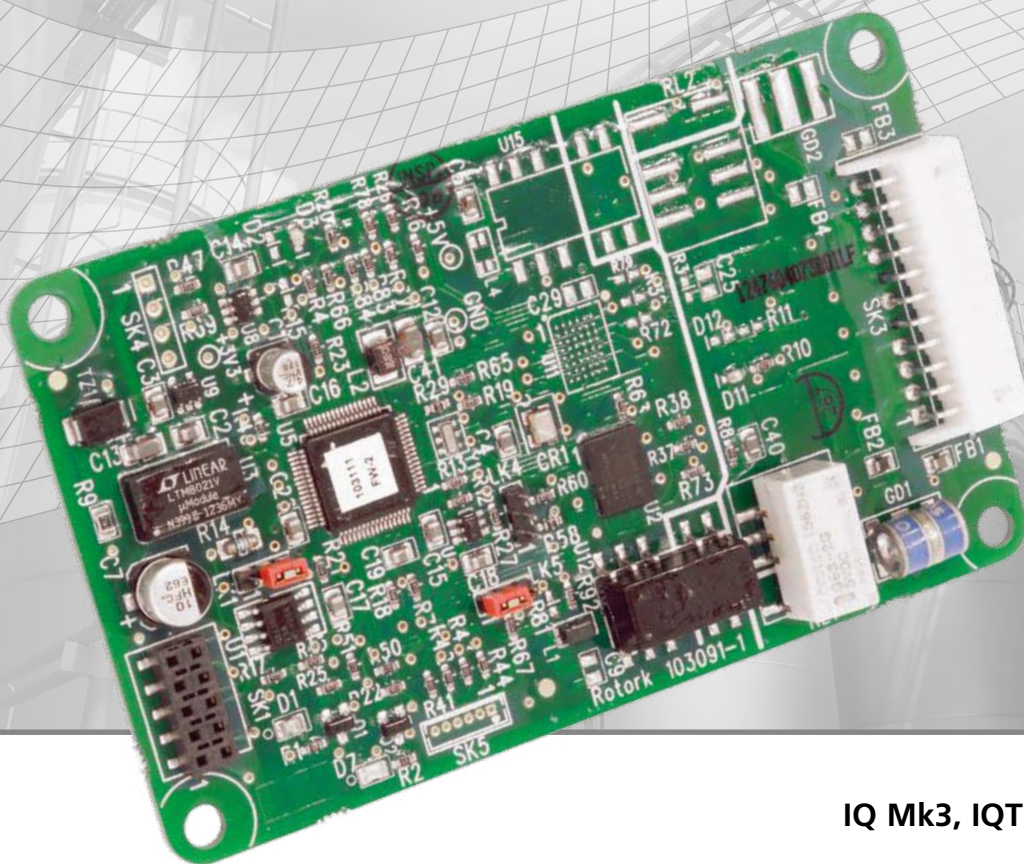# rotork®

Profibus DP Option Card
Technical Manual

IQ Mk3, IQT Mk3, SI₃, CVA, CMA

Keeping the World Flowing

C E

The Profibus card described in this manual contains static-sensitive devices. Suitable precautions, such as wearing an earthed anti-static wrist strap, should be taken before handling the card. It should be kept in an anti-static bag or box while it is not fitted within an actuator.

Note 1:

Throughout this manual the Profibus DP option module may be referred to as the module, the card or the Profibus Field Unit (PFU).

Note 2:

The information in this manual relates to the following firmware releases:

- Profibus Network Interface Card V101

The manual can be used with other versions, but be aware that there may be differences.

Note 3:

This manual assumes a pre-existing level of knowledge of using the actuator that the Profibus module is installed inside. It is recommended that the technical manual for the actuator is read prior to setting up Profibus with the actuator. Manuals can be downloaded from the Rotork website.

Note 4:

The Profibus Module described in this manual is suitable for inclusion in Rotork IQ Mk3, IQT Mk3, SI$_3$, CVA (only firmware version 1.14 or later) and CMA range actuators.

Note 5:

Inputs are the status messages from the actuator and outputs are the command messages to the actuator.

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

© The contents of this document are copyright and must not be reproduced without the written permission of Rotork Controls Ltd.

The name Rotork is a registered trademark

Windows is a registered trademark by Microsoft Corporation

Profibus is a registered trademark by PROFIBUS Nutzerorganisation e.V., Germany

Contents

rotork

Contents

Contents

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 Profibus 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.
RS-485	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 RS-485 fieldbus that is correctly terminated in its characteristic impedance. Each Segment can include up to 32 devices.

Abbreviations

ACTCON	Actuator Control		PDM	Process Device Manager
Comms	Communications		PFU	Profibus Field Unit
DIO	Digital Input/Output Board		PORTCM	Port Command
DTM	Device Type Manager		PORTST	Port Position
DV	Desired Value (Positioning)		POS_DV	Position Desired Value
EDD	Electronic Device Description		RAM	Random Access Memory
FDT	Field Device Tool		ROM	Read Only Memory
FR	Flying Redundancy		RTU	Remote Terminal Unit
GSD	Generic Station Description		SR	System Redundancy
O_STAT	Output Status		SW	Software

References

Profibus Guideline 2.112 - Installation Guideline for Profibus DP/FMS

Profibus Guideline 2.212 - Specification Slave Redundancy

Profibus Guideline 2.152 - Specification for Profibus Device Description and Device Integration – EDD

Profibus Guideline 2.162 - Specification for Profibus Device Description and Device Integration – FDT

Certification

All Rotork Profibus DP option modules conform to the PNO specifications, IEC61158 and EN50170.

Profibus **DP-V0** cyclic and Profibus **DP-V1** acyclic messages are supported.

Rotork's DTM is certified by the FDT group.

Profibus DP option modules conform to the PNO specifications, IEC61158 and EN50170. Both Profibus DP-V0 cyclic and Profibus DP-V1 acyclic communication are supported.

The inclusion of acyclic message capability (DP-V1) allows for system maintenance and asset management tools to be used. Electronic data sheets are provided in GSD and EDD formats and a DTM is provided for use with FDT technology.

- Profibus DP-V0 and DP-V1 compliant

- Dual channel cards have RedCom redundancy capability, both FR and SR modes

- GSD, EDD, FDT/DTM Device Description files available

- Supports Siemens PDM and FDT applications

- Address changes by class 2 master, FDT or PDM applications (all actuators)

- Address changes by Infra-red link and *Bluetooth* (where supported by actuator)

- Zero internal stub length

- Mounted within the double-sealed actuator enclosure

- Settings are non-intrusive and can be made over the data highway

The Profibus DP option 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.

CVA

CMA

IQ3

SI3
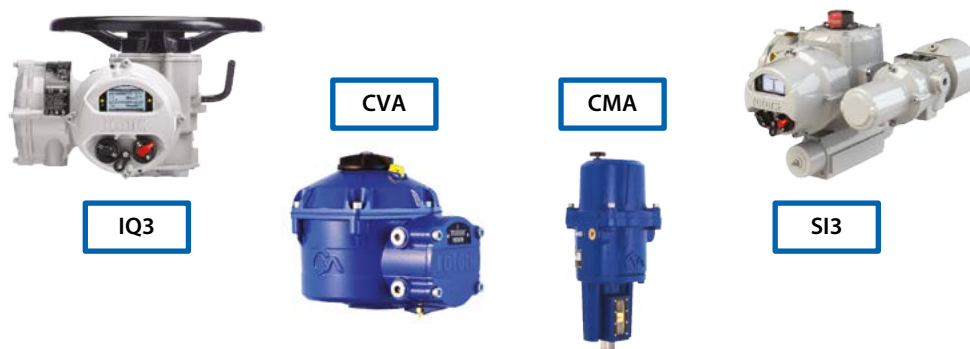
Fig 1:   The Profibus DP Module Option Card Actuator Compatibility

1.1   General

The Profibus module is available in two versions:

- Single channel Profibus DP
- Dual channel Profibus DP with independent isolated Profibus highways for redundancy

The Dual channel version can be operated in one of two modes:

- Simple dual channel mode for systems that do not support full RedCom diagnostics
- RedCom dual channel mode for RedCom compliant systems

The simple dual channel mode does not include Redstate diagnostics whereas the RedCom mode fully supports RedCom (Redundant Communication) extensions to the DP-V1 protocol as specified by PNO for systems using either FR (Flying Redundancy) or SR (System Redundancy) configurations.

The dual channel Profibus versions share the same physical module; the two modes are configured using different GSD files. The RedCom dual channel GSD file configures use of the extra messages for RedCom systems.

Where Redcom is not required or when PLCs cannot accept the extended diagnostic messages from RedCom slaves, the Simple dual channel GSD file should be used which will configure Simple dual channel mode.
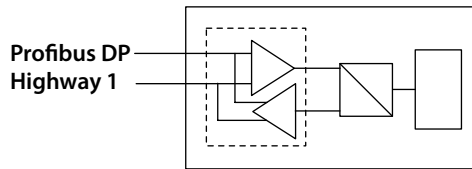
Single Profibus DP Highway
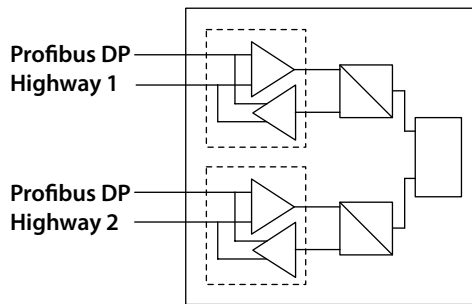
Simple Dual Profibus DP Highway Connections
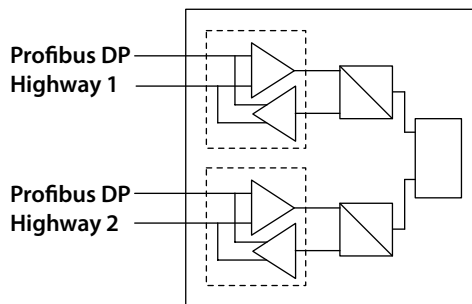
RedCom Dual Profibus DP Highway Connections

Fig 2:   The Types of Profibus DP Module Option Card

Communication Media	RS-485 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

2.1   Mechanical properties

The Profibus DP module is installed inside the actuator, mounting directly onto the main control board of the actuator using 4 Torx screws.

All the connectors are polarised to prevent incorrect insertion.

- **Profibus Field Unit (PFU)**

This small printed circuit board carries the Profibus DP, RS-485 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 Dual or RedCom Dual.
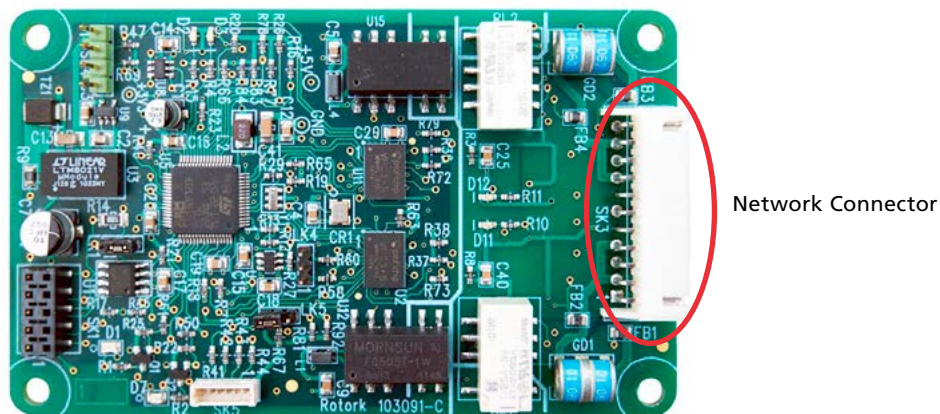
Network Connector

Fig 3:   The Profibus dual channel PFU, showing the network connector

2.2   Electrical Properties

The PFU connects directly to the main control board 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 to +70 °C

- Storage temperature: -50 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.

3.1   Inside an IQ Mk3, IQT Mk3 or SI₃ actuator

The PFU is suitable for fitting into IQ/IQT Mk3 actuators with wiring diagrams containing the letter 'P', for instance; 100P2000 and 310P3000. The connections and fitting in an IQT are similar to that for an IQ and the following information effectively relates to both actuator types. The PFU can be located onto any of the two slots available on the IQ/IQT Main PCB, or onto the second layer slots if more than two option cards are present.

The Profibus card must be correctly profiled and loaded with the appropriate links to match any necessary settings for the card. The illustration below shows the IQ/IQT version of the PFU.
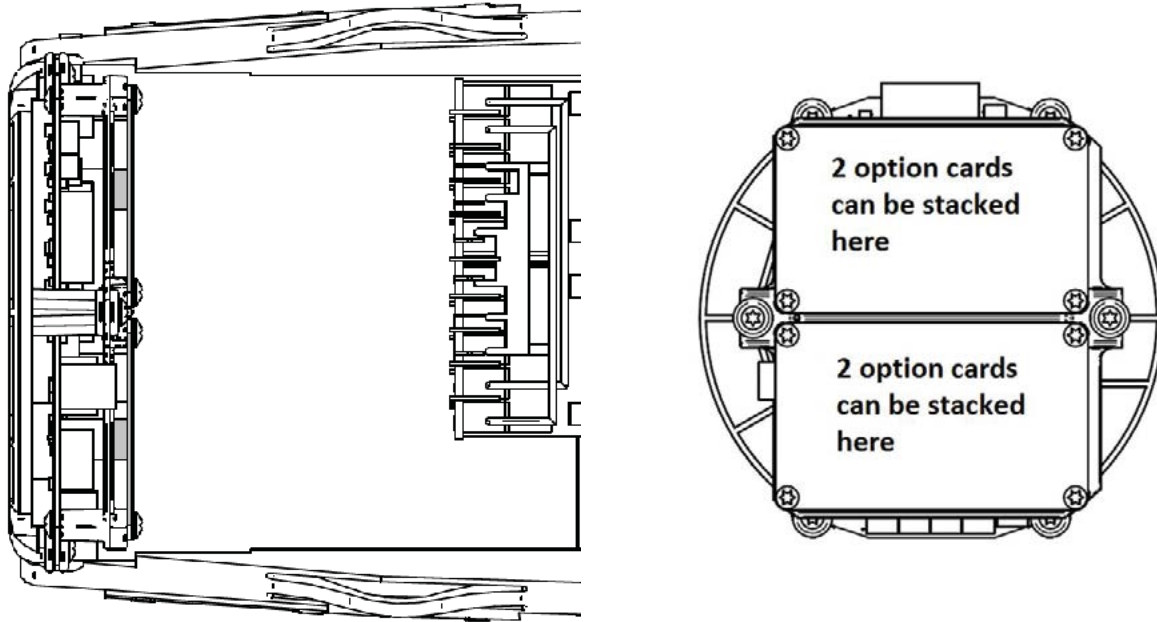
Fig 4:   The Profibus card profiled for the IQ or IQT actuator

Within the actuator the remote inputs are always present and are conditioned by the auxiliary mask setting 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 PFU should be replaced or fitted only in a suitable environment. The actuator must be made electrically safe before opening any covers. The electrical housing cover should be removed after unscrewing the four 6mm Allen machine screws. Unplug the electrical housing loom from the control board and remove the cover. Unplug the grey ribbon cable from the edge of the control board and unplug the black plastic carrier frame from the frame legs. Unplug the loom from the PFU card. Unscrew the Torx 20 (15 if second layer is used) screws holding the PFU card into the frame and carefully unplug the PFU card from the control board. The replacement board is fitted in the reverse order to removal. The wiring harness connectors are polarised so that only the correct one will fit its mating part on the circuit boards. Don't forget to re-connect the grey ribbon cable to the edge of the control board.

If the operation is to fit a PFU for the first time, then the necessary wiring loom must be added to the internal wiring harness of the actuator. The actuator wiring diagram shows the connectors and harness used. The wiring harness is fitted inside the actuator before attempting to fit the PFU. This requires that you remove the terminal bung, which is held in place by a large circlip. Be careful to attach the wiring loom to the correct terminals, which are numbered. Re-fit the terminal bung.

Once the loom is in place, connect it to the PFU, then fit the PFU to the actuator main board connector. Attach the PFU to the frame, using the Torx 20 (or 15) screws.

Once the module is fitted, the actuator should be re-assembled.

Once power is applied, the field unit parameters should be checked and corrected, where necessary.

Profibus parameters can be set and adjusted either by using the Infra-red and *Bluetooth* setting tools or by Insight 2 using *Bluetooth*. The parameter setting procedure is covered by the IQ Mk3 Full configuration, status and monitoring user manual, PUB002-040, available on the Rotork web site, www.rotork.com

3.2   Inside a CVA actuator

The single channel PFU is suitable for fitting into CVA actuators. When factory-fitted, the wiring diagram will be CXX-90 (where X can be any value). This 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. The PFU should be replaced or fitted only in a suitable environment.

The illustration below shows the position of the option board on the main control board:
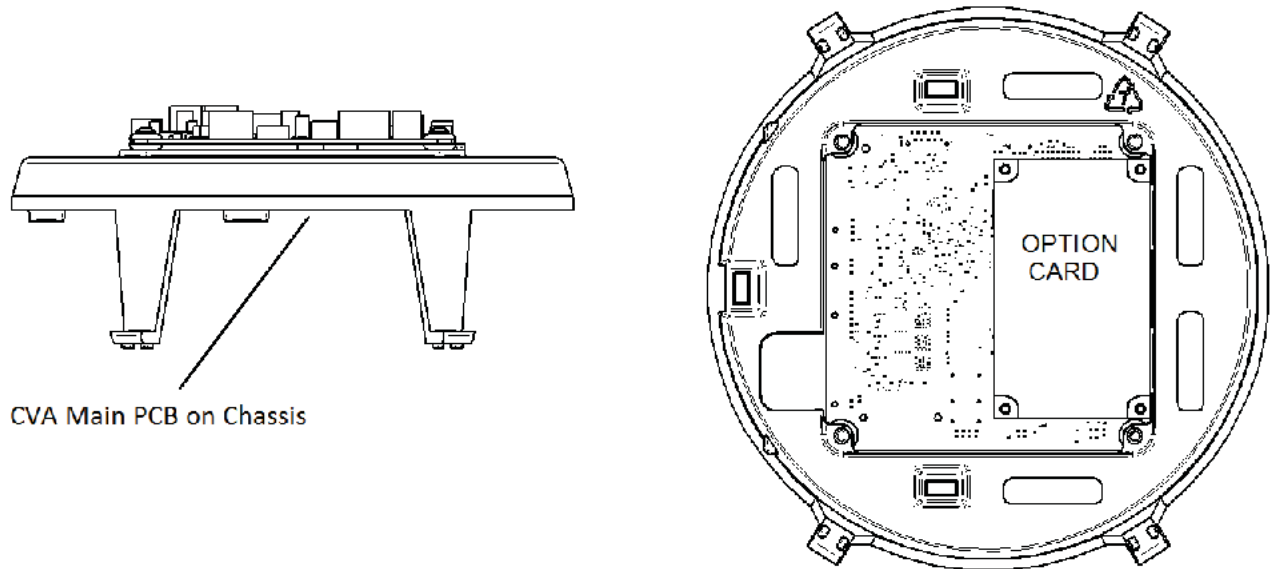
Fig 5:   The Profibus card profiled for the CVA actuator

To fit a PFU card, begin by removing power from the actuator and wait until the LED on the selector knob stops illuminating. This may take several minutes if a reserve power pack of capacitors is fitted.

Remove the six M10 machine screws from the upper cover and lift it off carefully, while removing its ribbon cable connector from the socket on the Main PCB.

Remove the various wiring looms from the sockets on the edges of the Main PCB, noting carefully where they attach. Each connector is different to avoid error.

Remove the Main PCB in its plastic chassis by gently pushing the chassis legs inwards to release them from a groove in the actuator housing.

Fit the PFU to the underside of the Main PCB using the hardware supplied with the PFU card.

The wiring loom from the actuator terminal bung connects the Profibus network field connections to SK3. If a new card is being fitted as an upgrade, then the actuator will need to have the loom fitted. Remove the terminal bung by removing the circlip and gently pulling the bung. Attach the loom and replace the bung.

The PFU is connected to the control module by a header, SK2.

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 conversions to Profibus or if a replacement card is fitted. To enable the card, the Rotork PDA software Enlight (downloadable from the Rotork web site) is required to be used to change parameter 34. It must be read and then 2048 decimal added to it.

This procedure is best performed by a Rotork Engineer.

3.3   Inside a CMA actuator

The PFU is suitable for fitting into CMA actuators, wiring diagrams MXX-PX (where X can be any value) detail the option card connections on the terminal strip. The PFU module is fitted in the only option board slot inside the CMA electrical housing.

Option location
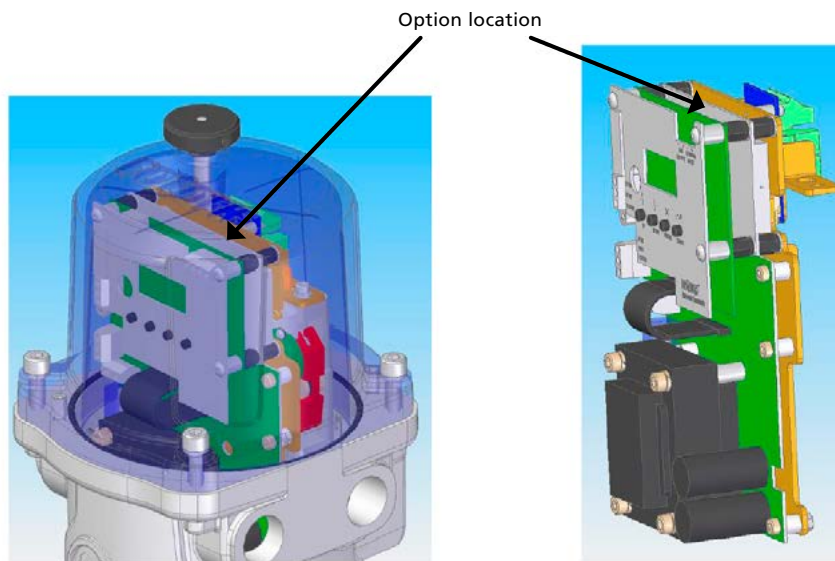
Fig 6:   The Profibus card located in a CMA actuator

Only the single channel Profibus option card can be fitted to this actuator family.

The PFU should be replaced or fitted only in a suitable environment. The actuator must be made electrically safe before opening any covers. The electrical housing cover should be removed after unscrewing the four 6mm Allen machine screws.

The PFU should be fitted in the position shown in the illustrations above. It plugs into the control board at the 10-way header, which is SK2 on the PFU board. There is a wiring loom which brings the Profibus network connection to SK3 on the PFU. This loom comes from SK5 and SK6 of the Profibus terminal board, which in turn is where the field network connections are made.

Connection details are shown in the illustrations on page 15.

The CMA actuator will need configuring, so that it is aware that control from the field is through the PFU card. This is done by accessing the menu structure shown in figures 7, 8, and 9.

Configuration details may be found in the CMA Installation and Maintenance manual, PUB094-003, found on the Rotork web site.

MENU STRUCTURE

BASIC		ADVANCED		INFO	CTR SETUP

BASIC
- **POSIT** — Position
- **SET PT** — Setpoint
- **THRUST or TORQUE** — Thrust Display or Ouput Torque
- **LOCREM** — Local / Remote Operation
- **MANJOG** — Manual Jog
- **TORQ/THRSTC** — Close Torque/Thrust
- **TORQ/THRSTO** — Open Torque/Thrust
- **CL ACT** — Close Action
- **OP ACT** — Open Action
- **CL LIM** — Close Limit (zero)
- **OP LIM** — Open Limit (span)
- **CMD4** — Field Command Signal4
- **CMD20** — Field Command Signal20
- **DBAND** — Deadband
- **STATUS**
- **FLTHST** — Fault History Access
- **ADVANC** — Advanced Menu
- **DEFLTS** — Default Menu Access

ADVANCED
- **CPT 4**
- **CPT 20**
- **STALL TIME**
- **CMD SRCE**
- **INFO**
- **CFG** — Control Setup
- **RELAYS**
- **SPLT RANGE**
- **ACT CFG**

INFO
- **ACT STS**
- **AMP STS**
- **TEMP**
- **SWR VER**

CTR SETUP
- **CTRLAL**
- **IN DMP**
- **LOS TO**
- **LOS ACT**
- **LOS LOW**
- **LOS HI**

RELAYS
- **RLY1 CFG**
- **RLY1 POS**
- **RLY1 FRM**
- **RLY2 CFG**
- **RLY2 POS**
- **RLY2 FRM**

ACT CFG
- **ACT TYPE**
- **ACT SIZE**
- **ENCOD IN**

SP RANGE
- **MIN CMD**
- **MAX CMD**
- **BSRACT**
- **BSRPOS**
- **ASRACT**

DEFAULTS
- **LD CUST**
- **ST CUST**
- **LD FACT**

Fig 7:   CMA menu structure for setting up the actuator: start at the BASIC setting and select the ADVANC button.

ADVANCED MENU STRUCTURE

ADVANCED		CMD SRCE		INFO		CTR SETUP
CPT 4		PRIMARY OPTION		ACT STS		CTRLAL
CPT 20		REM INPUT CTRL		AMP STS		IN DMP
SPEED		2 WIRE PRIORITY		TEMP		LOS TO
STALL TIME		ESD ACTION		SWR VER		LOS ACT
CMD SRCE						LOS LOW
INFO						LOS HI
CFG Control Setup						
RELAYS						RELAYS
DIG INPUTS				DIG INPUTS		RLY1 CFG
SPLT RANGE		SP RANGE		DNG1 CFG		RLY1 POS
ACT CFG		MIN CMD		DNG1 FRM		RLY1 FRM
COMMS		MAX CMD		DNG2 CFG		RLY2 CFG
		BSRACT		DNG2 FRM		RLY2 POS
		BSRPOS		DNG3 CFG		RLY2 FRM
		ASRACT		DNG3 FRM		RLY5 CFG
		ASPOS		DNG4 CFG		RLY5 POS
				DNG4 FRM		RLY5 FRM
				ACT CFG		RLY6 CFG
		COMMS		ACT TYPE		RLY6 POS
		MODBUS		ACT SIZE		RLY6 FRM
		PROFIBUS		ENCOD IN		RLY7 CFG
DEFAULTS		PAKSCAN				RLY7 POS
LD CUST		HART				RLY7 FRM
ST CUST		FFBUS				RLY8 CFG
LD FACT		COM TO				RLY8 POS
		LOS ACT				RLY8 FRM
		LOS PO				
		MIN SP				
		MAX SP				

Fig 8:   CMA menu structure for setting up the actuator: from the ADVANC setting, select the COMMS button.

ADVANCED MENU

COMMS

12. COMMS - Bus Option Card Configuration

The following menus appear automatically when a Bus Option Card is fitted.

For full details of each Bus Option Card and its menu settings please refer to the relevant technical manual.

PROFIBUS

PROFT	**Profibus Field Type**
PROAD	**Profibus Address**
PRORT	**Profibus Redundancy Type**
PRORM	**Profibus Redundancy Mode**
PROT1	**Profibus Termination1**
PROT2	**Profibus Termination2**
GSDAC	**Profibus GSD Active Characterisation Active**

COMMS

PRO FT

PRO AD

PRO RP

PRO RM

PRO T1

PRO T2

GSD AC

Fig 9:   CMA menu structure for setting up the actuator: from the COMMS setting, select the Profibus button. From here, you can adjust the individual Profibus settings.
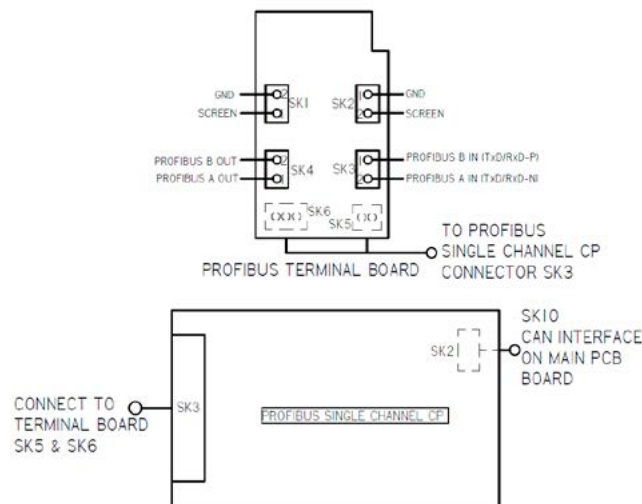
Fig 10:   Connections to the PFU located in a CMA actuator

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, or by using the auxiliary power supply option.

PLC

T = Terminator   Screened cable throughout
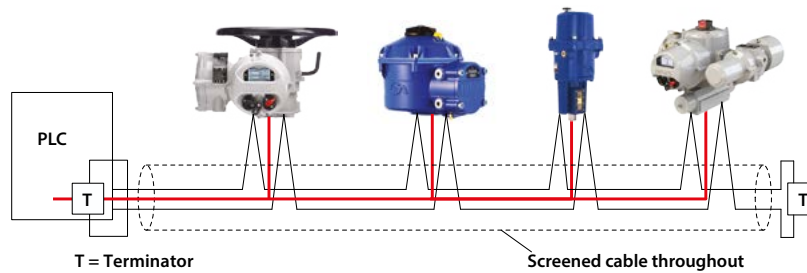
Fig 11:   Typical Profibus DP Data Highway

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	31[1]	31[1]	31[1]	31[1]	31[1]	31[1]	31[1]

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.

4.2   Segmented Single Highway System
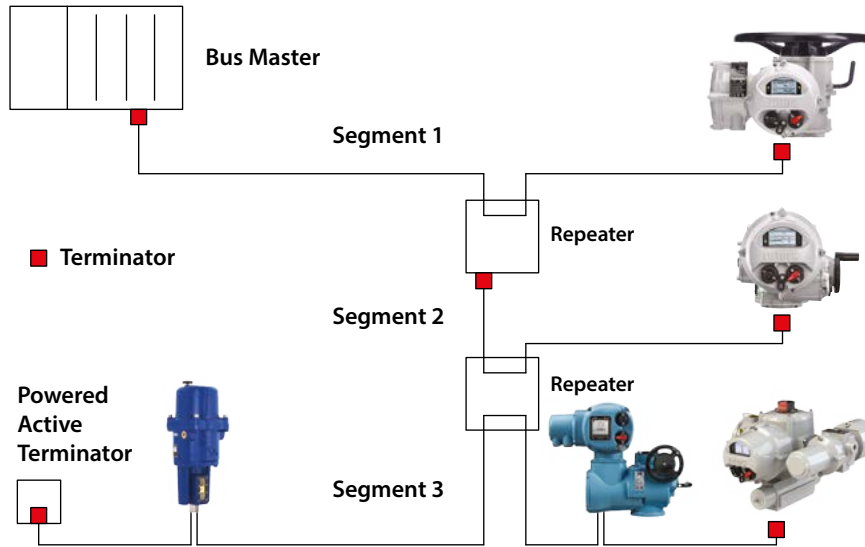
Fig 12:   Profibus Single Channel Data Highway Topology

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 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 connected to a RedCom compliant card. If the PLC does not support the RedCom standard then the Simple Redundant card must be used.
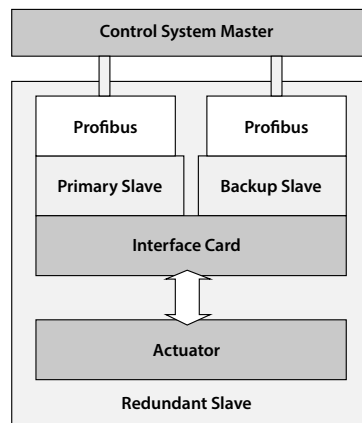
Fig 13:   Profibus DP Simple Dual Redundant Option Block Diagram

The Profibus DP 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
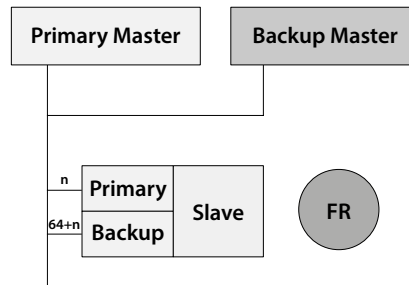
Fig 14:   Fig 15: Profibus DP Flying Redundancy Connection

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 mode 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
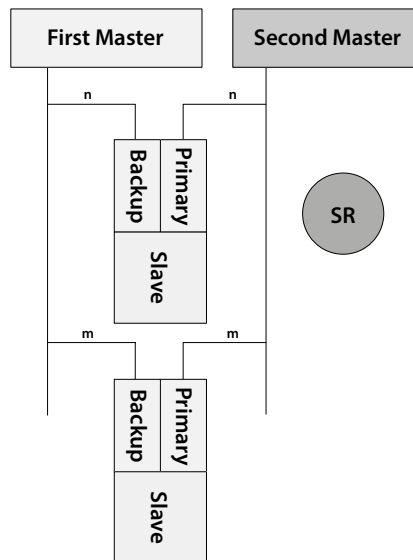
Fig 15:   Profibus DP System Redundancy Connection

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 2 seconds, then it will revert to Channel 1 and now it will wait 4 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 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 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.
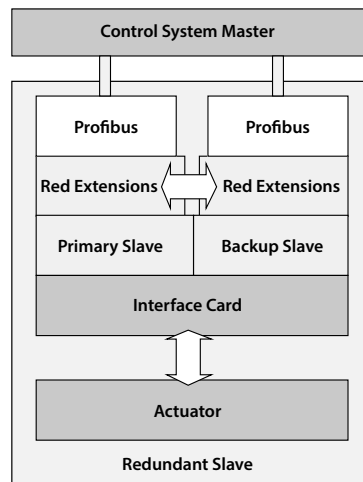
Fig 16:   Profibus DP RedCom Dual Redundant Option Block Diagram

The Profibus DP 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 Backup slave
Red_State_3	Not used

The information in the Red_State bytes is as below

| Bit No: | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | Description if set |

- This slave is the Backup
- This slave is the Primary
- There is a Hardware Defect
- This slave is in Data Exchange Mode
- Master State Clear
- Baud rate not found
- T^{oh} (Output Hold Time) started (hold timer active - set if a change of channel is imminent)
- Reserved
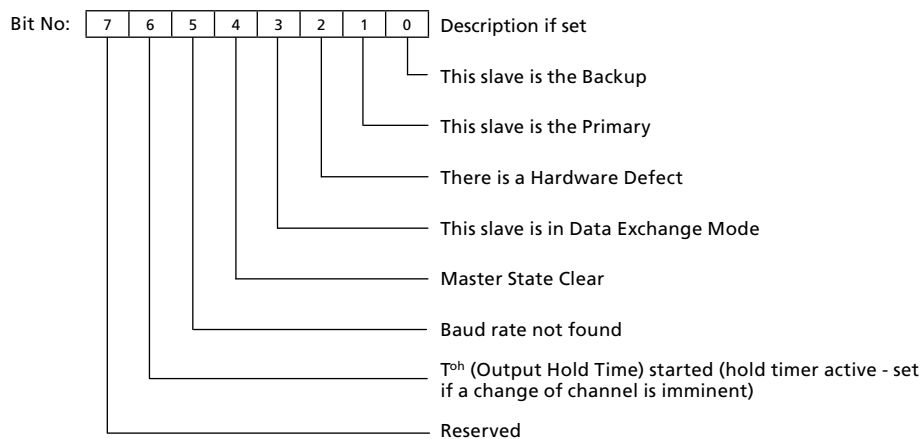
4.5   Cable Types

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 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'

Fig 17:   Typical Profibus DP cable specifications

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

The terminals to which the wires connect in 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 card includes the necessary components to allow an active termination to be connected. The termination can be set using the HMI or Insight2 software. It is advised that internal termination is only used during the testing/commissioning phase, because upon removal of power to the unit or removal of the unit itself, the termination will be lost, affecting communications of the entire network.

It is therefore advised that external termination is used during full operation.
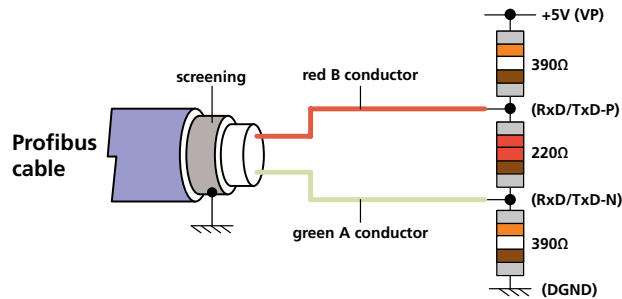
Fig 18:   Termination for Profibus highway

Active termination resistors are included on the Profibus card. These can be switched on or off using the menu. Please see the relevant actuator manual for details.

4.7   Connecting to the Highway and Setting up the Profibus Card

The Profibus variants allow for different highway connections. The 'single channel' can be used for simple highways. 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
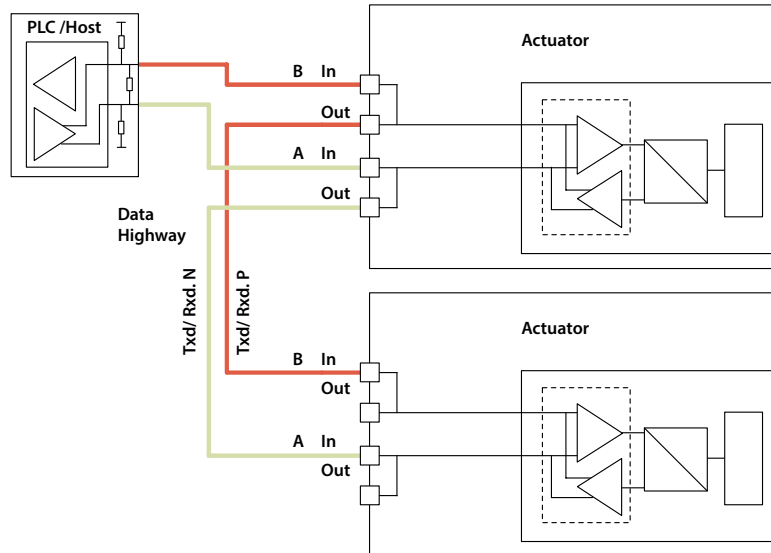
With the single channel option the actuator is connected to only one highway. The connection of the actuator to the highway uses terminals A and B (in and out terminals), the terminal numbers depend on the actuator type and are indicated on the actuator wiring diagram. The highway should be arranged so as to eliminate any stub connections. 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

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.
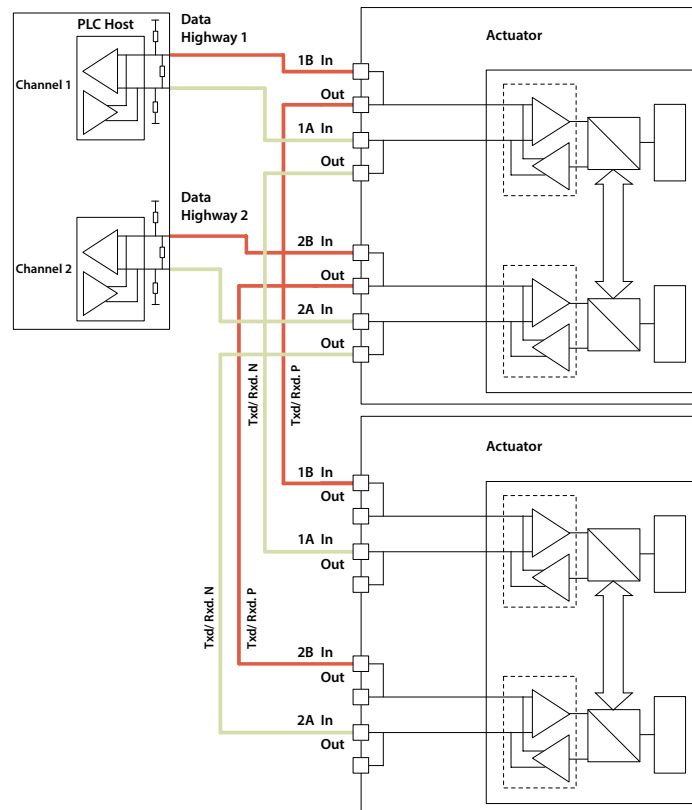
Fig 19:   Dual Highway SR Mode Connections

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. 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.

4.7.3   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.
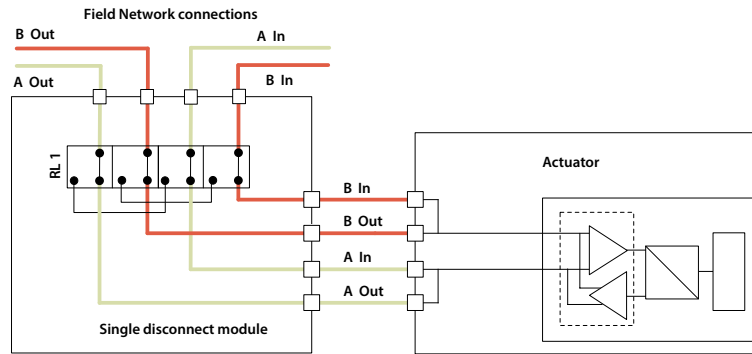
Fig 20:   *Disconnect module showing normal powered operation - connection though to the actuator.*

When power is removed from the actuator, the relays disconnect the actuator from the highway, meaning that the disconnect module can be removed from the actuator and placed on its parking housing. The actuator can be removed for servicing without disrupting the rest of the network.
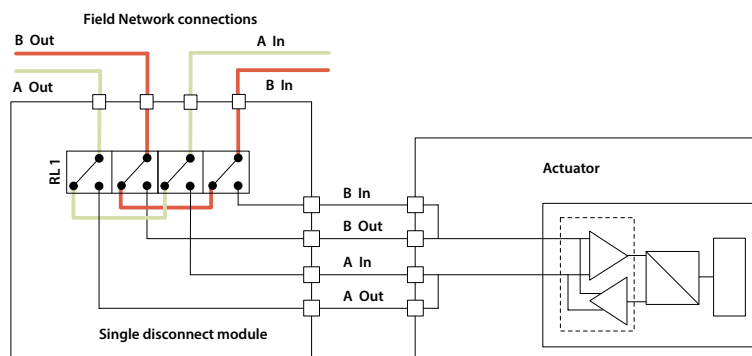
Fig 21:   *Disconnect module showing unpowered operation - disconnected from the actuator.*

> **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 be 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).**

Fig 22:   Disconnect module cabled up.

The Disconnect PCB contains decals to indicate how to connect the Profibus cable (board may vary in appearance depending on version).

The Figure above shows how the cables should be arranged in the module for a dual channel arrangement.

When the disconnect module is removed from the actuator it must be fixed to a parking housing to maintain environmental protection.

When not used, the parking housing will be fitted with a water tight cover that should be used to protect the terminal compartment of the actuator, when the disconnect module has been removed. The water tight cover is only for protection whilst the actuator is being maintained and must be removed and replaced by the disconnect module when the actuator is replaced and connected to power again.

The parking cover can be mounted to a surface using the fixing holes supplied.
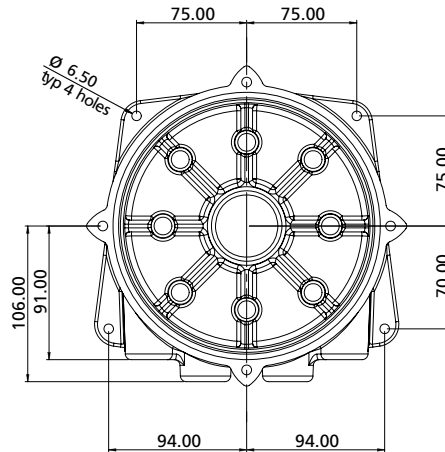
Fig 23:   *Parking housing (for disconnect module) mounting hole detail*

When mounted together the parking housing and disconnect modules appear as shown in the Figure below.
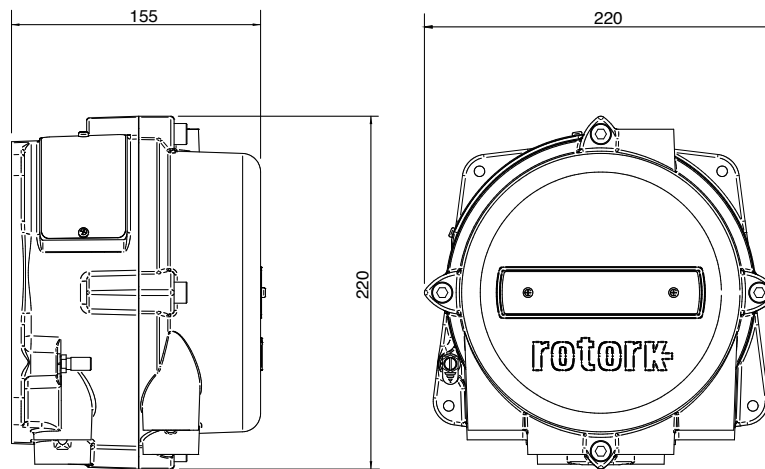
Fig 24:   *Parking housing and Disconnect module connected together*

The Profibus DP Module 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.
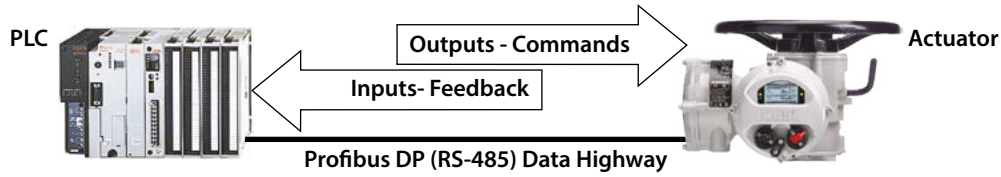
Fig 25:   Input and Output Data Direction

- **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 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	CMA	SI$_3$
Profibus over the network				
Open	✔	✔	✔	✔
Close	✔	✔	✔	✔
Stop	✔	✔	✔	✔
Emergency Shut Down	✔	✔	✔	✔
Analogue Position Demand	✔	✔	✔	✔
Partial Stroke	✔	✔	✔	✔
Multiport Position [3]	IQT	✖	✖	✖
Relay output DO-1	✔[1]	✖	✖	✖
Relay output DO-2	✔[1]	✖	✖	✖
Relay output DO-3	✔[1]	✖	✖	✖
Relay output DO-4	✔[1]	✖	✖	✖
Local Actuator Controls				
Open	✔	✖	✔[2]	✔
Close	✔	✖	✔[2]	✔
Stop	✔	✔	✔[2]	✔
Direct Hard-Wired Inputs				
Open	✔	✖	✖	✔
Close	✔	✖	✖	✔
Stop/Maintain	✔	✖	✖	✔
Emergency Shut Down (Network Disable)	✔	✖	✖	✔
Open Interlock (active prevents opening)	✔	✖	✖	✖
Close Interlock (active prevents closing)	✔	✖	✖	✖

Notes: 1 – Requires Extra Relay Indication board to be fitted
2 – Requires optional local control selectors to be fitted
3 – 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/CMA.
- 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 dependent on the type of valve. The IQT normally operates 90-degree valves, uses stop bolts on the actuator or gearbox, and stops 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 cause 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 assign a priority for those occasions when two or more commands are applied simultaneously.

IQ / IQT, SI₃ 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 SI₃ 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 SI₃ 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 Stop[2]	Local Close[1]	Hard-Wired Close	Profibus Close[3]
	Local Open[1]	Hard-Wired Open	Profibus Open[3]
Hard-Wired ESD[2]		Hard-Wired Stop[4]	Profibus Stop[3]
Profibus ESD[2,3]			Profibus Position[3]
			Profibus Part Stroke[3]
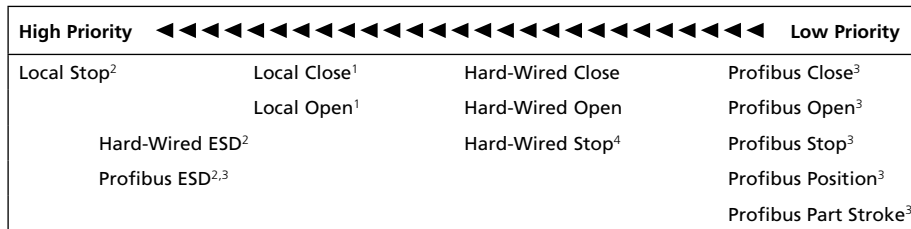
1   Mechanically interlocked to prevent both at the same time
2   The IQ/IQT can be set so that Local Stop has a higher priority than ESD
3   Only one Profibus command is permitted at a time
4   If a Profibus command is applied whilst Hard-Wired Stop is present, stop is cancelled

Fig 26:   IQ and IQT Controls Priorities

CVA/CMA 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' or 'LOCAL' mode command is inhibited. Refer to the CVA or CMA 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, it will override any other command.

High Priority ◀◀◀◀◀◀◀◀◀◀◀◀◀◀◀◀◀◀◀◀◀◀◀◀◀◀◀◀◀◀				Low Priority
ESD	Close	Open	Stop	positioning
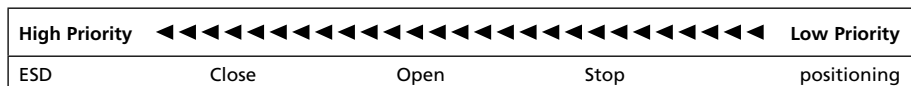
Fig 27:   CVA/CMA Controls Priorities

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	Partial 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/IQT '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 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.

IQ or IQT with Additional Relay Output Board fitted

Actuator Main Board → S1-S4

PFU → DO-1 to DO-4 Output Board
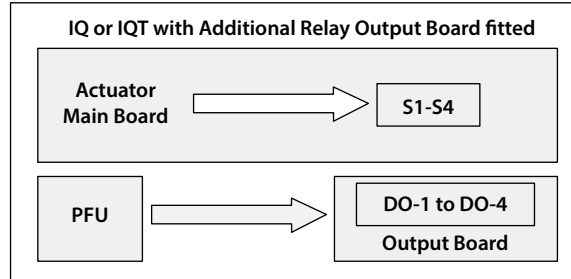
Fig 28:   IQ and IQT relay outputs DO-1 to DO-4

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

5.1.5 Multiport Position Selection using the PORTCM register

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 position set by 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/SI$_3$ 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 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 can also be achieved with a DIO board.

5.2   Digital Input Status Feedback

The Profibus DP Module 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. Data is reported as; register 0, bit 15 to bit 0 and then register 1, bit 15 to bit 0.

Register Name		Status Feedback	IQ	IQT	CVA	CMA	SI$_3$
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	✓	✓	✓	✓	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
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	Partial Stroke Error	✓	✓	✓	✓	✓
IDATA4/5	Register 1 Bit 13	Primary (0) or Back up (1)	✓	✓	5	5	✓
IDATA4/6	Register 1 Bit 14	1 or 2 Channels Available	✓	✓	5	5	✓
IDATA4/7	Register 1 Bit 15	SR (0) or FR (1) mode	✓	✓	5	5	✓

Notes: 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 or CMA

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, but this affects hazardous area certification, please see actuator manual. The bit will remain set at logic 1 until the motor cools down and the thermostat resets itself.
Monitor Relay	This signal is true (1) when actuator remote control is not available. The actuator Monitor Relay status is a composite signal for several alarms. This signal will be set true if the actuator selector is in Local or Local Stop (not in Remote) or if the thermostat trips. The mains supply is also monitored and if one of the three phases is lost this bit is set. If the actuator is operated from a single phase supply and this is lost then communications with the actuator will also be lost. Where a 3 phase supply is used, if the phase associated with the control circuits is lost then communications with the actuator will be lost.
Valve Obstructed	This bit will be true (1) if the actuator stops in mid travel when not expected to do so after receiving a command to move. If the actuator torque exceeds the trip value set during commissioning then the motor will stop and motion will cease. The reason for the actuator stopping will be the high torque due to an obstruction and not a 'Stop' signal or reaching the desired setpoint position. The bit will remain true (1) until the actuator position changes by 2% or more.

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

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

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

Valve Moving by Hand
The manual movement of the valve is reported as true (1) if the actuator is moved by the handwheel away from the last position. The percentage of travel required to trip the indication is set in the associated parameter during PFU set up.

The bit will remain true (1) until the actuator is moved electrically by either the local controls or a network command.

Moving Inhibited
This bit will be true (1) when the Motion Inhibit Timer is active or the Interrupter Timer is active (IQ/IQT only), or both are active. The Motion Inhibit Timer is used in position control to prevent the actuator from exceeding its prescribed number of starts per hour, or to reduce the effects of hunting during closed loop control. The Interrupter Timer in the IQ/IQT can be used over part or the entire actuator stroke to slow down the effective speed of valve travel.

When under network control, the control signal does not need to be re-applied when this bit is true, as the control action will continue once the time has elapsed.

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

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

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/SI$_3$ 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/ SI$_3$ 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/ SI$_3$ 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/ SI$_3$ 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 actuator also reports this bit, but this actuator does not have a slow mode capability.

5.2.2   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 any of the other settings tools, such as Insight 2, Enlight, *Bluetooth* setting tool or the HMI 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.

Partial 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 Partial 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 control 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 makes available over the network a number of analogue variables. These contain information about the valve and actuator. If an additional analogue input card is also installed as well as the Profibus DP Module, one associated plant measurement is also available.

Name	Register	Range	Analogue Feedback	IQ & IQT	CVA	CMA	SI$_3$
TORQUE/ THRUST	2	0-120 (0-78 hex) = 0-120%	Actuator Instantaneous Torque	✓	✗	✗	✓[2]
POSITN	3	0-1000 (0-3E8 hex) = 0-100%	Valve Position	✓	✓	✓	✓
TEMPER	4	32768 – 65535 (8000 – FFFF hex) = -32767 to -1 °C 0 (0 hex) = 0 °C 1 – 32767 (0001 – 7FFF hex) = 1 to 32767 °C	Temperature °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	IQT	✗	✗	✗

Notes: 1 – Requires the additional Analogue Input option card
2 – For SI and EH Pro this field will report Pressure

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.

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 °C.

[A value of 0 is 0 °C, 32767 (7FFF hex) is 32767 °C, 65535 (FFFF hex) is –1 °C and 32768 (8000 hex) is –32767 °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), 0-100% representing the percentage value to 0.1% resolution.

The input may be 0 to 5V, 0-10V, 0-20V or 0-5mA, 0-10mA, 0-20mA DC. from an externally powered field transmitter (the actuator does not provide the power for the transmitter).

The input must be calibrated during the setup of the PFU using the Analogue Input Max parameter. Writing a value of 1 to the parameter sets the Hi Value, writing a 2 sets the Low Value of the signal. The scaling is retained in memory 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 has 10 possible configurations as indicated in the table. The default value is Configuration 1. The PLC must send a Check Configuration message during start up to confirm the Configuration to be used.

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

6.1 Electrical Specification

Line Electrical Specification: RS-485, 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   For all actuator variants the address can be set over the highway using a Class 2 master. There are also other tools, such as Insight 2 and the *Bluetooth* setting tool for IQ/IQT/SI$_3$, Enlight for CVA or the HMI for the CMA.

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 card's two main processors.
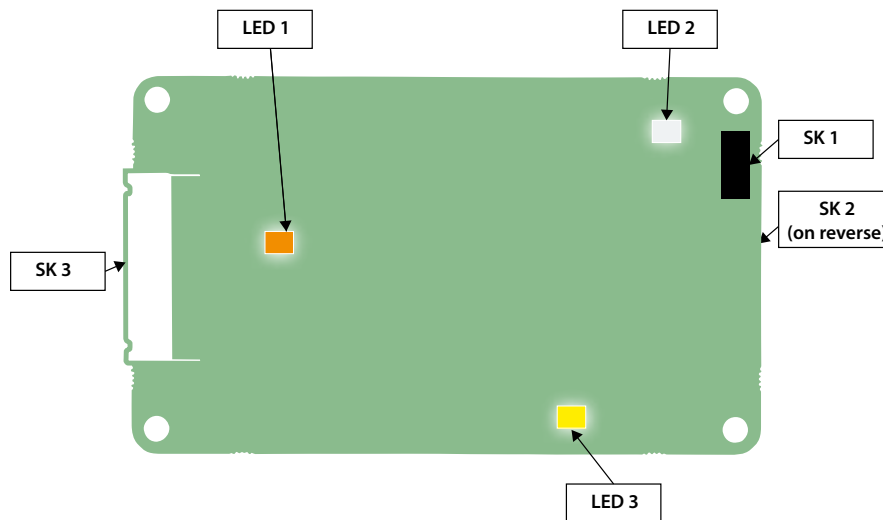
Fig 29:   Single Channel Profibus card LED positions

LED	Description	State	Function
1	Orange LED	Flash (variable speed)	Flashes when receiving Profibus messages. This LED flashes at the rate of the incoming messages, so faster baud rates will cause a faster flash (will appear dimmer at faster speeds).
2	Green LED	Slow flash	Indicates communication and power between the Profibus card and the actuator main board.
3	Yellow LED	Solid on	Indicates Profibus cyclic DPV0 communications.

PFU Socket	Function
SK1	Power and CANbus to option card 2
SK2	Power and CANbus from actuator
SK3	Profibus Fieldbus connection

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. For all actuator variants the address can be set over the highway using a Class 2 master. There are also other tools, such as Insight 2 and the *Bluetooth* setting tool for IQ/IQT/SI$_3$, Enlight for CVA or the HMI for the CMA.
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 30:   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. For all actuator variants the address can be set over the highway using a Class 2 master. There are also other tools, such as Insight 2 and the *Bluetooth* setting tool for IQ/IQT/SI₃, Enlight for CVA or the HMI for the CMA.

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.
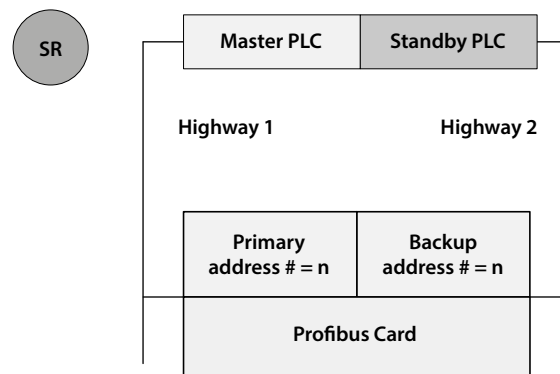

Fig 31:   Flying Redundancy – One highway redundancy

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.
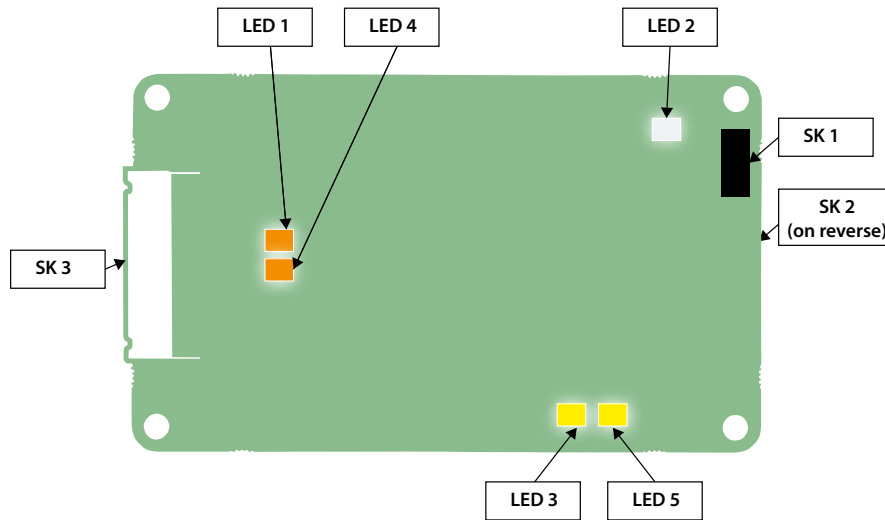
Fig 32:   Dual Channel Profibus card LED positions

LED	Description	State	Function
1	Orange LED (channel 1)	Flash (variable speed)	Flashes when receiving Profibus messages on channel one. This LED flashes at the rate of the incoming messages, so faster baud rates will cause a faster flash (will appear dimmer at faster speeds).
2	Green LED	Slow flash	Indicates communication and power between the Profibus card and the actuator main board.
3	Yellow LED (channel 2)	Solid on	Indicates Profibus cyclic DPV0 communications on channel 1.
4	Orange LED (channel 2)	Flash (variable speed)	Flashes when receiving Profibus messages on channel one. This LED flashes at the rate of the incoming messages, so faster baud rates will cause a faster flash (will appear dimmer at faster speeds).
5	Yellow LED (channel 2)	Solid on	Indicates Profibus cyclic DPV0 communications on channel 2.

PFU Socket	Function
SK1	Power and communications to option card 2
SK2	Power and communications from actuator
SK3	Profibus Fieldbus connection

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 – class 2 master.

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)

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.

For actuators with a Profibus firmware version of V103 or later: if the software is being updated in the IQ main board, communications to the PFU will be stopped, at this time the Static diagnostic bit will be raised. As soon as the software is updated and the communications to the PFU return, the static diagnostics bit will be de-asserted. In older versions of the Profibus firmware the same happens as described above except that the diagnostic bit is not asserted.
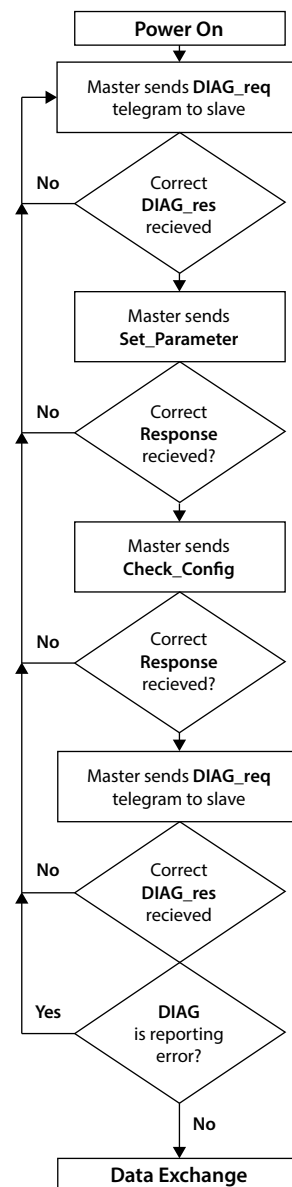
Fig 33:   Profibus Start Up Sequence

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 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/IQT and SI/EH Pro 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 (Where V1 read and write slot number is 0 for all parameters and the index number is the parameter number shown in the table) 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]	– 25.5%[2] 0000 – 00FF hex	5.0% 0032 hex
4	Hysteresis[1]	– 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
9	Watchdog Timeout	0 – 255 sec 0000 – 00FF hex	10 sec 000A hex
10	Action on Loss of Comms[4]	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	Partial Stroke position	1 – 99% 0001 – 0063 hex	90 005A hex
17	Partial 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), 17 – IQ3, 18 – IQT3, 11 – Multiport, 12 – CVL, 13 – CVQ, 20 – CMA, 21 – SI3.	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 – Bluetooth 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)
4 – For action of loss of comms on CMA software versions 2.10 or earlier see section 7.1.8.

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 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.
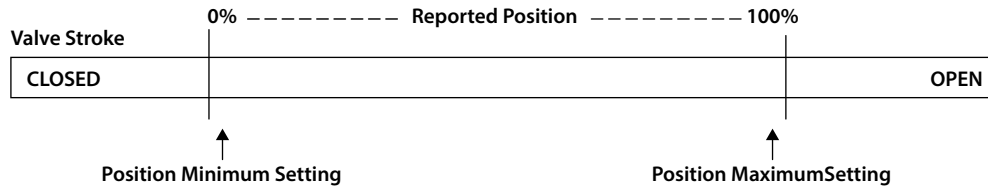

Fig 34:   Limited Range Position Control and Reporting

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 (limited range position 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.
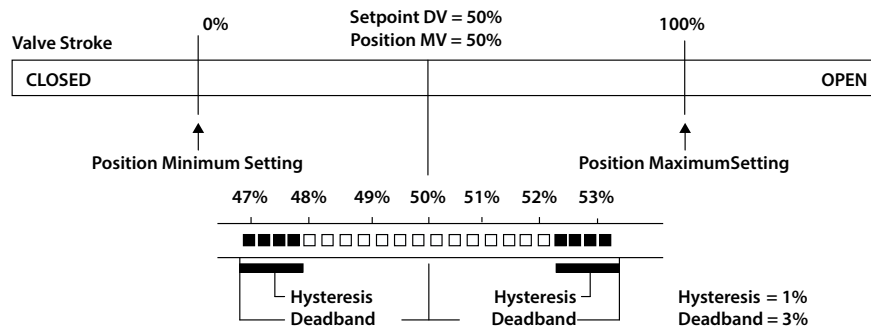
Not supported by CVA/CMA.

Fig 35:   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/CMA.

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).

On CMA actuators with software version V2.10 or earlier the enumeration list is different when setting the action of loss of comms via the GSD file.

See table below:

- 0 = **Close**
- 1 = **Open**
- 2 = **Stay Put**
- 3 = **Position**
- 4 = **Disabled**

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/SI$_3$ 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, $y^3y^2y^1y^0$, determine 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/SI₃ 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.

Can also be setup using the DI's of the optional DIO board, meaning that ESD is still available.

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 Partial 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 Partial 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	Start test from closed position
	1	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.

IQ Mk3   = 17 dec, 11 hex,

IQT Mk3   = 18 dec, 12 hex,

SI₃   = 21 dec, 15 hex,

CVL   = 12 dec, 0C hex,

CVQ   = 13 dec, 0D hex,

CMA   = 20 dec, 14 hex.

Default/Not known = 0 dec, 0 hex.

7.2   Parameters viewed and set by DP-V1 Communication

The Profibus DP Module 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 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.

For V1 read and writes the slot number is 0 for all parameters and the index number is the parameter number shown in the table.

Parameter No.	Data	Read/Write	Value / Range	Default Value
20	Actuator Tag data	R/W	12 byte	0
21	Actuator software version	R	4 byte	e.g. V111
22	Profibus interface software version	R	12 byte	e.g. V101
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 °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
40[1]	Configure Data Exchange Data	R	1-10, 1 to 000Ahex	0
41	Reserved			
42	Close Torque Set	R	0-120%, 0 to 0078 h	0
43	Open Torque Set	R	0-120%, 0 to 0078 h	0
44	Torque at 0% - open direction	R	0-120%, 0 to 0078 h	0
45	Torque at 10% - open direction	R	0-120%, 0 to 0078 h	0
46	Torque at 20% - open direction	R	0-120%, 0 to 0078 h	0
47	Torque at 30% - open direction	R	0-120%, 0 to 0078 h	0
48	Torque at 40% - open direction	R	0-120%, 0 to 0078 h	0
49	Torque at 50% - open direction	R	0-120%, 0 to 0078 h	0
50	Torque at 60% - open direction	R	0-120%, 0 to 0078 h	0
51	Torque at 70% - open direction	R	0-120%, 0 to 0078 h	0
52	Torque at 80% - open direction	R	0-120%, 0 to 0078 h	0

Parameter No.	Data	Read/Write	Value / Range	Default Value
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 'PO' contact S4	R/W	0-100%, 0 to 0064 h	0001
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

Parameter No.	Data	Read/Write	Value / Range	Default Value
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	-
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 Actuator main board software version in the form VXXX and parameter 22 holds the Profibus network interface card software version in the form VXXX

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.

7.2.5   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

7.2.6   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 (requires optional Analogue Input card).

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. See section 5.3 for more information.

7.2.7   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.

7.2.8   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 Configurations 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.

7.2.9   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.

7.2.10   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.

7.2.11   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.

Note: The relays can be set to extra functions that are not listed below, using the HMI or Insight 2 (these extra functions will appear as disabled (1C hex) over Profibus. Please consult the relevant technical manual for more detail on these functions.

Relay		
Name	**Hex (bits 1-15)**	**Function**
Disabled	1C	Relay turned off
Close Limit	00	Activates at closed limit
Open Limit	01	Activates at open limit
Position % Open	02	Activates when past a set function
Motor Running	18	Activates when motor is running
Closing	07	Activates when the centre column is moving closed
Opening	08	Activates when the centre column is moving open
Moving	09	Activates when the centre column is moving
Hand Op	0C	Activates when the centre column is moved manually
Move Blink	0D	Relay alternates when centre column is moving
Valve Alarm	19	Indicates a valve alarm is present
Torque Close	03	Activates when the unit reaches the set torque in the close direction
Torque open	04	Activates when the unit reaches the set torque in the open direction
Torque trip	05	Activates when the unit reaches the set torque in either direction
Torque Mid	06	Activates when the unit reaches the set torque in mid-travel
Motor Stall	0A	Indicates the motor has stalled
Stop Selected	0E	Indicates that local stop is selected
Local Selected	14	Indicates that local is selected
Remote Selected	15	Indicates that remote is selected
Control Alarm	1B	Indicates that there is a control alarm
ESD Active	12	Indicates that an ESD signal is present
Open Interlock	0F	Indicates that the open interlock is present
Close Interlock	10	Indicates that the close interlock is present
Interlock	11	Indicates that an interlock is present
Thermal Trip	1A	Indicates that the units thermal trip in the motor has activated
Loss Phase	13	Indicates that a phase has been lost (only on three phase units)
24 V Fail	17	Indicates that the 24 V customer supply has failed

7.2.12   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 (if available).

7.2.13   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.
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 (voids any Ex rating).
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.

7.2.14   Interlock enable (Parameter 102)

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

7.2.15   Open Limit position (Parameter 103)

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

7.2.16   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 starts 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 starts to be active when the actuator is travelling in the close direction.

7.2.17   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.

7.2.18   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.

In most applications the majority of the default settings in the Profibus DP Module 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. Files for both tools are available for download from the Rotork website.

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.
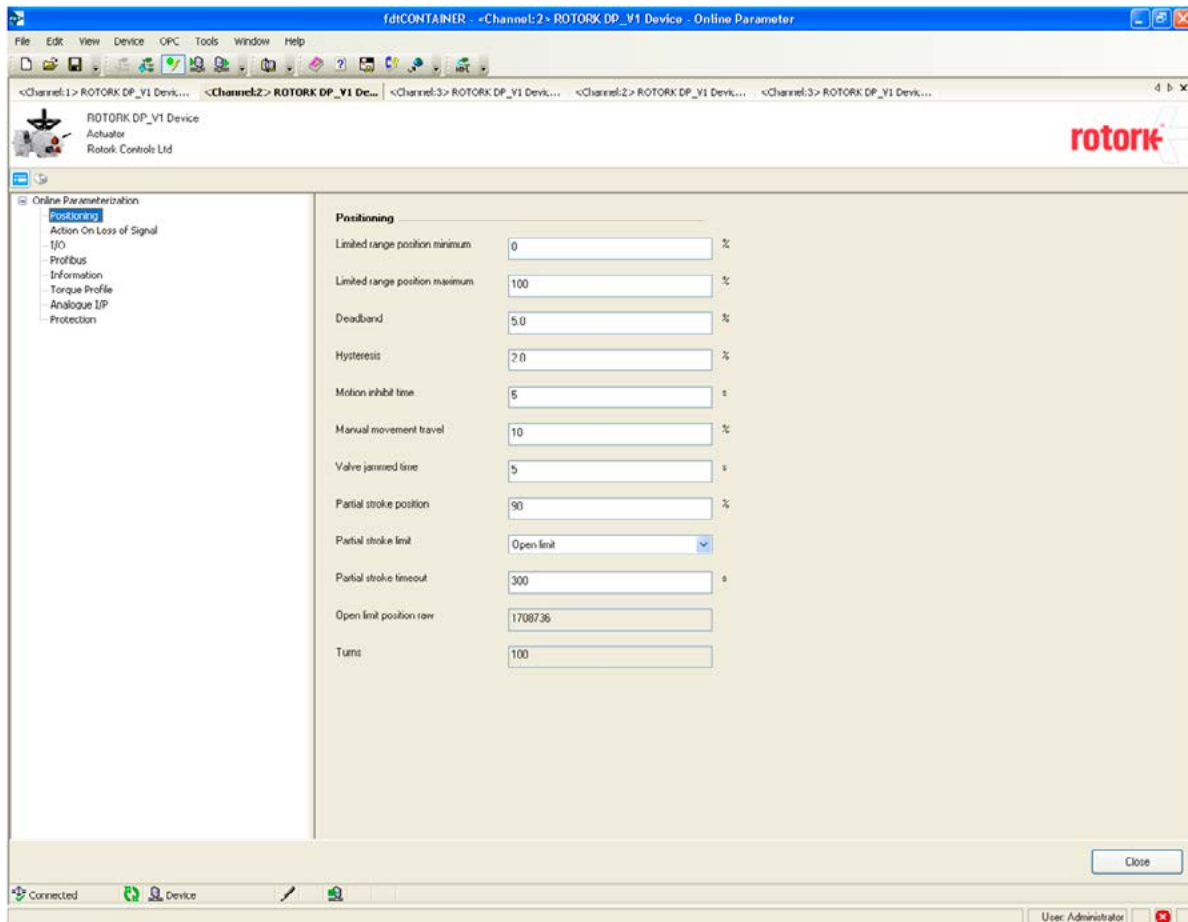
Fig 36:   Rotork DTM running in the M&M FDT container

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.
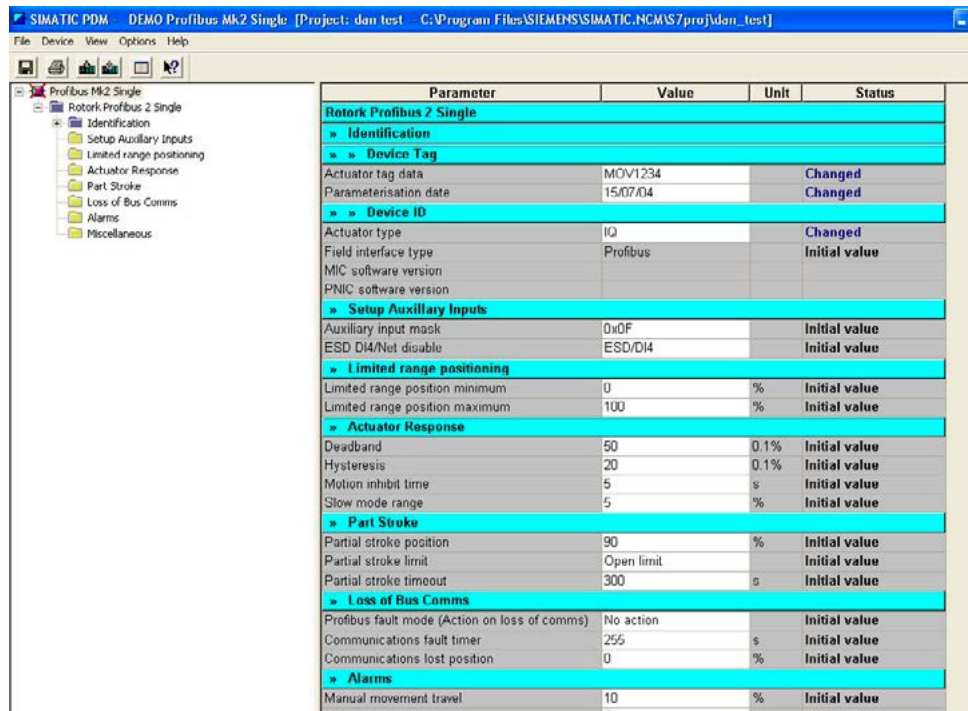

Fig 37:   Rotork EDD running in the Siemens PDM application

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 Insight 2 – Actuator Configuration Tool

This software can be used to configure and view the settings and configuration of the IQ/IQT/SI$_3$ actuators. It can be freely downloaded from the Rotork website. It designed to be run from a Windows computer and connects to the actuator using *Bluetooth*. Please see the relevant technical manual for more details.
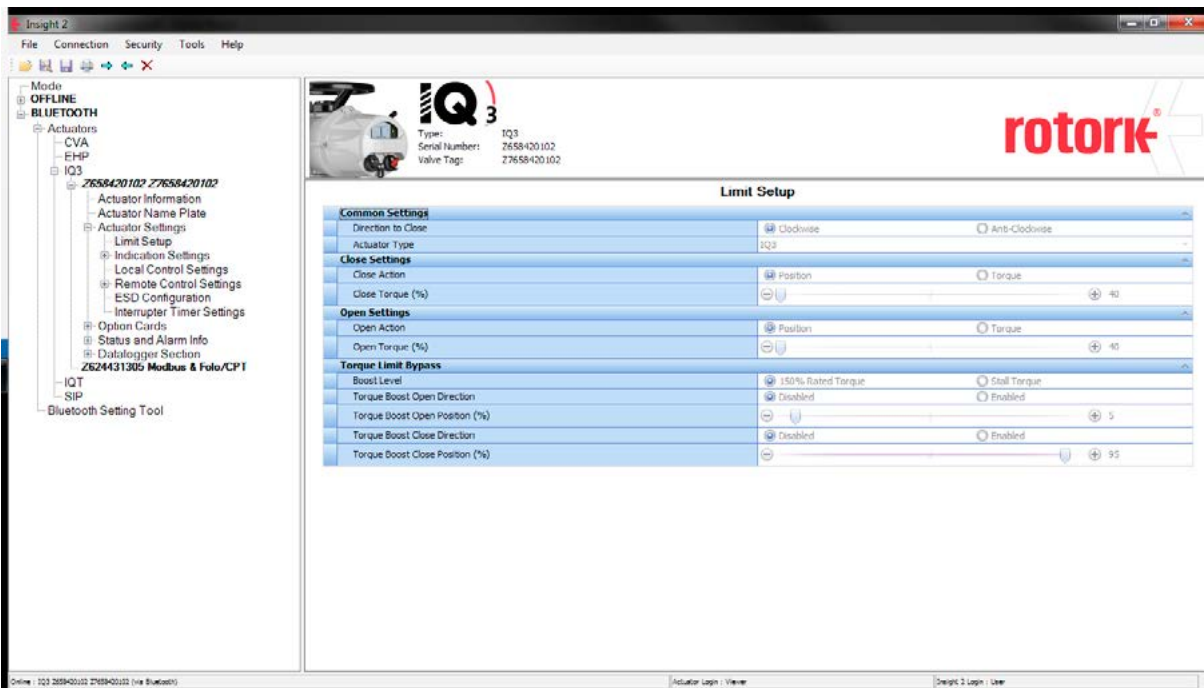

Fig 38: Rotork Insight 2 software

8.3   Enlight – Actuator Configuration Tool

This software can be used to configure and view the settings and configuration of the CVA actuator. It can be freely downloaded from the Rotork website. It is designed to be run from a Windows computer and connects to the actuator using *Bluetooth*. Please see the relevant technical manual for more details.
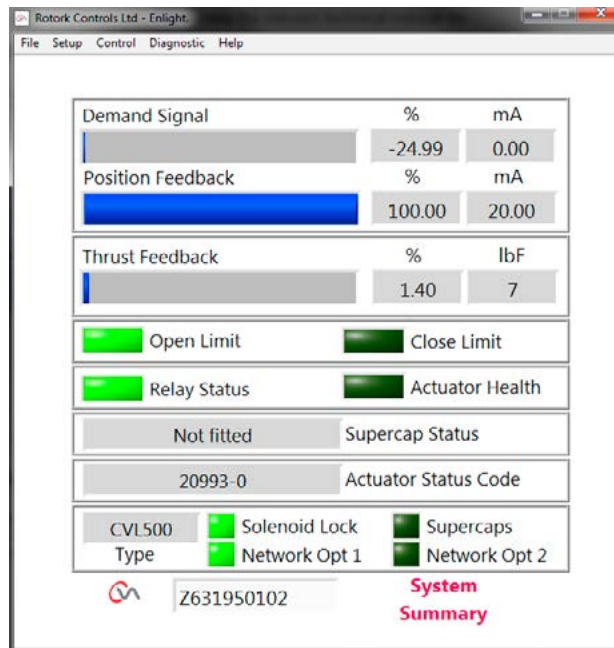
Fig 39:   Rotork Enlight software

8.4   Setting up the network address in the PFU

The IQ/IQT/SI₃/CVA actuators include a *Bluetooth* communication port, which can be used for setting the network address for the actuator, either with the supporting software (Insight2/Enlight) or a setting tool. The CMA has an HMI which can be used to change the address. All actuators can have the address set up over the Profibus network using a Class 2 master.

8.5   Setting up an IQ/IQT or SI₃ Pro with the *Bluetooth* Setting Tool

The IQ/IQT/SI₃/CVA/CMA actuators include some on-board method 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 parameters that may be set by using the Setting Tool and the external software 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/*Bluetooth* link if the actuator control selector 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	Address	0 – 126	126

8.5.1 IQ/IQT/SI₃ Menu Structure

The diagram illustrates the access route through the actuator menu screens to reach the settings that affect the PFU for an IQ/IQT actuator.
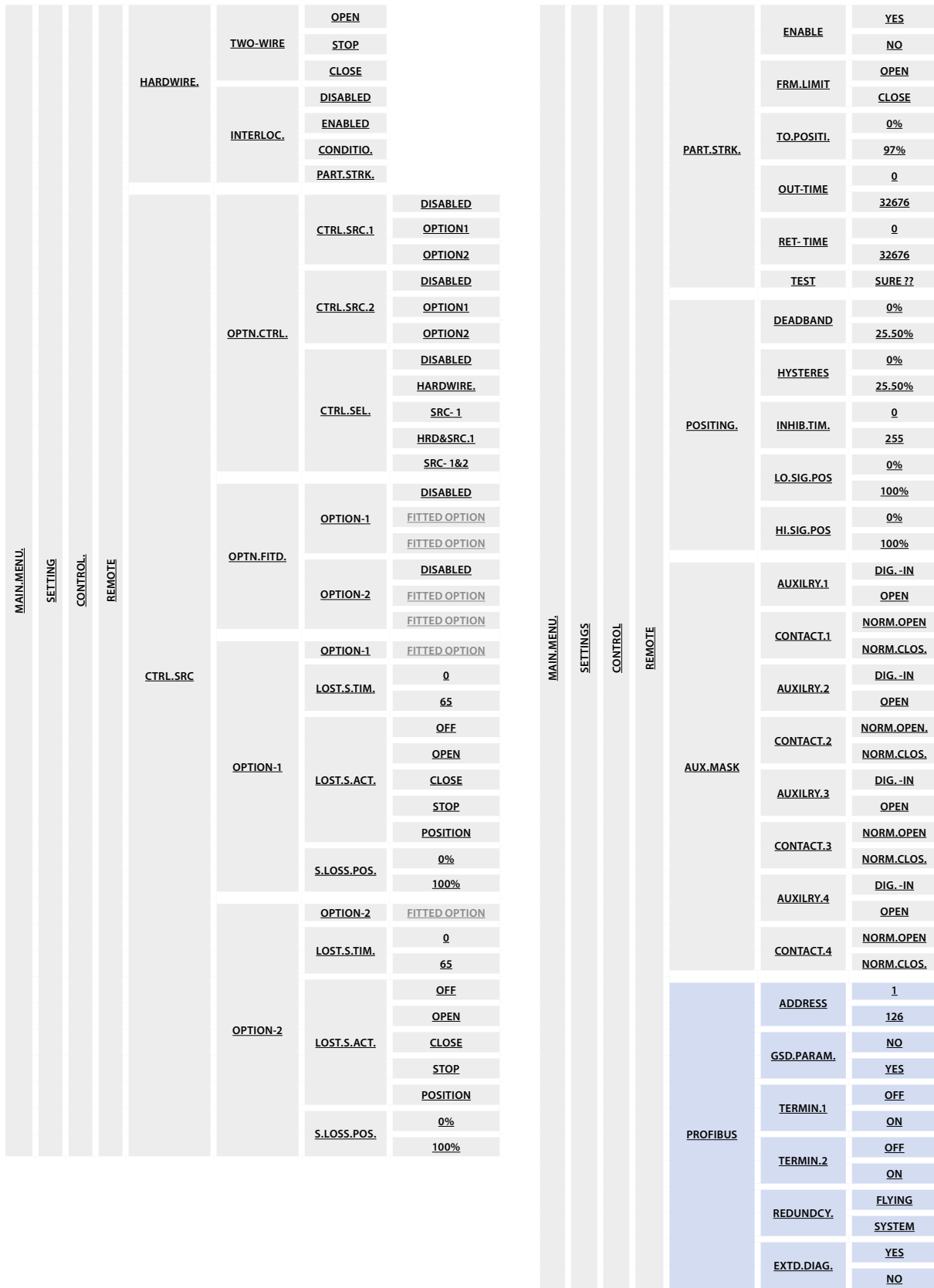

Fig 40: *IQ/IQT/SI₃ Setting tool menu structure and PFU settable parameters*

Refer to the installation manuals of the actuator for more details. See section 3.3 for CMA structure.

8.6 Setting up the remote source in an IQ/IQT/SI₃ with the *Bluetooth* Setting Tool

The actuators require that the correct Profibus address be set, otherwise the network will be unable to control the actuator. See the menu structures in section 8.5 for details.

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

8.7 Maintenance and Repair

There is no periodic service requirement for the PFU.

Repairs should not be attempted on the module. Static sensitive devices are used in the PFU, it is therefore mandatory to observe anti-static precautions when handling or working on the unit.

8.8 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	Auxiliary Input Mask		
14	ESD DI-4/Net Disable		
15	FR/SR mode and Simple/RedCom redundancy		
16	Partial Stroke position		
17	Partial 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		

rotork®

Keeping the World Flowing

www.rotork.com

A full listing of our worldwide sales and service network is available on our website.