Motor Exhaust Gas Analyzer MEXA-7000 Series
3. Data Processing System and Communications Line

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<Abstract>

On this motor exhaust gas analyzer, computation of measurement data and control of the entire measurement system is managed centrally by a main control unit (MCU) mounted on a general-purpose personal computer featuring a touch panel type GUI (Graphical Users Interface). Also, communication between the MCU and peripheral modules, and the MCU and a host computer is carried out over a LAN (Local Area Network). This allows user-friendly and highly flexible automotive emission gas analyzers to be built. This paper describes the data processing system and communications line of the MEXA-7000 series.

1. Introduction

Development of the MEXA-7000 series began with the intention of building an exhaust gas analyzing system capable of flexibly responding to a wide variety of market needs. To achieve this, the data processing system and communications line also had to be highly flexible and easy to operate. This was the reason behind our introduction of a local area network (LAN) and adoption of the RS-485 communication line, as well as the adoption of a personal computer as the main controller (MCU) for integrated data management.

2. Configuration of Communications Line

Figure 1 shows the configuration of the communications line of the MEXA-7000 series. The main controller (MCU), for integrating and controlling the entire analyzing system, and the interface controller (IFC), for converting data transferred between system modules, are connected by a LAN (10Base2, thin wire coaxial cable). Two or more IFCs can be connected on the communications line. A general-purpose LAN conforming to IEEE standard 802.3 (ISO 8802/3) is used for connecting IFCs. Table 1 shows the communications line specifications.
The IFC and analyzers are connected by a special-purpose digital bus (AZ-BUS, 37-pin D-Sub connector). A maximum of five analyzers can be mounted on a single analyzer rack (ANR). As two ANRs can be connected to each IFC, a total of ten analyzers can be connected to a single IFC. A 24-bit A/D converter (ADC) is

Type	Communications Speed	Cable Length	Topology	Number of Connected Units
GPIB	1Mbps	4m	Bus	15
RS-232C	20 kbps	15m	Point-to-point	1
RS-422	10 Mbps	120m (at 1 Mbps)	Point-to-point	1
RS-485	10 Mbps	120m (at 1 Mbps)	Bus	32
10BASE5	10 Mbps	500m	Bus	100
10BASE2	10 Mbps	185m	Bus	30
10BASE-T	10 Mbps	100m	Star (bus)	10 units max. connectable to hub

Table 1 Communications line specifications

incorporated into each analyzer, and analyzer signals are handled by the IFC via the AZ-BUS.

The IFC, solenoid valve unit (SVS), sampling unit (SHS), span gas selector (SGS) and temperature control system (TCS) are connected by an RS-485 cable. Each of the IFCs have two RS-485 connectors. A maximum of five units can be connected to the No.1 connector, while a maximum of eight units can be connected to the No.2 connector. The communications speed of the RS-485 interface is set to 19,200 bps, while the cable length of 120 m is sufficient for handling data communications over the entire system layout. The standard IFC supports the RS-232C interface, while GPIB interface functions are optional.

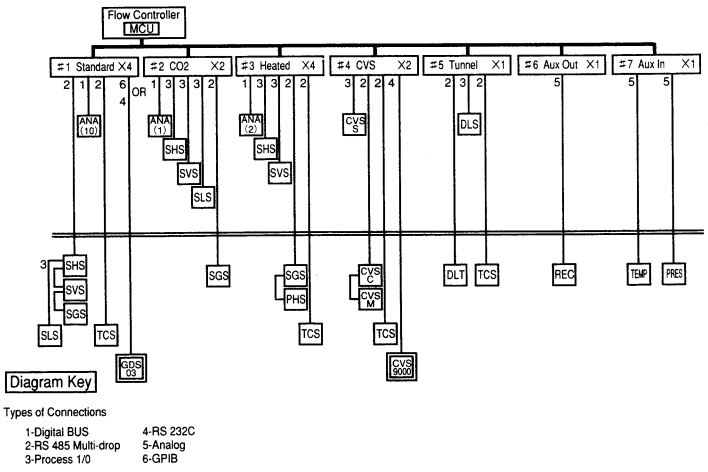

Fig. 1 MEXA-7000 series communications

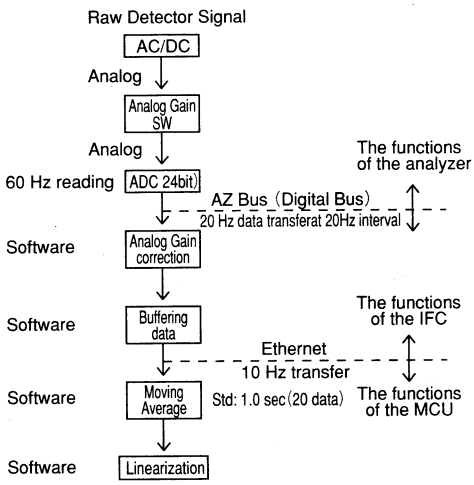

Fig. 2 Signal processing flow of analysis data

3. Data Processing Procedure

Fig.2 shows the signal processing flow of analysis data.

In a standard system, the IFC reads output signals from the analyzer every 50 ms, compensates the amplification factor of the analog signals, and sends two sets of signals to the MCU over the LAN every 100 ms as a single data packet. In limited option MEXA-7100 series products, output signals from the analyzer are read every 25 ms, and four sets of signals are sent to the MCU every 100 ms as a single data packet.

At the MCU, noise reduction processing using the moving average method is carried out on the output values from the analyzers received from the IFC. After undergoing zero and span calibration, and linearity compensation, the concentration values are calculated in ppm and vol% units.

These calculations are carried out in parallel for each of the gas components. The analog output signals for the concentrations are sent from the MCU to an IFC supporting an D/A conversion function (DAC) via the LAN.

Control signals are sent from the MCU to the IFC over the LAN by TCP/IP (Transmission Control Protocol/Internal Protocol) .By TCP/IP, acknowledgment signals for checking whether or not signals have been reliably received are returned internally, and automatically re-sent in the event of communications trouble.

4. MCU Configuration and Functions

The MCU is an important controller as it controls calculation of measurement data and the system. The MCU personal computer is compatible with IBM and other general-purpose personal computers so that maintenance can be carried out anywhere in the world. Real-time UNIX is built-in as the operating system (OS). This OS is used primarily because it supports simultaneous processing of large-load processes, and standard, powerful LAN communications over an internal communications bus.

The MCU centrally controls processing of analyzer calculations and coefficient data. The strong point of the MCU is that additional data processing such as compensation of interference between gas components, pressure compensation and temperature compensation can be easily added on. Important coefficient data not only is saved to the MCU's hard disk, it is also saved simultaneously to the analyzer's EEPROM. In this way, when the analyzer is replaced, the user can select which of the MCU data or the EEPROM data can be used.

Figure 3 shows the maintenance screen of the analysis unit. This screen displays in real time information needed for maintaining the analyzer. The trend chart display function (optional) is an effective function that allows changes in concentration values to be displayed graphically in real time. This allows the operator to visually grasp time-based changes. Figure 4 shows an example of a trend chart.
The linearity check function has been greatly improved. The auxiliary functions of manual gas fractionators can now read signals from each of the fractionators when calibrating the linearity of the analyzer. If a HORIBA gas fractionator is connected, the linearity can automatically be checked. The capability to read fractionating point data in the low-concentration range to fractionating point data in other ranges was carried out to (i) improve the accuracy of linearity calibration in low-concentration ranges, and (ii) enable calculation of the linearity calibration coefficient for covering two or more ranges.

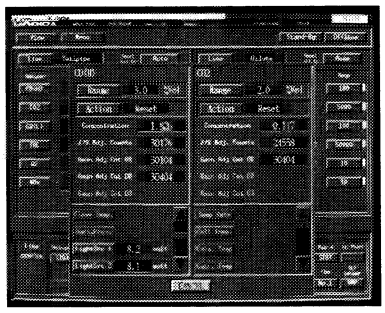

Fig. 3 Maintenance image for analysis unit

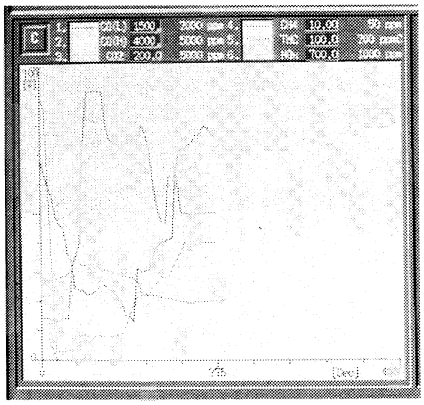

Fig. 4 Trend chart

The MCU controls not only the MEXA-7000 series but also peripherals such as the CVS.

A touch panel is used on a 17" color display screen (see Figure 5). A surface ultrasonic type analog detector used as the touch panel. This panel features strong resistance to static electricity and dust, outstanding endurance, and 16-stages of recognition also in the Z-axis. Mouse operation can also be selected. Also used is a screen incorporating a graphical users interface (GUI) that prevents eye strain over long periods of use.

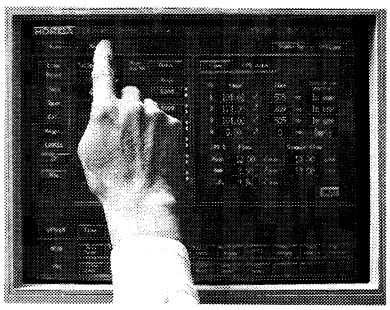

Fig. 5 Operating the system by the touch panel

5. Host Computer Online Compatibility

In the standard specification, a LAN is provided for connecting with a host computer. A LAN interface is used in consideration of requests for SCPI[*1] commands in the AIGER[*2] group and requests for RS-232C expandability from the German Automobile Measurement Standardization Committee (AK[*3]). LAN data must also be taken into consideration so that two or more gas lines in a more complex system can be controlled.

Just like the conventional MEXA-9000 series, a GPIB interface is also available. However, when using the GPIB interface, a maximum of four gas lines can be controlled. Currently, support of an AK protocol RS-23C interface is being promoted so as to build up a world-wide support system.

*1 SCPI
Standard Commands for Programmable Instruments

*2 AIGER
American Industry/Government Emissions Research group

*3 AK
Arbeitskreis

Kaoru OKADA

NM Project
Assistant Manager