Module includes the facility for highway termination by means of jumpers on the card itself.

The termination network meets the standards laid down by EN 50170 by having both a line termination resistor to eliminate reflections and a pair of pull up and pull down resistors to bias the highway during the turn round period.

Class 1 and 2 master

Profibus has two different types of master that can be connected to the highway. On most networks there will be only one PLC or master, though multiple masters are permitted and information on how to use more than one is included in the EN 50170 standard.

Rotork provides additional protection for the actuators by either eliminating or minimising the need to open covers for settings to be made. During parameterisation of the Profibus Module the address is configured by using a Class 2 master.

- Class 1 master
  Run time master that operates a configured system. It can determine the baud rate and handle the token.

- Class 2 master
  Required for full parameterisation of the slave devices and configuration of the network. In particular it is needed for the setting of the address of the Rotork AQ and Q range actuators.

GSD device description file

All Profibus devices have to have a GSD file to describe them to the system. This file contains details such as the supported baud rates, the message length to expect and the ability of the device to support various Profibus features. The Rotork actuator GSD is supplied as part of the actuator documentation package.
Technical data

Technical details

**Electrical interface:** EIA-485 (RS 485) electrical standard suitable for 2 wire connection, half duplex

**Lightning protection:** Gas discharge tubes

**Processor isolation:** Optical

**Programme data:** One Time Programmable processor for maximum integrity

**Communications interface:** Siemens SPC3

**Communication protocol:** Profibus DP V0 (slave device)

**GSD file:** Supplied in technical documentation

**Features supported:** Freeze Mode, Sync Mode, automatic baud rate detection, set slave address via the bus

**Data rates:** 9.6k baud to 1.5M baud

**Module address:** Programmable in the range 1 to 126, default 126

**Enclosure:** Suitable for fitting to Rotork IQ, AQ and Q actuators

**Environment:** As the actuator (-40˚C to +70˚C)

**Power consumption:** All power derived from the actuator

For more information on Profibus consult your regional Profibus User Group.

The Profibus web site at http://www.profibus.com provides answers to many common questions and information on your local user group.
A full listing of our worldwide sales and service network is available on our website at www.rotork.com.