SEQUENCE OF EVENTS RECORDER

X500F

RONAN
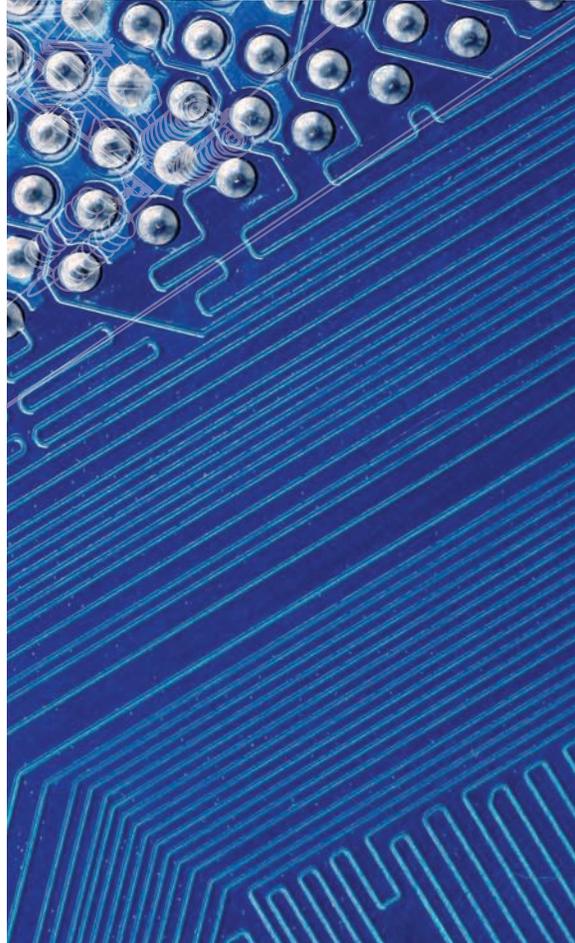### ENGINEERING COMPANY

*Monitoring for the Power Generation,
Power Distribution, and Process Industries*

Model X500F
Sequence of Events Recorder

The Ronan X500F Sequence of Events Recorder provides the Power Generation, Power Distribution, and Process Industries with the most advanced monitoring and fault finding data acquisition system. The system's high speed, high resolution digital multiplexers utilize a network interface for fast transmission of input status updates to the operator on a local monitor screen or a remote host and visual annunciators.

The Ronan multiplexers simultaneously store the historical event information internally, as well as a duplicate storage in the local or remote Ronan Server (X1000) for equipment failure or shutdown alarm analysis. The new Ronan digital multiplexer provides a user friendly network browser interface for input/output configuration, on-line alarm view, and local multiplexer history browsing.

The Ronan X1000 application software with a Windows 7 operating system provides clear and simple event information. Plant or station operators are able to interact quickly and efficiently with the status of all inputs via monitor display. The system software has the capability of grouping plant- or equipment-related inputs allowing immediate access to specific event information; and the system can route inputs or process events to different display/peripherals.
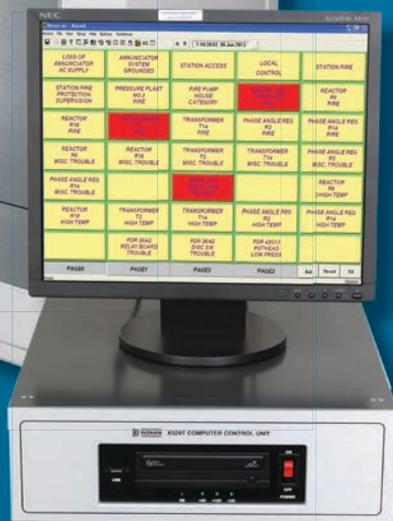
A complete system configuration consists of field contact termination facilities, network multiplexers, network Hub(s), X500F HMI industrial computers and peripherals such as keyboards and mouse, large screen LED monitor, printers, and the optional window type annunciators or lamp cabinets.

For critical applications the dual function SER/Visual Annunciator Systems are supplied in fully redundant configuration, where the loss of a single train does not adversely affect the information flow to the operators.

Features Summary

- **128 Channel Multiplexers (MUX)**
  - > Input connectors (4X32 channels ELCO connectors)
  - > Ethernet Port

- **128 Channel Redundant MUX**
  - > Input connectors (4X32 channels ELCO connectors)
  - > Dual Ethernet Ports

- **256 Channel Multiplexers MUX**
  - > Input connectors (8X32 channels ELCO connectors)
  - > Dual Ethernet Ports

- **256 Channel Multiplexers MUX**
  - > Input connectors (32X8 channels Input Terminals)
  - > Dual Ethernet Ports

- 1 msec Scan Rate
- Internal Time Clock, GPS or IRIG-B Time Sync
- Web Page, password protected browser interface to Multiplexer for Configuration, Event Status and History View
- Multiplexer 8,000 Event Storage
- Selectable Network Communication Protocol:
  - > Ronan Proprietary
  - > IEC60870-5-104 (single connection only) Over TCP/IP
  - > Slave Modbus RTU Protocol Over TCP/IP
- Continuous Multiplexer Hardware/ Software Diagnostics
- Live or Dry Contact Input (Opto-isolated)
- Three Digital Filters for each input: Types: ATC (Alarm Time Constant), NTC (Normal Time Constant), DTC (Debounce Time Constant). ATC and NTC can be configured as either integrating or non-integrating filters Range: 1 to 64,000 ms
- Automatic Disable/Enable of recurring alarms by configurable Limiting Mode
- Periodic Front End Input Test (Automatic)
- Automatic Hardware Detection

RONAN SOFTWARE

- Simulated fixed window annunciator on LED display
- Grouping of Events to distinguish priority levels - Displayed on large screen monitor or fed to printer server
- Multiple Split Window Display of Events, Operator Interaction, System Diagnostic Status, and Input State
- 500,000 Event History Storage
- NTP (Network Time Protocol) for Time Synchronization with 100 msec Resolution
- Search/Review of Event History Database
- Selective Data Printout and Screen Print
- Alarm Sequence Processing and Simulator Processing
- Configurable Window Annunciator with selectable window sizes and Mimic Display Views
- Configuration of legends, window colors and more...
- Multiplexer Distributed or Client/Server Systems Architecture
- Open Protocols for External Client Interface

RONAN COMPUTER HARDWARE

- Industrial Grade, Seismic/ Environmental Qualification IEEE344
- Solid State Drive (SSD) or Hard Drive
- DVD-RW Drive
- Intel® Core™ i7 Processor
- 4 GB Memory
- Dual, Triple Speed 10/100/1000 Megabit Ethernet Ports
- Dual Input Hot Swappable Power Supplies (Dual AC, Dual DC, Dual AC/DC)
- 8 channel Relay and 8 channel Input card for Hardware and Software Supervisory
- AC Input (100-240 VAC,50/60 Hz, 5-8 Amps)
- DC Input (90-264 VDC, 5-8 Amps)
- Windows 7 operating system

NETWORK HUBS

Standard or Switched Network Hub with RJ45 connectors and Fiber Optic Ports (if required) and Optional Dual AC or DC power supplies.
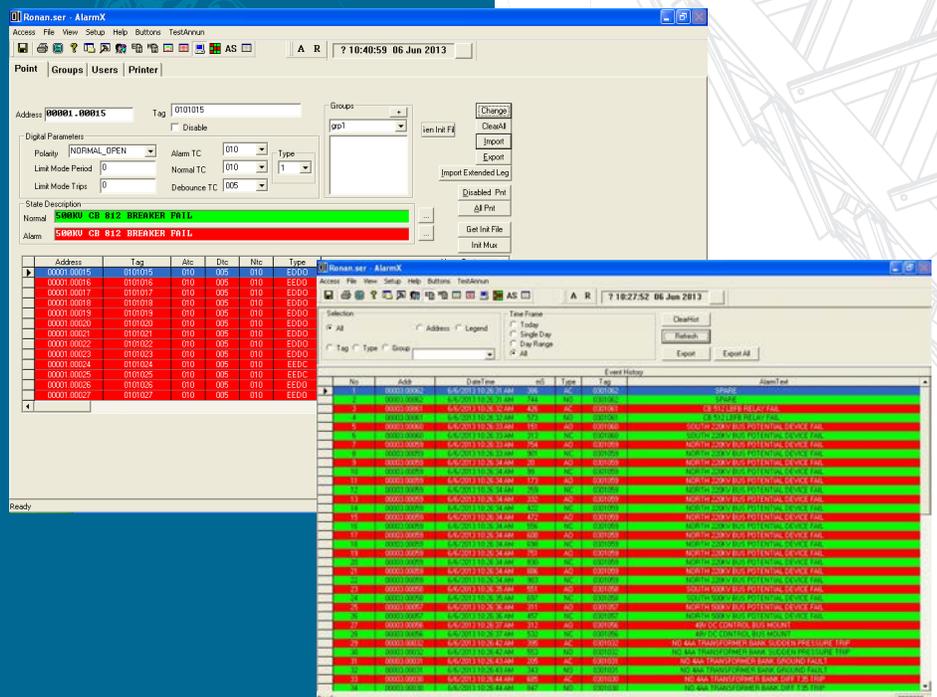
Building Blocks

FIELD TERMINATION ASSEMBLIES

Standard Field Termination Assemblies (FTAs) consist of 1 set of terminals for each input and an Elco connector for connection to a Ronan multiplexer.

- 32-point FTA: Din-type terminals
    - Accepts Ferrule 16-22
    - 250 spacing
- 64-point FTA: Quick disconnect terminals
    - Accepts Ferrule 16-22 qa
    - 350 spacing
- Customer specified FTA: Din-type or quick disconnect terminal assembly available with:
    - Single level or dual-level terminals for multiple output to DCS, PLC or plant computer
    - Isolate field contact switch
    - Field contact status indicators
    - Diode gating and opto-isolated terminals
    - Ground fault detection
    - Additional Elco for output to reflash
- Mating Field Terminal Cable Assemblies:
    - 38-pin Elco connector on each cable end
    - 38-pin Elco connector for mating FTA connector and flying leads (pigtail)
    - 150v multiconductor PVC jacket
    - 600v multiconductor XLPVC Jacket

MULTIPLEXERS

A Ronan Multiplexer is a high-speed data concentrator chassis that processes field data signals and transmits its data to central computers or other plant equipment. Ronan multiplexers, or MUXs, include the following features:

- 8,000 events in 1 ms event processing speed
- Specifically designed fit for industrial or harsh environments
- Chassis that may be populated with a full compliment of input modules and I/O for a maximum of 128 or 256 inputs
- 19" rack-mount or surface-mount chassis
    - Power and status indication LEDS
    - NEMA 1 ventilated
    - CRS construction
    - Gray powdered coat
- Universal chassis that may be converted from single train system to a redundant system without additional internal wiring
- Single power supply for all logic voltage and field contact wetting, 9 VDC logic, 24, 48 and 125 VDC field contact voltage
    - Power failure contact and indication
    - 130% over voltage protection
- Second power supply slot (dual power) for redundancy

128-INPUT MULTIPLEXER

256-INPUT MUX WITH ELCO CONNECTORS

256-INPUT MUX WITH REAR DISCONNECT TERMINALS

- Chassis source input power 115/235 AC or 125 VDC
- 16 digital input modules max per chassis, single train or redundant train
- Input modules, controller and power supply are hot swappable

Ronan X501 NET version 1.36
MUX 3, Ronan Engineering

Point List

Main Menu   Current user: User1   Logout

Refresh   Goto Bottom of page

Point	LogAddr	Tag	State Legend	Polarity
1	3-1	POINT 0	NORMAL	Normally Open
2	3-2	POINT 1	NORMAL	Normally Open
3	3-3	POINT 2	NORMAL	Normally Open
4	3-4	POINT 3	SPARE	Normally Open
5	3-5	POINT 4	NORMAL	Normally Open
6	3-6	POINT 5	SPARE	Normally Open
7	3-7	POINT 6	SPARE	Normally Open
8	3-8	POINT 7	NORMAL	Normally Open
9	3-9	POINT 8	NORMAL	Normally Open
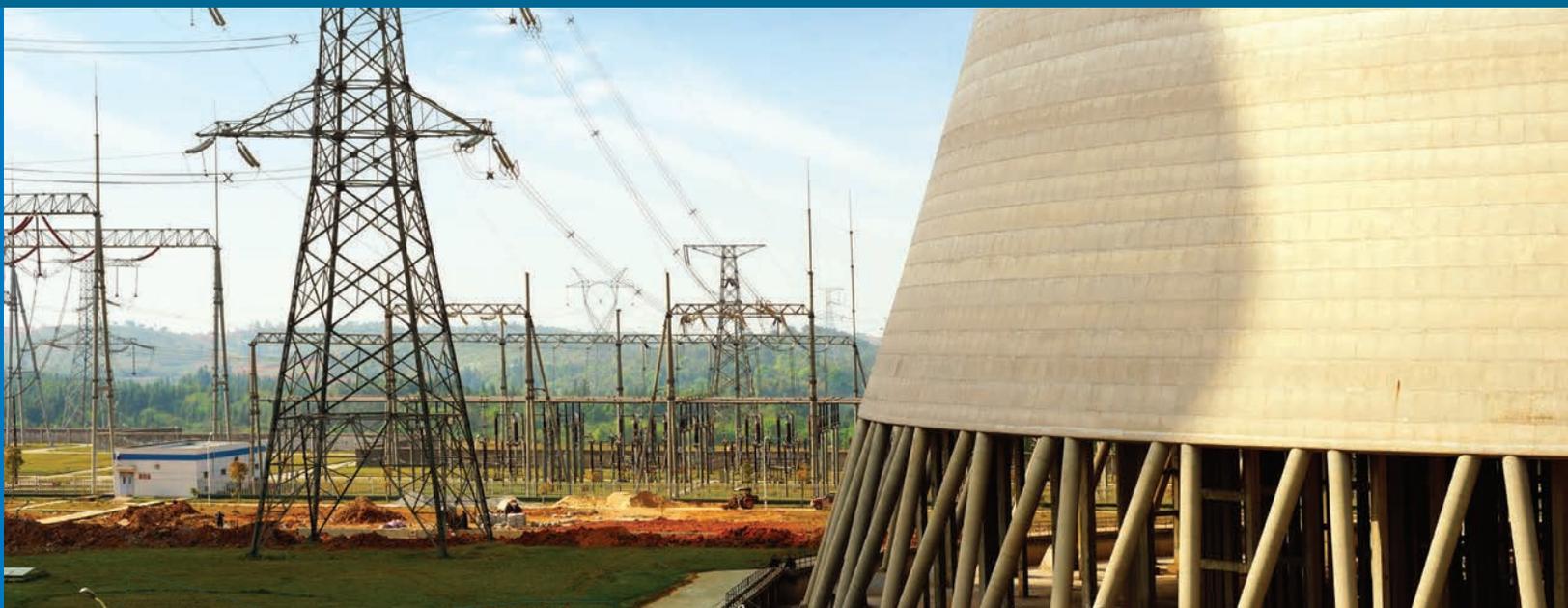
POWER SUPPLY	CONTROLLER CARD	SINGLE TRAIN INPUT CARD	REDUNDANT INPUT	RELAY CARD

CONTROLLER CARDS

Controller card/module is equipped with a microprocessor (10/100mbps and 2mb of flash memory).

Controller module interrogates event and status data from input cards power supply, relay card and receives health diagnostic data on the multiplexer chassis.

- Time tagging of events recording up to 1 ms resolution
- Transferring of events via several popular configurable communication protocols:
  - UDP
  - IEC 60870-5-104 (single connection only)
  - Modbus RTU protocol over the TCP/IP Ethernet Interface
  - DNP3
- On board time sync input IRIG-B, time synchronization clock for each controller module
- Handles input buffering and input contact debounce and/or input transmission adjustments

INPUT CARD

Up to 16 Input modules:

- Special threshold voltages optional
- Serve 8 input contacts
- Microprocessor controlled for input status interrogation
- Status change queuing
- Integrating and non-integrating digital filters by individual inputs for:
  - alarm
  - return-to-normal
  - relay debounce
- Relay debounce for filtering contact chatter
- Normally open/Normally closed

NETWORK HUBS

The network Hubs are utilized to connect network devices such as Multiplexers, HMI computers, and RONAN X110NET Serial Annunciator on to a common network segment while providing complete physical isolation. The 19-inch rack-mount chassis design features rugged industrial packaging with built-in power supplies (115/230 VAC, 50/60 HZ or 125 VDC inputs).

Features:

- 10/100 mbps communication processing
- Standard 16 ports — Models with additional ports available

RONAN **5**

Ronan Server Hardware/Software

RONAN INDUSTRIAL COMPUTER

The X500F Industrial Computer is available in table-top or 19-inch rack mount design. The CPU features a rugged CRS construction with slider rails and is IEEE approved for seismic qualifications. This high-powered CPU is equipped with:

- Windows 7 operating system
    - Hot swappable internal power supplies
- Solid state drive (SSD) or SATA Hard Drive
    - CPU board with Intel Core i7 microprocessor
    - 4 GB of memory
    - DVD-RW
    - 4 USB port
    - 2 Ethernet ports

The CPU is offered with color LCD/LED display monitor in custom sizes, printer server for continuous alarm/report printouts, and color laser printer for custom color report printing. The printers are offered as dedicated serial printers or network printers depending on the system's architecture.

X500F Software (X1000)

OPERATOR INTERFACE

The Ronan X500F Sequence of Events Recorder is provided with the X1000 Software, a highly integrated, Windows-based operator interface application software uniquely designed to suit different applications and system complexities.

X1000 INTEGRATED

This Windows based application is generally used with small and large systems where equipment is connected to a single network segment with a decentralized mode network. X1000 can function as a local database events recorder and meet redundant data acquisition needs.

The X1000 software presents clear, concise on-screen reporting to plant operators. It displays event data, the system's health, and alarm acknowledgement in a tabular format or virtual alarm window view.

Software access is comprehensively password protected for different levels of users with different access rights and privileges. The system is ideally suited for remote sub-stations, switchyards, power and process monitoring.

Configuring the user database requires a basic setup of menu items such as: normally open/normally closed field contact logic, filter parameters, display parameters (i.e. alarm text, text color, background color and more), alarm sequences, enable/disable points, user rights and group assignment.
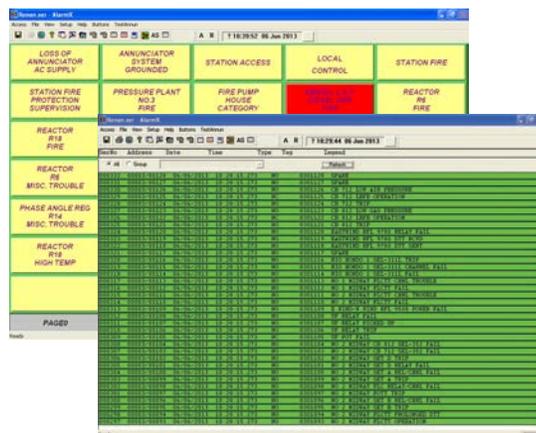
All event data is stored on the hard disc drive or in solid state memory. Historical information of up to 500,000 events may be reviewed on the screen in its entirety or queried with specific filter parameters for an accurately sorted display of information or hard copy.

With a simple click of each respective icon, the flexible user interface software is designed to quickly display:

- The status of all the Inputs on the "Current Events" screen and "Current Alarms" screen
- The Multiplexers communication status, IP addresses, Synchronization status, and Mux numbers in "Devices" screen
- The System Messages and push buttons activities in "Current Messages" screen

Reports

The X500F system provides a printout of all recorded data at the operator's request. Reports such as Current Alarms, Event History, Message History and Legends are generated and printed as needed. The application query feature allows user selection and sorting of stored data by any one record, or a combination of records in logical order. The system then allows print out of queried data as seen on the screen to a printer on the network. The application uses all of the advanced features of the Windows operating system print functionality for printing.

Peripherals

VIDEO
A wide variety of color LCD or CRT monitors are available for use with the X500F systems. Various resolutions and sizes are available for table top, panel or rack mounting.

PRINTERS
Various color, black and white serial or network printers are available for report or continuous alarm printing.
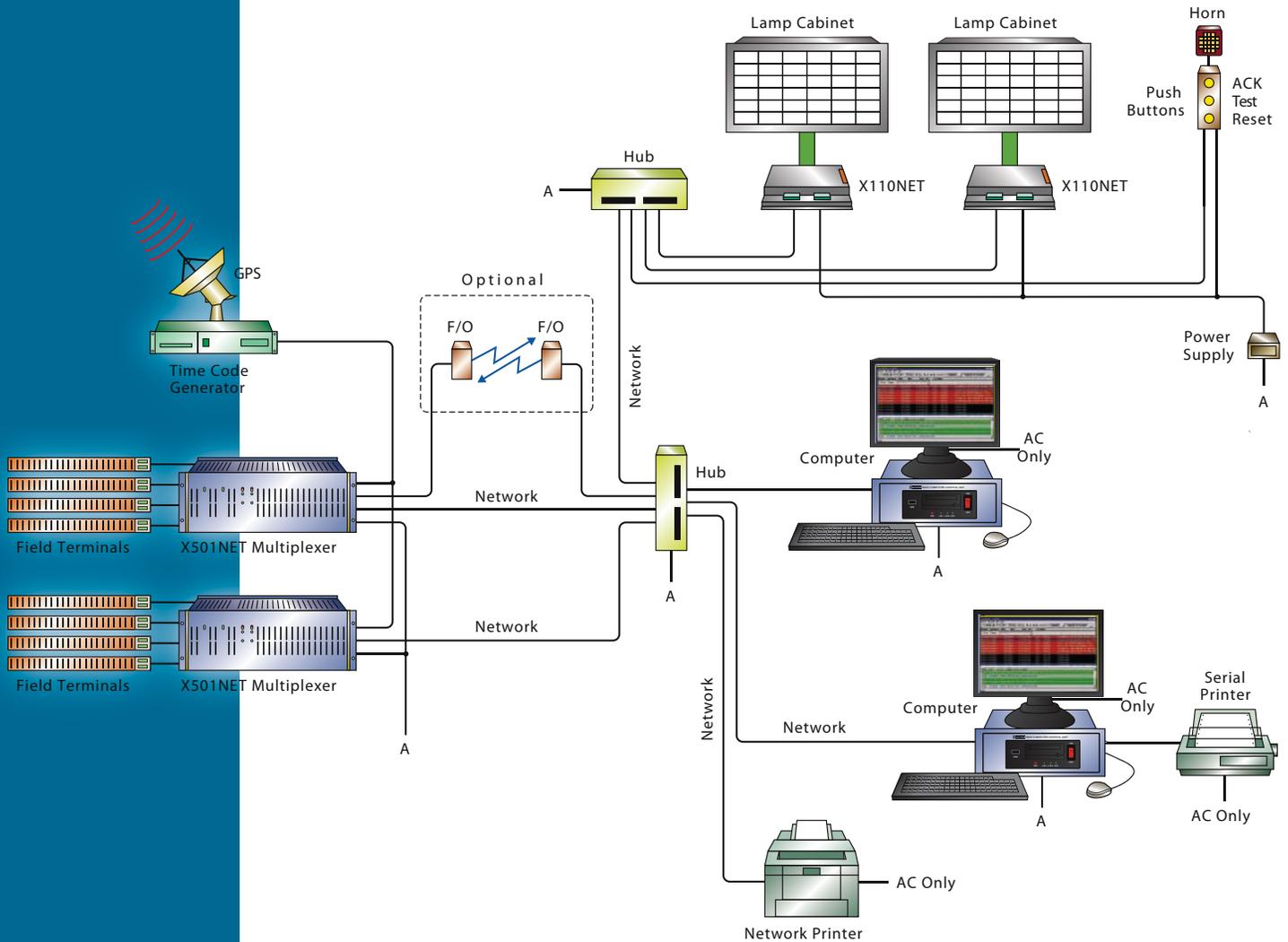
SERIAL INPUT VISUAL ANNUNCIATORS
The X500F system has the ability to send serial events via Ethernet to Ronan's X110 NET serial annunciator for visual annunciation on various Ronan lamp cabinet models.

HOST CONNECTIVITY
The Ronan network multiplexers provide host connectivity via IEC 60810 over TCP/IP, Modbus RTU and Ronan proprietary protocol to host device.

Plant Process Monitoring

The X500F basic system configuration consists of field contact termination assemblies, network multiplexers, network Hub, database server interface computer unit including the supporting modules based on customer site requirements, a color monitor, and one or more serial or networkable printers. The field termination assemblies are connected to the multiplexers via multiple conductor cable assemblies. The network cat5 cable is connected to a central Hub which is connected via similar cable to the computer's network module hosting the Ronan X500F database server and client hosts.. The system may, optionally, provide input status information to a lamp cabinet via Ronan network X110 NET serial input visual annunciator or X11CB Annunciator System.

Lamp Cabinet   Lamp Cabinet   Horn

Push Buttons   ACK Test Reset

Hub   X110NET   X110NET

A

GPS

Optional

F/O   F/O

Power Supply

A

Time Code Generator

Network

Field Terminals   X501NET Multiplexer

Network

Hub   Computer   AC Only

A

A

Field Terminals   X501NET Multiplexer

Network

Network

A

Network   Computer   AC Only   Serial Printer

A   AC Only

AC Only

Network Printer

A= Dual Source AC, Dual Source DC, or Single AC and Single DC

Dual Train Redundant System

For critical applications such as nuclear or conventional power plants, utilities or substations, petro chemical or chemical process installations, the X500F System has the flexibility of expansion from a single train system that may be configured to a dual redundant train system. On critical plant installations, or where costly down time impacts the plant's performance, dual redundant trains may be procured to achieve the highest reliability and meet MTBF requirements. All equipment is duplicated to provide two complete trains, connected via two parallel networks, to the HMI computers which provide output to the color monitor(s) and printer(s). Optionally, the system may provide input status changes to a redundant network serial input visual annunciator. All host interfaces are connected via the network Hub.
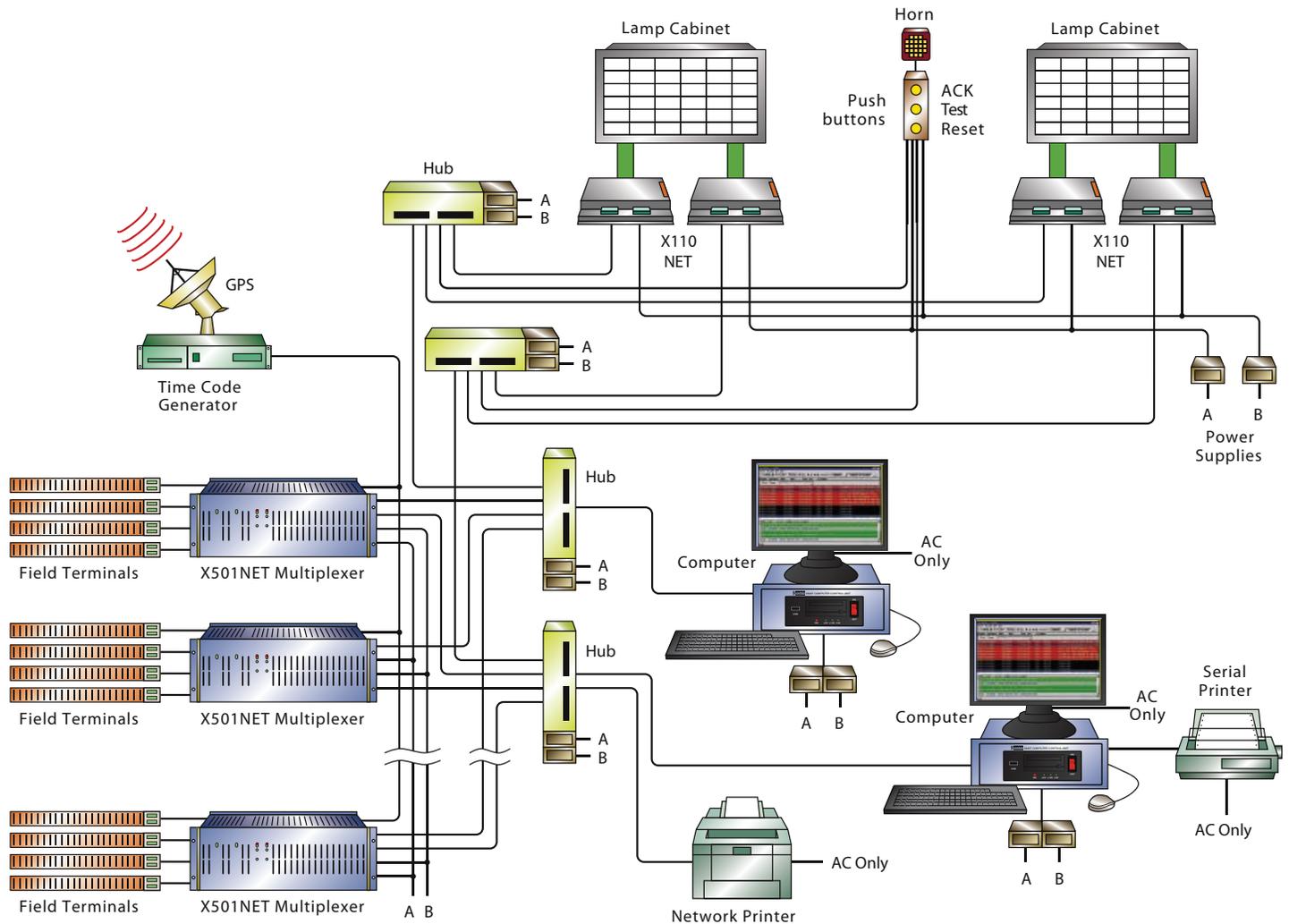
A & B = Dual Source AC, Dual Source DC or Single AC and Single DC

Redundant Monitoring – SER as Backup for DCS Control System

Ronan Engineering has served several plants and substations that choose to use the X500F SER as a backup for their DCS Control System. Even though the DCS has control of the system, and monitors all of the same points, technicians turn to the SER as their preferred alarm monitoring system for troubleshooting the DCS. While the X500F system is unquestionably a proven, dedicated system for alarm detection and annunciation, it also serves as a fundamental tool in determining the performance of the DCS system; even during normal operation.
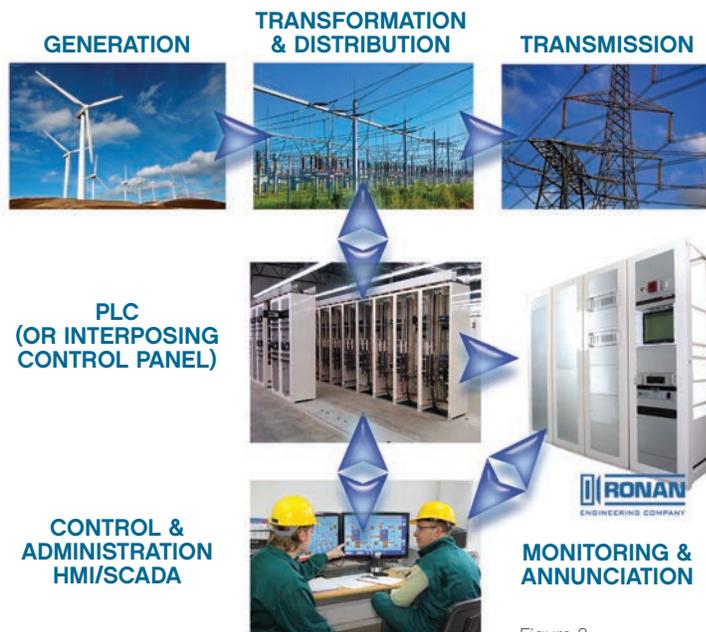

Figure 3

With the ability to sample up to 128 simultaneous inputs within a 1 millisecond resolution, each X500F Multiplexer detects and tags the opening and closing of contacts with timestamp information. The timestamp allows events to be recorded in time order and correlated to the alarm server database to verify the DCS's performance under various stimuli.

The X500F provides the operator continual awareness of all conditions (status or alarm) eliminating uncertainty for operators and reducing fault reaction and analysis time.

WHY TECHNICIANS PREFER X500F:
- Plant and DCS system faults and alarms visible to operators
- Clear reporting provides a quick view of the state of the events
- Low incidence of false alarms
- Editing and reconfiguring points is an easy task
- Plug-and-play design features make for simple system assembly
- Clean installation and low maintenance
- Internal modules are plug-and-play replaceable and require no special software knowledge or tools

HOW IT WORKS

One set of field sensors discreet outputs are generally tied to a PLC (or to an interposing control panel) and another set of discreet field sensor outputs are tied to the Ronan X500F Multiplexers which are configured for redundant alarm operation. Ethernet ports from each Multiplexer are routed to the Sequence of Events Recorder and then Ethernet ports are routed via the control network to the HMI/SCADA as seen in Figure 3.

Redundant Monitoring – Protecting Critical Processes from Cyber Attack

Industrial network infrastructures are no longer immune to malware and they are increasingly vulnerable to cyber attack spreading through the cyber world. Dangerous hackers have caught on to the damage that can be done when they discover IT vulnerability and gain remote access to control networks, ultimately allowing them to manipulate plant or substation operations.

The X500F is the safest engineering solution for mitigating down stream control system problems and serves as a powerful tool in protecting critical processes form crippling cyber attacks. With these types of applications in mind, the X500F is installed as a redundant system to a DCS while remaining isolated from a plant or substation control network. See diagram.

In the wake of a cyber attack that threatens the control network, potentially sending the control DCS/SCADA HMI into chaos with a flood of false status indications and alarms, the X500F has the proven capability to carry on monitoring its field contacts in an isolated environment. Plant and substation technicians can rely on the clear and speedy reporting of alarms by the SER to determine the real status in the midst of an emergency.

Annunciator Systems that monitor the most critical alarms while being isolated from a plant's control network offer an effective layer of protection from cyber attacks.

Diagram created by Ronan Engineering Company | www.ronan.com
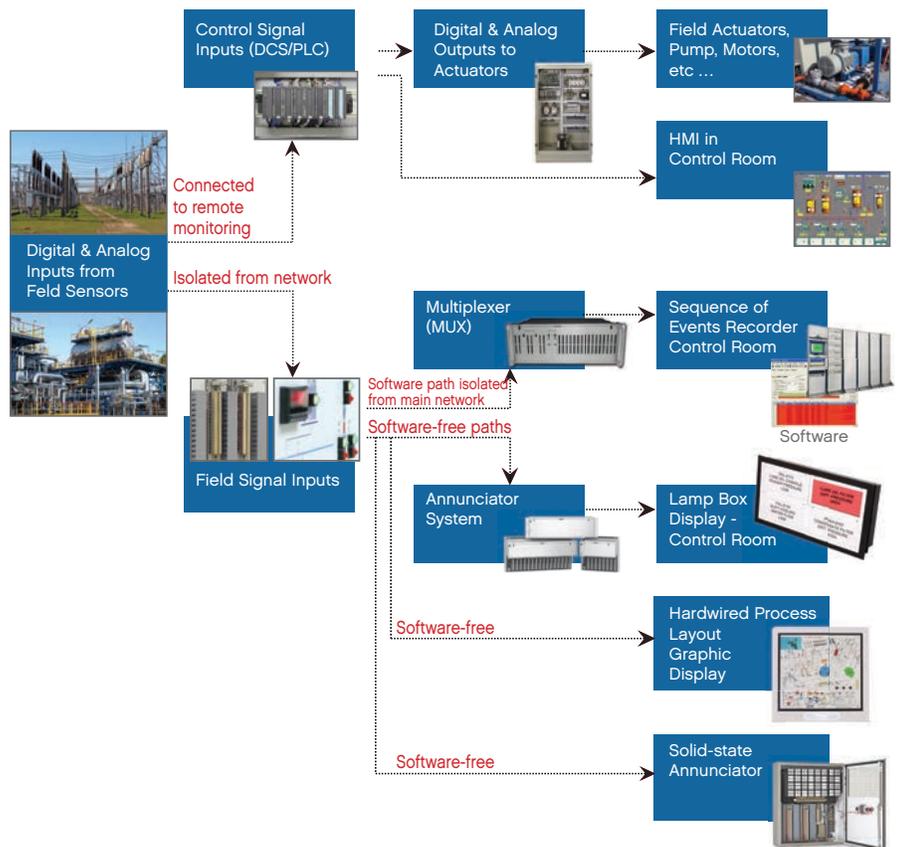
# Remote Monitoring/Event Recording With Central Data Acquisition - Management

Multiple site systems are typically designed to form a network that can transfer event information and site input configuration to and from a central master server station. This type of network scheme is typical in power distribution and switch yard applications. Equally valuable to plant engineering, remote SER systems can be connected to the master server station via dedicated Ethernet network or Broadband network. Ronan utilizes a client/server architecture using several different TCP/IP based protocols such as IEC 60870-5-104 (single connection only), Ronan proprietary protocol to communicate between remote client sites and central server station.

Clients reside in each multiplexer with their own dedicated IP address and connect to the central server/producer. All remote input configurations can be set up from the master station server application. Optionally, a client server and data storage is available at each remote SER site with its own display for local monitoring and maintenance.

Real time synchronization between multiple remote sites and central site is achieved by IRIG-B or GPS (Global Positioning System) signal feed to each multiplexer.

Example of remote mux in Nema 12 enclosure

A = Single Source AC or DC

A = Dual Source AC, Dual Source DC, or Single AC and Single DC
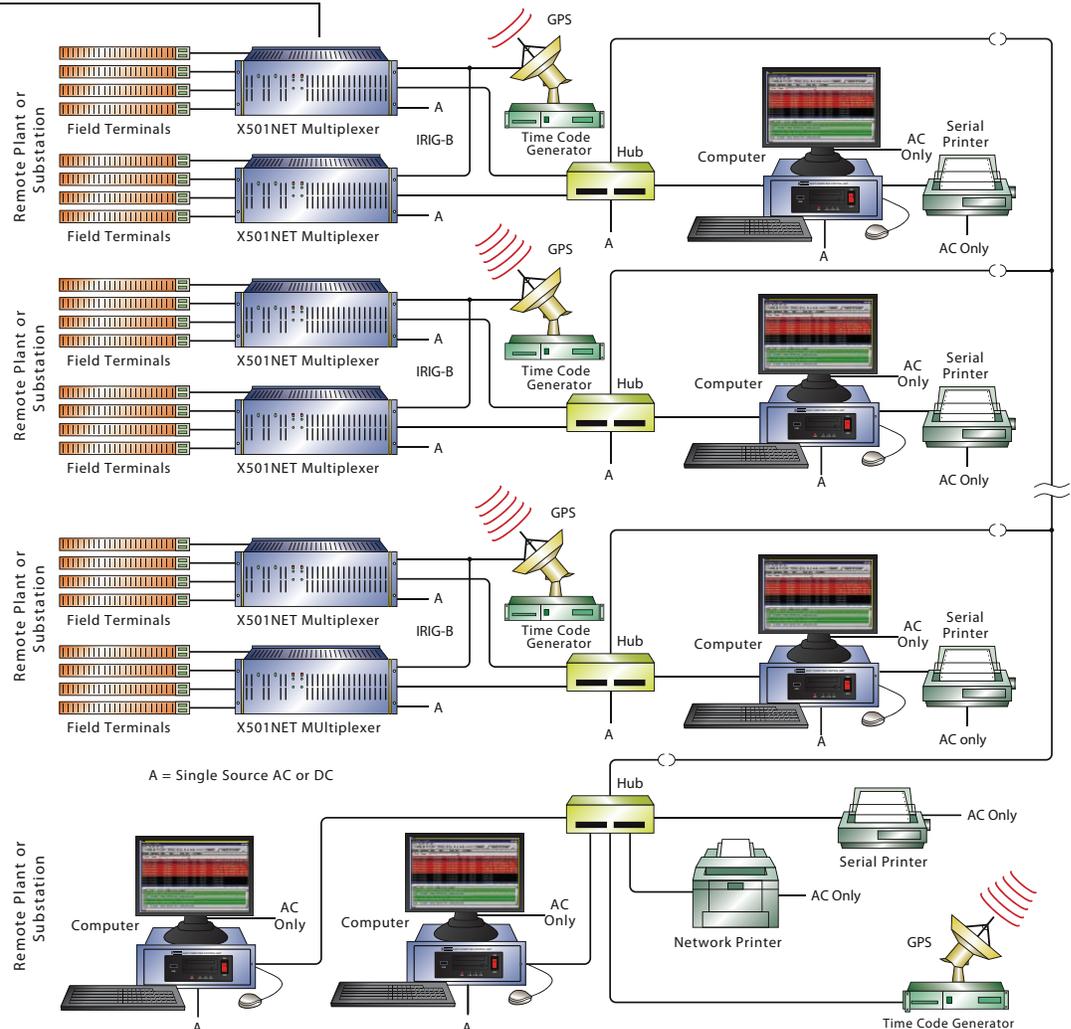
Redundant Power Source

All system components such as multiplexers, hubs, display components, and serial input annunciators are available with redundant power supplies, diode gated with short circuit protection. The design of each component allows live exchange of any defective power supply on line without adverse effect to the system's operation.

Communication Protocol And Host Interface

The system offers several different protocols bundled in with the X1000 software for communicating between multiplexers and display (X500F) computer(s) and X110 NET serial visual window annunciator. Ronan's proprietary protocol UDP with efficient and fast response time is used over TCP/IP as the base communication protocol.

The Multiplexers are equipped with international standard IEC 60870-5-104 (single connection only) and ModBus RTU Protocol to communicate with other devices such as DCS, PLC, SCADA and HMI Units.

Electrical Data Connections

The connection from remote or local multiplexer to the X500F server is through a local isolated hub using cat5 network cable. For longer distance connection between multiplexers and hubs typically Ethernet to fiber optic converters are used as network extenders. The connection between the X500F System and client computer could also be made with Cat5 or Fiber Optic cable.

System Programming and Configuration

The system design allows individual multiplexers or X110 NET network serial input annunciator to be accessed and configured online, using the Web browser of a computer connected to the segment of the network. The embedded Web server in each of these input/output devices allow fast configuration of each device.
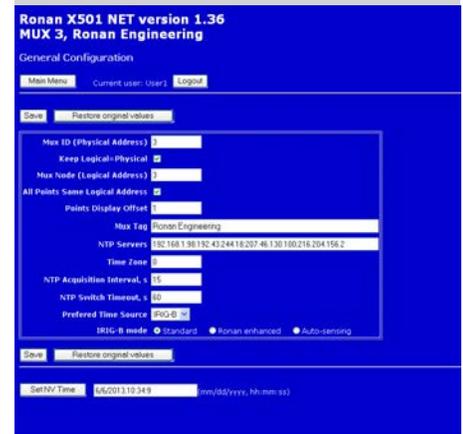
X501 NET GENERAL CONFIGURATION
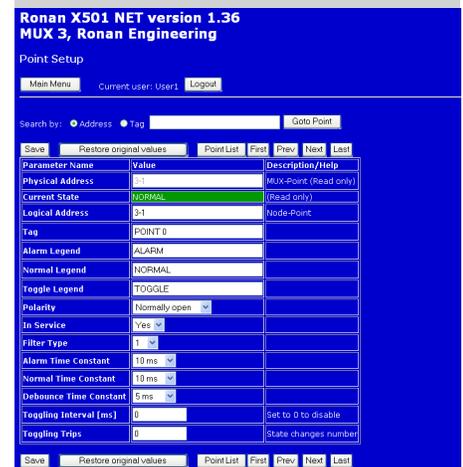
X501 NET POINT SET UP

Specifications

FIELD CONTACT TERMINATIONS

Terminals:	Screw Type or any type of terminals per customer request.
Terminals per Input:	2 for Live Inputs; 1 for each Dry Input
Mechanical Design:	Surface Mount Assembly; Din Rail Mounted; Unistrut Mounted; 16 Inputs for Live Contacts; 32 Inputs for Dry Contacts
Ground Fault Isolation:	1 Switch per 32 Points; 1 Switch per 16 Points; 1 Switch per Point
Connection to Multiplexer:	38 Pin Elco connectors or 8 input removable Screw Terminals
Cable Type:	PVC or Crosslinked Polyethylene (Fire Retardant)

MULTIPLEXERS

Chassis:	Rack Mount Rear Access, Rack Mount Front Access, Surface Mount Front Access
Channels:	128 Inputs, Dry or Live Contact Voltage; 128 Inputs, Redundant Dry or Live Contact Voltage; 256 Inputs Dry Contact voltage Choice of 24 VDC, 48 VDC, 125 VDC, or 115 VAC Field Contact Voltages.
Power Supplies	Input - 100-240 Vac 50/60 Hz, 125 Vdc
	Output - Logic Voltage 9 Vdc, Internal Field Contact Voltage 24Vdc, 48Vdc, or 125Vdc Power Indication - Front Panel LEDs for Logic and Contact Voltage
Time Synchronization:	GPS Antenna Signal Feed 200 nanosecond Resolution; IRIG-B 1 ms resolution output; NTP (Network Time Protocol) Client
Resolution/Scan Rate:	1 msec
Network Interface:	802.1 Ethernet Isolated Adapter 10baseT with RJ45 Connector; 10/100 Mbps Speed
Local Event Storage:	8,000 Events with Legends
Multiplexer Configuration:	Web Browser Interface; Configuration Application TCP/IP
Supervisory Monitoring:	Watchdog Signal for Communication Problem, Time Sync Problem, Hardware Failure
Communication Protocols:	Ronan Proprietary, IEC 60870-5-104 (single connection only) over TCP/IP; ModBus RTU over TCP/IP; For other Protocols Consult Ronan
Input Modules:	8 Channels per Module (single or redundant) for 128 points chassis. 16 channel per Module for 256 points chassis.

X500F SERVER COMPUTER

Chassis:	Industrial Grade, Seismic and Environmental Qualified Relay Rack Mount or Table Top
Power Supply:	Dual Redundant Hot Swappable AC Input (100-240 Vac, 50/60 Hz; Dual Redundant Hot Swappable DC Input (90-264) Vdc; or Dual Redundant Hot Swappable AC/DC Input.
Processor:	2nd Generation Intel i7 Core Mobile Processor.
Driver/Memory:	4 GB (2x2GB) SODDR3 PC3-8500 Memory
Network Module:	Single (CPU Integral) or Redundant Intel or Equivalent PCI Bus
Video Module:	Super VGA PCI Bus
Relay Module:	Relay Module with 8 Output Relays and 8 Input IO (Used for Supervisory or Control Function)
Keyboard Interface:	Qwerty 101 Enhanced
Mouse Interface:	PC Mouse
Printer Interface:	Serial or Network
Operating System:	Windows XP (SP3), 7 (Or check with factory for current release)

PERIPHERALS

Alarm/Report Printer:	Laser Network Printer
VGA Monitor:	Table Top; Panel Mount or Rack Mount; LCD/LED Color Monitor Display, Customer Selected
Keyboard/Mouse:	Table Top or Rack Mount

RONAN
ENGINEERING COMPANY

Ronan provides skilled and specific technical assistance to our valued Sequence of Event Recorder customers. We serve some of the globe's largest power generation and process industry leaders and are committed to assisting these customers with startup technical training and continued customer service.

SOME OF RONAN'S X500F CUSTOMERS:

Alliant Energy	Frontera Energy Center
Alumina Partners of Jamaica	Grant County Public Utilities
Arcata Associates Inc.	Hays Energy LP
Comisión Federal de Electricidad	Interstate Power and Light Company
Con Edison	Israel Electric Corporation
Crown Technical Systems	NASA Langley Research Center
Dron & Dickson	PG&E
Duke Energy	Saudi Electricity Company
DuPont	Southern California Edison
Enquest	Tennessee Valley Authority
Foster Wheeler Energy	University of Alaska Fairbanks

All X500F hardware, with the exception of the monitor display and printer, is manufactured by Ronan in the USA. Ronan is the original creator and owner of X1000 SER source code. Hardware and software have been qualification tested based on successful plant installations under nuclear operating conditions.

WARRANTY

Ronan warrants equipment of its own manufacture to be free from defects in material and workmanship, under normal conditions of use and service. Within one (1) year of its original purchase, Ronan will repair or replace any component found to be defective, on its return, transportation charges prepaid. This warranty carries no liability, either expressed or implied, beyond our obligations to replace the unit which carries the warranty. Extended warranty is available.

RONAN
ENGINEERING COMPANY

UKAS
ENVIRONMENTAL
MANAGEMENT
105-A

MS
JAB
CM025

PERRY
JOHNSON
REGISTRARS

ANAB
ACCREDITED

ACCREDIA
L'ENTE ITALIANO DI ACCREDITAMENTO

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