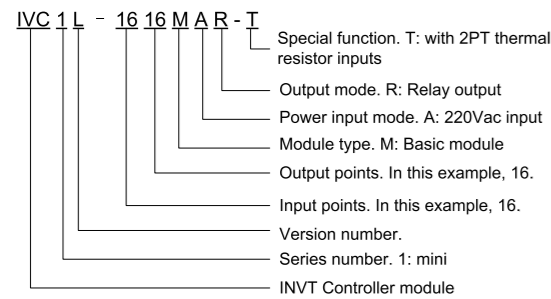# Quick Reference Manual of IVC1L-1616MAR-T with 2PT PLC

This quick start manual is to offer you a quick guide to the design, installation, connection and maintenance of IVC1L-1616MAR-T series PLC, convenient for on-site reference. Briefly introduced in this booklet are the hardware specs, features, and usage of IVC1L-1616MAR-T PLC, plus the optional parts and FAQ for your reference. For ordering the above user manuals, contact your INVT distributor or sales office. You can also visit http://www.invt-control.com to download PLC-related technical information or give feedback on PLC-related issues.

1   Introduction

1.1   Model Designation

The model designation is shown in the following figure.

IVC 1 L – 16 16 M A R - T

- Special function. T: with 2PT thermal resistor inputs
- Output mode. R: Relay output
- Power input mode. A: 220Vac input
- Module type. M: Basic module
- Output points. In this example, 16.
- Input points. In this example, 16.
- Version number.
- Series number. 1: mini
- INVT Controller module

1.2   Outline

The outline of the basic module is shown in the following figure by taking the example of IVC1L-1616MAR-T.
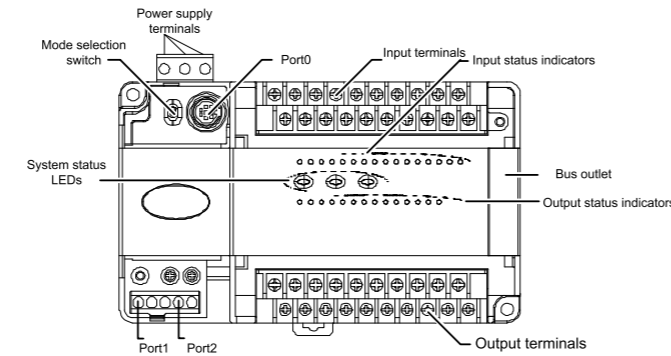
PORT0 and PORT1、PORT2 are communication terminals. PORT0 uses RS232 mode with Mini DIN8 socket. PORT1 and PORT2 have double RS485. The busbar socket is for connecting the extension module. The mode selection switch has three positions: ON, TM and OFF.

1.3   Terminal Introduction

1. The layouts of terminals are shown as follows:
Input terminals:

S/S	X0	X2	X4	X6	X10	X12	X14	X16	I1+	I1-	I2+	I2-
X1	X3	X5	X7	X11	X13	X15	X17	FG	R1+	R1-	R2+	R2-
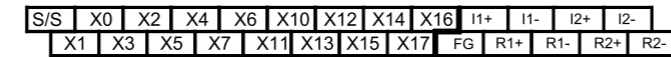
Input terminal definition table

No.	Sign	Description	No.	Sign	Description
1	S/S	Input source/sink mode selection terminal	14	X1	Digital signal X1 input terminal
2	X0	Digital signal X0 input terminal	15	X3	Digital signal X3 input terminal
3	X2	Digital signal X2 input terminal	16	X5	Digital signal X5 input terminal
4	X4	Digital signal X4 input terminal	17	X7	Digital signal X7 input terminal
5	X6	Digital signal X6 input terminal	18	X11	Digital signal X11 input terminal
6	X10	Digital signal X10 input terminal	19	X13	Digital signal X13 input terminal
7	X12	Digital signal X12 input terminal	20	X15	Digital signal X15 input terminal
8	X14	Digital signal X14 input terminal	21	X17	Digital signal X17 input terminal
9	X16	Digital signal X16 input terminal	22	FG	RTD cable shield ground
10	I1+	Positive RTD auxiliary current of CH1	23	R1+	Positive thermal-resistor signal input of CH1
11	I1−	Negative RTD auxiliary current of CH1	24	R1-	Negative thermal-resistor signal input of CH1
12	I2+	Positive RTD auxiliary current of CH2	25	R2+	Positive thermal-resistor signal input of CH2
13	I2−	Negative RTD auxiliary current of CH2	26	R2−	Negative thermal-resistor signal input of CH2

Output terminals:

+24	Y0	Y1	Y2	Y3	Y4	Y6	●	Y10	Y12	Y14	Y16	●
COM	COM0	●	COM1	COM2	Y5	Y7	COM3	Y11	Y13	Y15	Y17	●
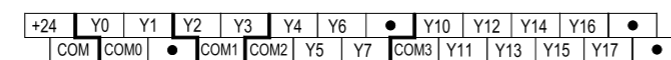
Output terminal definition table

No.	Sign	Description	No.	Sign	Description
1	+24	Positive pole of output power supply 24V	14	COM	Negative pole of output power supply 24V
2	Y0	Control output terminal	15	COM0	Control output common terminal
3	Y1	Control output terminal	16		Empty
4	Y2	Control output terminal	17	COM1	Common terminal of control output terminal
5	Y3	Control output terminal	18	COM2	Common terminal of control output terminal
6	Y4	Control output terminal	19	Y5	Control output terminal
7	Y6	Control output terminal	20	Y7	Control output terminal
8	●	Empty	21	COM3	Common terminal of control output terminal
9	Y10	Control output terminal	22	Y11	Control output terminal
10	Y12	Control output terminal	23	Y13	Control output terminal
11	Y14	Control output terminal	24	Y15	Control output terminal
12	Y16	Control output terminal	25	Y17	Control output terminal
13	●	Empty	26	●	Empty

2   Power supply specifications

The specification of PLC built-in power and power for extension modules is listed in the following table.

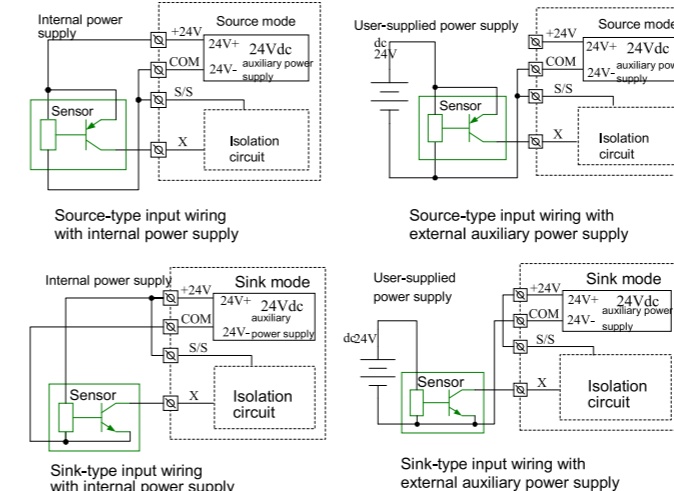| Item	Unit	Min.	Typical value	Max.	Note
Power supply voltage	Vac	85	220	264	Normal startup and operation
Input current	A	/	/	1.5	Input: 90Vac, 100% output
Rated output current	5V/GND	mA	/	900	/	The total power of outputs 5V/GND and 24V/GND ≤ 10.4W. Max. output power: 24.8W (sum of all branches)
	24V/GND	mA	/	300	/	
	+-15V/AGND	mA	/	200	/	
	24V/COM	mA	/	600	/	

3.   Digital Inputs & Outputs

3.1   Input Characteristic And Specification
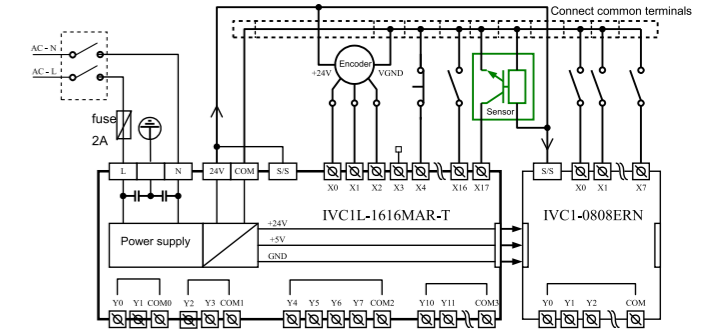
The input characteristic and specs are shown as follows:

Item		High-speed input terminals X0–X7	General input terminal
Input mode		Source mode or sink mode, set through s/s terminal	
Electric parameters	Input voltage	24Vdc	
	Input resistance	4kΩ	4.3kΩ
	Input ON	External circuit resistance < 400Ω	External circuit resistance < 400Ω
	Input OFF	External circuit resistance > 24kΩ	External circuit resistance > 24kΩ
Filtering function	Digital filter	X0–X7 have digital filtering function. Filtering time: 0, 8, 16, 32 or 64ms (selected through user programme)	
	Hardware filter	Input terminals other than X0–X7 are of hardware filtering. Filtering time: about 10ms	
High-speed function		X0–X7: high-speed counting, interrupt, and pulse catching X0 and X1: up to 50kHz counting frequency X2–X5: up to 10kHz counting frequency The sum of input frequency should be less than 60kHz	
Common terminal		Only one common terminal: COM	

The input terminal act as a counter has a limit over the maximum frequency. Any frequency higher than that may result in incorrect counting or abnormal system operation. Make sure that the input terminal arrangement is reasonable and external sensors used are proper.

The PLC provides an S/S terminal for selecting signal input mode among source mode and sink mode. Connecting the S/S terminal to the +24 terminal, i.e. set the input mode to the sink mode, enables a connection with the NPN sensor.

Source-type input wiring with internal power supply

Source-type input wiring with external auxiliary power supply

Sink-type input wiring with internal power supply

Sink-type input wiring with external auxiliary power supply

Input connection example

The following diagram shows an example of IVC1L-1616MAR-T in connection with an IVC1-0808ENR, which realizes simple positioning control. The positioning signals from the PG are input through high speed counting terminals X0 and X1, the limit switch signals that require high-speed response can be input through high-speed terminals X2–X7. Other user signals can be input through any other input terminals.
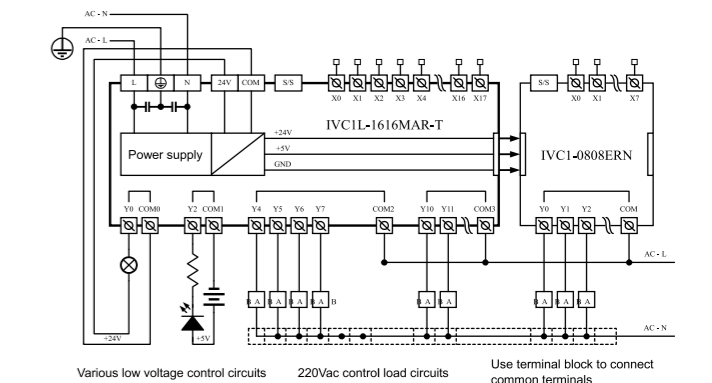

3.2   Output Characteristic And Specification

The electric specs of outputs is shown in the following table.

Item	Relay output
Switched voltage	Below 250Vac, 30Vdc
Circuit isolation	By Relay
Operation indication	Relay output contacts closed, LED on
Leakage current of open circuit	/
Minimum load	2mA/5Vdc
Max. output current — Resistive load	2A/1 point; 8A/4 points, using a COM 8A/8 points, using a COM
Max. output current — Inductive load	220Vac, 80VA
Max. output current — Illumination load	220Vac, 100W
Response time — OFF→ON	20ms Max
Response time — ON→OFF	20ms Max
Y0, Y1 max. output frequency	/
Y2, Y3 max. output frequency	/
Output common terminal	Y0/ Y1-COM0; Y2/Y3-COM1. After Y4, Max 8 terminals use one isolated common terminal
Fuse protection	None

Output connection example

The following diagram shows an example of IVC1L-1616MAR-T in connection with an IVC1-0808ENR. Some (like Y0-COM0) are connected to the 24Vdc circuit powered by local 24V-COM, some (like Y2-COM1) are connected to the 5Vdc low voltage signal circuit, and others (like Y4~Y7) are connected to the 220Vac voltage signal circuit. Different output groups can be connected to different signal circuits with different voltages.


Various low voltage control circuits   220Vac control load circuits   Use terminal block to connect common terminals

3.3   Thermistor Characteristic And Specification

Performance Specification

Item	Specification	
	Degrees Celsius (°C)	Degrees Fahrenheit (°F)
Input signal.	Termistor type: Pt100, Cu100, Cu50 Number of channels: 2	
Converting speed	(15±2%) ms × 4 channels (The conversion is not performed for unused channels.)	
Rated temperature range	Pt100 −150°C–+600°C	Pt100 −238°F–+1112°F
	Cu100 −30°C–+120°C	Cu100 −22°F–+248°F
	Cu50 −30°C–+120°C	Cu50 −22°F–+248°F
Digital output	The temperature value is stored in 16-bit binary complement code.	
	Pt100 −1500–+6000	Pt100 −2380–+11120
	Cu100 −300–+1200	Cu100 −220–+2480
	Cu50 −300–+1200	Cu50 −220–+2480

Specification Table

Item	Specification	
	Degrees Celsius (°C)	**Degrees Fahrenheit (°F)**
Lowest resolution	Pt100 0.2°C	Pt100 0.36°F
	Cu100 0.2°C	Cu100 0.36°F
	Cu50 0.2°C	Cu50 0.36°F
Precision	±1% of the full range	
Isolation	Analog circuits are isolated from digital circuits by using photoelectric couplers. Analog channels are not isolated from each other.	

The following figure shows the terminal wiring:

Terminal wiring
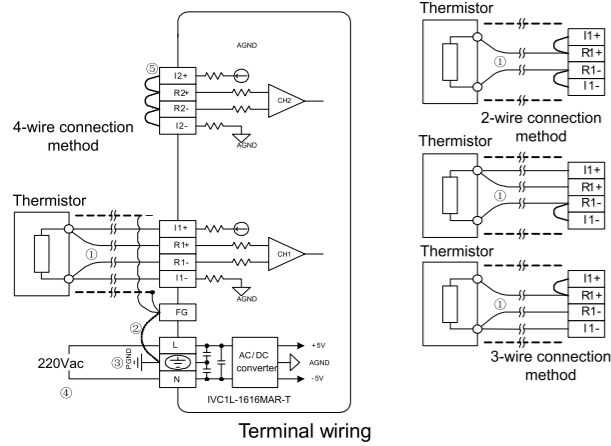
The labels ① to ⑤ in the above figure indicate the connection that you need to pay special attention to.

①. It is recommended that you connect the thermistor signals by using a shielded twisted-pair cable, and keep the cable away from power cables or other cables that may cause electrical interference. The connection of a thermistor is described as follows:

For thermistor sensors of the Pt100, Cu100, and Cu50 types, you can use the 2-wire, 3-wire, and 4-wire connection methods. Among them, the precision of the 4-wire connection method is the highest, that of the 3-wire connection method is the second highest, and that of the 2-wire connection method is the lowest. If the length of the wire is longer than 10 m, it is recommended that you use the 4-wire connection method to eliminate the resistance error caused by the wire. To reduce measurement errors and prevent noise interference, it is recommended that you use connection cables that are shorter than 100 m.

②. If too much electrical interference is caused, connect the shielding ground to the ground terminal PG of the module.

③. Ground the ground terminal PG of the module properly.

④. Use 220Vac power supply.

⑤. Short-circuit the positive and negative terminals that do not use a channel to prevent the detection of error data on the channel.
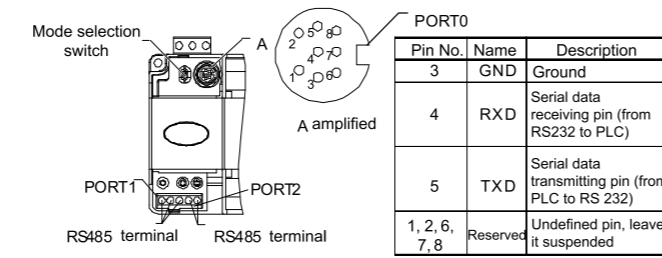
SD unit configuration

Address No.	Name	R/W attribute	Note
SD172	Sampling average of CH1	R	Default value: 0
SD173	Sampling times of CH1	RW	1–1000, Default value: 8
SD174	Sampling average of CH2	R	Default value: 0
SD175	Sampling times of CH2	RW	1–1000, Default value: 8
SD178	Mode selection for CH1 (8 LSBs) Mode selection for CH2 (8 MSBs)	RW	0: Disable 1: PT100 (-1500-6000, degrees Celsius) 2: PT100 (-2380-11120, degrees Fahrenheit) 3: Cu100 (-300-1200, degrees Celsius) 4: Cu100 (-220-2480, degrees Fahrenheit) 5: Cu50 (-300-1200, degrees Celsius) 6: Cu50 (-220-2480, degrees Fahrenheit)

Setting example:
In order to configure the PT100 for both CH1 and CH2, output the value in degrees Celsius, and set the points of average value to 4, you need to set the 8 leaset significant bits(LSBs) of SD178 to 0x01 and the 8 most significant bits(MSBs) of SD178 to 0x01, i.e. set the SD178 to 0x0101(hexadecimal). Then set the SD173 and SD175 to 4. The values of SD172 and SD174 are the average temperatures in Celsius degree of the four samplings detected by the CH1 PT100 and CH2 PT100, respectively.

4 Communication Port

IVC1L-1616MAR-T basic module has three serial asynchronous communication ports: PORT0, PORT1, and PORT2. Supported baud rates: 115200, 57600, 38400, 19200, 9600, 4800, 2400, 1200bps. The mode selection switch determines the communication protocol of PORT0.

Pin No.	Name	Description
3	GND	Ground
4	RXD	Serial data receiving pin (from RS232 to PLC)
5	TXD	Serial data transmitting pin (from PLC to RS 232)
1, 2, 6, 7, 8	Reserved	Undefined pin, leave it suspended

As a terminal dedicated to user programming, PORT0 can be converted to programming protocol through the mode selection switch. The relationship between PLC operation status and the protocol used by PORT0 is shown in the following table.

Mode selection switch position	Status	PORT0 operation protocol
ON	Run	Programming protocol, or Modbus protocol, or free-port protocol, or N: N network protocol, as determined by user program and system configuration
ON→TM	Running	Converted to programming protocol
OFF→TM	Stop	
OFF	Stop	If the system configuration of user program is free-port protocol, it converts to programming protocol automatically after stop; or system protocol keeps unchanged

PORT1 、PORT2 are ideal for connection with equipment that can communicate (such as inverters). With Modbus protocol or RS485 terminal free protocol, it can control multiple devices through the network. Its terminals are fixed with screws. You can use a shielded twisted-pair as the signal cable to connect communication ports by yourself.

5 Installation

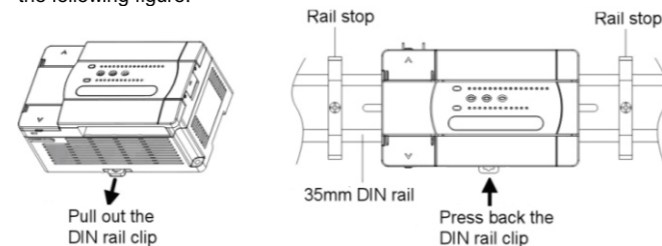PLC is applicable to Installation category II, Pollution degree 2.

5.1 Installation Dimensions

Model	Length	Width	Height	Net weight
IVC1L-1616MAR-T	182mm	90mm	71.2mm	750g

5.2 Installation Method

DIN rail installation

Generally you can install the PLC onto a 35mm-wide rail (DIN), as shown in the following figure.


The detailed procedure is as follows:
1. Fix the DIN rail onto the installation backplane;
2. Pull out the DIN rail clip from the bottom of the module;
3. Mount the module to the DIN.
4. Press back the DIN rail clip to lock the module.
5. Fix the two ends of the module with the rail stops to avoid sliding.
This procedure can be used to install the DIN rail for all other IVC1L-1616MAR-T PLCs.

Screw fixing

Fixing the PLC with screws can stand greater shock than DIN rail mounting. Use M3 screws through the mounting holes on PLC enclosure to fix the PLC onto the backboard of the electric cabinet, as shown in the following figure.

∅4 installation hole   Fix with M3 bolt
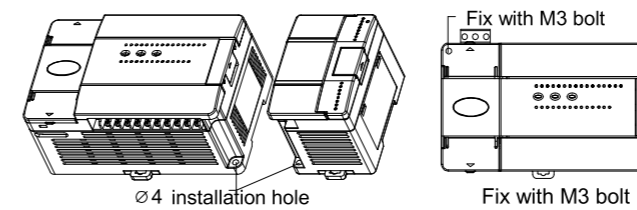
5.3 Cable Connection and Specification

Connect power cable and grounding cable. We suggest you wire a protection circuit at the power supply input terminal. The following figure shows shows the connection of the AC and auxiliary power supplies.
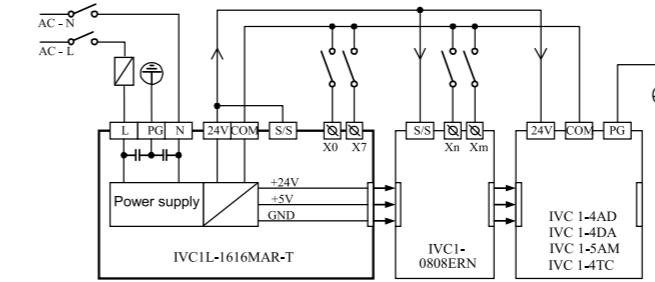
The anti-electromagnetic interference capability of the PLCs can be improved by configuring reliable grounding cables. When installing a PLC, connect the power supply terminal ⊕ to the ground.It is recommended that you use connection wires of AWG12 to AWG16 and try to shorten the wires, and that you configure independent grounding and keep the grounding cables away from those of other devices (especially those generating strong interference), as shown in the following figure.

Best   Good   Bad
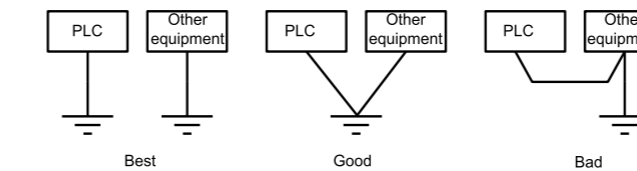
Cable specification

When wiring a PLC, use multi-strand copper wire and ready-made insulated terminals to ensure the quality. The recommended model and the cross-sectional area of the cable are shown in the following table.

Cable	Cross-sectional area	Recommended model	Cable lug and heat-shrink tube
AC power cable (L, N)	1.0–2.0mm²	AWG12, 18	H1.5/14 round insulated lug, or tinned cable lug
Earth cable (⊕)	2.0mm²	AWG12	H2.0/14 round insulated lug, or tinned cable lug
Input signal cable (X)	0.8–1.0mm²	AWG18, 20	UT1-3 or OT1-3 solderless lug
Output signal cable (Y)	0.8–1.0mm²	AWG18, 20	Φ3 or Φ4 heat shrinkable tube

Fix the prepared cable head onto the PLC terminals with screws. Fastening torque: 0.5–0.8Nm.
The recommended cable processing-method is shown in the following figure.
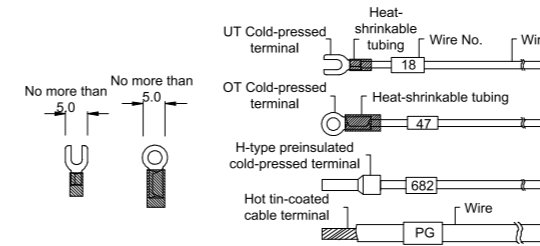
6 Power-on Operation And Maintenance

6.1 Startup

Check the cable connection carefully. Make sure that the PLC is clear of alien objects and the heat dissipation channel is clear.
1. Power on the PLC, the PLC POWER indicator should be on.
2. Start the AutoStation software on the host and download the compiled user program to the PLC.
3. After checking the download program, switch the mode selection switch to the ON position, the RUN indicator should be on. If the ERR indicator is on, the user program or the system is faulty. Loop up in the IVC series PLC Programming Manual and remove the fault.
4. Power on the PLC external system to start system debugging.

6.2 Routine Maintenance

Do the following:
1. Ensure the PLC a clean environment. Protect it from aliens and dust.
2. Keep the ventilation and heat dissipation of PLC in good condition.
3. Ensure that the cable connections are reliable and in good condition.

⚠ **Warning**

1. Use the relay contacts only when necessary, because the life span of relay contacts depends largely on its action times.
2. The relay contacts can support loads smaller than 2A. To support larger loads, use external contacts or mid-relay.
3. Note that the relay contact may fail to close when the current is smaller than 5mA.