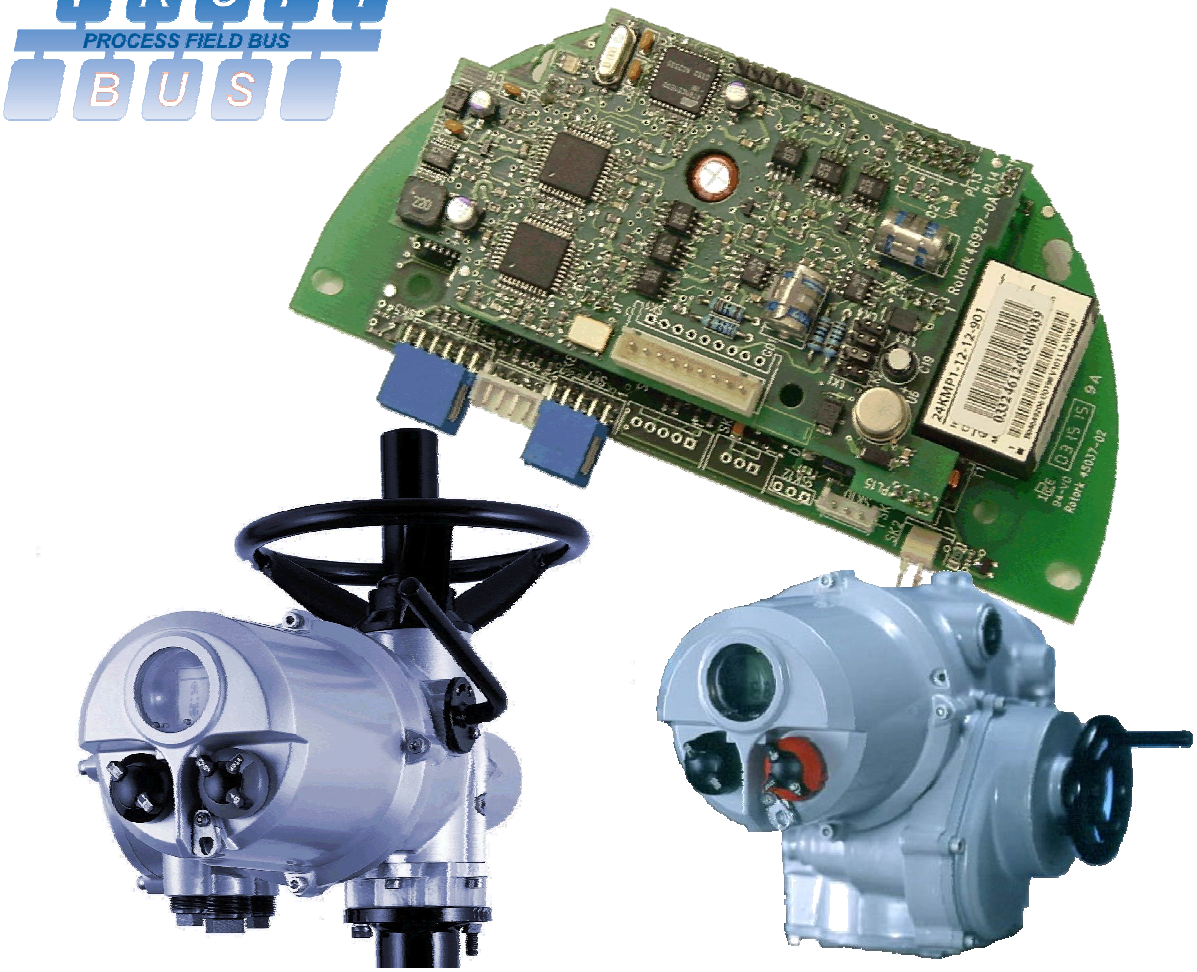
rotork

PROFI PROCESS FIELD BUS



Profibus Actuator Control
Profibus DP Option Card
Installation Manual

Publication S420E V3.0 Issue 01/05

Note 1:

Throughout this manual the Profibus DP Module (Mk2) may simply be referred to as the module or the Profibus module.

Note 2:

The information in this manual relates to the following firmware release

Profibus Network Interface Card software version PNIC 1.20 (single) and 1.40 (Simple dual and RedCom dual)

Actuator Interface Card software version M207

Note 3:

The Profibus DP Module (MK2) described in this manual is suitable for inclusion in Rotork IQ, IQT, and Q range actuators.

As we are continually developing our products their design is subject to change without notice.

Contents

Glossary of Terms:

Address	The unique address for a node on the fieldbus, range 0-126
Fieldbus	The digital, two-way, multi-drop Profibus-DP communication link
Field Unit	The Profibus option card fitted to the actuator
Interoperability	The capability for a device from one manufacturer to interact with that of another manufacturer, on a fieldbus network, without loss of functionality
Master/Slave	The method of communication used by the Profibus-DP Module. The fieldbus requires a Profibus master to control the data exchange on the highway.
Profibus DP	The communication protocol used on the highway.
Profibus DP-V0 and DP-V1	The cyclic (V0) and acyclic (V1) versions of the protocol supported by the Rotork module.
PNO	Profibus Nutzerorganisation – Profibus User Group, Germany
RedCom	Dual redundant system as defined in PNO 2.212
Node	A single device on the fieldbus
RS485	The electrical properties of the data highway as defined by the IEC 61158 standard, copper conductors, 2 wire twisted pair.
Segment	A section of an RS485 fieldbus that is correctly terminated in its characteristic impedance. Each Segment can include up to 32 devices.

Abbreviations:

Comms	Communications
PFU	Profibus Field Unit
RAM	Random Access Memory
ROM	Read Only Memory
RTU	Remote Terminal Unit
SW	Software

References:

Profibus Guideline 2.112	Installation Guideline for Profibus DP/FMS
Profibus Guideline 2.212	Specification Slave Redundancy
Profibus Guideline 2.152	Specification for Profibus Device Description and Device Integration – EDD
Profibus Guideline 2.162	Specification for Profibus Device Description and Device Integration – FDT

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1 INTRODUCTION

The Rotork Profibus DP Actuator Control option card (PFU) has been certified by the PNO as compliant with specifications IEC61158 and EN50170. The card supports both Profibus DP-V0 cyclic and Profibus DP-V1 acyclic messages. Three versions are available - single channel, simple dual channel and RedCom dual channel. The Simple dual channel card does not include the Redstate diagnostics whilst the RedCom dual channel card fully supports RedCom (Redundant Communication) extensions to the V1 protocol as specified by PNO for systems using either FR (Flying redundancy) or SR (System redundancy) configurations. The inclusion of acyclic message capability (V1) allows for system maintenance and asset management tools to be used. Electronic data sheets are available in GSD, EDD and DTM formats.

- ❑ Profibus DP-V0 and DP-V1 compliant
- ❑ RedCom redundancy included, both FR and SR modes
- ❑ GSD, EDD, DTM device description files available
- ❑ Supports Siemens PDM and FDT applications
- ❑ Address changes by master class 2, IR link (IQ and IQT only), FDT or PDM
- ❑ Zero internal stub length
- ❑ Mounted within the double sealed actuator enclosure
- ❑ All card settings are non-intrusive and can be made over the data highway

The Profibus-DP Module circuits do not impinge on the actuator control electronics; the actuator itself remains fully self-protecting. The module performs the tasks of network interface, actuator data collection and the issuing of actuator commands to open, stop, close, perform an ESD operation or move to a set position.

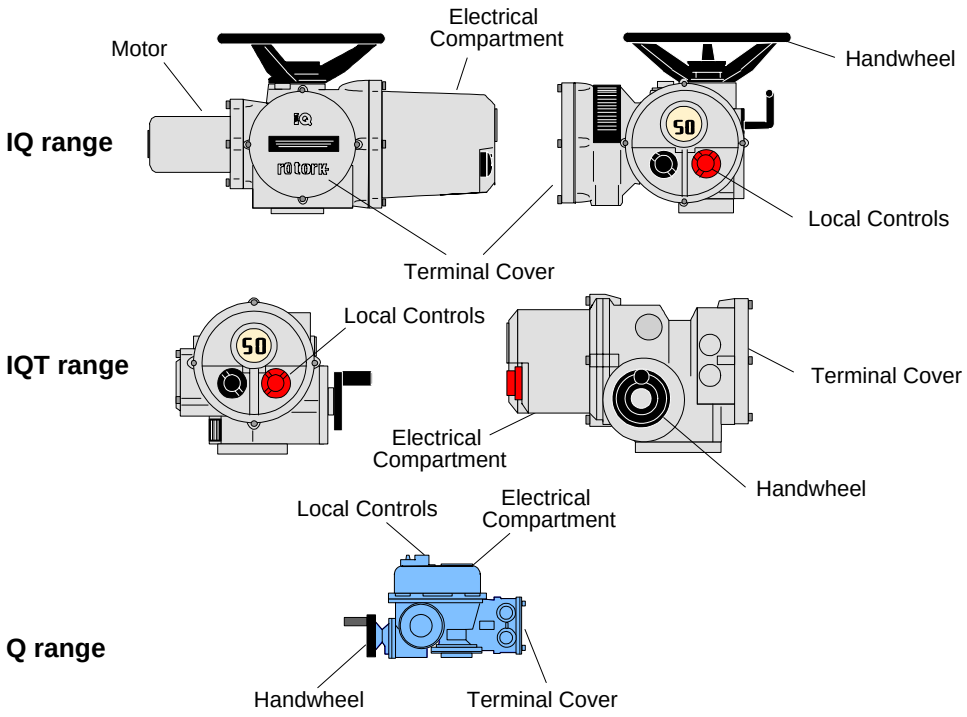


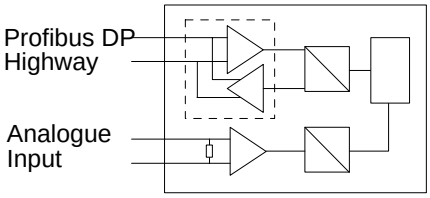
Fig 1: The Profibus DP Module (Mk2) Option Card Actuator Compatibility

1.1 General

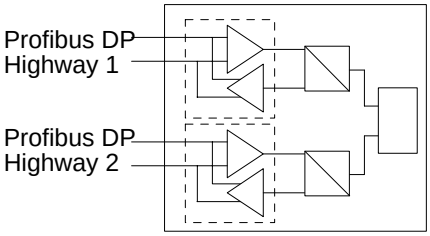
The Profibus DP Module (Mk2) has three versions:

- Single Channel Profibus DP plus one analogue input channel
- Simple Dual Channel, independent isolated Profibus DP highways for redundant systems that do not support full RedCom
- RedCom Dual Channel, independent isolated Profibus DP highways for RedCom compliant systems

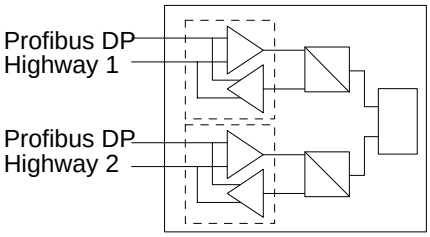
The two dual channel versions have the same physical assembly, but are configurable to include the necessary extra messages for RedCom systems. PLC's that cannot accept the extended diagnostic messages from RedCom slaves should use the Simple Dual channel card. The reporting of RedCom extended diagnostics can be selected from the GSD file.



Single Profibus DP Highway + Analogue Input



Simple Dual Profibus DP Highway Connections



RedCom Dual Profibus DP Highway Connections

Fig 2: The Types of Profibus DP Module (Mk2) Option Card

Communication Media	RS485 2 wire highway (single or dual), half duplex
Protocol	Profibus DP-V0 and DP-V1
Mode	Master/Slave, module is a slave, cyclic and acyclic messaging

2 PROFIBUS DP (MK2) OPTION CARD PROPERTIES

2.1 Mechanical properties

The PFU comprises two printed circuit boards connected together and the assembly is fitted inside the actuator electrical housing.

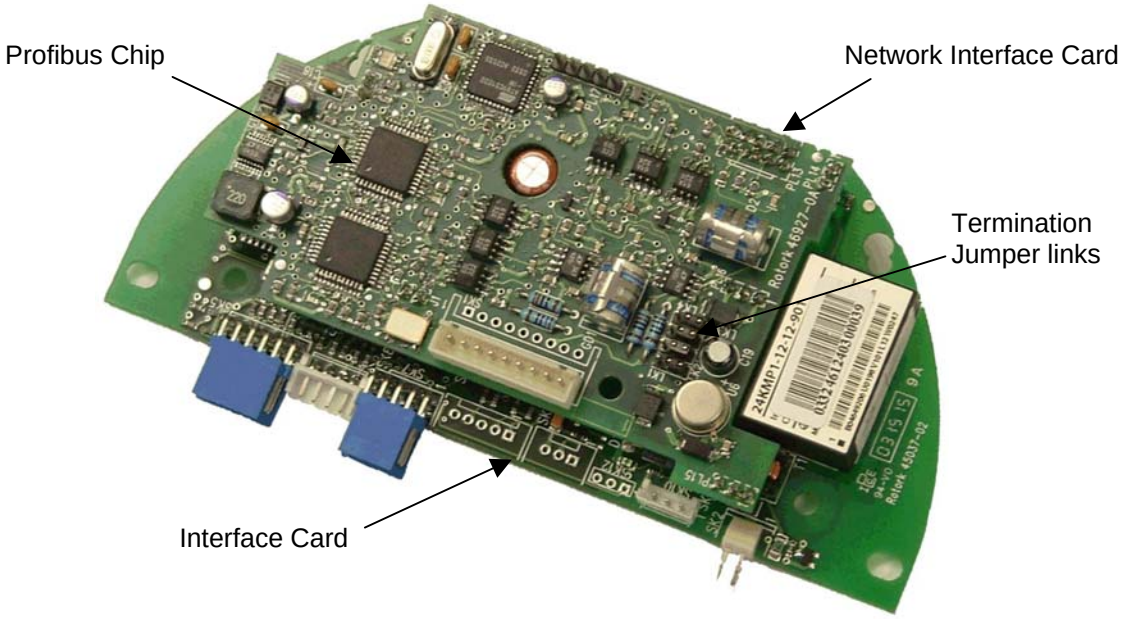


Fig 3: The Profibus dual highway module showing the NIC and Interface Card (IQ actuator)

- Network Interface Card - The small printed circuit board carries the Profibus DP, RS485 highway connections and protection circuits.
  There are two versions of the Network Interface Card, one for a single highway and a second for two highways, Simple or RedCom Dual. (RedCom has two highway configurations, 2 highways for SR mode or one highway with two network interface connections for FR use.)

- Interface Card The larger motherboard is profiled to suit the actuator into which it fits. The IQ actuator assembly is shown. It carries the processor, memory components and power supplies for the module.

The primary connection to the actuator circuits is by a multipin connector on the Interface Card that, due to its physical shape, may only be fitted in the correct polarisation. Internal wiring harnesses connect to the Interface Card for other signals and options within the actuator. The Network Interface Card carries the Profibus connector and termination and biasing resistors, this couples to the wiring harness routed to the terminal compartment of the actuator. Power for the Network Interface Card is taken from the Interface Card and the whole assembly is powered from the actuator.

All the connectors are polarised to prevent incorrect insertion.

2.2 Electrical Properties

The PFU connects directly to the Interface Card of the actuator. The PFU does not sit in the main control path for the actuator and does not affect the actuator control integrity.

An EPROM stored program controls the processor on the module; the software can be updated by replacing this chip.

The Profibus DP fieldbus data highway connections are fully isolated from the actuator electronics.

2.3 Operation and Storage

The PFU is designed to be stored in the actuator and operated within the same environment as the actuator. The constraints are:

- Operating temperature: -40^{o}C to +70^{o}C
- Storage temperature: -50^{o}C to +85^{o} C
- Relative Humidity: 5% to 95% (<50^{o}C) non-condensing

3 FITTING THE PROFIBUS DP (MK2) OPTION CARD

3.1 Inside an IQ or IQT actuator

The PFU is suitable for fitting into IQ Mk2 actuators with 3000 or 5000 series wiring diagrams and IQT with 6000 or 7000 series wiring diagrams. The connections and fitting in an IQT is similar to that for an IQ and the following information effectively relates to both actuator types. The PFU is normally located in the first option board slot inside the IQ/IQT electrical housing using connection SK1. In addition the PFU can be fitted inside IQ Mk1 actuators in certain cases.

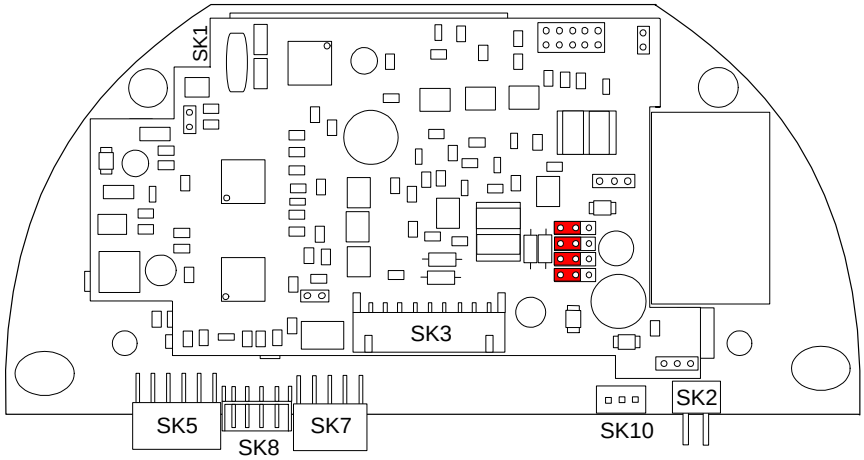


Fig 4: The Profibus Mk2 card profiled for the IQ or IQT actuator

The Interface card must be correctly profiled and loaded with the appropriate connectors to match the IQ/IQT actuator. The illustration (Fig 4) shows the IQ/IQT version of the PFU. The links for the bias resistors are shown in the 'not terminated' position.

With the IQ/IQT actuator the remote inputs are always present (they are conditioned by the PFU) and there is an option to include Digital Outputs from relay contacts. If the PFU is required to operate the 4 digital outputs that can be controlled from the card then the Extra Relay Indication card associated with these outputs must be fitted into the actuator. The following table describes the wiring harnesses and their function in the IQ and IQT actuator.

PFU Socket	Wiring Harness
SK2	24V power supply input from actuator
SK3	Profibus Fieldbus connection
SK5	Remote Digital Input connections
SK7	Digital Output connections ①
SK8	Data Logger Information
SK10	Analogue Input connection ②

Note: ① *– Requires Extra Relay Indication board to be fitted*
② *– Only available on Single Channel module, 3000-900 or 6000-900*

To restore the card to its factory defaults and the associated default parameter settings, LK1 on the Interface card should be fitted and the power cycled (see Fig. 6).

3.2 Inside a Q actuator

The PFU is fitted in the option board position in this actuator. Only one option board may be fitted at any one time. The necessary internal components must also be present; in this case a potentiometer and auxiliary limit switches at end of travel must be fitted to the actuator.

The illustration (Fig 5) shows the Q version of the circuit board. The links for the bias resistors are shown in the 'not terminated' position.

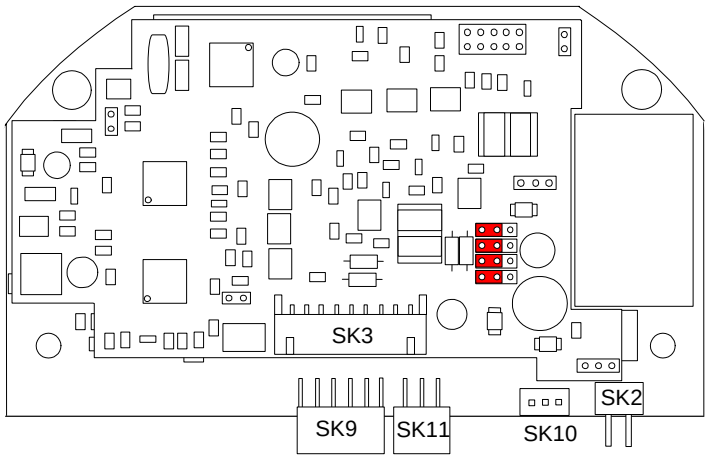


Fig 5: The Profibus Mk2 card profiled for the Q actuator

Digital Outputs from relay contacts are not supported from the Q actuator, nor is the ability to report the status of the remote control inputs as Digital Inputs. The following table shows the wiring harnesses that must be fitted and the function of each loom for the Q range actuator.

PFU Socket	Wiring Harness
SK2	24V power supply input from actuator
SK3	Profibus Fieldbus connection
SK9	Limit switches
SK10	Analogue Input connection ①
SK11	Potentiometer

Note: ① - Only available on Single Channel module

In a Q actuator there is a direct connection from PL2 on the Interface Card to SK5 of the actuator main board.

To restore the card to its factory defaults and the associated default parameter settings, LK1 on the Interface card should be fitted and the power cycled (see Fig. 6).

3.3 Replacing or Fitting a Profibus DP (Mk2) Option Card

The PFU should be replaced or fitted only in a suitable environment. The actuator must be made electrically safe before opening any covers and in the case of an IQ or IQT it is advisable to disconnect the internal battery. The electrical housing cover should be removed and the existing PFU carefully unplugged from its main connector. Once removed from the main connector the wiring loom connectors should be removed. The replacement board is fitted in the reverse order to removal. The wiring harnesses are polarised so that only the correct one will fit its mating part on the circuit board.

If the operation is to fit a PFU for the first time then the necessary wiring looms must be added to the internal wiring harness of the actuator. The actuator wiring diagram shows the connectors and harnesses used. The wiring harnesses are fitted inside the actuator before attempting to fit the PFU. Once the looms are in place connect them to the PFU, then fit the PFU to the actuator main board connector.

Once the module is fitted the actuator should be re-assembled and, in the case of the IQ or IQT, the battery replaced.

The PFU must not be split between its Network Interface Card and the Interface card. Only complete assemblies should be fitted or exchanged.

If at any time it is necessary to reset the card to its supplied default values the Network Interface card should be removed and a shorting link applied to LK1. The Interface card must then be put back in the actuator and the mains power cycled. The Network Interface card must then be re-assembled onto the interface board and the pair refitted into the actuator. LK1 is usually used as a mechanical connection link between the top and bottom boards.

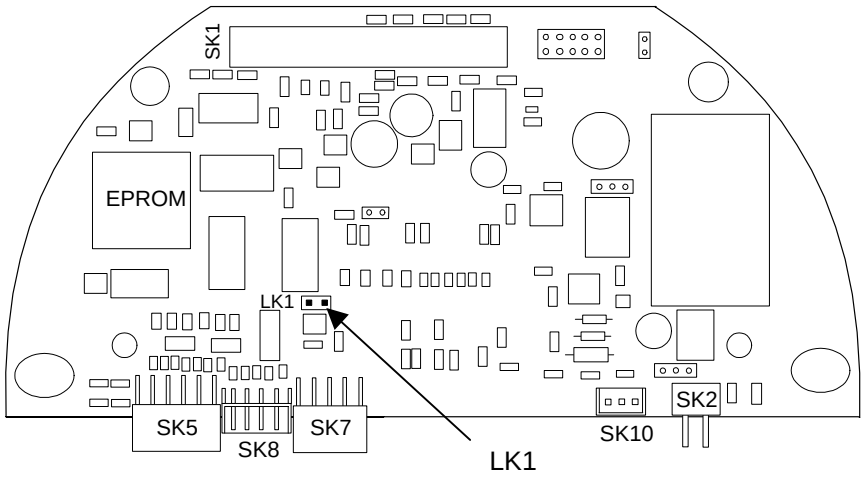


Fig 6: The Profibus Mk2 Interface card showing the position of LK1 (NIC removed)

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4 SINGLE AND DUAL DATA HIGHWAY CONFIGURATIONS

4.1 Profibus Data Highway

The rules governing the installation and connection of a Profibus DP highway should be observed at all times to produce a successful installation. The highway does not allow power to be transferred and the Profibus module is powered from the actuator itself. The module can only report data when the actuator is powered up.

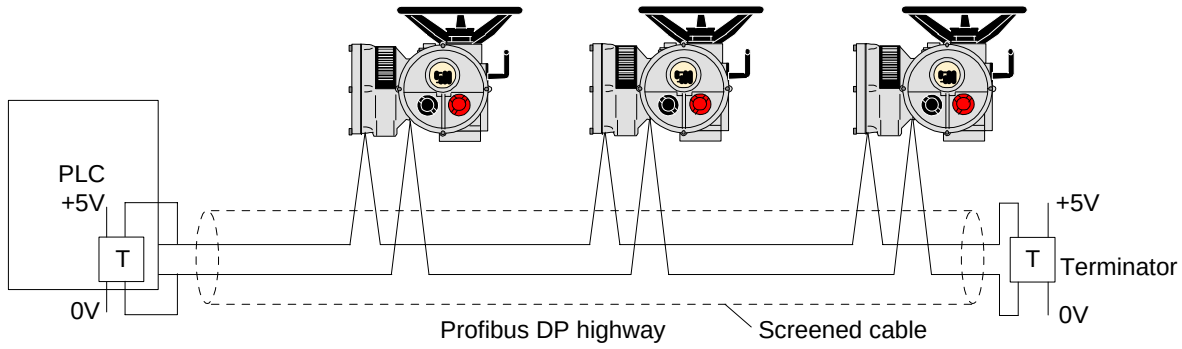


Fig 7: Typical Profibus DP Data Highway

The data highway must be terminated with a proper active termination network at each end of a segment. To ensure successful operation the highway itself should not use tapped spur or stub connections. The connection should be made in and out of each actuator in a daisy chain arrangement on separate terminals to eliminate any internal stubs cabling inside the actuator. The length of the highway and number of devices connected will vary from project to project. The standard permits up to 32 devices to be connected on a section, though one of these will be the PLC. If more devices are needed (up to the maximum addressable of 126) then repeaters may be added as required. Up to 9 repeaters can be used on a single highway provided no more than 4 are between any two devices.

Data Rate (Baud)	9600	19200	45.45k	93.75k	187.5k	500k	1.5M
Maximum Segment Length	1.2 km	1.2 km	1.2 km	1.2 km	1000m	400m	200m
Maximum Highway Length	10 km	10 km	10 km	10 km	10 km	4 km	2 km
Max number of actuators/segment	31①	31①	31①	31①	31①	31①	31①

Note: ① – The PLC or Repeater module will be one device. Max 32 devices/segment

Since the data passes over a single 2 wire cable there are periods between messages when no devices are actively driving the lines. In order to ensure that data continues to flow correctly after these periods it is advisable to ensure the lines are biased to suitable voltage levels during the time the line is idle. The PFU contains active termination circuits that ensure suitable levels are maintained on the line even with no device transmitting. To select these termination components the appropriate internal links must be fitted. A simple termination resistor is also included and can be connected by linking the appropriate terminals (refer to the actuator wiring diagram).

4.2 Segmented Single Highway System

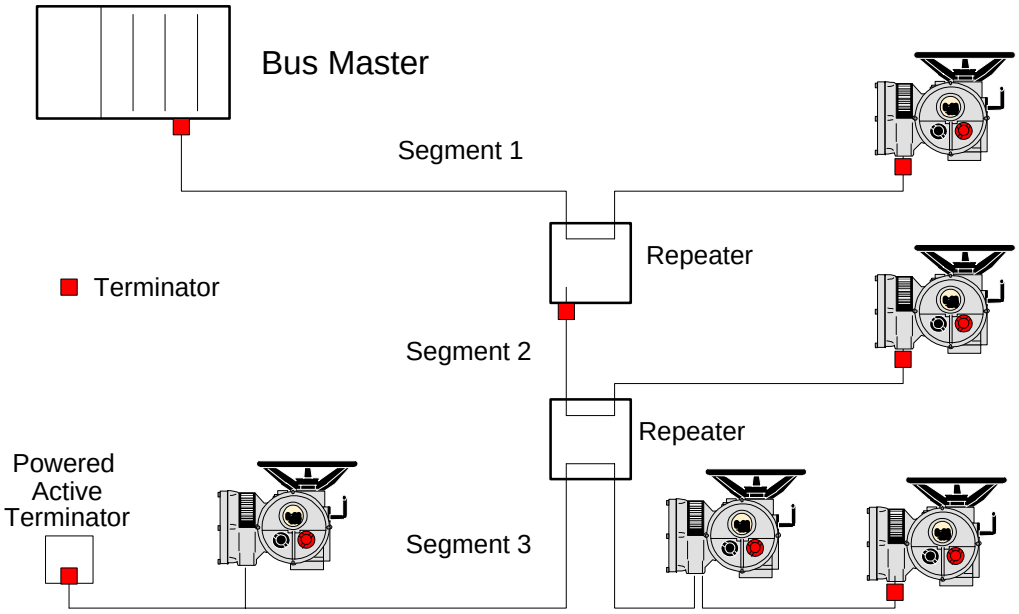


Fig 8: Profibus Single Channel Data Highway Topology

The data highway may be connected as several segments coupled by repeaters. The repeaters or actuator slaves will require termination components if they are on the end of the segment. Alternately separately powered active termination devices can be used so that when the actuator is switched off the bus performance is not affected.

Maximum number of devices participating in the exchange of data	127 (addresses from 0 to 126, 0 is usually the PLC)
Maximum number of devices per segment including repeaters	32
Maximum number of segments in series	EN50170 specifies a maximum of 4 repeaters between any two devices. Some manufacturers of repeaters allow more than this number.

4.3 Redundant Systems – Simple Redundancy

The Simple Dual Channel Profibus DP (Mk2) Option Card version has two redundant communications channels. Like the RedCom version, this card supports two types of redundant operation.

- SR – System Redundancy (One common slave address)
- FR – Flying Redundancy (Two slave addresses offset by 64)

The Simple Dual Channel card is suitable for all PLC's where redundant highways are being used. This option does not report the extended diagnostic bytes relating to the card's redundant status.

These two connection options allow for redundancy protection against either a failure of the highway (SR mode) or failure of the card interface channel (FR mode). Most dual channel systems use two highways and one connection to each, so the most common use for this card is in SR mode. The functionality and provisions of the card are identical to the RedCom version except in the way the card reports its status on the highway.

There are a number of PLC systems, including older PLC's, that do not have the ability to use the RedCom system and as a consequence they are likely to report errors when connect to a RedCom compliant card. If the PLC does not support the RedCom standard then the Simple Redundant card must be used.

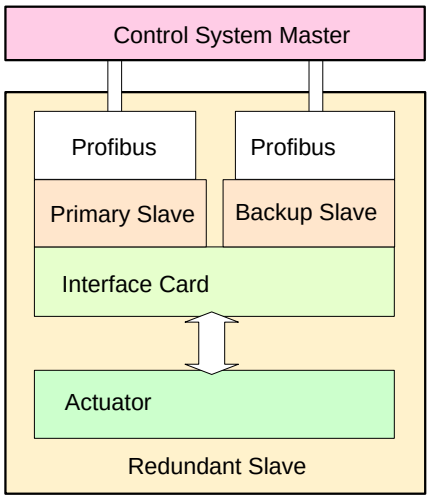


Fig 9: Profibus DP (Mk2) Simple Dual Redundant Option Block Diagram

The Profibus DP (Mk2) Simple Dual Channel card includes:

- Two Profibus Connections, Channel 1 and Channel 2
- Selectable FR/SR mode
- No Extended Diagnostics

A Simple Dual Channel card can be altered to a RedCom Dual Channel card, or vice versa, by entering the appropriate value in parameter 15 in the GSD file.

4.3.1 Flying Redundancy Slave to Master Connection

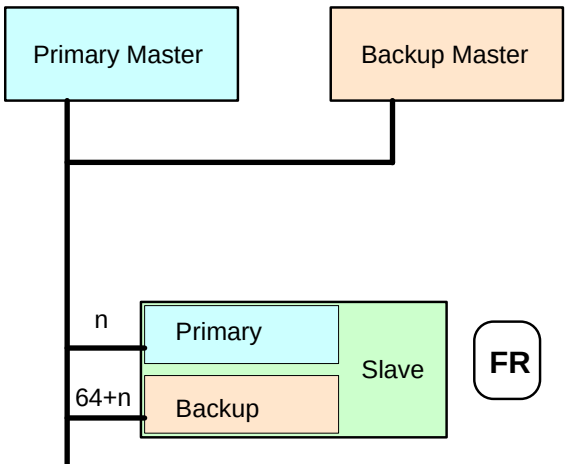


Fig 10: Profibus DP (Mk2) Flying Redundancy Connection

With FR (Flying Redundancy) the aim is to protect against a failure of the Profibus Interface. The data highway is considered to be more reliable than the connection interface. There is a single data highway and both the Profibus card inputs are connected to it. The card must be set to FR mode and it then adopts a fixed offset of 64 between the set address (used for primary communication) and the backup communication address.

When the card is powered 'on', Channel 1 will be the Primary channel. If the card does not enter Configuration Mode within 1 second (because there is no Master present) then Channel 2 will take over as Primary, once again if there is no communication within 1 second, then it will revert to Channel 1 and now it will wait 2 seconds before Channel 2 assumes Primary status. The switch over time will increase by a factor of 2 each time until it reaches its maximum of 32 seconds. It will continue to switch channels using a 32 second switch over time until one channel receives PLC messages.

In the event of a failure of the Primary channel, the Backup automatically changes to use the Primary address. Hence for all control purposes the Master only uses the Primary address. The Backup address can be used for exchanging data but any commands to move the actuator directed to the backup address will be ignored. If a configuration message is sent to the Backup address that is different to the one sent to the Primary address it will accepted, but not actioned. The data exchanged between the Master and the Primary includes information on the status of the device and hence the availability of a Backup should the Primary fail.

- ❑ Single Data Highway, two communication ports
- ❑ Channel 1 is Primary on power up
- ❑ Default method is SR mode, to achieve FR the associated parameter must be altered
- ❑ Fixed offset of 64 between Primary and Backup addresses
- ❑ Backup automatically adopts Primary address if Primary fails.
- ❑ V0 cyclic Commands to Backup ignored
- ❑ Reports the status of Primary and Backup to the Master
- ❑ Configuration and Parameterisation changes only over the Primary address

4.3.2 System Redundancy Slave to Master Connection

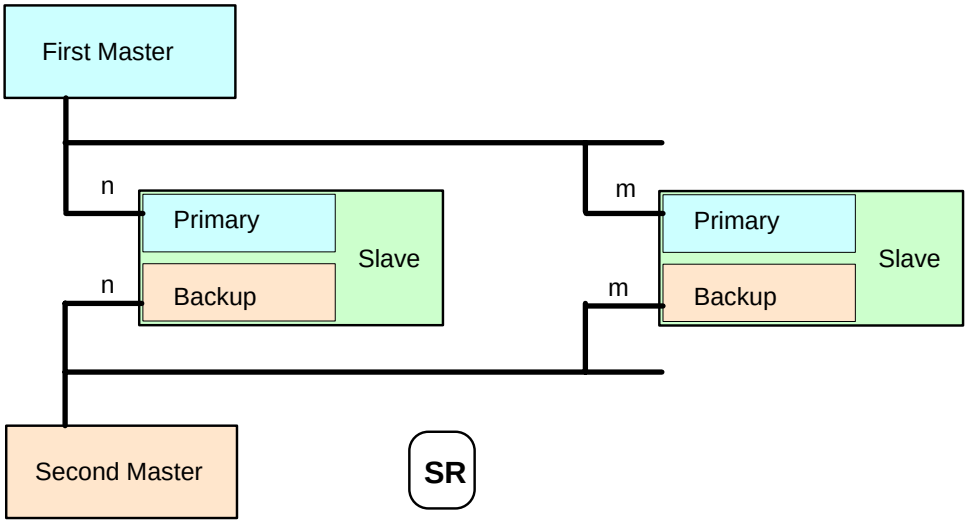


Fig 11: Profibus DP (Mk2) System Redundancy Connection

With SR (System Redundancy) there are two data highways and the aim of the redundancy is to secure communication with the actuator even if one of the highways fails. Although two masters are shown they will normally be a Primary and Backup pair and communication will occur directly between them. SR mode is the default for all dual Profibus cards.

The Profibus card has two communication channels and both have the same slave address. As with the FR mode, when the card is powered 'on', Channel 1 will be the Primary channel. If the card does not enter Configuration Mode within 1 second (because there is no Master present) then Channel 2 will take over as Primary, once again if there is no communication within 1 second, then it will revert to Channel 1 and now it will wait 2 seconds before Channel 2 assumes Primary status. The switch over time will increase by a factor of 2 each time until it reaches its maximum of 32 seconds. It will continue to switch channels using a 32 second switch over time until one channel receives PLC messages.

In the event of a failure of the Primary channel the Backup automatically changes to become Primary and communication will be established with the Second master on the second highway. The Backup channel can be used for exchanging data but any commands to move the actuator directed to the backup channel will be ignored. If a configuration message is sent to the Backup channel that is different to the one sent to the Primary it will be ignored. The data exchanged between the Master and the Primary includes information on the status of the device and hence the availability of a Backup should the Primary fail.

- ❑ Two Data Highways, two communication ports
- ❑ Channel 1 is Primary on power up
- ❑ Default communication method is SR mode
- ❑ Both channel have the same address
- ❑ V0 cyclic Commands to Backup channel are ignored
- ❑ Reports the status of Primary and Backup to the Master
- ❑ Configuration and Parameterisation changes only over the Primary channel

4.4 Redundant Systems – RedCom Redundancy

The RedCom Dual Channel Profibus DP (Mk2) Option Card version has two redundant communications channels. Like the Simple card, the RedCom card supports two types of redundant operation and the details are as described in Profibus Guideline 2.212 ‘Specification Slave redundancy’. The two modes are:

- SR – System Redundancy (One common slave address)
- FR – Flying Redundancy (Two slave addresses offset by 64)

The Rotork Profibus DP (Mk2) RedCom Dual Channel Option Card obeys the Profibus REDCOM Specification for Redundant Communications. This includes 3 bytes of Extended Diagnostics for RedState. Not all PLC systems can accept these diagnostic messages.

As with the Simple Redundant card, there are two basic considerations when looking at redundant systems, protection against the failure of the connecting cable and protection against failure of the device. Most systems consider cable protection to be the most important and this is termed ‘SR’ or System Redundancy. The alternate connection using only a single cable, but with two Profibus connections is termed ‘FR’ or Flying Redundancy. With FR systems there are two Profibus interfaces on the slave, but only one slave so protection against failure of the Profibus interface is included. SR and FR are described in more detail in the previous section.

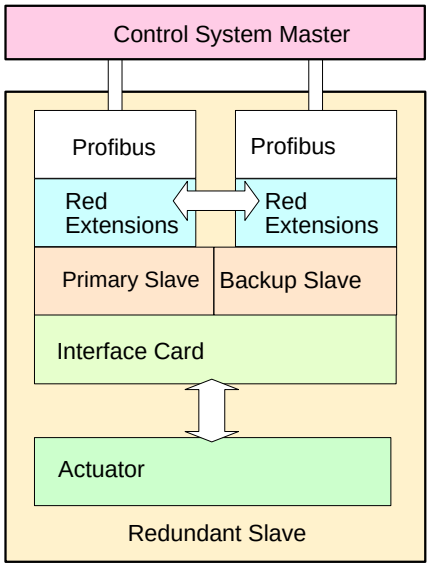


Fig 12: Profibus DP (Mk2) RedCom Dual Redundant Option Block Diagram

The Profibus DP (Mk2) RedCom Dual Channel card includes:

- Two Profibus Connections, Channel 1 and Channel 2
- RedCom link between the two connections
- Redundancy extensions to the V1 protocol
- No loss of data during switching
- Selectable FR/SR mode
- Status reported in Extended Diagnostics data

4.4.1 Extended Diagnostic Messages for RedCom

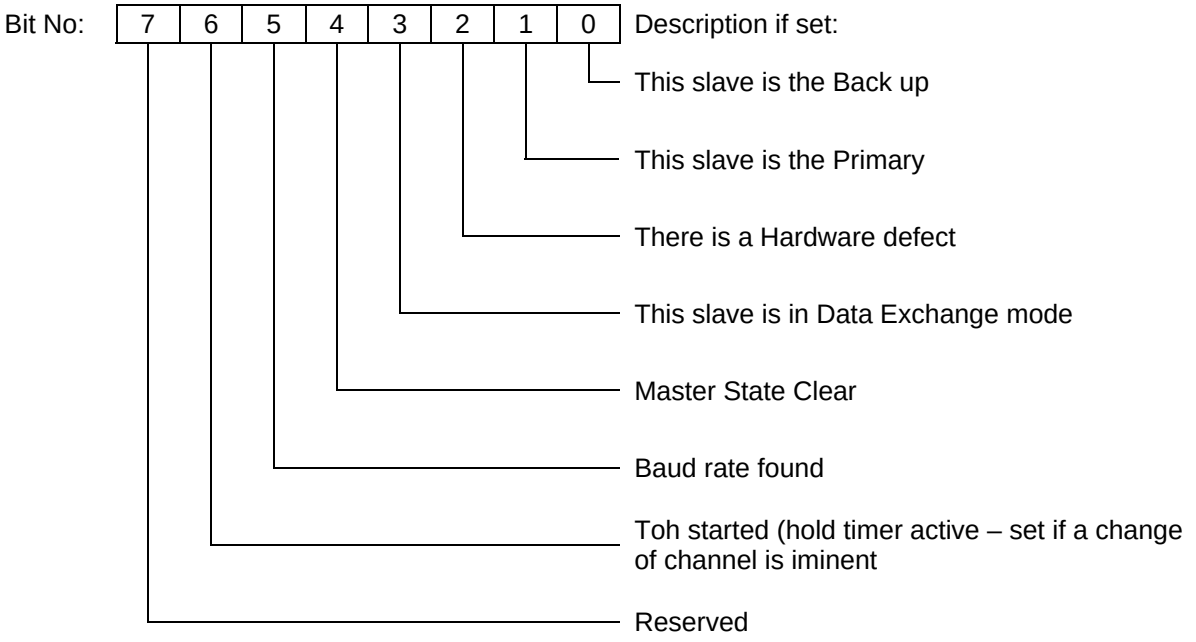
The Redundancy Extensions to the standard V1 protocol allow the two channels to communicate between themselves to establish correct operation of the highway if there is a failure, both the Simple and RedCom versions of the card do this. In addition to these there are extra Extended Diagnostic messages that are reported to the PLC as part of the RedCom system that the Dual RedCom card reports. Not all PLC's are RedCom compliant, so some are unable to understand these messages and as a consequence will mark the device as having an Error. If this is the case either reconfigure the Profibus card to be 'Simple' or disable the PLC's diagnostics package that is looking at the extended diagnostics.

A RedCom Dual Channel card can be altered to a Simple Dual Channel card, or vice versa, by entering the appropriate value in parameter 15 in the GSD file.

The extended diagnostics is contained in 3 bytes in the diagnostic message and is reported by the Primary slave only:

Description	Comment
Headerbyte	= 8 h
Status_Type	= 9Fh
Slot_Number	= 0 h
Specifier	
Function	
Red_State_1	State of Primary slave
Red_State_2	State of Back Up slave
Red_State_3	Not used

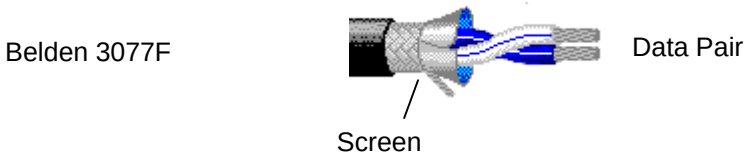
The information in the Red_State bytes is as below



4.5 Cable Types

The network must be connected using a suitable cable. Two conductors plus a shield are required and there is a Profibus specification for the cable. Type A cable should be used for all new installations.

Amongst the cable manufacturers Belden have the PVC jacketed 3077F single pair 2 core cable, which meets the minimum requirement. Information on Belden cable may be found on the Belden web site (www.belden.com).



Type A Profibus DP Cable Specification (for all new installations)	
Impedance	135 up to 165 ohm at a frequency of 3 to 20 MHz
Cable capacitance	<30 pF per metre
Core diameter	>0.34 mm2 (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

Fig 13: Typical Profibus Type A cable

The terminals to which the wires connect in the each actuator type will be different and the actuator wiring diagrams must be consulted to establish the connections.

4.6 Termination Network

In order to operate correctly all Profibus segments must be terminated at each end in an active network termination circuit. The Profibus DP (Mk2) card includes the necessary components to allow an active termination to be connected. In order to connect the termination network it is necessary to add a link to the actuator terminals and also fit two internal jumpers to the circuit card, per highway. The section 4.7 below for details where to fit the links in the various options of the card.

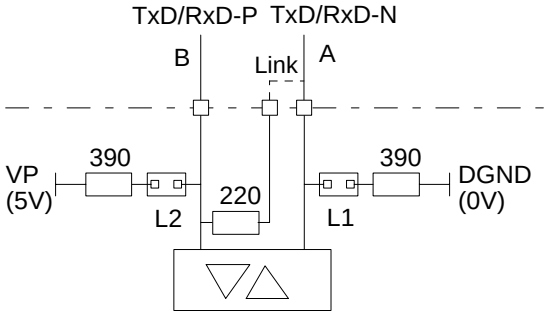


Fig 14: Termination for Profibus highway

4.7 Inter-connecting the Highway and Setting up the Profibus Card

The Profibus Mk2 variants allow for different highway connections. The 'single channel' can be used for simple highways, and where there is an analogue transmitter connected it will also return the value from the transmitter signal. The 'dual channel' (both Simple and RedCom compliant) is used for redundant highway applications where the highway integrity (SR mode) or the physical connection is important (FR mode).

4.7.1 Single Highway with Analogue Input

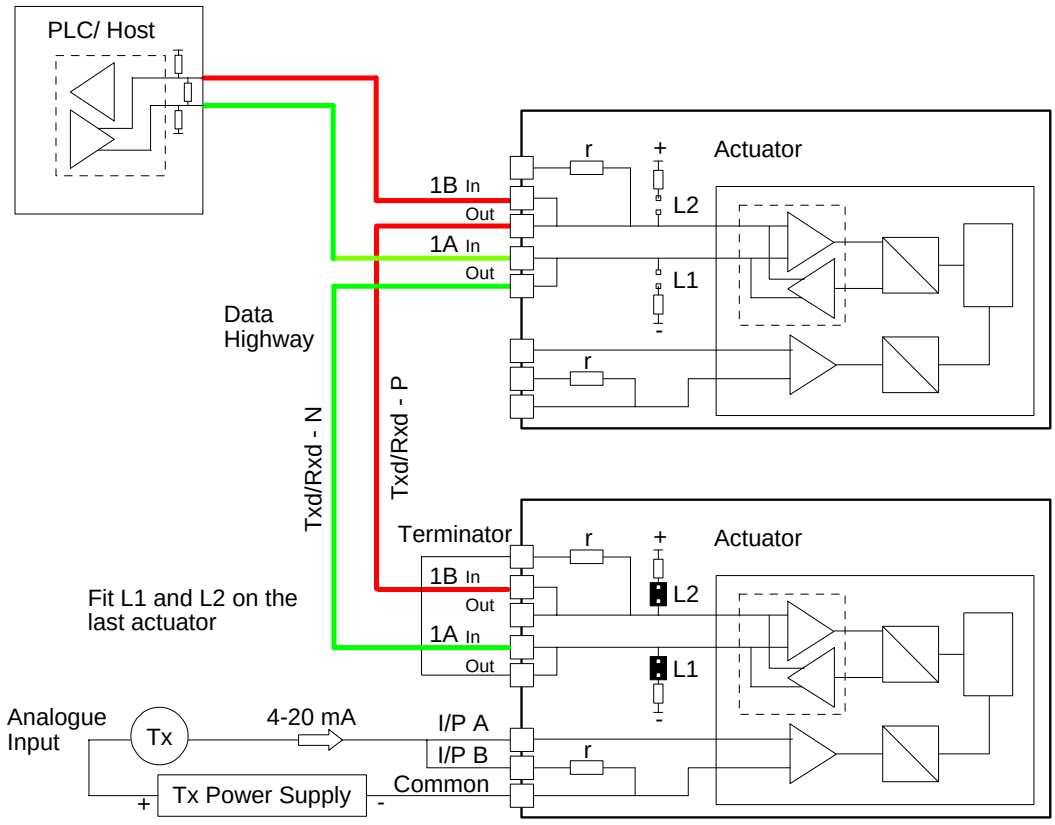


Fig 15: Single Highway + Analogue Connections

With the single channel option the actuator is connected to only one highway and an additional input is provided for measuring and reporting an analogue variable. The connection of the actuator to the highway uses terminals 1A and 1B (in and out terminals), the terminal numbers depend on the actuator type and are indicated on the actuator wiring diagram. The highway should be arranged so as to eliminate any stub connections. The last actuator on the highway should have the termination resistor connected by linking the highway 1B terminal to the Terminator terminal and fitting the internal links LK1 and LK2 in the Terminate position. Take care to ensure that the correct polarity is observed on the data highway connection, all the 1A terminals must be used on one data line and all the 1B terminals on the other.

- Data line 1B is positive with respect to data line 1A when the PFU is transmitting a ‘1’.
- Data line A is also called TxD/RxD-N
- Data line B is also called TxD/RxD-P

If an analogue input is being used it is connected to the analogue input terminals. The Profibus card caters for both current and voltage analogue signals. There is no power supply on the card for the analogue transmitter and an external power supply must be used to power it.

- For voltage inputs connect I/P A to the positive signal and analogue Common to the negative signal from the transmitter
- For current inputs connect I/P A to I/P B (to insert the conditioning resistor). The current input positive is to I/P A and I/P B whilst the current input negative is connected to the analogue Common.

Active termination resistors are included on the Profibus card. The jumper links LK1 and LK2 on the PNIC board are used to select the inclusion of these resistors.

- Fit LK1 and LK2 as shown to provide pull apart active termination to the network at this actuator and
- Link Terminals ‘Terminator’ and ‘Profibus A’ to add end of line termination

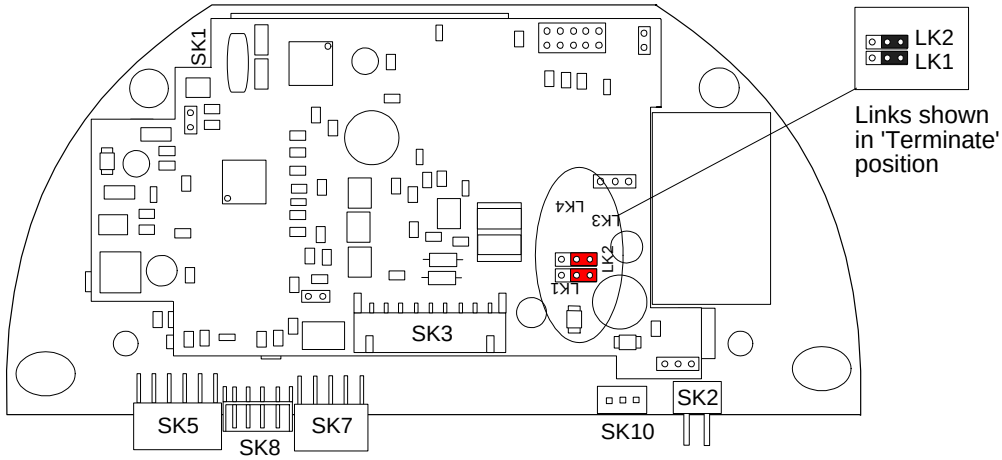


Fig 16: Single Highway Active Termination Links

4.7.2 Dual Highway

The most common application of the Dual channel card is for Dual Highways in SR (System Redundancy) applications. If FR (Flying Redundancy) is being used then a similar connection at the actuator applies, but only one channel will require termination at the end of the highway. The choice between Simple and RedCom compliant redundancy does not affect the connection options.

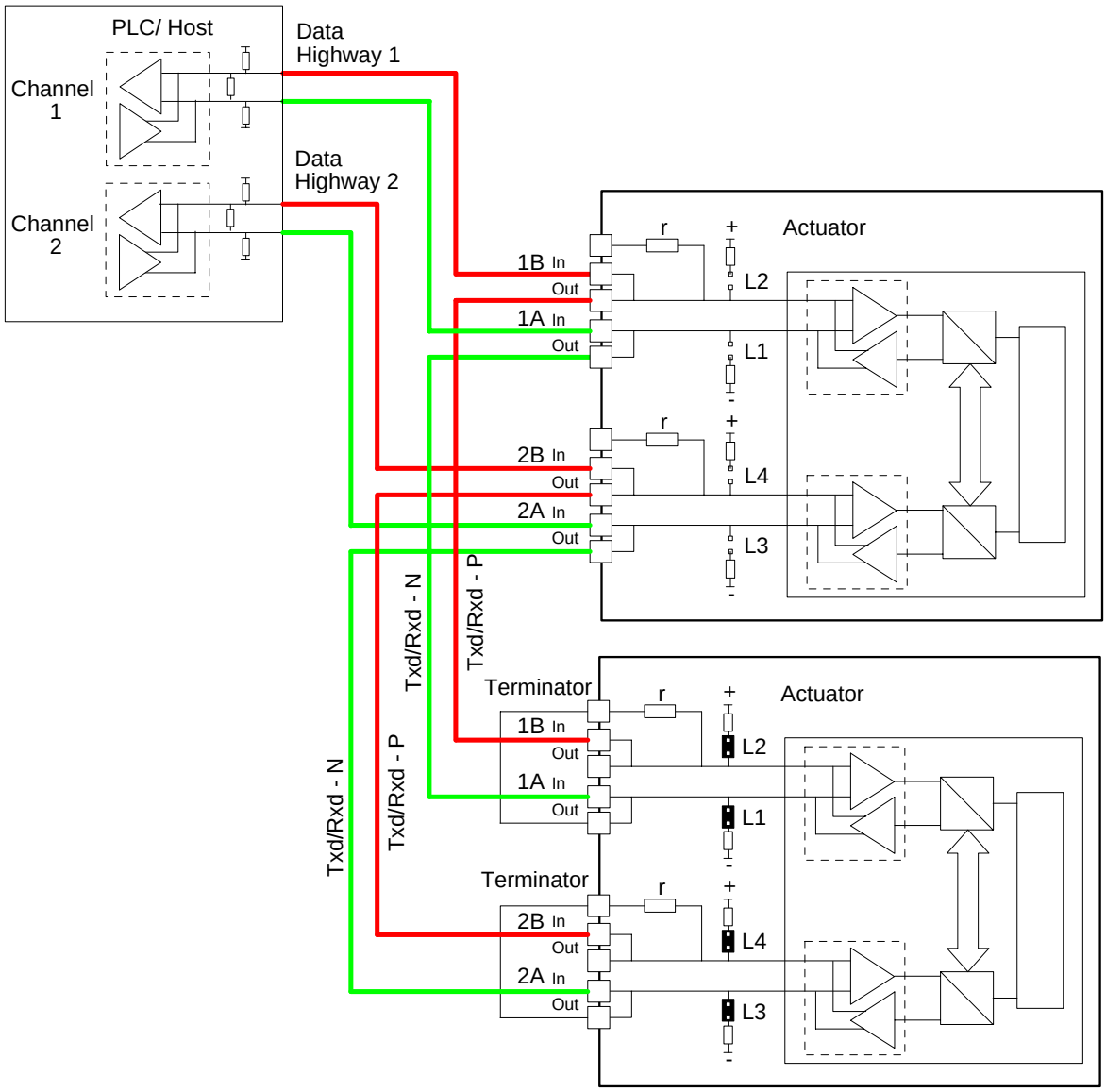


Fig 17: Dual Highway SR Mode Connections

The connection of the actuator to the highway uses terminals 1A /1B (in and out terminals) on highway 1 and 2A/2B (in and out terminals) on highway 2, the terminal numbers depend on the actuator type and are indicated on the actuator wiring diagram. The highways should be arranged so as to eliminate

any stub connections. The last actuator on the highway should have the termination resistors connected by linking the highway 1B terminal to the highway 1 Terminator terminal and fitting the internal links LK1 and LK2 in the Terminate position; and by linking the highway 2B terminal to the highway 2 Terminator terminal and fitting the internal links LK3 and LK4 in the Terminate position. Take care to ensure that the correct polarity is observed on the data highway connection.

- ❑ Data line 1B is positive with respect to data line 1A when the PFU is transmitting a '1'.
- ❑ Data line A is also called TxD/RxD-N
- ❑ Data line B is also called TxD/RxD-P

Both the Dual card options default to System Redundancy; this allows two separate highways to be used. When the RedCom compliant version is used the card uses RedCom extensions to the standard DP V1 protocol to permit redundancy to be used in a controlled manner. The host system should be able to support V1 messages and RedCom, if it cannot then the Simple redundant option should be used.

Active termination resistors are included on the Profibus card. The jumper links LK1 to LK4 on the PNIC board are used to select the inclusion of these resistors.

- ❑ Fit LK1, LK2, LK3 and LK4 as shown to provide pull apart active termination to the network at this actuator and
- ❑ Link Terminals 'Terminator 1' and 'Profibus 1A' and 'Terminator 2' to 'Profibus 2A' to add end of line termination

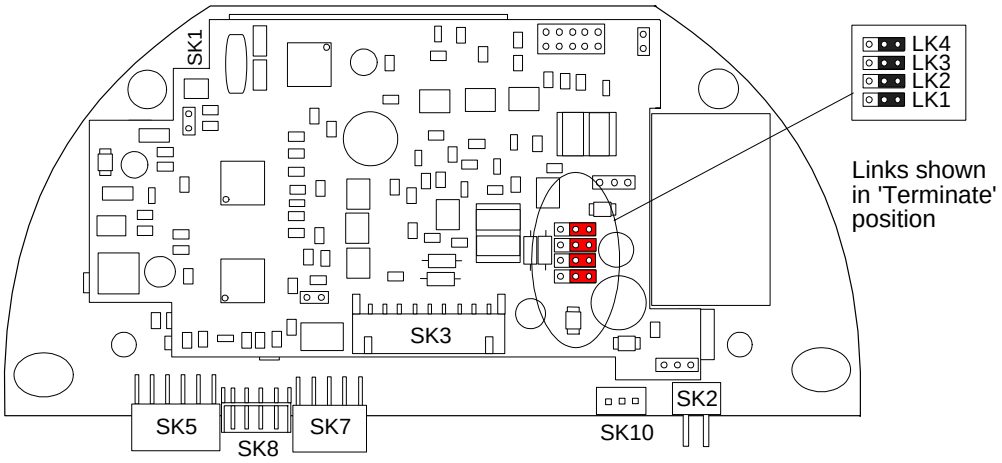


Fig 18: Dual Highway Active Termination Links for SR mode

5 THE ACTUATOR CYCLIC DATA SIGNALS

The Profibus DP Module (Mk2) allows the actuator to be controlled by, and to report data to, a suitable host device using Profibus DP protocol. This section explains the data signals that are presented during cyclic V0 data exchange and their meaning in relation to the actuator functionality. The register locations used for the data exchange is given later in this manual.

This section also gives information on the other control inputs available for moving the actuator.

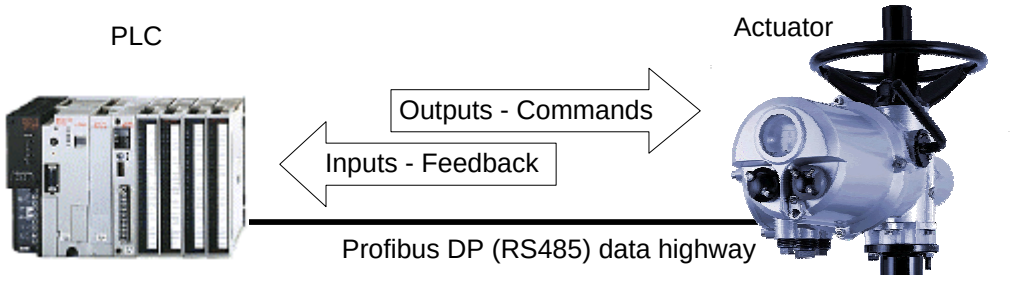


Fig 19: Input and Output Data Direction

- **Outputs** are defined as signals originating at the PLC and operating the actuator controls.
- **Inputs** are defined as signals originating at the actuator and fed back to the PLC over the Profibus network.

Cyclic Data Exchange			
	Output Registers		Input Registers
1	ACTCON	1	IDATA1/IDATA2
2	POS_DV	2	IDATA3/IDATA4
3	O_STAT	3	TORQUE
4	PORTCM	4	POSITN
		5	TEMPER
		6	ANALOG
		7	PORTST

***Note**: The actual registers exchanged during normal cyclic data exchange will depend on the Configuration set for the card. Section 5.4 contains information on the Configuration options available.*

5.1 Control Outputs

The Profibus DP Module (Mk2) can be used to control the actuator and position the valve. The valve may be moved fully closed, fully open or to an intermediate position. Additionally the actuator can make the valve adopt an Emergency Shut Down position. The actuator may also be operated from its local controls or by hard wired direct contact inputs (in the case of the IQ and IQT the Auxiliary Input Mask must be correctly set).

As well as controlling the actuator the PFU can also be used to operate 4 discrete output relays when fitted to an IQ/IQT actuator with the relay card fitted.

The control commands have three potential sources:

- ❑ Profibus DP network generated commands
- ❑ Actuator Local Controls
- ❑ Direct contact input controls

The full list of commands is shown in the table. The actuator types show whether the command is applicable to that actuator type.

Command	IQ actuator	IQT actuator	Q actuator
Profibus over the network			
Open	✓	✓	✓
Close	✓	✓	✓
Stop	✓	✓	✓
Emergency Shut Down	✓	✓	✓
Analogue Position Demand	✓	✓	✓
Partial Stroke	✓	✓	✓
Multiport Position ④	×	×	×
Relay output DO-1	✓①	✓①	×
Relay output DO-2	✓①	✓①	×
Relay output DO-3	✓①	✓①	×
Relay output DO-4	✓①	✓①	×
Local Actuator Controls			
Open	✓	✓	✓
Close	✓	✓	✓
Stop	✓	✓	✓
Direct Hard Wired Inputs			
Open	✓	✓	✓②
Close	✓	✓	✓②
Stop/Maintain	✓	✓	×②
Emergency Shut Down (Network Disable)	✓	✓	✓②③
Open Interlock (active prevents opening)	✓	✓	×
Close Interlock (active prevents closing)	✓	✓	×

Note: ① *– Requires Extra Relay Indication board to be fitted*
② *– Push to Run action only. Maintained action not available if analogue positioning is used*
③ *– Network Disable not available on Q range actuator*
④ *– Multiport functions require a multiport actuator, not described in this manual*

The Profibus DP network commands will operate the actuator provided –

- Local/Local Stop/Remote selector is in 'Remote',
- On IQ or IQT actuators, Profibus commands are not inhibited by the 'Inhibit/DI-4' input parameter setting and DI-4 condition
- No interlock is active on IQ or IQT actuators.
- There is no standing hard wired control input active
- No alarm condition prevents it from moving

❑ **Open** A digital command to cause the actuator to open to the fully open position as indicated by the Open limit switch. Under correct operation the actuator stops either when the open limit switch is reached, when the torque exceeds the value set and the open limit switch has been reached, or a new command is sent over the network.

❑ **Close** A digital command to cause the actuator to close to the fully closed position as indicated by the Close limit switch. Under correct operation the actuator stops either when the close limit switch is reached, when the torque exceeds the value set and the close limit switch has been reached, or a new command is sent over the network.

***Note**: Many IQ multi-turn actuators are set to open until the open limit switch is reached and, close until the closing on torque switch trips, but it is dependant on the type of valve. The IQT and Q normally operate 90-degree valves, use stop bolts on the actuator or gearbox, and stop when these are reached. The control room indication is always taken from the end of travel limit switch settings*

❑ **Stop** With no other command present this digital command causes an actuator motor that is running to stop.

❑ **Emergency Shut Down** A digital command that causes the actuator to drive to its Emergency position. There are settings within the actuator to determine if this is a closed, open or stay put action.

❑ **Analogue Position Demand** This function is only available over the Profibus DP network. To initiate Analogue Position Control the ACTCON register Position Enable bit must be set to 1 and all other bits to 0, enabling Position mode and a value must be written the Position DV register (range 0-100.0%, resolution 0.1%), the valve will open to the appropriate amount and stop in that position (within the deadband setting). If a subsequent digital command to open or close the valve is issued, from any source, this will take priority over the analogue position command. Once the setpoint is reached the positioning controller is switched off, but whilst the Profibus outputs are being written the positioner is continuously being updated. A new value in the Position DV register will cause a new position to be adopted and a new bit set in the ACTCON register will cancel positioning mode.

Provided limited range positioning is not invoked the values 0% and 100% written to the Position DV register produce a special case output where the command is revised so as to fully close the valve to its tight shut off position (0%) and fully open the valve (100%).

- **Partial Stroke** The actuator will move the valve to an intermediate position and back to the start position provided it is at the correct end of travel position when the command is issued. The end to start from and the amount of travel are selected during parameterisation.

- **Multiport Position** On multiport actuators the port to move to can be selected using this command. The actuator will move directly to the selected port. Valves with up to 10 ports can be controlled.

- **Relay Output DO1 to DO4** These 4 commands are used to energise and de-energise the internal relays on the additional relay board in an IQ or IQT actuator. (These outputs are referred to as S5-S8 in the standard actuator documentation when there is no Profibus DP Module in the actuator.) The resulting outputs can be used for operating other equipment such as a pump or indication light. The IQ/IQT actuator is not able to control these relays directly from the main board when the PFU is fitted. They will maintain their last state if power is removed from the actuator. On restoration of power the relays will be reset to their de-energised condition and the coils will report '0'.

- **Hard Wired Open and Close** These commands operate the actuator in the same way as the open and close commands sent over the Profibus highway.

- **Hard Wired Stop** The hard wired stop input acts as a change of state input. If the actuator is moving, opening the Stop input will stop the actuator. If the Stop input is already open and a Profibus command is sent to the actuator, the Profibus command will be initiated. To stop the actuator the hard wired input must be closed and opened again.

- **Hard Wired ESD (Network Disable**) The hard wired ESD may be set to causes the actuator to drive to its Emergency position. Alternately the input can be used to disable Profibus network control. The function of the input is determined by the parameterisation set into the PFU.

5.1.1 Controls Priority

Since there are three potential sources for control inputs the actuator and Profibus DP Module (Mk2) assign a priority for those occasions when two or more commands are applied simultaneously.

In addition, for the IQ and IQT actuator, the remote control hard wired inputs can be used as discrete input signals, to report the status of other devices or as control inputs. The associated Auxiliary Input Mask parameter must be set for the IQ or IQT to select the required function. In the case of the hard wired input for ESD this can be configured either as an ESD/DI-4 signal or as a 'Profibus Command Inhibit' to prevent network control signals from moving the actuator.

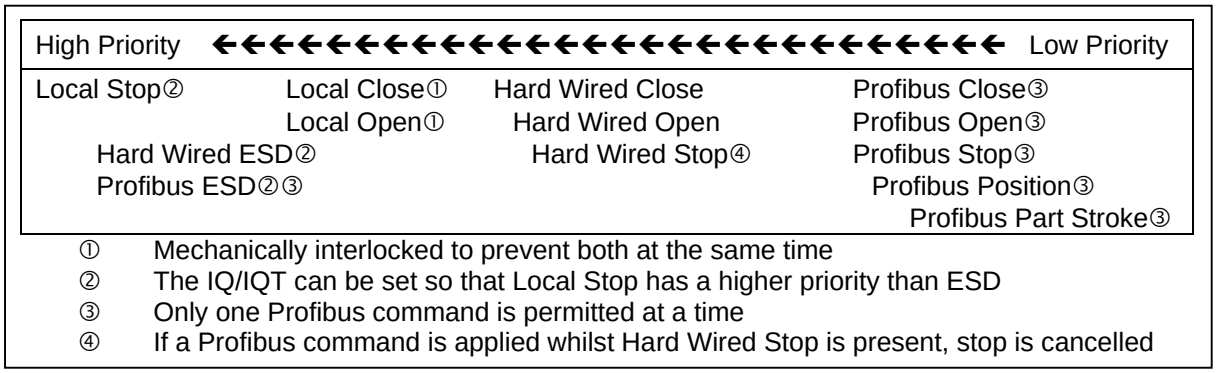


Fig 20: IQ and IQT Controls Priorities

In the case of the Q actuator the control selection is slightly different because the actuator uses a different control circuit. The Local Controls have a higher priority than hard wired or Profibus controls and the hard wired and Profibus controls share the same priority level

- If the Stop/Maintain hard wired input is closed (to provide maintained action on the other contact inputs to the actuator) then position control via Profibus cannot be used.
- The recommended connection is to use only an open and close buttons or contacts and 'push to run' mode where the actuator only moves whilst the contact is closed.
- If a Profibus and hard wired input are both present the control priority is set by the actuator priority setting

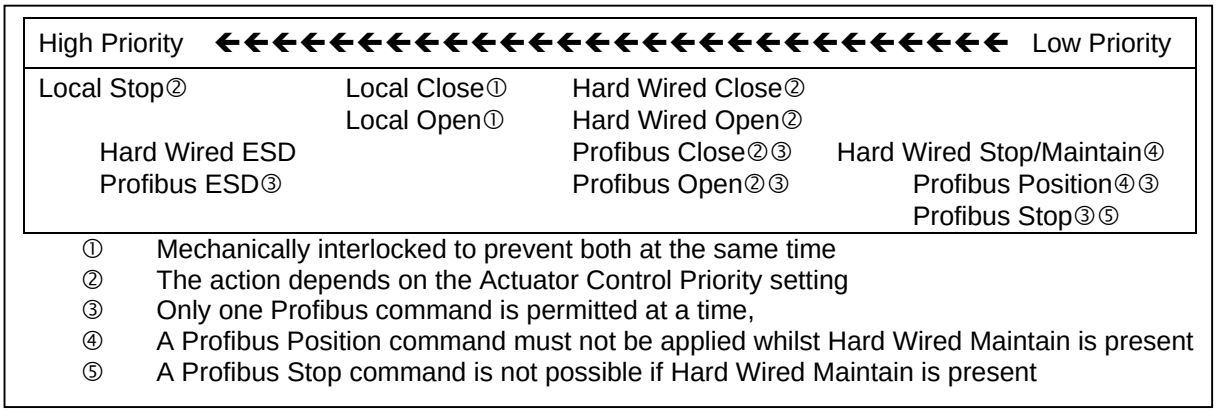


Fig 21: Q Controls Priorities

5.1.2 Profibus Control using the ACTCON Register

A single register is provided to allow the digital control of the actuator. Writing to the individual bits in the register causes the actuator to open, close, stop, ESD, adopt Positioning mode or perform a Partial Stroke and at the same time cancels any other command set. The bit written changes any output states already set to the new value. Only one bit may be written in a command. If more than one bit is set then the whole register is ignored.

ACTCON Register						
Bit 6 - 15	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Reserved	Part Stroke	Position Enable	ESD	Open	Close	Stop

5.1.3 Profibus Control using the POS_DV register

The analogue position control function requires two registers to be set.

- ❑ A desired position value to move the valve to should be placed in the POS_DV register
- ❑ The ACTCON register must be set to Position mode (0010 hex)

POS_DV Register
Register value: 0 to 1000 (0 to 3E8)
Position demand: 0.0% to 100.0% of valve travel

When the ACTCON register with Position mode set is sent the actuator will position to the value set in the POS_DV register and any other commands that are currently being carried out will be cancelled.

If the POS_DV register is set to 0% and limited range positioning is not being used the actuator will operate as though a ‘close’ command had been sent. Similarly if the POS_DV register is set to 100% under these conditions the actuator will interpret the instruction as an ‘open’ command.

Note that when limited range positioning is used and the actuator is in the fully closed position a POS_DV value of 0%, or when the actuator is in the fully open position a PS_DV value of 100%, are not acted upon.

5.1.4 The IQ ‘S’ contacts (Profibus DO’s) controlled by the O_STAT register

The IQ/IQT actuator has four ‘S’ contact outputs that may be configured to report the status of the actuator with signals such as Open Limit, Closed Limit etc. These are identified as S1 to S4.

In addition an optional additional relay board can be fitted with four more relays. The status of these relays is then adjusted by Profibus commands on outputs DO-1 to DO-4 in the O_STAT register. Writing a ‘1’ in the appropriate location energises the relay and ‘0’ de-energises the relay. Note that these relays are latching and, if energised, will not change state when the actuator power is removed. On restoration of power the relays will be reset to their de-energised condition.

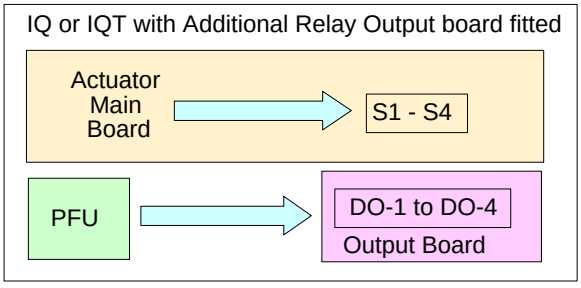


Fig 22: IQ and IQT relay outputs DO-1 to DO-4

O_STAT Register				
Bit 4 - 15	Bit 3	Bit 2	Bit 1	Bit 0
Reserved	DO-4	DO-3	DO-2	DO-1

5.1.5 Multiport Position Selection using the PORTCM register (Future)

The multiport actuator position selection requires the Configuration (see section 5.4) to be set to Configuration 10 and a value to be set into the PORTCM register corresponding to the desired port number to go to. In addition during parameterisation the number of ports and number of active ports must be set.

- ❑ A desired port value to move the valve to should be placed in the PORTCM register
- ❑ The CONFIG must be set to 10 for a multiport actuator.

PORTCM Register
Register value: 1 to 10 (1 to A hex)
Position demand: Port 1 to Port 10

The actuator will move directly to the port selected in the register each time the value is changed. If the actuator is set to Local and moved by the local controls, when returned to remote the positioning the PORTCM register will be adopted.

The valve can have up to 10 ports and the number of active ports can be selected. There are two parameters available to make these settings.

5.1.6 Profibus Network Control Disable feature

It is possible to set the IQ or IQT ESD/DI-4 input so that the IQ/IQT actuator ignores open, stop, close, ESD and position control signals sent over the Profibus network. If the ESD DI-4 / Net Disable parameter is set to Active then when the ESD input is connection is made (i.e. 24 volts applied to ESD), Profibus control is not allowed. This feature is independent of the Auxiliary mask setting. When the ESD DI-4 / Net Disable parameter is set to active, no ESD will be available.

This feature is not included in a standard Q range actuator.

5.2 Digital Input Status Feedback

The Profibus DP Module (Mk2) cyclically reports over the network a comprehensive data set relating to the status of the valve, actuator and card settings as indicated in the table below. The conventional contact indications are also available from the actuator limit switches and indication contacts.

Register Name		Status Feedback	IQ actuator	IQT actuator	Q actuator
IDATA1/0	Register 0 Bit 0	Actuator Moving	✓	✓	✓
IDATA1/1	Register 0 Bit 1	Close Limit	✓	✓	✓
IDATA1/2	Register 0 Bit 2	Open Limit	✓	✓	✓
IDATA1/3	Register 0 Bit 3	Running Closed	✓	✓	✓
IDATA1/4	Register 0 Bit 4	Running Open	✓	✓	✓
IDATA1/5	Register 0 Bit 5	Remote selected	✓	✓	✓
IDATA1/6	Register 0 Bit 6	Local Stop selected	✓	✓	✓
IDATA1/7	Register 0 Bit 7	Local selected	✓	✓	✓
IDATA2/0	Register 0 Bit 8	Thermostat Tripped	✓	✓	✓
IDATA2/1	Register 0 Bit 9	Monitor Relay	✓	✓	✓
IDATA2/2	Register 0 Bit 10	Valve Obstructed	✓	✓	✓
IDATA2/3	Register 0 Bit 11	Valve Jammed	✓	✓	✓
IDATA2/4	Register 0 Bit 12	Valve Moving by Hand	✓	✓	✓
IDATA2/5	Register 0 Bit 13	Moving Inhibited	✓	✓	✓
IDATA2/6	Register 0 Bit 14	Position Control Enabled	✓	✓	✓
IDATA2/7	Register 0 Bit 15	Watchdog Recovery	✓	✓	✓
IDATA3/0	Register 1 Bit 0	Battery Low	✓	✓	×
IDATA3/1	Register 1 Bit 1	Open Interlock input	✓	✓	×
IDATA3/2	Register 1 Bit 2	Close Interlock input	✓	✓	×
IDATA3/3	Register 1 Bit 3	DI –1	✓	✓	×
IDATA3/4	Register 1 Bit 4	DI –2	✓	✓	×
IDATA3/5	Register 1 Bit 5	DI –3	✓	✓	×
IDATA3/6	Register 1 Bit 6	DI –4	✓	✓	×
IDATA3/7	Register 1 Bit 7	Slow Mode	①	✓	①
IDATA4/0	Register 1 Bit 8	GSD Configuration Permitted	✓	✓	✓
IDATA4/1	Register 1 Bit 9	Reserved	✓	✓	✓
IDATA4/2	Register 1 Bit 10	Control Contention	✓	✓	✓
IDATA4/3	Register 1 Bit 11	Partial Stroke in Progress	✓	✓	✓
IDATA4/4	Register 1 Bit 12	Part Stroke Error	✓	✓	✓
IDATA4/5	Register 1 Bit 13	Primary (0) or Backup (1)	✓	✓	✓
IDATA4/6	Register 1 Bit 14	1 or 2 Channels Available	✓	✓	✓
IDATA4/7	Register 1 Bit 15	SR (0) or FR (1) mode	✓	✓	✓

Note: ① – This bit is reported when within the slow mode band, but does not affect the actuator.

5.2.1 Digital Inputs from All Actuator Types

- **Actuator Moving** Whenever the actuator position is changing due to the motor running or in the case of the IQ or IQT if the output drive is moving, this bit will be set true (1).

- **Close Limit** This data bit indicates that the actuator has reached the closed position. The limit switch should be set slightly within the actual valve stroke to allow for torque seating or overshoot on closing without damaging the valve. The data bit will remain true (1) even if the position is passed through or exceeded.

- **Open Limit** This data bit indicates that the actuator has reached the open position. The limit switch should be set slightly within the actual valve stroke to allow for torque seating or overshoot on opening without damaging the valve. The data bit will remain true (1) even if the position is passed through or exceeded.

- **Running Closed** Whenever the actuator motor contactor used to drive the actuator in the closing direction is energised this bit will be true (1).

- **Running Open** Whenever the actuator motor contactor used to drive the actuator in the opening direction is energised this bit will be true (1).

- **Remote Selected** This bit is true (1) when the actuator three position remote/local stop/local selector is in the Remote position. The selector must be in this position for Profibus control to be permitted.

- **Local Stop** The actuator three position selector passes from Local to Remote or Remote to Local through the Local Stop position. The switch can also be placed in Local Stop. When the switch is in the Local Stop position this bit will be true (1). Remote control of the actuator is not possible when the selector is in this position.

- **Local Selected** This bit is true (1) when the actuator three position remote/local stop/local selector is in the Local position. Remote control of the actuator is not possible when the selector is in this position.

- **Thermostat** If the temperature of the motor windings rises above the thermostat trip value, the thermostat contact will open and this signal will be present (1). There are no adjustments for the temperature at which the thermostat trip operates. The motor will be stopped if the thermostat trips. Only once the motor has cooled down and the thermostat has reset itself can a new Remote, Host or Local command to move the actuator be carried out. A setting on the actuator main board allows the ESD command to override the thermostat. The bit will remain set at logic 1 until the motor cools down and the thermostat resets itself.

- **Monitor Relay** This signal is true (1) when actuator remote control is not available. The actuator Monitor Relay status is a composite signal for several alarms. This signal will be set true if the actuator selector is in Local or Local Stop (not in Remote) or if the thermostat trips. The mains supply is also monitored and if one of the three phases is lost this bit is set. If the actuator is operated from a single phase supply and this is lost then communications with the actuator will also be lost. Where a 3 phase supply is used, if the phase associated with the control circuits is lost then communications with the actuator will be lost.

- **Valve Obstructed** This bit will be true (1) if the actuator stops in mid travel when not expected to do so after receiving a command to move. If the actuator torque exceeds the trip value set during commissioning then the motor will stop and motion will cease. The reason for the actuator stopping will be the high torque due to an obstruction and not a 'Stop' signal or reaching the desired setpoint position.
  The bit will remain true (1) until the actuator position changes by 2% or more.

***Note**:*	*Attempting to restart the actuator to move towards the obstruction (even if the obstruction no longer exists) is not possible, the actuator will not restart. The actuator must be electrically reversed away from the obstruction before attempting to continue in the original direction.*

- **Valve Jammed** This bit will be true (1) if the actuator is stationary at the end of travel and fails to move away from the seat of the valve when a network command requests it to do so. The actuator will trip on excessive torque due to the valve being jammed in the seat. The PFU fails to see movement and reports this status after the time set in the associated parameter during the PFU set up.
  The bit will remain true (1) until the actuator position changes by 2% or more.

***Note**:*	*Attempting to restart the actuator to move out of the seated position is not possible. The actuator must be reversed before it will run in the same direction again. The jammed seat must first be released manually before electrical control is attempted. The problem may be overcome by adjusting the actuator torque setting which is designed to provide extra power on leaving the seated position.*

- **Valve Moving by Hand** The manual movement of the valve is reported as true (1) if the actuator is moved by the handwheel away from the last position. The percentage of travel required to trip the indication is set in the associated parameter during PFU set up.
  The bit will remain true (1) until the actuator is moved electrically by either the local controls or a network command.

- **Moving Inhibited** This bit will be true (1) when the Motion Inhibit Timer is active or the Interrupter Timer is active (IQ/IQT only), or both are active.

The Motion Inhibit Timer is used in position control to prevent the actuator from exceeding its prescribed number of starts per hour, or to reduce the effects of hunting during closed loop control.
The Interrupter Timer in the IQ/IQT can be used over part or the entire actuator stroke to slow down the effective speed of valve travel.
When under network control, the control signal does not need to be re-applied when this bit is true, as the control action will continue once the time has elapsed.

- **Position Control Enabled** This bit will be true (1) when a Position command is being actioned. This data can be used to indicate that positioning mode has control of the actuator.

- **Watchdog Recovery** The PFU watchdog automatically resets the processor if it is tripped. This bit will be true (1) following a watchdog trip for the time period set in the associated watchdog timeout parameter.

5.2.2 Digital Inputs from IQ and IQT Actuator

- **Battery Low** Applicable to IQ and IQT actuators only. The status of the internal battery is monitored and should it fall below a critical level this signal will become true (1). The battery is used to power the circuits used to keep track of the valve position when the actuator mains power is switched off. This battery is used only when the actuator has no power feed and the valve is actually moved.

- **Open Interlock** Applicable to IQ and IQT actuators only. The input contact to the Open Interlock is monitored by the PFU. Whenever the input contact is closed this bit will be true (1). If the actuator is not using the interlock function then this input can be used as a digital status feedback for a plant signal not associated with the actuator. If the interlock circuit is being used then permission must be granted before the actuator can be opened and the presence of this bit will indicate that opening is permitted and permission is granted.

- **Close Interlock** Applicable to IQ and IQT actuators only. The input contact to the Close Interlock is monitored by the PFU. Whenever the input contact is closed this bit will be true (1). If the actuator is not using the interlock function then this input can be used as a digital status feedback for a plant signal not associated with the actuator. If the interlock circuit is being used then permission must be granted before the actuator can be closed and the presence of this bit will indicate that closing is permitted and permission is granted.

- **Digital Input DI-1** Applicable to IQ and IQT actuators only. This bit reports the status of the contact connected to the actuator hard wired **Open** terminals. The input can be used to control the actuator or simply to report the status of a plant feedback signal. The function is set in the Auxiliary Input Mask parameter which determines whether the bit is reported as true (1) for a closed contact or an open contact and whether the input

controls the actuator or not. Note that the input is always reported even when it is also controlling the actuator.

- **Digital Input DI-2** Applicable to IQ and IQT actuators only. This bit reports the status of the contact connected to the actuator hard wired **Close** terminals. The input can be used to control the actuator or simply to report the status of a plant feedback signal. The function is set in the Auxiliary Input Mask parameter which determines whether the bit is reported as true (1) for a closed contact or an open contact and whether the input controls the actuator or not. Note that the input is always reported even when it is also controlling the actuator.

- **Digital Input DI-3** Applicable to IQ and IQT actuators only. This bit reports the status of the contact connected to the actuator hard wired **Stop/Maintain** terminals. The input can be used to control the actuator or simply to report the status of a plant feedback signal. The function is set in the Auxiliary Input Mask parameter which determines whether the bit is reported as true (1) for a closed contact or an open contact and whether the input controls the actuator or not. Note that the input is always reported even when it is also controlling the actuator.

- **Digital Input DI-4** Applicable to IQ and IQT actuators only. This bit reports the status of the contact connected to the actuator hard wired **ESD** terminals. The input can be used to control the actuator or simply to report the status of a plant feedback signal. The function is set in the Auxiliary Input Mask parameter which determines whether the bit is reported as true (1) for a closed contact or an open contact and whether the input controls the actuator or not. Note that the input is always reported even when it is also controlling the actuator.
  A configuration feature also allows DI-4 to be set to act as a 'Disable Fieldbus Control' input. In this mode when the input is made (irrespective of the Auxiliary Mask setting) the actuator cannot be controlled over the network. This can be useful during plant commissioning to prevent unwanted valve movement.

5.2.3 Digital Inputs from IQT Actuator

- **Slow Mode** Applicable to IQT actuators only. In positioning mode, when the IQT actuator approaches its setpoint the motor automatically switches to 'slow mode' and the actuator runs at a lower speed. This allows any developed inertia to be dissipated and a better positional accuracy to be achieved without overshoot. The deviation from the setpoint at which slow mode is adopted is set in the associated parameter. When slow mode is in use this bit will be true (1).
  The IQ and Q actuators also report this bit, but these actuators do not have a slow mode capability.

5.2.4 Digital Inputs Reporting the Profibus Card Condition

- **GSD Parameterisation Permitted** If the actuator and card is being parameterised using either the FDT or PDM programmes and the associated device description files, then the ability to alter the card parameters by the GSD may need to be removed. The status of this bit shows if, during parameterisation after connection or power up the, the settings in the GSD file will be used or the existing settings will be retained. When the bit is true (1), GSD parameterisation is permitted.

Note:	*On start up of the card following connection to the bus the PLC will conduct a sequence of events including setting the Configuration of the card and then adjusting the card Parameters. The configuration will be the one selected for this particular card when it was commissioned onto the Profibus highway (see later). The parameterisation will be in accordance with the values in the GSD file associated with the specific actuator. It is possible to set the card so that GSD parameterisation is ignored, this then allows the actuator to be powered off and on again without resetting any parameter values.*

- **Control Contention** If an incorrect value is transmitted in the ACTCON register then there will be no control action and this bit will be true (1) until a valid ACTCON value is received. Only one bit may be set in the ACTCON register at a time.

- **Partial Stroke in Progress** When the actuator is performing a partial stroke this bit is true (1). Once the action is complete the bit is reset (0). If the partial stroke is interrupted by a new command then the bit will be reset.

- **Part Stroke Error** In order to perform a partial stroke of the valve, the starting position is specified as either the open limit or the close limit. If the actuator is commanded to perform a partial stroke when it is not in the correct starting position or when it is in a mid position this error is generated and the bit will be set (1).
  There is a timer associated with Partial Stroke that is set during parameterisation to a value long enough to cover a successful part stroke operation from end to mid position and back to the end. If the actuator fails to complete the partial stroke within the time set then this bit will be true (1).
  Once set, the Part Stroke Error bit will be reset to 0 when the actuator next moves at least 2% by either a manual or automatic operation.

- **Backup or Primary Channel** This bit is used to indicate if the Profibus communication is to a channel on the card that is able to move the valve (Primary) or to a channel that is prevented from operating the valve (Backup). When the communication is to the Primary Profibus DP channel the bit will be off (0).

Note: *With a single channel card this bit will always indicate 'Primary' and be (0).*

With a dual card set to FR mode the card there is only one highway and the card uses two addresses, one per channel. If the communication is directed to the address for the backup channel this bit will be set to 1, and if it is to the address for the primary channel it will be set to 0.

With a dual card set to SR mode only one address is used, but there are two highways. If the communication is direct on the highway connected to the backup channel of the card then the bit will be set to 1, if the highway is connected to the primary channel the bit will be set to 0.

Valve control can only be achieved if this bit reports as a 0.

- **1 or 2 Channels Available** This bit indicates the condition of the second channel on a dual channel card. It will be true (1) if both channels are available and working on the card. It does not indicate the status of the connection or highway to the second channel.
  On a single channel card it will always report 0.
  If there is a fault on the second channel of a dual channel card it will report 0, indicating that the second channel is not working correctly.

- **SR or FR Mode** This bit indicates the addressing mode chosen for the card. When reporting as 0 the bit indicates that one address is being used. On a single channel card only one address is permitted.
  On a dual channel card a single address is used when two Profibus DP highways are used and the System Redundancy is employed.
  If the bit reports as 1 then the card must be dual channel and the redundancy is using two addresses for Flying Redundancy configuration.

5.3 Actuator Analogue Input Feedback

The Profibus DP Module (Mk2) makes available over the network a number of analogue variables. These contain information about the valve and actuator. If the single highway with analogue input variant of the Profibus DP Module (Mk2) is used, one associated plant measurement is also available.

Name	Register	Range	Analogue Feedback	IQ actuator	IQT actuator	Q actuator
TORQUE	2	0-120 (0-78 hex) = 0-120%	Actuator Instantaneous Torque	✓	✓	✗
POSITN	3	0-1000 (0-3E8 hex) = 0-100%	Valve Position	✓	✓	✓
TEMPER	4	32768 – 65535 (8000 – FFFF hex) = -32767 to -1 ^{O}C 0 (0 hex) = 0 ^{O}C 1 – 32767 (0001 – 7FFF hex) = 1 to 32767 ^{O}C	Temperature ^{O}C	✓	✓	✗
ANALOG	5	0-1000 (0-3E8 hex) = 0-100%	Analogue Input ①	✓	✓	✓
PORTST	6	1-10 (1-A hex) = Position 1 to 10	Multiport position	✗	✗	✗

Note: ① – Requires the Single Highway + Analogue Input Profibus DP Module (Mk2)

- **Torque** — The currently developed torque value is reported as an Integer Value in the range 0 to 120 (0-78 hex) representing the percentage of actuator rated torque generated.

- **Valve Position** — The current valve position is reported as an Integer Value in the range 0 to 1000 (0 – 3E8 hex) representing the percentage position to 0.1% resolution.
  The IQ and IQT actuator automatically scales the valve position value reported from the setting of the limit switches.
  The Q actuator requires the valve to be stroked fully between the closed and open limit switches for the value to be automatically scaled. This scaling is retained in EEPROM when the actuator power is removed.
  If Limited Range Positioning is invoked by setting the appropriate parameters, then the reported valve position 0 to 100% follows the limited range of valve travel.

- **Temperature** — The actuator internal temperature is reported as a 2's compliment integer value in the range –32767 to +32767 ^{O}C.
  [A value of 0 is 0 ^{O}C, 32767 (7FFF hex) is 32767 ^{O}C, 65535 (FFFF hex) is –1 ^{O}C and 32768 (8000 hex) is –32767^{O}C.]

- **Analogue Input** The current value of the analogue input is reported as an Integer Value in the range 0 to 1000 (0 – 3E8 hex) representing the percentage value to 0.1% resolution.
  The input may be 0 to 5V or 0 to 20mA d.c. from an externally powered field transmitter (the actuator does not provide the power for the transmitter).
  The input must be calibrated during the set up of the PFU using the Analogue Input Max parameter. Apply a 100% signal and write a value to the parameter, the current value will then be reported as 100%. The scaling is retained in EEPROM when the actuator power is removed.

- **Multiport Position** On multiport actuators the current number of the port selected is reported as an integer in the range 1 to 10 (1-A hex).

5.4 Configuring the Registers to be Exchanged in Cyclic Communication

In the start up routine for Profibus communication the card firstly enters parameterisation mode and adjusts the card parameters according to the GSD file settings. Next the card enters configuration mode where the configuration settings in the GSD file are used to determine the registers to be exchanged with the PLC during the normal cyclic messaging.

The configuration stage allows for the tailoring of the registers to be exchanged to allow the system to be tuned to improve data throughput. If certain information or controls are not required by the PLC then they may be left out of data exchange by choosing the appropriate configuration.

Both the PLC and the card must be aware of the configuration chosen for successful data exchange.

The Profibus DP Module (Mk2) has 10 possible configurations as indicated in the table. The default value is Configuration 1. The PLC must send a Check Configuration message during start up to confirm the Configuration to be used.

Configuration		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
OUPUTS (16 Bits each)	ACTCON	✓	✓	✓	✓	✓	✓	✓	✓	✓	×
	POS_DV	✓	×	✓	×	✓	×	×	✓	×	×
	O_STAT	✓	×	×	×	×	✓	✓	✓	✓	×
	PORTCM	×	×	×	×	×	×	×	×	×	✓
INPUTS (16 Bits each)	IDATA1 & IDATA2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	IDATA3 & IDATA4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	TORQUE	✓	×	✓	×	✓	✓	×	✓	×	✓
	POSITN	✓	×	✓	×	✓	✓	×	✓	×	✓
	TEMPER	✓	×	×	✓	✓	×	✓	×	×	✓
	ANALOG	✓	×	×	✓	✓	×	✓	×	×	✓
	PORTST	×	×	×	×	×	×	×	×	×	✓

6 PROFIBUS DP COMMUNICATION

6.1 Electrical Specification

Line Electrical Specification: RS485, two wire, half duplex

6.2 Protocol

Profibus DP Cyclic (V0) and Acyclic (V1) communication
Supported Baud Rates 9k6, 19k2, 45k45, 93k75, 187k5, 500k, 1M5

Data Speed (Baud)	9k6	19k2	45k45	93k75	187k5	500k	1M5
Maximum Slave Response Delay Time (mS)	15	15	15	15	15	15	50

6.3 Single Highway, Single Channel

When using a single channel version the following must be set up:

- **Address** With IQ and IQT actuators the address can be set using the IrDA communication link directly with the actuator and the IQ setting tool. For all actuator variants the address can be set over the highway using a Class 2 master.
- **Baud Rate** This is selected by the PLC
- **Slave Configuration** One of the 10 configurations for the slave must be chosen.
- **Basic Parameterisation** The basic parameters such as deadband and motion inhibit time can be set using either the GSD file or a suitable PDM or FDT utility. The default settings will be suitable for most systems.

Communication will be established automatically between the PLC and the card once the correct GSD has been identified. If the actuator cover is opened there are several LED's on the circuit board that are used to indicate communication activity. These indicate both the communication between the Profibus highway and the card and the communication within the cards two main processors.

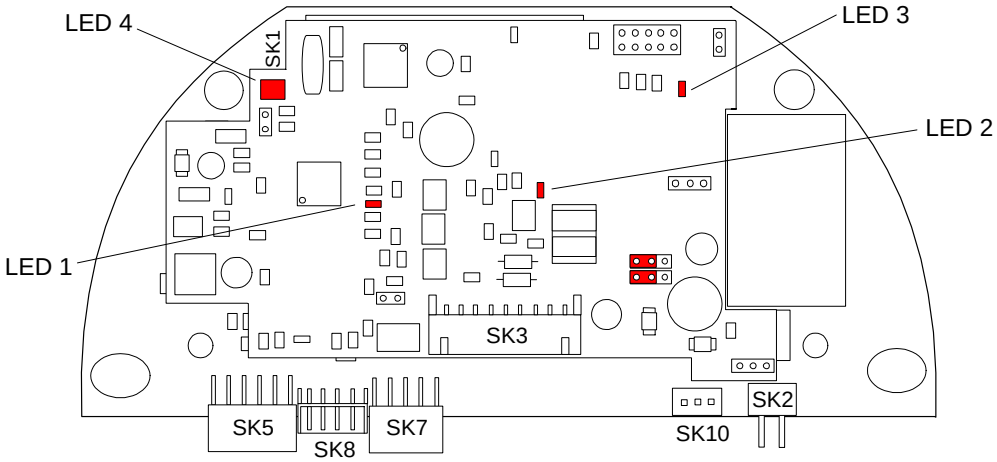


Fig 23: Single Channel Profibus card LED positions

LED	Description	State	Function
1	Channel 1 Data Exchange	On (Red) Off	In data exchange mode with PLC Not in data exchange mode
2	Channel 1 RTS line	On (Red) Off	Ready to reply to PLC Not ready to respond
3	Inter-processor comms	Flash (Red) Off	Inter-processor comms running No inter-processor comms
4	Diagnostic	Flash (Green) Solid (Green) Solid (Red) Flash (Green)	PLC comms not present Data being exchanged with PLC Fatal Error After solid green shows comms lost

6.4 Dual Highway, Dual Channel – SR Mode

When using the Simple or RedCom Dual Channel card the mode for communication has to be selected between SR (System Redundancy) and FR (Flying Redundancy). This is chosen during parameterisation by the GSD file values or by using a parameterisation utility such as FDT or PDM.

- **Redundancy** The default setting for redundancy is SR mode

In SR mode there are two highways and a redundantly configured PLC. The two channels on the card both use the same address. One channel is in Primary mode whilst the other is in Backup mode. The card is waiting for a communication message on the channel that is in Primary mode and the two channels will switch their mode whilst searching for comms. There is no definition between Channel 1 and Channel 2 to determine which is in Primary mode. The two channels will both try to adopt Primary mode.

When using either the Simple or the RedCom dual channel card in SR mode the following must be set up:

- **Address** The two channels share the same common address. With IQ and IQT actuators the address can be set using the IrDA communication link

directly with the actuator and the IQ setting tool. For all actuator variants the address can be set over the highway using a Class 2 master.

- **Baud Rate** This is selected by the PLC, both channels adopt the same baud rate

- **Slave Configuration** One of the 10 configurations for the slave must be chosen. Both channels will use the same configuration setting.
  Configuration can only be carried out on the Primary channel.

- **Basic Parameterisation** The basic parameters such as deadband and motion inhibit time can be set using either the GSD file or a suitable PDM or FDT utility. The default settings will be suitable for most systems. Both channels will adopt the same settings.
  Parameterisation can only be carried out on the Primary channel.
  IDATA4 Bit 5 indicates the channel status and will show if the channel in communication is the Primary or Backup.

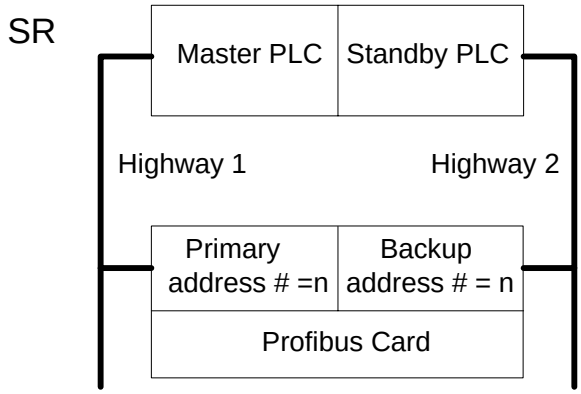


Fig 24: System Redundancy – Two highway redundancy

Note: ***SR Mode -***

- *Both channels have the same slave address.*
- *When the card is powered 'on' Channel 1 will be the Primary channel. After power up the card will seek a master to communicate with by alternating the channel 1 and 2 between Primary and Secondary mode. The switch over time increases with each change to a maximum of 32 seconds. The card will continue to switch channels using a 32 second switch over time until one channel receives PLC messages.*
- *It may be necessary for the PLC to wait until the correct channel is in Primary mode before communications is started.*
- *If the Primary channel fails the Backup will automatically adopt Primary status and wait for messages from the second master.*
- *The Backup channel can be used for exchanging data but any commands to move the actuator directed to the backup channel will be ignored.*
- *If a configuration message is sent to the Backup channel that is different to the one sent to the Primary it will be accepted, but not carried out.*

6.5 Single Highway Dual Channel – FR Mode

On either the Simple or RedCom dual channel card the mode for communications may be set to FR (Flying Redundancy) in some cases. This will require the card's GSD file to be changed or the parameter value altered by a PDM or FDT utility.

- **Redundancy** SR is the default mode, it must be altered for FR mode

In FR mode there is one highway and a single PLC can be used. The two channels on the card use addresses offset by 64. One channel is in Primary mode and uses the base address whilst the other is in Backup mode using the base address plus 64. As with SR mode, the card is waiting for a communication message on the channel that is in Primary mode and the two channels will switch their mode whilst searching for comms. There is no definition between Channel 1 and Channel 2 to determine which is in Primary mode. The two channels will both try to adopt Primary mode. The difference here is that the PLC can communicate with the backup using a different address.

When using either type of dual channel card in FR mode the following must be set up:

- **Address** The two channels have address offset by 64. Setting the base address will set the offset address. With IQ and IQT actuators the address can be set using the IrDA communication link directly with the actuator and the IQ setting tool. For all actuator variants the address can be set over the highway using a Class 2 master.

- **Baud Rate** This is selected by the PLC, both channels adopt the same baud rate

- **Slave Configuration** One of the 10 configurations for the slave must be chosen. Both channels will use the same configuration setting.
  Configuration can only be carried out on the Primary channel.

- **Basic Parameterisation** The basic parameters such as deadband and motion inhibit time can be set using either the GSD file or a suitable PDM or FDT utility. The default settings will be suitable for most systems. Both channels will adopt the same settings.
  Parameterisation can only be carried out on the Primary channel.
  IDATA4 Bit 5 indicates the channel status and will show if the channel in communication is the Primary or Backup.

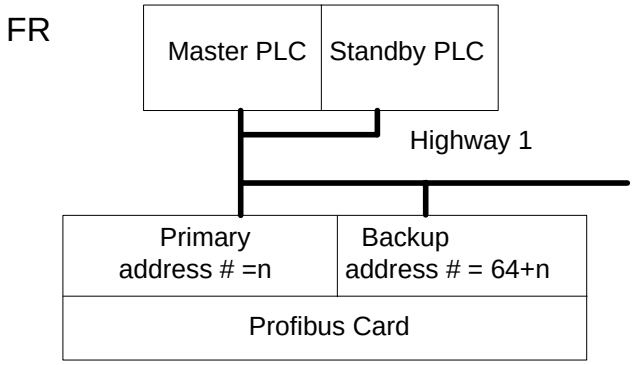


Fig 25: Flying Redundancy – One highway redundancy

Note: ***FR Mode -***

- *Primary is offset from Backup address by 64.*
- *When the card is powered 'on' Channel 1 will be the Primary channel. After power up the card will seek a master to communicate with by alternating the channel 1 and 2 between Primary and Secondary mode. The switch over time increases with each change to a maximum of 32 seconds. The card will continue to switch channels using a 32 second switch over time until one channel receives PLC messages. The channel addresses alternate at this point.*
- *The PLC need not wait for a particular channel to be in Primary mode before starting communications.*
- *If the Primary channel fails the Backup will automatically adopt Primary address and wait for messages from the master.*
- *The Backup channel address can be used for exchanging data but any commands to move the actuator directed to the backup address will be ignored.*
- *If a configuration message is sent to the Backup address that is different to the one sent to the Primary it will be accepted, but not carried out.*

6.6 Dual Channel Indication LEDs

If the actuator cover is opened there are several LED's on the circuit board that are used to indicate communication activity. These indicate both the communication between the Profibus highway and the card and the communication within the cards two main processors.

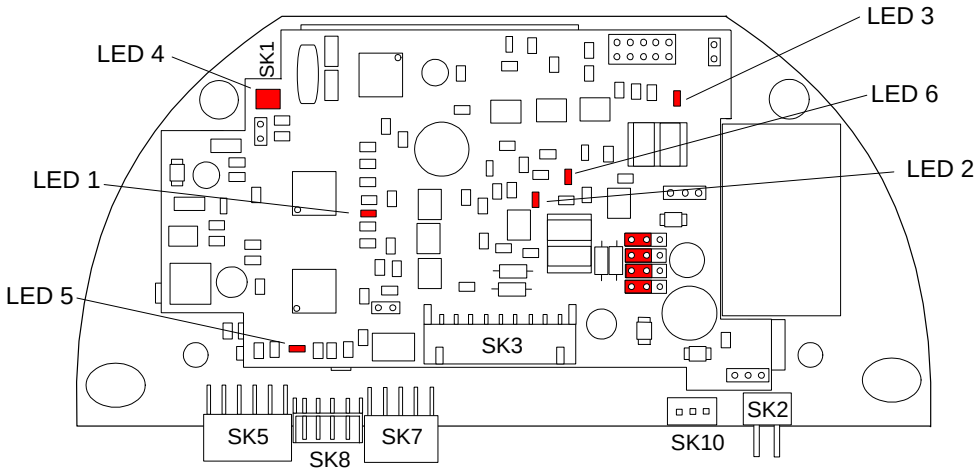


Fig 26: Dual Channel Profibus card LED positions

LED	Description	State	Function
1	Channel 1 Data Exchange	On (Red) Off	In data exchange mode with PLC Not in data exchange mode
2	Channel 1 RTS line	On (Red) Off	Ready to reply to PLC Not ready to respond
3	Inter-processor comms	Flash (Red) Off	Inter-processor comms running No inter-processor comms

LED	Description	State	Function
4	Diagnostic	Flash (Green) Solid (Green) Solid (Red) Flash (Red)	PLC comms not present Data being exchanged with PLC Fatal Error After solid green shows comms lost
5	Channel 2 Data Exchange	On (Red) Off	In data exchange mode with PLC Not in data exchange mode
6	Channel 2 RTS line	On (Red) Off	Ready to reply to PLC Not ready to respond

6.7 Basic Operation on Start up

Whenever a field device is powered up and it is found by the PLC it will go through the standard Profibus procedure of Parameterisation and Configuration before commencing Data Exchange. This exchange can include altering the address if the device has an address of 126 and the master supports address changes – master class 2.

1) The first message – master sends a **DIAG_req** telegram.
2) The response should be a **DIAG_res** with diagnostic data attached.
3) If this is correct a **Set_Parameter** telegram is sent with the parameterisation data attached.
4) The response should be a **Short Ack** message
5) If a correct response is received a **Check_Config** telegram is sent
6) The response should be a **Short Ack** message
7) If this is correct a **DIAG_req** telegram is sent
8) The response should be a **DIAG_res** with diagnostic data attached.
9) If DIAG is not reporting an error data exchange commences.

The Parameterisation data is extracted from the GSD file for the particular address of the slave device. The association between the GSD to be used and the address is made in the master during the configuration of the network on the master (a table is created). The association can also be defined in a Master 2 and sent to a Master 1 by the master to master comms. Most masters 1 devices permit the same device type (as described in the GSD) to have different GSD files, so allowing the GSD to be edited.

Editing the GSD file guarantees that a device coming on line after having been switched off will have the correct settings. If FDT or PDM changes the same parameters as those installed by a GSD then the GSD values will replace those set by the FDT or PDM when the device is switched off and on again, or the PLC is powered off and back on, unless GSD parameterisation is not permitted.

(See section 5.4 for information on the Configurations allowed).

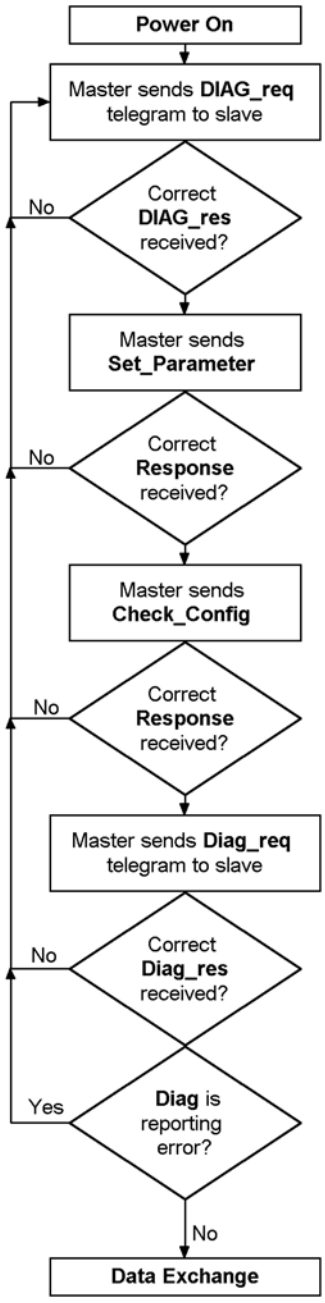


Fig 27: Profibus Start Up Sequence

7 PARAMETERS

7.1 Parameters set by GSD and DP-V1 Communication

Profibus defines a power on reset sequence for all devices as:

Diagnostic Request
Set Parameterisation
Check Configuration / Set Configuration
Diagnostic Request
Data Exchange

After a successful Diagnostic Request the Set Parameterisation Telegram is sent from the PLC. The Set Parameter message contains the user defined Parameter Data Unit (DU) of a minimum of 7 bytes, max 244 bytes. The first 7 bytes are mandatory and fixed. The following bytes contain the parameter values to be set and these are derived from the GSD file and the values in it. The response is a short acknowledgement (E5) with no data field if the Parameterisation is accepted.

The Profibus DP Module (Mk2) GSD contains 19 configurable parameter registers sent in a 23 byte string. The first 3 bytes are Profibus Specific, the next 19 relate to the configurable parameters and the 23rd is reserved for future use. With the IQ and IQT actuator some of the parameters can be altered by using the infra-red communications link and the setting tool. All of them can be altered by the values in the GSD file or by a V1 communication tool such as PDM or FDT when the appropriate files are provided. It is possible to lock out parameterisation by GSD in the more sophisticated uses of this card. This facility is there to ensure that V1, FDT or PDM parameterisation is not lost on a power cycle.

Care must be exercised with access to these parameter registers as they can alter the complete performance of the actuator. This section of the manual describes each variable parameter and should be used for reference when using the parameterisation tools.

The parameters that may be set by the GSD exchange or V1 comms are:

Parameter No.	Description	Value/Range	Default Value
1	Limited Range Position Minimum	0-100% 0000 – 0064 hex	0% 0000 hex
2	Limited Range Position Maximum	0-100% 0000 – 0064 hex	100% 0064 hex
3	Deadband ①	0.0 – 25.5% ② 0000 – 00FF hex	5.0% 0032 hex
4	Hysteresis ①	0.0 – 25.5% 0000 – 00FF hex	2.0% 0014 hex
5	Slow Mode Range	0 – 100% 0000 – 0064 hex	5% 0005 hex
6	Motion Inhibit Time	0 – 255 sec 0000 –00FF hex	5 sec 0005 hex
7	Manual Movement Travel	0 – 100% 0000 – 0064 hex	10% 000A hex
8	Valve Jammed Time	0 – 255 sec 0000 – 00FF hex	5 sec 0005 hex

Parameter No.	Description	Value/Range	Default Value
9	Watchdog Timeout	0 – 255 sec 0000 – 00FF hex	10 sec 000A hex
10	Action on Loss of Comms	0 = Nothing (No Action) 1 = Open 3 = Close 5 = Stop 7 = Position Any other value = Off	0 = Nothing (0000 hex)
11	Comms Lost Position	0 – 100% 0000 – 0064 hex	0% 0000 hex
12	Comms Fault Timer	0 – 255 sec 0000 – 00FF hex	255 sec 00FF hex
13	Aux Input Mask	0 – 255 0000 – 00FF hex	15 000F hex
14	ESD DI4/Net Disable and Data logger disable	DI-4 is ESD = 0 or 2 DI-4 is Net Disable = 1 or 3 Data Logger is enabled = 0 or 1 Data Logger is disabled = 2 or 4 (Bit 0 = EDS/Net disable Bit 1 = data logger en/disable)	ESD and Data Logger enabled 0 0000 hex
15	Redundancy FR/SR mode and Simple/RedCom mode	Bit 0 : SR mode = 0, FR mode = 1 Bit 1 : Simple = 0, RedCom = 1	0 ③ 0000 hex
16	Part Stroke position	1 – 99% 0001 – 0063 hex	90 005A hex
17	Part Stroke Limit and timeout	Bit 15 is 0 for close limit and 1 for open limit. Bits 0-14 are time values in seconds for timeout	Open and 300 secs 812C hex
18	Actuator Type	0 – Don't know (default) 2 – A, AQ, Q, 6 – IQ 8 – IQT 9 – EH 10 – Skilmatic 11 – Multiport	0
19	Reserved	0	0

Note: ① *- Setting the deadband lower than the hysteresis, or the hysteresis greater than the deadband causes the hysteresis to be set to 0.1%*
② *- IQ Setting tool only allows 0.0 to 9.9% deadband to be set*
③ *- On Redcom Dual Channel cards the default is 2 (0002 hex)*

These parameters set up the response the actuator will take to various control and network actions. There are three GSD files, one for a single channel card, one for a simple dual channel and one for a RedCom dual channel card. They all contain the same number of parameter settings.

- ❑ **Single Channel Card GSD file RTRK0845**
- ❑ **Simple Dual Channel Card GSD file RTRC0845**
- ❑ **RedCom Dual Channel Card GSD file RTRR0845**

7.1.1 Limited Range Position Minimum and Maximum (Parameter 1 and 2)

These parameter registers are used to define the positions in the range of valve travel that will be reported as 0 to 100% if it the whole travel from the closed position to the open position is not used. In addition the position demand setpoint output value will also be modified to follow this limited range.

It is possible to make the position data reported and the position controller relate to a reduced span of actual valve travel. In this mode the position data relates to the reduced portion of the valve stroke. This is sometimes used where the valve is required to have a 0% position (or 100% position) that is not the same as the fully closed position (or fully open position). These parameters define the actual limited range of valve travel that will be used for the position reporting and control by the positioner.

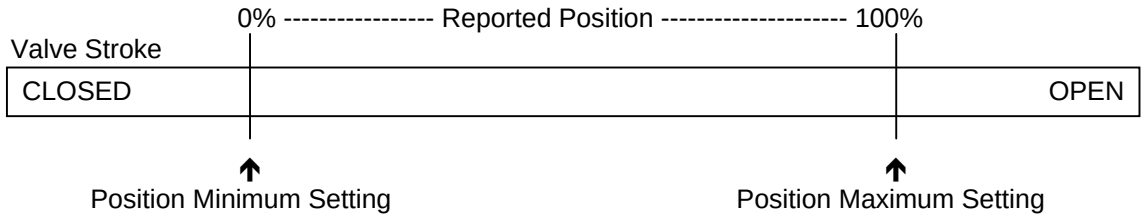


Fig 28: Limited Range Position Control and Reporting

Note that the digital open and close commands will still make the valve travel over its full stroke. The special case analogue commands of 0% and 100% that would otherwise cause the actuator to travel to the limit switch or torque off positions are inhibited if values other than 0 and 100 are set in these parameters.

The values inserted relate to the maximum total valve travel between closed and open and represent the point in the full stroke which will now be used for the limited stroke 0 and 100 values.

7.1.2 Deadband and Hysteresis (Parameter 3 and 4)

When using position control by sending a value to the Actuator Position DV setpoint there are a number of parameter registers used to tune the position controller and reduce the possibility of damage to the actuator. These two registers are set to prevent hunting around the setpoint due to high inertia of the valve. They will require adjustment for each specific application. In addition the Motion Inhibit Timer is used to ensure the actuator does not carry out an excessive number of starts in a given period.

- **Deadband** The control used for the positioner is proportional only. The PFU will run the actuator to the desired position and then it stops. As the actuator and valve combination have some inertia there is a possibility that the desired position may be overrun and the positioner will then reverse the direction of travel to make the valve adopt the desired position. This overshoot and return may continue for a number of cycles and is known as hunting, the valve and actuator combination will hunt around the setpoint if the inertia is high. To prevent this from happening there is a Deadband setting whereby once the actuator enters the deadband the motor will be stopped. For example a 5% deadband will cause the motor to be stopped once the actual position is within 5% of the desired position. The inertia will then bring the actual position nearer the desired position.

The deadband is the allowable error around the setpoint.

❑ **Hysteresis**

In addition to the deadband a second setting, hysteresis, further refines the performance of the position controller. The positioner will run the actuator towards the setpoint DV until the actual position is within the deadband minus the hysteresis setting. This has the effect of instructing the actuator to stop when it is nearer the DV. The actuator will not restart unless it overshoots and runs outside the deadband or a new command places the new desired position outside the deadband.

The Hysteresis is the amount of movement inside the deadband permitted before the motor stops.

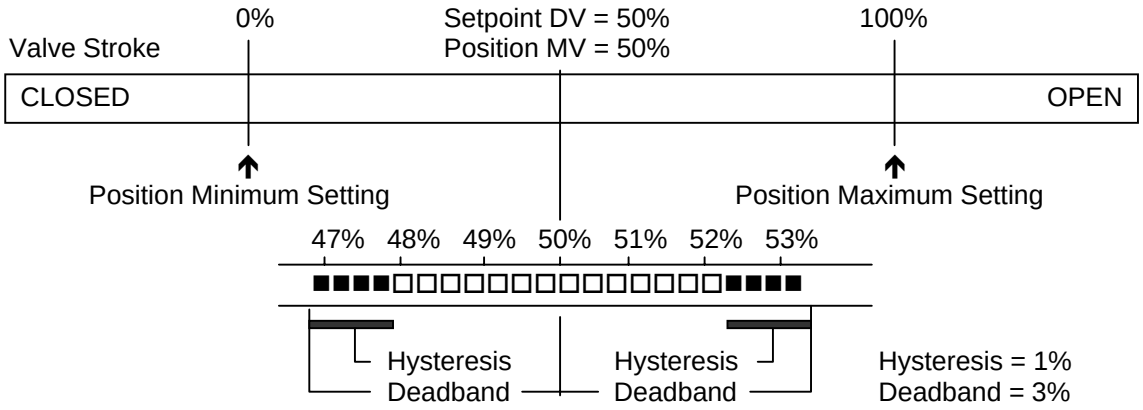


Fig 29: Deadband and Hysteresis settings

7.1.3 Slow Mode Range (Parameter 5)

This parameter register is only applicable to IQT actuators. The Slow Mode Range sets the deviation between the setpoint and current position in positioning mode inside which the actuator motor will slow to minimum speed.

If the setpoint (DV) is 50% and the setting for this parameter is 10%, then when the actuator moves within the range 40% to 60% the motor will adopt low speed. The actuator does not use slow mode for digital (Open/Close) commands.

7.1.4 Motion Inhibit Timer (Parameter 6)

The Motion Inhibit Timer setting is the period that must elapse between consecutive starts of the actuator motor when in positioning mode. The idle period will prevent the actuator motor from exceeding its rated number of starts per hour.

In addition, when tuning the valve positioner the setting can be used to allow the plant dynamics to stabilise between valve movements.

7.1.5 Manual Movement Travel (Parameter 7)

Manual Movement Travel sets the amount of valve travel not under motor action that is permitted before being considered 'Manual Movement'. The setting must be sufficiently large to cover over run of position control due to valve inertia. Too small a setting will result in Manual Movement alarms each time the valve is positioned, particularly if the deadband is small.

7.1.6 Valve Jammed Time (Parameter 8)

Parameter 8 sets the time delay that must elapse without any actuator movement before deciding the Valve Jammed status bit must be set. Valve Jammed is only announced if the actuator is asked to move and fails to respond when it should. The time must be long enough to ensure that the valve is not moving at all.

7.1.7 Watchdog Timeout (Parameter 9)

If the watchdog trips to reset the processor the Watchdog Recovery data bit is set. The data bit will automatically reset to '0' after the time period set in this parameter register.

7.1.8 Action on Loss of Comms (Parameter 10)

This parameter is used in conjunction with Parameter 11 (Comms Lost Position) and 12 (Comms Fault Timer).

The Action on Loss of Comms parameter defines the actuator action that will result after the time set for the Comms Fault Timer (parameter 12) if there is no network communication activity detected by the PFU.

The action may be

- ❑ **Nothing** (0) No action, actuator will complete any command in process (the default setting)
- ❑ **Open** (1) The actuator will open the valve
- ❑ **Close** (3) The actuator will close the valve
- ❑ **Stop** (5) The actuator stops
- ❑ **Position** (7) The actuator will adjust the valve position to the setting given in the Comms Lost Position (parameter 11).

7.1.9 Comms Lost Position (Parameter 11)

The setting in this parameter determines the position in the range 0 to 100% that the actuator will move to if the Profibus network communications stops being received, provided the Action on Loss of Comms (parameter 10) is set to 'Position'. No action will be taken unless the communications stops for a period equal or greater than the setting in the Comms Fault Timer (parameter 12).

7.1.10 Comms Fault Timer (Parameter 12)

Parameter 12, the Comms Fault Timer setting, determines the number of seconds that network communication must be absent before the setting for the Fault Mode will be carried out.

7.1.11 Auxiliary Input Mask (Parameter 13)

This parameter relates to the IQ and IQT actuators only and allows the auxiliary inputs (open, stop, close, ESD) to be set to control the actuator or simply report their status. In addition it allows the sense of the input (open or closed contact) that is reported as true (1) to be set. Actuator control always requires a true (1) input signal. The status of the inputs is always reported over the network and they can be used to report associated plant inputs instead of controlling the actuator.

The register should be considered in its binary format using the low order byte. The number has the binary form $x^7x^6x^5x^4$, $y^3y^2y^1y^0$, requiring 8 bits. Each bit in the high order nibble, $x^7x^6x^5x^4$, either enables or disables the associated input for control of the actuator. The bits in the low order nibble, $y^3y^2y^1y^0$, determines if the input reports a closed contact as a '1' or an open contact as a '1'. Only when the input is a '1' as set by the mask and the contact state will the actuator respond to the input if it is also set to control the actuator.

To allow an input to act as a control signal its associated bit in the high order nibble must be set to a '1' in the mask. To allow a closed contact to be reported as a '1' then its associated bit in the low order nibble must be set to '1' in the mask.

Bit	Position	Value	Function
7	X^7	0	Disable ESD input as command
		1	Enable ESD input as command
6	X^6	0	Disable Stop/Maintain input as command
		1	Enable Stop/Maintain input as command
5	X^5	0	Disable Close input as command
		1	Enable Close input as command
4	X^4	0	Disable Open input as command
		1	Enable Open input as command
3	Y^3	0	Report closed contact on ESD input as ‘0’
		1	Report closed contact on ESD input as ‘1’
2	Y^2	0	Report closed contact on Stop/Maintain input as ‘0’
		1	Report closed contact on Stop/Maintain input as ‘1’
1	Y^1	0	Report closed contact on Close input as’0’
		1	Report closed contact on Close input as ‘1’
0	Y^0	0	Report closed contact on Open input as ‘0’
		1	Report closed contact on Open input as ‘1’

The following examples show how the Auxiliary Input Mask settings can be applied.

	Most Significant Bit							Least Significant Bit
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
	X^7	X^6	X^5	X^4	Y^3	Y^2	Y^1	Y^0
	Enable DI-4 ESD	Enable DI-3 Stop	Enable DI-2 Close	Enable DI-1 Open	Invert DI-4	Invert DI-3	Invert DI-2	Invert DI-1
Example 1	0	0	0	0	1	1	1	1
Example 2	1	1	1	1	1	1	1	1
Example 3	0	0	0	0	0	0	0	0

- ❑ Example 1 — The default value of '15' (0000,1111 binary or 0F hex) makes all 4 inputs report closed contacts as true (1) and none of the inputs will operate the actuator.
- ❑ Example 2 — The value 255 (1111,1111 binary or FF hex) makes all 4 inputs report closed contacts as true (1) and all the inputs control the actuator in their predefined way.
- ❑ Example 3 — The value 0 (0000,0000 binary or 00 hex) makes all 4 inputs report open contacts as true (1) and none of the inputs will operate the actuator.

7.1.12 ESD DI-4/Net Disable and Data Logger Disable (Parameter 14)

In the IQ/IQT actuator this input determines the mode of operation for the ESD/DI-4 remote input. The input can be used either to disable control of the actuator from the network, or to act as an ESD/digital input. When this setting is made 'Active' the input will disable network control of the IQ/IQT when the contact input is closed irrespective of the Aux Mask setting.

In addition the logging of torque and motor contactor starts count can be inhibited if the data logger is turned off.

Function	Value	
DI4 = ESD, Data Logger enabled	0	0000 hex
DI4 = Network disable, Data Logger enabled	1	0001 hex
DI4 = ESD, Data Logger disabled	2	0010 hex
DI4 = Network disable, Data Logger disabled	3	0011 hex

7.1.13 Redundancy FR/SR Mode and Simple/RedCom Mode (Parameter 15)

When using either type of dual channel card there are two methods for redundancy that can be used, Flying Redundancy where the two channels have addresses 64 apart and System Redundancy where they have the same address. The first bit of this parameter selects the type of redundancy to be used. In addition the way that data is reported can be altered and the second bit selects either Simple redundancy where there is no extended diagnostics message, or fully RedCom compliant redundancy that includes the RedCom extended diagnostics messages.

Function	Value	
SR and Simple, two highways and no extended diagnostics	0	0000 hex
FR and Simple, one highway and no extended diagnostics	1	0001 hex
SR and RedCom, two highways plus extended diagnostics	2	0010 hex
FR and RedCom, one highway plus extended diagnostics	3	0011 hex

7.1.14 Part Stroke Position (Parameter 16)

This parameter sets the position to travel to when a Partial Stroke command is carried out. The partial stroke can be initiated from either the open or the closed position of the valve. The target position can be any value in the range 1-99% where 1 % is near the closed position. Note that the desired value to which the actuator is required to move must be outside the deadband setting.

7.1.15 Part Stroke Limit and Timeout (Parameter 17)

This parameter is used to set two values. The most significant bit in the register is used to determine the starting position which can be either the open position (1) or closed position (0) for the valve. The remaining 7 bits are used to set the time limit before which the required position (set by parameter 16) must be achieved if the test is successful.

Bit	Value	Function
15	0 1	Start test from closed position Start test from open position
0-14	0-7FFF hex	Time to complete, 0 – 32676 seconds

7.1.16 Actuator type (Parameter 18)

This parameter allows the identification of the type of actuator in which the PFU is fitted. This can be useful on some systems to allow the correct display and controls to be enabled.

7.2 Parameters viewed and set by DP-V1 Communication

The Profibus DP Module (Mk2) supports V1 acyclic communication as well as V0 cyclic messages. These parameters can be accessed in a number of ways including using standard Profibus tools and the specialist device description files associated with them.

- ❑ **FDT** Field Device Tool, this utility requires a DTM (Device Type Manager) file.
- ❑ **PDM** Process Device Manager, this tool requires an EDD (Electronic Device Description) file

The Profibus DP Module (Mk2) supports both these utilities. The list of parameters that can be accessed by these tools is as below. In addition these tools will allow the actuator to be controlled and monitored by the tools as they support the display of the registers containing feedback status and output commands. The size of the parameter is listed together with the ability to Read (R) or Write (W) to the parameter using one of these utilities.

Parameter No.	Data	Read / Write	Value / Range	Default Value
20	Actuator Tag data	R/W	12 byte	0
21	MIC software version	R	4 byte	*e.g. M204*
22	PNIC software version	R	12 byte	*e.g. PNIC 1.20*
23	Reserved			
24	Field Interface type	R	00 to FF	02
25	Permit GSD Parameterisation	R/W	1 = Permit GSD 0 = Lock out GSD	1
26	Actuator digital control	R/W	0000 to FFFF	0
27	Actuator Position control	R/W	0000 to FFFF	0
28	Multiport position control	R/W	0000 to FFFF	0
29	Additional Control Flags	R/W	0000 to FFFF	0
30	Input data IDATA1/2	R	0000 to FFFF	0000
31	Input data IDATA3/4	R	0000 to FFFF	0000

Parameter No.	Data	Read / Write	Value / Range	Default Value
32	Torque Feedback	R	0-120%, 0000 to 0078 h	0
33	Position feedback	R	0-100.0%, 0000 to 03E8 h	0
34	Temperature	R	-32767 to +32767 ^{O}C 0000 to FFFF	0
35	Analogue input max	R/W	Used to calibrate AI 0000 to FFFF	0
36	Analogue input	R	0-100.0%, 0000 to 03E8	0
37	Multi port position feed back	R	1-10, 1 to 000A h	0
38	Multiport Number of ports	R/W	2-10, 2 to 000A h	0
39	Multiport Active ports	R/W	0-1023, 0 to 03FF h	3FF
40①	Configure Data Exchange Data	R	1-10, 1 to 000Ah	0
41	Reserved			
42	Close Torque Set	R	0-120%, 0 to 0078 h	0
43	Open Torque Set	R	0-120%, 0 to 0078 h	0
44	Torque at 0% - open direction	R	0-120%, 0 to 0078 h	0
45	Torque at 10% - open direction	R	0-120%, 0 to 0078 h	0
46	Torque at 20% - open direction	R	0-120%, 0 to 0078 h	0
47	Torque at 30% - open direction	R	0-120%, 0 to 0078 h	0
48	Torque at 40% - open direction	R	0-120%, 0 to 0078 h	0
49	Torque at 50% - open direction	R	0-120%, 0 to 0078 h	0
50	Torque at 60% - open direction	R	0-120%, 0 to 0078 h	0
51	Torque at 70% - open direction	R	0-120%, 0 to 0078 h	0
52	Torque at 80% - open direction	R	0-120%, 0 to 0078 h	0
53	Torque at 90% - open direction	R	0-120%, 0 to 0078 h	0
54	Torque at 100% - open direction	R	0-120%, 0 to 0078 h	0
55	Torque at 0% - close direction	R	0-120%, 0 to 0078 h	0
56	Torque at 10% - close direction	R	0-120%, 0 to 0078 h	0
57	Torque at 20% - close direction	R	0-120%, 0 to 0078 h	0
58	Torque at 30% - close direction	R	0-120%, 0 to 0078 h	0
59	Torque at 40% - close direction	R	0-120%, 0 to 0078 h	0
60	Torque at 50% - close direction	R	0-120%, 0 to 0078 h	0
61	Torque at 60% - close direction	R	0-120%, 0 to 0078 h	0
62	Torque at 70% - close direction	R	0-120%, 0 to 0078 h	0
63	Torque at 80% - close direction	R	0-120%, 0 to 0078 h	0
64	Torque at 90% - close direction	R	0-120%, 0 to 0078 h	0
65	Torque at 100% - close direction	R	0-120%, 0 to 0078 h	0
66	Close Contactor counts	R	4 bytes,	0
67	Open Contactor count	R	4 bytes	0
68	Parameterisation Date (8 ASCII character string dd/mm/yy)	R/W	DD/MM/YY, 8 byte	0

Note: ① - Only readable by V1 comms on Simple Dual and RedCom Dual modules.

7.2.1 Actuator Tag Data (Parameter 20)

This parameter allows the Profibus card to hold a tag name for the actuator, up to 12 characters long.

7.2.2 Software Versions (Parameter 21 and 22)

Parameter 21 holds the Interface card software version in the form MXXX and parameter 22 holds the Profibus network interface card software version in the form PNIC X.XX

7.2.3 Field Interface Type (Parameter 24)

This parameter reports the type of network interface card fitted. It will read 02 for a Profibus card.

7.2.4 Permit GSD Parameterisation (Parameter 25)

If the Profibus card has been set up using FDT or PDM it may be desirable to prevent any of parameters 1 to 19 from being altered by the GSD file during normal start up or on a power cycle. If the actuator is switched off, then back on the standard Profibus start up routine will impose the parameter values set in the GSD file for the device.

This parameter allows the card to be set to ignore the GSD parameterisation routine. If it is set to '1' then the GSD Parameterisation is permitted. The default value is 1.

7.2.6 Control Outputs (Parameter 26 to 29)

Parameter 26 allows the actuator to be controlled using the same values as in the ACTCON register described in section 5.1.2.

Parameter 27 allows the actuator to be positioned using parameter 26 and 27 to set the position to go to as in the POS_DV register, refer to section 5.1.3.

Parameter 28 allows the multiport actuator to be positioned for control as with the PORTCM register as described in section 5.1.5.

Parameter 29 allows the relay outputs of an IQ or IQT to be controlled as described in section 5.1.4 and also allows the values in the contactor start counters to be reset to zero and the data logger to be reset. Resetting the data logger clears all the values currently stored in the memory on the main board and also the values in the historical torque and starts counters.

Parameter 29									
Bit	13 - 15	12	11	10	4 - 9	3	2	1	0
Function	Reserved	Reset data logger	Clear close counter	Clear open counter	Reserved	DO4 control	DO3 control	DO2 control	DO1 control

7.2.7 Actuator Feedback Data (parameter 30 to 36)

These 7 parameters replicate the data reported in the cyclic registers described in section 5.2 and 5.3 and also allow for the calibration of the Analogue input.

Parameter	Register	Description
30	IDATA1 and IDATA2	Actuator status
31	IDATA3 and IDATA4	Actuator status
32	TORQUE	Torque feedback
33	POSITN	Valve position
34	TEMPER	Actuator temperature
35	-	Calibrate Analogue Input
36	ANALOG	Analogue Input

Parameter 35 is used to set the scale of the Analogue Input. Apply a 100% signal and write any value to the parameter, the current value will then be reported as 100%. The scaling is retained in EEPROM when the actuator power is removed.

7.2.8 Multiport feedback and Setup (Parameter 37 to 39)

When the Profibus card is used in a multiport actuator it is necessary to set up the controls using parameter 39. This allows the number of active ports to be set.

Parameter 37 reports the current position of the valve as described in section 5.3, multiport position.

Parameter 38 is used to set up the actuator to match the multiport valve. The value in this register sets the number of ports that will be used up to the maximum of 10. If the valve has 6 ports but only 4 are active, then the value should be set to 6. Permissible values are 2 – 10.

Parameter 39 selects which of the 10 or fewer ports is active. The binary bit set in the register indicates that the port is to be used. This allows for unequal spacing of the ports on the valve to be catered for. The example below shows how the 4 active ports to be used are spaced amongst the 6 positions.

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Port	x	x	x	x	x	x	x	x	x	x	6	5	4	3	2	1
Active	x	x	x	x	x	x	x	x	x	x	1	0	1	1	0	1

Note that port 1 is always active.

7.2.9 Configure Data Exchange (Parameter 40)

The data to be exchanged during normal cyclic data exchange is determined by the Configuration set during start up of communication between the PLC and the Profibus card. In setting up the card from the PLC one of the 10 possible Configuration will have been chosen – refer to section 5.4.

Parameter 40 shows which of the 10 possible configurations has been chosen and allows the choice to be verified. It cannot be changed except by the choice entered during the configuration stage.

7.2.10 Data Logger Information (Parameter 42 to 67)

The Profibus card makes available some of the IQ and IQT data logged information from parameters in the data base. The data available is updated shortly after the actuator stops moving provided the actuator selector is in the ‘Remote’ position and can be read from the appropriate parameters.

- **Close Torque Set** Parameter 42, the actuator setting for the maximum generated torque value permitted when the actuator is moving towards the closed position is recorded in this register.

- **Open Torque Set** Parameter 43, the actuator setting for the maximum generated torque value permitted when the actuator is moving towards the open position is recorded in this register.

- **Torque at x% when opening** Parameter 44 to 54, there is a set of parameters that each record the last value for the torque generated when the actuator is moving from closed to open and reaches a particular position (x%). The parameters contain 11 values of torque generated in 10% position increments between 0% and 100% of valve travel.

- **Torque at x% when closing** Parameter 55 to 65, there is a set of parameters that each record the last value for the torque generated when the actuator is moving from open to closed and reaches a particular position (x%). The parameters contain 11 values of torque generated in 10% position increments between 100% and 0% of valve travel.

- **Motor Starts – Closing Direction** Parameter 66 contains the total number of times the motor contactor to close the valve has been operated. The counter can be reset to zero using parameter 29.

- **Motor Starts – Opening Direction** Parameter 67 contains the total number of times the motor contactor to open the valve has been operated. The counter can be reset to zero using parameter 29

7.2.11 Parameterisation Date (Parameter 68)

This parameter can be set to contain information showing the date when the card was set up. The format for the entry should be DD/MM/YY. This parameter does not automatically update and must be set manually.

7.3 Return to Defaults

The card may be restored to the default settings for the configuration parameters if necessary. To carry out this procedure will require the board to be fitted with a suitable shorting link on LK1 and the power to the card to be cycled.

- Switch the actuator off
- Access the interface card and fit a shorting link across LK1
- With the card in the actuator, switch the power on and off
- Access the interface card and remove the shorting link from LK1

The link LK1 must not be fitted under normal operating conditions. The position of the link is shown in section 3, figure 6.

8 SETTING UP AND MAINTAINING THE PROFIBUS MODULE

In most applications the majority of the default settings in the Profibus DP Module (Mk2) will be suitable for the operation of the valve and need not be altered. However, in every case it will be necessary to alter the address since the default should never be used within a live system (the default value is 126).

8.1 Using a Network Configuration Tool

The Profibus DP Module caters for two configuration tools, FDT and PDM.

8.1.1 FDT (Field Device Tool)

This utility uses DTM device description files and a suitable FDT utility to act as a container. A typical configuration screen is illustrated below.

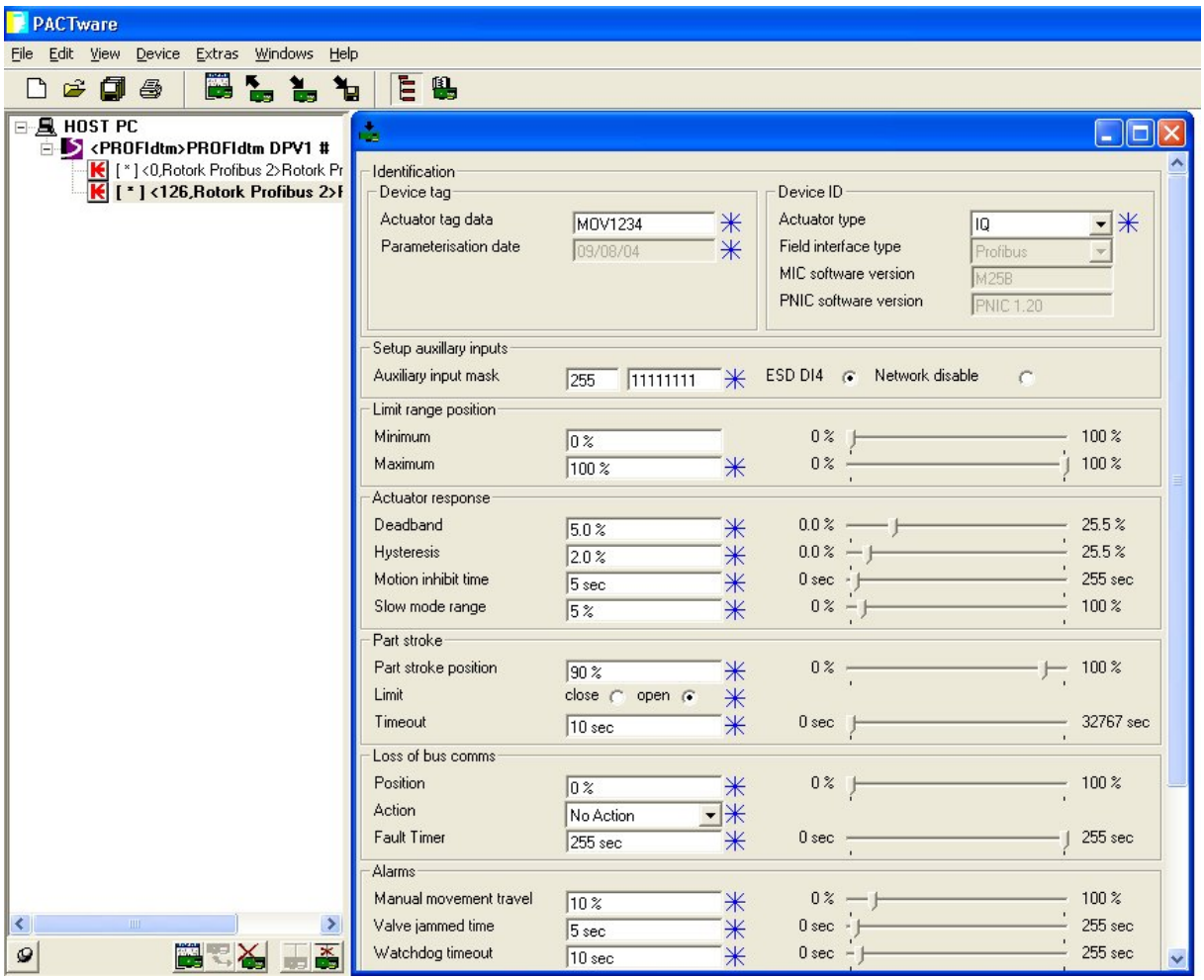
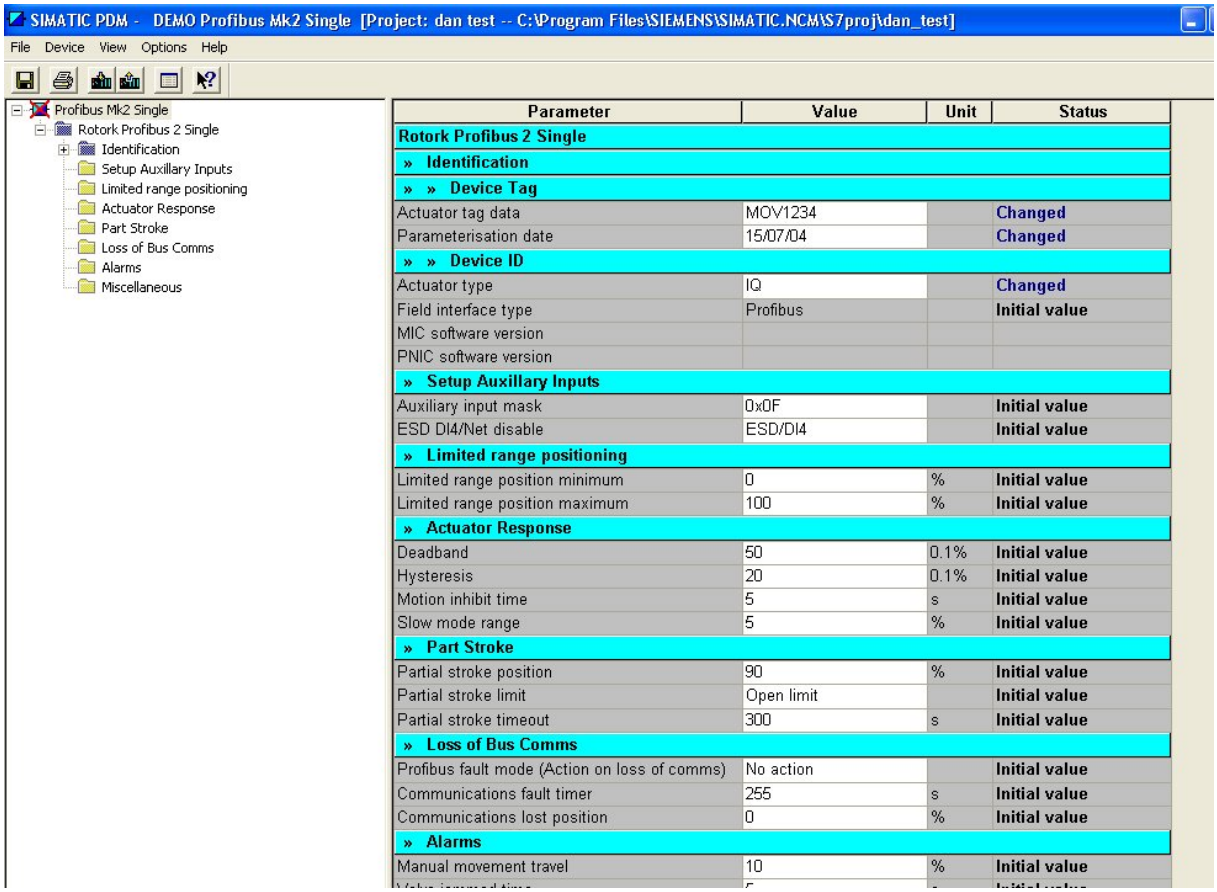


Fig 30: Rotork DTM running in Pactware FDT

The settings for the parameters and the control and review of actuator information can all be carried out in the FDT container using the DTM. When loading the files there is a prompt to choose single or dual channel cards, though both drivers can be loaded.

8.1.2 PDM (Process Device Manager)

This utility uses EDD device description files and the PDM programme from Siemens. A typical configuration screen is illustrated below.



Parameter	Value	Unit	Status
Rotork Profibus 2 Single			
» Identification			
» » Device Tag			
Actuator tag data	MOV1234		**Changed**
Parameterisation date	15/07/04		**Changed**
» » Device ID			
Actuator type	IQ		**Changed**
Field interface type	Profibus		**Initial value**
MIC software version			
PNIC software version			
» Setup Auxillary Inputs			
Auxiliary input mask	0x0F		**Initial value**
ESD DI4/Net disable	ESD/DI4		**Initial value**
» Limited range positioning			
Limited range position minimum	0	%	**Initial value**
Limited range position maximum	100	%	**Initial value**
» Actuator Response			
Deadband	50	0.1%	**Initial value**
Hysteresis	20	0.1%	**Initial value**
Motion inhibit time	5	s	**Initial value**
Slow mode range	5	%	**Initial value**
» Part Stroke			
Partial stroke position	90	%	**Initial value**
Partial stroke limit	Open limit		**Initial value**
Partial stroke timeout	300	s	**Initial value**
» Loss of Bus Comms			
Profibus fault mode (Action on loss of comms)	No action		**Initial value**
Communications fault timer	255	s	**Initial value**
Communications lost position	0	%	**Initial value**
» Alarms			
Manual movement travel	10	%	**Initial value**

Fig 31: Rotork EDD running in the Siemens PDM application

As with FDT, the parameters and the control and review of actuator information can all be carried out in PDM using the EDD device description file.

8.2 Setting up an IQ or IQT with the Setting Tool

The IQ and IQT actuator includes an infra-red communication port for setting the actuator performance, limit switches and so on. This communication link can be used to set some, but not all, of the PFU parameters. The parameters should still be checked with a utility such as FDT or PDM to ensure optimum actuator and network compatibility. The diagram illustrates the access route through the actuator menu screens to reach the settings that affect the PFU.

- ❑ Note that the **[Od]** function must be set to **[OP]**, if it is not then the card will not be able to control the actuator.

The parameters that may be set by using the Setting Tool and the infra red link are listed below. The available range for the deadband setting when using the setting tool is less than the range found using the configuration tools.

Note: Parameters may only be altered by the IR link if the actuator control knob is set to the Local or Local Stop position.

Parameter No.	Menu Code	Description	Range	Default Value
1	FL	Limited Range Position Minimum	0 – 100%	0%
2	FH	Limited Range Position Maximum	0 – 100%	100%
3	Fd	Deadband	0.0 – 9.9%	5.0%
6	Ft	Motion Inhibit Time	0 – 255 sec	5 sec
10	FA	Action on Loss of Comms	Nothing (No Action), Stop, Close, Open, Position	Nothing
11	FF	Comms Lost Position	0.0 – 100.0%	0.0%
13	PF	Aux Input Mask	0 – 255 (00 – FF hex)	15 (0F)
-	PA	Address①	0 – 126	126

Note: ① - When altered, the new value will only take effect after the actuator power has been cycled twice.

Note that changes to the address by the IR link have to be transmitted across two boundaries, the actuator main board and the Profibus interface card and hence two actuator power cycles are required before the new address becomes effective.

If the address is changed using a Class 2 master directly on the Profibus link then the new address becomes effective immediately. The actuator power must be cycled once to make the correct address appear in the actuator window.

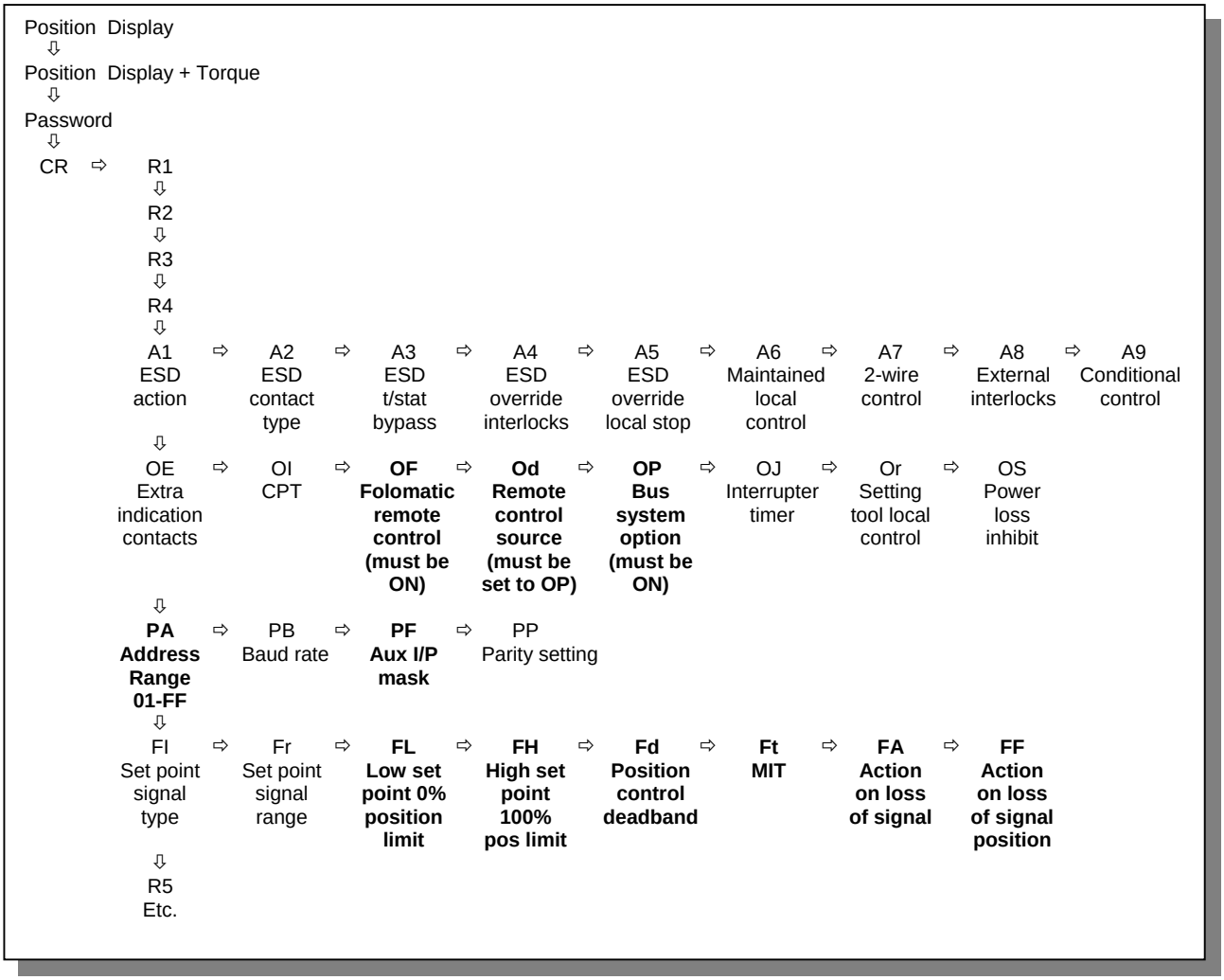


Fig 32: Setting tool menu structure and PFU settable parameters

8.3 Maintenance and Repair

There is no periodic service requirement for the PFU.

Repairs should not be attempted on the module. The Network Interface Card and Interface Card are a pair and should never be separated. Replacing the complete PFU assembly with a new replacement device should rectify any failure. Static sensitive devices are used in the PFU, it is therefore mandatory to observe anti-static precautions when handling or working on the unit.

8.4 Records

In order that a replacement can be easily introduced in the event of a device failure it is very important to record and keep safe all the settings made for the variable registers. The table lists all the registers that must be checked and set up for each Profibus Module on a network. The data should be recorded for each module.

***Note**:*	*Make a note of all changes to register settings to ensure that, in the case of a failure, the replacement device can be swiftly set to the correct values.*

❑ **GSD accessed Parameters**

	Device Address:		
Parameter No.	Description	Setting	Notes
1	Limited Range Position Minimum		
2	Limited Range Position Maximum		
3	Deadband		
4	Hysteresis		
5	Slow Mode Range		
6	Motion Inhibit Time		
7	Manual Movement Travel		
8	Valve Jammed Time		
9	Watchdog Timeout		
10	Action on Loss of Comms		
11	Comms Lost Position		
12	Comms Fault Timer		
13	Aux Input Mask		
14	ESD DI-4/Net Disable		
15	FR/SR mode and Simple/RedCom redundancy		
16	Part Stroke position		
17	Part Stroke Limit and timeout		
18	Actuator Type		

❑ **Acyclic Communications accessed Parameters**

Parameter No.	Description	Setting	Notes
20	Actuator Tag data		
25	Permit GSD Parameterisation		
38	Multiport Number of ports		
39	Multiport Active ports		
68	Parameterisation date		

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