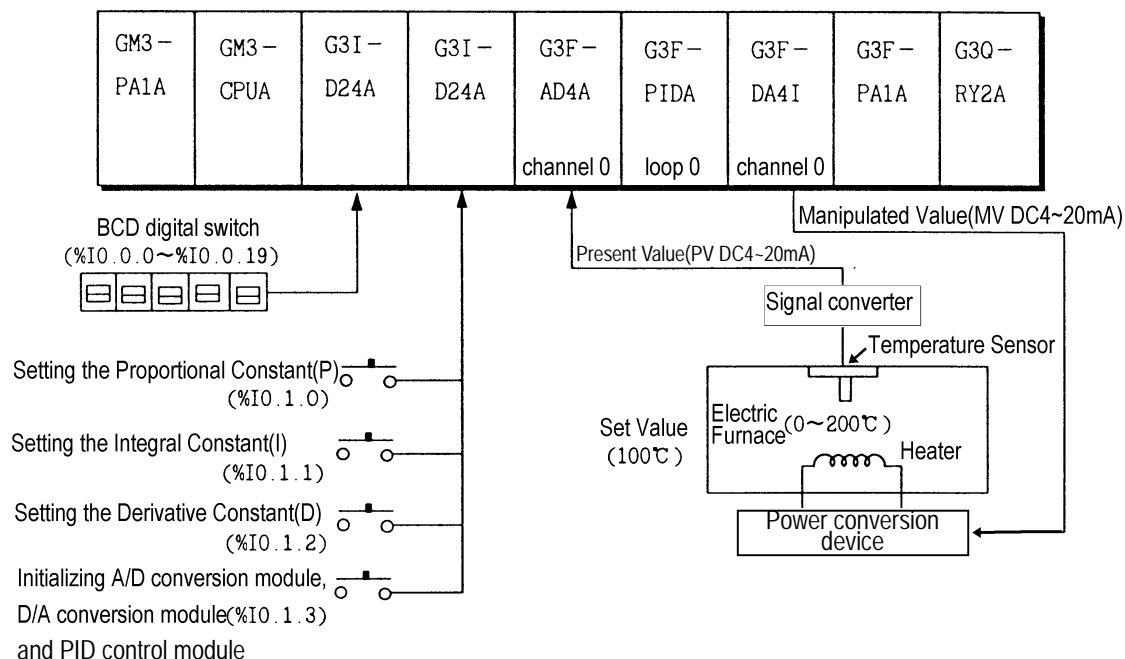


## Chapter 7. PROGRAMMING

### 7.1 A Program for Controlling an Electric Furnace (with Applying the A/D Conversion Module, PID Control Module and D/A Conversion Module)

#### 1) System Configuration



#### 2) Initial Settings

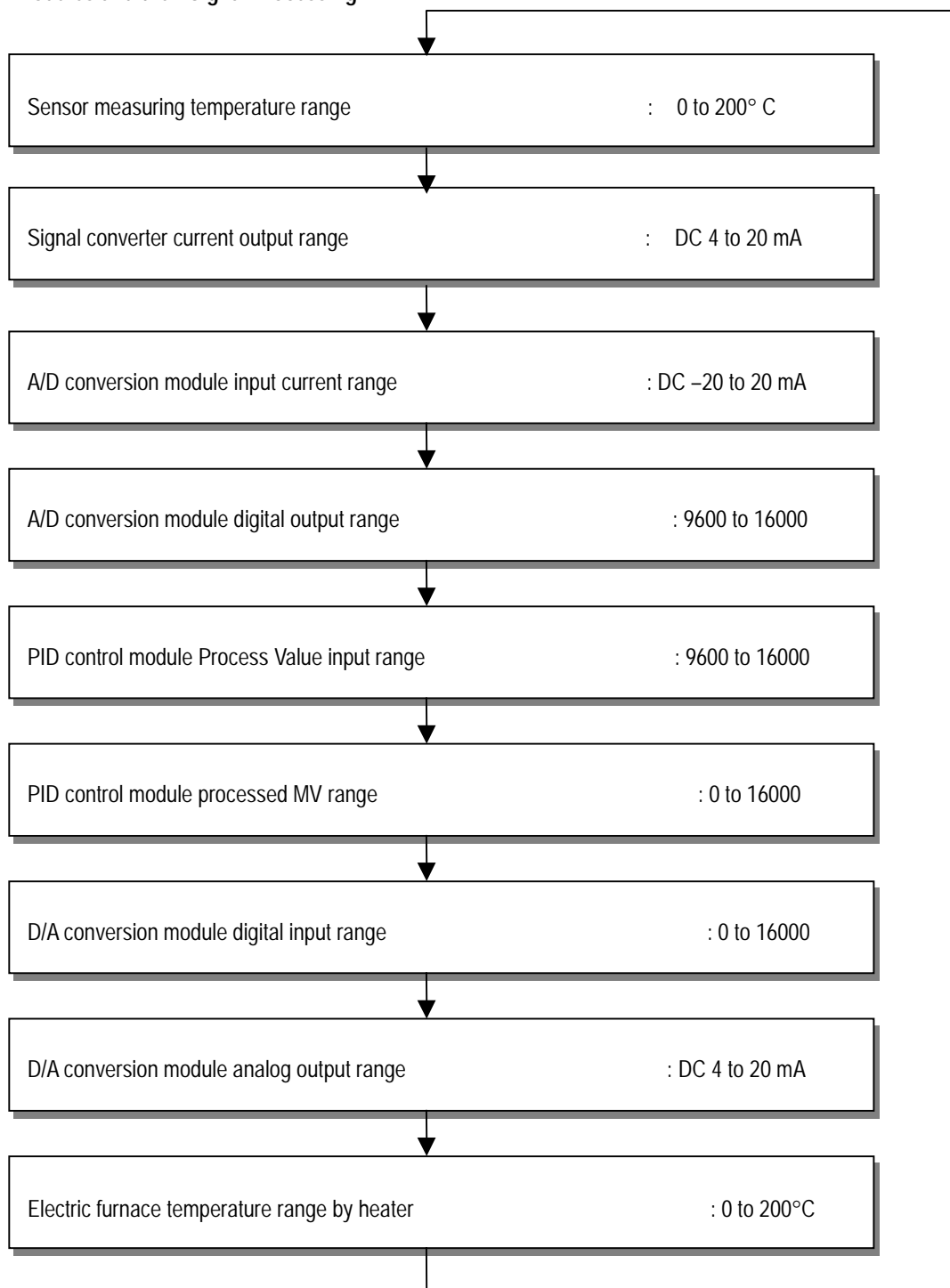
- (1) PID control module
  - A) Used loop : loop 0
  - B) Specifying forward/reverse action : forward action
  - C) Setting SV: 12800
  - D) Specifying auto/manual processing : auto processing
- (2) A/D conversion module
  - A) Used channel: channel 0
  - B) Specifying output data type: -192 to 16191
  - C) Setting filter constant: 50
- (3) D/A conversion module
  - A) Used channel: channel 0
  - B) Specifying input data type: -192 to 16191
  - C) The output when no channel is used or the CPU module is in the stop state : The median value of the output will be output.

#### 3) Descriptions of the Program

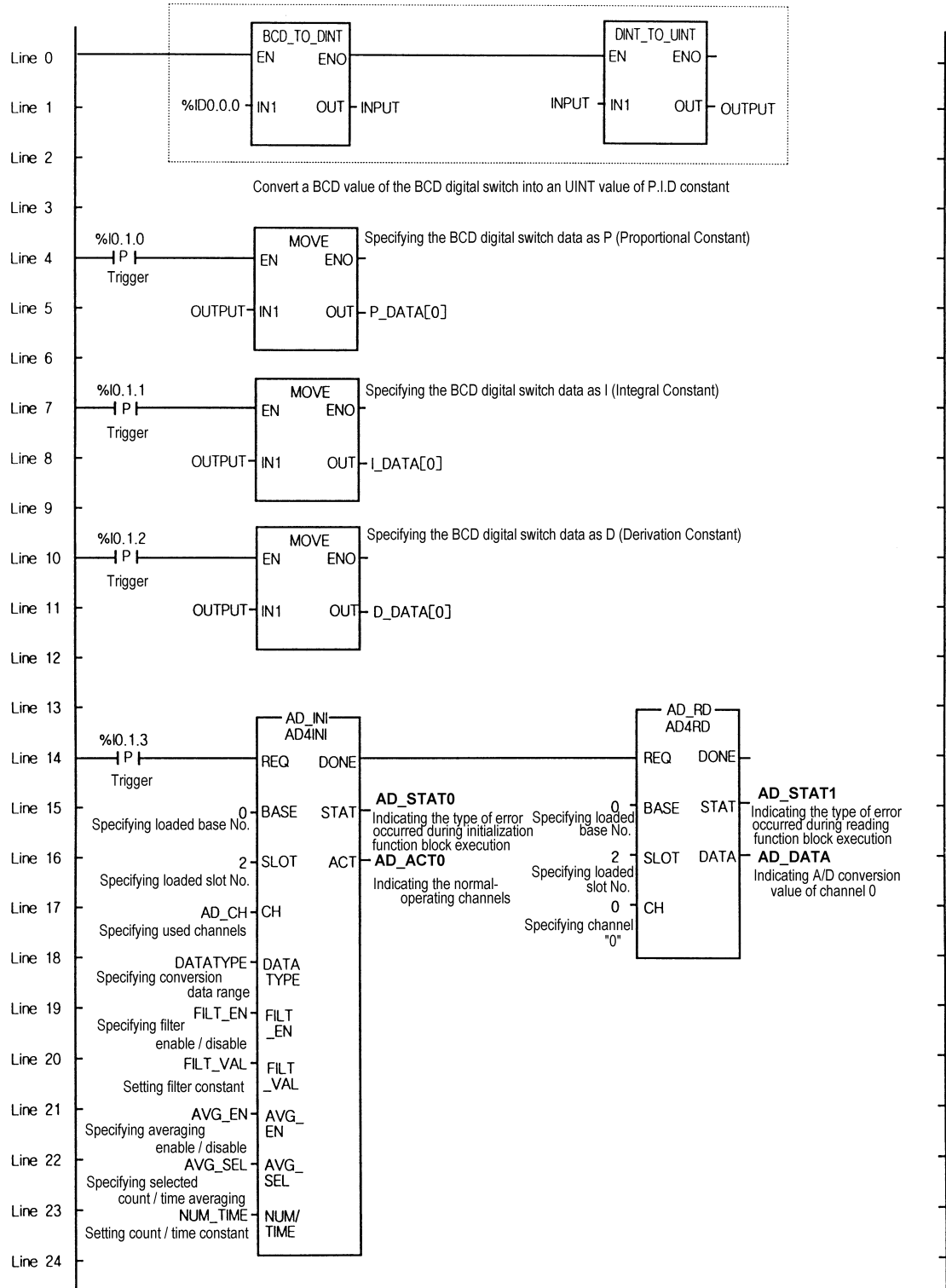
- (1) A temperature 0 to 200°C from the temperature sensor is converted into an analog signal 4 to 20 mA and then the signal is input to the channel 0 of the A/D conversion module channel and converted into a digital value 9600 to 16000.

- (2) In the PID control module, 100°C (where the signal converter output is 12 mA and 12800 as a digital value.) is set as SV. With regards to P.I.D constants, the manipulated value in the BCD digital switch is set to the proportional constant when %I0.1.0 is on, to the integral constant when %I0.1.1 is on, and to the derivative constant when %I0.1.2 is on.
- (3) MV, the result from PID processing is output at the channel 0 of the D/A conversion module.
- (4) If %I0.1.3 turns on, initial setting of the A/D conversion module, PID control module and D/A conversion module is executed.

#### 1) Modules and their Signal Processing



5) Program



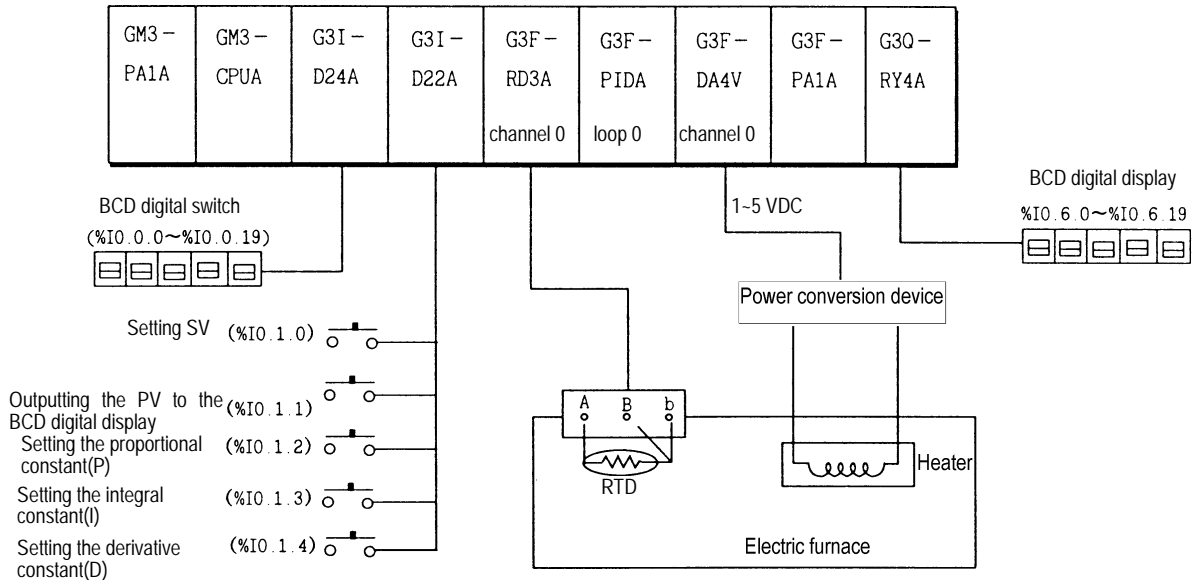


## 6) I/O Variables Used in the Program

Variable Name	Var_Kind	Data Type	(AT Address)	(Initial Value)
AD_ACTO	: VAR	: ARRAY [0..15] OF BOOL		
AD_CH	: VAR	: ARRAY [0..15] OF BOOL	: = {	1.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0 }
AD_DATA	: VAR	: INT		
AD_INI	: VAR	: FB Instance		
AD_RD	: VAR	: FB Instance		
AD_STAT0	: VAR	: USINT		
AD_STAT1	: VAR	: USINT		
AVG_EN	: VAR	: ARRAY [0..3] OF BOOL	: = {	0.0.0.0 }
AVG_SEL	: VAR	: ARRAY [0..3] OF BOOL	: = {	0.0.0.0 }
D_DATA	: VAR	: ARRAY [0..31] OF UINT	: = {	0.0 }
D_R	: VAR	: ARRAY [0..31] OF BOOL	: = {	0.0 }
DA_ACTO	: VAR	: ARRAY [0..15] OF BOOL		
DA_CH	: VAR	: ARRAY [0..15] OF BOOL	: = {	1.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0 }
DA_DATA	: VAR	: INT		
DA_INI	: VAR	: FB Instance		
DA_STAT0	: VAR	: USINT		
DA_STAT1	: VAR	: USINT		
DA_WR	: VAR	: FB Instance		
DATATYPE	: VAR	: ARRAY [0..15] OF BOOL	: = {	0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0 }
FILT_EN	: VAR	: ARRAY [0..3] OF BOOL	: = {	1.0.0.0 }
FILT_VAL	: VAR	: ARRAY [0..3] OF USINT	: = {	50.0.0.0 }
I_DATA	: VAR	: ARRAY [0..31] OF UINT	: = {	0.0 }
INPUT	: VAR	: DINT		
M_MV	: VAR	: ARRAY [0..31] OF INT	: = {	0.0 }
NUM_TIME	: VAR	: ARRAY [0..3] OF UINT	: = {	0.0.0.0 }
OUTPUT	: VAR	: UINT		
P_DATA	: VAR	: ARRAY [0..31] OF UINT	: = {	1.0 }
PID_ACTO	: VAR	: ARRAY [0..31] OF BOOL		
PID_INI	: VAR	: FB Instance		
PID_LOOP	: VAR	: ARRAY [0..31] OF BOOL	: = {	1.0 }
PID_RD	: VAR	: FB Instance		
PID_STAT0	: VAR	: USINT		
PID_STAT1	: VAR	: USINT		
SELECT	: VAR	: ARRAY [0..15] OF USINT	: = {	0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0 }
SV	: VAR	: ARRAY [0..31] OF INT	: = {	12800.0 }

## 7.2 A Program for Control Using a RTD (with Applying the RTD Input Module, PID Control Module and D/A Conversion Module)

### 1) System Configuration



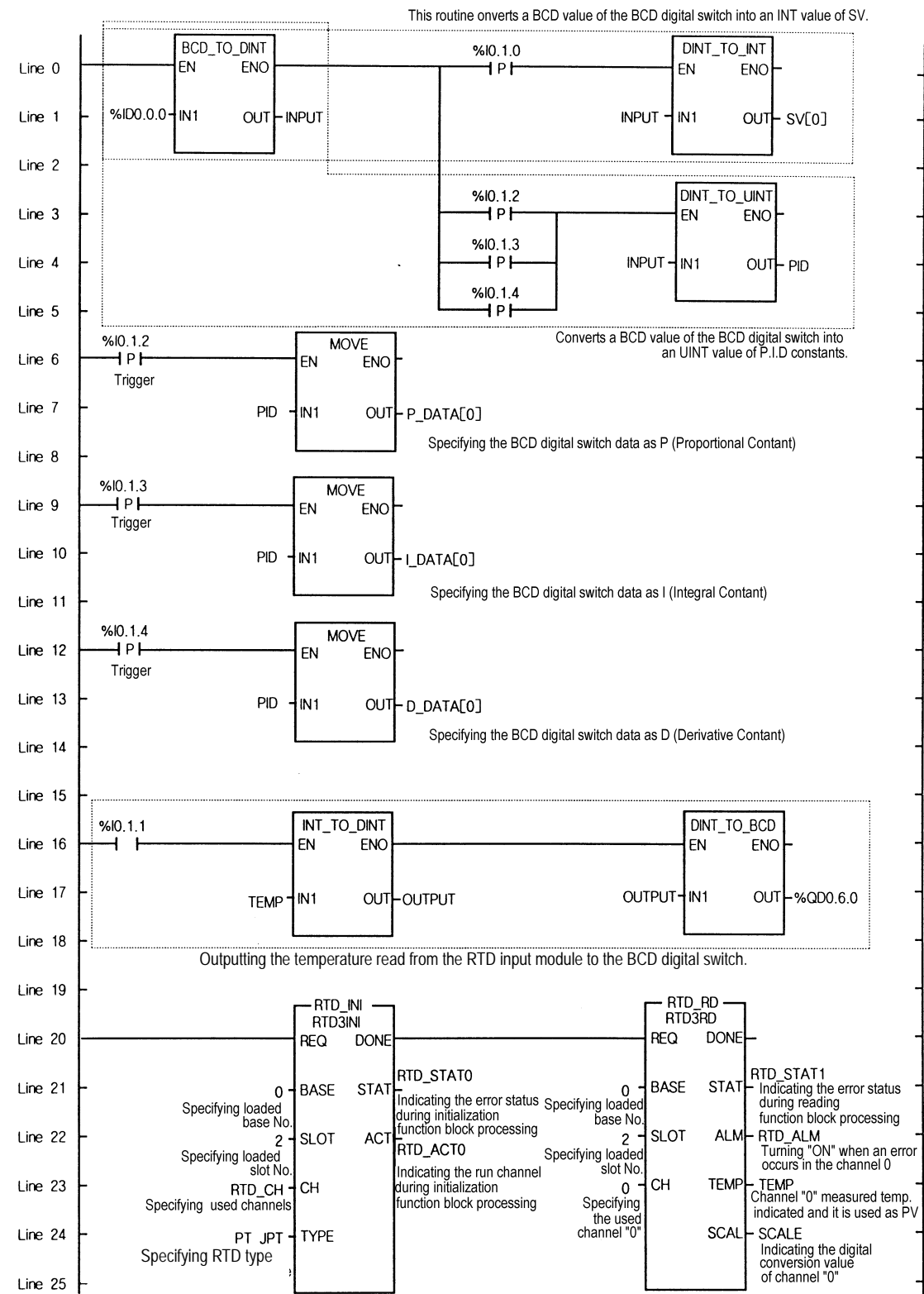
### 2) Initial Settings

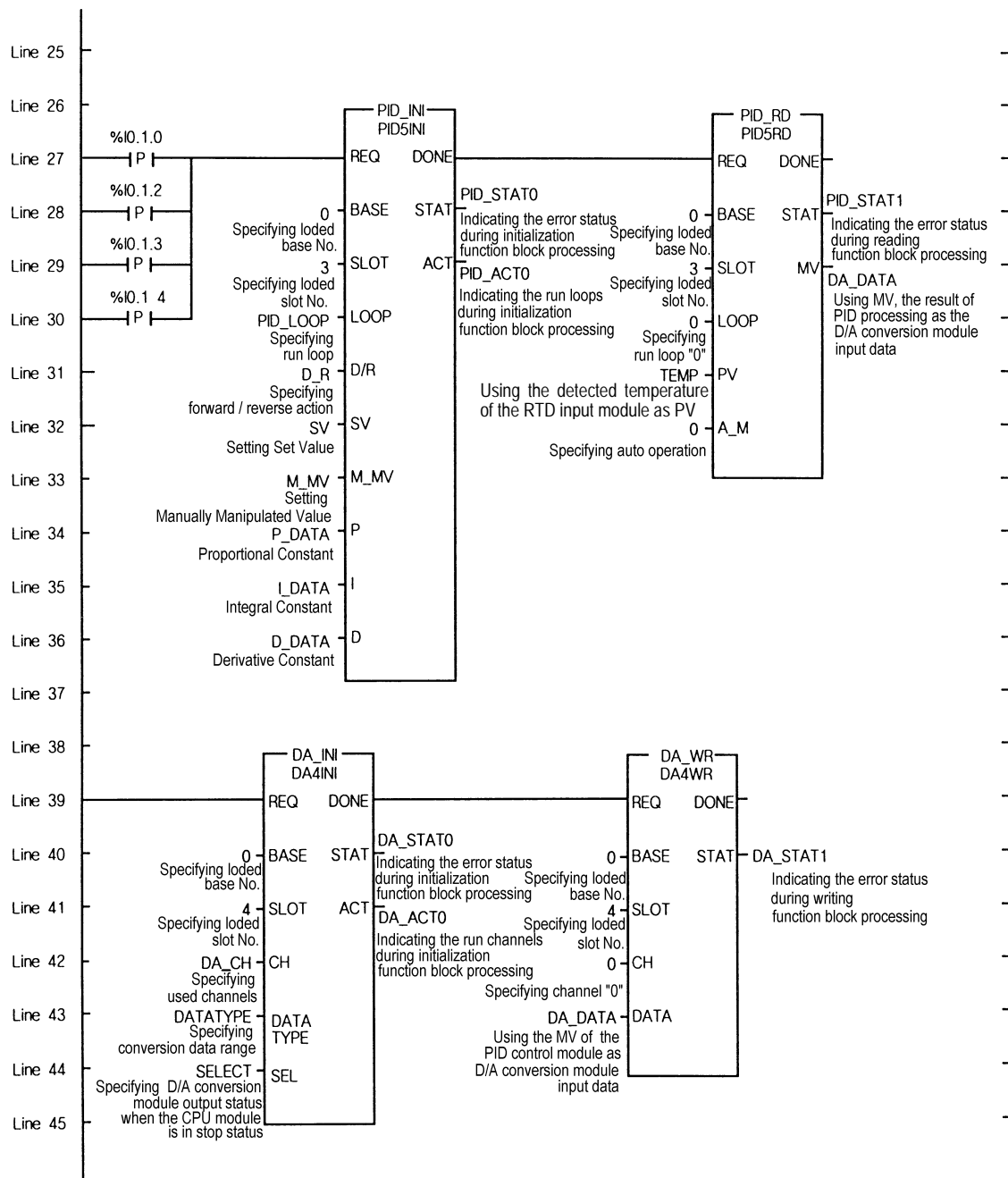
- (1) PID control module
  - A) Specifying used loop : loop 0
  - B) Specifying forward/reverse action: forward action
  - C) Specifying auto/manual processing : auto processing
- (2) RTD input module
  - A) Specifying used channel: channel 0
  - B) Specifying RTD sensor type: Pt100
- (3) D/A conversion module
  - A) Setting the voltage input range to -5 to 5 VDC (offset: 1 VDC, gain: 3 VDC)
  - B) Specifying used channel : channel 0
  - C) Specifying input data type : 0 to 16000

### 3) Descriptions of the Program

- (1) The channel 0 of the RTD input module detects a temperature of the electric furnace through Pt100 and receives it as a digital value.
- (2) The Set Value of PID control module loop 0 is set to 8000(where the temperature is 100C). With regards to P.I.D constants, the manipulated value in the BCD digital switch is set to the proportional constant when %IO.1.2 is turned on, as the integral constant when %IO.1.3 is turned on, and as the derivative constant when %IO.1.4 is turned on.
- (3) As the change of MV, the manipulated value in the BCD digital switch is set to a new MV when %IO.1.0 is turned on.
- (4) MV, the result from PID processing is output at the channel 0 of the D/A conversion module.
- (5) If %IO.1.1 turns on, PV is displayed on the BCD digital display.

4) Program



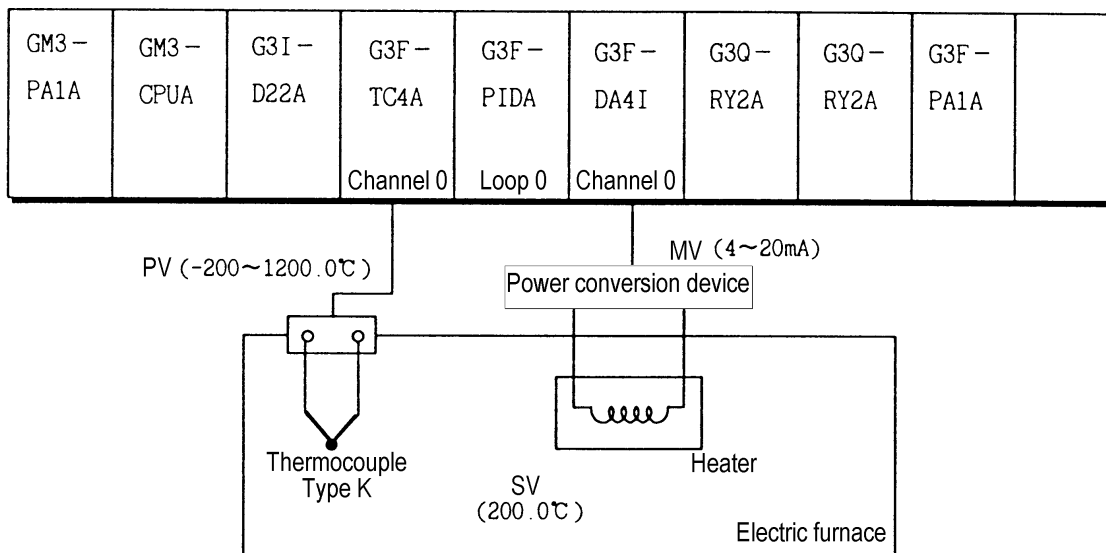






### 7.3 A Program for Control Using a Thermocouple (with Applying the TC Input module, PID Control Module and D/A Conversion Module)

#### 1) System Configuration



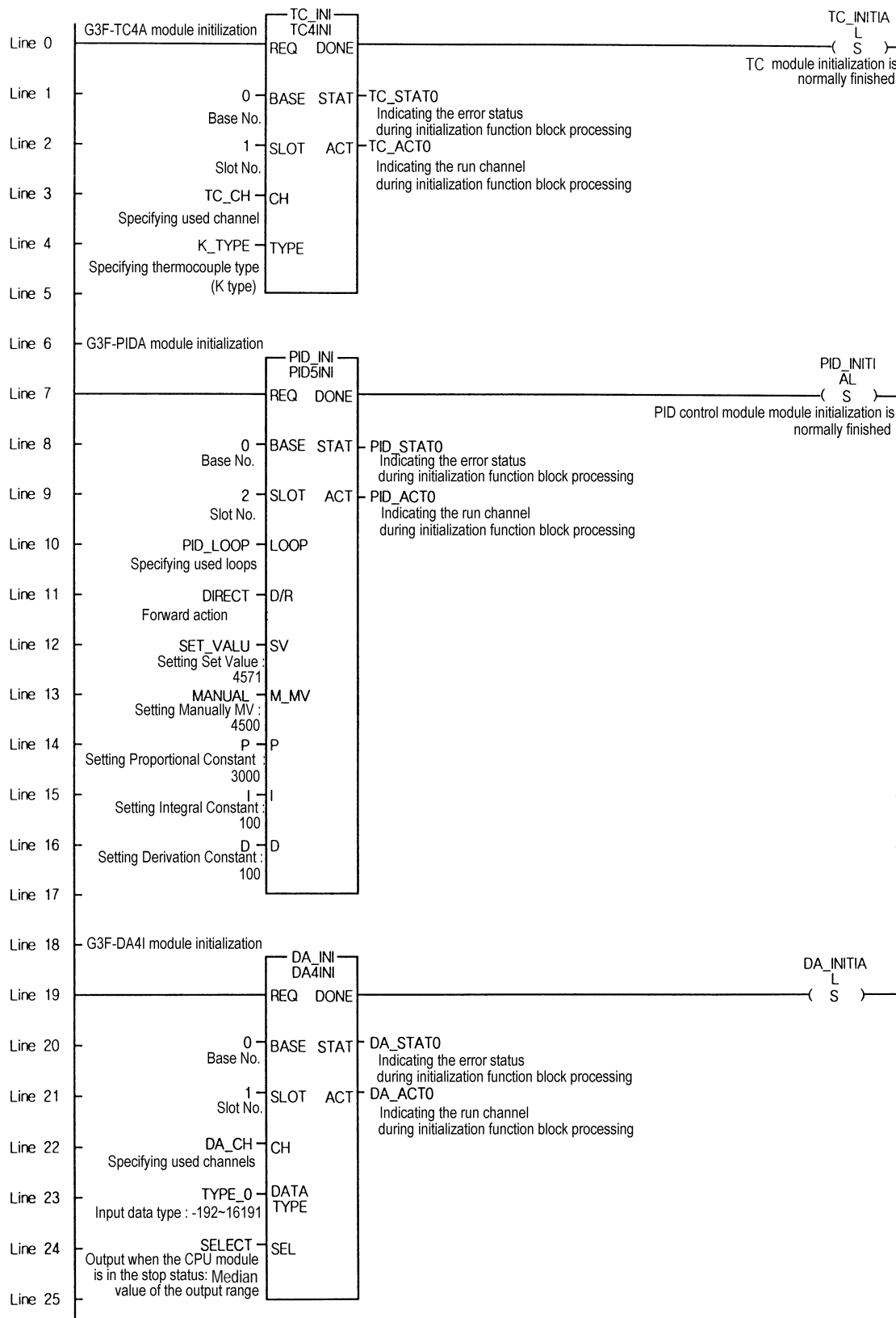
#### 2) Initial Settings

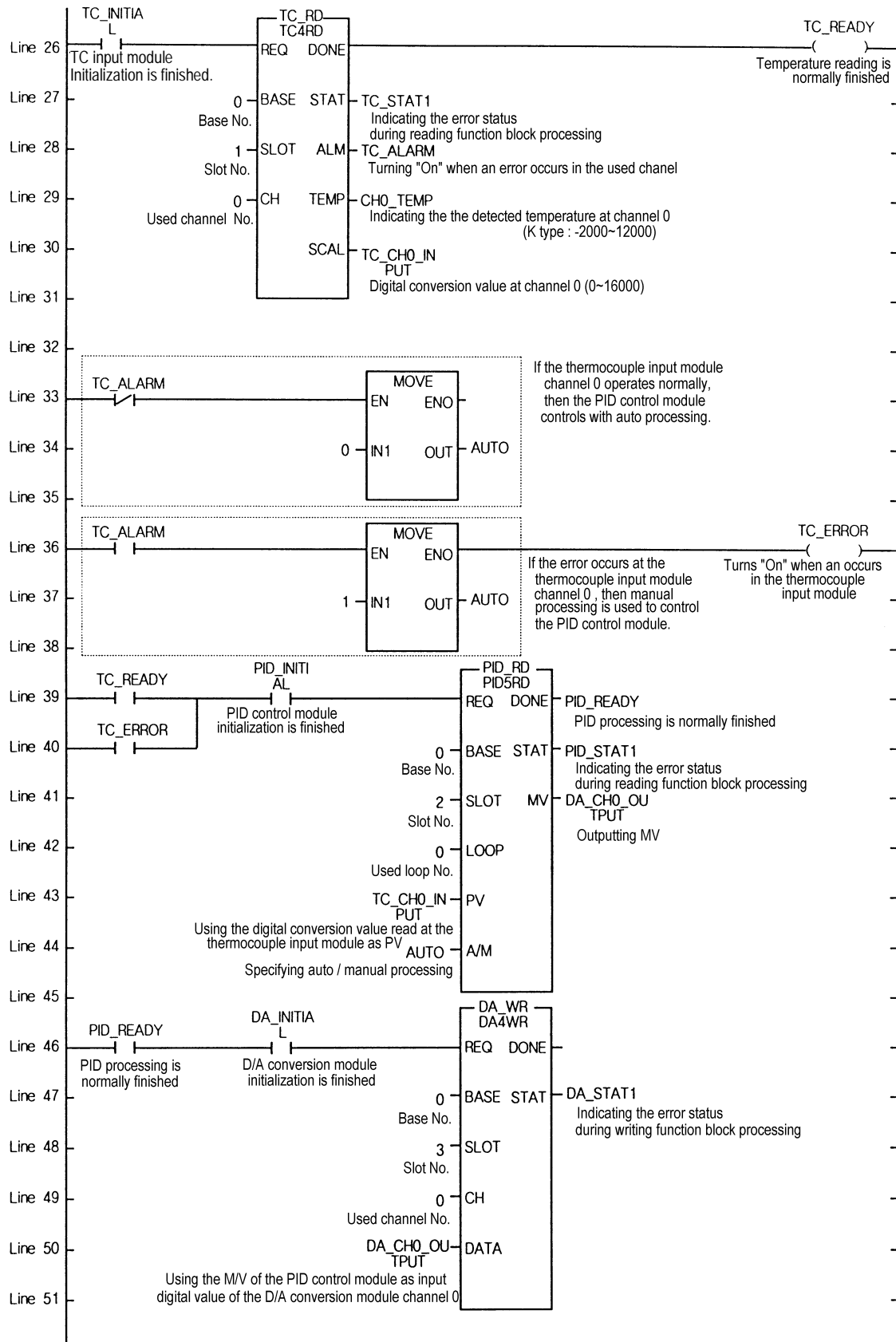
- (1) TC input module
  - A) Specifying used channel : channel 0
  - B) Specifying TC type: K type
- (2) PID control module
  - A) Specifying used loop : loop 0
  - B) Specifying forward/reverse action: forward action
  - C) Specifying auto/manual processing : auto processing
  - D) Setting SV: 200°C (4571 as digital value)
  - E) Setting M\_MV (Used when errors occur) : 4500
  - F) Setting P : 3000
  - G) Setting I : 100
  - H) Setting D : 100
  - I) Auto processing is changed to manual processing when errors occur.
- (3) D/A conversion module
  - A) Specifying used channel: channel 0
  - B) Specifying input data type: -192 to 16191
  - C) Output when the CPU module is in the stop state : The median value of the output range is output.

#### 3) Descriptions of the Program

- 1) The temperature of the electric furnace is converted into a digital value through the channel 0 of the thermocouple input module, and the digital value in the reading function block output variable SCAL is used as PV of the PID control module.
- 2) The MV of the PID control module is used as input digital data of the channel 0 of the D/A conversion module.
- 3) If ALM, an output variable of the reading function block of the thermocouple input module turns On, A/M, an input variable of the read function block of the PID control module changes from "0" to "1" and the manual control processing is executed.

## 4) Program





### 5) I/O Variables Used in the Program

Variable Name	Var_Kind	Data Type	(AT Address)	(Initial Value)
AUTO	: VAR	: BOOL		
CHO_TEMP	: VAR	: INT		
D	: VAR	: ARRAY [0..31] OF UINT	= {	{ 100.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0. 0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0 }
DA_ACTO	: VAR	: ARRAY [0..15] OF BOOL		
DA_CH	: VAR	: ARRAY [0..15] OF BOOL	= {	{ 1.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0 }
DA_CHO_OUTPUT	: VAR	: INT		
DA_INI	: VAR	: FB Instance		
DA_INITIAL	: VAR	: BOOL		
DA_STATO	: VAR	: USINT		
DA_STAT1	: VAR	: USINT		
DA_WR	: VAR	: FB Instance		
DIRECT	: VAR	: ARRAY [0..31] OF BOOL	= {	{ 0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0 0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0 }
I	: VAR	: ARRAY [0..31] OF UINT	= {	{ 100.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0 0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0 }
K_TYPE	: VAR	: ARRAY [0..15] OF USINT	= {	{ 0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0 }
MANUAL	: VAR	: ARRAY [0..31] OF INT	= {	{ 4500.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0 0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0 }
P	: VAR	: ARRAY [0..31] OF UINT	= {	{ 3000.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0 0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0 }
PID_ACTO	: VAR	: ARRAY [0..31] OF BOOL		
PID_INI	: VAR	: FB Instance		
PID_INITIAL	: VAR	: BOOL		
PID_LOOP	: VAR	: ARRAY [0..31] OF BOOL	= {	{ 1.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0 0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0 }
PID_RD	: VAR	: FB Instance		
PID_READY	: VAR	: BOOL		
PID_STATO	: VAR	: USINT		
PID_STAT1	: VAR	: USINT		
SELECT	: VAR	: ARRAY [0..15] OF USINT	= {	{ 0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0 }
SET_VALU	: VAR	: ARRAY [0..31] OF INT	= {	{ 4571.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0 0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0 }
TC_ACTO	: VAR	: ARRAY [0..15] OF BOOL		
TC_ALARM	: VAR	: BOOL		
TC_CH	: VAR	: ARRAY [0..15] OF BOOL	= {	{ 1.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0 }
TC_CHO_INPUT	: VAR	: INT		
TC_ERROR	: VAR	: BOOL		
TC_INI	: VAR	: FB Instance		
TC_INITIAL	: VAR	: BOOL		
TC_RD	: VAR	: FB Instance		
TC_READY	: VAR	: BOOL		
TC_STATO	: VAR	: USINT		
TC_STAT1	: VAR	: USINT		
TYPE_0	: VAR	: ARRAY [0..15] OF BOOL	= {	{ 0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0 }