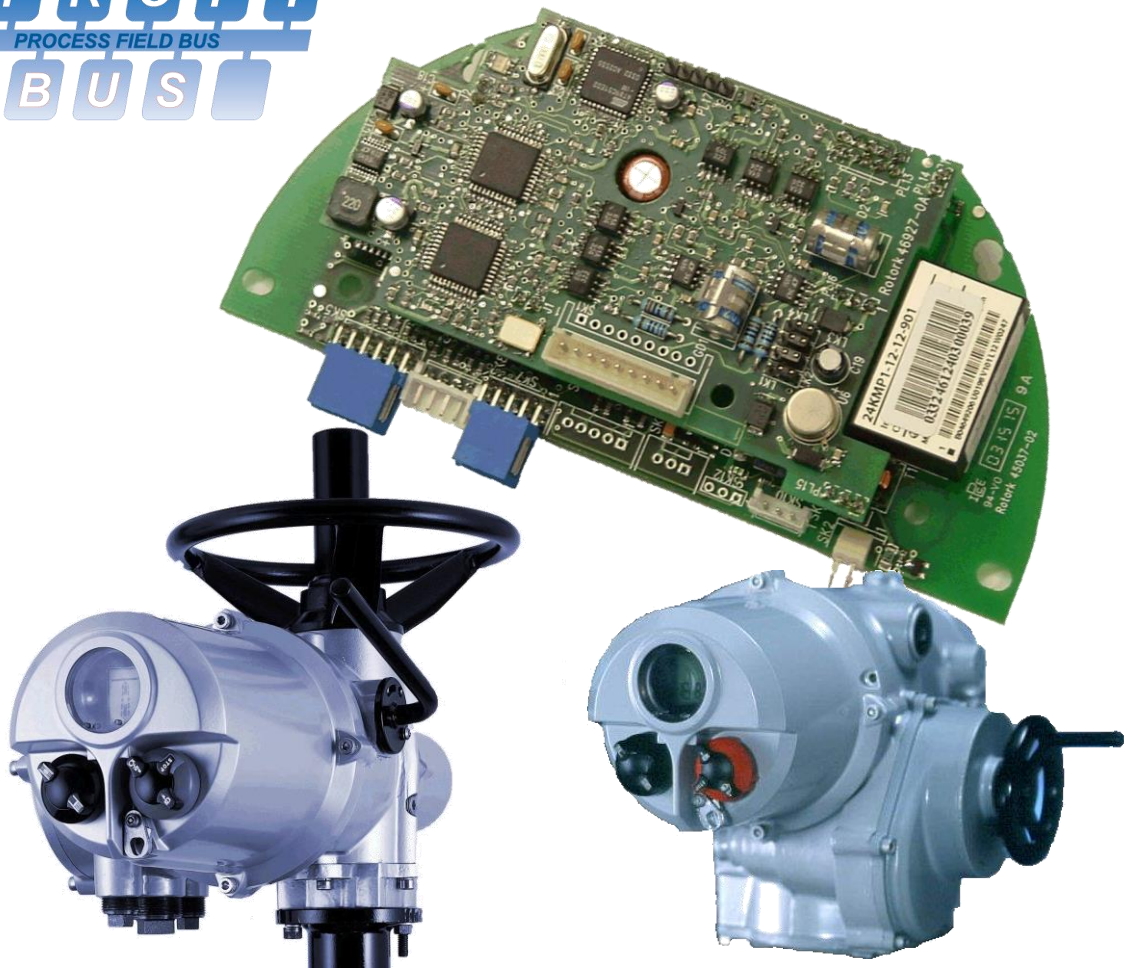
rotork

PROFI PROCESS FIELD BUS



Profibus Actuator Control
Profibus DP Option Card
Installation Manual

Publication PUB088-005-00_1017

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 releases

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

Actuator Interface Card software version M207, IQ M304, CVA V1.08 ROMPAK V1.01, or newer.

Note 3:

The Profibus DP Module (MK2) described in this manual is suitable for inclusion in Rotork IQ, IQT, CVA, ROMPAK, Skil and Q 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
DTM	Device Type Manager	RAM	Random Access Memory
EDD	Electronic Device Description	ROM	Read Only Memory
FDT	Field Device Tool	RTU	Remote Terminal Unit
GSD	Generic Station Description	SW	Software

PDM Process Device Manager

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

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.

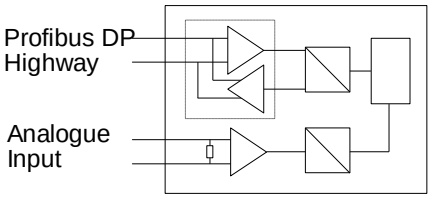
Fig 1: The Profibus DP Module (Mk2) Option Card Actuator Compatibility

1.1 General

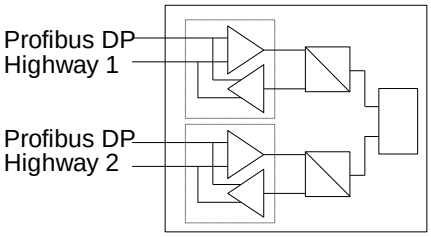
The Profibus DP Module (Mk2) has three versions:

- ❑ 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

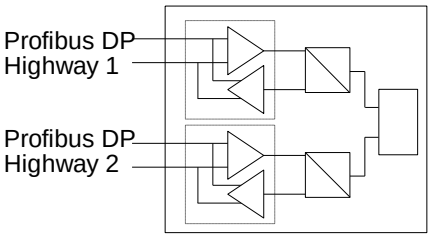
The two dual channel versions have the same physical assembly, but are configurable to include the necessary extra messages for RedCom systems. PLCs that cannot accept the extended diagnostic messages from RedCom slaves should use the Simple Dual channel card. The reporting of RedCom extended diagnostics 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 module consists of a network interface card, that either fits directly to the main actuator printed circuit board (CVA and ROMPAK) or fits to an interface card; then the two board assembly is fitted inside the actuator electrical housing (IQ range, Skil/EH and Q).

All the connectors are polarised to prevent incorrect insertion.

- **Network Interface Card (NIC)**

  This 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, two highways for SR mode or one highway with two network interface connections for FR use.)

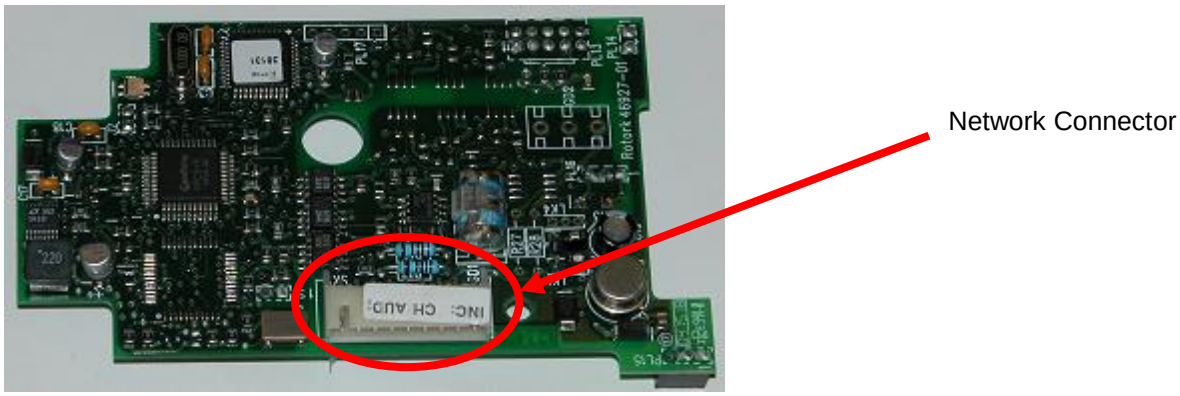


Fig 3: The Profibus single channel NIC, showing the network connector.

❑ Interface Card (IQ/Skil/EH/Q)

The CVA and ROMPAK do not require in additional interface card.

The interface card is profiled and assembled to fit an IQ, Skil or Q actuator. For the Skil/EH and Q, it carries the processor for collecting the data from the actuator main board and passing this data to the Network Interface card. For the IQ/IQT it is used simply for physical connection to the main card.

The primary connection to the actuator circuits is by a multi-pin 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 Interface card is powered from within the actuator.

Fig 4: The Interface Card (Q and Skil/EH actuators)

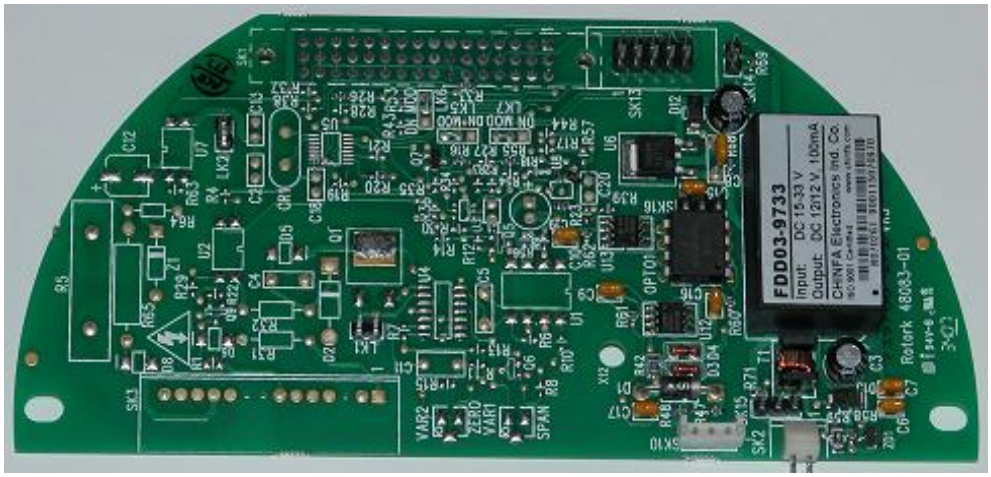


Fig 5: The Interface Card (IQ/IQT actuator)

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.

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°C to +70°C
- Storage temperature: -50°C to +85° C
- Relative Humidity: 5% to 95% (<50°C) non-condensing

Refer to actuator manuals for environmental range applicable for the particular actuator type.

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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 Main PCB connection SK1. In addition the PFU can be fitted inside IQ Mk1 actuators in certain cases.

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

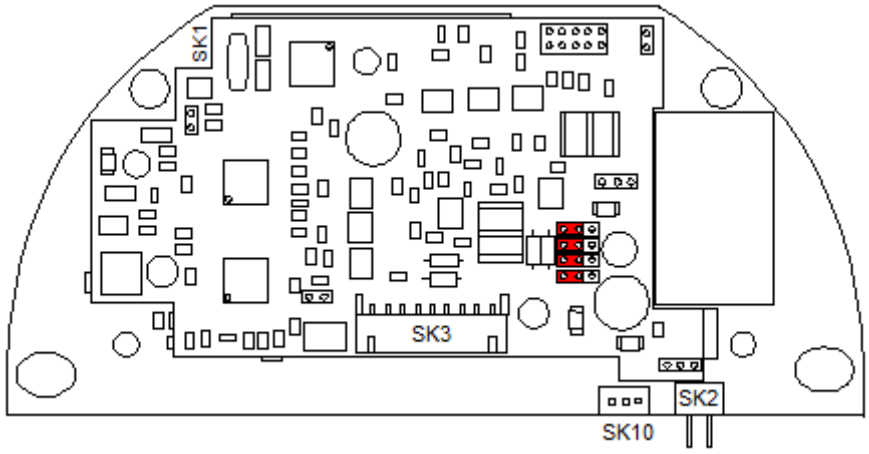


Fig 6: The Profibus Mk2 card profiled for the IQ or IQT actuator

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
SK10	Analogue Input connection ①

Note: ① – Only available on Single Channel module, 3000-900 or 6000-900

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 below shows the Q version of the circuit board. The links for the bias resistors are shown in the 'not terminated' position.

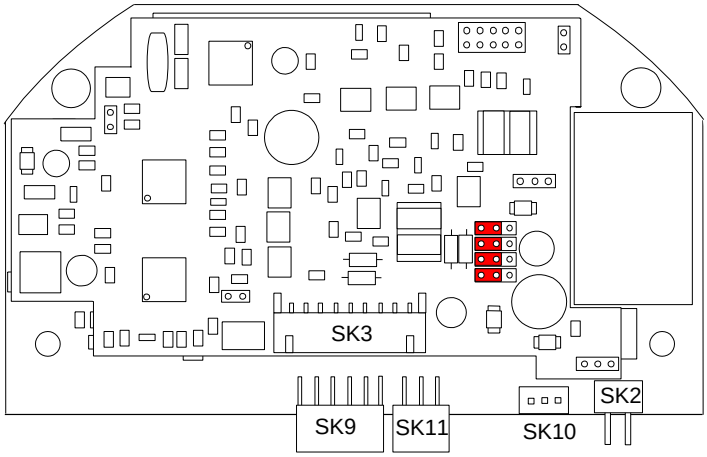


Fig 7: The Profibus Mk2 card profiled for the Q actuator

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 interface card to its factory defaults and the associated default parameter settings, LK1 on the Interface card should be fitted and the actuator power cycled (see Fig. 11).

3.3 Inside a CVA actuator

The PFU is suitable for fitting into CVA actuators, wiring diagrams CXX-90 (where X can be any value) details the option card connections to the terminal bung. The PFU module is fitted in the only option board slot inside the CVA electrical housing – on the underside of the Main PCB assembly.

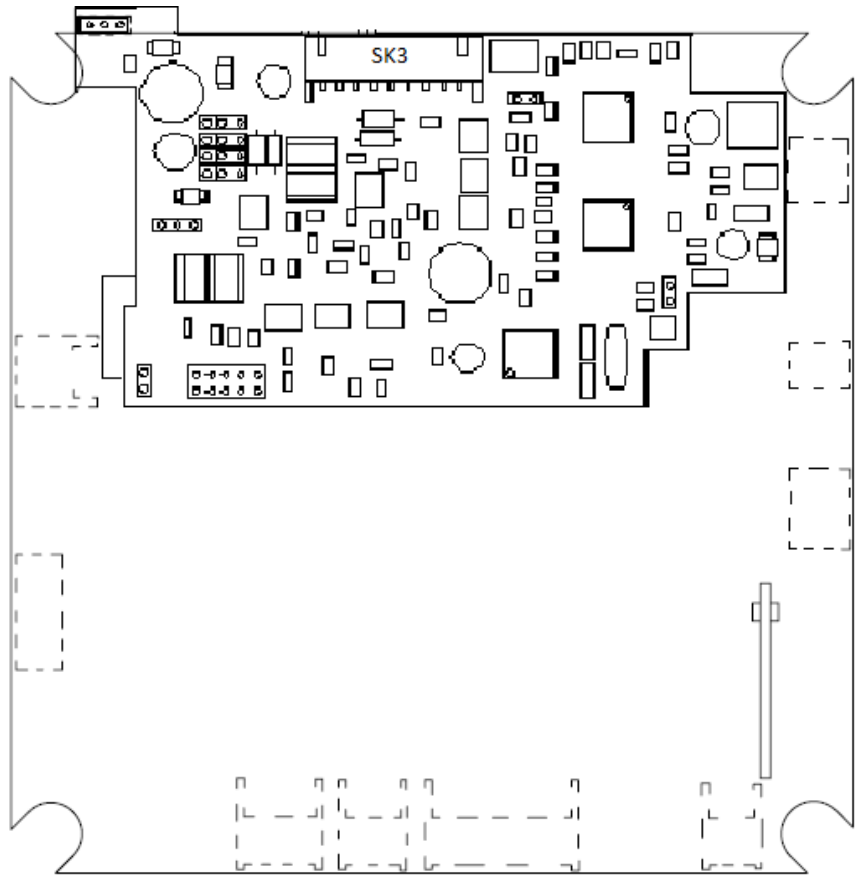


Fig 8: The Profibus Mk2 card located in a CVA actuator

SK3 is the connection to the Profibus Fieldbus Data Highway.

The PFU in the CVA must be enabled. This would usually be done during factory test, but may be required to be completed on site for spares. To enable, the Rotork PDA software Enlight (downloadable from the Rotork web site) is utilised to change parameter 34. It must be read then 2048decimal added to it.

3.4 Inside ROMPAK actuator

The PFU is suitable for fitting into ROMPAK actuators, wiring diagram RX0X-6X0 (where X can be any value) details the option card connections on the terminal strip. The PFU module is fitted in the only option board slot inside the ROMPAK electrical housing.

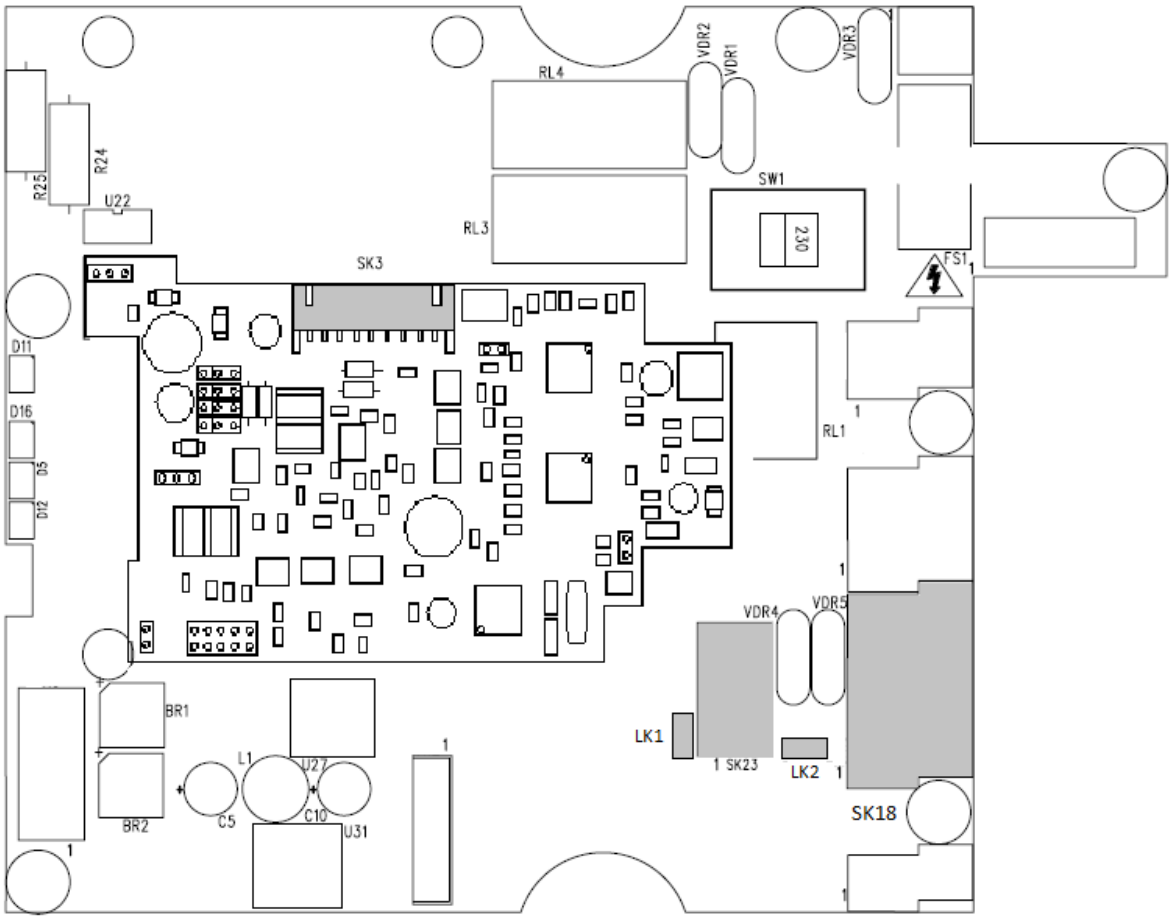


Fig 9: The Profibus Mk2 card located in a ROMPAK actuator

SK3 is the connection to the Profibus Data Highway; this is connected to SK23 on the main PCB assembly via an internal loom. The user wires the Profibus connections to the main PCB assembly at the terminal block SK18 as per the wiring diagram.

On the ROMPAK, termination is achieved by setting L1 and L2 on the profibus card as per section 4.7; this fits the 'biasing resistors'. To connect the main termination resistor, attach a jumper to LK1 and LK2 between pins 1 & 2. Pin 1 is labelled on the printed circuit board, next to LK1 and LK2.

3.5 Inside a Skil or EH actuator

The PFU is suitable for fitting into Skil and EH actuators, wiring diagram SWM SI-001 and WD18460. The PFU is normally located in the first option board slot inside the electrical housing using connection SK1.

The Interface card must be correctly profiled and loaded with the appropriate connectors to match the actuator. The illustration below shows the Skil and EH version of the PFU. The links for the bias resistors are shown in the 'not terminated' position.

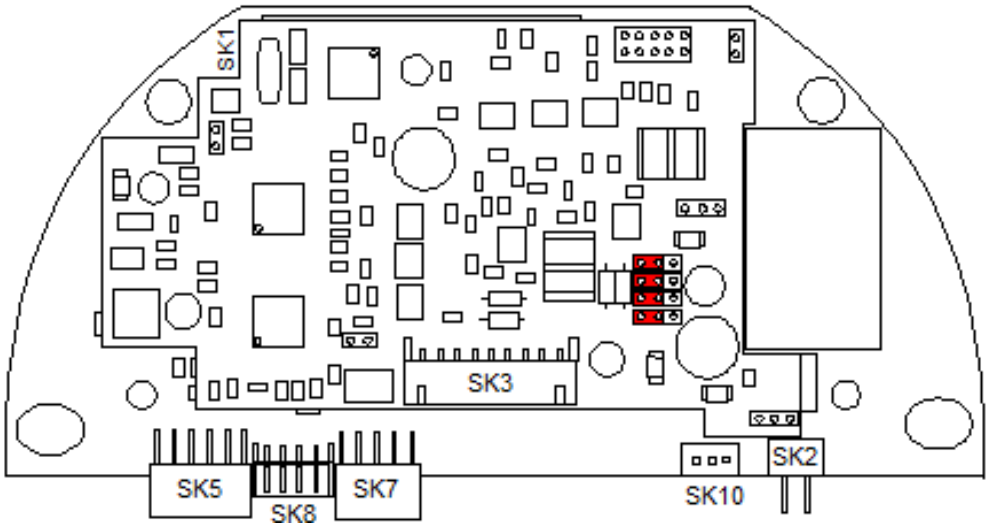


Fig 10: The Profibus Mk2 card profiled for the Skil and EH actuators

With the Skil/EH 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. The following table describes the wiring harnesses and their function in the Skil/EH actuator.

PFU Socket	Wiring Harness
SK2	24V power supply input from actuator
SK3	Profibus Fieldbus connection
SK5	Main Board connections
SK7	Not used
SK8	Not used
SK10	Analogue Input connection ①

Note: ① – Only available on Single Channel module.

To restore the interface 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. 11).

3.6 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.

Suitable anti-static precautions should be taken, as the actuator circuitry contains static-sensitive components.

The electrical housing cover should be removed and the existing PFU carefully unplugged from its main connector. The Interface card will be attached to the Main PCB mounting ring by two screws, which may be T20. 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 interface card used for the Q and the Skil / EH 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.

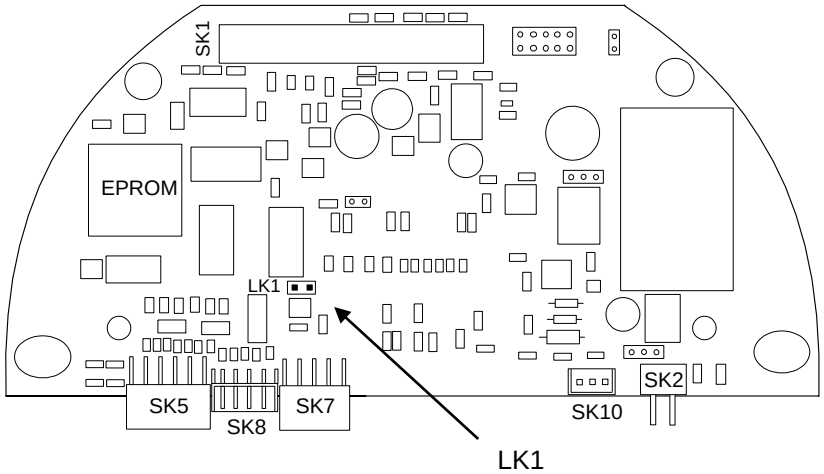


Fig 11: The Profibus Mk2 Interface card showing the position of LK1 (NIC removed)

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.

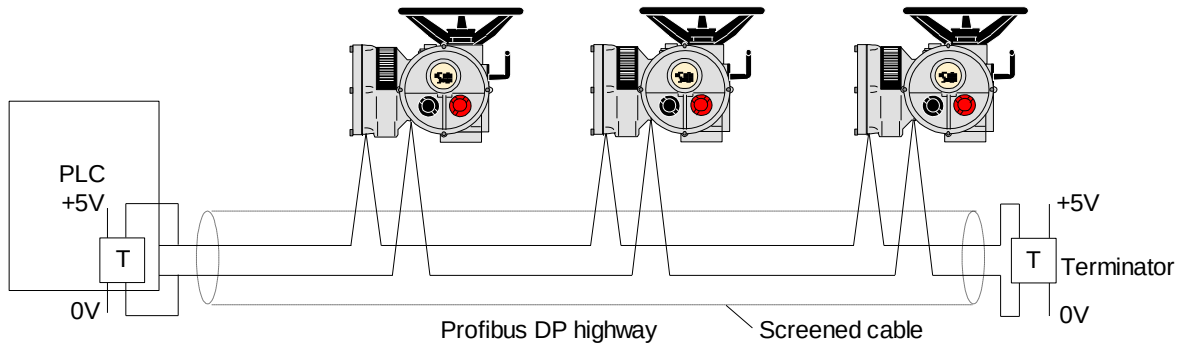


Fig 12: Typical Profibus DP Data Highway

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 cabling stubs 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 actuator terminals (refer to the actuator wiring diagram).

4.2 Segmented Single Highway System

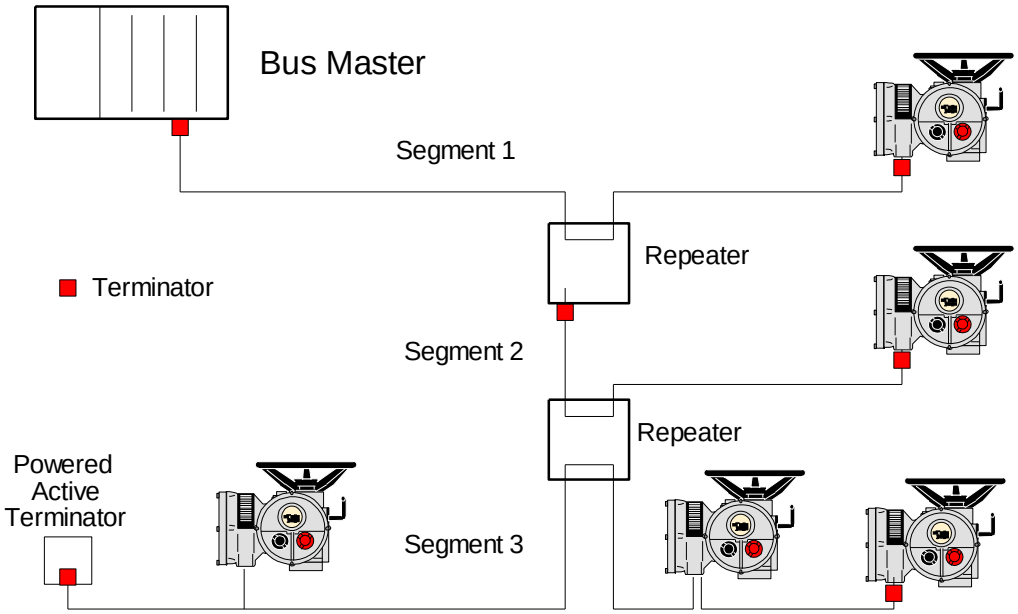


Fig 13: Profibus Single Channel Data Highway Topology

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. Alternatively, 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 PLCs 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 PLCs, 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.

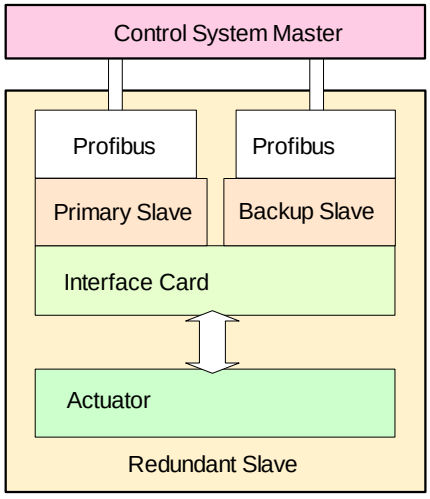


Fig 14: Profibus DP (Mk2) Simple Dual Redundant Option Block Diagram

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

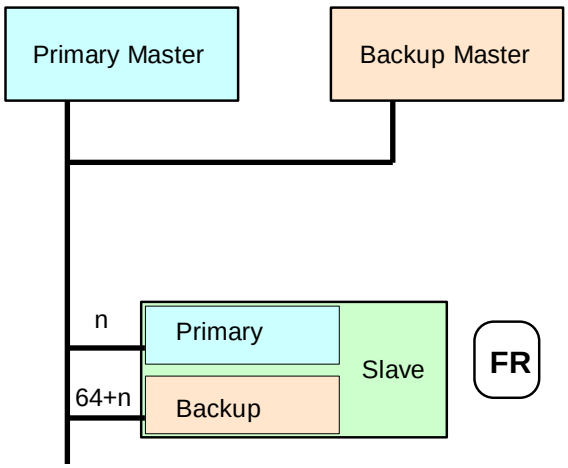


Fig 15: Profibus DP (Mk2) Flying Redundancy Connection

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 be 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 parameter 15 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

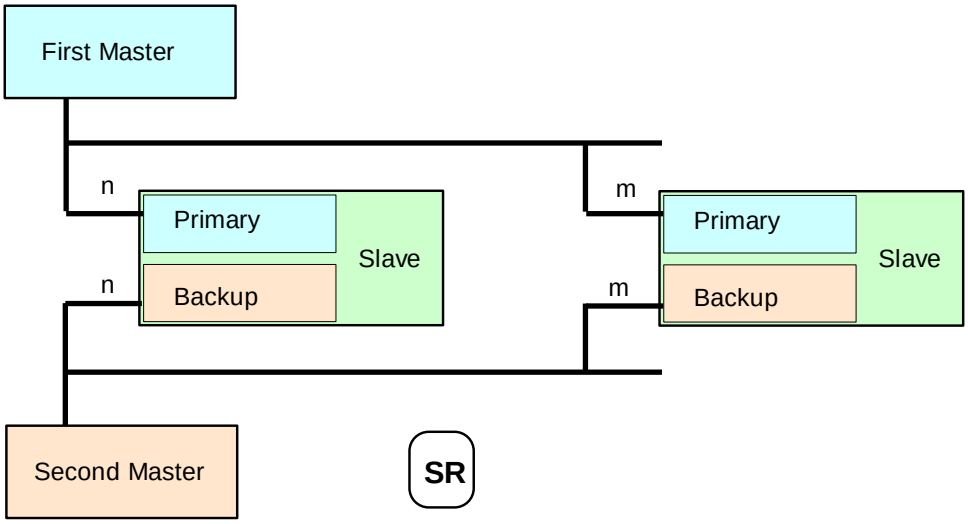


Fig 16: Profibus DP (Mk2) System Redundancy Connection

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 channels 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 alternative setup, 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.

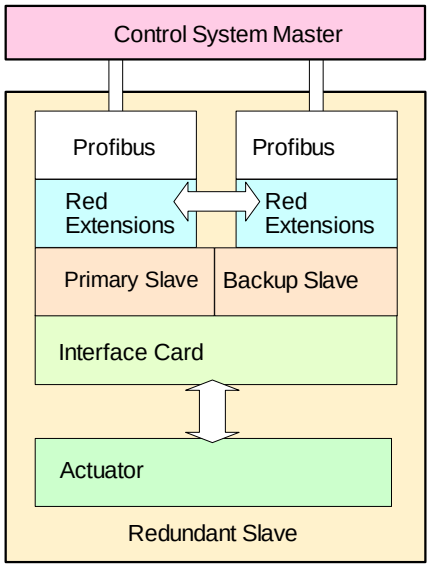


Fig 17: Profibus DP (Mk2) RedCom Dual Redundant Option Block Diagram

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

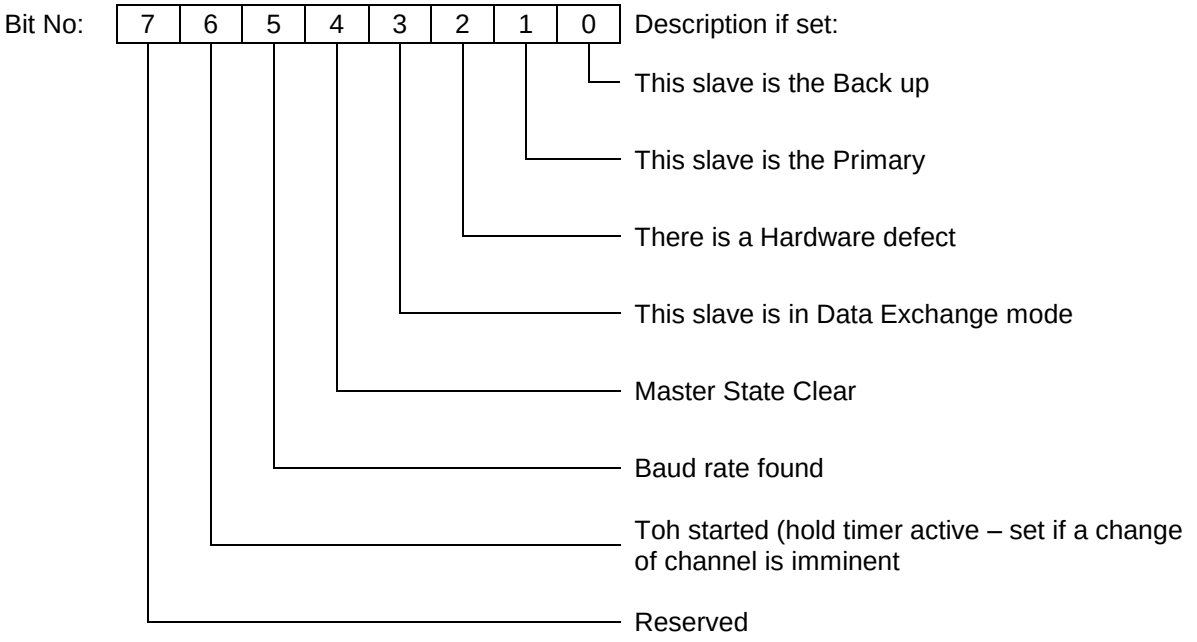
The Redundancy Extensions to the standard V1 protocol allow the two channels to communicate between themselves to establish correct operation of the highway if there is a failure, both the Simple and RedCom versions of the card do this. In addition to these, there are extra Extended Diagnostic messages that are reported to the PLC as part of the RedCom system that the Dual RedCom card reports. Not all PLCs 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 hex
Status_Type	= 9Fhex
Slot_Number	= 0 hex
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 for Profibus DP applications. Two conductors plus a shield are required and there is a Profibus specification for the cable.

Amongst the cable manufacturers Belden have the PVC jacketed 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).

PVC sheath, usually coloured purple

Tinned copper screen

Signal wires
Red is positive, 'B'
Green is negative, 'A'

Typical Profibus DP Cable Specification	
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 18: Typical Profibus DP cable specifications

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. See section 4.7 below for details where to fit the links in the various options of the card.

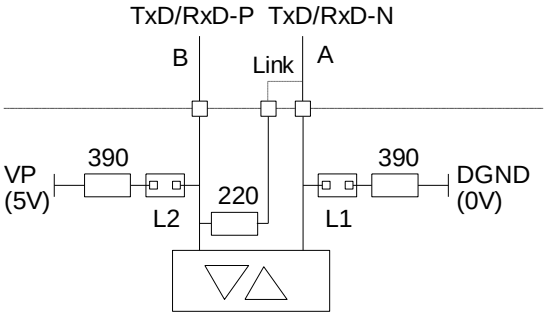


Fig 19: Termination for Profibus highway

4.7 Connecting to 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

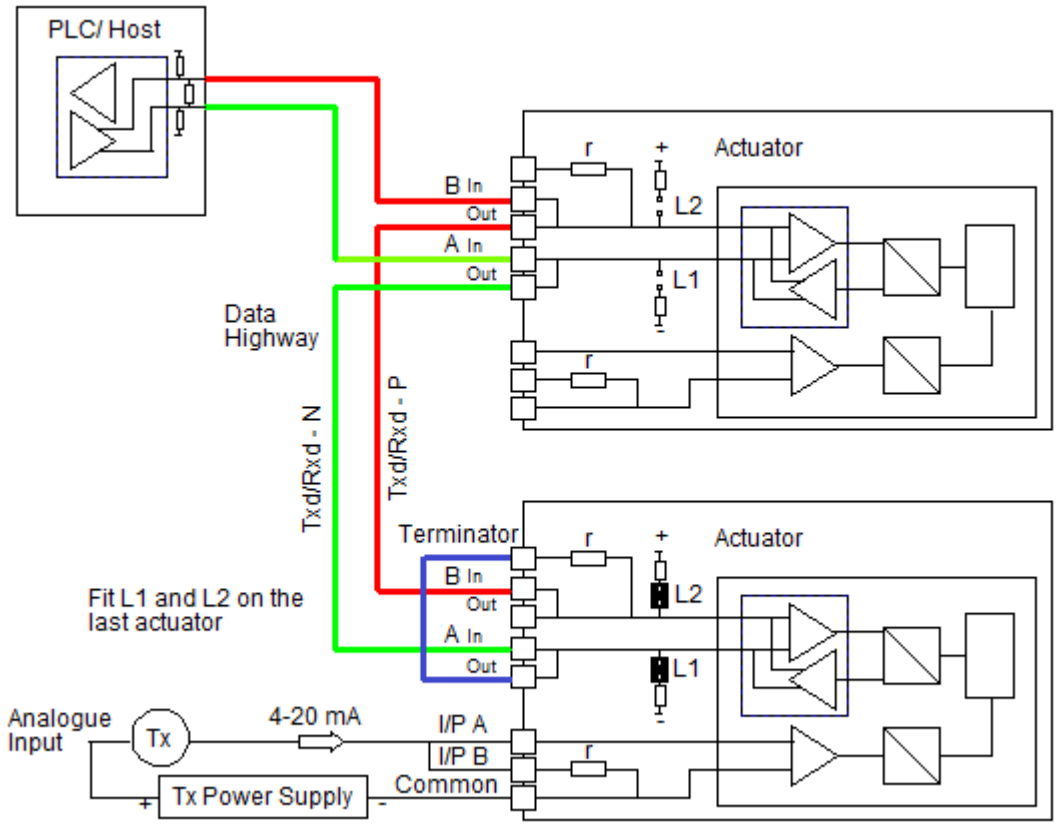


Fig 20: Single Highway + Analogue Connections

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 A and B (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 ‘A Out’ terminal to the ‘Terminator’ terminal (blue link in diagram above) 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 A terminals must be used on one data line and all the B 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 Out’ to add end of line termination

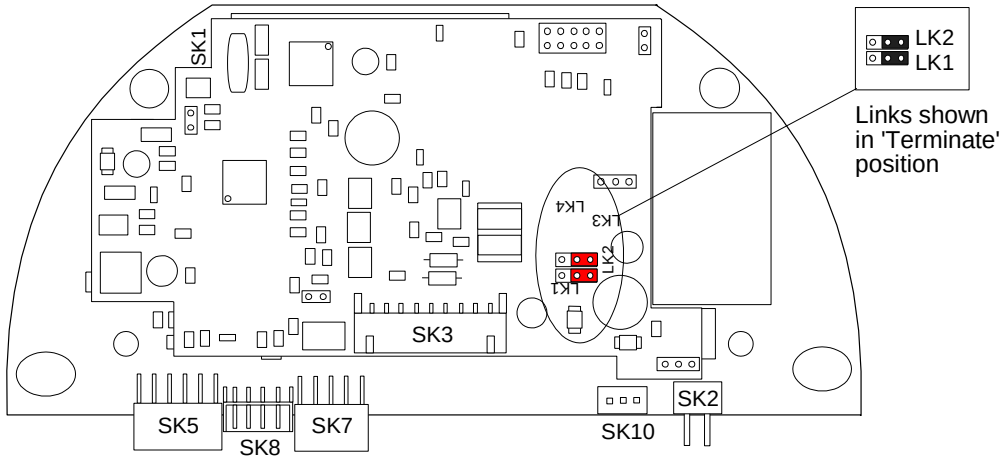


Fig 21: Single Highway Active Termination Links

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.

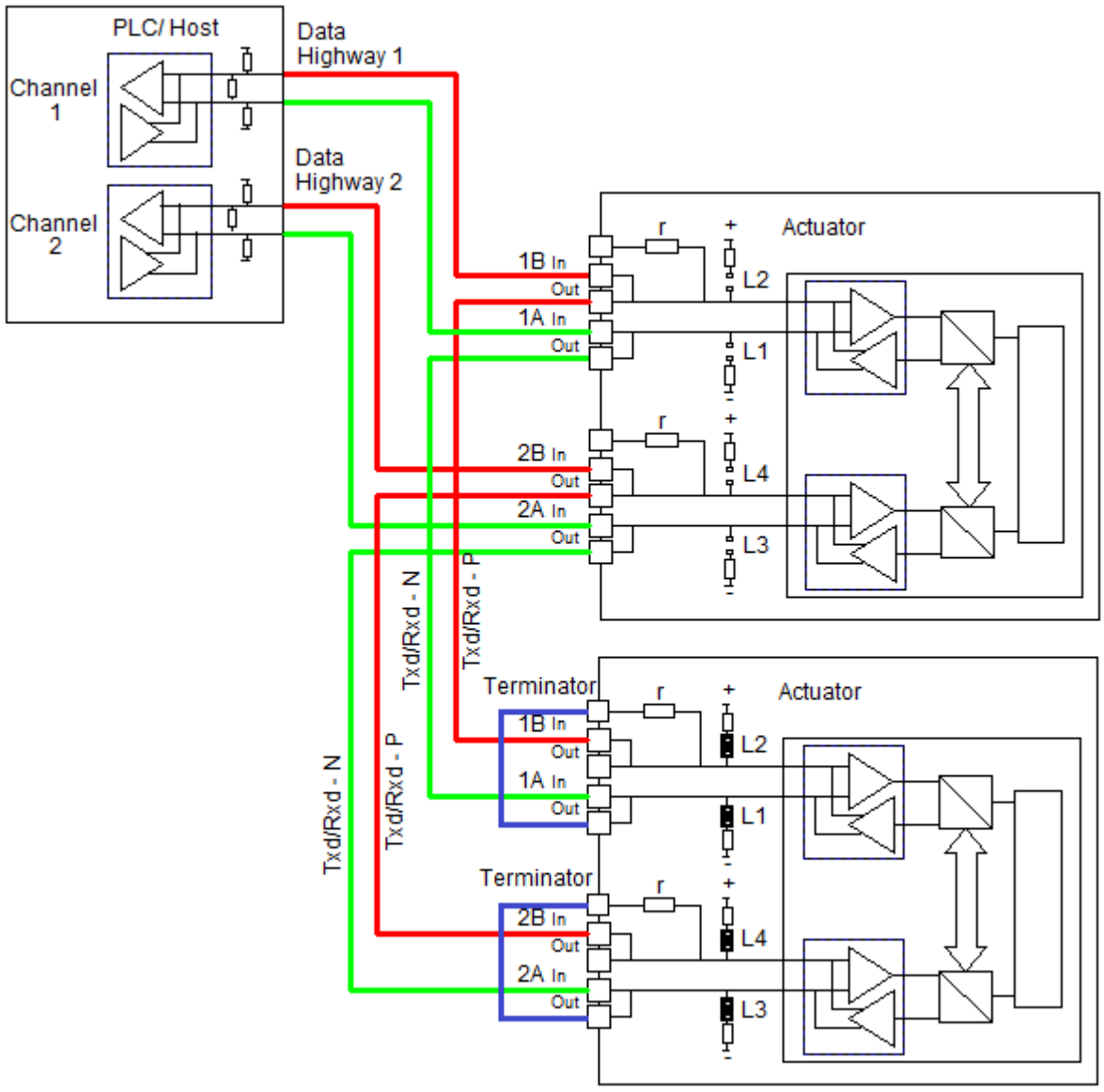


Fig 22: Dual Highway SR Mode Connections

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 ‘1A Out’ terminal to the highway 1 ‘Terminator’ terminal (blue link in diagram above) and fitting the internal links LK1 and LK2 in the Terminate position; and by linking the highway ‘2A Out’ 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

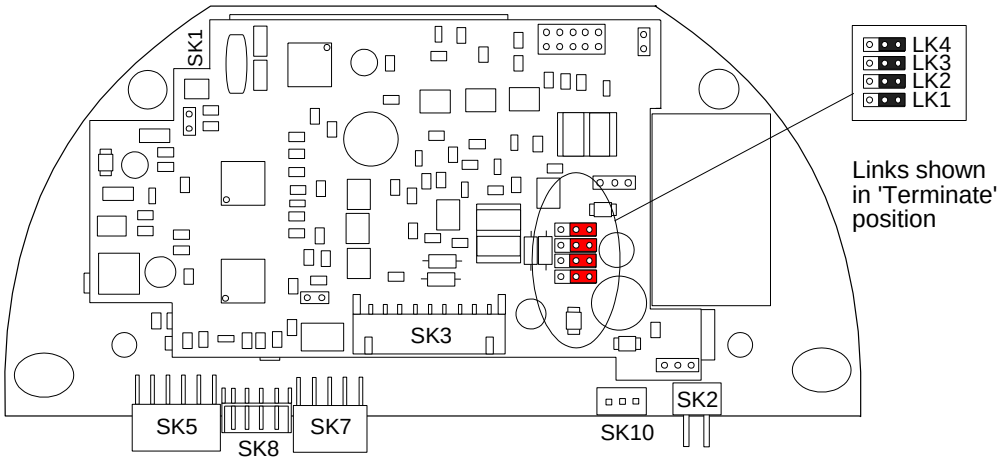


Fig 23: Dual Highway Active Termination Links for SR mode

4.7.2 Optional IQ and IQT disconnect module

The IQ and IQT range of actuators can be fitted with an optional disconnect module, the purpose of which is to enable the removal of the actuator for service without disrupting the network. Without the disconnect module, due to the 'IN' / 'OUT' nature of the connection to the actuator (to prevent stub lines) the network will be disrupted during removal of an actuator.

Under normal circumstances, where power is applied to the actuator, the relay fitted on the disconnect module is powered and ensures that the Profibus signals are passed to the actuator as shown below.

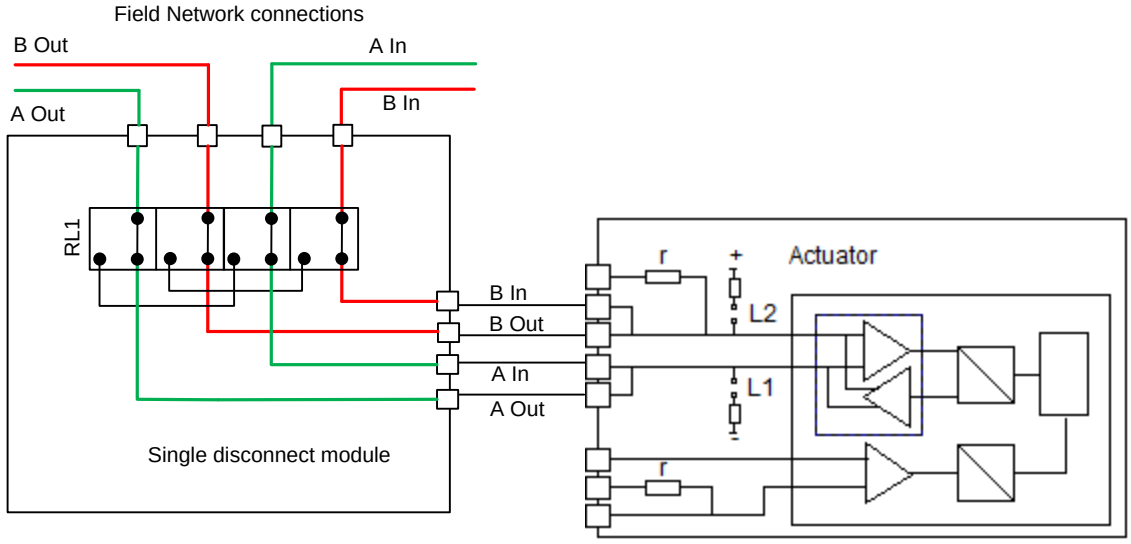


Fig 24: Disconnect module showing normal powered operation - connection though to the actuator.

When power is removed from the actuator, the relay disconnects the actuator from the highway, meaning that the disconnect module can be removed from the actuator and placed on its parking housing, then the actuator can be removed for servicing without disrupting the rest of the network.

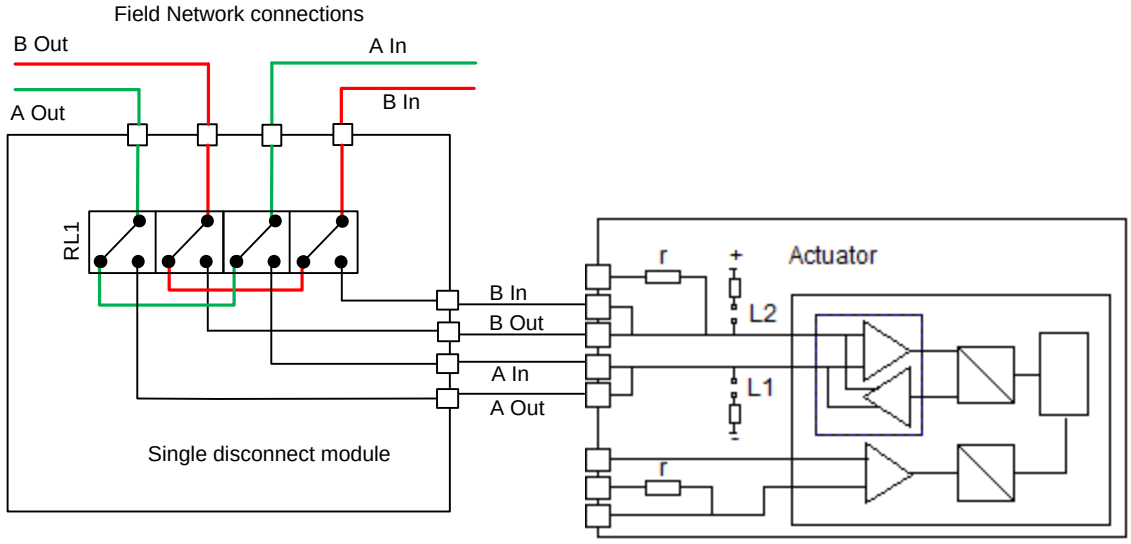


Fig 25: Disconnect module showing unpowered operation - disconnected from the actuator.

Note: For actuators fitted with the profibus disconnect module and that are installed in potentially explosive atmospheres (hazardous areas), the hazardous area rating of the actuator (as stated on the nameplate) is only maintained when the profibus disconnect module is correctly assembled to the actuator and installed (e.g. cable glands) in accordance with the relevant hazardous area code of practice. If for any reason the profibus disconnect module has to be removed from the actuator (for instance to replace the actuator), the power must be removed from it (and the network) and the necessary hazardous area permits to work must be obtained. Under no circumstances, while the profibus disconnect unit is removed from the actuator, must the power be connected to it and to the network, when a potentially explosive atmosphere is present. If it is required that the network is 'powered up' with a potentially explosive atmosphere present then the profibus disconnect module must correctly installed and assembled to an actuator or it can be assembled to a suitable approved ROTORK designed parking housing (refer to ROTORK for more information).

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 are given later in this manual.

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

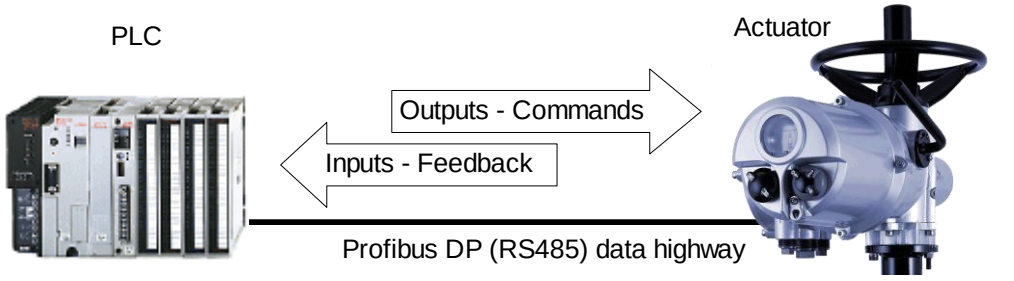


Fig 26: Input and Output Data Direction

- **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 extra relay indication board 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 & IQT	CVA	Q	ROMPAK	Skil/EH
Profibus over the network					
Open	✓	✓	✓	✓	✓
Close	✓	✓	✓	✓	✓
Stop	✓	✓	✓	✓	✓
Emergency Shut Down	✓	✓	✓	✓	✓
Analogue Position Demand	✓	✓	✓	✓	✓
Partial Stroke	✓	✓	✓	✓	✓
Multiport Position ④	✗	✗	✗	✗	✗
Relay output DO-1	✓①	✗	✗	✗	✗
Relay output DO-2	✓①	✗	✗	✗	✗
Relay output DO-3	✓①	✗	✗	✗	✗
Relay output DO-4	✓①	✗	✗	✗	✗
Local Actuator Controls					
Open	✓	✗	✓	✓	✓
Close	✓	✗	✓	✓	✓
Stop	✓	✓	✓	✓	✓
Direct Hard-Wired Inputs					
Open	✓	✗	✓②	✓②	✓
Close	✓	✗	✓②	✓②	✓
Stop/Maintain	✓	✗	✗②	✗②	✓
Emergency Shut Down (Network Disable)	✓	✗	✓②③	✓②③	✓
Open Interlock (active prevents opening)	✓	✗	✗	✗	✗
Close Interlock (active prevents closing)	✓	✗	✗	✗	✗

See notes on next page.

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 or ROMPAK ranges*
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', or 'Run' for CVA.
- On IQ/IQT/Skil/EH 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 to 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 DO-1 to DO-4**
  These 4 commands are used to energise and de-energise the internal relays on the extra relay indication 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. Alternatively, 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.

IQ / IQT, Skil/EH controls priority

Local controls go direct to the main board and override any Profibus controls and any hard-wired controls except hard-wired ESD. An actuator that has Local selected cannot be controlled over the Profibus network.

In addition, for the IQ / IQT and Skil/EH actuators, 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 / IQT and Skil/EH to select the required function. When selected for control, the hard-wired inputs take priority over the Profibus controls, but are subordinate to the local controls (except for ESD). If there is a Profibus command still present when a Local or Hard-wired command is removed, the Profibus command will re-assert itself.

In the case of the hard-wired input for ESD, this can be configured either as an ESD/HW_DI-4 signal or as a ‘Profibus Command Inhibit’ to prevent network control signals from moving the actuator.

High Priority	←←←←←←←←←←←←←←←←←←←←←←←←←←←←←		Low Priority
Local Stop②	Local Close①	Hard-Wired Close	Profibus Close③
	Local Open①	Hard-Wired Open	Profibus Open③
Hard-Wired ESD②		Hard-Wired Stop④	Profibus Stop③
Profibus ESD②③			Profibus Position③
			Profibus Part Stroke③

① Mechanically interlocked to prevent both at the same time
② The IQ/IQT can be set so that Local Stop has a higher priority than ESD
③ Only one Profibus command is permitted at a time
④ If a Profibus command is applied whilst Hard-Wired Stop is present, stop is cancelled

Fig 27: IQ and IQT Controls Priorities

CVA controls priority

In the case of the CVA, whilst the actuator is in the ‘RUN’ mode it is able to be commanded from the field unit. When the actuator is in the ‘STOP’ mode command is inhibited. Refer to the CVA manual for more details. When ‘RUN’ is selected, control priorities are as indicated below. The actuator will always respond to the last Open/Stop/Close input or DV command.

If the command is an ESD, then it will generally override any other command.

High Priority	→→→→→→→	→→→→→→→	→→→→→→→	Low Priority
ESD	Close	open	stop	positioning

Fig 28: CVA Controls Priorities

Q controls priority

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 button or contact 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.

High Priority	←←←←←←←←←←←←←←←←←←←←←←←←←←←←←		Low Priority
Local Stop②	Local Close①	Hard-Wired Close②	
	Local Open①	Hard-Wired Open②	
Hard-Wired ESD		Profibus Close②③	Hard-Wired Stop/Maintain④
Profibus ESD③		Profibus Open②③	Profibus Position④③
			Profibus Stop③⑤

① Mechanically interlocked to prevent both at the same time
② The action depends on the Actuator Control Priority setting
③ Only one Profibus command is permitted at a time,
④ A Profibus Position command must not be applied whilst Hard-Wired Maintain is present
⑤ A Profibus Stop command is not possible if Hard-Wired Maintain is present

Fig 29: Q Controls Priorities

ROMPAK controls priority

In the case of the ROMPAK, the actuator is able to be commanded either from the local controls, the field unit, or the Remote Auxiliary Inputs. When the actuator is in local, only ESD and the local commands can control the actuator. When Remote is selected, control priorities are as indicated below. The actuator will always respond to the last Open/Stop/Close input or DV command.

If the command is an ESD, then it will generally override any other command. It is possible for Local Stop to override ESD by setting the actuator for this priority.

High Priority	←←←←←←←←←←←←←←←←←←←←←	Low Priority
Aux Input ESD	Aux Input Stop	Master Station Stop
Master Station ESD	Aux Input Close	Master Station Close
	Aux Input Open	Master Station Open
		Set DV

Fig 30: ROMPAK 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 POS_DV value of 100%, are not acted upon.

5.1.4 The IQ 'S' contacts (Profibus DOs) 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 extra relay indication 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

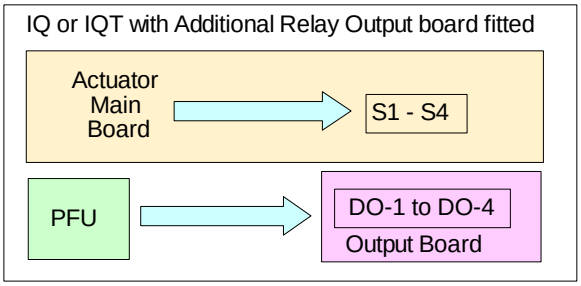


Fig 31: IQ and IQT relay outputs DO-1 to DO-4

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.

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.

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/IQT/Skil/EH ESD/DI-4 input so that the 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.

Register Name		Status Feedback	IQ	IQT	Q	CVA	EH/ Skil	ROM PAK
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	✓	✓	✓	④	✓	✓
IDATA2/0	Register 0 Bit 8	Thermostat Tripped	✓	✓	✓	⑥	②	×
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	✓	✓	×	×	③	×
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	×	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 Back up (1)	✓	✓	✓	⑤	✓	✓
IDATA4/6	Register 1 Bit 14	1 or 2 Channels Available	✓	✓	✓	⑤	✓	✓
IDATA4/7	Register 1 Bit 15	SR (0) or FR (1) mode	✓	✓	✓	⑤	✓	✓

Note: ① – This bit is reported when within the slow mode band, but does not affect the actuator
② - This bit represents the Fault Relay Output on EH / Skil
③- This bit indicates the state of the Hardwired Partial stroke input on EH / Skil
④- Test mode, refer to CVA actuator information
⑤- Dual channel option not available for CVA
⑥- Thermostat is tripped when CVA is set to hand operation

5.2.1 Digital Inputs

- **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, Network 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.

  CVA only. In addition to the normal Thermostat function described above. If a manual override facility is fitted, this can only be operated

if the motor is de-energised. Engaging the manual override breaks the thermostat switch which prevents motor operation.

- ❑ **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.

- **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/IQT/Skil/EH 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/IQT/Skil/EH 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/IQT/Skil/EH 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/IQT/Skil/EH 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 Network 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.

- **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, PDM programmes and the associated device description files, or (for the IQ/IQT only) using the Infra-red tool, 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 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 partial 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 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; 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 & IQT	Q	CVA	Skil/ EH	ROM PAK
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 actuators automatically scale the valve position value reported from the setting of the limit switches, although 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 complement 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	×	×	×	×	×	×	×	×	×	✓

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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 LEDs 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.

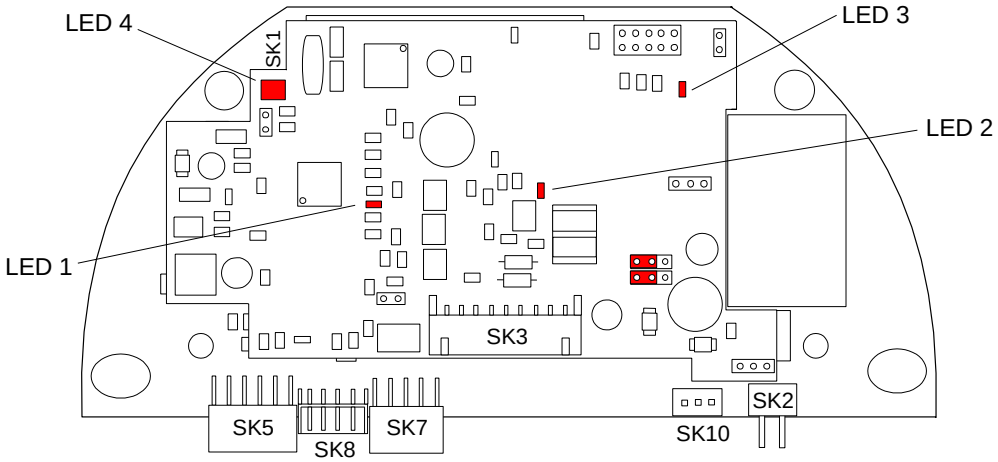

Fig 32: Single Channel Profibus card LED positions

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 discrimination 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.

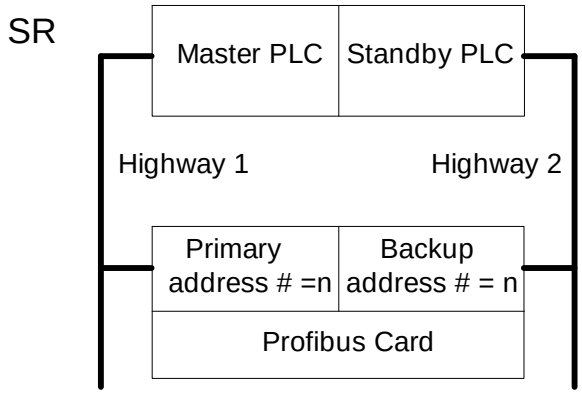

Fig 33: System Redundancy – Two highway redundancy

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 communication 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 each have an address 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 discrimination 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.

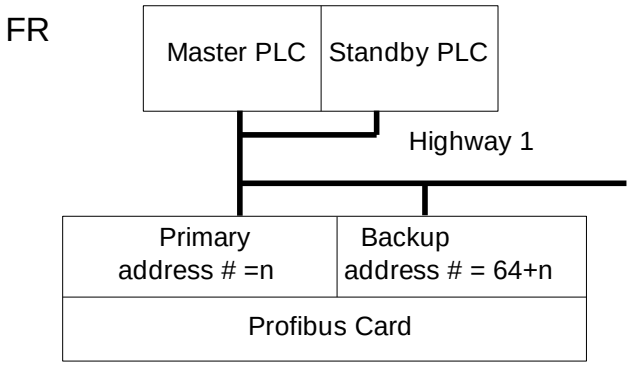

Fig 34: Flying Redundancy – One highway redundancy

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 LEDs 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 card's two main processors.

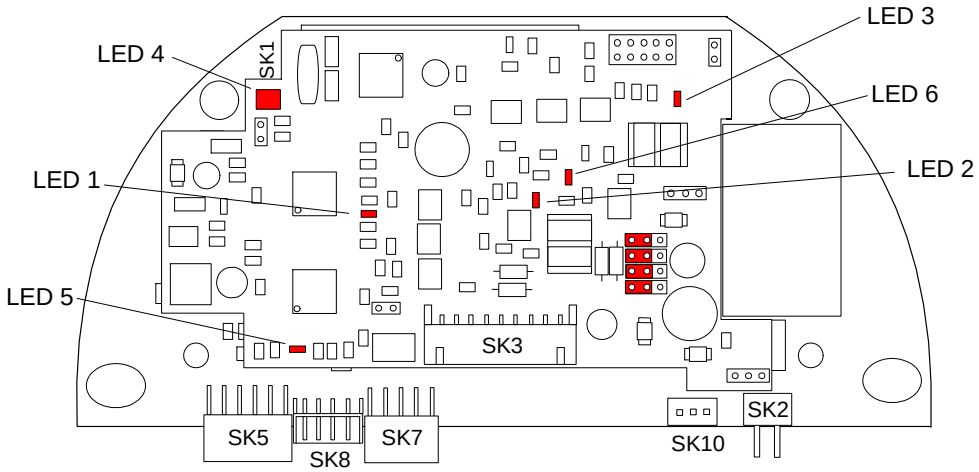

Fig 35: Dual Channel Profibus card LED positions

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 master 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).

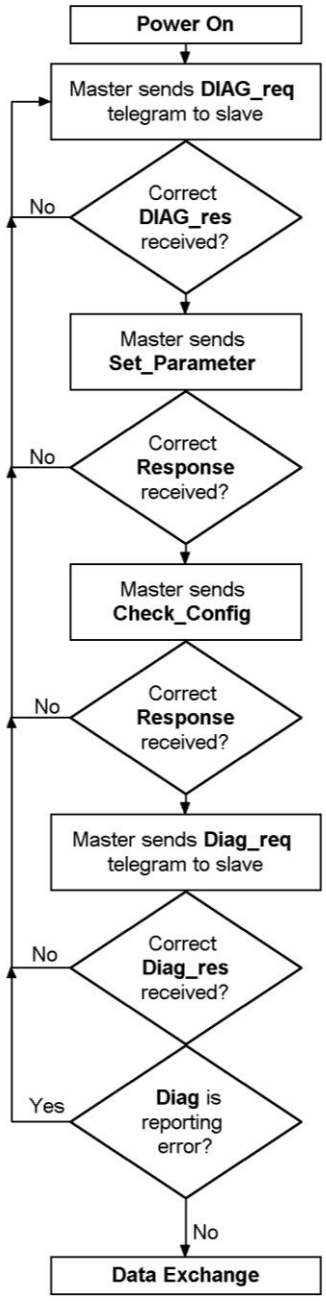

Fig 36: Profibus Start Up Sequence

6.8 Static Diagnostics

Within the standard Profibus Diagnostics reply is a bit named ‘Static Diagnostic’. In the unlikely event that the PFU loses communication with the main board to which it is connected, this bit will be asserted to alert the user to this situation. If the PFU is unable to communicate to the main board, the data which is sent in data exchange communication is potentially stale (not current). Therefore if the static diagnostic bit is raised the user should be aware not to utilise that data and to wait for the bit to be reset. If the bit does not de-assert itself in a timely manner (i.e. after about 5 minutes) the user should power cycle the actuator to regain communications.

The static diagnostic bit is not expected to be seen under normal operating conditions.

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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:

Param. 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

Param. 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, 12-CVAL, 13-CVAQ, 14- ROMPAK	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 make 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.

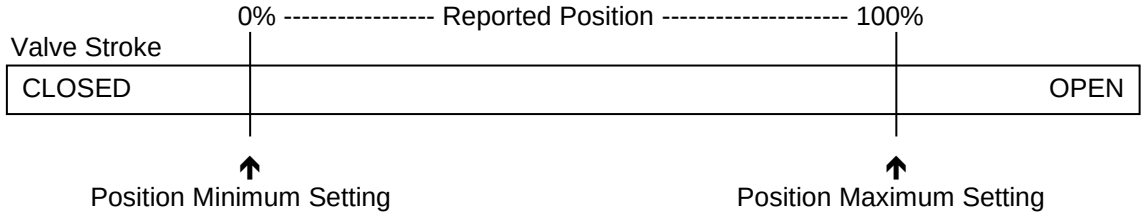

Fig 37: Limited Range Position Control and Reporting

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.

Not supported by CVA.

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.

Not supported by CVA.

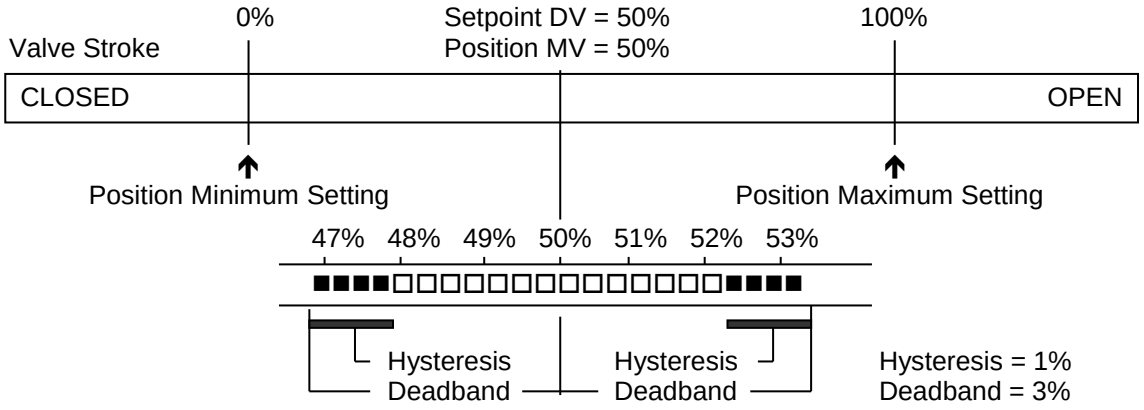

Fig 38: Deadband and Hysteresis settings

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.

Not supported by CVA.

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 overrun 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 communication 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 IQ/IQT/Skil/EH 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/Skil/EH 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 actuator 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	
DI-4 = ESD, Data Logger enabled	0	0000 hex
DI-4 = Network disable, Data Logger enabled	1	0001 hex
DI-4 = ESD, Data Logger disabled	2	0010 hex
DI-4 = 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. 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. 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
32	Torque feedback	R	0-120%, 0000 to 0078 hex	0
33	Position feedback	R	0-100.0%, 0000 to 03E8 hex	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 hex	0
38	Multiport Number of ports	R/W	2-10, 2 to 000A hex	0
39	Multiport Active ports	R/W	0-1023, 0 to 03FF hex	3FF
40①	Configure Data Exchange Data	R	1-10, 1 to 000Ahex	0

Parameter No.	Data	Read / Write	Value / Range	Default Value
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
69	Reserved	R	1 byte	0
Parameters that follow, only available for software versions PNIC 1.23 and PNIC1.42 or newer. These are 'Actuator Parameters' and are for the IQ and IQT range ONLY.				
70-77	If Torque Profiling is selected, these parameters contain the variables used for this. Rotork use only.	R	16 bytes	0
78	Function for Indication contact S1	R/W	Bit 0: 0-Normally Open, 1 – Normally Closed. Bits 1 to 15: See separate table 'S contact functions'.	0000
79	Function for Indication contact S2	R/W		0001
80	Function for Indication contact S3	R/W		0002
81	Function for Indication contact S4	R/W		0003
82	Position trip when function set to 'PO' contact S1	R/W	0-100%, 0 to 0064 h	0001
83	Position trip when function set to 'PO' contact S2	R/W	0-100%, 0 to 0064 h	0001
84	Position trip when function set to 'PO' contact S3	R/W	0-100%, 0 to 0064 h	0001
85	Position trip when function set to	R/W	0-100%, 0 to 0064 h	0001

Parameter No.	Data	Read / Write	Value / Range	Default Value
	'PO' contact S4			
86	Function for Indication contact S5	R/W	Bit 0: 0-Normally Open, 1 – normally closed. Bits 1 to 15: See separate table 'S contact functions'.	0001
87	Function for Indication contact S6	R/W		0003
88	Function for Indication contact S7	R/W		000D
89	Function for Indication contact S8	R/W		002B
90	Position trip when function set to 'PO' contact S5	R/W	0-100%, 0 to 0064 h	0001
91	Position trip when function set to 'PO' contact S6	R/W	0-100%, 0 to 0064 h	0001
92	Position trip when function set to 'PO' contact S7	R/W	0-100%, 0 to 0064 h	0001
93	Position trip when function set to 'PO' contact S8	R/W	0-100%, 0 to 0064 h	0001
94 - 96	For future use	R		0000
97	ESD direction	R/W	00: Close, 01: Open, 10: Stationary 11: Ignore ESD	0000
98	ESD contact	R/W	0: ESD break contact 1: ESD make contact	0000
99	ESD bypasses the actuator interlocks	R/W	0: bypass disabled 1: bypass enabled	0000
100	ESD bypasses the Thermostat trip	R/W	0: bypass disabled 1: bypass enabled	0000
101	ESD bypasses Local stop	R/W	0: bypass disabled 1: bypass enabled	0000
102	Bits0 to 5 - reserved Bit6 – Interlocks enable / disable Bits7 to 15 - reserved	R	0: Interlocks Enabled 1:Interlocks Disabled	0001
103	Open limit position	R	-	001A0000
104	Interrupter timer start limit	R/W	0: Around close limit 1:Around open limit	0000
105	Interrupter timer off time	R/W	1-99secs, 0 to 0063h	0002
106	Interrupter timer on time	R/W	1-99secs, 0 to 0063h	0003
107	Interrupter timer activated when opening if below xx%	R/W	0-100%, 0 to 0064 h	0028
108	Interrupter timer activated when closing if below xx%	R/W	0-100%, 0 to 0064 h	002D
109	Bits0 to 4 - reserved bit5 – Language Bits6 to 15 - reserved	R	0: English 1: Alternative language	0000
110	Reserved	R	-	0000
111	ID Main	R	16bytes ASCII	-
112	ID Locals	R	16bytes ASCII	-
113	ID Resolver	R	16bytes ASCII	-
114	ID Power	R	16bytes ASCII	-

Parameter No.	Data	Read / Write	Value / Range	Default Value
115	ID Option1	R	16bytes ASCII	-
116	ID Option 2	R	16bytes ASCII	-
117	ID Option 3	R	16bytes ASCII	-
118	ID Option 4	R	16bytes ASCII	-
119	Manufacture notes	R	48bytes ASCII	-
120	General Notes	R/W	67bytes ASCII	-

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 (in conjunction with Parameter 26) allows the actuator to be positioned using the same values 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	DO-4 control	DO-3 control	DO-2 control	DO-1 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**
  Parameters 44 to 54 are 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**
  Parameters 55 to 65 are 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.

7.2.12 Function for indication Contacts S1 – S8 (Parameters 78-81 and 86-89)

These parameters enable the indication contacts S1 to S8 to be set to trip to any one of the following functions. The contact can be set to Normally Open or Normally Closed using bit 0.

Value, Bits 1-15 (hex)	Description
0	Closed end position – indicates true limit position.
1	Open end position – indicates true limit position.
2	Intermediate position – indicates that the actuator is above or below a configurable position.
3	Torque trip closing – indicates that the torque switch tripped when the actuator was closing.
4	Torque trip opening – indicates that the torque switch tripped when the actuator was opening.
5	Torque trip any position – indicates that the torque switch has tripped.
6	Torque trip mid travel – indicates that the torque switch tripped when the actuator was travelling in either direction and was not at an end limit.
7	Actuator closing – indicates that the actuator is closing.
8	Actuator opening – indicates that the actuator is opening
9	Actuator output rotating – indicates centre column rotation.
0A	Motor Stalled – indicates the motor has stalled.
0B	Battery low – indicates that the battery is low.
0C	Hand operation – indicates that the centre column is rotating without electrical power to the motor.
0D	Blinker – indicates, by opening and closing the relay that the centre column is rotating.
0E	Local Stop – indicates that the local stop has been selected.
0F	Open Interlock active – indicates that the open interlock is active.
10	Close Interlock active – indicates that the close interlock is active.
11	Interlock active – open and/or close interlock active.
12	ESD signal present – indicates that the ESD is active.
13	Lost Phase – indicates that a phase loss has been detected.
14	Local selected – indicates that local has been selected.
15	Remote selected – indicates that remote has been selected.
16	Actuator fault icon present
17	+24V good – indicates that the customer 24V supply is ok.
18	Actuator Motor is Running
19	Valve fault icon present – indicates a valve error
1A	Actuator Thermostat tripped
1B	Control fault icon present – Indicates a control error

7.2.13 Position Trip for indication Contacts S1 – S8 (Parameters 82-85 and 90-93)

These parameters select the position for the contact to trip at if the Intermediate position contact function has been selected.

7.2.14 ESD Parameters (Parameter 97 - 101)

The ESD signal is used to operate actuators to a pre-determined state, under shutdown conditions. There are a number of settings that can be made for this operation.

- **ESD direction (Parameter 97)**
  This parameter sets the direction of operation in the event of an ESD signal being applied to the actuator.

- **Parameter ESD Contact (Parameter 98)**
  This parameter sets the polarity of the ESD contact, either Normally Open or Normally Closed.

- **ESD Bypasses the actuator interlocks (Parameter 99)**
  This parameter selects whether an ESD will override the interlock setting on the actuator.

- **ESD Bypasses the Thermostat trip (Parameter 100)**
  This parameter selects whether an ESD will continue to operate in the event of a Thermostat trip.

- **ESD Bypasses Local Stop (Parameter 101)**
  This parameter selects whether an active ESD will still operate the actuator even if it is in Local Stop.

7.2.15 Interlock enable (Parameter 102)

This parameter indicates if the interlocks are enabled or disabled on the actuator.

7.2.16 Open Limit position (Parameter 103)

The DTM decodes this parameter to show the number of turns that the actuator has been set to.

7.2.17 Interrupter Timer parameters (104 – 108)

The interrupter timer enables pulsed ‘start / stop’ operation as a response to local or remote control commands. This can be used to extend the valve stroke time. There are a number of parameters that can be set up for this.

- **Interrupter Timer start limit (Parameter 104)**
  This parameter sets up the limit around which the interrupter timer will operate, whether the open or the closed limit.

- **Interrupter Timer off time (Parameter 105)**
  This parameter sets up the time that the interrupter timer will stop the actuator for.

- **Interrupter Timer on time (Parameter 106)**
  This parameter sets up the time that the interrupter timer will start and run the actuator.

- **Interrupter Timer activated when opening if below xx% (Parameter 107)**
  This parameter sets the position that the interrupter timer start to be active when the actuator is travelling in the open direction.

- **Interrupter Timer activated when closing if above xx% (Parameter 108)**
  This parameter sets the position that the interrupter timer start to be active when the actuator is travelling in the close direction.

7.2.28 Language used (Parameter 109)

This parameter indicates if the language used in the local actuator display is the standard English language or an alternative one.

7.2.28 IDs and notes (Parameters 111 - 120)

The 'ID' parameters contain information about the serial numbers of the Printed circuits boards inside the actuator. The Manufacturing notes section contains details of the manufacture of the actuator i.e. wiring diagram.

The final section 'General notes' is available to be written to for any notes required.

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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 container. A typical configuration screen is illustrated below.

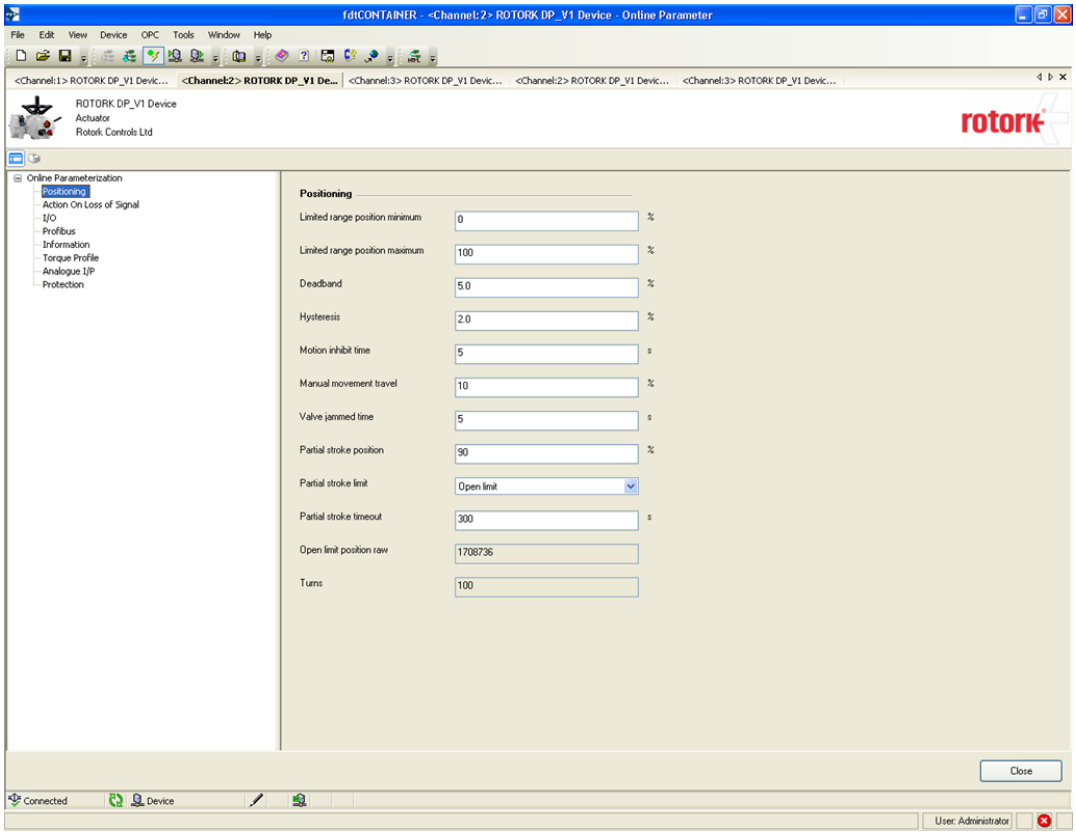

Fig 39: Rotork DTM running in the M&M FDT container

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. The screens displayed will be dependent on the software version of the profibus card and the actuator type.

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.

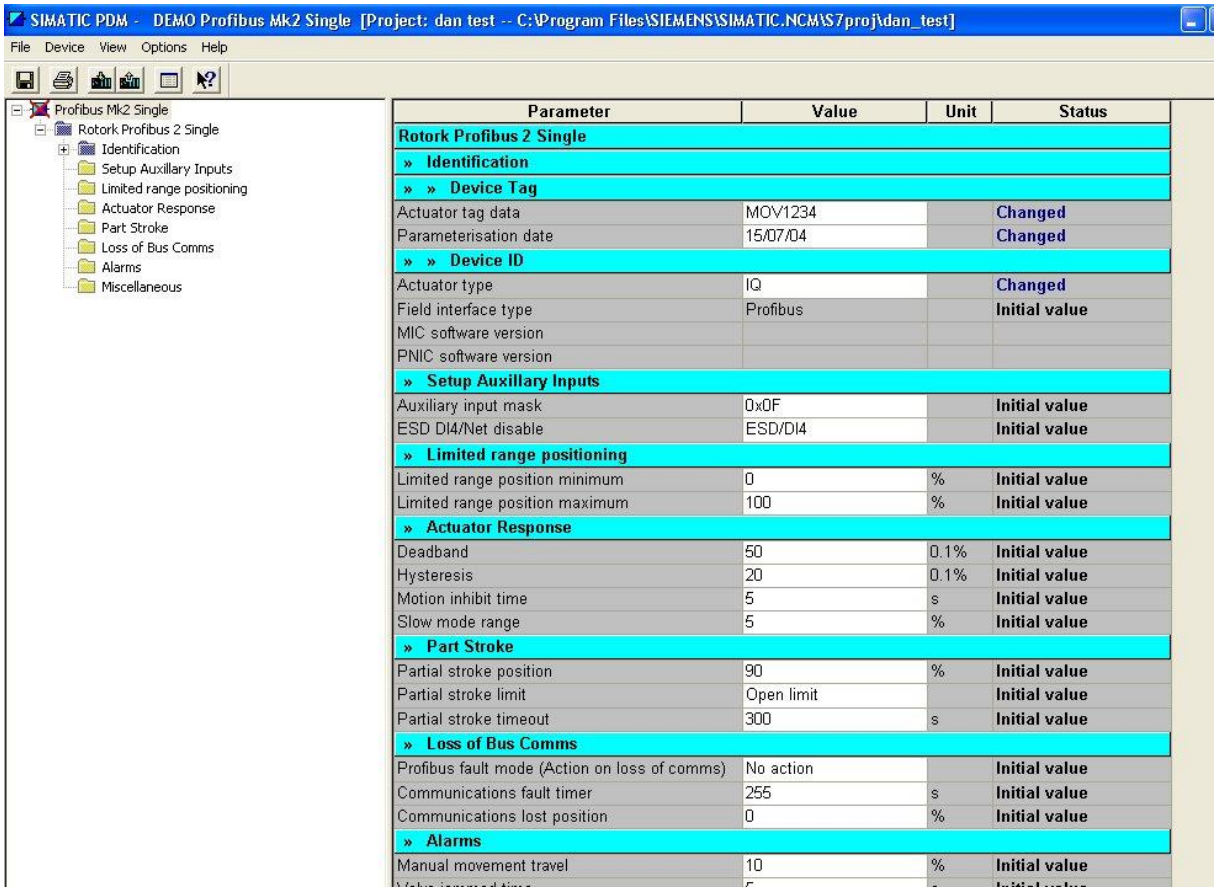

Fig 40: Rotork EDD running in the Siemens PDM application

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 the network address in the PFU

The IQ and IQT actuator includes an infra-red communication port for setting the network address for the actuator. The other actuators require the address to be set up over the Profibus network using a class 2 master.

8.3 Setting up an IQ or IQT with the Infra-red 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.

Note: Unless parameter 25 (Permit GSD parameterisation) is set to '0', any modification from the GSD setting to the parameters listed in this section will be lost in the event of a power cycle or bus reset (if the actuator is connected to a master on the Profibus highway).
This is because the master will write to the Profibus card with the settings that it has for that device in its configuration file, created from the GSD.

Parameter updates should either be completed with an update to the GSD file OR if using the Infra-red tool, parameter 25 must be set to '0'.

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 other 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 require a power cycle of the actuator 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.

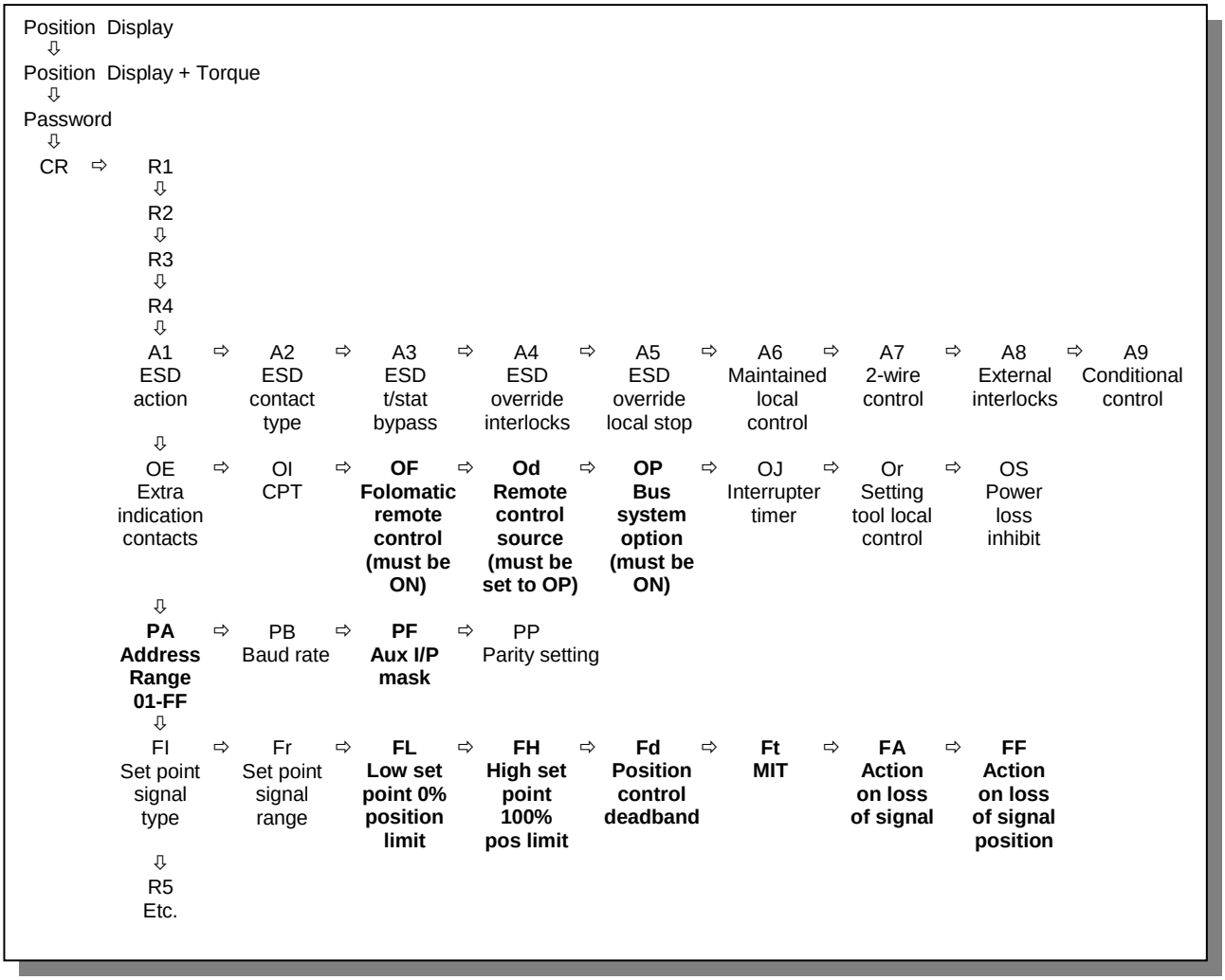

Fig 41: Setting tool menu structure and PFU settable parameters

8.3 Setting up a Skil or EH with the Infra-red Setting Tool

The Skil and EH actuator includes an infra-red communication port for setting the actuator performance, limit switches and so on. This communication link is also used to select the remote source for the actuator.

The choices for remote source are as follows:

- **[OF]** – No remote control from any source.
- **[rE]** – Remote control from Remote Digital Inputs **ONLY**.
- **[OP]** – Remote control from an Option card, control from remote Digital Inputs possible if the Auxiliary mask set correctly.
- **[OE]** - Remote control from an Option card, control from remote Digital Inputs possible if Auxiliary mask set correctly. **BUT** the ESD input is Hardwired i.e. the Auxiliary mask does not apply to this particular input and the ESD will operate as if the setting were **[rE]**.

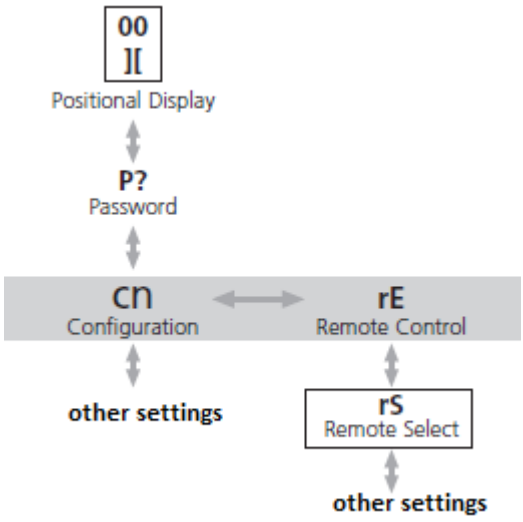

Fig 42: Skil and EH setting tool menu structure showing remote select

Refer to the installation manual of the actuator for more details.

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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