FUJI ELECTRIC

FC SERIES COMPACT CONTROLLER S
(PROGRAMMABLE, CONTINUOUS OUTPUT TYPE)

DATA SHEET

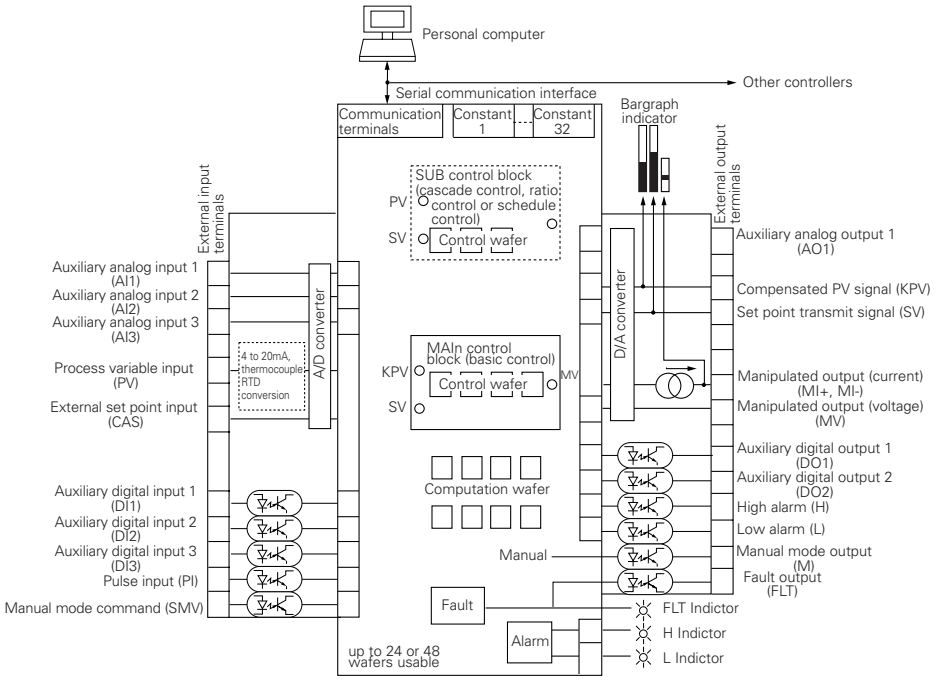
PNA2

The Compact Controller S (programmable type) is a compact single-loop controller using a microprocessor. It accepts uniform signal, and signals from thermocouple and RTD (Resistance bulb) as input, and is equipped with abundant control and computation functions to allow composing a flexible system with a high cost/performance.

FEATURES

1. Abundant control and computation functions
   The controller has a variety of control and computation functions in addition to PID auto tuning, and also has a transmission function for data exchange with a host system.
2. Control and computation programming can be made at the site
   Since the control and computation functions are built into wafers (functional units), an optimum program or the control object can be formed just by keying on the front panel.
3. High reliability
   LED's (red and green) are used for the bargraph indicator and also for the parameter indication (red), and a non volatile memory enables retaining the control and computation parameters even if power should be interrupted.
4. All operation is made from the front panel
   Operations such as parameter setting, auto/manual changeover, hard manual operation etc. are all made from the front panel.
5. Personal computer interface
   Generic interface availability for personal computer (IBM PC-AT) for supervision, operation, support, maintenance, etc.

FUNCTIONAL DIAGRAM



SPECIFICATIONS

1. Control functions

PID control: Proportional band (P); 1.0 to 3276.7%
Integration time (I); 0.1 to 3276.7 sec
Derivative time (D); 0.0 to 900.0 sec
PID auto tuning function (according to code specification)

Wafer system program:

The following kinds of control are possible by combining wafers (functional units)
(Example of control)
Cascade control, ratio control, program control, gain schedule control, selective control, dead time compensation control, etc.

Type of alarms:

PV high/low alarm PV change rate alarm DV high/low alarm	Determined by wafer connection Alarms are indicated with front panel lights

Control cycle: 0.2 sec (24 wafer type)
0.4 sec (48 wafer type)

2. Computation functions

(1) Wafer

The wafer is a functional unit software package containing control and computation functions needed for measurement and control. Combination of these wafers each having its own particular function enables composing a flexible system applicable to a wide range of control … from basic PID control up to complex advanced control. The PNA2 can accommodate up to 24 or 48 wafers.
The following kinds of wafers are prepared to allow selection according to the control purpose.

① For control … PID control, ratio control, program control, gain scheduler, PID parameter setting
② For computation Various computations possible by combining the wafers given in Table 1

(2) Internal input/output terminals

Various internal terminals are provided for external analog input/output, digital input/output and wafer connection.

(3) Constants

Various parameters used in computation and control can be freely defined.
(24 wafer type : 32 constants
48 wafer type : 48 constants)

Table 1 List of computation wafers

Wafer name	Kinds	Functional outline
Logical operation	6	Carries out AND, OR, NOT, EOR and a combination of these logical operations.
Arithmetic operation	5	Carries out a combination of addition, subtraction, multiplication and division.
Temperature/pressure compensation	1	Carries out temperature and pressure compensation through use of differential pressure, compensated pressure, proper temperature.
Linearize	3/6	Carries out segmented-line approximation with 15-segmented-line function. (24 wafer type : 3 kinds, 48 wafer type : 6 kinds).
Program control	4	Time schedule control by step or polygonal line approximation with 7 segments.
Flip-flop	1	RS flip-flop.
Pulse width integration	1	Adds the change of input at each basic cycle to the previous integration value.
Selector	1	Compares two input values, and provides HIGH output (Large one), LOW output (Smaller one), and result of judgement on large/small.
Changeover	1	Selects input or output via a switch function. Analog hold circuit also provided.
Timer	1	Outputs on-delay, off-delay timer signal via start of input signal according to timer setting.
Absolute value/sign inversion	1	Carries out absolute value processing on input and outputs the result. Also judges the sign (Positive, negative) of input value and outputs the result.
Square root extraction	1	Extracts square root of input value and outputs the result. Low input cutoff function equipped.
Lead, lag	1	Carries out lead/lag operation on the input and outputs the results. Used as analog filter function and for various compensations.
Limiter	1	Limits the input within the range of high/low limit settings, and outputs the result. Also outputs high/low limit alarm signal.
Ramp function	2	Outputs signal which changes…in ramp from toward target value at the set full scale time. There are two of these wafers…in minute unit and hour unit.
Analog averaging	1	Carries out sequential integration on input data, calculates the average value at each averaging time, and outputs the result.
Analog integration	1	Integrates the value obtained by multiplying the input data by a proportional constant, and outputs the result.
Pulse generation	1	Outputs a pulse at the set time interval.
Dead band	1	Adds dead band compensation to the input and outputs the result.
Pulse No. counter	1	Detects rise of pulse and counts the number of pulses.
Pulse No. output	1	Integrates the input signal and converts it to number of pulses for output.
Decoder	1	Decodes 2-bit pure binary input and outputs it to 4 terminals.
Moving average	2	Calculates moving average of input data and outputs the result.
Sample hold	1	Holds the input value according to sample signal (0/1) and continues the output.
Dead time	6	Usable for dead time compensation control etc. Data sampling can be done in 1 sec or 1 min units.
ON-OFF	1	Outputs ON-OFF signal with hysteresis versus the input.
Alarm	1	Compares the input and set value and outputs the judgement result.
Position type pulse width conversion	1	Performs output processing in time proportional PID control.

A variety of applications are possible through combination of wafers.

3. Input signals

(1) Process variable input signal: One input selectable from the following

Voltage input signal	I_+ I_0 I_-	1 to 5V DC	Input resistance 1MΩ or more Allowable error ±0.2%/FS*
Current input signal		4 to 20mA DC	24V DC can be supplied to transmitter in case of AC power supply Allowable error ±0.2%/FS
Thermocouple input		Types J : 0 to 600°C K : 0 to 1200°C E : 0 to 800°C R : 0 to 1600°C	10mV DC span or more; cold junction compensation comprised Allowable error ±0.5%/FS
Resistance bulb input		Pt100Ω JPt100Ω –50 to 500°C	50°C span or more Allowable error ±0.5%/FS*

(2) Analog input signal: 4 points

External set point	CAS	1 to 5V DC	Input resistance 1MΩ or more, allowable error ±0.2%/FS*
Aux. analog input	AI1		
Aux. analog input	AI2		
Aux. analog input	AI3		

CAS is usable as aux. analog input.

(3) Digital input signal: 4 points

Manual mode command	SMV	Contact input (Photocoupler isolation)	ON 0V, OFF 24V (Input current about 11mA/24V DC)
Aux. digital input	DI1		
Aux. digital input	DI2		
Aux. digital input	DI3		

(4) One set of pulse width or one set of pulse number input signal:

Pulse width input signal	PI_+, PI_-	Contact input (Photocoupler isolation)	ON 0V, OFF 24V (Input current: about 11mA/24V DC)
Pulse No. input signal			ON 0V, OFF 24V (Input current: about 11mA/24V DC) Input max. freq. : 500Hz

4. Output signals

(1) Manipulated output signal: 1 point

Current output	MI_+, MI_-	4 to 20mA DC	Allowable load resistance 600Ω or less, allowable error ±0.2%/FS

(2) Analog output signal: 4 points

Compensated PV signal	KPV	1 to 5V DC	Output resistance 1Ω or less, allowable error ±0.2%/FS
Set point transmit signal	SV		
Manipulated output (Voltage)	MV		
Aux. analog output	AO1		

KPV, SV and MV is usable as aux. analog output.

(3) Digital output signal: 6 points

Fault output	FLT	Open collector output (Photocoupler isolation)	Output rating 30V DC 0.1A max.
Manual mode output	M		
High alarm output	H		
Low alarm output	L		
Aux. digital output	DO1		
Aux. digital output	DO2		

H and L are usable as aux. digital output.

Note: *FS.....full scale

5. Internal uniform data conversion

(1) Analog data

Standard	Minimum	Maximum
0.00 to 100.00%	–327.6%	327.67%

(2) Digital data

Input/output form	Data
ON (Contact closed)	0.01%
OFF (Contact open)	0.00%

6. Indication, setting, operation functions

(1) Bargraph indication

Indication method	PV indicator	SV indicator	MV indicator
Indication method	LED (Red)	LED (Green)	LED (Red)
No. of segments	101 + 2	101 + 2	51 + 2
Range	0 to 100% linear	0 to 100% linear	0 to 100% linear
Resolution	1%/FS	1%/FS	2%/FS
Scale length	100mm	100mm	50mm
Indication mode	0 to 100% bargraph indication, 0 to 100% reverse bargraph indication, dot indication, –50 to 50% deviation indication		

(2) Operation mode indication

Indication method:

LED (Red and green)
Red; M, HM, SCC
Green; A, R

(3) Numerical indication, setting

Indication method:

LED (Red), name in 3 digits+number in 5 digits (Negative sign included)

Indication contents:

Process variable (Industrial value), set point (Industrial value), alarm high/low values, PID parameters etc.
Indication contents are selectable by F/S, △, ▽ keys on front panel.

Setting method:

By use of F/S, △, ▽, ▷, ST keys on front panel.

(4) SV setting function

Fixed value setting method:

By ▲ ▼ buttons on front panel.
Setting speed; about 40 sec/FS*

Remote setting method:

By external set point signal (Voltage or pulse width input)

(5) MV operating function

Manual operating method:

By ▲, ⇕, ▼ buttons on front panel.
Setting speed; about 40 sec/FS*
About 8 sec/FS* when ⇕ pressed simultaneously.

(6) Operation mode changeover

By R/A/M pushbuttons and HM switch on front panel.

R → A changeover		Balanceless bumpless
A → R changeover	Voltage signal	Balance bumpless
	Pulse width input	Balanceless bumpless
A or R ⇄ M changeover		Balanceless bumpless
A or R → M changeover		Balanceless bumpless

7. Power failure processing function

Power failure detection:
Control stoppage at power failure detection

During power failure:
Operating parameters backed up by ca pacitor when power failure within 5 min utes
Initial set point and manipulated output values, PID parameters etc. are stored in nonvolatile memory (lasts for 10 years expected at ambient temperature of 50°C or less)

Power failure recovery time:
Initial or continuous start mode can be set for power failure within 5 minutes. Recovery from power failure lasting longer than 5 minutes is done by initial.

*Operation mode at initialization is settable.
M: Manual mode
A: Automatic mode
R: Remote mode
SCC: SCC mode

8. Self-diagnosis functions

Computation/control circuit abnormality:
FLT indicator lights up, FLT contact output turns ON, and computation and control stop.
Manipulated output can be controlled manually at FLT (Soft manual).

Input/output signal abnormality, manipulated output break:
FLT indicator lights up, FLT contact output turns ON, control stops, and manipulated output is held. Computation processing and output processing other than for manipulated output continue.

Fault contents indication:
Cause of fault is indicated numerically on numerical indicator of front panel.

9. Transmission functions

(1) Transmission items
Supervisory items:
From PNA to host
Process variable, set point, manipulated output, deviation, operation mode, alarm information, fault information, PID parameters, various limiter values, constants, etc.

Setting operation items:
From host to PNA
Set point, manipulated output, operation mode, PID parameters, various limiter values, constants, etc.

(2) Transmission setting inhibit:
Parameter setting enable/inhibit can be designated by transmission from the host. Designation is done by set keys on the front panel.

(3) Transmission interface

(a) T-link: Private interface
Transmission speed: 500Kbps
No. of units connectable: 32 max.
Transmission distance: 1Km max.
Transmission form: Multi-drop
Control method: I/O transmission and message communication

(b) RS-422A/485: Universal interface
Transmission speed: 2400, 4800, 9600 or 19200 bps configurable
No. of units connectable: 31 max.
Transmission distance: 1km max.
Transmission form: Multi-drop
Control method: Polling/selecting

(c) CC data line: Private interface
Transmission speed: 19.2 Kbps (fixed)
No. of units connectable: 15 max.
Transmission distance: 500m max.
Transmission form: Multi-drop
Control method: Polling/selecting

CODE SYMBOLS

1 2 3 4	5 6	7 8	9	10	11	12	Description
P N A 2		5	-				
	A						**Process variable input signal** 1 to 5V DC
	B						4 to 20mA DC
	C						J thermocouple (10mV DC span or more, with cold junction compensating function)
	D						K thermocouple
	E						E thermocouple
	F						R thermocouple
	G						Resistance bulb JPt100Ω 3-wire type, 50°C span or more
	W						Resistance bulb Pt100Ω 3-wire type, 50°C span or more
		A					**Setting method** A–M type
		B					R–A–M type
			1				**Power supply** 24V DC (20 to 30V DC)
			2				100V AC (85 to 132V/47 to 63Hz AC)
			3				200V AC (187 to 264V/47 to 63Hz AC)
				0			**Hard manual unit** Without
				1			With (only when 24V DC power supply)
					Y		**Transmission function** Without
					T		T-link
					R		RS-422A
					S		RS-485
					C		CC data line
						0	**Wafer connection/Available wafer numbers** Without/24 wafers
						1	With/24 wafers
						2	Without/48 wafers
						3	With/48 wafers
						Y	**PID auto tuning function** Without
						A	With

Notes: Symbols of resistance bulbs are as follows.
JPt100…JIS C 1604-1981
Pt100…IEC Pub751-1983
(JPt100/Pt100 changeover is possible with front key.)

10. Other functions

Data protective function by means of pass code

11. Optional functions

(1) Hard manual unit (HMV)
Control output: 4 to 20mA DC
Allowable load resistance: 600Ω or less
(This option is available when power supply is 24V DC)

12. Operating conditions

Power supply: Selectable from the following 3 types 24V DC (20 to 30V DC), 100V AC (85 to 132V/47 to 63Hz AC), 200V AC (187 to 264V/47 to 63Hz AC)

Power consumption:
Approx. 12W (DC), 20VA (AC)

Dielectric strength:
1500V AC for 1 minute

Insulation resistance:
100MΩ or more at 500V DC

Ambient temperature:
0 to 50°C

Ambient humidity:
90%RH or less

Enclosure: Steel case

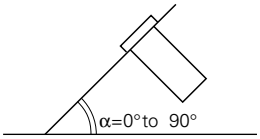
Enclosure class: Front IP65 (IEC 529)

Rating plate (Name plate):
100(H) x 70(W), white acrylic

Dimensions: 144(H) x 72(W) x 391(D)mm, IEC (DIN) standards

Mass{weight}: Approx. 2.9kg

Mounting method:
Flush on indoor panel; vertical mounting is standard
Mounting on tilted surface possible (Angle α)



Finish color: Munsell N1.5 for front panel and case

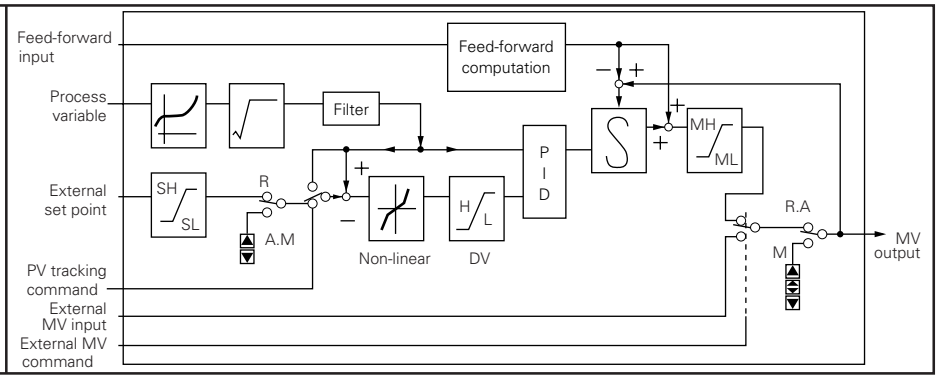
scope of delivery: Controller and mounting bracket

Item prepared separately:
Transmission cable (Type PNZ)

VARIOUS CONTROL EXAMPLES

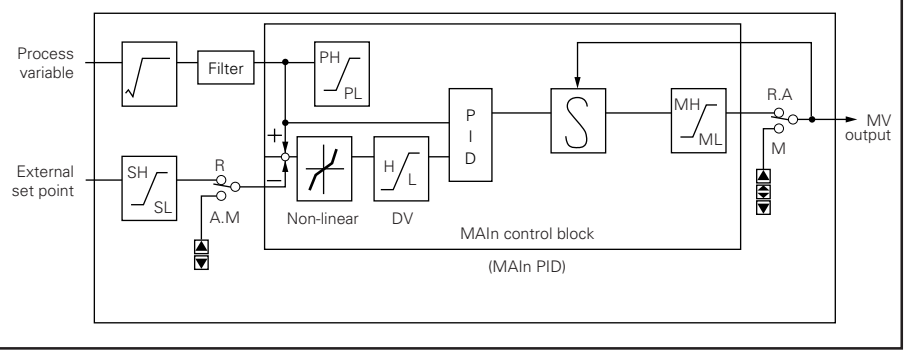
Basic type PID control (Fixed function)

This is a PID control function which is fixedly defined beforehand. The definition can be made through simple operation, and wafer connection is unnecessary.
(Computation elements such as square root, filter, limiter, non-linear etc. can be made valid or invalid through specification.)



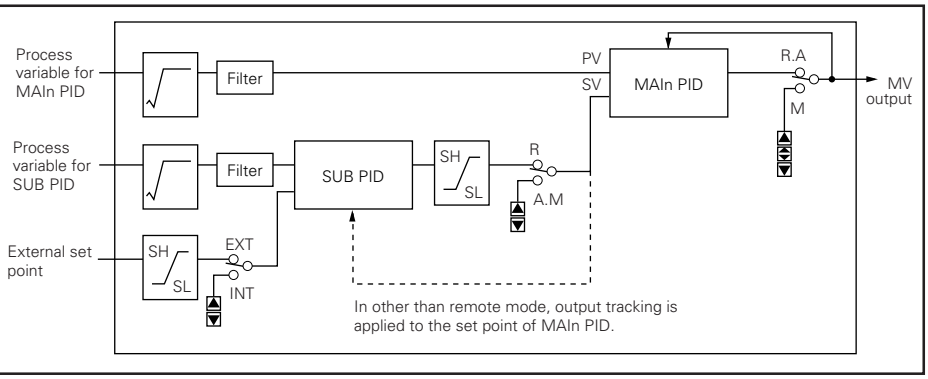
PID control

Fixed value control is carried out by using only the MAIn control block. PID control by means of an external set point is also performed. (Computation elements such as square root, filter, limiter, non-linear etc. can be made valid or invalid through specification.)



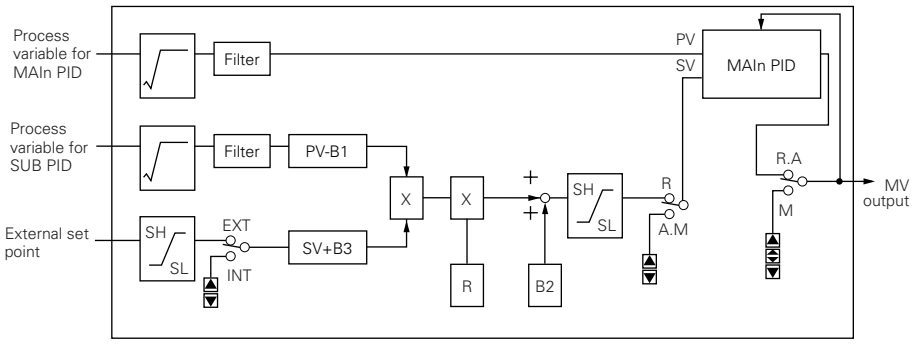
Cascade control

Cascade control is carried out by combining two PID control blocks. By having the output of the SUB PID controller follow up the set point of the MAIn PID controller, A and R can be changed over balancelessly.



Ratio control

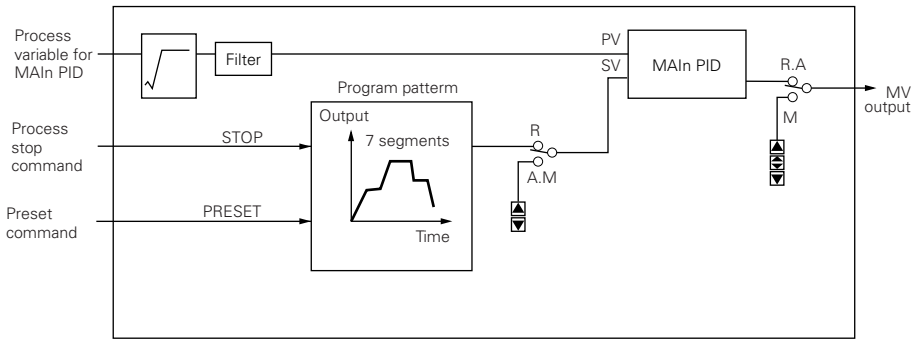
Ratio control is carried out by combining a ratio computation block and a PID control block.



Program control

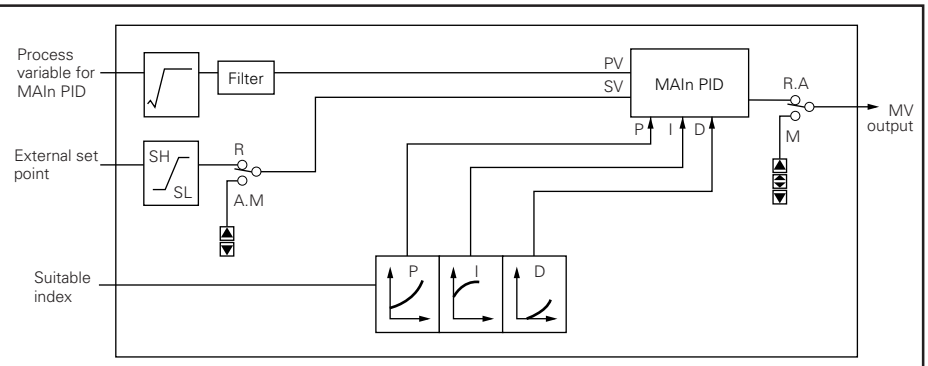
By combining a program setting block and a PID control block, the set point is changed and controlled via a time function.

A preset function is also provided for starting program control from the present temperature in a furnace for control of heating or the like.



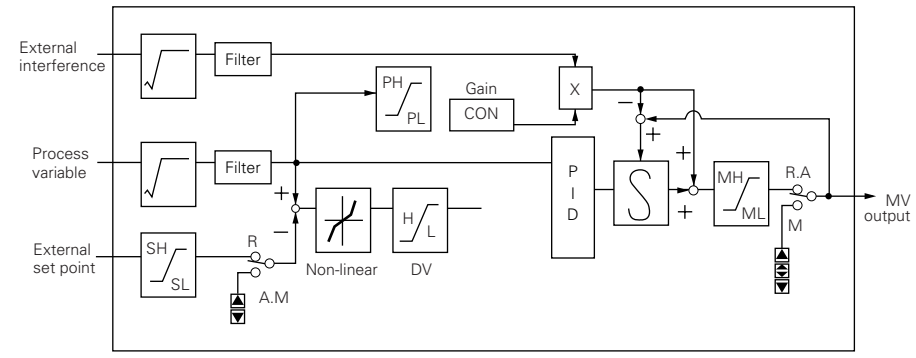
Gain schedule control

Carries out PID control according to three (3) P, I, D parameter patterns, which are stored in the form of 7 segmented line graph.



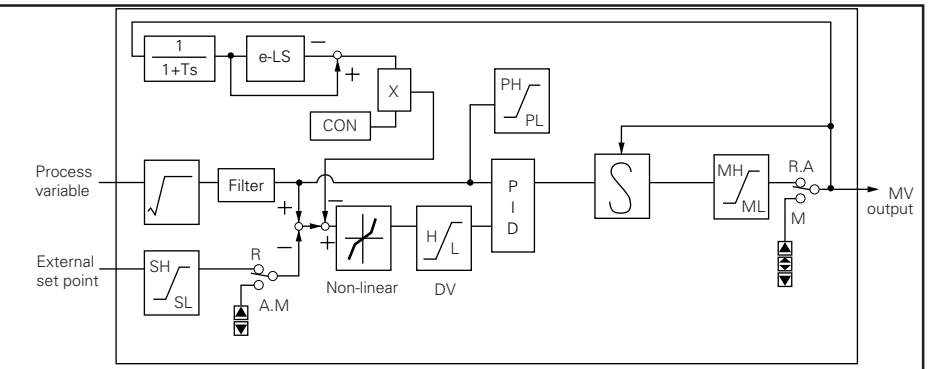
Feed forward control

By applying a suitable gain to an external interfering signal and adding it to the PID computation output, the effect of external interference can be eliminated.



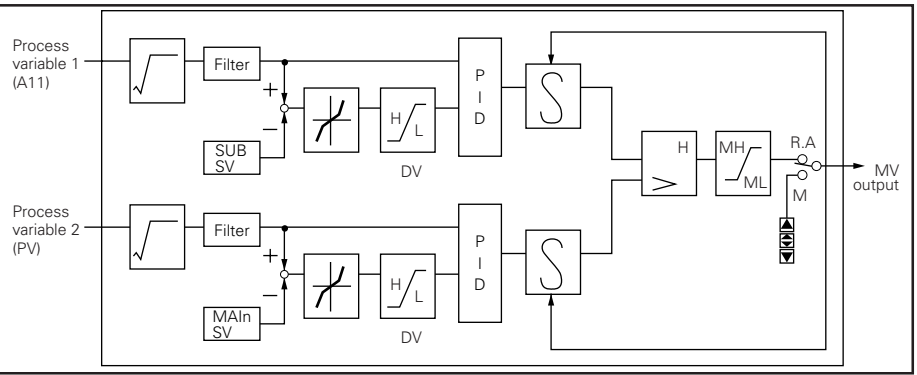
Dead time compensating control (Smith method)

When the process includes some dead time, a compensating circuit can be added to eliminate the effect of the dead time. The Smith method is effective when the process characteristics are clearly known.



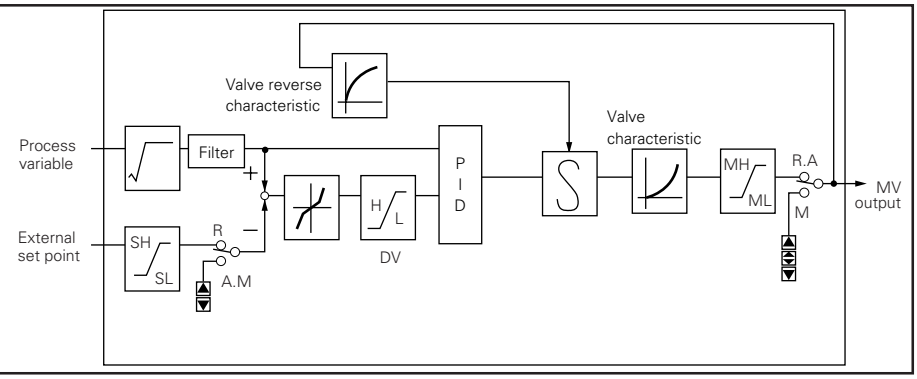
Selective control (auto selector)

PID control is carried out using the process variables at two measuring points.
In this example, output of the larger one of the PID computation results is selected.



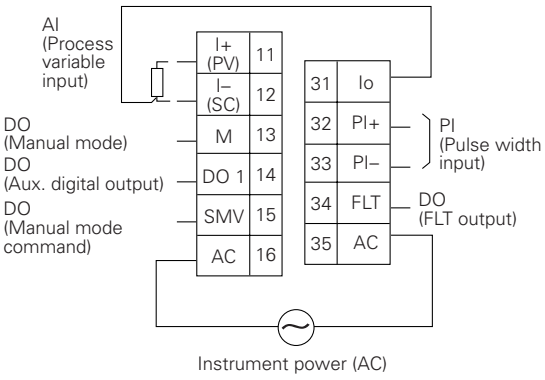
PID with valve compensating function

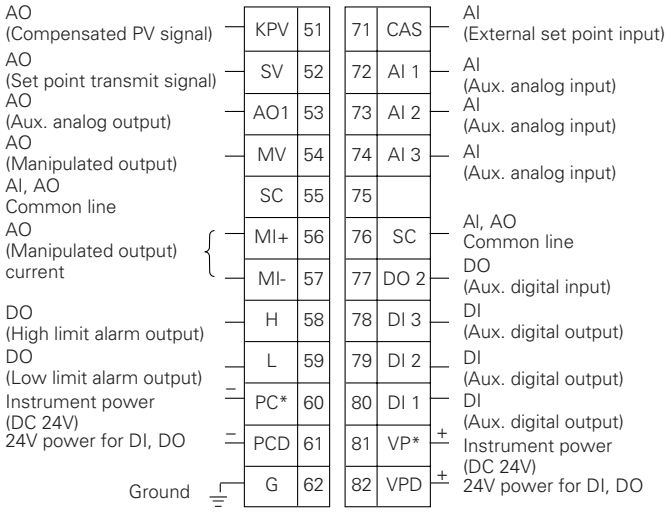
When the relation between the output signal (MV) for a valve and the valve opening is not linear, control can be made by compensating the valve characteristics.



EXTERNAL CONNECTION DIAGRAM

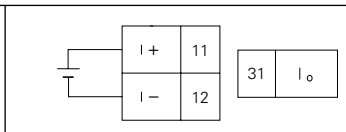
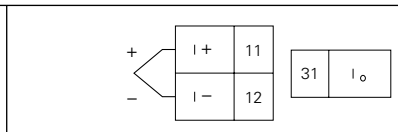
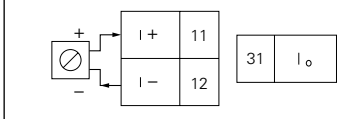
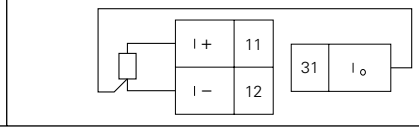
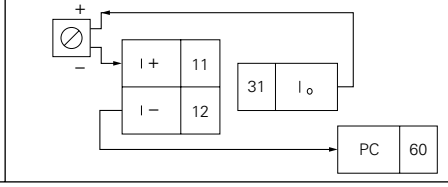
Block terminals (M4 screw)



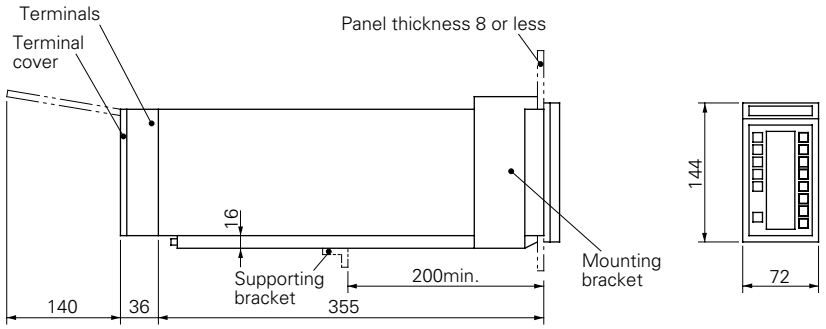


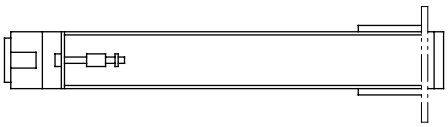
Note* : In case of AC instrumentation power supply, approximately 24V DC (0.1A max.) is supplied as VPO and PCO.

TERMINAL CONNECTION OF PV INPUT

DC 1 to 5V (Code symbol "A" in 5th digit)		Thermocouple (Code symbol "C","D","E","F" in 5th digit)	
DC 4 to 20mA (Code symbol "B" in 5th digit)		Resistance bulb (Code symbol "G", "W" in 5th digit)	
DC 4 to 20mA power supply with inner DC power supply of CC-S (Code symgol "B" in 5th digit)			

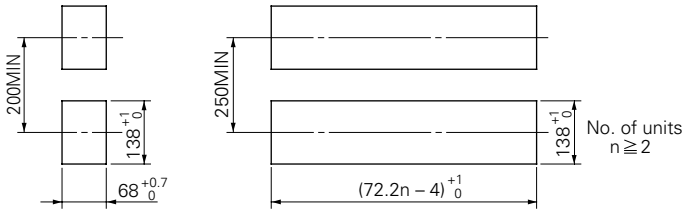
OUTLINE DIAGRAM (Unit:mm)



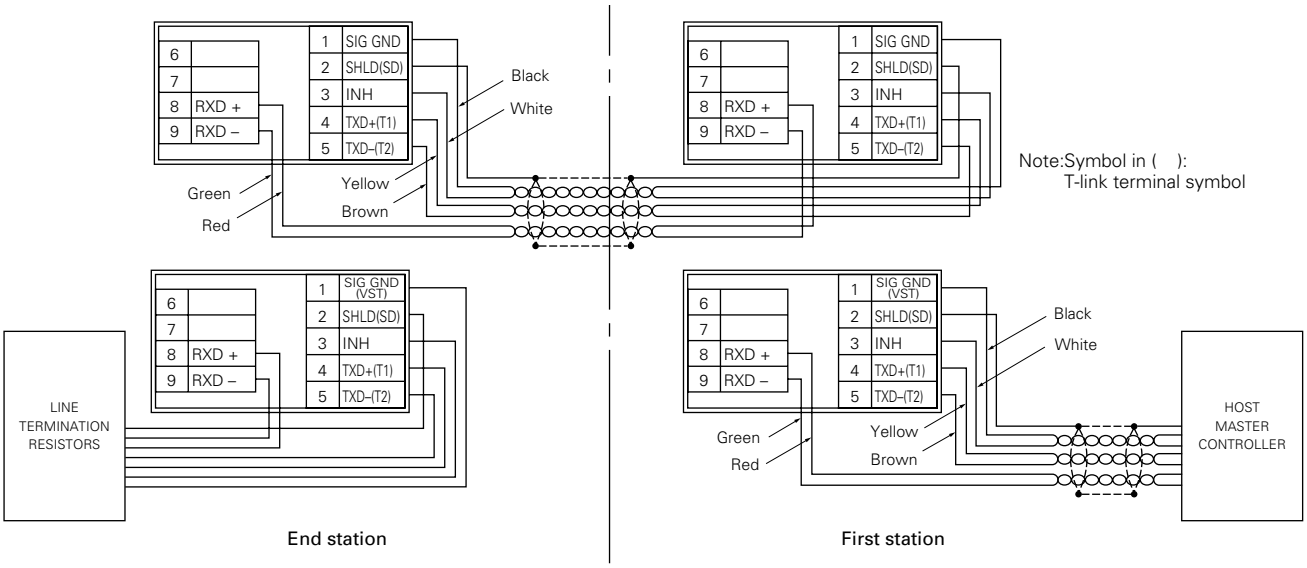


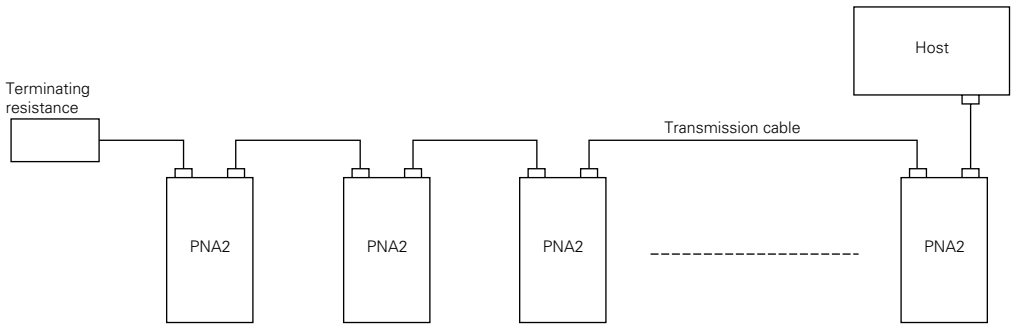
Panel cutout

When mounting one unit When mounting "n" units



TRANSMISSION CONNECTOR





Fuji Electric Co.,Ltd.

Head office
11-2, Osaki 1-chome, Shinagawa-ku, Tokyo, 141-0032 Japan
Phone: 81-3-5435-7111
http://www.fujielectric.co.jp/eng/sg/KEISOKU/welcome.htm

Fuji Electric Instruments Co.,Ltd.

Sales Div.
International Sales Dept.
No.1, Fuji-machi, Hino-city, Tokyo, 191-8502 Japan
Phone: 81-42-585-6201, 6202
Fax: 81-42-585-6187, 6189

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