UDC 681.323:62-523.658.7

APPLICATION OF PROGRAMMABLE CONTROLLER TO MATERIAL HANDLING SYSTEM

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1. FOREWORD

In the steady automation of factory production systems in recent years, there are material handling systems with individually automated robots, automated warehouses, etc., but the principle system is becoming a system which inter-connects and intraconnects processes by introducing automated guided vehicles and promotes FA of the entire factory coupled with a production control system.

The overall objective of application of the programmable controller which becomes the center of tis material handling system is describes and the functions demanded of the PC and its recommended usage method are introduced by taking several concrete example.

2. OVERALL OBJECTIVE OF APPLICATION OF PC

In the rapid growth of automation in all areas, even for PC introduced in a material handling system, the PC is not introduced as a single system, but is often introduced as a composite system connecting vertical and horizontal systems and PC with complete consistent product series, network, man-machine interface, etc. is demanded.

An outline of the general system configuration of a composite system, the functions of each level, and the flow of data between each level or between systems in the same level are shown in *Fig. 1*.

With this system, a material handling control computer which controls material handling in the factory is placed at a low level of the production control system which controls the entire factory and material handling divided by function or area are distributed under this computer.

The automated warehouse system, automated guided vehicle material flow system, and conveyor system are classical examples of material handling systems.

Regarding the automated warehouse system, not only large automated warehouses which store materials and finished goods, but also small high-speed automated warehouses as an intermediate buffer between processes are demanded.

As for the automated guided vehicle material flow system, the flexible features should be used for its layout and a more flexible movement system and a simplified ground facilities or overhead controller software and independent running, etc advanced running control system are demanded.

The conveyor system is a high material flow efficiency continuous material flow system as opposed to an automated guided vehicle intermittent material flow system. However, with the growth of multiproduct, small lot production in recent years, the rapid, positive, and cheap grasping and control of each object to be transported has become a big point.

The points demanded of the PC introduced in the system when following the trend of each material handling system above and building a composite system such as that shown in *Fig. 1* are described below.

(1) Building of optimum distributed control system

With a composite system, the following points must be considered and an optimum distributed control system built.

(a) Minimal effect when trouble occurs.
(b) Easy system modification and addition.
(c) High control performance at individual systems.
(d) High efficiency at system start-up and adjustment.

Therefore, to realize high efficiency and high quality linking between individual systems, a highly adjustable network is demanded.

(2) Hierarchical system and data centralization

To realize flexible data processing and control as a total system while performing distributed control and to make a system with good prospects and increase its trouble-shooting nature, a hierarchical system and data centralization must be realized. Even regarding this, connection of high level hierarchy or low level hierarchy by a highly adjustable network is demanded.

(3) Easy linking with each controller and each system

Linking with MC, NC and other machine tools, automated guided vehicle, automated warehouse stacker crane, robots, and other handling equipment, and bar code reader, mobile data storage system (*Fig. 2*), and other material flow ancillary I/O devices, must be easy. (Generally, RS-232-C is used.)

(4) Easy data handling

Fig. 1 Outline of general system in FA system

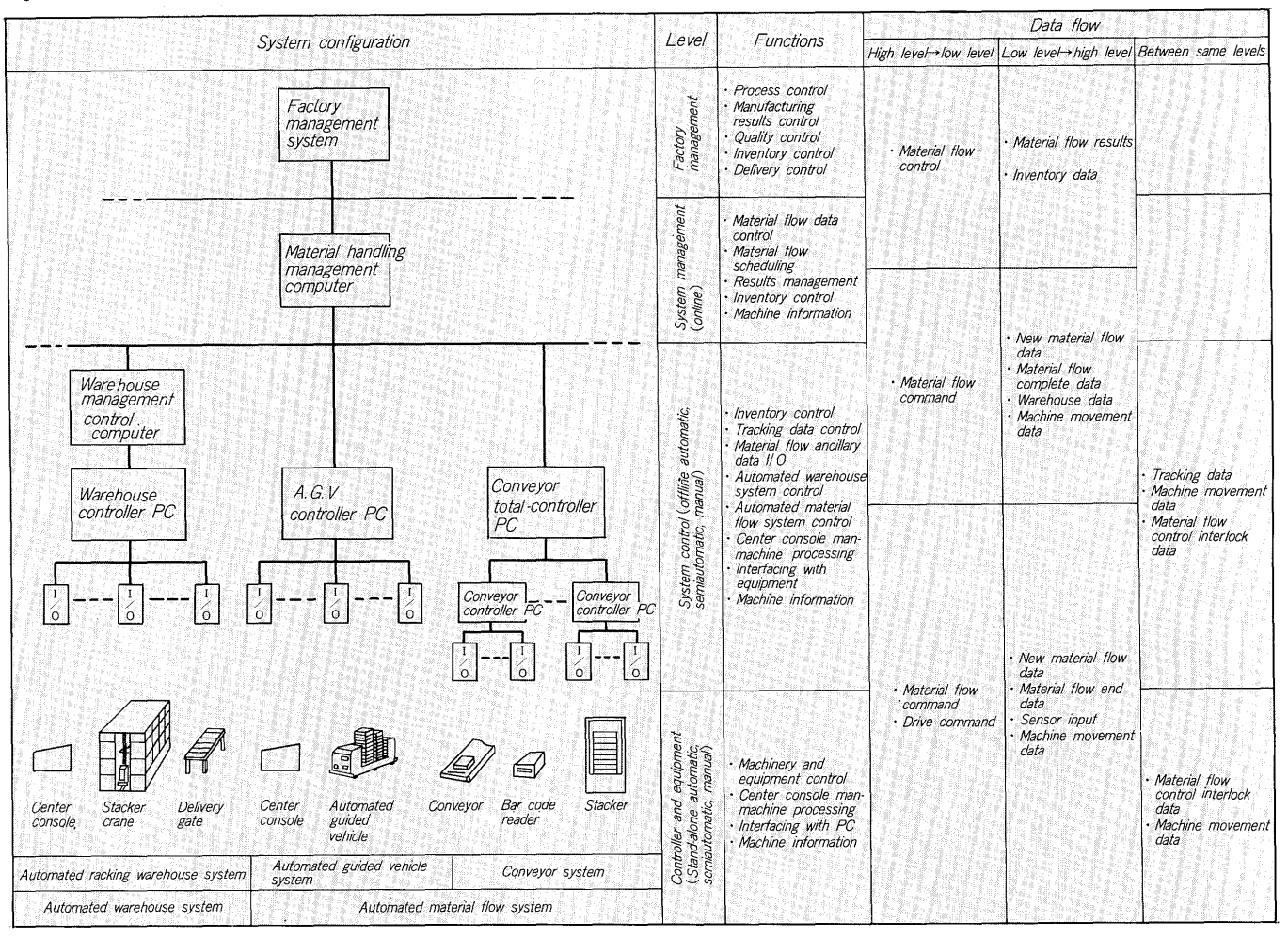
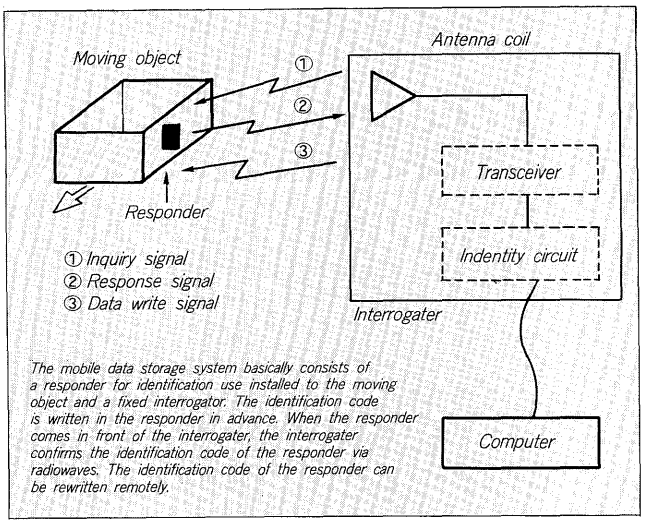


Fig. 2 Mobile data storage system



Tracking control at the local level of the material flow ancillary data to increase data control efficiency and improve reliability by matching the flow of material and data accompanying multiproduct, small lot production and control of the material flow reservation commands which are transmitted from a high level system or input from each center console at offline operation and other data handling are necessary. Therefore, work area and file area and other memory areas and command groups must be provided.

(5) High speed processing

The demand for higher speed at each material handling system mentioned above and the increase of data processing are accompanied by a demand for higher speed processing.

(6) Expandability

With a material handling system, there are more cases of gradual expansion or local modification than of building of an entire system at one time. Therefore, A product series and network which can easily meet this are demanded.

For the contents above, the Micrex-F, the Fuji Electric PC, is available in a consistent product series designated the F50, F80, F100, and F200. A easy and certain connection configuration between PCs or between Fuji Electric industrial microstation L25 and supermicrocomputer FASMIC G series is possible with the P-link (5Mpbs) and T-link (500kpbs) network (F-Net) as the medium.

I/O devices can be distributed with 16, 32, and 64 points digital I/O (DI/DO) card as the stand-alone or unit configuration. In addition, an interface capsule with built-in processor (independent synchronous system BSC or no

protocol) is available for communication by RS-232-C. A configuration which connects multiple units to the same PC and does not adversely affect the load of the PC itself is taken.

Examples of actual application of the MICREX-F to an automated warehouse system and an automated guided vehicle system are described.

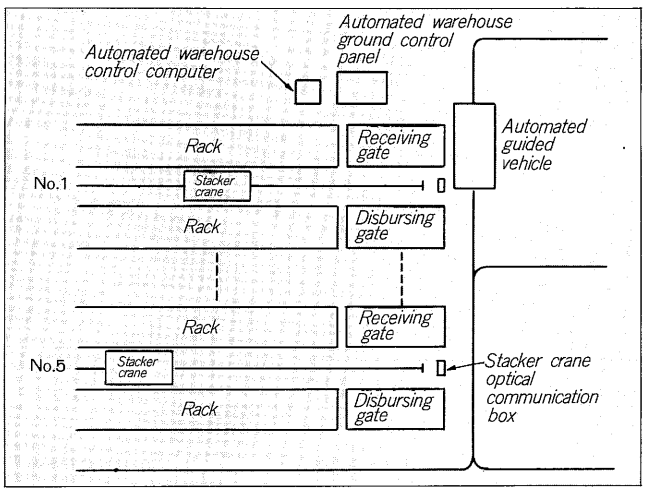
3. SPECIFIC EXAMPLES OF PC APPLICATION

3.1 Automated warehouse system

There are two kinds of automated warehouses: automated racking warehouse at which things are stored in fixed shelves and stock is received and disbursed by stacker crane and horizontal circulating type automated warehouse at which stock is received and disbursed by rotating the shelves themselves.

The example of the automated racking warehouse shown in *Fig. 3* is described here.

Fig. 3 Automated racking warehouse system layout



With this system, semifinished goods from the preceding process are temporarily stored in the warehouse via an automated guided vehicle and the semifinished goods are taken from the warehouse and sent to the next process by using the automated guided vehicle again in step with the advance of processing and assembly of the next process.

The system configuration is shown in *Fig. 4*.

As an general system, an L25 which controls everything and an L25 which controls the warehouse and a MICREX-F105 which controls the automated guide vehicles are linked and the overall material flow control is performed.

As an automated warehouse system, an automated warehouse control panel is installed under the automated warehouse control computer and grand-control of the automated warehouse is performed by the PC (MICREX-F205) in the panel.

The hardware configuration and functions of this MICREX-F205 are described below.

3.1.1 Hardware configuration

A center console to control the operation mode and to input commands at offline automatic and semiautomatic operation by stacker crane is installed in the ground control panels of the automated warehouse. A TU10 unit is housed in the ground control panel as the I/O device (PIO) for these.

Communication with the stacker cranes is performed via an optical conversion modem and the delivery gates are controlled directly by PIO. Wiring costs reduction, increased efficiency at debugging, etc. are considered, and an interface capsule (FK) and I/O capsule (TK10) are housed in the machine side box for each.

3.1.2 Functions

The functions are outlines in *Fig. 5*.

Usually, online commands are received from the auto-

Fig. 4 Automated racking warehous system configuration

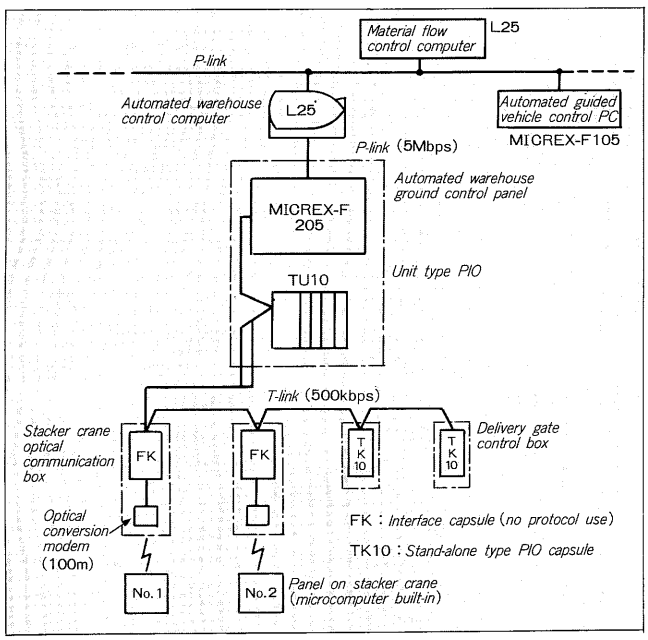


Fig. 5 Automated racking warehouse system functions

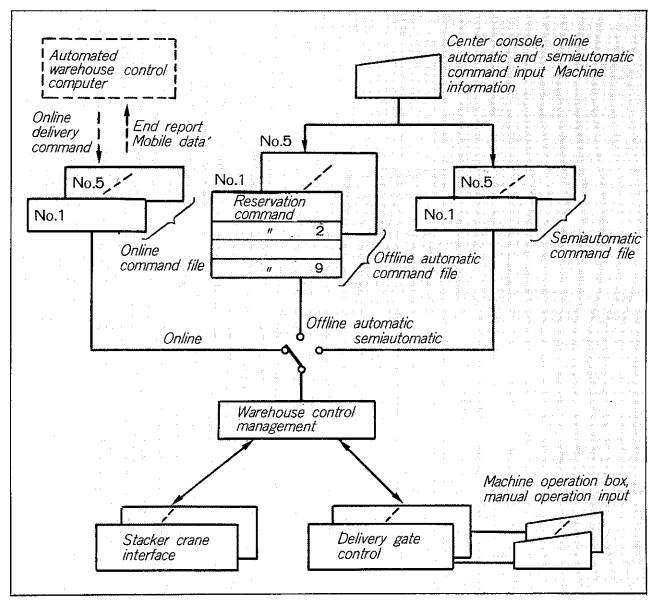


Fig. 6 Distribution center automated guided vehicle system layout

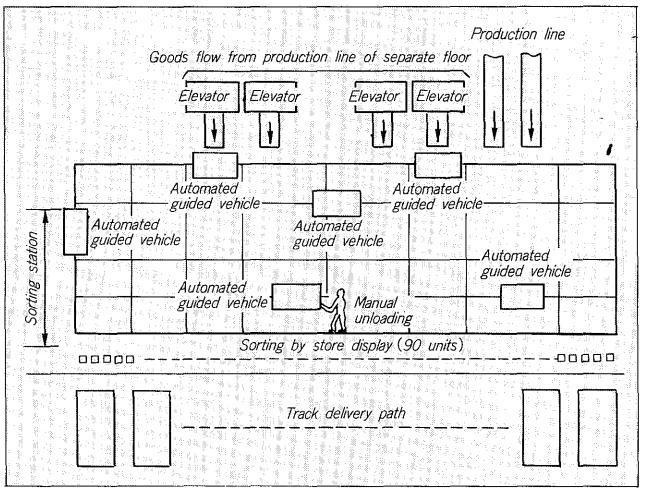
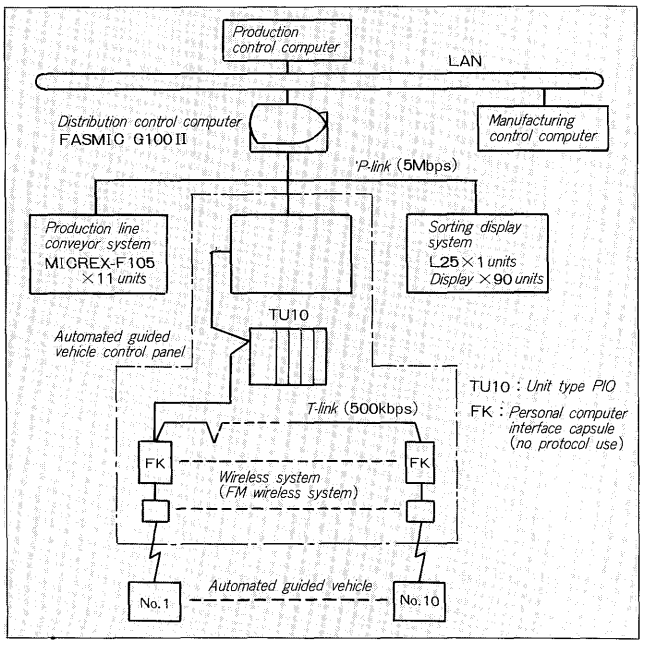


Fig. 7 Distribution center automated guided vehicle system configuration



mated werehouse control computer and receiving and disbursing are performed. However, an offline automatic mode is provided and up to nine delivery reservation commands can be input for each stacker.

A semiautomatic mode is also provided as an operation mode at abnormality recovery so that cyclic operation crane horizontal running, raising, lowering, and other discrete operations is performed from the ground control panel.

3.2 Automated guided vehicle system

An example of an automated guided vehicle system at a distribution center with a production line is shown in *Fig. 6* . The system configuration is shown in *Fig. 7*.

This system has the following features:

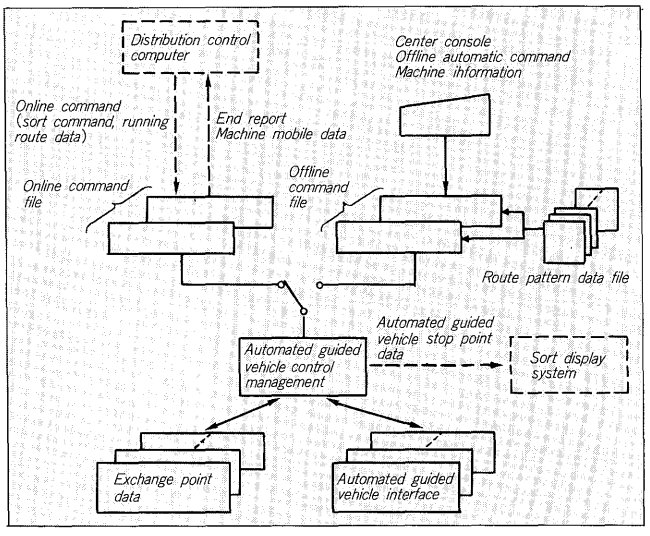
(1) To save space, the product storage area after sorting by store and the automated guide vehicle running area is shared. Therefore, the automated guided vehicle running route is shaped like a checkerboard and the route corresponding to the sorted amount is selected.

(2) The distribution control computer outputs sort commands and the running route data to the automated guided vehicles for each unit lot product flowing from the production line while comparing it them with the sorting station sorting record control data.

(3) Since unloading is performed manually at the sorting station, the automated guided vehicle control panel and sorting display system are linked and sorting orders are given to the sorters.

(4) Because the running route is complex, basic control of running is performed by writing small scale map data in the responder of the mobile data storage system and embedding this at the required places on the ground and reading its contents with the automated guided vehicle.

Fig. 8 Distribution center automated guided vehicle system functions



The hardware configuration and functions of the PC (MICREX-F205) in the automated guided vehicle control panel are described below.

3.2.1 Hardware configuration

Similar to the automated warehouse system previously described, a center console is installed on the automated guided vehicle control panel and a TU unit is housed in the automated guided vehicle control panel as its PIO. Interfacing with the automated guided vehicle is performed by wireless modem (FM wireless system). Interface capsules (FK) for several automated guided vehicles are housed in the automated guided vehicle together with the wireless modem.

3.2.2 Functions

The functions are outlined in *Fig. 8*.

Usually, online commands from the distribution control computer are received and sorting and material flow control is performed. However, distribution control computer shutdown is considered and an offline automatic

mode is installed. Transporting is performed by selecting the route pattern data registered in advance.

4. CONCLUSION

The overall objective of application of the PC to a material handling system and the functions demanded of the PC and the recommended usage method were introduced concretely. In the rapid advance of automation in all fields, filling out of a consistent product series, network, interface with other equipment, data handling, man-machine interface, etc. is demanded of the PC which becomes the center of the material handling system.

The PC MICREX-F offered by Fui Electric is a product group that covers all of these. We are confident that it is a PC that can display its effect amply when building not only a material handling system, but also an FM and FMS system.

The authors will be happy if this article serves as MICREX-F application reference when building a material handling system.