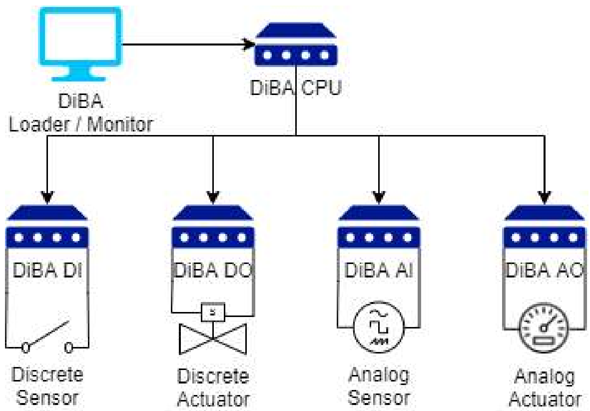
DG17E4C

1. Summary

DG17E4C is an analog input module of DiBA PLC (Programmable Logic Controller). DiBA PLC composes an automatic control system with modules for each function as shown in [Figure 1], and users can select the optimal module configuration according to the size and characteristics of the control target.



[Figure 1] Configuration of automatic control system

The product name of the model DG17E4C is MODBUS RTU AI. The model name consists of the product label, the release year, and the representative model name (E4C).

Since E4C operates only as a MODBUS RTU slave, it is controlled by a MODBUS RTU master such as E5A (CPU Type 1). Users can create a DST file to specify what E5A will work with. (More details are in the E5A manual.)

The AI terminal of E4C measures the voltage and current supplied from the outside. Voltage can be measured in the range of 0~10[V], and current can be measured in the range of 0~20[mA]. E4C's UI (Universal Input) terminal measures the temperature by PT1000 (Platinum Temperature Sensor, which has a resistance value from 0[℃] to 1000[Ω]), one of the resistance sensors called RTD (Resistance Temperature Detector), or You can measure ON/OFF like DI (Digital Input) by connecting a switch. When the UI of E4C is used as DI, it reads short-circuit status as ON and open status as OFF. The information read in this way is displayed on the LED assigned to each DI. When it is ON, the LED turns on and when it is OFF, the LED turns off.

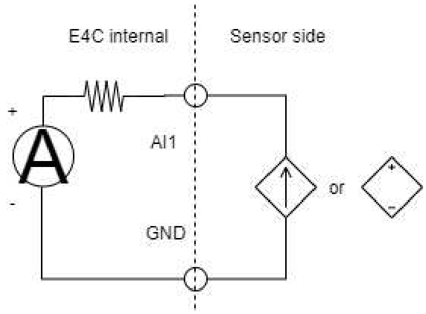
The isolation design is applied to the E4C so that the user of the automatic control system can safely control various devices. (Refer to [Figure 4]) The internal area where the user is (isolated group 1) includes the power supply and RS485, and the external Area (Containment Group 2) contains AI and UI.

Terminals		function	Normal input range	characteristic
AI (8)		Voltage measurement	0~10[V]	No separate settings are required for voltage or current measurement, and both pieces of information can be used.
		Current measurement	0~20[mA]	
UI (8)	DI	resistance measurement (Short decision)	ON: 0~4[kΩ] OFF: more than 4[kΩ]	No separate setting is required to select DI function or RTD function, and both types of information are always available.
	RTD	resistance measurement (Temperature calculation)	0~4[kΩ] (-200~800[℃])	

2. Specification

E4C has 8 AIs. [Figure 2] is an easy-to-understand representation of the internal circuit of AI1. The rest of the AI has the same shape.

AI measures the voltage or current supplied by the sensor. The internal resistance of AI is 500[Ω], so if 20[mA] is supplied from the sensor side, 10[V] is measured at the AI terminal.

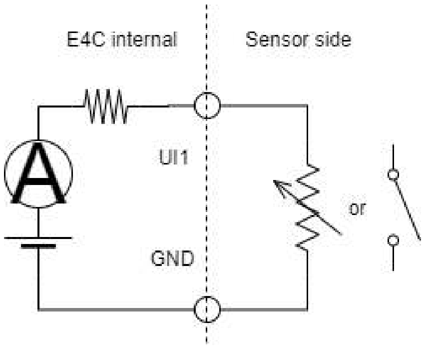


[Figure 2] Internal circuit model of AI and usage example

E4C has 8 UIs. [Figure 3] is an easy-to-understand representation of the internal circuit of UI1. The rest of the UI has the same shape. Users can connect and use switches, resistors, and temperature sensors (PT1000) to the UI.

(Caution) Connecting the power to the sensor side of the UI may cause product failure.

UI measures the resistance of the sensor side. The usage example is an equivalent circuit for connecting a temperature sensor (PT1000). You can read ON/OFF by connecting a switch instead of a variable resistor. When the external circuit of the UI is connected and the resistance value falls below about 4[kΩ], the UI is judged as ON as DI.



[Figure 3] UI's internal circuit model and usage example

3. Operation basics

All E4C information is mapped to the MODBUS Holding Register area and cannot be accessed from other areas. If the MODBUS RTU master cannot properly process the request sent to E4C, it will respond with an error. The error response includes an error code, and the error codes used by E4C are as follows:

Error code	Error name	Content of error
1	Illegal Function	Function not supported
2	Illegal Address	Nonexistent register or write request for read-only
3	Illegal Value	Value outside the valid range

Operate the E4C's Dip Switch to set the baud rate and Slave ID. When the Dip Switch is pushed inside the E4C body, it is ON, and when it is pushed outside the E4C, it is OFF. Baudrate can be set as follows.

Dip Switch: Baudrate1	Dip Switch: Baudrate0	Set baudrate [bps]	Common setting
OFF	OFF	9600	No Parity 8 Data Bits 1 Stop Bit
OFF	ON	19200	
ON	OFF	38400	
ON	ON	57600	

E4C's Slave ID is the same as the value read Dip Switch in binary. If the Dip Switch is ON, it is reported as 1, and if it is OFF, it is reported as 0, and Slave ID is calculated by looking at Address5 ~ Address0 as 25(=32) ~ 20(=1). Two examples are given below and summarized in the table. (2# is an indicator for binary notation) If Slave ID is set to 0, E4C does not respond.

(Example 1) Setting Slave ID to 37. Address5 ~ Address0 = 2#100101

(Example 2) Setting Slave ID to 1. Address5 ~ Address0 = 2#000001

Name of Dip Switch	Place value	(Example 1) 37 = 2#100101 = 1 x 2^5 + 0 x 2^4 + 0 x 2^3 + 1 x 2^2 + 0 x 2^1 + 1 x 2^0	(Example 2) 1 = 2#000001 = 0 x 2^5 + 0 x 2^4 + 0 x 2^3 + 0 x 2^2 + 0 x 2^1 + 1 x 2^0
Address5	2^5	1 = ON	0 = OFF
Address4	2^4	0 = OFF	0 = OFF
Address3	2^3	0 = OFF	0 = OFF
Address2	2^2	1 = ON	0 = OFF
Address1	2^1	0 = OFF	0 = OFF
Address0	2^0	1 = ON	1 = ON

The temperature measured at the UI terminal is stored in “RTD” (unit [0.1 ℃]), and DI information is stored in “RTD connection”. If the wire between the UI terminal and PT1000 is long, the resistance value of the wire is added and the measured temperature error increases. To reduce the temperature error by reflecting the resistance value of the wire in advance, update the “RTD line resistance correction” (unit [0.1 Ω]). The value stored in “RTD line resistance correction” is maintained even when the E4C power is turned off, so after installation, the line resistance is measured and reflected only once.

The voltage measured at the AI terminal is stored in “AI voltage” (unit [mV]). If there is an error in the external AO voltage or the wire is long, an error may occur in the measured voltage. The error between −1000 and 1000 [mV] can be corrected by using “AI voltage correction” (unit [mV]). The value stored in “AI voltage correction” is maintained even when the E4C is powered off.

When E4C is set to the factory default value, “AI Fit” is the same as the current measured by AI (unit [μA]). Users can convert the value of “AI Fit” into a desired range by using “AI Custom Min” (unit [mV]), “AI Custom Max” (unit [mV]), and “AI Custom Scale”. . The conversion formula is as follows.

$$\text{AI Fit} = \frac{\text{AI voltage} - \text{AI Custom Min}}{\text{AI Custom Max} - \text{AI Custom Min}} \times \text{AI Custom}$$

The factory default value is “AI Customization Min” is 0, “AI Customization Max” is 10000, and “AI Customization Magnification” is 20000, so if you calculate by entering the range of “AI voltage” 0 and 10000 [mV], “AI Customization” is You can see it converts to the measured current (0 and 20000 [μA]).

When AI voltage = 0 [mV] = 0 [V],

AI Fit = $\frac{0-0}{10000-0} \times 20000$ = 0 [μA] = 0 [mA]

When AI voltage = 10000 [mV] = 10 [V],

$$\text{AI Fit} = \frac{10000 - 0}{10000 - 0} \times 20000 = 20000\ [\mu A] = 20\ [mA]$$

The conversion formula of “AI fit” is “AI voltage” to “AI fit minimum” to 0, and “AI fit maximum” to

This is the process of normalization to 1 (normalization, changing to a value between 0 and 1 to change to a unitless state), multiplying by “AI custom scale” and converting to a new unit. When “AI Voltage” is lower than “AI Fit Min”, “AI Fit” is 0, and when “AI Voltage” is higher than “AI Fit Max”, “AI Fit” is equal to the set “AI Fit Multiplier”. The following example shows that the output current range of the external AO is 4~10 [mA], and E4C converts it to the range of 0~100 and saves it in “AI Custom”.

Design goal	Output current range of external AO: 4 ~ 10 [mA] Conversion result range of “AI fit”: 0 ~ 100
Product Specifications	Internal resistance of AI terminal: 500 [Ω]
Converting design goals into conversion information	Output voltage range of external AO: 2000 ~ 5000 [mV]
“AI custom minimum” extraction	Minimum external AO output voltage: 2000 [mV]
“AI Custom Max” extraction	Maximum external AO output voltage: 5000 [mV]
“AI custom magnification” extraction	Maximum value of “AI fit” conversion result: 100
(Ex) External AO current = 1 [mA]	Measured “AI voltage” = 500 [mV] Because “AI voltage” is less than “AI fit minimum” “AI Fit” = 0
(Ex) External AO current = 4 [mA]	Measured “AI voltage” = 2000 [mV] “AI voltage” used in conversion formula = 2000 [mV] “AI Fit” = $\frac{2000-2000}{5000-2000} \times 100$ = 0
(Ex) External AO current = 5 [mA]	Measured “AI voltage” = 2500 [mV] “AI voltage” used in conversion formula = 2500 [mV] “AI Fit” = $\frac{2500-2000}{5000-2000} \times 100$ = 16
(Ex) External AO current = 10 [mA]	Measured “AI voltage” = 5000 [mV] “AI voltage” used in conversion formula = 5000 [mV] “AI Fit” = $\frac{5000-2000}{5000-2000} \times 100$ = 100
(Ex) External AO current = 12 [mA]	Measured “AI voltage” = 6000 [mV] Because “AI voltage” is greater than “AI fit maximum” “AI Fit” = 100

If the output range of the external AO terminal is displayed as 4~20 [mA], if you want to read this output value as 4,000~20,000 [uA], you must use the factory default value. When “AI Fit Min” is set to 2000 [mV], the unit of the value stored in “AI Fit” is not [uA]. At this time, if 4000 [uA] is entered in the AI terminal, the value of “AI Alignment” is read as 0.

4. MODBUS Protocol Memory Map

E4C is a MODBUS slave and only provides holding registers. Holding register is an area where both read and write are possible, but read and write are not possible at addresses where E4C does not provide registers. In addition, there are addresses that can only be read, so the MODBUS master must be accessed by referring to the table below. Registers do not exist for addresses not shown in the table.

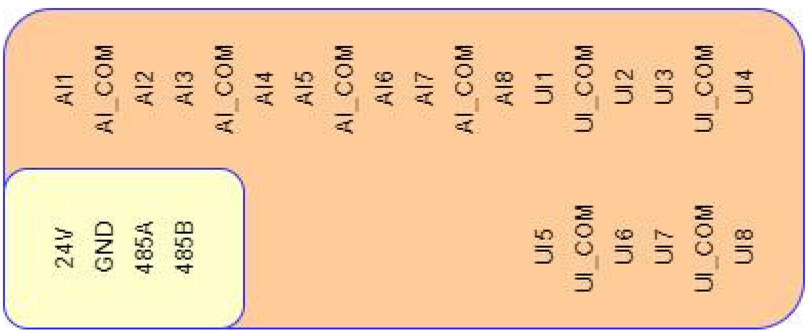
address	Read/Write	name	value(= meaning)
0	R	RTD 1 (PT1000)	-2000~8000 = Temperature [0.1 °C] (예) If it reads as -123, it is -12.3 [°C].
1	R	RTD 2 (PT1000)	-2000~8000 = Temperature [0.1 °C]
2	R	RTD 3 (PT1000)	-2000~8000 = Temperature [0.1 °C]
3	R	RTD 4 (PT1000)	-2000~8000 = Temperature [0.1 °C]
4	R	RTD 5 (PT1000)	-2000~8000 = Temperature [0.1 °C]
5	R	RTD 6 (PT1000)	-2000~8000 = Temperature [0.1 °C]
6	R	RTD 7 (PT1000)	-2000~8000 = Temperature [0.1 °C]
7	R	RTD 8 (PT1000)	-2000~8000 = Temperature [0.1 °C]
8	R	RTD connection (Can be used as DI)	0~255 = bit mapped in the word Bit 0 (LSB): RTD 1 {1 = connected, 0 = NC} ... Bit 7: RTD 8 {1 = connected, 0 = NC}
10	R	AI Voltage 1	0~10000 = Voltage [mV] (예) If it reads as 123, it is 123 [mV].
11	R	AI Voltage 2	0~10000 = Voltage [mV]
12	R	AI Voltage 3	0~10000 = Voltage [mV]
13	R	AI Voltage 4	0~10000 = Voltage [mV]
14	R	AI Voltage 5	0~10000 = Voltage [mV]
15	R	AI Voltage 6	0~10000 = Voltage [mV]
16	R	AI Voltage 7	0~10000 = Voltage [mV]
17	R	AI Voltage 8	0~10000 = Voltage [mV]
20	R	AI Fit 1	0~Magnification
21	R	AI Fit 2	0~Magnification
22	R	AI Fit 3	0~Magnification
23	R	AI Fit 4	0~Magnification
24	R	AI Fit 5	0~Magnification
25	R	AI Fit 6	0~Magnification
26	R	AI Fit 7	0~Magnification
27	R	AI Fit 8	0~Magnification

address	Read/Write	name	value(= meaning)
1000	R/W	RTD 1 Line resistance correction	0~100 = Line resistance [0.1 Ω]: Factory default 0 (예) If it reads as 12, it is 1.2 [Ω].
1001	R/W	RTD 2 Line resistance correction	0~100 = Line resistance [0.1 Ω]
1002	R/W	RTD 3 Line resistance correction	0~100 = Line resistance [0.1 Ω]
1003	R/W	RTD 4 Line resistance correction	0~100 = Line resistance [0.1 Ω]
1004	R/W	RTD 5 Line resistance correction	0~100 = Line resistance [0.1 Ω]
1005	R/W	RTD 6 Line resistance correction	0~100 = Line resistance [0.1 Ω]
1006	R/W	RTD 7 Line resistance correction	0~100 = Line resistance [0.1 Ω]
1007	R/W	RTD 8 Line resistance correction	0~100 = Line resistance [0.1 Ω]
1010	R/W	AI Voltage 1 correction	-1000~1000 = Correction voltage [mV]: Factory default 0
1011	R/W	AI Voltage 2 correction	-1000~1000 = Correction voltage [mV]
1012	R/W	AI Voltage 3 correction	-1000~1000 = Correction voltage [mV]
1013	R/W	AI Voltage 4 correction	-1000~1000 = Correction voltage [mV]
1014	R/W	AI Voltage 5 correction	-1000~1000 = Correction voltage [mV]
1015	R/W	AI Voltage 6 correction	-1000~1000 = Correction voltage [mV]
1016	R/W	AI Voltage 7 correction	-1000~1000 = Correction voltage [mV]
1017	R/W	AI Voltage 8 correction	-1000~1000 = Correction voltage [mV]
1020	R/W	AI Fit minimum 1	0~3000 = Minimum voltage of sensing range [mV]: Factory default 0
1021	R/W	AI Fit minimum 2	0~3000 = Minimum voltage of sensing range [mV]
1022	R/W	AI Fit minimum 3	0~3000 = Minimum voltage of sensing range [mV]

address	Read/Write	name	value(= meaning)
1023	R/W	AI Fit minimum 4	0~3000 = Minimum voltage of sensing range [mV]
1024	R/W	AI Fit minimum 5	0~3000 = Minimum voltage of sensing range [mV]
1025	R/W	AI Fit minimum 6	0~3000 = Minimum voltage of sensing range [mV]
1026	R/W	AI Fit minimum 7	0~3000 = Minimum voltage of sensing range [mV]
1027	R/W	AI Fit minimum 8	0~3000 = Minimum voltage of sensing range [mV]
1030	R/W	AI Fit maximum 1	4000~10000 = Maximum voltage of sensing range [mV]: Factory default 10000
1031	R/W	AI Fit maximum 2	4000~10000 = Maximum voltage of sensing range [mV]
1032	R/W	AI Fit maximum 3	4000~10000 = Maximum voltage of sensing range [mV]
1033	R/W	AI Fit maximum 4	4000~10000 = Maximum voltage of sensing range [mV]
1034	R/W	AI Fit maximum 5	4000~10000 = Maximum voltage of sensing range [mV]
1035	R/W	AI Fit maximum 6	4000~10000 = Maximum voltage of sensing range [mV]
1036	R/W	AI Fit maximum 7	4000~10000 = Maximum voltage of sensing range [mV]
1037	R/W	AI Fit maximum 8	4000~10000 = Maximum voltage of sensing range [mV]
1040	R/W	AI Fit magnification 1	100~30000 = Maximum value of display range: Factory default 20000
1041	R/W	AI Fit magnification 2	100~30000 = Maximum value of display range
1042	R/W	AI Fit magnification 3	100~30000 = Maximum value of display range
1043	R/W	AI Fit magnification 4	100~30000 = Maximum value of display range
1044	R/W	AI Fit magnification 5	100~30000 = Maximum value of display range
1045	R/W	AI Fit magnification 6	100~30000 = Maximum value of display range
1046	R/W	AI Fit magnification 7	100~30000 = Maximum value of display range
1047	R/W	AI Fit magnification 8	100~30000 = Maximum value of display range
9000	R	Total number of inputs available	16
9001	R	Number of RTD (PT1000)	8
9002	R	Number of AI (voltage/current)	8
9900	R	Design Year	2017
9901	R	Family Number	69
9902	R	Product Number	4
9903	R	Compatibility number	67
9990	R	Version	2

address	Read/Write	name	value(= meaning)
9991	R	Lot	0~199

	MSIP-REM-Diu-DGE4C Company name: Ilpum Co., Ltd., Manufacturer: Ilpum Co., Ltd., country of manufacture: Korea Model name: DG17E4C, Derivative model name: MOAI16
Use environment	Normal operating temperature range = -10 ~ 65 [°C] No dew condensation, no dust.
Power	Rated voltage = DC 24 [V] (Operating range 19 ~ 27 [V]) Current consumption = 500 [mA]
Communication	Physical standard: TIA/EIA-485A (RS485) Maximum number of devices on the track = 64 node ESD protection = Up to 15 [kV] Data protocol: MODBUS RTU protocol
AI input method	Voltage: 0 ~ 10 [V] Current: 0 ~ 20 [mA]
UI input method	Resistance: 0 ~ 4 [kΩ]
DI detection indication	LED lights up when ON detection
Isolation	Photocoupler. Maximum isolation voltage = 3.75 [kV rms] Isolation area 1: Power terminal, RS485 terminal Isolation area 2: E4C power , AI terminal, UI terminal
Dimension	Width 145 [mm], Depth 90 [mm], Height 41 [mm]
Fixed way	Can be mounted on DIN rail Can be fixed with 4 screws (Width 135 [mm], Depth 70 [mm])



[Figure 4] Internal isolation of E4C