rotork®

Pakscan IIS

sequencer
master station

rotork®

Pakscan IIS
Sequence Control

The Pakscan IIS master station controls the plant for you. The inbuilt logic sequence and interlock controller looks after the plant 24 hours a day. Continuously monitoring the status of the plant and taking protective action automatically or on demand from the plant supervisor.

Pakscan IIS is the ultimate in control distribution. It encompasses the proven features of the Pakscan 2 wire control system with the logic and programmability more commonly found in a PLC, to provide a fully featured sequence and interlock control package. Easily programmed by 'fill in the box' actions the Pakscan IIS is quickly ready to run your plant.

Smart in appearance and smart in its actions the Pakscan IIS has a fully sealed keypad and LCD display allowing it to be located in the field adjacent to the process. Pakscan IIS permits control and monitoring of each of the connected field elements on the 2 wire loop.

Where these field units are used for digital and analogue inputs and outputs, these too can be monitored and the outputs changed to control the plant.

The associated function keys and LED displays are used to indicate the current status and initiate the user set sequences, or apply actions such as manual intervention in a sequence.

Where two or more Pakscan IIS master stations are used to control a more complex plant the master stations can easily exchange data using a unique peer-to-peer RS485 communication feature on communication port 1.

Fully compatible with the remainder of the Pakscan family the Pakscan IIS has all the features found in the Pakscan IIE, plus the addition of a third communication port. This gives the Pakscan IIS the ability to interface to two independent host computers, In-vision or a DCS whilst still maintaining peer-to-peer communication.
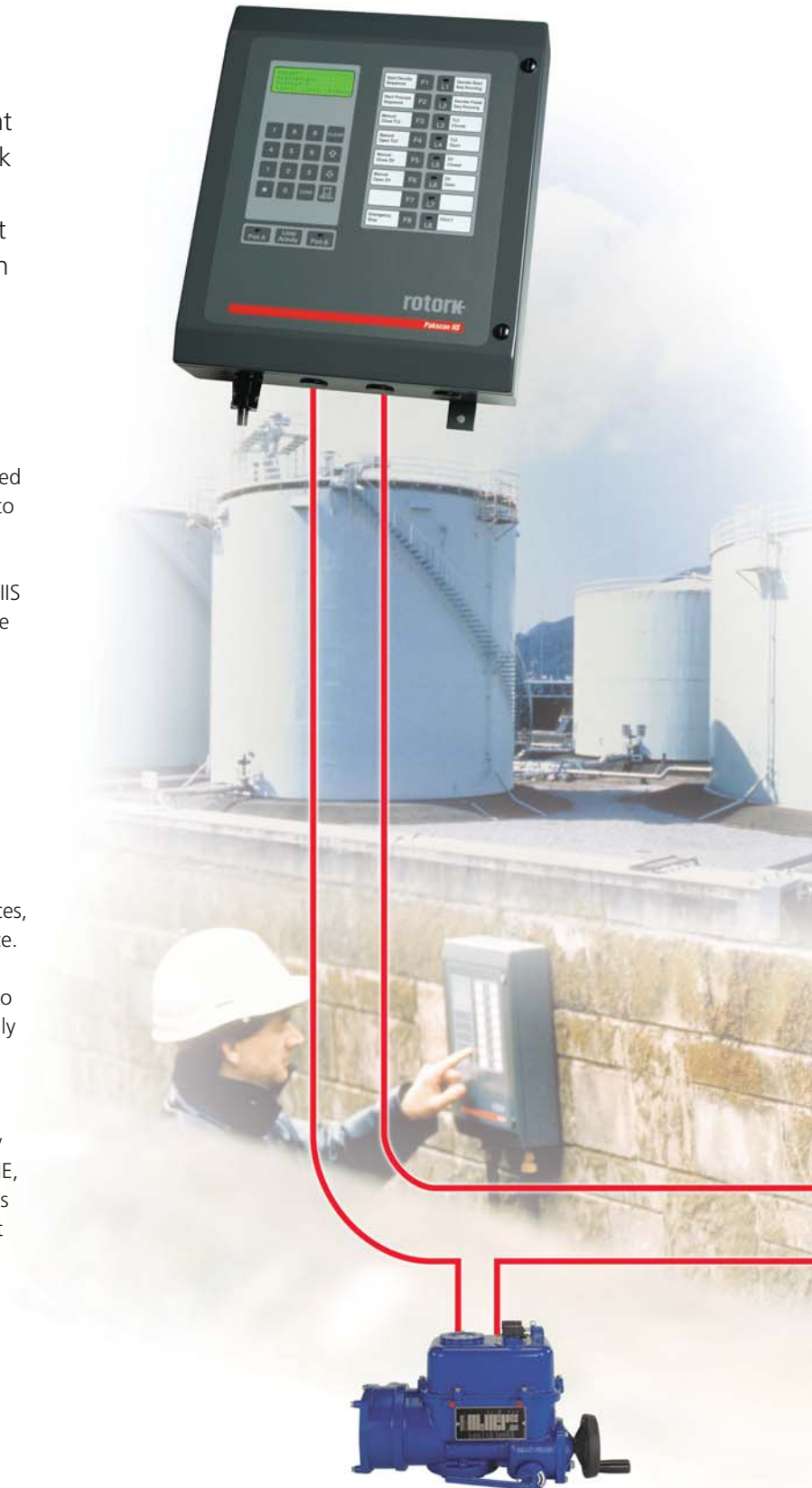
The Pakscan IIS 2 wire loop can have up to 32 field units connected. The field units are the same as those used for the Pakscan IIE system. They are integrally mounted inside the Rotork actuator explosionproof double sealed enclosure, or in the case of General Purpose field units, in a Pakbox or housed in a 19" rack.

All Pakscan field units share the ability to be set non-intrusively without the need to remove any covers. Settings are made either by the Setting Tool using the infra-red communication port on the IQ and IQT actuators, or by using the Paktester tool connected to the 2 wire cable for all types of actuator and General Purpose field units. In addition, once the system is running, all the parameters except for the field unit address can be updated directly using the master station LCD and keypad.

Intelligent Sequence Control

- Up to 80 independent sequences.
- 16 high-speed sequences all executed every 0.25 sec.
- 64 standard sequences all executed every 1sec.
- Logic, time delay, event and arithmetic operators.
- Status flags and General registers for variables.

Interlocking Capability

- 128 Actuator control command interlocks.
- Commands inhibited if interlock conditions not met.
- Continuous plant monitoring to check status.

High Performance

- Priority given to commands to the plant.
- Full monitoring and control of every field unit and actuator connected.
- Fully compatible with all Rotork actuators.
- Master station monitors the full network at all times, relieving the host system.
- Field unit parameterisation from the master station.
- Industry standard Modbus protocol to PLC, DCS or In-Vision.

Large Plant Capacity

- Each IIs network has the capacity for up to 32 actuators distributed over a single 20 km 2 wire loop.
- No restrictions on inter-node distances.
- Capable of controlling various field devices including actuators, pumps, heaters and mixers.

Low Cost of Ownership

- Increased information flow allows for optimised and correctly planned maintenance of the actuators and valves.
- System fault tolerance ensures continuous operation even when a fault exists on the system.
- In the unlikely event of a failure Pakscan is simple and quick to repair ensuring the shortest possible downtime.
- Large number of inbuilt diagnostic features including communication performance data and fault location indication.

High Reliability

- Field units integral with and double sealed inside Rotork actuators.
- High levels of surge protection for poor field environments.
- Non-intrusive setting of all parameters.
- Full isolation between the network cable and the field unit or master station.
- Secure communication protocol.
- Complete cable fault protection with redundant field communication path.
- No repeaters necessary.

Installed Cost Savings

- Direct reduction in cable costs by using a single twisted pair instead of expensive multicore cable.
- Direct reduction in engineering costs due to network's simple design.
- Lower commissioning costs due to faster and easier installation.
- Increased plant productivity by reducing down time losses.
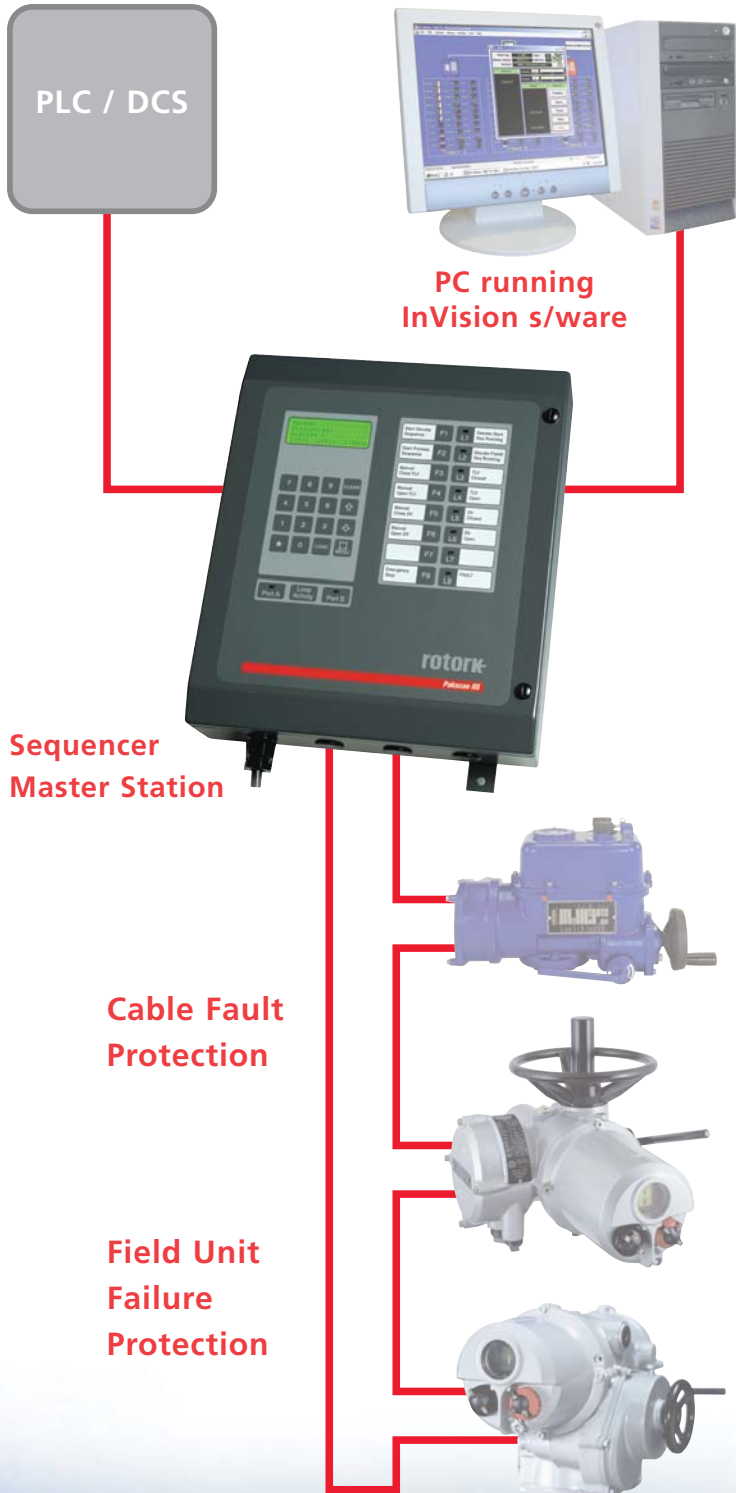
The System

Pakscan includes the experience gained by Rotork in network control systems and their applications. The Pakscan IIS adds the capability to automatically control the plant when simple interlock protection or valve movement sequences are needed.

Sequence Control	Up to 80 fully independent sequences, user pre-programmed into the master station.
Interlock Protection	Every control output may be protected by an interlock statement pre-programmed into the master station.
Continuous Monitoring	Pakscan continuously monitors the plant status, ready to initiate automatic sequences at any time.
Real Time Clock and Calendar	Sequence initiation on time of day or day of the week.
Block Structure Programming	Sequence written using a simple 'fill in the box' procedure on a PC using the Rotork SCT programme.
Two wire Loop	Up to 32 field units distributed over a 20 km twisted pair loop.
Compatibility	Fully compatible with all Rotork Pakscan II two wire control products and In-Vision.
Triple Host Comms	Three RS485 multi-drop or RS232 communication links using Modbus protocol to host computers.
Peer to Peer Comms	Pakscan IIS inter-unit communications set up as part of the sequence controls.

Applications

- **Water Filtration Plant**
- **Water Treatment Plant**
- **Sewage Treatment Plant**
- **Sewage Desluge Operations**
- **Treatment Works Inlet and Outlet Control**
- **Irrigation controls**
- **Condensate Polishing Plant**

- **Dust Suppression Facilities**
- **Scrubbers and Scourers**
- **Damper Control**
- **Tank Farm Management**
- **Truck Loading and Unloading**
- **Product Import and Export**
- **Batch Cycle Control**

PLC / DCS

**PC running
InVision s/ware**

**Sequencer
Master Station**

**Cable Fault
Protection**

**Field Unit
Failure
Protection**

rotork

Sequence Commands

Open	Hold
Close	Get
Stop	Greater than
Set Position	Less than
Timer	If
Wait delay	And
Wait event	Or
Add	Manual
Subtract	Auto
Multiply	Go to
Divide	

Interlock Commands

And
Or
Not
Equal to
Greater than
Less than

S I M P L E   T O   O P E R A T E — controls and displays

The Pakscan IIS master station is designed for panel or wall mounting and is sealed to IP65. The keypad and display, together with the LED's and function keys, are sealed behind a weatherproof membrane.

Simple Installation

The master station requires a power connection and the field cables to be attached and it is ready to go. Each system is supplied preconfigured, already having a full data base and Modbus protocol configuration installed when it is delivered. To complete the plant specific settings the number of field units, loop speed and host communication parameters are quickly entered using the keypad.

Simple Diagnostics

In-built diagnostics show the performance of the host communications, the individual field units and network cable. The screens give information on any alarms present on the system. The loop map shows the position of every field unit relative to the master station.

Function Keys and LED Status

The 8 function keys and 8 LED's are user defined and operated from the sequences set in the master station. They are used for sequence initiation or specific device controls and indication. The labels alongside are inserted behind the membrane layer and are easily modified.

Multiple Hosts Communication Ports

Each Pakscan IIS master station includes three Modbus RTU communication ports, one fixed RS232 and the other two each selectable between RS232 and RS485. The three ports can each communicate with a different host system or be used in redundant communication highways. In addition Port 1 (RS485) supports a custom peer to peer communication for data exchange between Pakscan IIS master stations. The internal Modbus database for host system communication has multiple formats to increase data transfer efficiency.
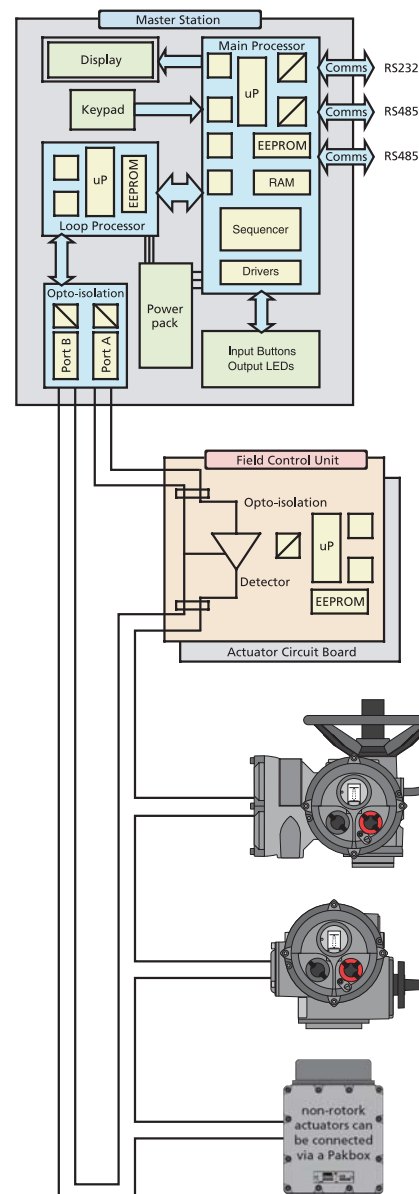

Diagram 1: Pakscan IIS Master Station and 2-wire loop showing system isolation

System Performance Data

DCS or PLC communications
Port 1 communications monitor and analyse
Port 2 communications monitor and analyse
Port 3 communications monitor and analyse

Field Network communications
Relative geographic position of each field unit address
Communications failure count for each field unit address
Location of any field cable fault by adjacent address
Test communication performance at various data speeds
Address range to be scanned

Field Unit Settings
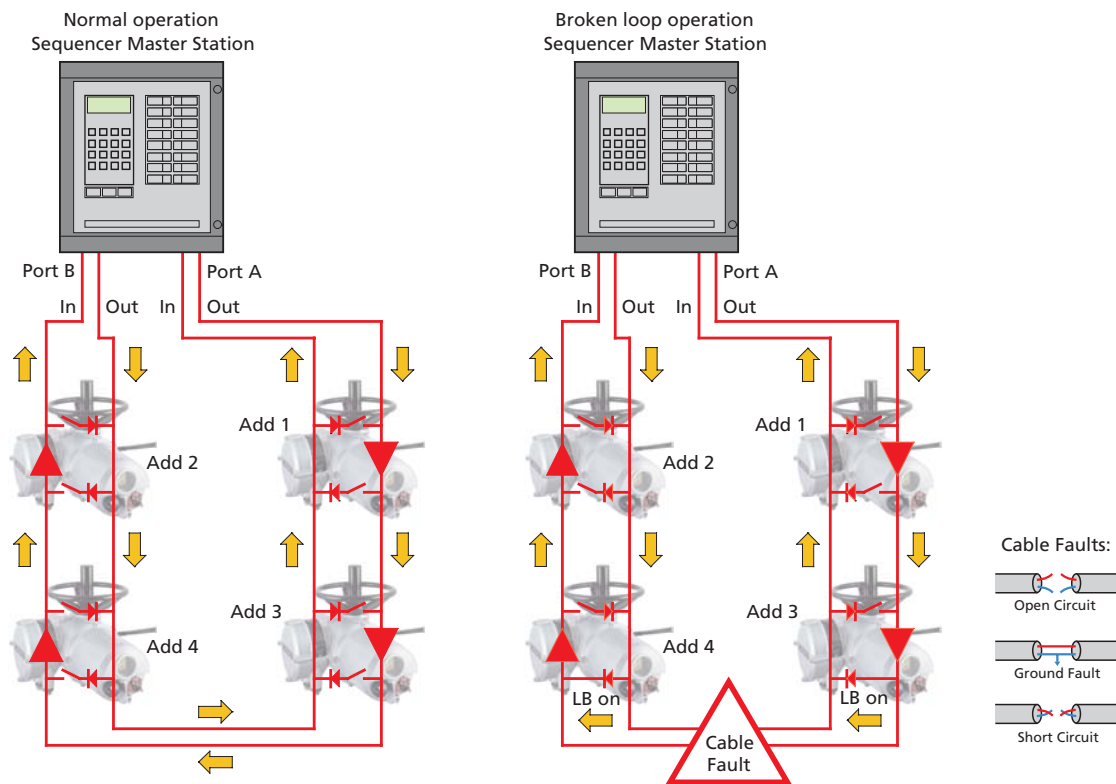Parameter settings for each address
Actuator type at each address

Diagram 2: System Fault Tolerance - 2 wire loop integrity.

Loop Wiring

The Pakscan network carries a 15V 20 mA current loop signal. This signal is modulated by the master station to send and receive data from the attached field units. The cable is a single twisted pair with an overall screen for protection which is easy to install, easy to maintain, low cost and highly effective in all operating conditions.

Comprehensive Data Reporting

2 wires carry the data previously requiring 22 conductors. No additional actuator hardware is needed for position or torque data reporting from IQ and IQT actuators.

Noise Protection

The Pakscan system protects against electrical interference by using a current loop and surge arresters. The use of a 20mA current loop automatically ensures that the system offers a low impedance to any noise currents and prevents these currents from generating significant voltage spikes. Any voltage spikes that do result are swiftly clamped to acceptable levels by the high speed surge arresters fitted at each field unit and the master station.

System Fault Recovery

The two wires are connected to, and taken from, each field unit in turn. They originate from and return to the master station to create a single twisted pair two wire loop. As each device may now be accessed from either direction a redundant communication path is available. Pakscan fully utilizes this arrangement in the event of a cable fault.

The integrity of the 2 wire cable is continuously checked whilst the system is running. In normal operation port A is acting as a transceiver and port B as a receiver only. The current passes from master station port A 'out' to port B 'in' via all the actuator field units. Port B is able to monitor all the communication from port A through the cable.

If the communications should fail for any reason, the master station stops transmission and after a quiet period all the field units assert their loopback circuits. A short period later the master station begins communicating to each field unit in turn from port A. It identifies each unit's address and instructs the field unit to remove its loopback.

Progressively the current loop is extended until the location of the fault is revealed. Port B then reconfigures as a transceiver and the procedure is repeated from the other direction. Once the process is complete the system will have located the position and precise nature of the fault and maintained communication with all the field units on each side of the fault.

The loopback feature is unique to the Pakscan system and allows the system to have two communication routes without the need for two cable runs. It also allows the system to cope with cable breaks, short circuits and ground faults.

In order to program a Pakscan IIS sequence or interlock Rotork provides a software package that runs under Microsoft Windows. This software is a dedicated, self contained, software application requiring a computer and serial link to the Pakscan IIS master station. The program is compatible with Widows 2000 and XP operating systems and requires only a few Mbyte of disk space. The program creates a specially compiled file containing the sequence that is verified before being downloaded to the master station.
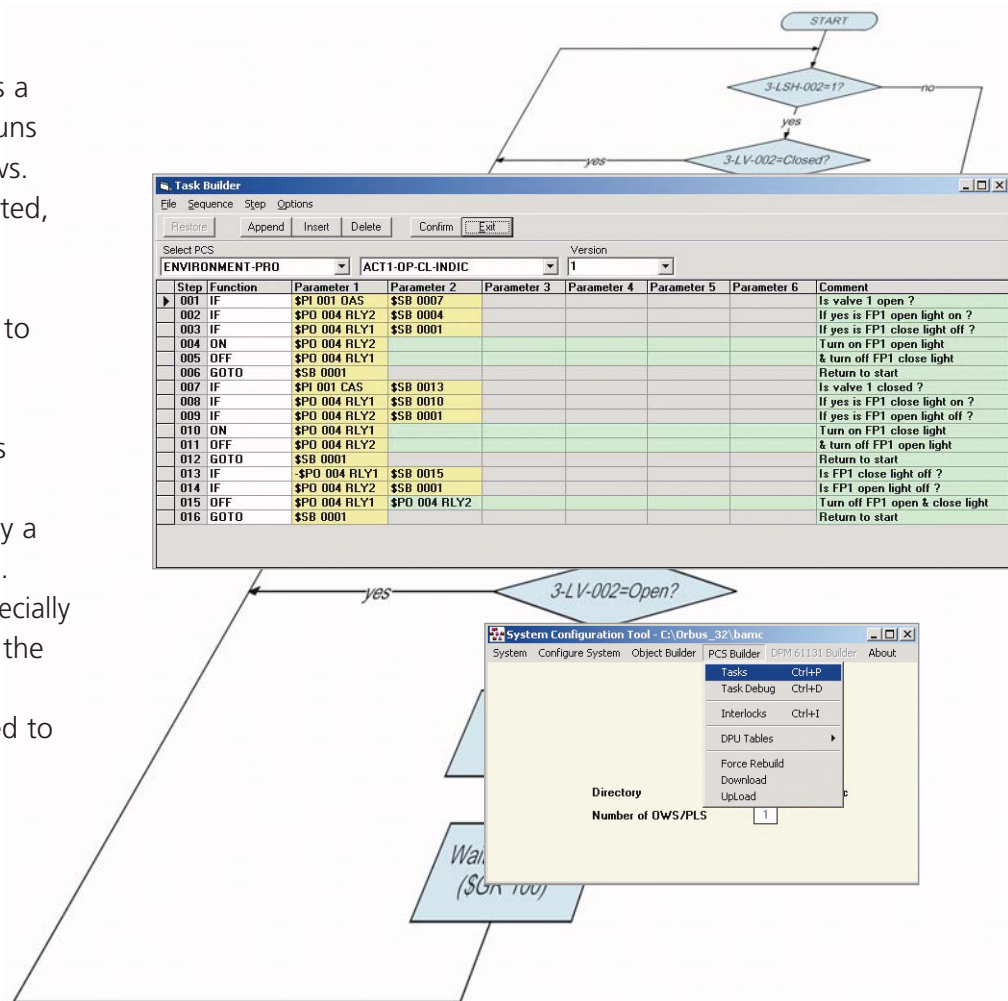
80 Concurrent Sequences

The master station can hold and operate 80 sequences all running at the same time. The first 16 sequences run at high speed, all executing every 0.25 seconds. They are ideal for capturing short time period events such as pushbutton operation. The remaining 64 sequences run slightly slower and all execute every 1 second, they can be used for subroutines or part sequences. One sequence, number 80, is used to control all the other sequences and ensure they start correctly.

To create a sequence the SCT software is started on the programming PC and a screen appears in which the sequence number and name are selected. The sequence is created using blocks,

there are 1000 blocks available and a sequence can be up to 100 blocks long. Each block includes a function and up to six parameters. A function might be a command such as Open or Close, and the parameters could be 6 different valves identified by their address on the Pakscan loop. There are over 80 different functions and the library includes the normal valve operations such as open, close, stop, plus math functions, timers, clocks, logic functions, PID control algorithms, delays, comparators and event monitoring.

Each sequence comprises a list of things to do. These are executed in the same order as written, so the sequence moves through the blocks as if they were steps. One critical difference between this approach

and PLC ladder logic is that the Pakscan sequence is executed in parts rather than as a complete operation. In a ladder logic system it is usual to operate on one ladder at a time while Pakscan can operate on all the sequences all the time. Therefore several sequences may be in operation at one time and they may all be on different steps.

Using this technique it is possible, for example, to operate 8 different sets of 4 valves (total 32 valves) as independent sets. If there is a need for interaction between the sets then there can be an overview sequence controlling the interdependence.

Interlocks

The master station has the capability to provide interlock protection on all the output elements. Once again the SCT software is used to construct the interlocks. A maximum of 128 interlocks may be programmed into the Pakscan IIS by using a 'fill in the box' procedure similar to that used for sequence generation. The interlock statements permit the selected outputs to operate only if the plant conditions are true for the interlock being checked.

Each statement is a combination of 'logic AND' and 'logic OR' statements on the conditions reported from the field units. Once the statement is true then the requested action (open or close a valve for example) takes place. Interlocked outputs are automatically checked as the sequences proceed.

Operator Interaction

Where operator interaction is required the 8 function keys on the Pakscan IIS front panel can be used for control inputs. Similarly the 8 status LED's are available to show the condition of the sequences or the plant. The control of these buttons and lights is directly from the sequence in the master station itself. If more conventional switches or indicators are required they can be connected to General Purpose field units on the 2 wire loop and gain access to the sequence logic by this route.

Plant Condition Effects

The primary feature of the sequence control is the ability to monitor the plant status at all times. By carefully composing the sequences the effect of an out of service valve, or the result of a manual intervention can be identified and acted upon. If necessary the sequence can be stopped and the plant placed in the ESD condition or any other specified state.

De-Bugging and Downloading

Once the sequence or interlock is created the SCT includes a powerful debugging facility. Each step must be verified to check its syntax and the acceptability of the parameters as valid. If there is an error this is flagged to the programmer and the next part of the configuration cannot take place. After all the steps are verified as correct the program can be compiled ready to download to the master station. The preparation, verification and compiling activities can be carried out without the need for connection to the master station itself. These activities can therefore take place away from the plant. Once the program is ready, the compiled configuration is downloaded to the master station using a serial link. This link can be either RS232 or RS485.

Pakscan networks use a unique proprietary protocol that achieves very fast update times whilst using relatively low data transmission rates. Compressing the data field to a minimum length allows more data to pass over the network in a given time at each data rate. The result is a system that can handle long transmission distances and a large number of units whilst still maintaining a quick and efficient communication.

Field units are scanned in turn by the master station and report their current status back in compressed code messages, shortening the transaction period to a minimum.

The field cable used for the Pakscan network is typical instrumentation cable. A simple twisted pair with overall screen using polyethylene insulation will suffice.

The use of low transmission speeds allows the current loop to achieve long distance communication with field devices without the need for repeaters. Where the loop distance is shorter then higher speeds can be used.

The communication protocol gives priority to instructions sent from the master station to the field units. Commands are considered more important than reports so the routine polling of the field units is momentarily suspended when a command needs to be issued. Because command instructions occur infrequently there is a negligible effect on the scan time for the system.

The scan time in the table assumes that only one actuator has new data or a new event to report during each scan cycle. The loop protocol uses a 'report by exception' technique to minimise the message lengths. The field unit does not repeat the data sent once it receives confirmation of receipt by the master station. If the scan time is short then the probability of more than one actuator with a new event to report is very small and the figures given will be accurate.
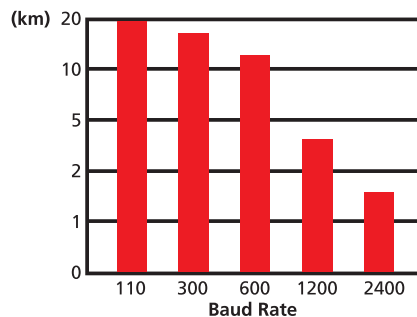
Scan Time (sec) for 32 field units

Baud Rate	Time
110	4.5
300	1.6
600	0.8
1200	0.4
2400	0.2
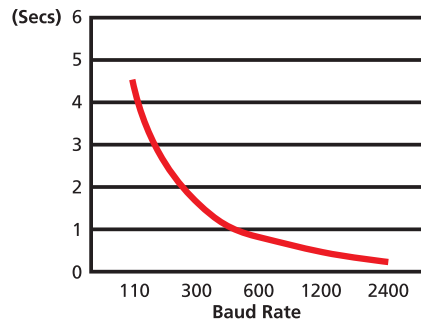
Time to issue a command (msec)

Baud Rate	Time
110	614
300	230
600	110
1200	60
2400	30
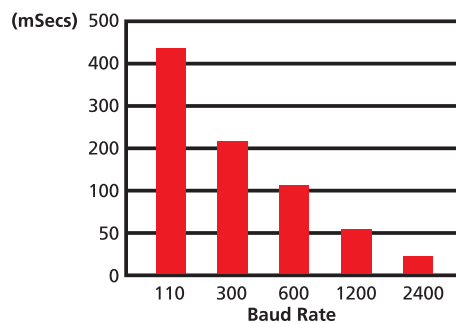
Loop Distance (km) with 1.5mm² cable

Baud Rate	Distance
110	20.3
300	17.1
600	12.2
1200	4.1
2400	1.5

The Pakscan Ethernet bridge allows the IIS master station to communicate to its host controller using the most widely available network in use today.

Ethernet allows for high speed data access and multiple users, all on a single Local Area Network (LAN). The bridge connects the LAN to the master station using one of the serial ports. Information on the plant is made available to the host system over the LAN with minimal delay since the bridge holds a full set of current system and field unit data.

LAN Connection

The Pakscan Ethernet bridge operates an asynchronous communication link to the master station, polling it continuously for the latest data. The Ethernet connection is provided with this data so ensuring no delay in responding to messages from the LAN.

Up to 10 simultaneous connections are allowed to the LAN and hence several hosts can access the data at the same time at speeds of either 10Base-T or 100Base-TX.

The LAN can be extended to a WAN or even the World Wide Web. For connection to the World Wide Web a router will be needed and the correct port enabled to ensure security is maintained.

The user connection is a standard RJ45 Ethernet connector.

Modbus TCP

The Ethernet protocol used for control and reporting is Modbus TCP. This is very similar to Modbus, but allows the data strings to be broken into Ethernet packets for transmission over the LAN. Host DCS or PLC systems can connect to the bridge using Modbus TCP and use the standard Pakscan database formats (Generic, Yokogawa or Honeywell) for data communication.


Embedded Web Server

The Pakscan Ethernet bridge has an embedded server for the connected IIS master station that allows the user to browse to the master station using any web browser programme and a PC connected to the same network. If the bridge is connected to the World Wide Web then the PC can be anywhere in the world, provided it has a web connection.

The web server allows the status of the connected actuators to be seen and, provided they have sufficient access rights the valves can be controlled over the network. The prime function of the server is to provide user diagnostics and data about the Pakscan system to which the bridge is connected.

- System Configuration
- Alarm Monitoring
- Network diagnostics
- Email notification

Security

The Modbus TCP communication protocol and the inherent protection of a router provide a high degree of security for the system. In addition the ability to control actuators or issue commands is under password protection.
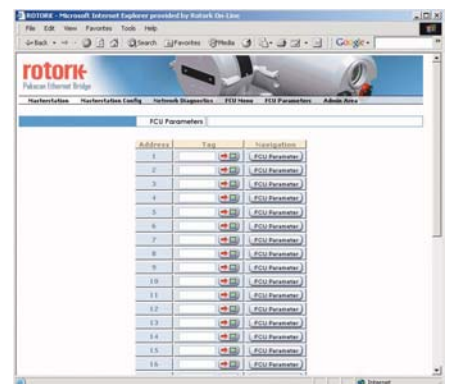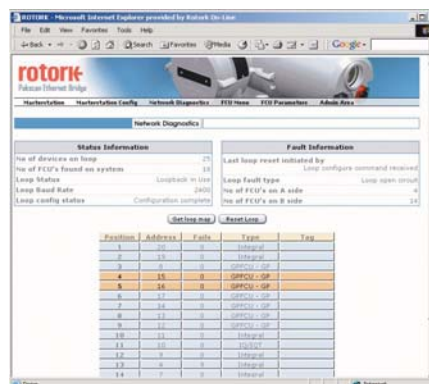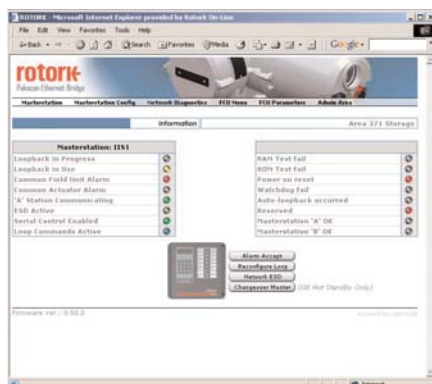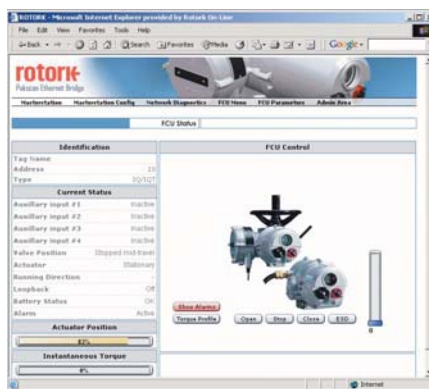
Enclosure
Weatherproof to IP65

Cable Entry
4 x 20 mm cable entry holes

Supply Voltage
a.c. 90 to 264v, 43-440 Hz
Fuse 1 amp

Power Consumption
30 VA

Current Loop
20 mA 15V max Pakscan Protocol
500 ohm max cable resistance
3µF max cable capacitance

Field Control Units
32 maximum
Supports all Rotork actuator types IQ, IQT and Q, plus
General Purpose field unit

Host Communication
3 Modbus RTU half duplex comms ports.
2 off RS485 or RS232, 1 off RS232
Optional Ethernet Modbus TCP (uses the RS232 port)

I/O Connections
Screw clamp terminals suitable for 1.5 mm² cables

Power Connector
Screw clamp terminals suitable for 1.5 mm² cables

Environmental Specification
Operating temperature -10°C to 50°C
Humidity 5% to 95% R.H. non condensing

Display
4 line by 20 character LCD
2 loop activity LED's
8 User defined LED's
The LCD contrast may diminish at extremes of working
temperature range.

Controls
16 key keypad
8 user defined function keys

Sequences
80 concurrent sequences
1000 sequence blocks

Sequence Functions
Control actions
Math functions
Logic functions
Timer functions
Clock functions
PID algorithm
Limit settings
Setpoint detection

Interlocks
128 concurrent interlock statements
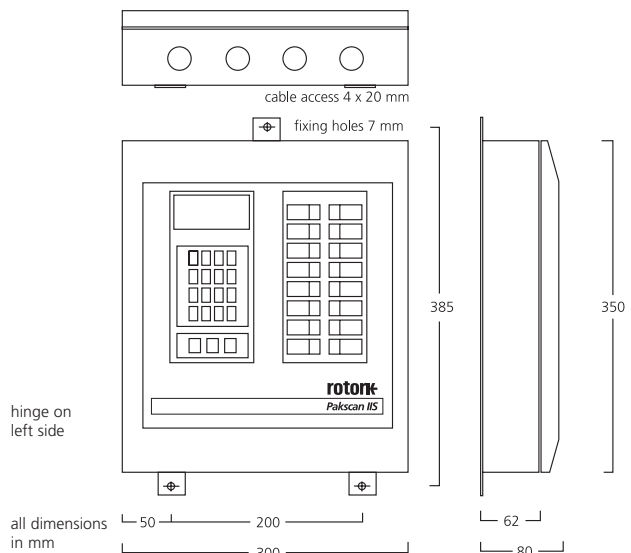
Interlock Functions
'Logic AND' and 'logic OR' functions of the field unit
inputs to permit output actions

Sequence and Interlock Programming
Rotork SCT software requiring Microsoft® Windows®
v9X/2000/XP

Programming Tools
PC, laptop or other computer with serial comms port

cable access 4 x 20 mm
fixing holes 7 mm
385
350
hinge on
left side
all dimensions
in mm
50
200
300
62
80
rotork
Pakscan IIS

A full listing of our worldwide
sales and service network
is available on our website at
www.rotork.com