Development Of The "SANMOTION C" Motion Controller

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1. Introduction

Motion controllers have been developed mainly for the control of servo motors, with the objective of high quality position control and speed control for industrial applications. On the other hand, PLC (sequence controllers), which are developed as a replacement for relay control circuits, are already in wide use in the market. Motion controllers and PLC are each absorbing the benefits of the other technology. Additionally, price competition in the market has caused a reduction in wiring, which resulted in network-supported products, and they are now accepted as well as motion control and PLC.

The needs of the market are lower prices and innovating diversified advanced technique.

Up until now, neither PLC nor motion control alone has been able cover all functions, so every device has needed to have a both a motion controller and a PLC unit. This has been a significant barrier to lowering costs. Additionally, the market is now demanding system products with multiple automated features. such as those that use both machines tools and robotics, and semiconductor manufacturing equipment.

Our goals in this development cycle were innovating diversified advanced technique and lower cost. Another goal was to integrate system control functions by combining the motion controller, robotic controller, and PLC functions. We also aimed to develop a network controller that would reduce wiring.

The following in an introduction to the outline and features of the "SANMOTION C" controller.

2. Development Background

Up until now, PC-based controllers with multi-task function are used to attain both motion controller and PLC functions. Installing the software for motion controllers or the software for PLC on the PC-based controllers could achieve each function. However, because PC-based controllers designed for the standard office computer are restyled by office needs, there are problems maintaining a long term steady product supply. For industrial applications, upgrades and the required setup cause problems with both time and money. For this reason, there is a need for controllers designed for devices with a long lifetime.

On the other hand, upgrading system products, such as adding a robot, has also required adding another specialized controller or control board. What is needed is a multicontroller that can act as a robot controller, a general-purpose controller, or a PLC controller by changing only the firmware without changing the current configuration.

3.Outline of the "SANMOTION C" Controller

3.1 CPU Unit

Figure 1 shows an exterior view of the CPU unit (CP231/X).

There are two types of CPU units available: a 266 MHz unit and a 400 MHz unit. The CPU unit is equipped with a 64 MB memory. Attain the best cost performance by selecting the best model based on which functions you need.

Up to 12 extension modules can be connected to the extension port on the right-hand side of the CPU unit. The available extension modules include a field bus module to connect the servo amplifier to the network, a digital I/O module, an analog I/O module, and a bus link module that allows you to connect more than 12 extension modules to the CPU unit.

The front of the CPU unit also has three slots where CAN, Ethernet, RS-232, or RS-422/485 plug-in modules can be added for further expansion.

Software and data can be loaded through the Compact Flash port on the front of the unit. Even after major maintenance, such as replacing the CPU unit, programs, functions, and data can be reinstalled simply by loading them from the Compact Flash.

Figure 1 shows the specifications for the CPU unit.

Figure 1 Exterior view of the CPU unit

Table 1 CPU unit specifications

Item	CP232/Z	CP231/X	CP230/Z
CPU speed	400MHz	266MHz	
Main memory	64MB	64MB	16MB
SRAM	512KB		
Interface	CAN RS485/422 Ethernet	CAN RS485/422 Ethernet Graphic	CAN RS485/422 Ethernet
Power source	24 V DC		
Power consumption	8W	10W	8W
Dimensions	125×180×100mm		
Mass	580g	650g	580g

Table 2 F299/A field bus module specifications

Item	FM299/A
Communication LSI	GA1060
Number of modules	2 modules
Controllable axes	Up to 16 axes
Position command update period	1, 2, 4, 8, 16, 32 ms
Network length	10 m (to terminal)

Table 3 FM280/A field bus module specifications

Item	FM280/A
Communication baud rate	2 Mbps / 4 Mbps
Number of modules	1 module
Controllable axes	Up to 8 axes
Network Length	50 m (Plastic fiber)

3.2 Field Bus Module

The FM299/A field bus extension module is a Sanyo Denki GA1060 serial interface network module. GA1060 (Sanyo Denki's unique multi-drop serial interface) amplifiers can be controlled on up to 16 axes. The specifications for the FM299/A are shown in table 2.

The FM280/A is a SERCOS interface module, which can control up to eight axes of Sanyo Denki's SERCOS amplifiers or those manufactured by third parties. The specifications for the FM280/A are shown in table 3.

3.3 I/O Module

The I/O extension module comes in two formats: the DM260/A, which has eight inputs and eight outputs, and the DM262/A, which has an output drive capability of up to 2A.

Two analog I/O modules are available. One is the AM299/A, which has a differential input of ±10 V. The other is the AM299/B, which has an input of 10 V. Each can use two input channels and two output channels. The digital input can use four channels each of input and output. Table 4 shows the specifications for the digital I/O modules. Table 5 shows the specifications for the analog I/O modules.

Table 4 Digital I/O module specifications

Item	DM260/A	DM262/A
External voltage	24 V DC	
Digital input	8 points (2 point interrupt)	
Input response time	1ms	
Input insulation	Photocoupler insulation	
Digital output	8 points	
Rated output voltage	24 V DC	
Output delay time	1ms	
Rated output current	0.5A	1 A (2 A: 50%)
Output insulation	Photocoupler insulation	

Table 5 Analog I/O module specifications

Item		AM299/A	AM299/B
Analog	Input	2 points	
	Input voltage	±10V	0 to 10 V
	Input format	Differential	Single end
	Input resolution	12bit	
	Input insulation	No insulation	
	Output	2 points	
	Output voltage	±10V	
	Output conversion time	1ms	
	Output resolution	12Bit	
	Output insulation	No insulation	
Digital	Input	4 points	
	Input response time	1ms	
	Input insulation	Photocoupler insulation	
	Output	4 points	
	Rated output voltage	24 V DC	
	Output delay time	1ms	
	Rated output current	0.5A	
	Output insulation	Photocoupler insulation	

3.4 Bus Link Module

The bus link module allows you to add more extension modules.

The CPU unit is connected to the network with a CAN cable, which can be extended up to 25 m. Figure 2 shows an example of module expansion using the bus link module.

3.5 Control Software

The available control software is the "plc.CP23x" PLC control software and the "ttmcu.CP23x", which is a PLC control program with motion control capabilities.

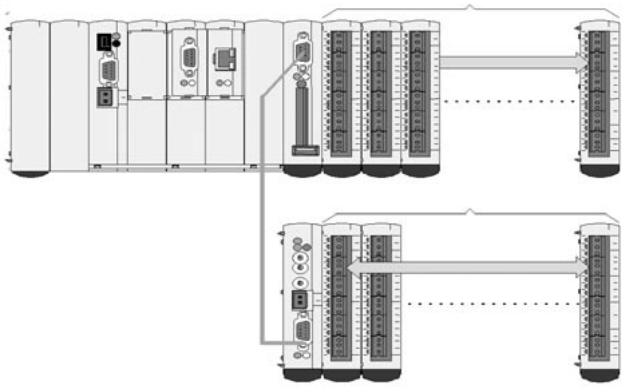


Figure 2 Example of bus link module connection

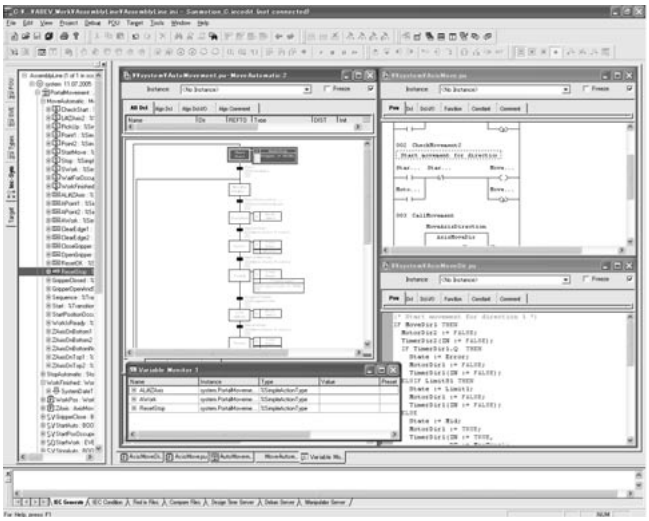


Figure 3 Screenshot from iecedit

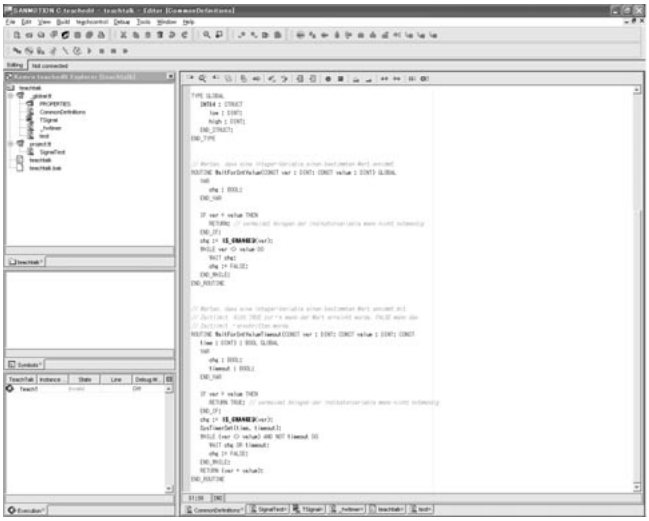


Figure 4 Screenshot from teachedit

The "plc.CP23x" PLC control software allows you to execute programs written in PLC language. The motion programs described by the function blocks in the program can be executed.

The "ttmcu.CP23x" motion control program adds the ability to execute programs written in robotic programming languages to PLC control.

3.6 Programming Tools

The programming tools used to make applications are "iecedit" for PLC language based programming and "teachedit" for robotic programming. The programming tool software is run on a Windows XP/2000 PC that is connected to the CPU unit by an Ethernet connection. The applications that are created are compiled and then the execution module is sent to the CPU unit for execution. "iecedit" allows programming LD (ladder diagram), ST (structured text), SFC (sequential function chart), and in IL (Instruction list), which bears the IEC61131-3 standard. A screenshot of "iecedit" is shown in figure 3.

"teachedit" is a robot programming tool designed to control robots. A screenshot of "teachedit" is shown in figure 4.

3.7 Monitoring Tools

Included is Scope, an application that allows you to check the operation of programs you have written. Scope allows you to monitor the I/O state, speed of control axes, and current position value while running on the computer in which the programming tool is installed. Figure 5 shows a screenshot of Scope.

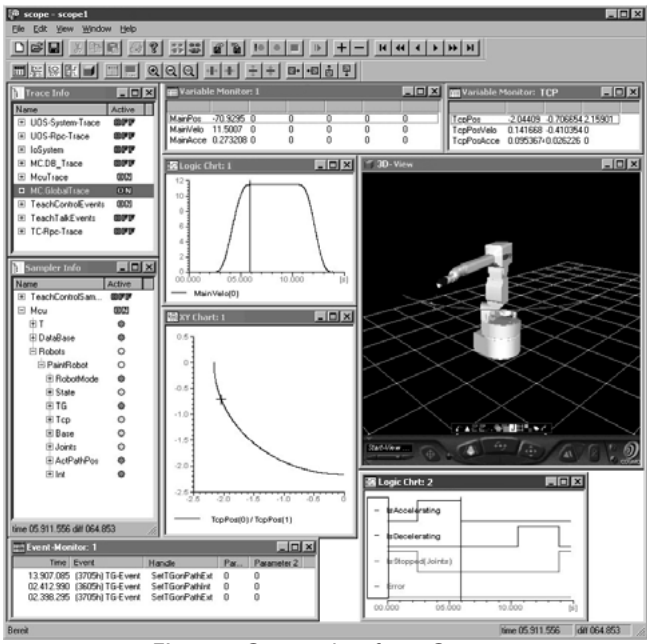


Figure 5 Screenshot from Scope

Table 6 General specifications

Item	"SANMOTION C"
Supply voltage	24 V DC
Safety class	Class III (as specified by IEC61131-2)
Cooling system	Natural cooling
Operating temperature	0°Cto 55°C (No condensation)
Storage temperature	–40°C to 70°C
Humidity	10% to 95% (No condensation)
Vibration	IEC61131-2 compliant
Shock	IEC61131-2 compliant
Safety standard	UL508 (listed)
IP Class	IP20
Installation	DIN rails

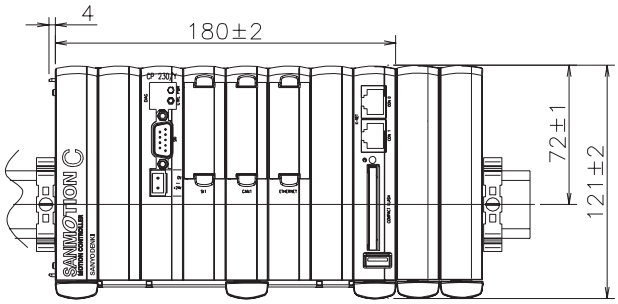


Figure 6 CPU unit dimensions

3.8 General Specifications

The general specifications for the "SANMOTION C" are shown in table 6. Figure 6 shows the dimensions of the CPU unit.

4. Features

4.1 Motion Control

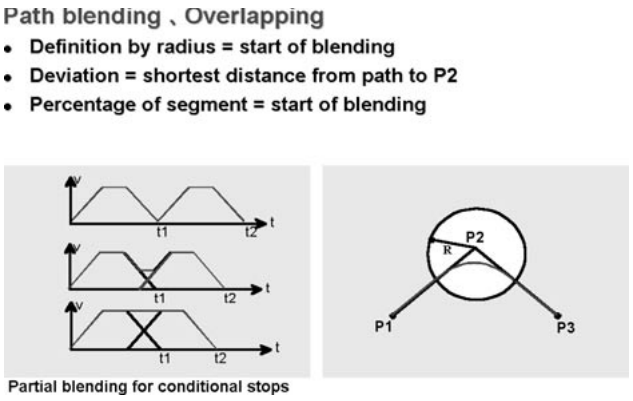
An example of the motion control function of the "SANMOTION C" controller is shown in figure 7. There are several control modes available, including overlap, which uses two motions consecutively, and path point, which traverses the shortest path between two points.

4.2 Robot Control

Examples of robot control with the "SANMOTION C" controller are shown in figures 8 and 9.

Figure 8 shows, in XYZ coordinates, straight-line control, circular control, and spline control.

Figure 9 shows XYZ movement with a multi-axis robot.



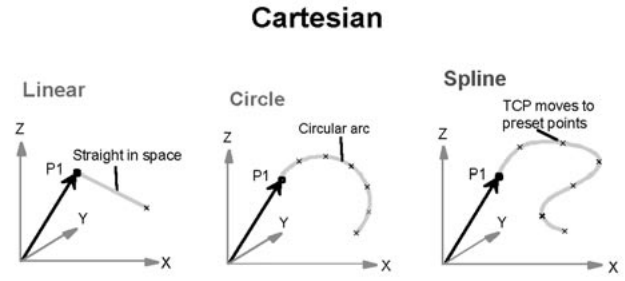


Figure 8 Examples of operation in XYZ coordinates

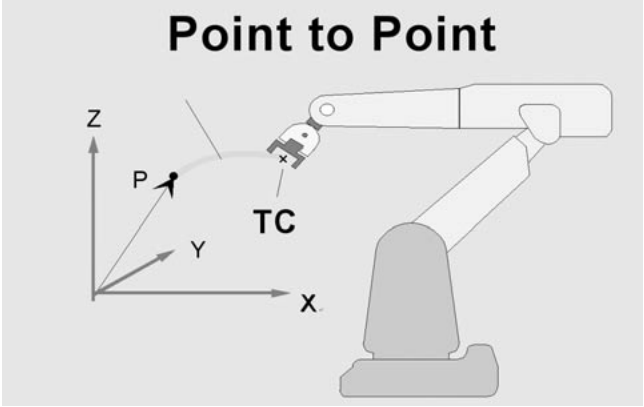


Figure 9 Example of operation of a multi axis robot

5. Conclusion

The "SANMOTION C" was designed with the idea of creating an integrated PLC controller, motion controller, and robot controller. A diversified controller is an excellent response to the market demand for improved cost performance. Additionally, use of PLC software and programs, which are growing in popularity, reduces system setup time and cost. As networking capability of the servo interface and the I/O interface has greatly improved, it is now a requirement for the controller to support various types of network. Our next goals are greater use of the network and the addition of images and security functions. We would also like to look into features such as wireless LAN.

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