COMMON FUNCTIONS OF THE GREEN SERIES OF TEMPERATURE CONTROLLERS

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We have developed a new range of temperature controllers called the Green series. The whole series, which ranges from the low-end 300 series to the mid-range 500 series and high-end 700 series which is equipped with additional applications such as custom computation functions and dual-loop control capabilities, is developed based on common specifications.

This paper describes the pre-configured control strategy (UT mode) on the 500 series and 700 series and the communication protocols (PC link communication, ladder communication and coordinated operation) available over the entire series.

INTRODUCTION

In order to meet user needs, the Green series of controllers has not only been equipped with control computation systems, "Super" overshoot suppressing function and generous alarm functions proven on existing models, but have also been fitted with a number of new functions. These include various pre-configured control functions or "UT modes" (500 and 700 series); versatile display functions with LCD (700 series only); custom-built control function capabilities –"custom computation" (700 series only); and three communication protocols – PC link communication, ladder communication and coordinated operation. This paper explains the characteristic functions of the series, such as control and communication functions.

UT MODE — PRE-CONFIGURED CONTROL FUNCTION

The 500 and 700 series of controllers have more than one pre-configured control function to meet the demands of various applications. These control functions are called UT modes. The UT750, a 700 series controller, has 13 UT modes, while the 500 series controllers UT550/UT520 have 8 (as shown in Table 1). The UT mode is selected using the keys on the front panel. For example, when the UT mode parameter UTM is set at 4, the controller for the cascade control application is active.

Table 1 UT Mode

UTM	UT mode	UT750	UT550/520
1	Single-loop control	○	○
2	Cascade primary loop control	○	○
3	Cascade secondary loop control	○	○
4	Cascade control	○	○
5	Loop control for backup	○	○
6	Loop control with PV switching	○	○
7	Loop control with PV auto-selector	○	○
8	Loop control with PV-hold function		○
11	Dual-loop control	○	
12	Temperature & humidity control	○	
13	Cascade control with 2 universal inputs	○	
14	Loop control with PV switching and 2 universal inputs	○	
15	Loop control with PV auto-selector and 2 universal inputs	○	
21	Custom computation control	○	

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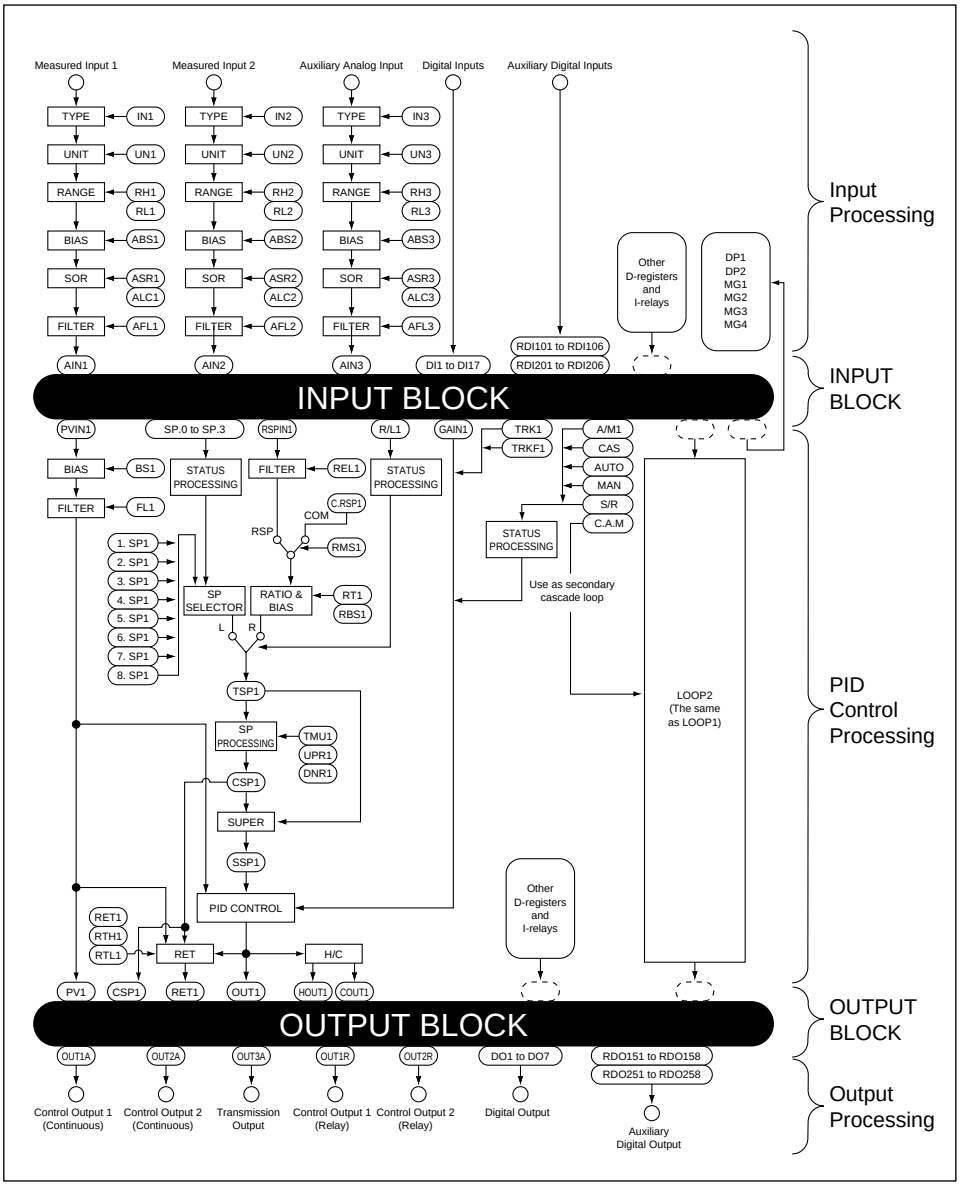

Figure 1 Diagram for UT750 Control Computation Concept

1. UT Mode

The internal controls for each UT mode are divided into fixed components and variable components so that multiple control capabilities can be realized. Figure 1 illustrates the control computation concept applied in the UT750. Fixed components include an input hardware manager with linearizing temperature conversion computations (input processing section in the figure); a target setpoint calculator and PID control (PID control processing section in the figure); and an output hardware manager (output processing section in the figure). Variable components exist for each application which requires different input data and calculation data to compute the control output level (input block and output block in the figure).

The type of data displayed, the display sequence and the display conditions can also be selected (this information is called "operating display information"). The input and output block functions can be easily configured in order to perform functions by incorporating the supplied software computation modules.

Figure 2 shows the input block and the output block layout. In this example, the input data from AIN1 and AIN2 are converted to the same scale by an EU range conversion module and then transmitted to the 2-input selector module. The 2-input selector module selects either the AIN1 or AIN2 data according to the upper and lower selection limits or the selector signal. The selected data are processed by a 10-segment linearizer module and transmitted from the PVIN1 input block to the control computation section.

Thus, the information required by the selected UT mode is obtained at power-on by first configuring the input/output block information and the operating display information for each UT

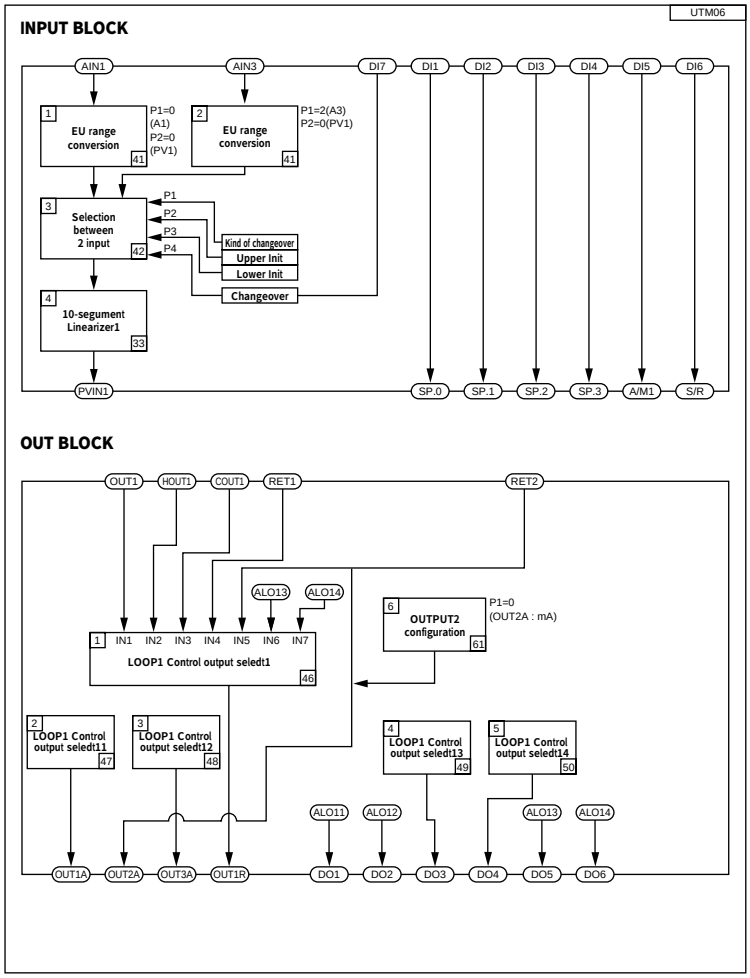

Figure 2 Input/Ooutput Block for UT Mode 6 (loop control with PV switching)

mode in the firmware.

2. Custom Computation Function

The custom computation function enables easy configuration of the control function by manipulating the UT mode structures. The function uses the LL200 PC-based Custom Computation Building Tool to rearrange the input/output block information and the operating display information to meet various application requirements and transmit this information to the controller for downloading. The controller carries out the input/output block processes according to the downloaded custom computation information. The 65 computation modules available for customization are shown in Table 2.

DATA REGISTER STRUCTURE AND COMMUNICATION FUNCTIONS

The Green series of controllers are equipped with three communication protocols: two general-purpose communication functions — PC link communication and ladder communication

Table 2 Computation Modules

No.	Module	No.	Module	No.	Module
1	Addition	23	Equal	45	Detection of change
2	Subtraction	24	Not equal	46	Loop1 control output select 1
3	Multiplication	25	Range	47	Loop1 control output select 11
4	Division	26	Delay	48	Loop1 control output select 12
5	Absolute	27	AND (double word)	49	Loop1 control output select 13
6	Reciprocal	28	OR (double word)	50	Loop1 control output select 14
7	Min/max/average/difference	29	Word shift	51	Loop2 control output select 2
8	Hold maximum value	30	Totalization	52	Loop2 control output select 21
9	Hold minimum value	31	Timer	53	Loop2 control output select 22
10	Hold	32	Rate-of-change limiter	54	Loop2 control output select 23
11	Switch	33	10-segment linearizer 1	55	Display data unit conversion
12	Limiter	34	10-segment linearizer 2	56	Parameter setting
13	Constant	35	Inverse 10-segment linearizer 1	57	Data display 1
14	AND	36	Inverse 10-segment linearizer 2	58	Data display 2
15	OR	37	Curve linearizer 1	59	Special contact output setting
16	Exclusive OR	38	Curve linearizer 2	60	Output 1 configuration
17	NOT	39	Ratio	61	Output 2 configuration
18	Latch	40	First-order-lag filter	62	Fluid temperature compensation factor
19	Greater	41	EU range conversion	63	Fluid pressure compensation factor
20	Lesser	42	2-input selector	64	10-segment linearizer 3
21	Decrement counter	43	Temperature/humidity calculation	65	10-segment linearizer 4
22	Counter	44	Square-root extraction		

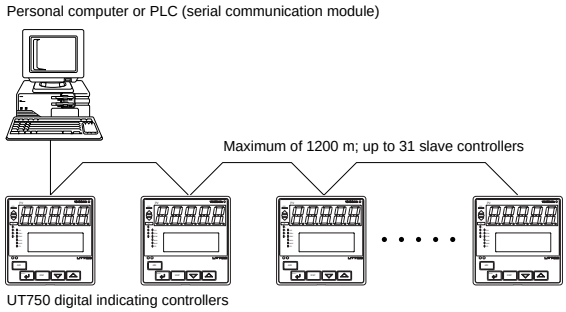

Figure 3 Example of PC Link

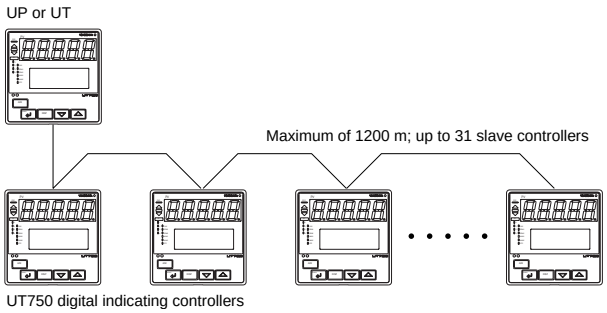

Figure 4 Example of Coordinated Operation

— and a specific function for communication between the various controllers, or coordinated operation.

1. Data Register Structure

The multitude of control parameters, such as the target setpoint, PID parameters and input types and others, which must be defined, are arranged in the data registers and managed by numbers; for example, No. D301 represents the target setpoint and No. D306 the proportional band. These data register numbers are common among the entire range of the Green series, that is, common from high-end models through to low-end models.

2. PC Link Communication

The PC link communication is a protocol which is used to communicate with a personal computer (abbreviated as PC) or a graphic panel. It is compatible with the PC link protocol used in Yokogawa's programmable logic controller (PLC) FA-M3/ FA500 series and assorts the read/write command data into register numbers. ASCII code (ex. 21 is taken as 3231hex) is used as send/receive data format. An example of communication is shown in Figure 3.

Communication to a graphic panel (Yokogawa TOP series and others) can be made by simply selecting the register number, without having to refer to the specific protocol.

Generally, PLCs use the ladder communication protocol discussed in section 3.3 below; however, the FA-M3 UT link module can also be used to monitor data by simply setting the actuating relay to "on" with a ladder program.

3. Ladder Communication

Ladder communication is a protocol used to communicate with PLCs. It employs PLC communication modules (Yokogawa ladder communication module and others) to communicate with simple ladder programs. In general, ladder programs do not use ASCII codes, but opt for simple BCD codes (e.g. 21 refers to 21hex) to change the ladders between send/receive data formats. Specification of send/receive data is also carried out using the register numbers.

4. Coordinated Operation

Coordinated operation involves linking a number of slave controllers to one master controller via communication terminals and running the slave controllers the same way as the master controller. An example is shown in Figure 4.

Features of coordinated operation:

- Digital signal transmissions do not produce the errors of analog signals.
- Slave controllers can also use the "Super" overshoot suppressing function.
- Slave controllers can be operated simultaneously with, and using, the same Stop/Run status and PID numbers as master controller.

All of the digital indicating controllers (UT) and program controllers (UP) in the Green series can operate as master controllers, while all the UTs can operate as slave controllers. The existing UP27 and UT37 models can also be connected in the coordinated operation.

CONCLUDING REMARKS

The UT mode function in the high-end and mid-range models, allows a number of control applications to be performed easily. In addition, the merits of standardizing specifications in communication protocols and register numbers will be revealed in engineering load reductions in communication applications, et cetera.

This is the first time a UT mode function has been applied to the controller market. Our aim is to not only keep ahead of market trends by incorporating highly versatile control applications but, more so to develop controllers with advanced functions and user-friendly operations. ◆

REFERENCES

(1) Mano, S., et al. UT2000 Series of Multiple-point Temperature Controllers. Yokogawa Technical Report. Vol. 38, No.3, pp. 137-140 (1994) in Japanese
(2) Matsumura, et al. Common Design for Green Series of Temperature Controllers. Yokogawa Technical Report. No.22 pp. 29 to 33 (1996)