DEVELOPMENT OF COMPACT CONTROLLER FAMILY

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1 OVERVIEW OF COMPACT CONTROLLER FAMILY

Five years have passed since the compact controller F (CC-F) was placed on sale in 1979 as an FC Series controller. During this time, family units have been developed around the CC-F. These units make up the controller family. Its overall objectives are shown in *Fig. 1*. The family is roughly made up of device groups belonging to the following three kinds of functions:

(1) Controller section
(2) Transmission control section
(3) Supervision section

1.1 Controller section

The controller consists of compact controller F, compact controller E, compact calculator, compact program-

mer, and compact blender. All units contain a microprocessor, and have the same basic design concept. The features common to all units are:

(1) Single loop controller and a configuration which can allows easy distribution regionally and functionally.
(2) Since a microprocessor is installed, high precision computation and complex control can be easily achieved.
(3) Since a microprocessor-based self-test function is provided, trouble information can be output and quick action can be taken during troubleshooting and repair.
(4) A function configuration matched to the objective can be realized by combining wafers with packaged computation and control programs. Therefore, control system modification is easy, and demands for system expansion, repression, etc. can be easily met. However, the functions of compact controller E are selected by format specification.

Fig. 1. Compact Controller Family Organization
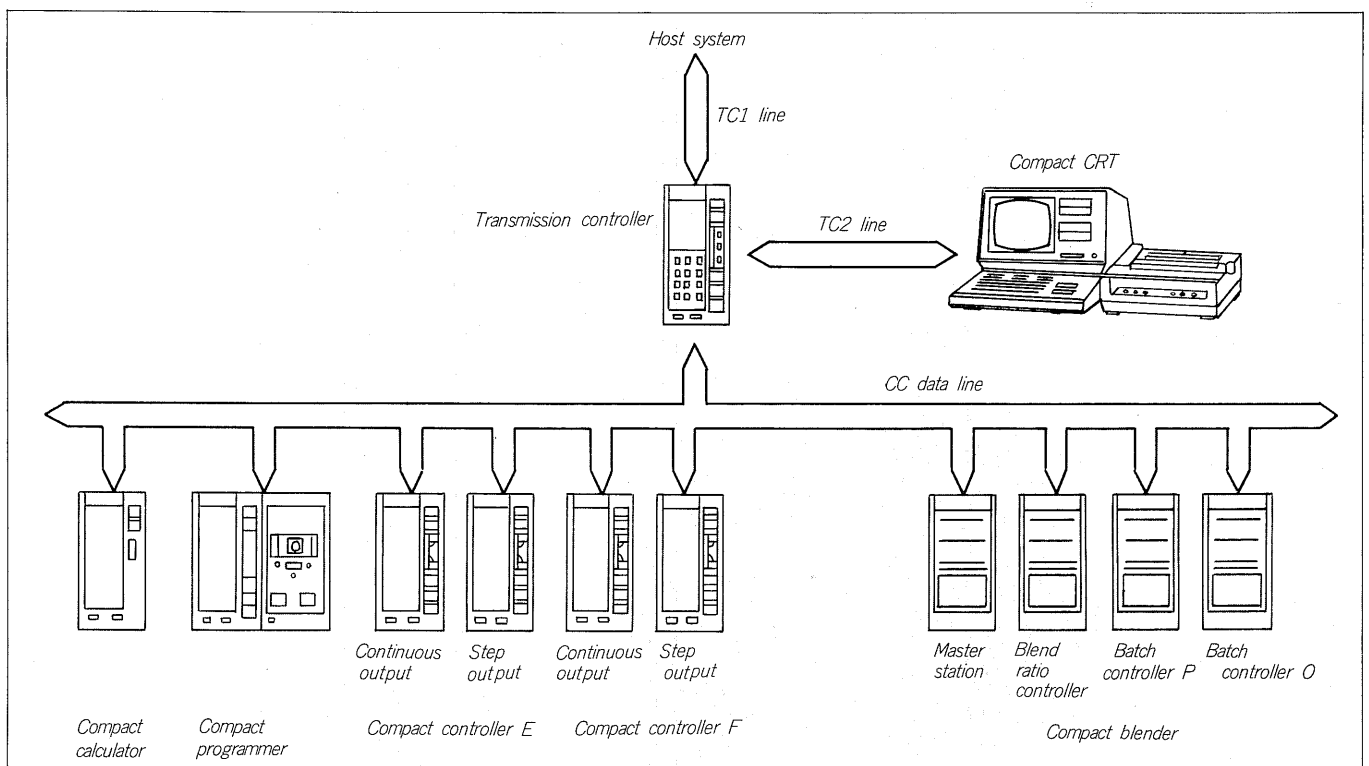
(5) Since all the units making up the controller section have a transmission function, a hierarchal structure with the central processor can be built by connection to a transmission controller through the CC data line. Moreover, since each controller is intelligent, each loop can continue control even when trouble occurs at the central processor.

(6) The front display is a solid-state indicator. Because there are few moving parts, reliability is high and recognition is excellent.

(7) The interior has a unit construction. The number of spare parts can be reduced for standardization throughout the entire family.

1.2 Transmission control section

Transmission control is performed by a transmission controller.

The transmission controller is positioned as a CC data line master station and as a slave station to the host system, and performs data transmission with the controller and central processŏr. Supervision of the controller directly from the transmission controller front display and operation panel or from the side data entry unit is also possible.

1.3 Supervision section

Supervision can be performed by compact CRT. The compact CRT permits centralized supervision of up to 30 compact controller F and other controllers through the transmission controller. Comparatively simple process supervision and control are performed.

② OUTLINE OF·FAMILY UNITS

2.1 Compact controller F

CC-F is a controller with which self-completeness as a single loop has been pursued. The analog instruments for the signal computation necessary for loop control and the relays and other functions are built-in as wafers and fixed command control, cascade control, and ratio control, of course, perform simple sequence control processing and

Fig. 2. Compact Controller F


control by combining these wafers.

Since fairly complex control can also be executed for this reason, even complex instrumentation can be realized with extremely simple wiring by suitable distribution of functions to CC-F. An exterior view of the CC-F is shown in *Fig. 2* and its specifications are given in *Table 1.*

Table 1 Compact Controller F Specifications

Item		Specification
Unit		Continuous output controller (Type PMK) Step output controller (Type PML)
Input signal	Process variable input signal	DC1~5 V
	External set point signal	DC1~5 V or pulse width input
	Auxiliary analog input signal	DC1~5V, 5 points
	Digital input signal	5 points + 5 points*/PMK, 5 points + 4 points*/PML
	Opening indicator input signal	10~100~10Ω 3-wire potentiometer or DC1~5 V
Output signals	Control output signal	DC4~20 mA, DC1~5 V (PMK) Pulse width output signal (PML)
	Analog output signal	DC1~5 V, 2 points + compensated process variable signal, set point transmission signal
	Digital output signal	8 points + 8 points*/PMK, PML
Indica-tion	Process variable and set point Control variable	Plasma display: Resolution 2.5% of full scale, 0~100% linear, Scale length: 100 mm LED display: Resolution 2.5% of full scale, 0~100% linear, scale length: 60 mm
Data entry unit		○ Constants and parameters setting and display ○ Connection of control or computation wafers
Transmission		Transmission with high-level system
Instal-lation	Ambient environment	0~45°C, 90% RH or less
	Power requirement	DC 24 V
	Weight	Approx. 5 kg
	Power consumption	Approx. 11W
	Dimensions (H x W x D)	144 x 72 x 400(mm), IEC (DIN) Standard
Control and com-putation func-tions	Basic period	200 ms
	Control functions	Basic control, ratio control, cascade control, PID control with gap, PID control with error squared, adaptive gain control, feed forward control, dead time compensation control, selective control
	Computation functions	Primary delay element, linearization, extraction of square root, temperature and pressure compensation, limiter, logic operation

* : Input/output meaningful inside instrument.
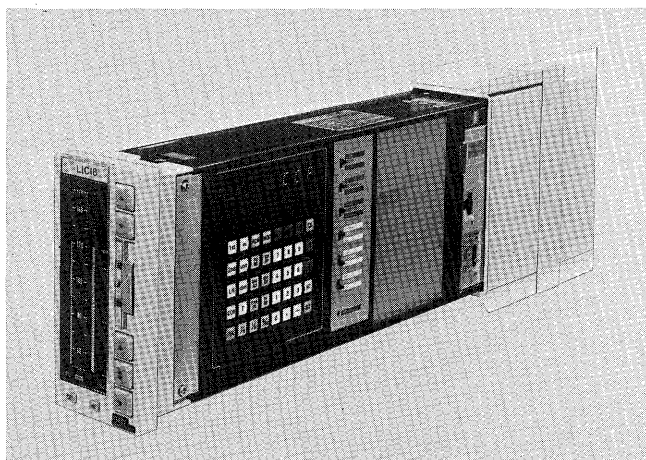
2.2 Compact controller E

CC-E is a controller in which application to comparatively simple loops is emphasized. Its functions are fixed and constant, cascade, ratio control, and other control systems can be selected by format specification. Moreover, extraction of square root computation, PID control with gap, intermittent control, and feed forward control are provided as standard.

The CC-E specifications are given in *Table 2*. Since it

Table 2 Compact Controller E Specifications

Item		Specification
Unit		Continuous output controller (Type PMA) Step output controller (Type PMC)
Input signals	Process variable input signal	DC1~5 V
	External set point signal	DC1~5 V or pulse width input
	Analog input signal	DC1~5 V, 3 points*/PMA 1 point*/PMC
	Digital input signal	4 points*
	Opening indicator input signal	10~100~10Ω 3-wire potentiometer or DC1~5 V (PMC)
Output signals	Control output signal	DC4~20 mA, DC1~5 V (PMA) Pulse width output (PMC)
	Analog output signal	DC1~5 V, 1 point** + compensated process variable signal set point transmission signal
	Digital output signal	6 points*
Indication	Process variable and set point Control variable	Plasma display: Resolution 0.5% of full scale, 0~100% linear Scale length: 100 mm LED display: Resolution 2.5% of full scale, 0~100% linear, scale length: 60 mm
Data entry unit		Constants and parameters setting and display
Transmission		Transmission with high-level system
Installation	Ambient environment	0~45°C, 90% RH or less
	Power requirement	DC24 V
	Weight	Approx 4.5 kg
	Power consumption	Approx 9 W
	Dimensions (H x W x D)	144 x 72 x 400(mm), IEC (DIN) Standard
	Basic period	200 ms
Control and computation functions	Control functions	Basic control (external cascade setting possible), non-linear control, ratio control, intermittent control
		Feed forward control, selective control (PMA)
	Computation functions	Extraction of square root

* : Input/output meaningful in instrument.
**: Output signal by to format specification.

has self-test and transmissions functions, in addition to control functions, and a data entry unit, hard manual unit can be installed as options, safe and finer control can be realized economically.

2.3 Compact calculator

The compact calculator is a dedicated computation device to complementing the computation functions of the CC-F and CC-E. All internal computations are performed by wafer connection.

2.4 Compact programmer

This is a controller which performs control along a target value which changes at preset times. At the CC-F, the target value pattern is limited to one kind, but can have up to 16 kinds with the compact controller. Control is performed by selecting these pattern by front panel switch. This is effective when temperature control is performed by changing the set pattern at each batch, such as with a heat treatment furnace, etc.

2.5 Compact blender

The compact blender is a controller which performs fixed amount shipment and blending control in batch/blending systems. It is made up of four kinds of controller: master station, blend ratio controller, batch controller P, and batch controller O. Its exterior views are shown in *Fig. 3* and its specifications are given on *Table 3*.

Similar to the CF-F, etc. the functions of the compact blenders can be built with wafers. However, where as the CC-F, etc. control the instantaneous value of the control variable, the compact blender controls the accumulated value of the control variable. Therefore, the PI (D) control algorithm is also different and there is some difference in the wafers available with both.

The biggest feature of the compact blender is that, of the sequence processing and computation processing at batch/blending systems, those which are comparatively simple can be realized by wafer connection. Therefore, the number of auxiliary devices outside the compact blender can be reduced.
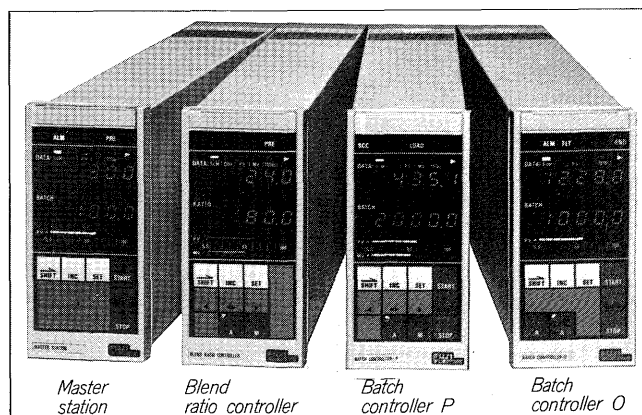
Fig. 3. Compact Blender

Master station   Blend ratio controller   Batch controller P   Batch controller O

Table 3 Compact Blender Specifications

Item		Specification
Unit		Master station (Type PMR1) Blend ratio controller (Type PMR2) Batch controller P (Type PMR3) Batch controller O (Type PMR4)
Input signals	Pulse input signal Digital input signal Analog input signal Resistance temperature detector input signal	Voltage pulse, 2 points 6 points + 6 points*/PMR 2, 3 6 points + 4 points*/PMR 1, 4 DC1 ~5 V, 3 points Pt 100Ω (0°C), 1 point
Output signals	Pulse output signal Digital output signal Analog output signal Control output signal	1 point 8 points + 5 points*/PMR 2, 3 8 points + 4 points*/PMR 1, 4 DC1 ~5 V, 3 points + compensated process variable signal DC4 ~20mA DC1 ~5 V 1 point each (PMR 2, PMR 3)
Indication	Digital display (accumulated value, etc.) Process variable Control variable (PMR 2, PMR 3) Control mode, batch Sequence display Status display	6 digits LED numeric display × 2 LED display (green): Resolution 10% of full scale, 0~100% linear LED display (red): Resolution 10% of full scale, 0~100% linear LED display
Setting		By front panel setting flat keyboard of side panel data entry unit • Constants and parameters setting and display function • Connection of control or computation wafers
Transmission function		Transmission with high-level system
Installation	Ambient environment Power requirement Weight Power consumption Dimensions (H x W x D)	0~45°C, 90% RH or less; DC24 V Approx 5 kg Approx 11 W 144 x 72 x 400(mm), IEC (DIN) Standard
Control and computation functions	Control period	Basic period 200 ms Batch control period 40 ms
	Accumulation function	Pulse input or analog input accumulation (batch accumulation and total accumulation)
	Control functions	2-stage valves opening/closing control, PI control, program control
	Computation functions	Various logic operations, switching, limiter, selector, timer, extraction of square root Flow compensation computation (ATSM compensation, general second order equation compensation)

*: Input/output meaningful inside the instrument.

2.6 Transmission controller

The transmission controller has two transmission lines complying with EIA RS-232C as the physical link with a high-level system. These lines are TC1 and TC2.

Data transmission between the central processor, general purpose CRT and the transmission controller is performed through these lines. Data transmission between the transmission controller and controllers is performed through the CC data line.

Regarding TC1 and TC2 line processing, the line used first has priority. While one line is being processed, the other line waits. After processing of the first line is complete, the other line processed.

All compact control family controllers can be connected to the CC data line. Up to 15 controller can be connected.

2.7 Compact CRT

At the present supervision and control of the CC-F, CC-E, and compact calculator is performed at the compact CRT. Of course, the central processor can also perform supervision of the compact programmer and compact blender through the transmission controller.

The compact CRT has the following three main functions:
(1) Operation functions
Online display and setting of the controller process data, etc.
(2) System maintenance function
Function which performs wafer connection which determines the control and computation functions of the controller and modification constants, etc. on the CRT and set the data at the controller or store it on mini floppy disk.
(3) Initial definition function
Defines the TAGNO, comments, loop configuration, etc. necessary at the CRT screens of the operation function.

3 CONCLUSION

As described above, the compact controller family employs a hierarchy construction. The control objectives extend batch processes, blending systems and continuous processes. Therefore, most control systems can be built with compact controller family alone. However, recent advances in the control field have been amazing. We will develop new units matched to current needs and to serve in improving control systems in the future.