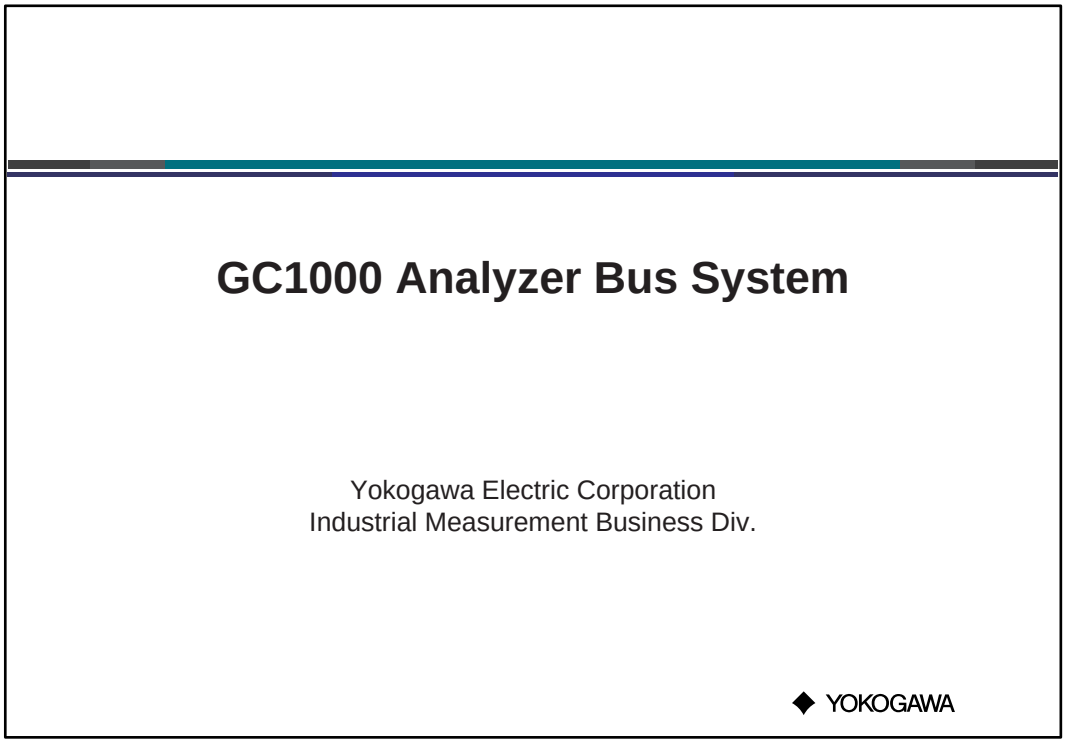
Technical Information

GC1000
Analyzer Bus System



Yokogawa Electric Corporation has been developing the so-called analyzer bus, an analyzer network that focuses on process analyzers, in particular process gas chromatographs, since 1993. We would now like to introduce this analyzer bus.

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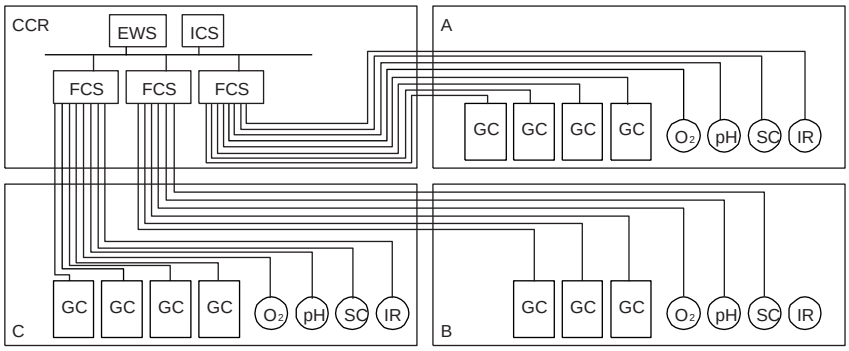
TI 11B5A1-03E

1st Edition: Mar. 1998 (YK)

What is an Analyzer Bus? (1)

CONVENTIONAL ANALYZER SYSTEM



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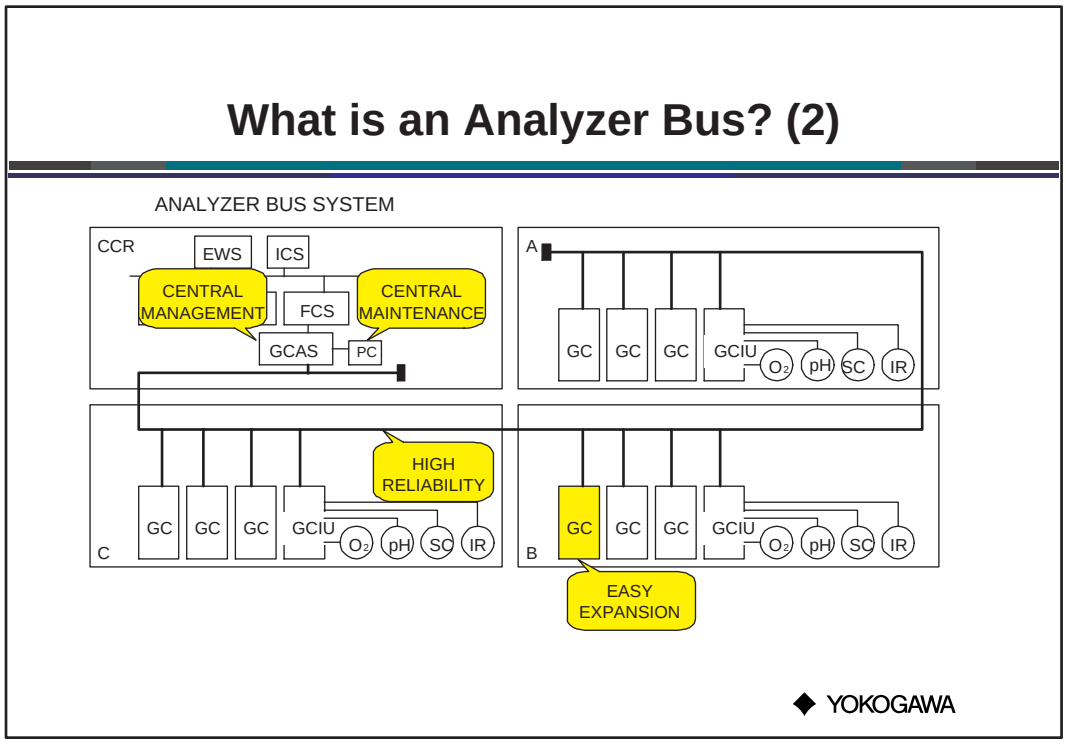
This shows an example of a conventional system of networking a DCS with numerous analyzers installed in a process. As shown in the diagram, it was necessary to connect DCSs to individual analyzers, which meant that the expenditure on cables, I/O cards for DCSs, and installation work became tremendous.

Furthermore, the probability of failure increases as linking becomes more complicated, and identifying the cause of any failure that occurs also becomes more difficult.

In addition, maintenance work for analyzers requires service personnel to visit user sites.



This shows an example of the connections using an analyzer bus system.

As all analyzers are connected to a network, the cost of cables and I/O cards for DCSs is reduced. Furthermore, it is very easy to add on systems later.

As the network and the analyzer server can be duplicated, reliability is drastically improved compared with that of individual wiring.

Centralized control of analyzer conditions is also possible because you can get maintenance data for all analyzers from the analyzer server installed in the CCR.

Purpose of Analyzer Bus System

- Centralized management of analyzers
- To maintain optimum conditions & accuracy
- Gateway to DCS (process control system)
- High reliability
- Easy expansion
- Save on maintenance & construction costs

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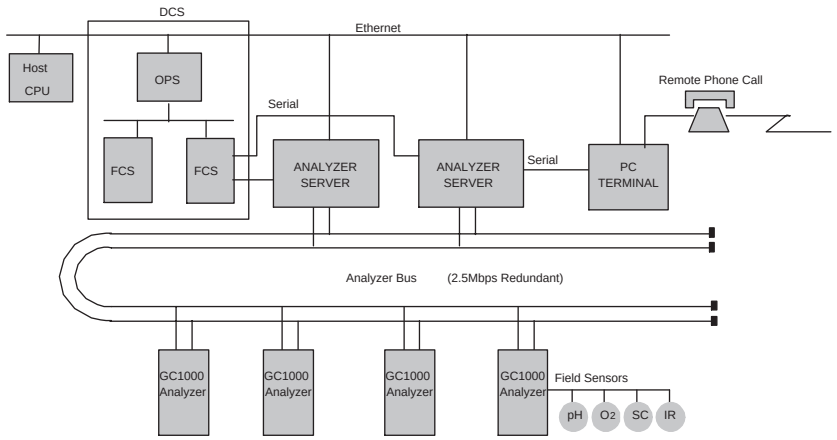
Analyzer Bus System Configuration



This shows the conceptual diagram for the analyzer bus system configuration.

All of the field analyzers including the GC1000 are connected along a network.

The central analyzer servers manage the entire network. A personal computer connected to an analyzer server, functions as a maintenance terminal for status displays and the operation of all field analyzers.

Analyzer servers are connected to the DCS via serial communications or analog and contact signals. Data can be exchanged with other networks on this Ethernet line. For this protocol, we adopted the TCP/IP standard protocol.

Analyzer Bus System Components

- Analyzer Bus Network
- GCAS (Analyzer Server)
- GCHUB (Analyzer Bus Hub)
- GC1000 (Gas Chromatograph)
- GCIU (Field Interface Unit)
- GCCU (Computing Unit)
- ASMT (AS Maintenance Terminal)

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The components of the analyzer bus system are as shown.

Features of Analyzer Bus

- High Speed :2.5 Mbps
- Wide Coverage :6 Km (Cable + Hub)
- Large Capacity :240 analyzers, 14 servers
- High Reliability :Fully Redundant
- Safety :Explosion proof
- Real time :Token passing protocol
- Toughness :16V p-p signal level

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As the features of the analyzer bus network indicate, the analyzer bus system has the most suitable conditions to function as a network system for processes.

- High speed performance of 2.5 Mbps
- A network distance that covers a wide area of up to 6 km.
- Able to connect up to 240 analyzers and up to 14 analyzer servers.
- Full duplication ensures high reliability.
- Explosion protection is provided.
- Real-time operation is assured by the token passing communication protocol.
- Noise immunity is achieved by high signal level.

Analyzer Bus vs Ethernet

	Analyzer Bus	Ethernet
Environment	Process	Office
Signal level	16 Vp-p	1.8 Vp-p
Speed	2.5 Mbps	10 Mbps
Protocol	Token passing	CSMA/CD
Real time	Yes	No
Data loss	Never	Possible

*CSMA/CD:Carrier Sense Multiple Access with Collision Detection

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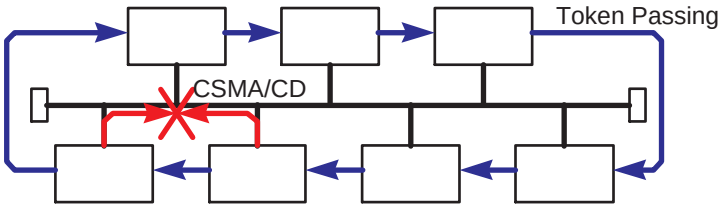
Let’s compare the analyzer bus network for processes with the Ethernet network for offices.

The analyzer bus enables stable communication in fields with a great deal of noise, as the signal level is 16 V. The token passing communication protocol guarantees the maximum transmission time for communication, which means that there is no data loss caused by data collisions during transmission. These factors show that the network is most suitable as a real-time system.

The Ethernet, on the other hand, is a network suitable for high-speed transfers of large amounts of data.

Token Passing vs CSMA/CD



- Advantages of Token Passing
  - » No data collision (HIGH RELIABILITY)
  - » Guarantees maximum transfer time (REAL-TIME)
- Advantages of CSMA/CD
  - » High-speed transfer for large amounts of data

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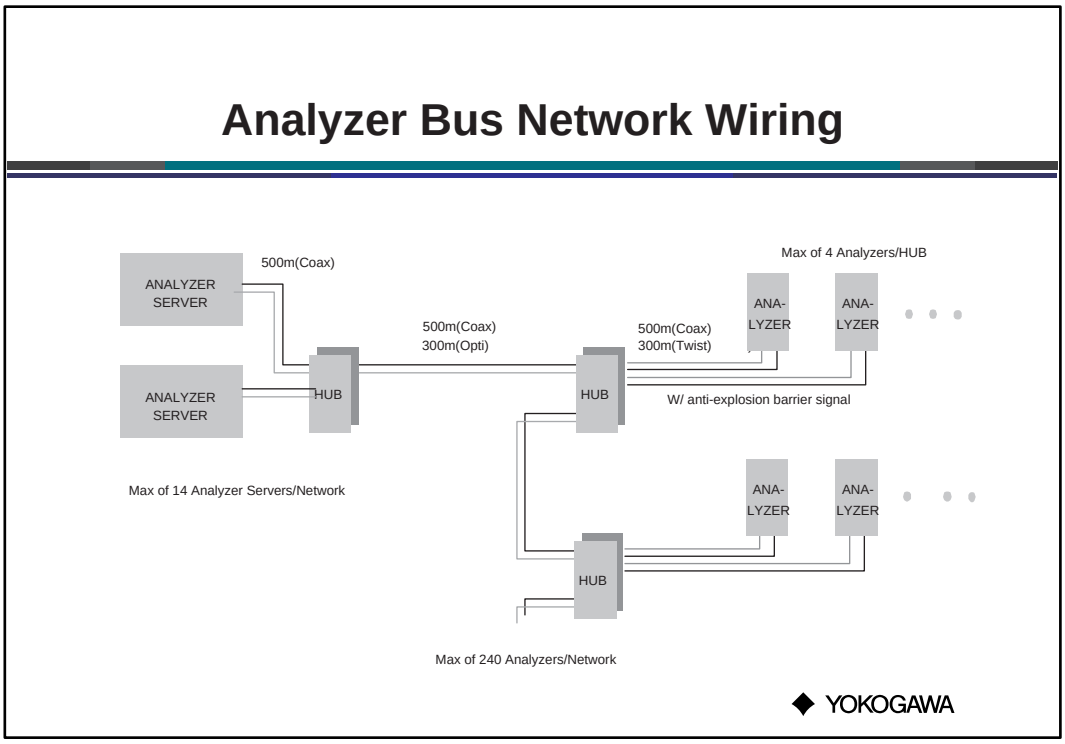
This diagram highlights the differences between the transfer system of the analyzer bus and that of the Ethernet.

Token passing protocol in the analyzer bus has all nodes on the network transfer each token in turn. Since only the node having the token transmits data, collisions of data in communication do not basically occur.

Because the size of communication to be transmitted at one time is determined, the maximum transfer time for token circulation is assured. That is, transmission is definitely completed within a certain period, and real-time communication is assured.

In the CSMA/CD protocol, each node starts communication freely unless the system is communicating on the network. If there are two or more nodes to be communicated with, data collisions necessarily occur. When data collide, the node concerned does not start communicating again until after a certain time. If collision cannot finally be avoided, the communication data is lost.

Thus, communication transfer to a second party within a certain time without fail is not assured.



This display shows the network wiring.

The main line of the analyzer bus uses coaxial cables or optical fiber cables.

Distributors that send out information from the analyzers or analyzer servers onto the main line of the network are called “hubs.” One hub can connect up to four analyzers or two analyzer servers.

In a duplicated network, an analyzer and an analyzer server have connection terminals for two channels and are connected to two sets of hubs and network cables independent to each other.

A hub contains an explosion protection mechanism for the entire network. This mechanism shuts off the communication lines if an analyzer’s explosion protection is lost due to a drop in air supply or power supply.

Analyzer Server (GCAS)

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This is an external view of the analyzer bus server.

Features of Analyzer Server (GCAS)

- High Reliability :VME-based real-time system
- DCS Gateway :Two ports RS-232C (Modbus/Yokogawa)
- LAN Gateway :Ethernet (telnet/ftp)
- PC Connection :Ethernet & RS-232C
- Data Storage :Analysis data, Chromatogram, Calibration, Alarm
- ANABUS Watching :Node, Channel, Message
- Remote Maintenance :By PC via phone line

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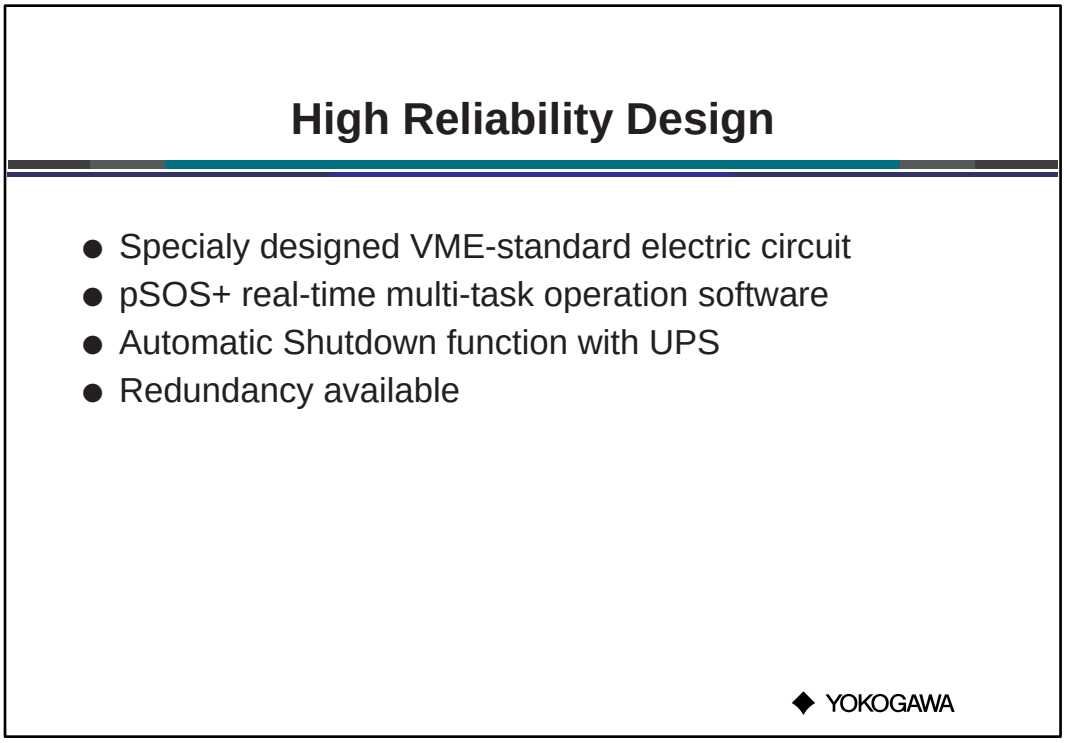
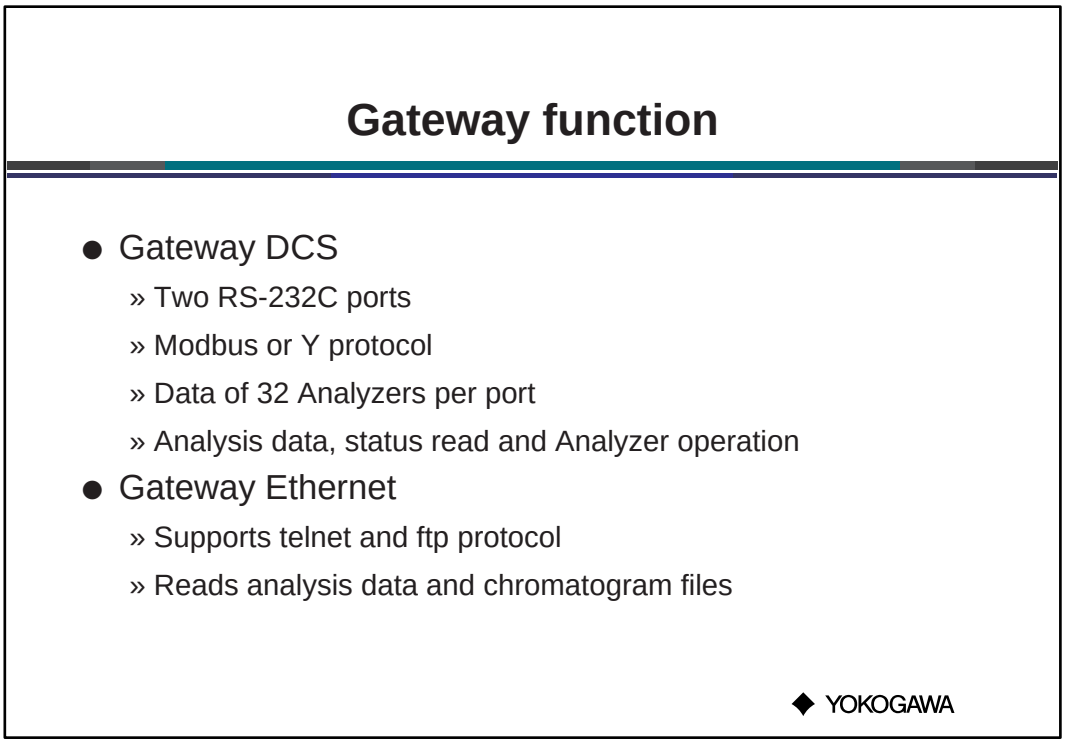
The features of the analyzer server are as follows:

- The analyzer server ensures high reliability by adopting VME bus boards, the industry standard in real time systems.
- The server has two RS-232C ports for DCS connection. It supports both the Modbus protocol and Yokogawa's own protocol.
- The server has an Ethernet port for LAN connection and supports "telnet" and "ftp" protocols.
- The server is connected to a personal computer via an RS-232C interface and an Ethernet port.
- The results of analyses, chromatograms, calibration data, and alarms are stored in history.
- The server acts as an analyzer bus monitoring function, by monitoring the node conditions in each channel on the network and sending messages.
- Remote maintenance is available, whereby analyzers located in the field are directly operated from Yokogawa via telephone lines and a PC modem.



The analyzer server is primarily designed to achieve high reliability.

- The analyzer server employs VME bus boards, the industrial standard for real-time systems.
- For software, it uses pSOS+, the industrial standard for real-time multi-task operation systems.
- Combined with an uninterruptible power supply, it can carry out automatic shutdown of hard disk files.
- The analyzer server itself can be made redundant by duplication.



The functions of remote connection of the analyzer server can be summarized as follows:

- Gateway DCS
  The server supports two RS-232C ports and, allows either the Modbus protocol or the Yokogawa-dedicated protocol to be selected as the communication system. The analysis results and analyzer conditions for up to 32 analyzers can be read and operated by one port.
- Gateway LAN
  Since the server supports the “telnet” protocol for console functions and the “ftp” protocol for file transfers, it can read the results of analyses and chromatograms from the file.

Accessible Analyzers

No. of Analyzers	=>32	=>64	=>240
Analysis data	YES	YES	YES
Alarm message	YES	YES	YES
Analyzer operation	YES	YES	YES
Chromatogram	YES	31	31
PC maintenance	YES	31	31
LCD maintenance	1	1	1
Time Synchronization	YES	YES	YES

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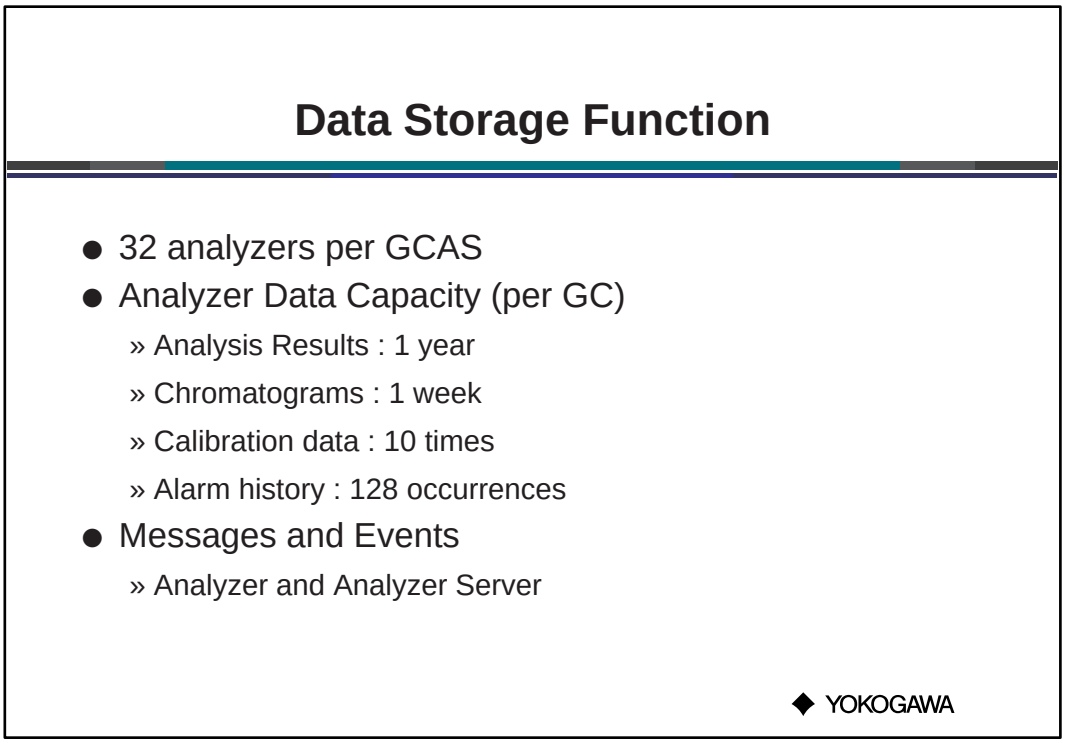
The display and operating functions of the analyzer server vary with the number of analyzers connected.

All of the display and operating functions are available if the number of analyzers connected to each analyzer server is less than 32. If the number of analyzers is 32 or more, the results of analyses and alarm message displays for all analyzers can be obtained, but chromatogram displays and analyzer operations from a personal computer are only available for up to 31 analyzers.



Data storage function of analyzer server

The analyzer server stores data of up to 32 analyzers. The server storage capacity per analyzer is:

Analysis Results: for one year

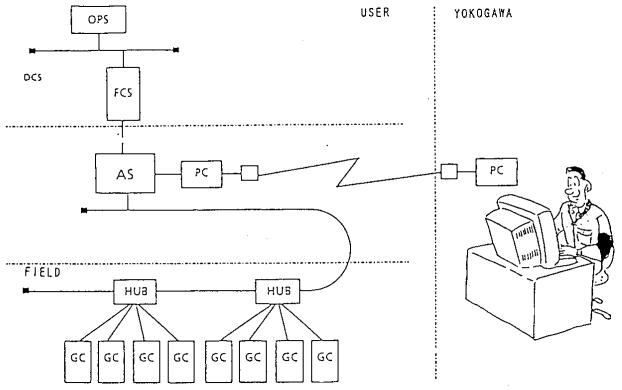
Chromatograms: for one week

Calibration data: for ten calibrations

Alarm history: for 128 alarm occurrences

In addition, the messages and events of analyzers and analyzer servers can be stored.

Remote Maintenance Concept



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The analyzer server supports remote maintenance functions.

The analyzer server can perform remote maintenance via a personal computer terminal. The conditions of all analyzers in the analyzer bus system can be known and operated from a remote place via a modem and public telephone network.

HUB (GCHUB)

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This is an external view of a hub (GCHUB). It is enclosed in a flameproof case.

Features of Hub (GCHUB)

- Main line connection : Coaxial cable
- Branch connections :4 Twisted pair cables, 2 OR Coaxial calbles
- Bus type :for daisy chain connection
- Repeater type :for loop connection
- Optical Fiber :Extendable to a maximum of 3000m
- Safety :Pressure-resistant construction, node's explosion-proof interlock

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There are two types of hubs: one that connects four channels to an analyzer by twisted pair cables and another that connects two channels to an analyzer server by coaxial cables. The hub for 4-channel twisted-pair cables can be either the bus-type hub for daisy chain connection or the repeater-type hub that incorporates an amplifier for loop connection.

Daisy chain connection is mainly used for small-scale systems and loop connection for large-scale systems.

Another feature of the hub is its safety. The hub itself is contained in a flameproof case. In this case, an interlock circuit is incorporated. If explosion protection is lost due to a drop in the air supply or power supply for the analyzer bus, the interlock circuit maintains the explosion protection of the entire network by receiving the air or power supply drop signal and immediately cutting off the communication line.

Network Design Principle

- Loop network for large system
  - » Use Repeater or Optical-Fiber type HUBs
  - » Total network length < 6,000m
  - » Length(m)=Main loop + Longest branch + Second longest branch + (No.of HUBs)*60
- Daisy Chain network for small system
  - » Use Bus type HUBs
  - » No. of HUBs < 8
  - » Main line length < 200m

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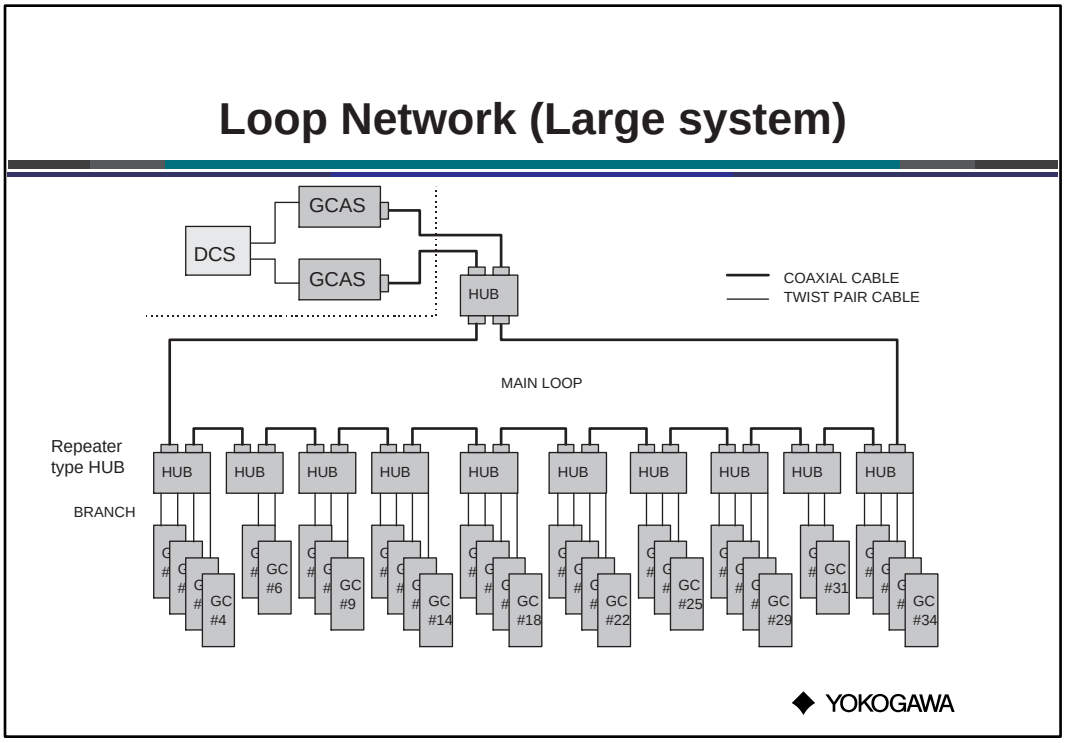
There are two analyzer bus design principles depending on the scale of the system.

1. Construct loop networks for large-scale systems.

- On the loop network, communication between all nodes continues even if one part of the network is disconnected.
- Use the repeater type hub or the optical-fiber type hub.
- The maximum length of the network is 6,000 m.
- Determine the network length by taking the sum of the main loop length, the two longest branch line lengths, and the product of the number of hubs and the hub length of 60 m.

2. Construct daisy chain networks for small-scale systems.

- Use bus type hubs. The bus type hub allows the main line communication to continue even if the power supply to the hub itself drops.
- Up to eight hubs can be connected.
- The maximum length of the main line is 200 m.

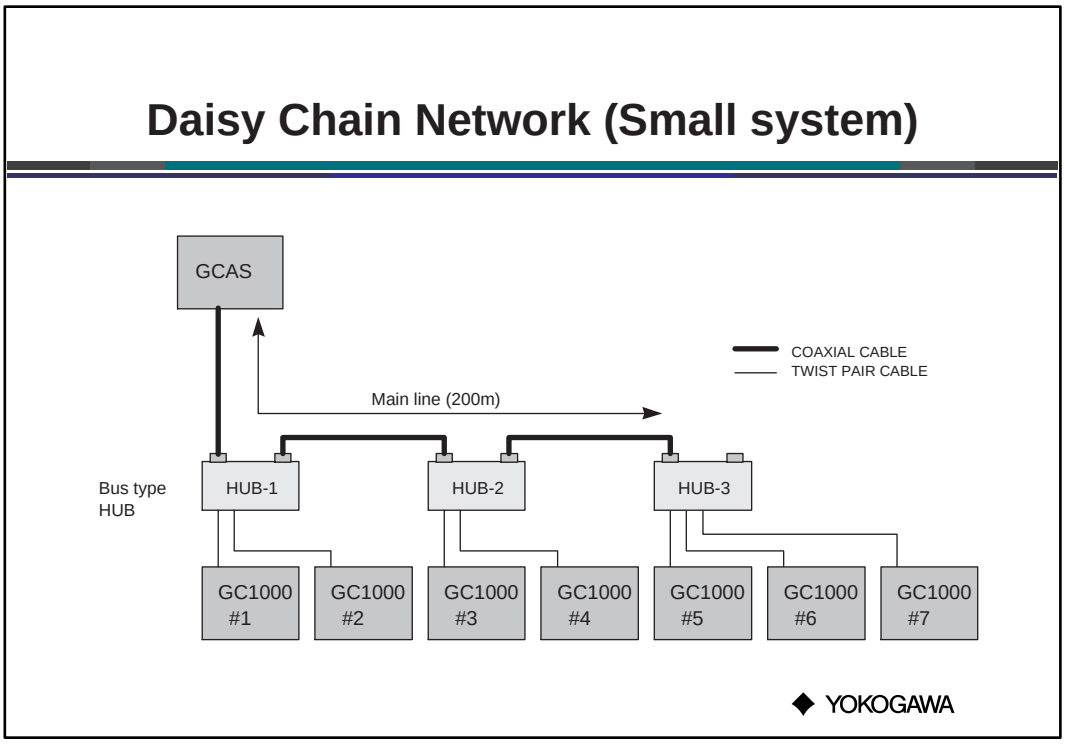


This is an example of a loop network configuration in a large-scale system.

In this case, 34 analyzers are connected to the network which is duplicated and includes analyzer bus servers. This figure does not show the duplication of the system because the number of analyzers is too high, but the system is actually a duplex system.

Construct a loop network for a large-scale system.

In the loop network, communication between all nodes can continue even if one part of the network is disconnected.



This is an example of a daisy chain network configuration in a small-scale system.

Seven analyzers are connected to an analyzer bus server.

The bus type hub continues the main line communication even if the power supply to the hub itself is cut.

Field Interface Unit (GCIU)

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This is an external view of the field interface unit (GCIU).

It is housed in an enclosure conforming to Y purge in the FM explosion-protection standard.

Features of Interface Unit (GCIU)

- Analog Input :16 channel (1-5V / 4-20mA / 4-20mA with power selectable)
- Input Rate :1sec (refresh), 60sec (average)
- Contact Inputs :16 points (dry contact)
- Contact Outputs :16 points (general purpose)
- C/O Operations :Remote/Program/Manual
- Alarm Outputs :2 (System alarm, pressure low)
- Analyzer Bus :2 channels
- Safety :Pressure-resistance construction

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Specifications of the field interface unit are as follows:

- Analog input consists of 16 channels. You can select the type of channel input as either 1 to 5 V, 4 to 20 mA without power supply, or 4 to 20 mA with power supply.
- The analog-input acquisition rate is 1 second updating (instantaneous value). These values are updated every 60 seconds (average value) to obtain an analysis value.
- Contact input consists of 16 points. These are dry contacts.
- Contact output consists of 16 points.
- There are three methods of operating contact output. These include remote operation from a DCS, programmed operation by the timer, and manual operation from a personal computer.
- There are two alarm outputs—a system alarm and a low pressure alarm.
- Analyzer bus connection
- Safety is achieved by housing the unit in an enclosure conforming to Y purge in the FM explosion-protection standard.

Similarity of GC1000 and GCIU

	GC1000	GCIU
Instant value	Chromatogram	Instant value
Average	Analysis data	Average value
DCS com.	Modbus & Yokogawa	Modbus
Modbus read	Analysis data	Instant & Average
Modbus write	Operation	Contact Output

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This display presents the similarity between analog values of the field interface unit and analyzer data.

Instantaneous values are represented in a chromatogram of the analyzer. Average values are used as the value analyzed by the analyzer.

DCS communication supports Modbus. The interface unit can read instantaneous and average values from Modbus and operate contact outputs.

Required PC Specifications

- HARDWARE
  - » IBM-compatible PC
  - » CPU : Pentium-100MHz or more
  - » Memory : 32Mb or more
  - » Hard Disk space : 20Mb
  - » CRT : SVGA(1024*768)
  - » Serial port & Ethernet adapter
- SOFTWARE
  - » MS-Windows95 or NT4.0

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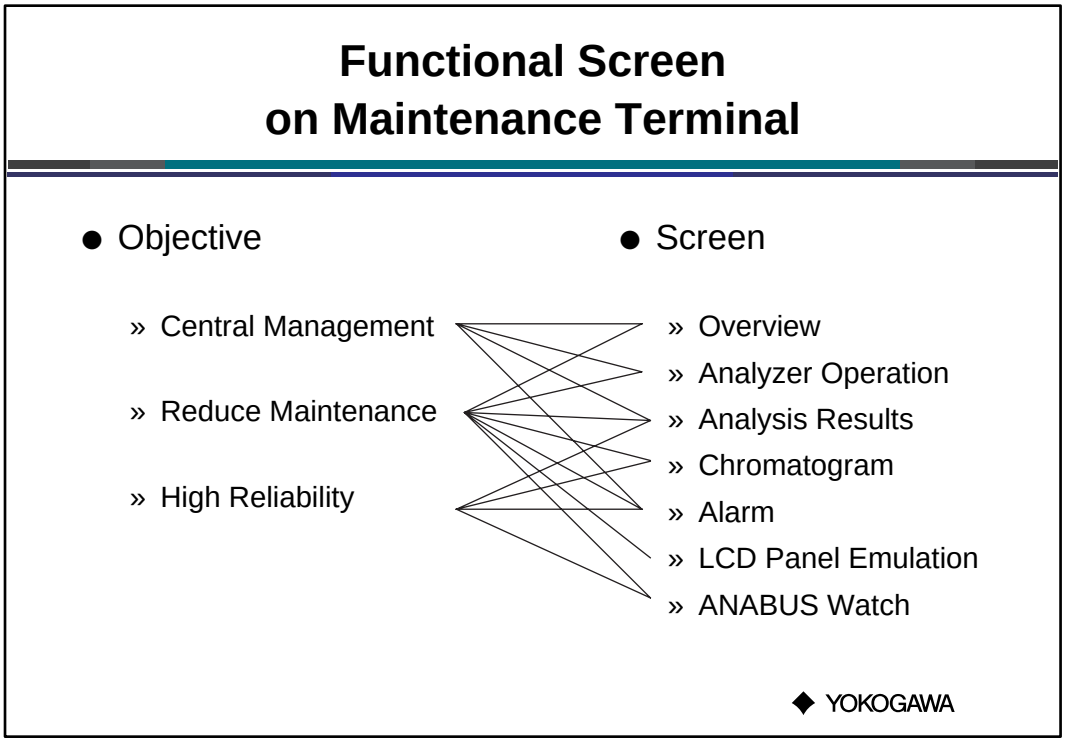
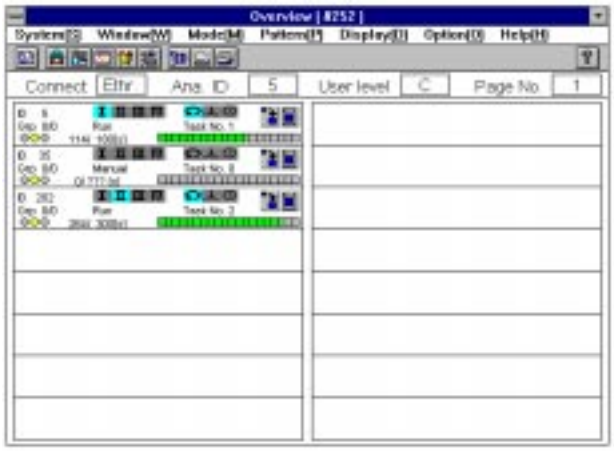
The specifications required in order to use a personal computer (PC) as a maintenance terminal are:

- General-purpose specifications for hardware of an IBM-compatible PC (serial port and Ethernet adapter are necessary); and
- Windows95 or WindowsNT as the software environment.



The PC maintenance terminal is provided with screens suitable for achieving the objectives of central management of maintenance, improvement of maintenance efficiency (reducing maintenance), and high reliability for the analyzer bus system.

Overview Screen



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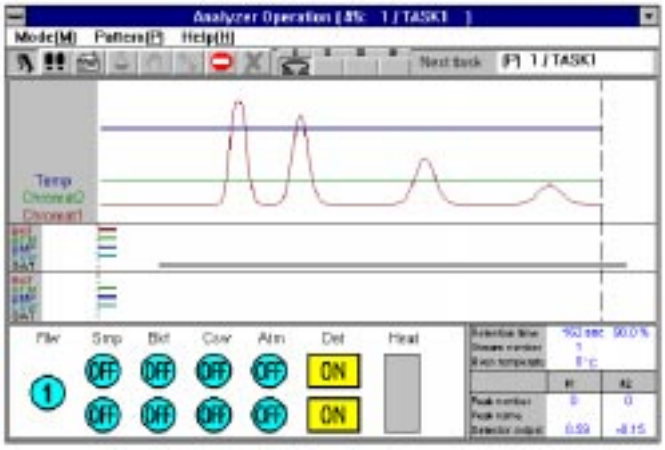
This is the overview screen.

You can know at a glance what type of condition the connected analyzers are in, that is, whether the analyzers have stopped in failure or are operating without problems.

One frame represents one analyzer. In the upper center part of a frame, the operation pattern is shown representing the state of the analyzer, such as during process measurement or during calibration. The bar graph in the lower right part of a frame indicates the measurement cycle and becomes a monitor showing the time left to complete the analysis period.

The screens that will be explained next all start from this screen.

Analyzer Operation Screen



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This is the analyzer operation screen.

The operating condition of an individual analyzer are displayed on this screen. A real-time chromatogram is displayed in the upper half of the screen and valve sequences, such as sampling, back flush, column switching, and atmospheric pressure balancing valves, and gating times for peaks are displayed as bar graphs under the chromatogram. It is easy to gain an intuitive understanding of column systems from the display of the column valves and their corresponding condition in this part, along with the real-time chromatogram. More detailed information on the state of detectors and thermostatic ovens can be obtained by clicking on this part.

You can directly switch the analyzer operation mode and pattern from this screen. You can also send such commands as calibration, stream change, analysis start/stop, or forced shutdown.

Analysis Results Screen

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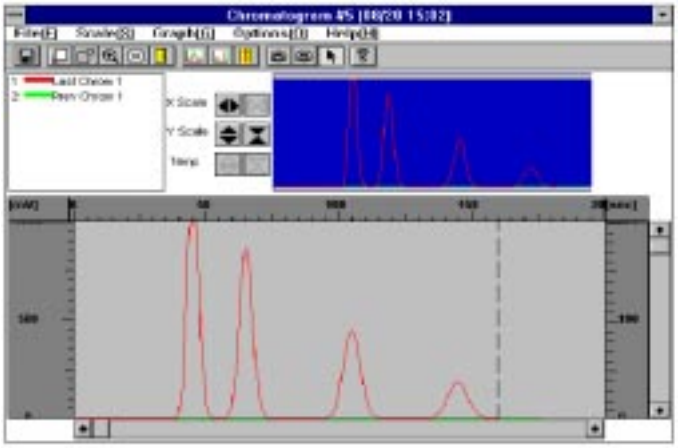
The results of analysis are automatically displayed on the PC screen after being arranged in the table format. As shown in this example, not only simple analysis results but also column management data, such as retention time (RT), resolution, and tailing coefficient, can be displayed and stored together. Graphs of concentration and RT can also be obtained by a single button operation from this table. In addition, this data file can be easily converted to Lotus123 or Excel.

Chromatogram Screen



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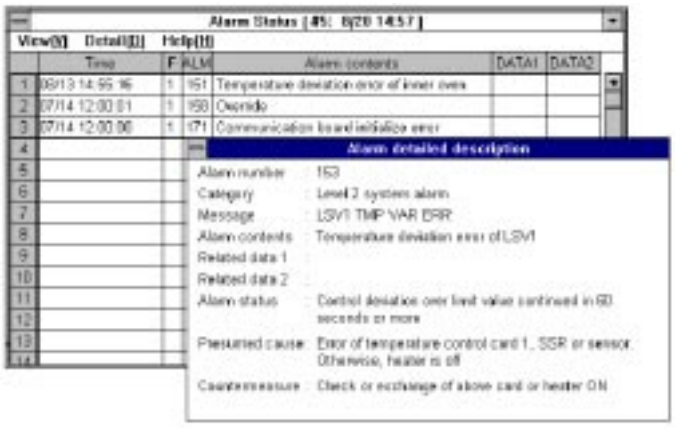
This is the chromatogram screen.

This screen is called up by a command from the preceding operation screen. On this screen, chromatograms and their storage capacity can be expanded and contracted, and comparisons and referencing can be made between stored chromatograms or between a stored chromatogram and the current chromatogram. The most convenient feature is the ability to observe chromatograms at the same time by overlapping them. For example, if a chromatogram of a standard sample taken one year ago is overlapped with the results of the current calibration of that sample, the change in a column over time or the change in the standard sample composition itself should be quite obvious. It is also easy to check whether unclear components that are not normally present are contained in the process sample, by comparing the process sample with the standard sample.

Alarm Screen



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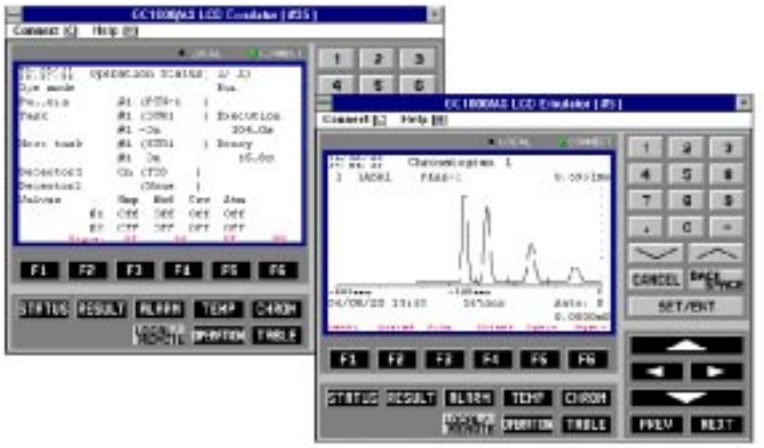
The alarm status screen announces that an alarm has been issued when an alarm occurs. The alarm status or history for each analyzer is displayed as a batch display. Also, the details of the alarm, the presumed causes and the countermeasures are displayed as a guidance function for maintenance personnel, by opening the detailed description screen. While this function only gives a general direction, we believe that this guidance of maintenance methods for maintenance personnel, is of great significance.

LCD Panel Emulator Screen



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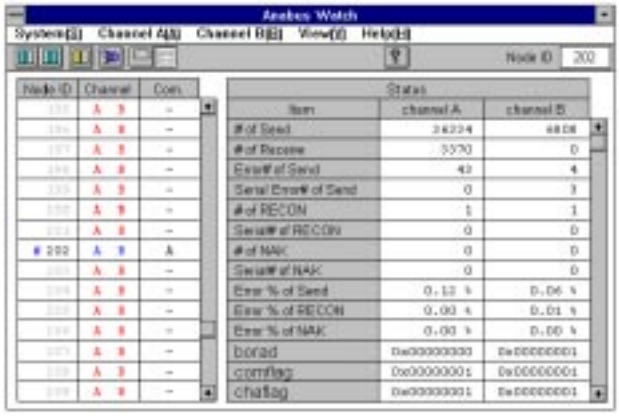
Use this LCD emulator screen if you need to change the detailed parameters of the analyzer. This is entirely the same as the LCD operating screen located on the front panel of the analyzer and the LCD emulator screen displayed on the personal computer located a few kilometers away. The analyzer can be remotely operated from the personal computer in exactly the same way as it is operated directly. Like the analyzer, this LCD emulator screen displays chromatograms and a status data in real time.

ANABUS Watch Screen



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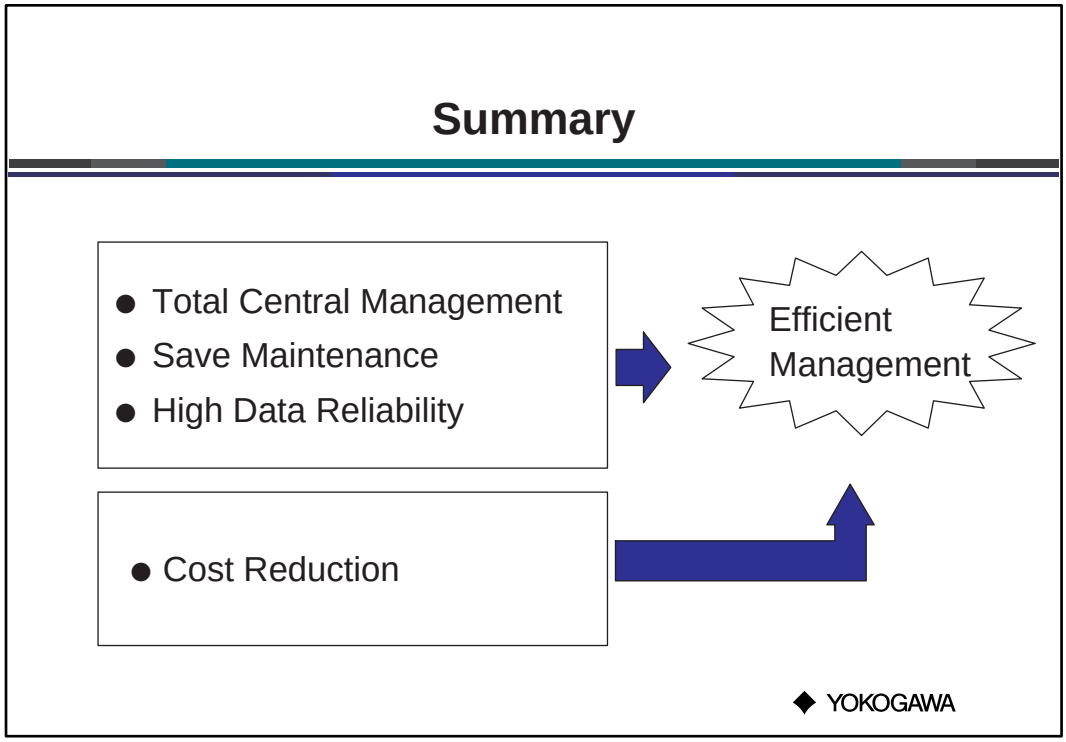
This screen is for monitoring the status of the analyzer bus. This part shows each analyzer and through which channel, A or B, the analyzer's data were communicated.



The analyzer bus system of Yokogawa Electric realizes efficient analyzer management by performing centralized maintenance of process analyzers, reducing the amount of time required for maintenance, providing high reliability, and saving on maintenance and work costs.