

# The Specification and Use of Profibus in the UK Water Industry

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## SCOPE OF TODAY'S PRESENTATION

- The Pump Centre and WIMES
- The arrival of Intelligent Motor Control Centres (IMCCs) in the UK water industry
- WIMES 3.02 (A) - the design, construction and initial inspection & testing of Profibus networks in the UK water industry
- The current and future use of IMCCs in the UK water industry
- Questions?

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## THE PUMP CENTRE AND WIMES

### ■ What is the Pump Centre?

- The Pump Centre ([www.pumpcentre.com](http://www.pumpcentre.com)) is a membership organisation with a technical focus. It offers a **“Comprehensive Technical Approach to Pumps and Pumping Systems”**
- The Pump Centre was launched in 1992 with support from the Department of Trade & Industry. It has been ‘self-funding’ since 1996, deriving its income from membership fees, training courses and technical projects
- Membership of the Pump Centre is open to companies with an interest in pumps, pumping systems and related equipment
- The Pump Centre is operated by ESR Technology, based in Warrington, Cheshire ([www.esrtechnology.com](http://www.esrtechnology.com))

## THE PUMP CENTRE AND WIMES

- What is or are 'WIMES'?
- WIMES stands for **W**ater **I**ndustry **M**echanical & **E**lectrical **S**pecifications
- The WIMES project is a Pump Centre technical project, whose main objective is to generate and manage mechanical and electrical specifications for the UK water industry
- The WIMES project has been running for almost 20 years
- There are now around 65 WIMES available, covering a wide range of equipment, from relatively simple machinery items, such as pumps and motors, to complex items of package plant
- A comprehensive list of the WIMES and associated resources can be found on the Pump Centre website ([www.pumpcentre.com](http://www.pumpcentre.com))

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## THE PUMP CENTRE AND WIMES



## THE PUMP CENTRE AND WIMES

### ■ Water companies involved with WIMES:

- Affinity Water
- Anglian Water
- Bristol Water
- Cambridge Water
- Dwr Cymru
- Northern Ireland Water
- Northumbrian Water
- Scottish Water
- Severn Trent Water
- South East Water
- South West Water
- Southern Water
- Thames Water
- United Utilities
- Wessex Water
- Yorkshire Water



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## **THE ARRIVAL OF IMCCs IN THE UK WATER INDUSTRY**

- WIMES 3.01, the LV switchgear and controlgear assembly specification for the UK water industry was revised in 2006
- Discussions arising during the revision of WIMES 3.01 indicated that there was a growing use of 'Intelligent Motor Control Centres (IMCCs)' across the UK water industry
- To 'capture the moment', a Pump Centre 'Networking Seminar' was organised to compare and contrast the use of 'IMCCs' across the UK water industry

## THE ARRIVAL OF IMCCs IN THE UK WATER INDUSTRY

- Each water company was asked the following questions:
- On a given project, why opt for an IMCC?
- What is your preferred IMCC 'system architecture' and why?
- What is your preferred communications protocol and why?
- What are your preferred types/makes of intelligent device, PLC and why?
- On recent projects involving IMCCs, what were the typical CAPEX savings, compared to conventional MCCs
- What operational benefits have been realised by using IMCCs?
- How many IMCCs have been/will be installed during AMPs 3 & 4?

## THE ARRIVAL OF IMCCs IN THE UK WATER INDUSTRY

- **On a given project, why opt for an IMCC?**
- **Mainly:**
  - The reduced CAPEX of the IMCC and its associated scheme
  - Compared to a conventional MCC, an IMCC comprises significantly less 'door furniture' and internal wiring. Aswell as reducing costs in itself, this means that IMCCs are smaller than conventional assemblies, which also means that they can be housed in smaller/cheaper buildings & kiosks
  - Some water companies defined a limiting number of motor starters (typically 5 or 6), above which an MCC should be intelligent – this was essentially a financial 'breakeven point' above which IMCCs tended to be more cost effective on a CAPEX basis



## THE ARRIVAL OF IMCCs IN THE UK WATER INDUSTRY

- On a given project, why opt for an IMCC?
- Also:
  - The reduced size of the MCC (e.g. MCCs located in 'sensitive' locations)
  - The enhanced levels of information available from IMCCs on various drive parameters (e.g. energy consumption, machinery condition)
  - The ability to remotely monitor and control drives (if necessary, off-site)



## THE ARRIVAL OF IMCCs IN THE UK WATER INDUSTRY



Reduced door furniture



## THE ARRIVAL OF IMCCs IN THE UK WATER INDUSTRY



Reduced compartment wiring



## THE ARRIVAL OF IMCCs IN THE UK WATER INDUSTRY



SFA IMCC - 50 % smaller, 40 % cheaper than predecessor





## THE ARRIVAL OF IMCCs IN THE UK WATER INDUSTRY

**INLET PUMP 1**

23/07/04  
16:44:47

**EXTENDED DIAGNOSTICS**

UNIT NODE NUMBER	COMM FLT
OPERATING HOURS	COMM FLT
NUMBER OF OVERLOAD TRIPS	COMM FLT
TRIP CURRENT OF LAST OVERLOAD	COMM FLT
PHASE BALANCE WARNING	COMM FLT
SHORT CIRCUIT SENSOR LINE	COMM FLT
EARTH FAULT WARNING	COMM FLT
OVERLOAD WARNING	COMM FLT
OVERLOAD ASYMMETRY WARNING	COMM FLT
OVERLOAD ASYMMETRY FAULT	COMM FLT
HIGH CURRENT LIMIT WARNING	COMM FLT
LOW CURRENT LIMIT WARNING	COMM FLT
HIGH CURRENT LIMIT	COMM FLT
LOW CURRENT LIMIT	COMM FLT
THERMISTOR WARNING	COMM FLT
THERMISTOR FAULT	COMM FLT
MOTOR STALLED	COMM FLT
HARDWARE FAULT	COMM FLT
PARAMETER ERROR	COMM FLT
COOLING TIME RUNNING	COMM FLT

**SIMOCODE DATA**

FULL LOAD CURRENT - SETPOINT	COMM FLT
NUMBER OF STARTS	COMM FLT
SENSOR	COMM FLT
COUNTER LINK 1	COMM FLT
COUNTER LINK 2	COMM FLT
GENERAL WARNING	COMM FLT
LOCKOUT	COMM FLT
OVERLOAD FAULT	COMM FLT
EXPANSION MODULE STATUS	COMM FLT

**Terminal Block Diagram:**

- 110 VAC
- A1, A2, T1, T2
- 1, 2, 3, 4, 5
- SIEMENS
- Ready (Green)
- Bus (Green)
- Gen.Fault (White)
- Test/Reset (Blue)
- PROFIBUS-DP
- 6, 7, 8, 9, 10, 11, B, A, SPE/PE
- CONTRACTOR DE-ENERGISED

**Buttons:** HMI AUTO, START 1, START 2, RESET

**Drive Status:** STATUS UNAVAILABLE | Drive Current: --0.00 AMPS

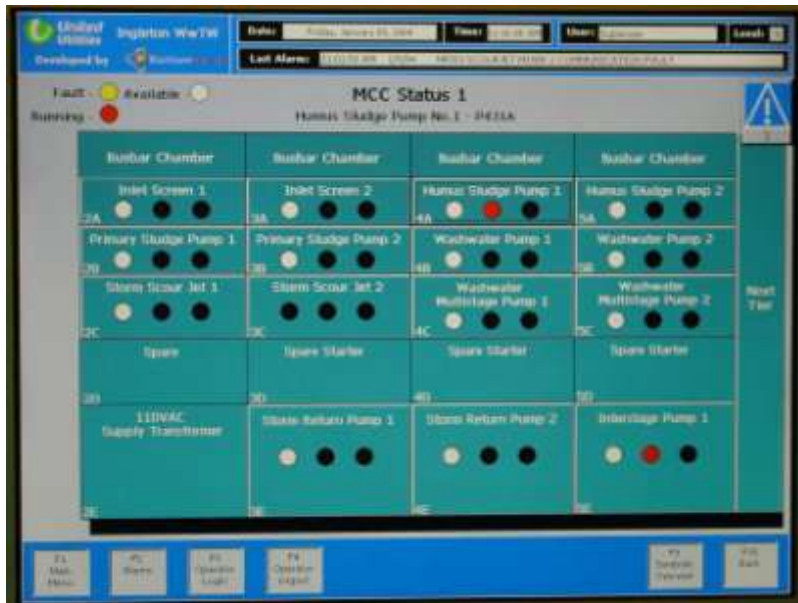
**Drive Auto Control:** STATUS UNAVAILABLE

**Profibus Communications:** COMMS HEALTHY BETWEEN THIS NODE AND MASTER

### Enhanced Diagnostics



# THE ARRIVAL OF IMCCs IN THE UK WATER INDUSTRY



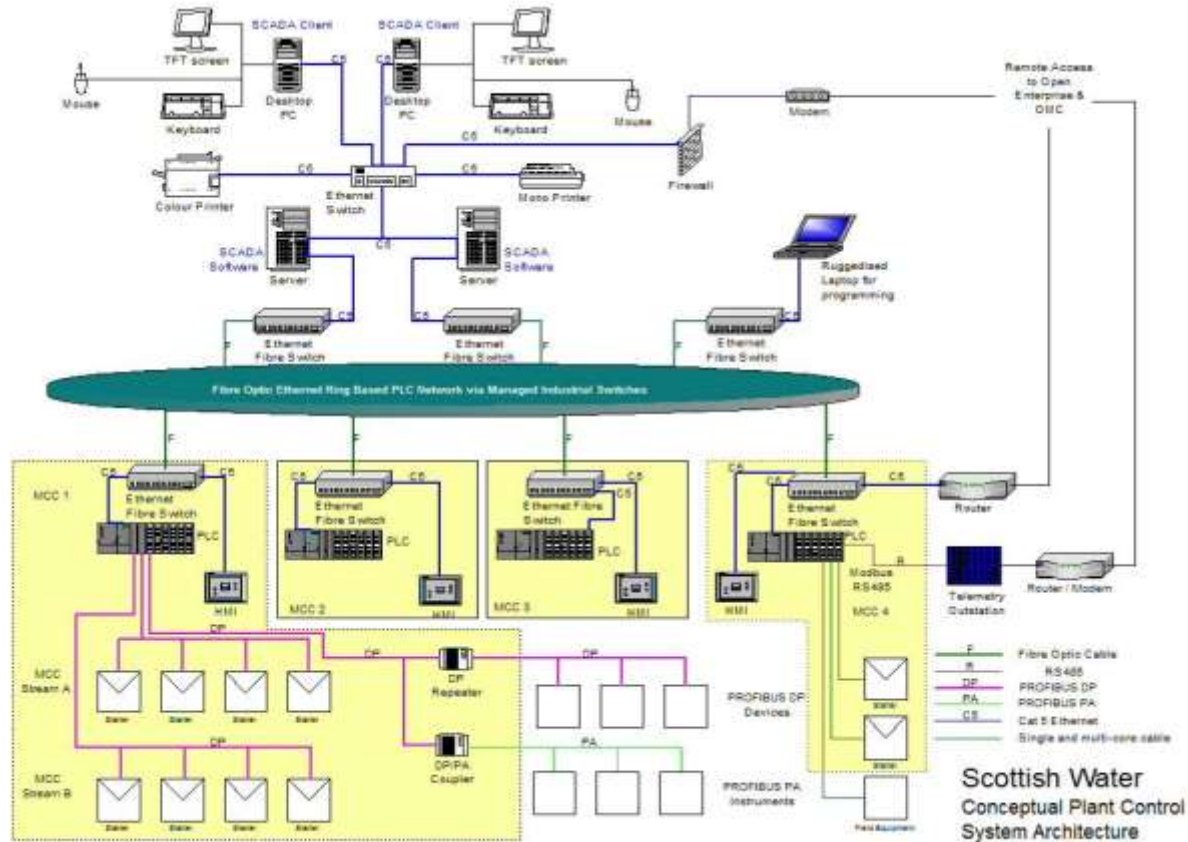
Remote monitoring and control



## THE ARRIVAL OF IMCCs IN THE UK WATER INDUSTRY

- **What is your preferred IMCC 'system architecture?**
- Most water companies incorporated IMCCs within a similar architecture. The main features were:
  - Ethernet TCP/IP optical fibre networks between PLCs and PLCs and HMIs
  - Profibus DP/PA or DeviceNet networks between PLCs and devices
  - A HMI mounted on the door of the common control section of the IMCC
  - Within the IMCC, duty & standby drives are linked to the PLC via separate networks. Field networks for duty & standby equipment are also separated
  - Critical or EA reportable instrument signals are hardwired to displays or telemetry

# THE ARRIVAL OF IMCCs IN THE UK WATER INDUSTRY



## THE ARRIVAL OF IMCCs IN THE UK WATER INDUSTRY

- **What is your preferred communications protocol?**
- **Mainly** - Profibus DP V0 and V1
- **Also** – DeviceNet
  
- **Why was Profibus preferred?**
- It had a proven track record (over 10 million installed nodes at the time)
- There was excellent availability of compatible plant control items and motor control equipment from a large number of vendors
- It could be used in hazardous areas and utilise fibre optic cable
- It conformed to an open standard - IEC 61158 and IEC 61784
- It was perceived to be future-proof

## THE ARRIVAL OF IMCCs IN THE UK WATER INDUSTRY

- **What are your preferred types/makes of intelligent device?**
- **Mainly** - Siemens Simocode & Simocode Pro-V intelligent motor starters
- **Also** - Rockwell E3 intelligent motor starters
- **Why was the Simocode preferred?**
- It had a proven track record of reliable use
- It was capable of manual, autonomous operation in 'hand mode', independent of the PLC and the comms network. This allowed continued motor control in the event of PLC failure.
- Some design standards required underload monitoring using true power measurement for dry-running protection of pumps. At the time of selection, the only device found offering this feature with overload protection in a single unit was the Simocode
- It's chosen comms protocol was Profibus!

## THE ARRIVAL OF IMCCs IN THE UK WATER INDUSTRY

- **What were the typical CAPEX savings associated with IMCCs, compared to conventional assemblies?**
- There was some variation in the responses received, however, the CAPEX savings on the MCC itself tended to be relatively small (< 10 %)
- The smaller MCC size (up to 20-25 % smaller for the larger MCCs) tended to be offset by the increased costs of the 'intelligent components'
- The largest cost savings were associated with the reduced civils costs associated with the smaller buildings & kiosks required to house the smaller IMCCs (up to 20 % smaller)
- The reduced cost of cabling to networked instruments in the field was not generally included in the assessment

## THE ARRIVAL OF IMCCs IN THE UK WATER INDUSTRY

- **What operational benefits have been realised by using IMCCs?**
- A vast amount of diagnostic information can be relayed back to the PLC and displayed on the HMI, for each networked drive/device
- Remote monitoring and control is possible
- Energy monitoring and more importantly **energy management** is possible
- Predictive maintenance is possible for critical assets (e.g. early warnings of plant maintenance requirements)
- IMCCs fulfil aspirations for increased levels of automation
- IMCC's should be as reliable as conventional MCCs
- **Will increased diagnostics result in greater plant availability?**



## THE ARRIVAL OF IMCCs IN THE UK WATER INDUSTRY

- **How many IMCCs have been/will be installed during AMPs 3 & 4?**
- The Information provided during the 2006 event was updated for the June 2008 Profibus Conference presentation and is summarised below
- Six of the twelve UK water utilities had installed a significant number of IMCCs on a wide range of projects:
  - 5 of these utilities (NIW, SWW, SW, UU and WW) had standardised on Profibus DP and PA for networking PLCs and devices
  - TW had standardised on DeviceNet within the IMCC, with instruments being networked using Profibus PA
- STW were still evaluating the use of Profibus on a number of major AMP 4 projects (e.g. Minworth and Wanlip WwTWs), with a view to eventually optimising and standardising their network and fieldbus technologies

## THE ARRIVAL OF IMCCs IN THE UK WATER INDUSTRY

- **How many IMCCs have been/will be installed during AMPs 3 & 4?**
- DCWW and YW had installed IMCCs and Profibus networks on a number of projects, however, selection tended to focus on initial CAPEX savings, as opposed to ‘downstream’ operational benefits
- AW, NWL and SCW had installed few (if any) IMCCs to date, although trials were underway in SCW at Camphill WTW

## SCOPE OF TODAY'S PRESENTATION

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## WIMES 3.02 (A) – THE DESIGN, CONSTRUCTION & INITIAL TESTING OF PROFIBUS NETWORKS IN THE UK WATER INDUSTRY

### ■ Background

- Following the IMCC networking seminar in 2006 and subsequent discussions within the WIMES Electrical Working Group in early 2008, it was apparent there was a growing need to develop a water industry specification for the design, construction and testing of Profibus networks
- To address this need, Issue 1 of WIMES 3.02 (A) was developed and released in July 2008
- The scope of Issue 1 included optical fibre networks and focussed mainly on network design. Network installation was covered by WIMES 3.02 – LV electrical installations

## WIMES 3.02 (A) – THE DESIGN, CONSTRUCTION & INITIAL TESTING OF PROFIBUS NETWORKS IN THE UK WATER INDUSTRY

### ■ Background

- In line with the 'normal' 4 to 5 yearly WIMES review cycle, Issue 2 of WIMES 3.02 (A) was released in April 2013
- The scope of Issue 2 now includes Profibus network design **and** installation and no longer covers optical fibre networks, which are now covered by WIMES 3.02 (B)
- Issue 2 of WIMES 3.02 (A) is due for revision in Autumn 2016
- The Pump Centre is grateful to Andy Verwer (Verwer Training & Consultancy) for his help in the development of WIMES 3.02 (A)
- **WIMES 3.02 (A) is obviously based on existing codes of practice published by Profibus International!**

## WIMES 3.02 (A) – THE DESIGN, CONSTRUCTION & INITIAL TESTING OF PROFIBUS NETWORKS IN THE UK WATER INDUSTRY

### ■ Network Design (DP networks)

- Networks shall be designed to operate at 1.5 Mbps (even though some users will run them at 0.5 Mbps)
- The number of devices/nodes within a given segment shall be limited to 28 to allow for the incorporation of extra devices, network expansion (i.e. the use of repeaters) and the connection of diagnostic equipment
- To facilitate network analysis and troubleshooting, each segment shall incorporate at least one connector with a piggyback socket (at the beginning or end of the segment)
- If there is a requirement to incorporate more than 28 devices within the network, the network may be extended by the use of repeaters, hubs and/or optical couplers, which shall be powered at all times

## WIMES 3.02 (A) – THE DESIGN, CONSTRUCTION & INITIAL TESTING OF PROFIBUS NETWORKS IN THE UK WATER INDUSTRY

### ■ Network Design (DP networks)

- To avoid reflections from the ends of the cables, every segment shall be provided with a powered termination network at the start and end of the segment and nowhere else. Spur lines, if used, shall not be terminated
- As far as possible spur lines shall be avoided. If unavoidable, the total length of all spurs in a given segment shall not exceed 6 m (1.5 Mbps limit). Individual spur lines shall not exceed 450 mm in length
- The total length of a given segment shall not exceed 200 m (1.5 Mbps limit)
- To avoid reflections, there shall be a minimum cable length of 1 m between consecutive devices/nodes in a given segment

## WIMES 3.02 (A) – THE DESIGN, CONSTRUCTION & INITIAL TESTING OF PROFIBUS NETWORKS IN THE UK WATER INDUSTRY

### ■ Component Selection (DP networks)

- Cables shall be of the screened, twisted pair type (IEC 61158-2 (Type A))
- If there is a significant likelihood of cables being subjected to high mechanical stresses or attack by vermin during service and it is not practical to protect them by guards, etc., they shall be armoured
- For unarmoured cables, the 'default' outer sheath colour shall be violet. For armoured cables, the colour shall be agreed with the Purchaser
- Connectors shall be of the 9 pin sub-D, 5 pin M12 or hybrid type, depending on location
- All connector pins and sockets shall, as a minimum, be flash gold plated



## WIMES 3.02 (A) – THE DESIGN, CONSTRUCTION & INITIAL TESTING OF PROFIBUS NETWORKS IN THE UK WATER INDUSTRY

### ■ Component Selection (DP networks)

- 9 pin sub-D connectors shall incorporate a termination resistor (externally enabled/disabled) and a piggyback socket
- The operation of the termination resistor enable/disable switch shall be consistent within a given installation (e.g. up is always enabled)
- Insulation displacement (fast-connect) type 9 pin sub-D connectors shall only be used on solid core cable
- When using 5 pin M12 connectors, T-connectors shall be used to allow disconnection of devices from the network without causing significant disruption/downtime
- The specification of repeater(s) shall be appropriate to the network topology

## WIMES 3.02 (A) – THE DESIGN, CONSTRUCTION & INITIAL TESTING OF PROFIBUS NETWORKS IN THE UK WATER INDUSTRY

### ■ Cable Routing and Installation (DP Networks)

- There are no special requirements for Profibus DP cable compared with other types of data transmission cable
- Cables shall maintain correct segregation from power cables, shall not be directly buried and shall have a min. bending radius of 75 mm

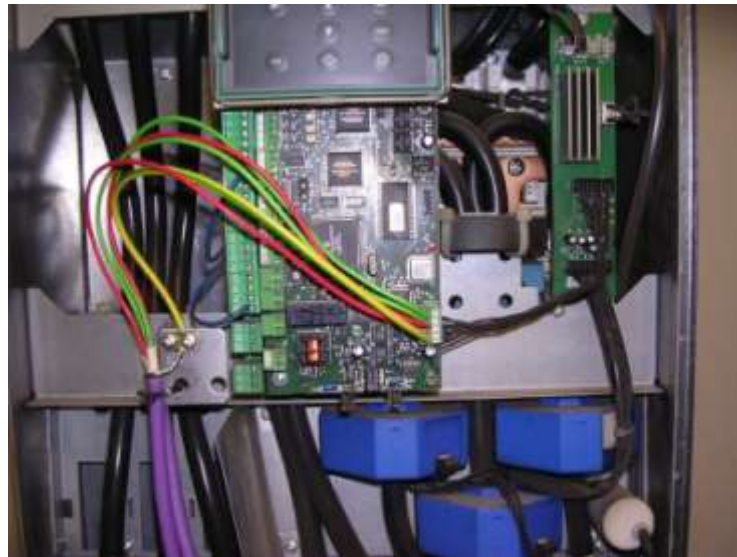
### ■ Attaching Connectors to Cables (DP Networks)

- Connectors shall be attached to cables strictly in accordance with the connector manufacturer's instructions
- Solid core cables shall be attached to their connectors using an insulation displacement technique (cable ends shall never be re-used)
- Stranded core cables shall be attached to their connectors using a screw connection method

## WIMES 3.02 (A) – THE DESIGN, CONSTRUCTION & INITIAL TESTING OF PROFIBUS NETWORKS IN THE UK WATER INDUSTRY

### ■ Attaching Connectors to Cables (DP Networks)

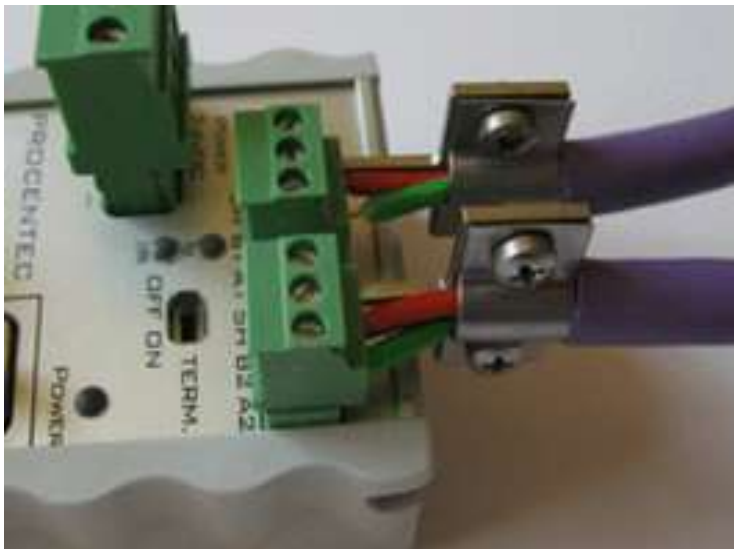
- With screw connections, the braided screen shall be as close as possible to the device terminals, to ensure that the length of the stripped cores (which are unscreened and untwisted) is minimised and thus prevent:



## WIMES 3.02 (A) – THE DESIGN, CONSTRUCTION & INITIAL TESTING OF PROFIBUS NETWORKS IN THE UK WATER INDUSTRY

### ■ Attaching Connectors to Cables (DP Networks)

- When the braided screen is to be connected to a screw terminal, a screen clamp with integrated pin shall be used, as shown below:



## WIMES 3.02 (A) – THE DESIGN, CONSTRUCTION & INITIAL TESTING OF PROFIBUS NETWORKS IN THE UK WATER INDUSTRY

### ■ Earthing and Bonding (DP Networks)

- The network shall be provided with an effective earthing and equipotential bonding system to divert electrostatic interference to earth and prevent earth currents flowing along screens
- Cable screens shall be earthed at both ends of the cable, either via their connectors (when the connector is plugged into the device) or via suitable earthing facilities (for devices requiring direct cable connection)
- Cable screens shall also be earthed at their point of entry into an assembly via a proprietary screen connection clamp
- To prevent electrical currents passing along the screens of cables connecting devices installed in parts of the network subject to different earth potentials, optical fibre or potential equalisation cables shall be used instead of, or in conjunction with, conventional network cables

## WIMES 3.02 (A) – THE DESIGN, CONSTRUCTION & INITIAL TESTING OF PROFIBUS NETWORKS IN THE UK WATER INDUSTRY

### ■ Network Design (PA networks)

- Networks operate at a fixed baud rate of 31.25 kbps
- Each segment shall be configured in a trunk and spur topology
- In theory, a maximum of 32 devices may be incorporated in a given segment. In practice, the characteristics of the segment power supply and/or requirements for intrinsic safety can reduce this number significantly
- Each segment shall be connected to the Profibus DP network via a link/ interface module and one or more DP/PA couplers

## WIMES 3.02 (A) – THE DESIGN, CONSTRUCTION & INITIAL TESTING OF PROFIBUS NETWORKS IN THE UK WATER INDUSTRY

### ■ Network Design (PA networks)

- To avoid reflections from the ends of the cable, each segment shall be terminated by 'passive' terminators located at the ends of the trunk cable and nowhere else
- The maximum spur line length shall depend on the number of spur lines (e.g. 1 m with 25 to 32 spurs and up to to 120 m with 1 to 12 spurs)
- In theory, the maximum length of a given segment (including all spurs & branches) shall not exceed 1900 m. In practice, voltage drop considerations and/or requirements for intrinsic safety may reduce this significantly
- Networks that will be installed in hazardous areas shall be designed in accordance with BS EN 60079-27 (FISCO Model)

## WIMES 3.02 (A) – THE DESIGN, CONSTRUCTION & INITIAL TESTING OF PROFIBUS NETWORKS IN THE UK WATER INDUSTRY

### ■ Component Selection (PA networks)

- Cables shall be of the screened, twisted pair type (IEC 61158-2 (Type A))
- If there is a significant likelihood of cables being subjected to high mechanical stresses or attack by vermin during service and it is not practical to protect them by guards, etc., they shall be armoured
- For unarmoured cables, the ‘default’ outer sheath colour shall be orange for non-IS duties and light blue for IS duties. For armoured cables, the ‘default’ colour shall be the manufacturer’s standard sheath colour
- Where possible, each spur line shall be connected to its associated Junction Box (JB) and device using a 4 pin M12, A coded connector



## WIMES 3.02 (A) – THE DESIGN, CONSTRUCTION & INITIAL TESTING OF PROFIBUS NETWORKS IN THE UK WATER INDUSTRY

- **Component Selection (PA networks)**
- Each spur line shall be connected to the trunk cable via a proprietary JB and not a split-T connector (a single JB may be used for connecting multiple spur lines to the trunk cable)



## WIMES 3.02 (A) – THE DESIGN, CONSTRUCTION & INITIAL TESTING OF PROFIBUS NETWORKS IN THE UK WATER INDUSTRY

### ■ Component Selection (PA networks)

- The IP rating, corrosion resistance and impact strength of JB's shall be appropriate to their operating environment
- JB's shall be designed to ensure uninterrupted bus operation when exchanging devices or extending spur lines
- JB's shall incorporate a termination resistor that may be switched in or out, as required (depending on whether the JB is at the end of the trunk cable!)
- JB's for IS applications shall be coloured light blue and be labelled with the appropriate hazardous area label
- DP and PA networks shall be interfaced using one or more DP/PA couplers. These shall be capable of linking Ex and non-Ex rated PA segments to the DP network

## WIMES 3.02 (A) – THE DESIGN, CONSTRUCTION & INITIAL TESTING OF PROFIBUS NETWORKS IN THE UK WATER INDUSTRY

### ■ Cable Routing and Installation (PA Networks)

■ As Profibus DP

### ■ Attaching Connectors to Cables (PA Networks)

■ As Profibus DP

### ■ Earthing and Bonding (PA Networks)

■ As Profibus DP in non-hazardous areas

■ In accordance with BS EN 60079-27 (FISCO) model in hazardous areas

## WIMES 3.02 (A) – THE DESIGN, CONSTRUCTION & INITIAL TESTING OF PROFIBUS NETWORKS IN THE UK WATER INDUSTRY

- **Network Design Verification, Inspection & Testing & Commissioning**
- **Design verification** – requirements for design documentation (network installation drawings and cable schedules, etc.) that shall be submitted to the Purchaser before and after network installation
- **Visual inspection** – performed to confirm that the installation complies with design documentation with respect to the specification and layout of cables and components. Includes verification of correct cable/component support, segregation, earthing & bonding, labelling, etc.
- **Electrical testing** – performed to detect open/short circuits in/between data cores and screens and confirm that no data cores are reversed, termination resistors have been correctly set and electrical parameters are within prescribed limits. Includes a device count check

## WIMES 3.02 (A) – THE DESIGN, CONSTRUCTION & INITIAL TESTING OF PROFIBUS NETWORKS IN THE UK WATER INDUSTRY

- **Network Design Verification, Inspection & Testing & Commissioning**
- **Configuration testing** – performed to confirm that transmission speed and Profibus addresses have been correctly set. Includes a slave addressing check (bus scan) and segment cable length measurements
- **Commissioning testing (health checking)** – performed to confirm that the network can operate at the design bit rate (1.5 Mbps) and to check for interference and reflections etc.
- **Handover tests** – performed before/during the ‘reliability/testing’ period (typically 14 days) to check for errors, retries, sync events or corrupted telegrams

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## CURRENT/FUTURE USE OF IMCCs IN THE UK WATER INDUSTRY

- So what's changed in the 7 years since I gave this presentation?

## CURRENT/FUTURE USE OF IMCCs IN THE UK WATER INDUSTRY

### ■ **Anglian Water**

- AW are still not a major user of IMCCs
- No IMCCs were installed before AMP 5 (2010), however, during AMP 5 the following projects incorporating IMCCs/Profibus networks were delivered:
  - Raithby WTW, Louth, Lincs. (TCP Ethernet and Profibus)
  - Bures WTW, nr Colchester (Profibus)
  - Cambridge STW (Profibus)
- AW have also used Ethernet (without IMCCs) on various sites for control and communications purposes
- AW are currently reviewing their strategy for implementation of fieldbus systems during AMP 6



## CURRENT/FUTURE USE OF PROFIBUS IN THE WATER INDUSTRY

### ■ Dwr Cymru (Welsh Water)

- DCWW's automation strategy is anchored by its decision to use intelligent fieldbus devices. They are still some way, however, from incorporating these devices into all of their assets
- DCWW selected Profibus as their network comms protocol during AMP 3, ahead of CC-link, Modbus and DeviceNet, etc.
- The use of intelligent fieldbus devices was not initially well received by operations personnel, as the benefits could not easily be appreciated, however, the advantages of motor protection units with intelligent CT/VT's are now starting to be recognised
- DCWW are increasingly integrating their PLCs & SCADA systems with the intelligent fieldbus devices, allowing more effective local and remote monitoring of drives and instruments

## CURRENT/FUTURE USE OF PROFIBUS IN THE WATER INDUSTRY

### ■ Dwr Cymru (Welsh Water)

- Intelligent fieldbus devices are not installed on projects where the technical skills required for configuring or trouble-shooting the devices exceeds the capability of the associated operations personnel e.g. two-pump sewage pumping stations
- Although DCWW are currently committed to Profibus, they are aware of the trouble-shooting benefits conferred by networking standards such as Ethernet/IP and ProfiNet which have more expansive (and often free) PC tools. This is where they see the future 'battle lines' being drawn, with many manufacturers moving closer to this technology

## CURRENT/FUTURE USE OF PROFIBUS IN THE WATER INDUSTRY

### ■ Northumbrian Water

- NW are still not widespread users of IMCCs
- It is likely that NW would use more IMCCs if tangible benefits could be demonstrated, however, this has not occurred to date
- For the few IMCCs installed to date, the driver has tended to be the smaller footprint of the IMCC as opposed to its improved diagnostic capability

## CURRENT/FUTURE USE OF PROFIBUS IN THE WATER INDUSTRY

### ■ **Scottish Water**

- SCW first trialled the use of fieldbus networks at Camphill WTW in 2008
- During 2008-2015, SCW installed have installed a significant number of IMCCs (incorporating Profibus DP)
- One example is the £125 m Glencorse WTW, which during construction (2008-2011), was SCW's largest construction project (by value)
- The following slides (from Glencorse WTW) show:
  - Actuators networked using Profibus
  - A cable tray installation installed before the decision to use IMCCs was finalised! The tray was designed for the large numbers of cables required for conventional MCCs and shows the amount of cabling that can be saved with Profibus
  - A typical IMCC



## CURRENT/FUTURE USE OF PROFIBUS IN THE WATER INDUSTRY

### ■ Scottish Water



Actuators networked using Profibus



## CURRENT/FUTURE USE OF PROFIBUS IN THE WATER INDUSTRY

### ■ Scottish Water



‘Underutilised’ cable tray



## CURRENT/FUTURE USE OF PROFIBUS IN THE WATER INDUSTRY

### ■ Scottish Water



A typical IMCC



## CURRENT/FUTURE USE OF PROFIBUS IN THE WATER INDUSTRY

### ■ **Scottish Water**

- For SR15 (2015-2021), SCW have developed a range of generic IMCCs using Profibus networks in a Standard Product IMCC Catalogue, which will be the designers first choice, before considering a bespoke design
- Typical examples are shown in the following slides



## CURRENT/FUTURE USE OF PROFIBUS IN THE WATER INDUSTRY

### ■ Scottish Water



Generic SCW IMCC designs

## CURRENT/FUTURE USE OF PROFIBUS IN THE WATER INDUSTRY

### ■ Scottish Water



Generic SCW IMCC design

## CURRENT/FUTURE USE OF PROFIBUS IN THE WATER INDUSTRY

### ■ Severn Trent Water

- STW have not installed any Profibus networks on their works, since their use on a number of major projects in late AMP 4 (e.g. Minworth & Wanlip STWs)
- During AMP 5 (on large works only), STW have installed around 30 IMCCs using DeviceNet and around 5 installations with 10 to 20 valve actuators networked using DeviceNet
- STW's current ICA strategy (e.g. at Evesham STW) is to network panel-mounted modular distributed I/O (Rockwell Flex or Point I/O) to a central control panel via Ethernet/IP. This solution currently uses 'conventional' instruments and motor starters, however, Ethernet/IP network compatible intelligent motor starters may be used in the future
- Compared to other strategies considered, the solution proposed for Evesham STW should confer significant savings in hardware, cabling and civil engineering costs

## CURRENT/FUTURE USE OF PROFIBUS IN THE WATER INDUSTRY

### ■ Severn Trent Water

- STW perceive that the main disadvantages with Profibus networks are:
  - There are a limited number of skilled external Profibus installers available and in-house staff struggle to support/maintain the systems, once installed
  - Modification of GSD files (e.g. to add new instruments) is a relatively complex process, typically costing around £3k for a new device to be installed
  - The relatively high capital costs of Profibus systems (in terms of compatible instruments, interface cards and other network hardware) tend to outweigh the savings associated with reduced cabling
  - To date, none of the additional data available has been used

## CURRENT/FUTURE USE OF PROFIBUS IN THE WATER INDUSTRY

### ■ South West Water

- SWW has not yet widely adopted IMCCs. The attraction of rich datasets is offset by the cost of intelligent components and it is still a matter for debate as to what value the extra data offers the business, as there is not the resource to analyse and translate it into useful information
- SWW's process automation network topology is based on the extensive use of Ethernet networks using Modbus TCP as the comms protocol. The current aspiration is to distribute Ethernet as far into the field as possible, via FOC where appropriate. Where instruments do not support Ethernet, they will be connected to the automation layer via remote distributed I/O
- SWW would normally adopt a topology where Modbus TCP to Profibus gateways are used in the field and restrict the Profibus segments to the local plant areas rather than distribute Profibus over wide areas

## CURRENT/FUTURE USE OF PROFIBUS IN THE WATER INDUSTRY

### ■ South West Water

- SWW's standard states that Profibus shall be used where instruments are required to have a direct digital reading (with no A to D conversion) or where there are 6 or more Profibus compatible instruments grouped together
- Profibus is therefore typically used where there are large concentrations of valves and associated instruments (generally on water treatment works, as opposed to waste water sites)
- There have been 6 such Profibus installations in AMP 5 and 2 further installations are planned for AMP 6. These are new or re-furbished Rapid Gravity Filter (RGF) or Granular Activated Carbon (GAC) filter installations
- GSDs have proved awkward!!! SWW prefer to use FDT/DTM technologies, where available, as these are fully supported by their automation provider

## CURRENT/FUTURE USE OF PROFIBUS IN THE WATER INDUSTRY

### ■ South West Water



Valves and instruments networked using Profibus on a SWW site



## CURRENT/FUTURE USE OF PROFIBUS IN THE WATER INDUSTRY

### ■ Southern Water

- SW's current strategy is to continue to design and install IMCCs and Profibus networks on a wide range of projects. The standard approach is that an MCC shall be intelligent when there are 6 or more starters, apart from where compatibility of existing systems on a site takes precedence
- SW are, however, aware that the water industry is increasingly using Ethernet/Profinet networks (especially as more devices become available for use with these networks). There are concerns about how SW will support existing Profibus networks if Profibus becomes obsolete?
- Like a number of other water companies, SW need to review the data acquisition benefits of networking 'intelligent' instruments and actuators, as opposed to networking distributed remote I/O (e.g. on Ethernet/Profinet) and then connecting 'conventional' equipment to the remote I/O stations



## CURRENT/FUTURE USE OF PROFIBUS IN THE WATER INDUSTRY

### ■ Southern Water

- The enhanced data acquisition capabilities of intelligent devices housed within IMCCs have been partly utilised (e.g. power monitors on incomers and motor starters).
- There have, however, been problems defining what useful data is really needed from intelligent instruments, actuators and other field devices and it would be useful for the industry to agree a standard approach to this
- Some problems experienced (early on!) with Profibus networks included:
  - Having to re-load GSD files (in order to make a new device work correctly) when replacing faulty devices, such as an ultrasonic level controllers
  - Locating comms failures when the exact order of devices on a network is not detailed on a SCADA system/ local HMI

## CURRENT/FUTURE USE OF PROFIBUS IN THE WATER INDUSTRY

### ■ Thames Water

- Unless there is a significant CAPEX penalty, TW will install IMCCs on every project, due to their enhanced data acquisition capabilities
- If there is a significant CAPEX penalty, TW will install a conventional MCC, unless it incorporates a PLC for process control or has more than 6 starters, in which case an IMCC will be selected
- TW currently use Rockwell intelligent starters and DeviceNet networks within their IMCCs. Ethernet/IP networks and compatible devices may be used in the future, however there are concerns about the ease with which these systems allow process parameters to be accessed/adjusted
- There is an ongoing debate about how to make best use of the available data from IMCCs and what data is worthwhile monitoring

## CURRENT/FUTURE USE OF PROFIBUS IN THE WATER INDUSTRY

### ■ United Utilities

- UU installed more than 60 IMCCs (incorporating Profibus DP) in AMP 4 and AMP 5
- The approach for AMP 6 will be the same as for AMP 5, but may be reviewed based on new framework agreements
- For each project, the main factors influencing the selection of IMCCs vs. conventional MCCs are:
  - The CAPEX of the IMCC vs. the conventional MCC (including installation costs)
  - The business requirements
  - The remote monitoring requirements; (i.e. the information required off-site)

## CURRENT/FUTURE USE OF PROFIBUS IN THE WATER INDUSTRY

### ■ United Utilities

- With initial projects, problems arose due to a lack of awareness of IMCC /Profibus network design and installation requirements amongst UU personnel/contractors
- This has now been addressed by appropriate training and UU electrical & ICA system design specifications now include requirements for certification of IMCC/Profibus designers and installers to relevant Profibus standards

## CURRENT/FUTURE USE OF PROFIBUS IN THE WATER INDUSTRY

### ■ United Utilities



A typical IMCC

## CURRENT/FUTURE USE OF PROFIBUS IN THE WATER INDUSTRY

### ■ United Utilities



An 11 kW VSD compartment in an IMCC

## CURRENT/FUTURE USE OF PROFIBUS IN THE WATER INDUSTRY

### ■ **Wessex Water**

- WW installed around 150 to 160 IMCCs (incorporating Profibus DP) during AMP 4, with slightly more being installed during AMP 5. It is likely that around 200 to 220 IMCCs will be installed during AMP 6, due to the increased spend on capital maintenance and replacement MCCs
- Feedback from WW's MCC builders suggests that the cost of producing an IMCC is about the same as that of a conventional MCC, with the increased costs of 'intelligent' components being offset by the reduced build time of IMCCs due to fewer components and far fewer interconnections, etc.
- This data, coupled with the smaller IMCC 'footprint', means that IMCCs are generally cheaper to build and install than conventional MCCs and hence WW are unlikely not to specify an IMCC for the majority of projects incorporating reasonably sized drives

## CURRENT/FUTURE USE OF PROFIBUS IN THE WATER INDUSTRY

### ■ **Wessex Water**

- Compared to conventional MCCs, IMCCs obviously offer increased data and energy monitoring, diagnostic and remote access capabilities. WW is not currently maximising these benefits, however, this may change in the future
- Feedback from WW's maintenance staff indicates that Profibus hardware is reliable and rarely needs replacing, with a failure rate of 1 to 2 items per year from a relatively large installed base of components



## CURRENT/FUTURE USE OF PROFIBUS IN THE WATER INDUSTRY

### ■ Yorkshire Water

- YW's current approach is that IMCCs (incorporating Profibus DP) will be installed wherever there is an associated reduction in CAPEX
- IMCCs will also be installed if they are 'cost neutral', because of potential downstream operational benefits
- Consequently, IMCCs only tend to be installed on larger projects (typically where they incorporate > 8 to 10 starters)
- YW is not currently making full use of the data monitoring, diagnostic and remote access capabilities of their IMCCs

## CURRENT/FUTURE USE OF PROFIBUS IN THE WATER INDUSTRY

### ■ Summary

- There has been widespread adoption of IMCCs throughout the UK water industry during the past 10 years
- The incentives to use IMCCs as opposed to conventional MCCs include:
  - Reduced project CAPEX (mainly in terms of reduced cabling and MCC size)
  - The enhanced levels of information available from IMCCs on various drive parameters (e.g. energy consumption, machinery performance, etc.)
  - The ability to remotely (if necessary, off-site) monitor and control drives
- The types of intelligent devices and serial communications networks used by a given water company within their IMCCs obviously depend on that company's preferred PLC supplier (e.g. Siemens, Rockwell, Schneider)

## CURRENT/FUTURE USE OF PROFIBUS IN THE WATER INDUSTRY

### ■ Summary

- DCWW, NIW, SCW, SW, UU, WW and YW currently use Siemens intelligent devices and Profibus DP networks within their IMCCs
- STW and TW currently use Rockwell intelligent starters and DeviceNet networks within their IMCCs, although Ethernet/IP networks and compatible devices may be used in the future
- SWW have not embraced IMCCs to any significant extent. Profibus networks are, however, used to network valve actuators and instruments in the field
- AW have not embraced IMCCs to any significant extent, but are currently reviewing their strategy for implementation of IMCCs during AMP 6. NW are still to be convinced of the benefits of IMCCs

## CURRENT/FUTURE USE OF PROFIBUS IN THE WATER INDUSTRY

### ■ Summary

- IMCCs are/will be an established part of many current/future installations in the UK water industry. Their wider adoption is, however, currently hampered by an inability to demonstrate how their functionality can be used to increase the energy efficiency, availability and service life of driven equipment
- In the field, there is an increasing tendency to network remote I/O via Ethernet/Profinet and connect instruments, actuators and other devices to these remote I/O stations, as opposed to using extensive Profibus networks
- There is ongoing debate about whether or not instruments, actuators and other devices should be intelligent. This appears to be associated with difficulties in defining the data acquisition requirements of this equipment

## SCOPE OF TODAY'S PRESENTATION

- The Pump Centre and WIMES
- The arrival of Intelligent Motor Control Centres (IMCCs) in the UK water industry
- WIMES 3.02 (A) - the design, construction and initial inspection & testing of Profibus networks in the UK water industry
- The current and future use of IMCCs in the UK water industry
- Questions?