rotork

*Device**Net***
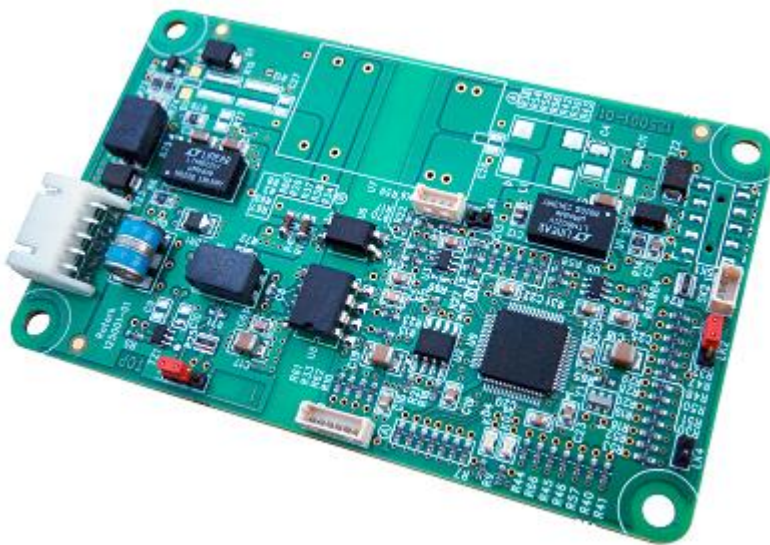

DeviceNet Actuator Control
DFU Option Card
Installation Manual
(IQ and IQT 3rd generation, CMA, CK)

The DeviceNet 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 DeviceNet DFU may simply be referred to as 'the module' or 'DFU'.

Note 2:

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

EDS file version V1.05 (will operate fine with the exception of a notification about software version)

EDS file version V1.06 (new version with no warning, will also operate fine with the IQ (2nd generation) DFU card, with the exception of a notification about software version)

CP DeviceNet software version V103

Note 3:

The DeviceNet DFU module described in this manual is suitable for inclusion in IQ / IQT 3rd generation, CMA electric actuators (software version 2.05 onwards) and CK electric actuators (software versions Ctrl-V105, UIB-V106 onwards).

Note 4:

For simplicity, the IQ (multi-turn actuator) / IQT (quarter turn actuator) 3rd generation products are referenced within this document as 'IQ', unless there is a specific difference in their operation.

Note 5:

The CK must be fitted with a DSM (Digital Switch Mechanism) or an MSM (Mechanical Switch Mechanism) + Potentiometer if any positioning commands or feedback are to be used.

Note 6:

The CK must be fitted with the optional Bluetooth module if Insight 2 it to be used, or if you wish to connect using the Bluetooth setting tool. Infra-red is supported as standard.

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

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Windows is a registered trademark by Microsoft Corporation.

Contents

Glossary of Terms:

Controller Area Network	Generic name for DeviceNet, CAN forms the basis for DeviceNet communications
Electronic Data Sheet (EDS)	A file that provides information to a DeviceNet configuration tool to allow the variable parameters in the DFU to be set up and specifies the number of data bits exchanged between the DFU and the master
Fieldbus	The digital, two-way, multi-drop communication links.
Interoperability	The capability for a device from one manufacturer to interact with that of another manufacturer, on a fieldbus network, without loss of functionality
MAC ID	The unique address for a node on the fieldbus, range 0-63.
Master/Slave	The method of communication used by the DFU. The fieldbus requires a master scanner to control the data exchange on the highway.
Node	A single device on the fieldbus
Partial Stroke Test	Moving a little-used valve by a small percentage from an end limit and then returning it, proving that it will operate when required. Safety related.
Scanner	A DeviceNet component that controls the movement of messages on the fieldbus.
Segment	A section of a DeviceNet fieldbus that is terminated in its characteristic impedance. Each Segment can include up to 64 devices.

Abbreviations:

CAN	Controller Area Network, a type of bus system
CMA	Compact Modulating Actuator
Comms	Communications
DIO	Digital Input (DI) / Digital Output (DO) Option Board
DFU	DeviceNet Field Unit
DV	Desired Value
ESD	Emergency Shut Down
LED	Light Emitting Diodes
MAC ID	Media Access Controller Identifier
MV	Measured Value
ODVA	Open DeviceNet Vendor Association
PCB	Printed Circuit Board
RAM	Random Access Memory
RIRO	Remote Input Remote Output Option Board
ROM	Read Only Memory
Insight2	A graphical user interface for communication with Bluetooth enabled actuators. This is downloadable from the Rotork web site, www.rotork.com

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1   INTRODUCTION

The Rotork DeviceNet Actuator Control option card (DFU) conforms to the ODVA DeviceNet standard, DeviceNet Adaptation of CIP Edition 1.13 April 2013. It is suitable for use on a DeviceNet fieldbus and uses the standard 5 connections to the fieldbus, two wires for connection to the data highway and two wires for connection to the DC power lines of the highway, plus a screen connection. It is necessary to have a suitable power supply and termination on the highway for the DFU to function correctly.

This version of the DFU assembly may be fitted into the IQ, CMA and CK range of actuators. The DFU is an integral part of the actuator in which it is housed. For the IQ, the module is fitted within the main double sealed electrical housing. This electrical housing need never be opened once the actuator leaves the assembly plant, power and field connections are made to the terminal bung located behind the terminal cover. The CMA range of actuators do not have double sealing and the electrical cover is required to be opened for making field connections. In the CK the DFU is housed within a sealed electrical housing, which does not need to be opened once the actuator leaves the assembly plant, power and field connections are made to the terminal bung.

Adjustments to the settings for the DFU may be made via the DeviceNet data highway using a suitable network configuration tool. The IQ and CK actuators also allow the settings to be adjusted via the infra-red or Bluetooth programming link, either using the in-built menu structure or PC software Insight2 (Bluetooth). The CMA settings can also be adjusted via its user interface, which is accessible when the electrical cover is removed.

The DFU 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.

The DFU may command the actuator into which it is fitted to open, stop, close, perform an ESD operation, perform a partial stroke test (IQ and CK only) or move to a set position. Commands to the module come from the network and will be generated in a master controller. The DFU operates in two communication modes, Polling and Master/Slave.

Figure 1: The DeviceNet Option Card Actuator Compatibility

1.1   Reference Documentation

Supporting Documents from the ODVA www.odva.org:

❑   PUB00027R1 Cable Installation Guide

Supporting document from Rotork:

❑   PUB094-009 CMA Installation manual
❑   PUB002-040 IQ Full configuration, status and monitoring user manual
❑   PUB111-005 CK Full Centronik Full configuration message manual

1.2   General

The DFU has the following characteristics –

Device Type	Generic
Group	Group 2 only slave device
Communication	Explicit and Polled I/O messaging of the predefined master/slave connection
Speed	500k, 250k, 125k baud (default 125kbaud)
MAC ID (address)	0-63, default 63
Output (to actuator)	4 bytes
Inputs (from actuator)	8 bytes

Bus Connection	Function
+V (Red)*	24V DC power supply
CAN_H (White)	Data High
Screen	Shield
CAN_L (Blue)	Data Low
-V (Black)*	0V DC power supply

The DC power supply can be in the range 9volts to 36volts, it powers a step down DC-DC converter, the CAN transceiver and optical isolators on the DFU.

2 DEVICENET OPTION CARD PROPERTIES

2.1 Mechanical properties

The DFU comprises a single printed circuit board that fits inside the actuator electrical housing. The DFUs primary connection to the actuator circuits is by a multi-pin connector.

In most cases, the DFU connects directly to the main actuator control PCB (Printed Circuit Board). In an IQ, it can be fitted directly to the control Module PCB using either one of the 2 slots available, or can be fitted on top of another option module that may already be fitted in one of these slots. There are 4 available slots for option cards to be mounted either directly or indirectly behind the control module PCB. For the CMA there are 2 option slots available. In the CK the DFU is either mounted directly in the single option slot, or fitted on top of another option card that is fitted in the slot.

The DFU carries the fieldbus connector, this couples to the actuator wiring harness routed to the terminal compartment (IQ and CK) or interconnect PCB (CMA) of the actuator, refer to the appropriate wiring diagram of your actuator for connecting the field network connections.

The field network connector is polarised to prevent incorrect insertion.
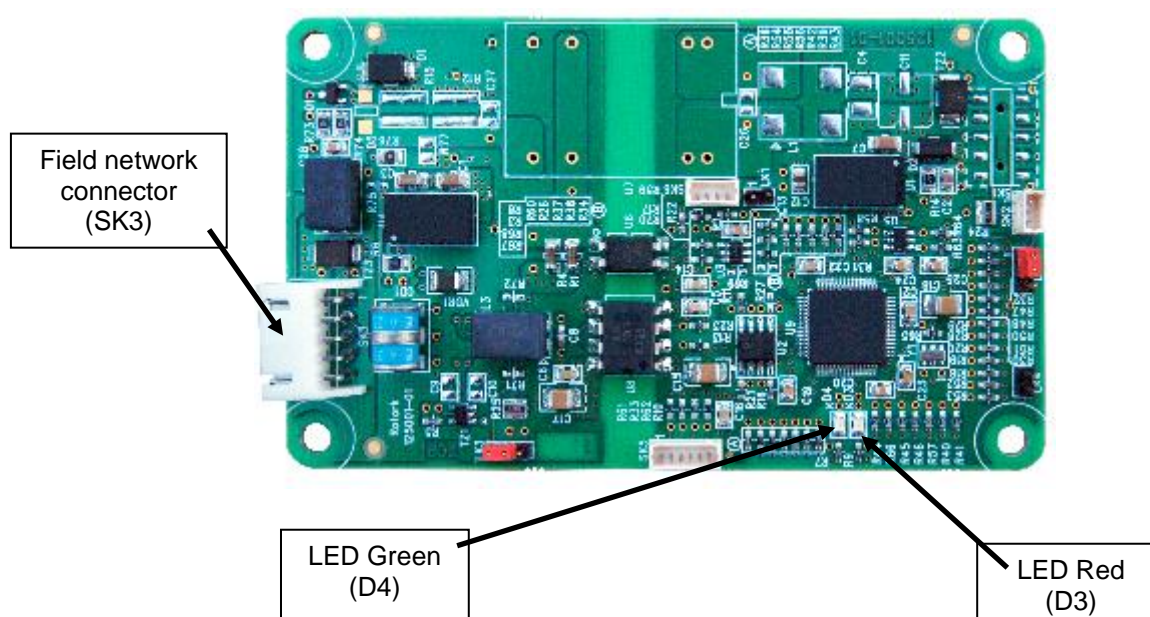
Figure 2: The DFU module, connectors and LEDs

2.2 Electrical Properties

The DFU connects directly to the main board of the actuator. The DFU does not sit in the main control path for the actuator and does not affect the actuator control integrity.

The DeviceNet fieldbus data highway connection and power lines are fully isolated from the actuator electronics.

The DeviceNet fieldbus power supply must be connected to the actuator for correct operation. Cycling the power on the DeviceNet network will cause the device to reset.

2.3 On-Board Indication LEDs

There are 2 LEDs on the DFU, one green and one red, refer to Figure 2 for the location of the LEDs. They are used to indicate the state in which the unit is in:

No LEDs lit	The DFU has shut down due to an internal error or some remote command.
Green LED Flashing (D4)	The DFU is communicating in Master/slave mode (not polling). OR The DFU is 'unallocated' i.e. it has successfully joined the network but is not currently "owned" by a DeviceNet Master device. OR The DFU has timed out because messages have failed to arrive on one or more connections with the Master device.
Green LED solid on (D4)	The DFU is communicating in a polling mode to a master.
Solid Red LED (D3)	The device has detected an internal error or received a Duplicate MacID response message. It is in a FAULTED state. This is not a recoverable error. OR The DFU is in the BusOff state, where it has detected significant network errors and has removed itself from network operation. This is typically a hardware failure in the device circuitry or the absence of the network 24volt DC supply.

2.4 Operation and Storage

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

- ❑ Operating temperature: -40°C to +70°C
- ❑ Storage temperature: -50°C to +85° C
- ❑ Relative Humidity: 5% to 95% (<50°C) non-condensing

3 FITTING THE DFU OPTION CARD

3.1 Inside an IQ actuator

The DFU is suitable for fitting into IQ actuators with wiring diagrams containing a 'D' as the 4th character, for example 100D2000. The FCU can be located in one of 4 option 'slots' located on the back of the control module PCB, housed in the electrical cover. There are 2 slots for directly connecting the option module to the Control module and where those slots are already filled, the option card can be fitted on top of an existing option module with the appropriate fixings. The modules can be stacked 2 high.

Figure 3: The DFU and its location behind the control module on an IQ (multi-turn)

On the IQ actuator the remote inputs are always present (they are conditioned by the control board) and there are 4 standard Digital Outputs from relay contacts. If the DFU is required to operate digital outputs, then an Extra Relay Indication card or DIO card must be fitted into the actuator; providing relay contacts S5 to S8 and S9 to S12 where 2 extra cards are fitted.

The DFU is connected to the control module by a header, which contains most of the interconnections. The wiring harness from the actuator terminal bung connects the field connections to SK3. See section 2.1 for details of the location of the connectors on the card.

3.2   Inside CMA actuator

The DFU is suitable for fitting into CMA actuators, wiring diagrams MXX-NX or MXX-XN (where X can be any value). The DFU module is fitted onto the only option slot available inside the CMA electrical housing for a CMA with the standard cover.

Std single option location

interconnect board location
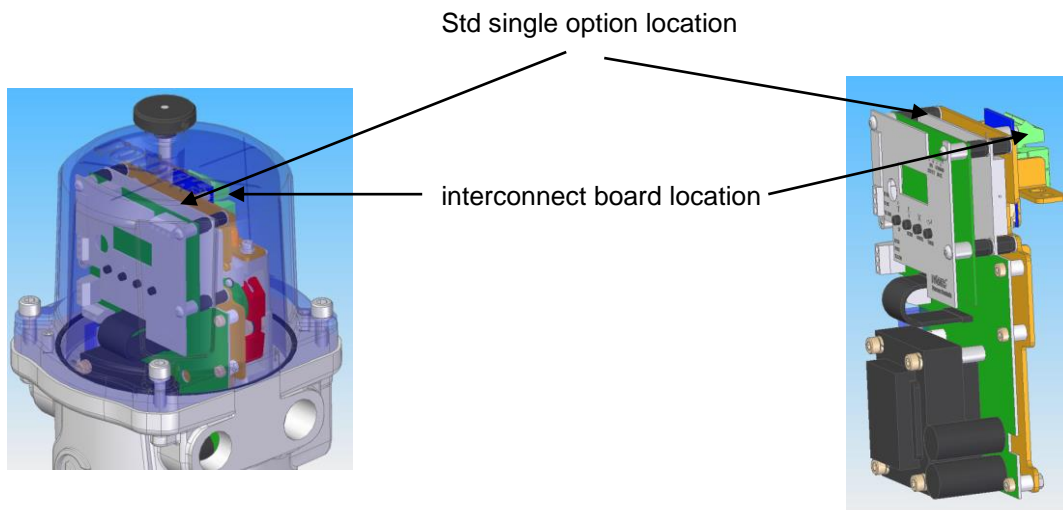
Where 2 option cards are fitted a longer cover is required as the additional card is added to the top of the standard assembly. The display and control knobs depicted here are optional.

2nd option card location
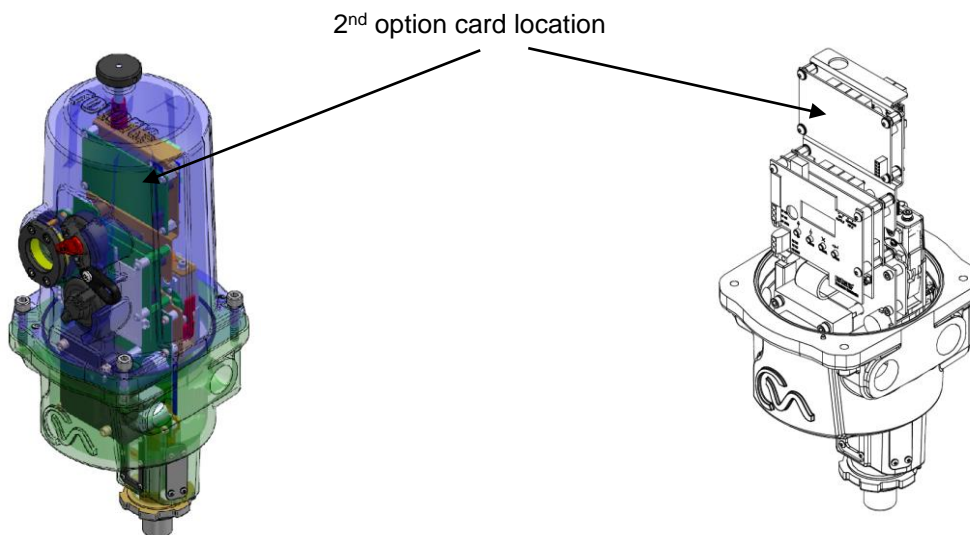
Figure 4: The FCU located in a CMA actuator

SK3 on the DFU connects to the CMA interconnect board. The user wires the connections to the interconnect board assembly at the terminal block SK1-SK4 as per the wiring diagram.

3.3   Inside CK Actuator

The DFU is suitable for fitting into CK actuators with wiring diagrams containing an 'H' as the 3rd or 4th character, for example P0H00020. The FCU can be located in one of 2 option 'slots' located on the control module PCB, housed in the electrical cover. There is 1 slots for directly connecting the option module to the Control module and where the slot is already filled, the option card can be fitted on top of an existing option module with the appropriate fixings. The modules can be stacked 2 high.
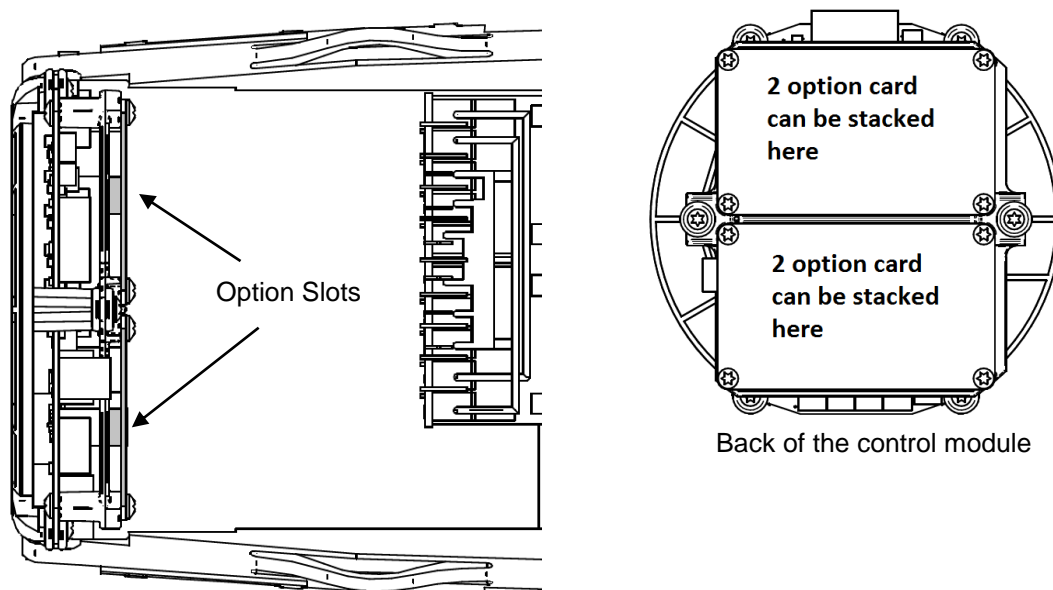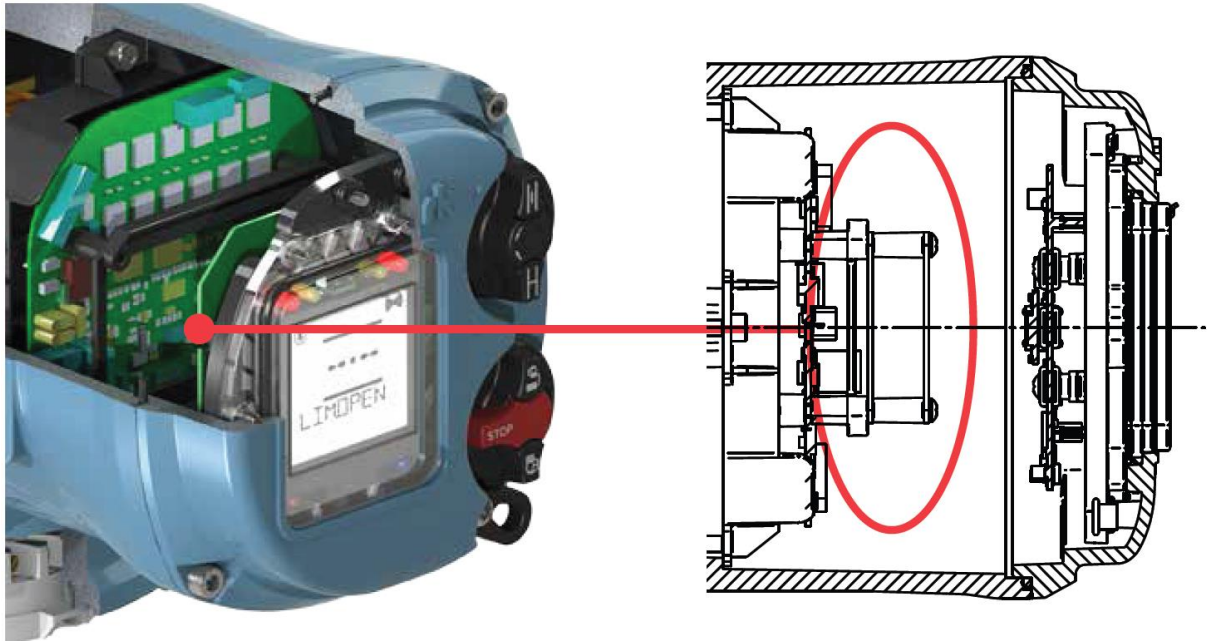

Figure 5: The DFU and its location behind the control module in a CK

On the CK actuator the remote inputs are always present (they are conditioned by the control board) and there are 4 standard Digital Outputs from relay contacts. If the DFU is required to operate digital outputs, then an Extra Relay Indication card or DIO card must be fitted into the actuator; providing relay contacts S5 to S8.

The DFU is connected to the control module by a header, which contains most of the interconnections. The wiring harness from the actuator terminal bung connects the field connections to SK3. See section 2.1 for details of the location of the connectors on the card.

3.4   Replacing or Fitting a DFU Option Card

The DFU should be replaced or fitted only in a suitable environment. The appropriate actuator manual should be reviewed before proceeding, see section '1.1   Reference Documentation'. The actuator must be made electrically safe before opening any covers and in the case of an IQ it is advisable to disconnect the internal battery. In the case of a CMA that contains an optional back-up power pack, it is advisable to make sure the back-up power has dissipated before opening the electrical cover.

The electrical housing cover should be removed and the existing DFU carefully unplugged from its connector. Once removed from the connector the wiring loom connectors should be removed. The replacement board is fitted in the reverse order to removal.

If the operation is to fit a DFU for the first time then the necessary wiring looms must be added to the internal wiring harness of the actuator. The actuator wiring diagram shows the connectors and harnesses used. The wiring harnesses should be fitted inside the actuator before fitting the DFU. Once the looms are in place connect them to the DFU, then fit the DFU to the actuator main board connector. For the IQ and CK actuators it is necessary to add the DFU to the list of option cards fitted to the actuator in its menu, if the DFU is fitted in to the actuator for the first time. Contact Rotork service for this operation.

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

The DFU 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.

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4 DEVICENET DATA HIGHWAY AND CONNECTIONS

4.1 Data Highway

The DeviceNet network is based on the CAN bus system. The network carries the power and signal wires, together with a shield, to each node on the network. Two wires are used for the data highway (CAN_H and CAN_L) and two wires carry the 24V dc power. The DFU is part powered from the actuator and part powered from the 24V dc network supply. The assembly can only report data when the actuator is powered up as well as the 24V dc network supply being present.
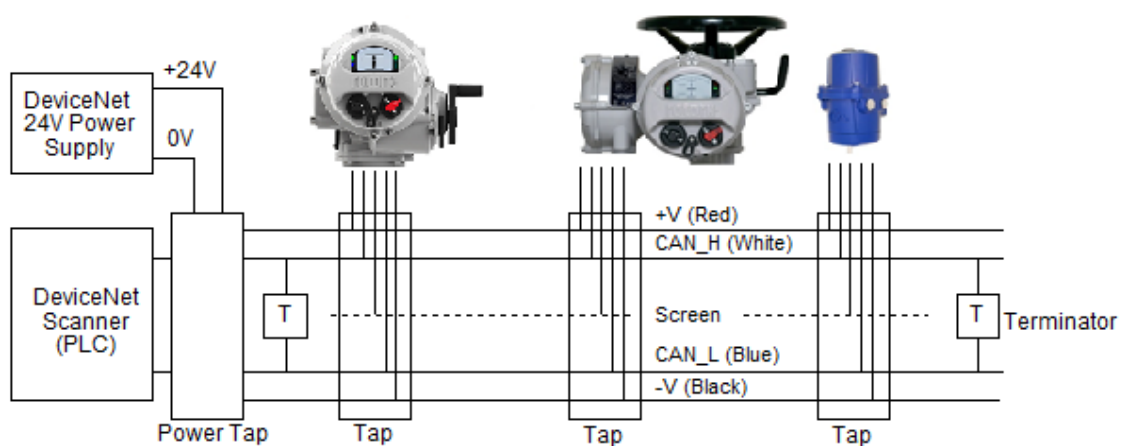
Figure 6: Typical DeviceNet Data Highway

The data highway must be terminated with proper balancing devices at either end. The highway itself can use tapped spur or stub connections to the actuators but it is recommended to keep any stub lengths to a minimum for successful operation. Alternatively the connection can be made in and out of each actuator in a daisy chain arrangement. The length of the highway and number of devices connected will vary from project to project. The standard permits up to 64 (address 0-63) devices to be connected, though address 63 is best not used in a live system as this is the standard default address.

The length of the highway will determine the maximum speed for the data transmission. The greatest length obtainable is achieved using 'flat' cable, but this is not very practical for actuator wiring. Most systems will use round 'thick' cable where a distance of 500 metres can be achieved. With this cable and speed the maximum drop length for a spur is 6 metres, with a cumulative total that must not exceed 156 metres. With the smaller cross section round 'thin' cable the distance reduces to 100 metres.

Each network will require a suitable DeviceNet power supply. The –V line (0V) is used as the system reference.

4.2   Highway Topography

A variety of different connection topologies can be used for DeviceNet. The basic system is a trunk line with various drop lines from it. This system will require the location of the taps in junction boxes near to the actuators. Alternately the actuators can be directly connected to the trunk line in a daisy chain, or a drop line can daisy chain a number of actuators together. All the configurations require the cumulative total of the drop lines and stub lines to be kept within the permitted maximum for the network speed to be used.

It is good practice to avoid drop lines wherever possible.
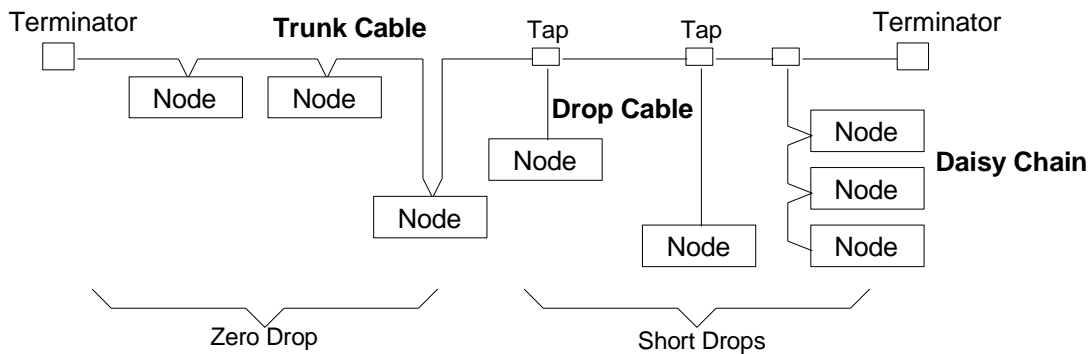
Figure 7: DeviceNet Data Highway Topology

Connections onto the trunk line are made using 'taps' that are designed to minimise the possibility of connection errors. Where a power supply is to be connected then a power tap should be used as this includes a fuse and protection circuit.

The maximum length of each drop line and the cumulative total are dependent on the system speed in use. The table below gives the maximum figures for each cable type.

Data Rates	125 kbaud	250 kbaud	500 kbaud
Trunk Length (Thick)	500 metres	250 metres	100 metres
Trunk Length (Thin)	100 metres	100 metres	100 metres
Trunk Length (Flat)	380 metres	200 metres	75 metres
Max Drop Length	6 metres	6 metres	6 metres
Cumulative Drop	156 metres	78 metres	39 metres
Number of Nodes	64	64	64

Within each actuator there is a short drop line or stub connection wire from the terminals to the DFU itself. This length must be included in any calculation for total and individual drop lengths.

Actuator Type	IQ	IQT3	CMA	CK
Internal Drop length (metres)	0.53	0.40	0.15	0.31

4.3   DeviceNet Cable

The network must be connected using a suitable cable. Four conductors plus a shield and drain wire are required for the 5 connections to the devices. There are thick and thin round cables and also a special flat cable. In general the thick round cable will be most suited for actuator wiring.

Amongst the cable manufacturers Belden have the PVC jacketed 3082A round thick cable which provides a typical example of the cable requirements. Information on the Beldon cable may be found on the Belden web site (www.belden.com), where a search on DeviceNet will reveal technical papers and cable information.

Power Pair

Data Pair

Screen
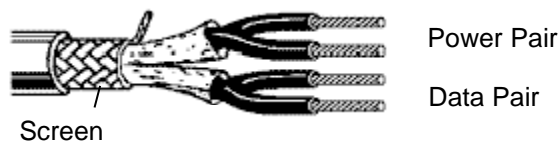
Belden Part No.	AWG (stranding) dia. Inches Nom. DCR	Insulation material (colour code)	Nominal O.D.	Nom Impedance (ohms)	Nominal Capacitance	Test Frequency (MHz)	Maximum Attenuation dB/100ft
3082A	2 – 15 AWG (19 x 28) .067 tinned copper 11.8 ohm/km' 2 – 18 AWG (19 x 30) .046 tinned copper 22.7 ohm/km	Power pair PVC – Polyvinyl Chloride (Black/red) Data pair FPE - Foam Polyethylene (blue/white)	12.2 mm	120	12.0 pF/ft	0.125 0.5 1	0.13 0.25 1.36

Figure 8: Typical DeviceNet cable

The cable is colour coded to help reduce installation errors. It is important to ensure that the correct colour sequence is used as all DeviceNet systems use the same colours. The terminals to which the wires connect in the each actuator type will be different and the actuator wiring diagram must be consulted to establish the connections.

The standard colour codes are indicated in the table.

Sleeve Colour	Function	Usage
Red	V+(24VDC)	Power
White	CAN_H	Data Signal
Bare (no sleeve)	Drain	Shield
Blue	CAN_L	Data Signal
Black	V- (0VDC)	Power

4.4 Termination Network

In order to operate correctly all DeviceNet highways must be terminated at each end of the main trunk line using a 120 ohm resistor. These will usually be near the scanner PLC and near the furthest actuator. The resistors are connected across the CAN_H and CAN_L data lines. If the termination resistors are not fitted there is a possibility that the network communications will be unsatisfactory.

There are no termination facilities inside the actuator itself.
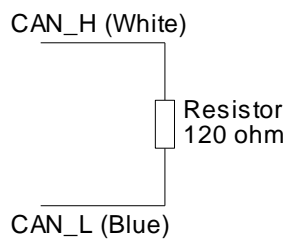
Figure 9: Termination for DeviceNet highway

4.5 Cumulative Volt Drop

To preserve the common mode noise immunity margins for the DeviceNet communications it is necessary to ensure that the volt drop between any two points on the V- conductor does not exceed 5V. The voltage drop that does occur will be due to the resistance of the conductor (ohms) multiplied by the current carried (in amps).

The current drawn by the DFU varies with the applied voltage and is as follows:

Power Supply Voltage	Current Drawn (mA)
36	14 mA
24	15 mA
16	16 mA
9	25 mA

5 THE ACTUATOR INPUT AND OUTPUT SIGNALS

The DFU is a Generic Device Type as defined by the ODVA since it does not fit into any predefined device types. It uses only one instance of the input and output assemblies within the device in order to simplify its use and application on a DeviceNet system.

In order to make proper use of the DFU it is necessary to set all the variable parameters to suitable values for the individual valve on which the actuator is mounted and the duty for which the actuator is intended. The setting of these parameters will require a suitable configuration tool and the installation of the Rotork EDS file for use by the configuration tool. An explanation of the EDS file and the adjustable parameters follows later in this manual.
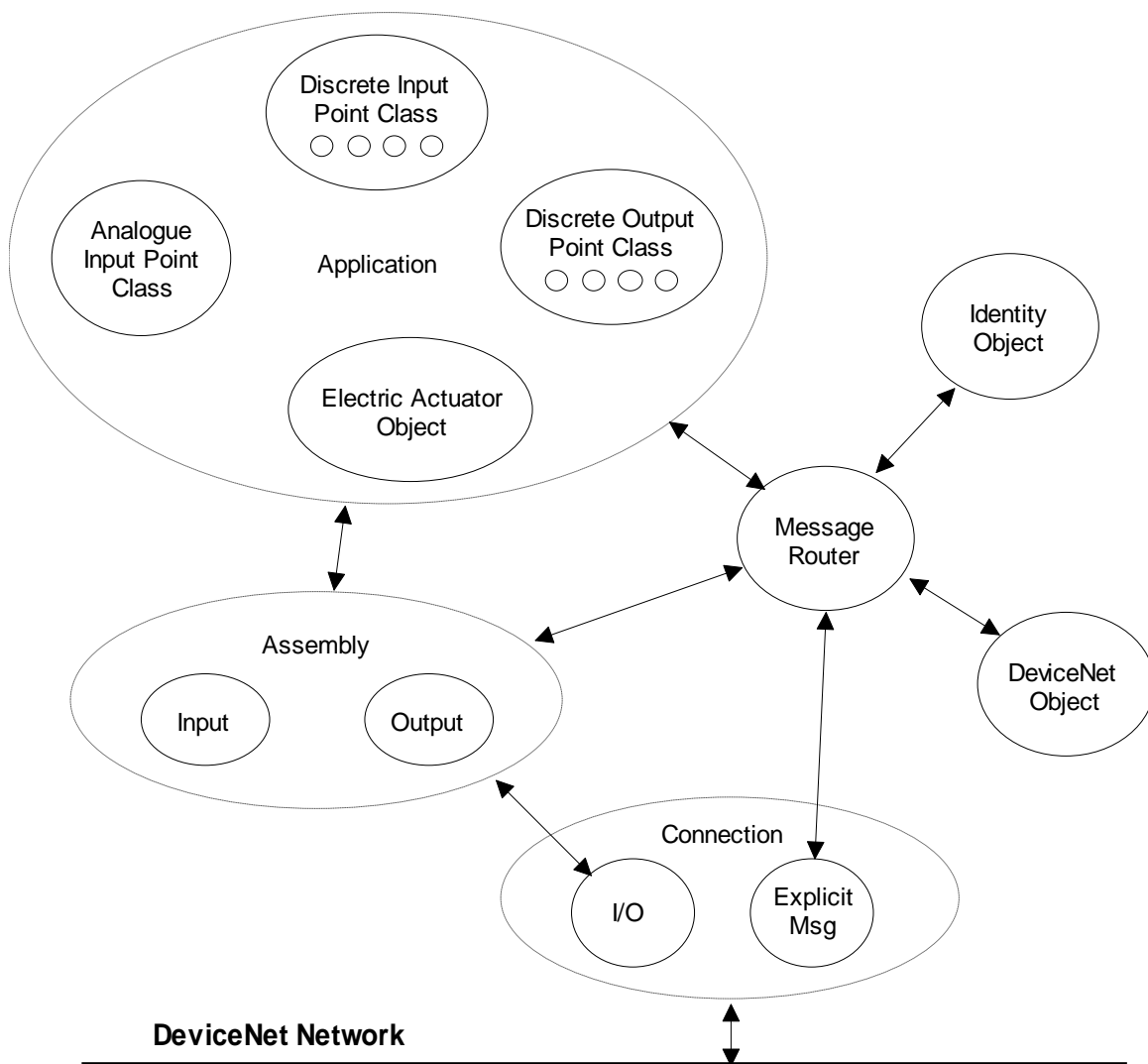
Figure 10: Actuator Object Model

5.1 Input/Output Assembly Instance

The DFU supports inputs and outputs via polled I/O connection through the Assembly Object as illustrated in the Object Model. There is only one input assembly instance and one output assembly instance for the DFU.

❑ **Inputs** are defined as signals originating at the actuator and fed back to the PLC over the network.

❑ **Outputs** are defined as signals originating at the PLC and operating the actuator controls.

On the communication link, 4 bytes are used for the output data to the actuator and 8 bytes for the feedback data during polling.

5.1.1 Output Assembly Instance

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Reserved	Reserved	Partial Stroke	Position Enable	ESD	Run Open	Run Closed	Stop
1	DO-8	DO-7	DO-6	DO-5	DO-4	DO-3	DO-2	DO-1
2	Lower 8 bits Position DV							
3	Reserved						Upper 2 bits Position DV	

5.1.2 Input Assembly Instance

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Local Selected	Local Stop Selected	Remote Selected	Running Open	Running Closed	Open Limit	Close Limit	Actuator Moving
1	Reserved	Position Control Enabled	Moving Inhibited	Valve Moving by Hand	Valve Jammed	Valve Obstructed	Monitor Relay	Thermostat Tripped
2	Reserved	DI-4	DI-3	DI-2	DI-1	Close Interlock	Open Interlock	Battery Low
3	8 bits Torque							
4	Lower 8 bits Position MV							
5	Reserved						Upper 2 bits Position MV	
6	Lower 8 bits Analogue Input							
7	Reserved		Upper 6 bits Analogue Input					

5.2 Control Outputs

The DFU may 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 CK the Auxiliary Input Mask must be correctly set). As well as controlling the actuator the DFU can also be used to operate up to 8 discrete digital output relays when fitted to an IQ actuator (4 relays in CK). The control commands have three potential sources:

❑ DeviceNet generated commands
❑ Actuator Local Controls
❑ Direct contact input controls

The full list of commands applicable to each actuator type is shown in the table below.

Command	IQ actuator	CMA	CK
DeviceNet Network			
Open	✓	✓	✓
Close	✓	✓	✓
Stop	✓	✓	✓
Emergency Shut Down	✓	✓	✓
Position Enable	✓	✓	✓
Partial Stroke	✓	✘	✓
Digital output DO-1	✓①	✓①	✓①
Digital output DO-2	✓①	✓①	✓①
Digital output DO-3	✓①	✓①	✓①
Digital output DO-4	✓①	✓①	✓①
Digital output DO-5	✓①	✘	✘
Digital output DO-6	✓①	✘	✘
Digital output DO-7	✓①	✘	✘
Digital output DO-8	✓①	✘	✘
Analogue Position demand	✓	✓	✓
Local Controls			
Open	✓	✓	✓
Close	✓	✓	✓
Stop	✓	✓	✓
Direct Wired Inputs			
Open	✓	✓②	✓
Close	✓	✓②	✓
Stop/Maintain	✓	✓②	✓
Emergency Shut Down	✓	✓②	✓
Open Interlock (active prevents opening)	✓	✘	✓
Close Interlock (active prevents closing)	✓	✘	✓

Note: ① – Requires Extra Relay Indication board(s) to be fitted
Note: ② – Requires Remote input (RIRO / DIO) board to be fitted

The DeviceNet network commands will operate the actuator provided -

- For IQ and CK - the L/S/R selector is in 'Remote' and there is no interlock active and the DeviceNet commands are not inhibited by the 'Inhibit/DI4' input parameter setting and DI4 condition
- For CMA - Remote Operation Mode is selected and the Primary Option Control is DeviceNet and the Remote Input Control selection is for the Primary Option Control,
- 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 and CK multi-turn actuators are set to open until the open limit switch is reached and, close until the closing on torque switch trips, but it is dependant on the type of valve.* *The IQT normally operates 90-degree valves, use stop bolts on the actuator or gearbox, and stop when these are reached. The control room indication is always taken from the*

❑ **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 the action.

❑ **Position Enable** A digital command that enables the actuator to obey the position demand setpoint (DV).

Note:	*Only one operation command (Open, Close, Stop, ESD, Position, Partial Stroke) is allowed over the DeviceNet network at any one time. If two operation commands are present in the output command register, this is a control contention. Under this circumstance, if the unit is in the process of an operation, it will continue until the actuator finishes that operation. The actuator will not operate again, until the control contention has been removed i.e. only one operation command is present in the output command register.*

❑ **Partial Stroke** If a network command to perform a partial stroke test is sent to an IQ or CK actuator, it will carry out the test sequence provided the actuator has been set up to enable partial stroke testing (refer to the actuator manual). The actuator must be set to Remote and be at the correct end limit set for partial stroking. The actuator will also carry out a partial stroke test if a signal is applied to the open interlock input, if the Interlock configuration has been set to Partial Stroke. Over the

DeviceNet interface it is only possible to instigate the partial stroke, it is not possible to access the feedback data for the operation - success can be inferred by actuator movement and return to the original limit.

❑ **Digital Output DO1 to DO8**   These 8 commands are used to energise and de-energise the relays on the additional relay board(s). It is important to note that these outputs maybe referred to with different labels in the standard actuator documentation. It is possible to fit 2 extra relay cards into the IQ, the first card will contain S5-S8 (DO-1 to DO4) and the second card S9-S12 (DO-5 to DO8). It is possible to fit 1 extra relay card to the CMA and CK, which will contain relays 5 - 8 (DO-1 to DO4). The resulting outputs can be used for operating other equipment such as a pump or indication light. The table below clarifies which relays are controlled:

DeviceNet reference	IQ actuator wiring diagram reference	CMA actuator wiring diagram reference	CK actuator wiring diagram reference
DO-1	S5	RIRO relay 5	Extra relay 5
DO-2	S6	RIRO relay 6	Extra relay 6
DO-3	S7	RIRO relay 7	Extra relay 7
DO-4	S8	RIRO relay 8	Extra relay 8
DO-5	S9	-	-
DO-6	S10	-	-
DO-7	S11	-	-
DO-8	S12	-	-

The relays are NOT latching, therefore, their state will revert to de-activated on loss of mains power to the actuator or on device reset.

❑ **Analogue Position**   This function is only available over the DeviceNet network. To initiate Analogue Position Control the Position Enable bit must be set and the appropriate value placed in the Position DV register (range 0-1000, 0-100.0%, resolution 0.1%), the valve will open to the appropriate amount and stop in that position. Once the setpoint is reached the positioning controller is switched off unless the positioning command is still being sent. A new network poll that includes the Position Enable bit and a Position DV value will initiate positioning mode once more.
Provided limited range positioning is not invoked the values 0% and 100% written to this 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%).
The control used for the positioner is proportional only.
When using position control there are a number of parameters used to tune the position controller and reduce the possibility of damage to the actuator. These are deadband, Hysteresis and Motion Inhibit Timer – see the actuator related configurable parameters section for more details.

❑ **Hard Wired Stop** The hard wired stop will stop a unit running under network control.

5.2.1   IQ and CK Remote Controls Priority

For the IQ and CK 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 or CK to select the required function. In the case of the hard wired input for ESD this can be configured either as an ESD/DI-4 signal or as a 'DeviceNet Command Inhibit' to prevent network control signals from moving the actuator.

The following statements are useful when considering control priority relating to the network commands and the hardwired inputs:
1. DeviceNet commands and commands using the hardwired inputs, with the exception of ESD, will not operate the actuator unless it is in the remote mode.
2. All DeviceNet command have the same priority, multiple DeviceNet commands sent at the same time will cause control contention, at which point it will continue to perform the last good command. New DeviceNet commands clear previous commands.
3. An ESD command sent over the DeviceNet network or using the hardwired inputs (when enabled with the Auxiliary mask) will have priority over all other commands (bear in mind point 2). The ESD will operate the actuator in local and remote.
4. Any ESD (DeviceNet network or hardwired) can also be set to override local stop in an IQ or CK (refer to the manual for the IQ or CK).
5. An ESD over the hardwired only operates in Push-to-Run (PTR) mode, i.e. it is not maintained.
6. A standing (PTR) hardwired command (when enabled using the auxiliary mask) will override any DeviceNet network command, except network ESD.
7. A maintained hardwired command (when enabled using the auxiliary mask) can be overridden by a DeviceNet network command.
8. An ESD over the DeviceNet network is maintained until a new command is received, this includes a new DeviceNet network command received in local i.e. a DeviceNet network STOP will remove a DeviceNet network ESD whilst in local.

5.2.2   CMA Remote Controls Priority

There are a number of CMA menu items that are important for setting up which source of control is being used by the CMA. Refer to the installation manual for more details (PUB094-009).

For the CMA to be operated by the DeviceNet the following must be true:
1) LOCREM : set to REMOTE (Basic setting)
2) CMDSRC -> PRM OC : Set to PO-DVN (Advanced setting)
3) CMDSRC -> RI CTRL : Set to RC-POC (Advanced setting)

It is also possible to operate the CMA with Hardwired Digital Inputs. If the Hardwired Digital Inputs are required to operate the unit, a change to the RI CTRL setting is required. The various settings for the RI CTRL are shown below:

RC-OFF	no remote control
RC-DIO	Control via Hardwired Digital Inputs only
RC-POC	Control via option card
RC-PSH	Control selectable between the DeviceNet and the Hardwired Digital Inputs via a Manual / Auto Input (on the DIO option card)

It is not possible to get a command contention situation (i.e. Hardwired Digital Input applied at the same time as a DeviceNet command) as, at any one time, only one control source can be selected (Hardwired or DeviceNet)

5.2.3   Issuing DeviceNet Control Commands

Stop	write '1' into Output data byte 0 bit 0 to apply, write '0' to remove
Close	write '1' into Output data byte 0 bit 1 to apply, write '0' to remove
Open	write '1' into Output data byte 0 bit 2 to apply, write '0' to remove
ESD	write '1' into Output data byte 0 bit 3 to apply, write '0' to remove
Partial Stroke test	write '1' into Output data byte 0 bit 5 to apply, write '0' to remove
DO-1 to DO-8	write '1' into Output data byte 1 bit 0 to 7 (DO-1 to DO-7) to energise the relay, write '0' to de-energise the relay
Analogue Position	write '1' into Output data byte 0 bit 4 to enable position control and write a value into the Position DV register, Output data bytes 2 and 3. Scaled 0000 hex for 0.0% to 03E8 hex for 100.0%. (Note that position control may be subject to Limited Range Positioning as described later in this manual.)

The commands to open, close, stop, Partial Stroke or ESD the actuator are not cancelled by writing a '0'. The actuator latches the instruction and will complete the action unless a subsequent affirmative command is received. With position control the positioner will maintain control at the desired position whilst the Position Enable bit is true.

5.2.4   IQ and CK DeviceNet Control Disable feature

It is possible to set the IQ and CK ESD/DI-4 input so that the actuator ignores open, stop, close, ESD, partial stroke and position control signals sent over the DeviceNet. If the ESD DI4 / Net Disable parameter is set to Active then when the ESD input is connected to made, DeviceNet control is not allowed. This feature is independent of the Auxiliary mask setting.

In IQ3 range contact type can be set to either N/O or N/C in CTRL version V117 or later. Earlier versions and CK are always N/O.

If a network command is operating an actuator when the network disable feature is invoked (signal applied to ESD DI4), the actuator will stop and the current command will be reset.

5.3 Actuator Digital Input Status Feedback

The DFU module reports over the network a comprehensive data set relating to the status of the valve and actuator as indicated in the table below. This information is contained within the 8 byte return message in routine polling mode. The conventional contact indications are also available from the actuator limit switches and indication contacts.

Status Feedback	IQ actuator	CMA	CK	Location
Actuator Moving	✓	✓	✓	Byte 0 Bit 0
Close Limit	✓	✓	✓	Byte 0 Bit 1
Open Limit	✓	✓	✓	Byte 0 Bit 2
Running Closed	✓	✓	✓	Byte 0 Bit 3
Running Open	✓	✓	✓	Byte 0 Bit 4
Remote selected	✓	✓	✓	Byte 0 Bit 5
Local Stop selected	✓	✓	✓	Byte 0 Bit 6
Local selected	✓	✓	✓	Byte 0 Bit 7
Thermostat Tripped	✓	✓	✓	Byte 1 Bit 0
Monitor Relay	✓	✓	✓	Byte 1 Bit 1
Valve Obstructed	✓	✓	✓	Byte 1 Bit 2
Valve Jammed	✓	✓	✓	Byte 1 Bit 3
Valve Moving by Hand	✓	✗	✓	Byte 1 Bit 4
Moving Inhibited	✓	✗	✓	Byte 1 Bit 5
Position Control Enabled	✓	✓	✓	Byte 1 Bit 6
Reserved	✗	✗	✗	Byte 1 Bit 7
Battery Low	✓	✗	✗	Byte 2 Bit 0
Open Interlock input	✓	✗	✓	Byte 2 Bit 1
Close Interlock input	✓	✗	✓	Byte 2 Bit 2
DI –1	✓	✗	✓	Byte 2 Bit 3
DI –2	✓	✗	✓	Byte 2 Bit 4
DI –3	✓	✗	✓	Byte 2 Bit 5
DI –4	✓	✗	✓	Byte 2 Bit 6
Reserved	✗	✗	✗	Byte 2 Bit 7

5.3.1 Digital Inputs

❑ **Actuator Moving** Reported in Byte 0 Bit 0, whenever the actuator position is changing due to the motor running or if the centre column is moving, this bit will be set true (1).

❑ **Close Limit** Reported in Byte 0 Bit 1, 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** Reported in Byte 0 Bit 2, 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** Reported in Byte 0 Bit 3. Whenever the actuator motor contactor used to drive the actuator in the closing direction is energised this bit will be true (1). For an IQ or CK this will also be set when the actuator is hand wound in the close direction.

❑ **Running Open** Reported in Byte 0 Bit 4. Whenever the actuator motor contactor used to drive the actuator in the opening direction is energised this bit will be true (1). For an IQ or CK this will also be set when the actuator is hand wound in the open direction.

❑ **Remote Selected** Reported in Byte 0 Bit 5, this bit is true (1) for the IQ or CK when the actuator three position remote/local stop/local selector is in the Remote position or when the CMA is set to remote operation. The actuator must me in remote for DeviceNet control to be permitted.

❑ **Local Stop** Reported in Byte 0 Bit 6. The IQ or CK 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. For the IQ or CK when the switch is in the Local Stop position this bit will be true (1), or when the CMA is set to local stop. Remote control of the actuator is not possible when the selector is in this position.

❑ **Local Selected** Reported in Byte 0 Bit 7, this bit is true (1) for the IQ or CK when the actuator three position remote/local stop/local selector is in the Local position or when the CMA is set to local operation. Remote control of the actuator is not possible when the actuator is in this mode.

❑ **Thermostat** Reported in Byte 1 Bit 0. If the temperature of the motor windings rises above the thermostat trip value, the thermostat contact will open and this signal will be present (1). There are no adjustments for the temperature at which the thermostat trip operates. The motor will be stopped if the thermostat trips. Only once the motor has cooled down and the thermostat has reset itself can a new Remote, Host or Local command to move the actuator be carried out. A software setting in the IQ actuator allows the ESD command to override the thermostat. The bit will remain set at logic 1 until the motor cools down and the thermostat resets itself.

❑ **Monitor Relay**   Reported in Byte 1 Bit 1. This signal is true (1) when actuator control is not available. The actuator Monitor Relay status is a composite signal for a number of alarms. This signal will be set true if the actuator is not in Remote or if the thermostat trips. The mains supply is also monitored and if one of the three phases is lost the monitor relay 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** Reported in Byte 1 Bit 2. This bit will be true (1) if the actuator stops in mid travel, following a command, when not expected to do so. 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 is operated in the opposite direction.

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**   Reported in Byte 1 Bit 3. 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 DFU fails to see movement and reports this status after the time set in the associated parameter during the DFU set up. The bit will remain true (1) until the actuator is operated in the opposite direction.

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**   Reported in Byte 1 Bit 4, **applicable to IQ actuators only**. 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 bit will remain true (1) until the actuator is moved electrically by either the local controls or a network command.

❑ **Moving Inhibited** Reported in Byte 1 Bit 5, **applicable to IQ actuators only**. This bit will be true (1) when the Motion Inhibit Timer is active or the Interrupter Timer is active, 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 MIT only operates when the actuator is operating under positioning commands, it starts when the actuator completes a movement to position.

The Interrupter Timer can be used over part or all of the 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 action will continue once the time has elapsed.

❑ **Position Control Enabled** Reported in Byte 1 Bit 6. This bit will be true (1) when the actuator is being controlled using the positioning method. On reaching the desired position, the bit will be reset.

❑ **Battery Low** Reported in Byte 2 Bit 0, **applicable to IQ 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** Reported in Byte 2 Bit 1, **applicable to IQ and CK actuators only**. The input contact to the Open Interlock is monitored by the DFU. Whenever the input contact is closed and the interlock function has been enabled in the actuator this bit will be true (1). This bit indicates the existence of an interlocking input that can prevent the actuator from opening.

❑ **Close Interlock** Reported in Byte 2 Bit 2, **applicable to IQ and CK actuators only**. The input contact to the Close Interlock is monitored by the DFU. Whenever the input contact is closed and the interlock function has been enabled in the actuator this bit will be true (1). This bit indicates the existence of an interlocking input that can prevent the actuator from opening.

❑ **Digital Input DI-1** Reported in Byte 2 Bit 3, **applicable to IQ and CK 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** Reported in Byte 2 Bit 4, **applicable to IQ and CK 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** Reported in Byte 2 Bit 5, **applicable to IQ and CK 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** Reported in Byte 2 Bit 6, **applicable to IQ and CK actuators only**. This bit reports the status of the contact connected to the actuator hard wired **ESD** terminals. The input can be used to control the actuator or simply to report the status of a plant feedback signal. The function is set in the Auxiliary Input Mask parameter which determines whether the bit is reported as true (1) for a closed contact or an open contact and whether the input controls the actuator or not. Note that the input is always reported even when it is also controlling the actuator.
A configuration feature also allows DI-4 to be set to act as a 'Disable Fieldbus Control' input. In this mode when the input is made (irrespective of the Auxiliary Mask setting) the actuator cannot be controlled over the DeviceNet. This can be useful during plant commissioning to prevent unwanted valve movement.

5.4 Actuator Analogue Input Feedback

The DFU module reports over the network a number of analogue variables. These contain information about the valve and actuator as well as one associated plant measurement. This information is contained within the 8 byte return message in routine polling mode.

Analogue Feedback	IQ	CMA	CK	Location
Actuator Instantaneous Torque	✓	✓	✓	Byte 3
Valve Position	✓	✓	✓	Byte 4 and 5
Analogue Input	✓	✓	✓	Byte 6 and 7

❑ **Torque**
Reported in Byte 3.
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**
Reported in Byte 4 and Byte 5.
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. Byte 4 contains the low order 8 bits and byte 5 the high order 2 bits of the 10 bit number. The actuator automatically scales 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.

❑ **Analogue Input**
Reported in Byte 6 and Byte 7.
For the IQ and CK: requires a separate analogue input option card. The current value of the analogue input option card is reported as an Integer Value in the range 0 to 10,000 (2710 hex). Byte 6 contains the low order bits and byte 7 the high order bits.
The input may be 0 to 5V or 0 to 20mA DC from an externally powered field transmitter (the actuator does not provide the power for the transmitter). The analogue input is calibrated using the appropriate IQ in-built menu, or using the Analogue input calibration register.
For the CMA: these bytes return the Set Point of the actuator. Therefore for a network positioner control situation, Position DV is returned. If a closed or open network command is sent, the returned value is 0 or 10,000 depending on whether it is being commanded to close or open. If an ESD were issued, the resulting commanded position would be reflected in these bytes. Finally, if the unit was being set to operate using the on board analogue input, they would return the value of this input.

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6   EDS PARAMETERS

In order to make the best use of the DFU the module has a number of configurable parameters that may be adjusted to optimise the performance of the actuator. All the parameters have factory default settings designed to meet the most common requirements for the actuator. If these are not suitable for a particular application then by using a DeviceNet configuration tool, such as Rockwell's RSNetWorx for DeviceNet, the values can be changed. The use of these tools requires the Electronic Data Sheet (EDS) file to be loaded so that the Rotork DFU is correctly identified. If you do not have the EDS file, it may be found on the Rotork web site at www.rotork.com.

The EDS file contains 56 parameters, for the IQ and CK some of these can be altered by using the infra-red or Bluetooth communications link directly interfacing to the actuator menu or via Insight2. For the CMA settings can be changed using the in-built menu and selection buttons. By using a suitable configuration tool connected to the DeviceNet highway, parameters may be reviewed and altered to suit the particular application for the actuator.
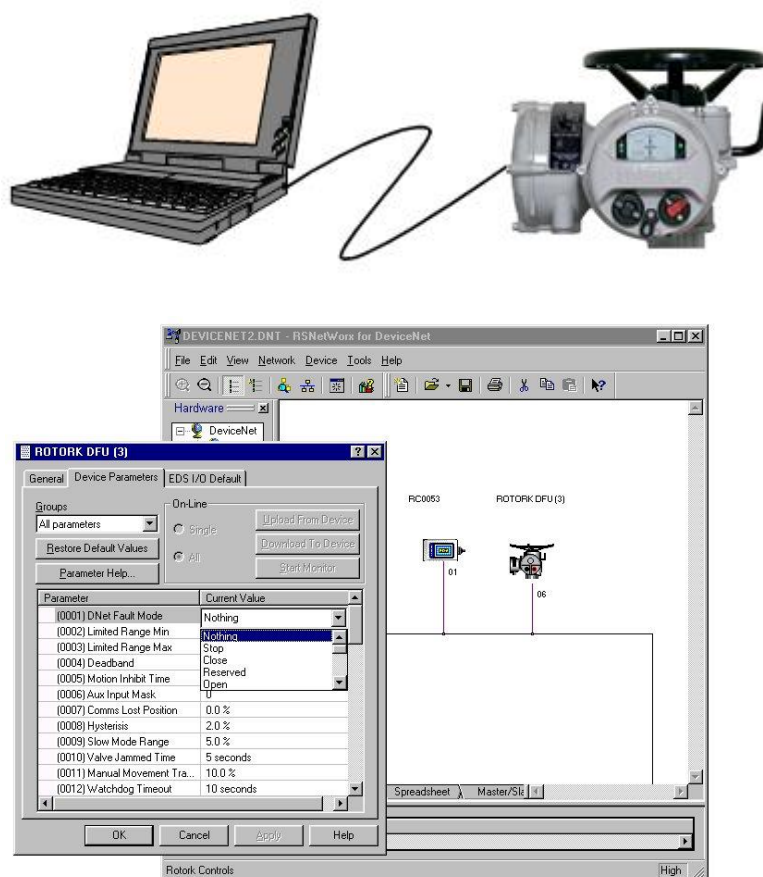

Figure 11: DeviceNet Configuration Tools

This section of the manual describes each variable parameter and should be used for reference when using the configuration tools. The following tables list the parameters.

❑   **Actuator Related Network Configurable Parameters**

Param No.	Description	Range	Default Value
1	DeviceNet Comms loss action	Nothing (No Action), Stop, Close, Open, Position	Nothing
2	Limited Range Position Minimum	0 – 100%	0%
3	Limited Range Position Maximum	0 – 100%	100%
4	Deadband	0.0 - 25.5%	5.0%
5	Motion Inhibit Time (IQ and CK)	0 – 255 sec	3 sec
6	Aux Input Mask (IQ and CK)	0 – 255 (00 - FF hex)	15 (0F)
7	Comms Lost Position	0 - 100%	0%
8	Hysteresis (IQ and CK)	0.0 - 25.5%	2.0%
9 -12	reserved	N/A	N/A
13	ESD DI4/Net Disable (IQ and CK)	ESD/DI4 or Disable	ESD/DI4
14	Analogue Input Calibration (IQ and CK)	1 - 2	N/A
15	Comms Fault Timer	0 – 65 sec	10 sec

❑   **DeviceNet Related Network Configurable Parameters**

Param No.	Description	Range	Default Value
16	MAC ID (Address)	0 – 63	63
17	Baud Rate (kbaud)	125k, 250k, 500k	125k
54	Bus Off Interrupt	Disable/Enable	Disable
55*	Bus Off Counter	0 – 5	0
56*	ID Object Status	Data 0000 to FFFF	0

* Read only

❑   **Actuator Digital Control Related Parameters**

Param No.	Description	Range	Default Value
18	Run Open command	0 – 1	0
19	Run Closed command	0 – 1	0
20	Stop command	0 – 1	0
21	ESD command	0 – 1	0

❑ **Actuator Status Related Parameters**

Param No.	Description	Range	Default Value
22	Close Limit	0 - 1	0
23	Open Limit	0 - 1	0
24	Actuator Moving	0 - 1	0
25	Manual Movement (IQ **and CK**)	0 - 1	0
26	Thermostat Tripped	0 - 1	0
27	Local Select	0 - 1	0
28	Remote Select	0 - 1	0
29	Local Stop	0 - 1	0
30	Running Open	0 - 1	0
31	Running Closed	0 - 1	0
32	Valve Obstructed	0 - 1	0
33	Valve Jammed	0 - 1	0
34	Monitor Relay	0 - 1	0
35	reserved	0 - 1	0
36	Battery Low (IQ only)	0 - 1	0
37	Motion Inhibit (IQ only)	0 - 1	0
38	Watchdog Reset	0 - 1	0
39	Target Position	0.0 - 100.0%	0.0%
40	True Position	0.0 - 100.0%	0.0%
41	Analogue Input	0.0 - 100.0%	0.0%
42	Position Mode	Digital/Position Mode	Digital
43	Torque	0 - 120%	0%

❑ **Discrete I/O Related Parameters**

Param No.	Description	Range	Default Value
44	DI-1 Digital Input 1 (IQ and CK)	0 - 1	0
45	DI-2 Digital Input 2 (IQ and CK)	0 - 1	0
46	DI-3 Digital Input 3 (IQ and CK)	0 - 1	0
47	DI-4 Digital Input 4 (IQ and CK)	0 - 1	0
48	OIL Open Interlock (IQ and CK)	0 - 1	0
49	CIL Close Interlock (IQ and CK)	0 - 1	0
50	DO-1 Digital Output 1	0 - 1	0
51	DO-2 Digital Output 2	0 - 1	0
52	DO-3 Digital Output 3	0 - 1	0
53	DO-4 Digital Output 4	0 - 1	0

6.1   Actuator Related Configurable Parameters

These parameters set up the response of the actuator will take to various control and network actions.

6.1.1   Dnet Fault Mode (Parameter 1)

This parameter is used in conjunction with parameter 7 and 15.

Dnet Fault Mode defines the actuator action that will result after the time set for the Comms Fault Timer (Parameter 15) if there is no network communication activity detected by the DFU.

The action may be
- ❏ **Nothing**   No action, actuator will complete any command in process (the default setting)
- ❏ **Stop**   The actuator stops
- ❏ **Close**   The actuator will close the valve
- ❏ **Open**   The actuator will open the valve
- ❏ **Position**   The actuator will adjust the valve position to the setting given in the Comms Lost Position (Parameter 7).

6.1.2   Limited Range Position Minimum and Maximum (Parameter 2 and 3)

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

It is possible to make the position data reported and the position controller relate to a reduced span of actual valve travel. In this mode the position data relates to the reduced portion of the valve stroke. This is sometimes used where the valve is required to have a 0% position (or 100% position) that is not the same as the fully closed position (or fully open position). These parameters define the actual limited range of valve travel that will be used for the position reporting and control by the positioner. 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 0.0 and 100.0 are set in these parameters.

The values inserted relate to the maximum total valve travel between closed and open and represent the point in the full stroke which will now be used for the limited stroke 0.0 and 100.0 values.
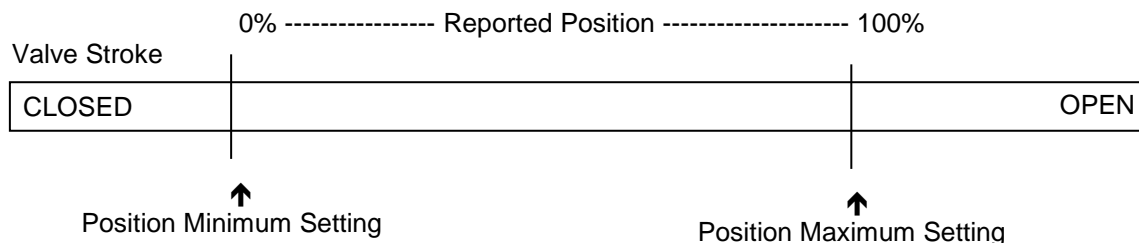
```
              0% ----------------- Reported Position --------------------- 100%
Valve Stroke       |                                              |
  ┌────────────────┼──────────────────────────────────────────────┼──────────┐
  │ CLOSED         │                                              │     OPEN │
  └────────────────┼──────────────────────────────────────────────┼──────────┘
                   ↑                                              ↑
           Position Minimum Setting                      Position Maximum Setting
```

Figure 12: Limited Range Position Control and Reporting

6.1.3   Deadband (Parameter 4)

The deadband value controls how much the desired position or setpoint must change before the actuator will action a new position request; it effectively controls the 'step change' and is the allowable error around the setpoint. A new setpoint must be at least the deadband away from the current position for the unit to move. The deadband can be configured to suit the requirements of the application.

6.1.4   Hysteresis (Parameter 8)

For an IQ or CK multi-turn actuator (not an IQT) the actuator and valve combination have some inertia, therefore 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 hysteresis value and deadband combine to prevent hunting around the setpoint and to provide improved positional accuracy over a system that only used deadband.

When positioning the IQ or CK multi-turn actuator to a mid-travel position (near limit is a special case, see next page) 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.

For example a 3% deadband (0% hysteresis) will cause the motor to be stopped once the actual position is within 3% of the desired position. The inertia will then bring the actual position nearer the desired position. If the inertia consistently makes the actuator overrun on by 2%, by setting the Hysteresis to 1%, the actuator will attempt to stop the actuator deadband minus the hysteresis away from the desired position (2% away), and the inertia of 2% movement will cause the unit to stop moving at the actual position required.

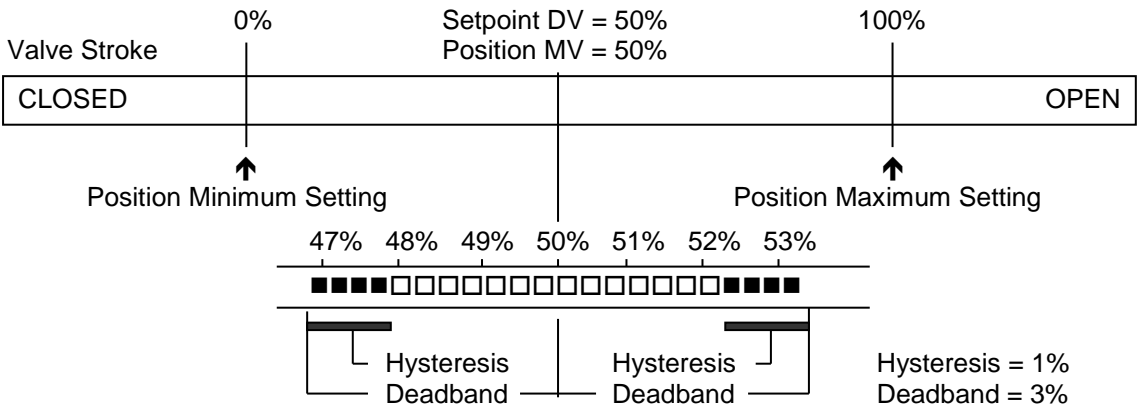The Hysteresis is the amount of movement inside the deadband permitted before the motor stops.

Figure 13: Deadband and Hysteresis settings

Both the Hysteresis (IQ and CK range only) and the deadband can be configured in the actuator setting menu or via the DeviceNet configurable registers.

Special Note for IQ (including IQT) near limit positioning
When positioning toward the limit, if the desired position is within the deadband minus the hysteresis of the limit, the actuator will continue to the limit. For example if the deadband is 5% and the hysteresis is 2%, if the desired position is 97% or higher the actuator will run to the open limit. This applies to both limits.

Special Note for IQT
The deadband is used by the IQT to control the step change and also it is used in combination with the hysteresis for positioning near the limit as per the IQ and CK multi-turn (see above). But for mid travel positioning the IQT uses its own fixed positioning parameters for achieving a position. This is because the IQT is able to control its speed and slow down during the final stages of positioning and hence prevent overrun due to inertia. The IQT is capable of positioning to within 0.1% to 0.2% of the requested position depending on the application.

Special note for CMA
The deadband is used by the CMA to control the step change, but it uses its own fixed positioning parameters for achieving a position. This is because the CMA is able to control its speed and slow down during the final stages of positioning and hence prevent overrun due to inertia. The CMA uses its own fixed position parameters for this process. The CMA is capable of positioning to within 1 encoder count of the desired position.

6.1.5   Motion Inhibit Timer (Parameter 5)

Applicable to IQ actuators only. The Motion Inhibit Timer is used to ensure the actuator does not carry out an excessive number of starts in a given period. 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. The Motion Inhibit Timer starts timing when the actuator has stopped moving.

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

6.1.6   Auxiliary Input Mask (Parameter 6)

This parameter relates to the IQ and CK range 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 parameter is set as a decimal number in the range 0-255, but should be considered in its binary format. The number has the binary form $x^7x^6x^5x^4, y^3y^2y^1y^0$, requiring 8 bits. Each bit in the high order nibble, $x^7x^6x^5x^4$, either enables or disables the associated input for control of the actuator. The bits in the low order nibble, $y^3y^2y^1y^0$, determines if the input reports a closed contact as a '1' or an open contact as a '1'. Only when the input is a '1' as set by the mask and the contact state will the actuator respond to the input if it is also set to control the actuator.

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

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

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

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

❑   Example 1   The default value of '15' (0000,1111 binary or 0F hex) makes all 4 inputs report closed contacts as true (1) and none of the inputs will operate the actuator.

❑   Example 2   The value 255 (1111,1111 binary or FF hex) makes all 4 inputs report closed contacts as true (1) and all the inputs control the actuator in their predefined way.

❑   Example 3   The value 0 (0000,0000 binary or 00 hex) makes all 4 inputs report open contacts as true (1) and none of the inputs will operate the actuator.

6.1.7   Comms Lost Position (Parameter 7)

The setting in this parameter determines the position in the range 0 to 100% that the actuator will move to if the DeviceNet network communications stops being received, provided the Dnet Fault Mode (Parameter 1) is set to 'Position'. No action will be taken unless the communications stops for a period equal or greater than the setting in the Comms Fault Timer (Parameter 15).

6.1.8   ESD DI4/Net Disable (Parameter 13)

Applicable to IQ and CK actuators only. In the IQ range actuator this input determines the mode of operation for the ESD/DI-4 remote input. The input can be used either to disable control of the actuator from the network, or to act as an ESD/digital input. When this setting is made 'Active' the input will disable network control of the IQ.

In IQ3 range contact type can be set to either N/O or N/C in CTRL version V117 or later. Earlier versions and CK are always N/O.

6.1.9   Analogue Input Max (Parameter 14)

Applicable to IQ and CK actuators only. As an optional extra the IQ **and CK** can include an analogue input channel for a process input, check wiring diagram for its inclusion. This input will require calibration to ensure it is accurately reported.

This parameter can only be set when the DFU is on line and the analogue input should be connected to a calibration source. When the parameter is set this causes the analogue input to be sampled and the value reported (in the Analogue input value) to be as either 0.0% or 100.0%.

A value of 1 written to the parameter will cause the Analogue input Maximum value to be calibrated, a value of 2 will cause the Analogue input minimum value to be calibrated. Typically the Maximum value would be 20mA (100.0%) and the minimum 4mA (0.0%).

6.1.10   Comms Fault Timer (Parameter 15)

Parameter 15, the Comms Fault Timer setting, determines the number of seconds that network communication must be absent before the setting for the Dnet Fault Mode will be carried out.

6.2 DeviceNet Related Configurable Parameters

These parameters set up the DFU for network communications.

6.2.1 MAC ID (Parameter 16)

The Media Access Control Identifier is the address on the network that the DFU will respond to. The MAC ID address can be in the range 0 to 63, though 63 is generally not used as this is the default address and may be used by any newly introduced device on the network.

Changing the MAC ID will cause the DFU to reset and the change will take effect immediately. Changing the MAC ID does not affect the values set in the other parameters of the device.

6.2.2 Baud Rate (Parameter 17)

Parameter 17 sets the communication baud rate. Note that the setting will not become active until the DFU is reset. The DFU is reset by powering the actuator off and on or by cycling the network power.

6.2.3 Bus Off Interrupt (Parameter 54)

The CAN chip includes hardware detection for message errors such as framing errors, parity errors and transmission errors. If the number of these errors exceeds the internal counter limit of 255 without sufficiently good data transactions (which reduce the counter) then, when the Bus Off Interrupt is Disabled, the CAN chip will go to the Bus Off state, show a red led and disable the DFU. Recovery requires the actuator power to be cycled or the network power to be cycled.

If the parameter is Enabled the DFU will try up to 5 times to recover from the Bus Off condition before finally disabling itself.

Note that when a Bus Off occurs the comms will stop and the Dnet Fault condition specified in Parameter 1 will be carried out

6.2.4 Bus Off Counter (Parameter 55)

The number of times that a Bus Off has occurred since the last reset is recorded in this parameter. The count can reach 5 at which time the DFU will be disconnected and no further comms will be possible. The actuator power or the network power must be cycled to recover from this condition.

6.2.5 ID Object Status (Parameter 56)

The Identity Object Status word represents the current status of the entire device. Within the word, Bit 0 indicates the ownership of the device. When Bit 0 is true (1) this DFU is owned by a master. In addition Bit 4 is used to indicate the condition of the DFU EEPROM memory. When Bit 4 is true (1) this indicates a failure in the EEPROM and the device. If a failure is indicated a power cycle on the actuator may correct the problem. Alternatively the DFU should be replaced.

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7   SETTING UP AND MAINTAINING THE DEVICENET DFU

In most applications the majority of the default settings in the DeviceNet DFU 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 MAC ID address value since the default should never be used within a live system. (The default value of 63 is reserved for new devices, if any new actuator or other device is introduced it will appear as MAC ID 63.)

In order to correctly set up a DeviceNet system each node must be correctly set for address and speed.

DeviceNet provides one way to set up the variable parameters including the MAC ID over the network by use of explicit messages. The EDS device description file must be loaded into the configuration tool prior to attempting to set up the actuator. In addition for the IQ actuator the infra-red or Blue tooth setting tools along with the in-built menus or for the CMA the on board HMI can be used to alter some of the DFU parameters including the MAC ID. Refer to the appropriate actuator manual for details of the menu structure.

The individual parameter values required may be different for each actuator and will depend on the application and process being controlled as well as the actuator size, speed and other design features.

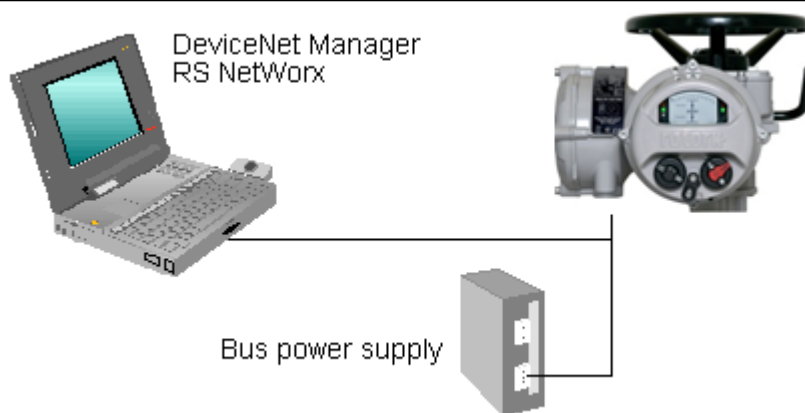| |
|---|
| *Note*:   *Setting up will require each actuator to be brought on line individually so that it can be identified and correctly addressed* |

Figure 14: Using RS NetWorx to configure the DeviceNet DFU

The DeviceNet bus power should be applied when using the configuration tools to ensure correct operation of the scanner in the computer and the DFU card in the actuator.

7.2   Setting up an IQ, IQT and CK with Insight2

Along with the in-built menus, it is possible to view the DeviceNet settings and some status information using Rotorks Insight2 application software. This can be downloaded from the Rotork web site.
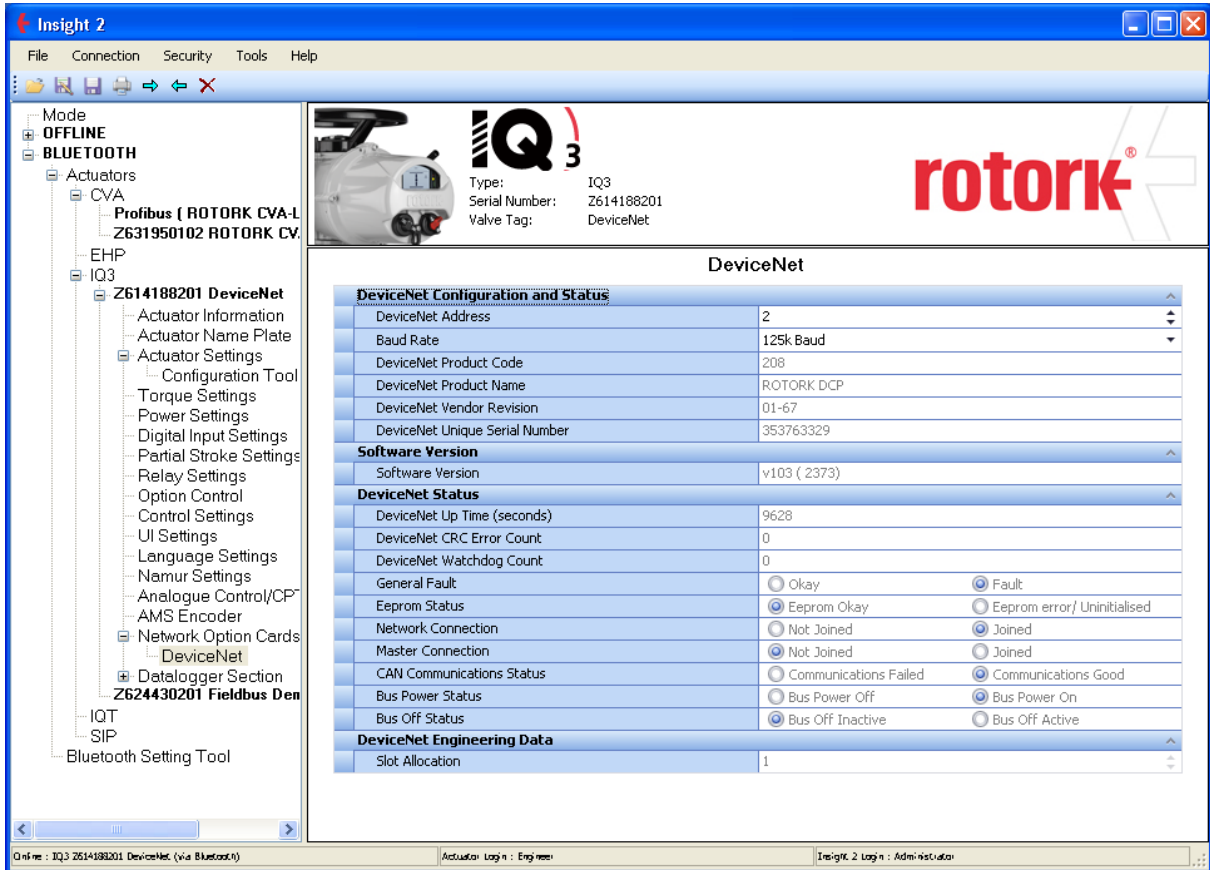

Figure 15: Insight2 DeviceNet menu

7.3   Maintenance and Repair

There is no periodic service requirement for the DFU.

Repairs should not be attempted on the DFU. Replacing the complete DFU assembly with a new replacement device should rectify any failure. Static sensitive devices are used in the DFU, it is therefore mandatory to observe anti-static precautions when handling or working on the unit.

7.4 Records

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

It would also be possible to save configuration files downloaded by Insight2 or screenshots of Insight2 to record the data.

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

❑ **Actuator Configurable Parameters**

Param No.	Description	Setting
1	Dnet Fault Mode (Action on Loss of Comms)	
2	Limited Range Position Minimum	
3	Limited Range Position Maximum	
4	Deadband	
5	Motion Inhibit Time	
6	Aux Input Mask	
7	Comms Lost Position	
8	Hysteresis	
13	ESD DI4/Net Disable	
15	Comms Fault Timer	

❑ **DeviceNet Configurable Parameters**

Param No.	Description	Setting
16	MAC ID (Address)	
17	Baud Rate (kbaud)	
54	Bus Off Interrupt	

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