Dobot Magician Demo Description (PLC)

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Preface

Purpose

This topic describes how to use **Siemens** PLC to control Dobot Magician with I/O interface.

Intended Audience

This document is intended for:

- Customer Engineer
- Sales Engineer
- Installation and Commissioning Engineer
- Technical Support Engineer

Change History

Date	Change Description
2018/09/10	The first release

Symbol Conventions

The symbols that may be founded in this document are defined as follows.

Symbol	Description
⚠DANGER	Indicates a hazard with a high level of risk which, if not avoided, could result in death or serious injury
⚠WARNING	Indicates a hazard with a medium level or low level of risk which, if not avoided, could result in minor or moderate injury, robotic arm damage
⚠NOTICE	Indicates a potentially hazardous situation which, if not avoided, can result in robotic arm damage, data loss, or unanticipated result
🕮NOTE	Provides additional information to emphasize or supplement important points in the main text

Contents

1. PLC Environment Building

Siemens offers numerous PLC products. Taking **S7-1200 CPU 1212C** as an example, this topic describes how to install and configure **TIA Portal V15**, which is the IDE of **S7-1200 PLC**.

1.1 Software Installation

At present, TIA Portal is the **Siemens** official development software, please obtain the installation package and its license from the official website. This topic takes **TIA Portal V15** as an example for installation description, please replace it based on site requirements.

If there is any problem during installing, please refer to https://support.industry.siemens.com/cs/products?mfn=ps&pnid=14667&lc=en-CN to find the solution.

TIA Portal V15 supports the following Windows versions.

- Windows 7 64bit
- Windows 8 64bit
- Windows 10 64bit

📖NOTE

Before installing the **TIA Portal V15**, please close all other software. DO NOT operate your PC during installing, to avoid installation errors.

Step 1 Launch the installation package and select the setup language, as shown in Figure 1.1.

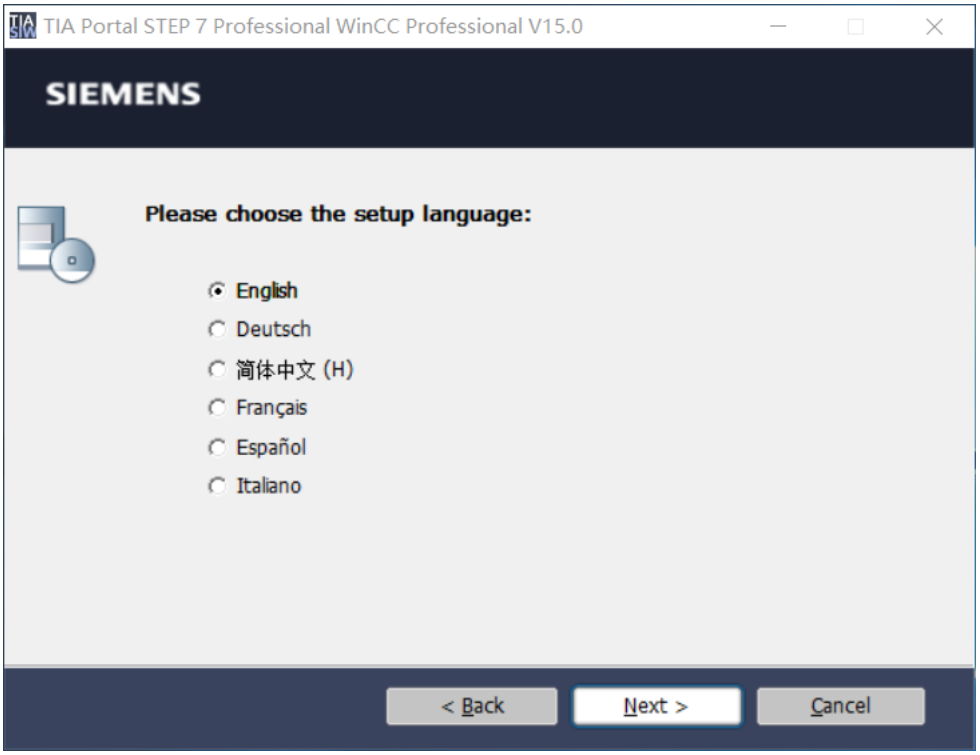


Figure 1.1 Start installing

Step 2 Install the software as instructed and wait for the file to be decompressed successfully, as shown in Figure 1.2.

Please set all the settings by default.

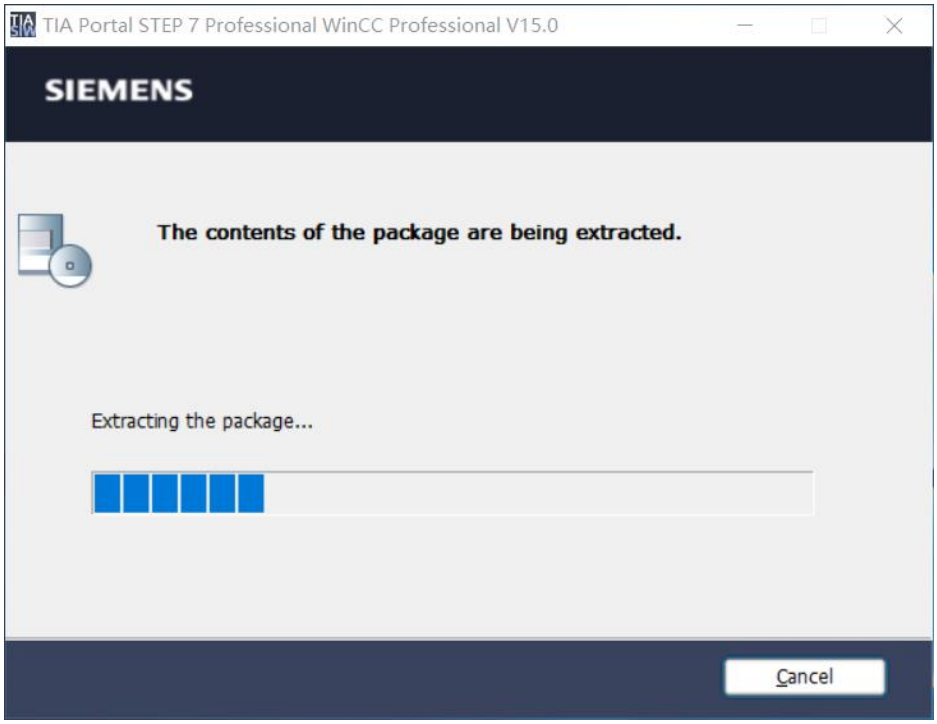


Figure 1.2 Decompress data

After the file is decompressed, the installation page is displayed, as shown in Figure 1.3.

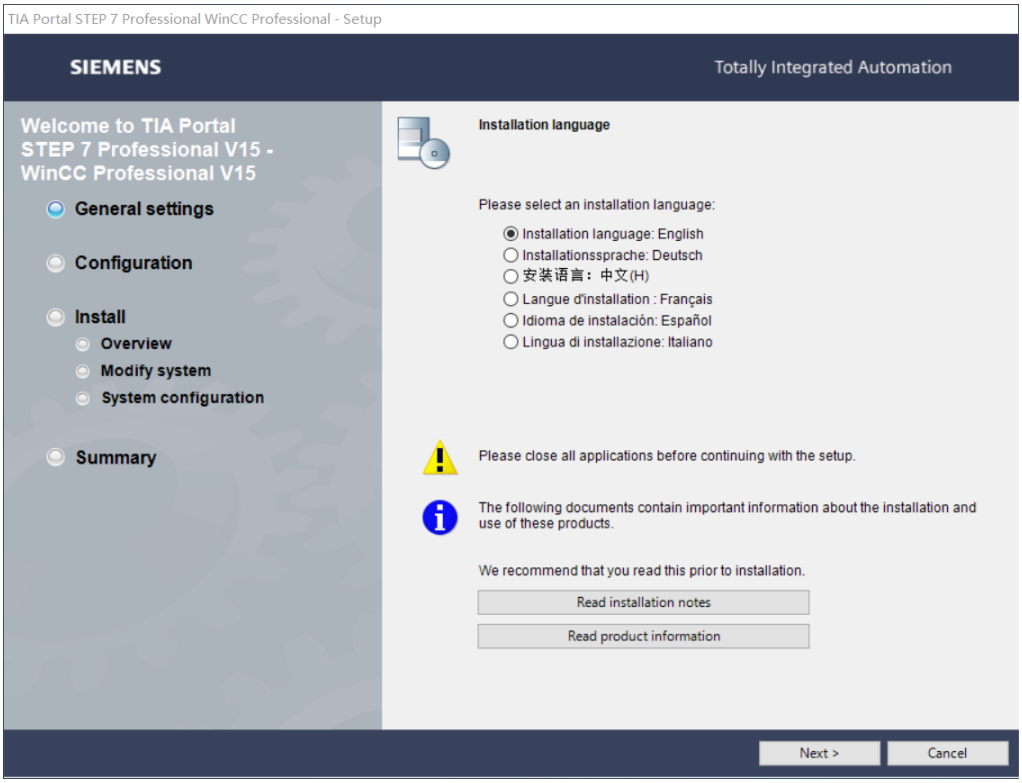


Figure 1.3 Installation page

Step 3 Install the software as instructed and set all the settings by default.

⚠NOTCE

During installing, you can set the installation path, as shown in Figure 1.4. The installation path cannot contain Chinese character and space.

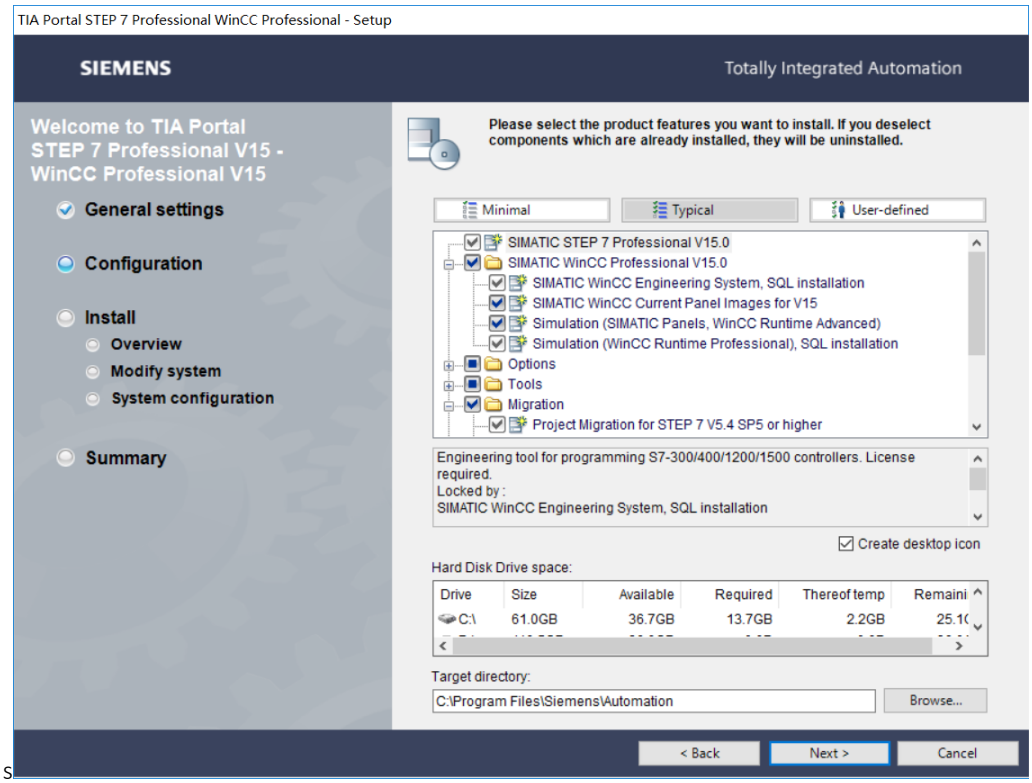


Figure 1.4 Set the installation path

Step 4 After the installation is completed, restart your computer and input keys to activate the software as instructed.

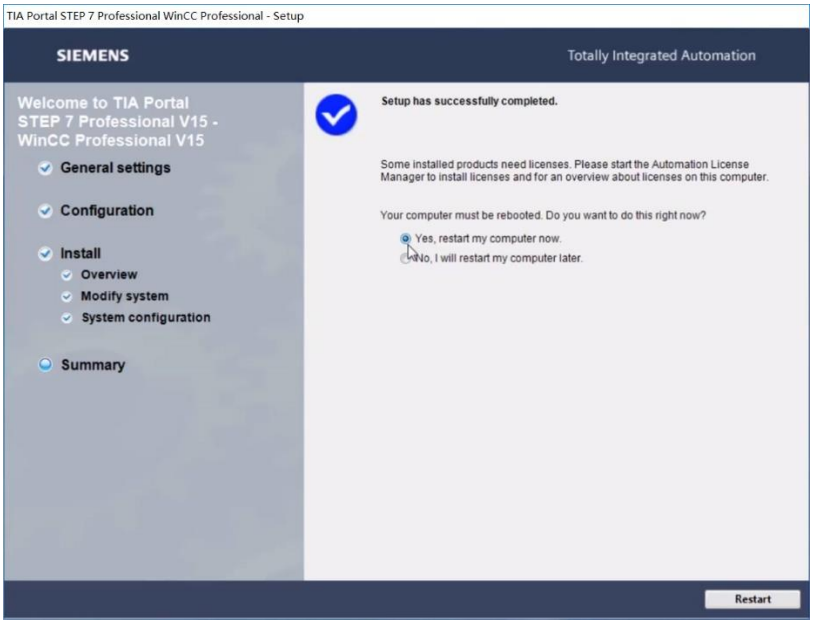


Figure 1.5 Installation completion page

1.2 Configure Environment

Step 1 Launch **TIA Portal** and select **Open existing project**.

Step 2 Click **Browse**, select the directory where the demo is saved and open the file with suffix **.ap15**, as shown in Figure 1.6.

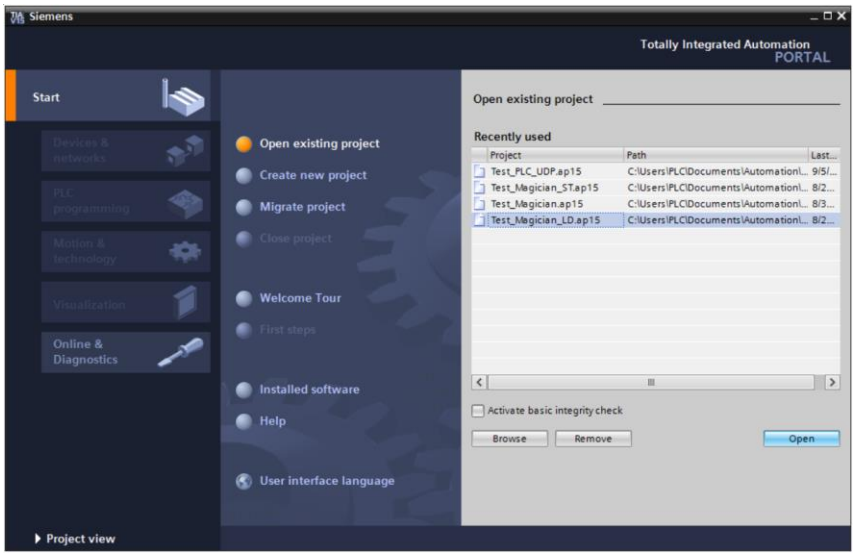


Figure 1.6 Open the project

Step 3 (Optional) Add the PLC device based on site requirements.

Click **show all devices** on the **Devices&networks** page to check the hardware configuration after importing the demo. If the displayed equipment is not matched with your PLC, please select **Add new device** to add your PLC, as shown in Figure 1.7

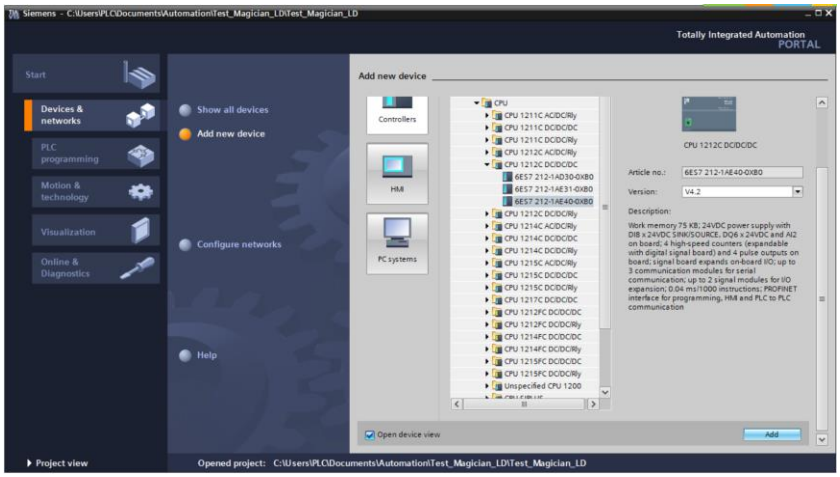


Figure 1.7 Add equipment

Step 4 Click **Configure networks** on the **Device&networks** page.

The device configuration page is displayed, as shown in Figure 1.8.

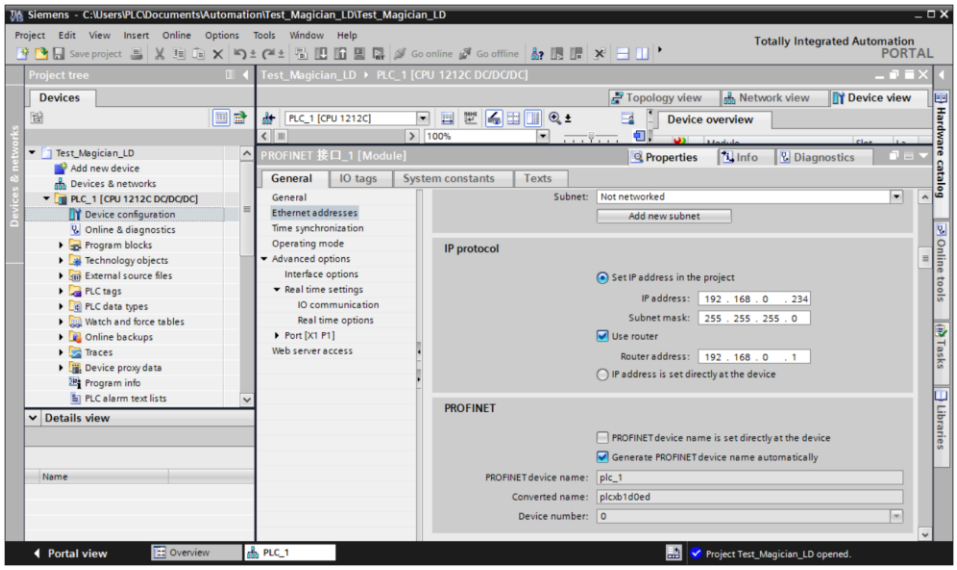


Figure 1.8 Device configuration page

Step 5 Select your PLC on the **Project tree** navigation tree and click **Go inline**, as shown in Figure 1.9.

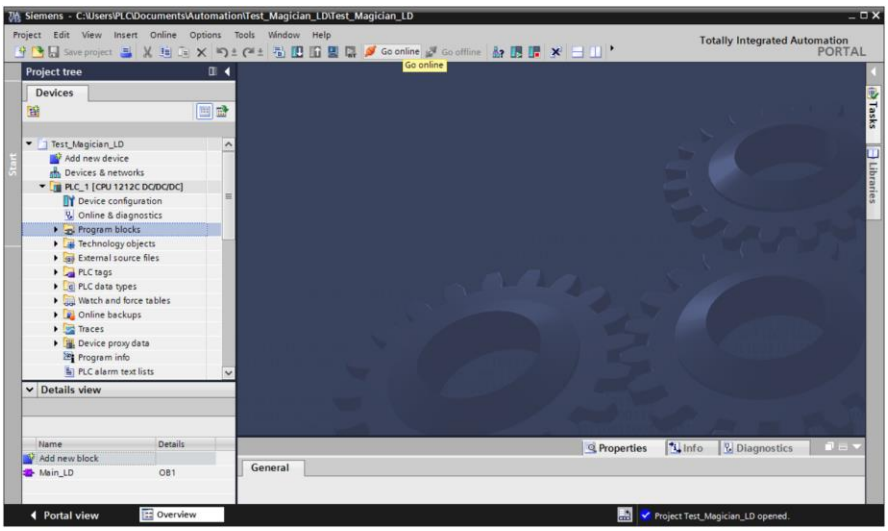


Figure 1.9 Click Go onlie

The **Accessible devices** page is displayed, as shown in Figure 1.10.

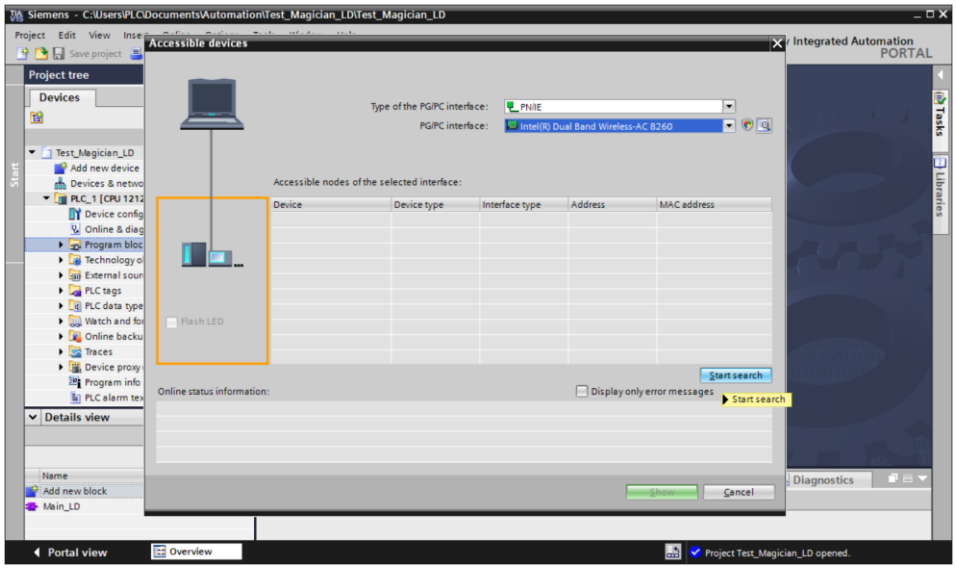


Figure 1.10 Accessible devices page

Step 6 Click **Start Search** on the **Accessible devices** page.

About 30s later, your PLC IP address will be displayed on the **Accessible devices** page.

If your PLC IP address is not displayed or the IP address of PLC and PC is not on the same network segment, please modify the PLC IP address. For details, please see *Appendix A How to Modify the PLC IP Address*.

Step 7 Select the searched PLC and click **Show**.

Step 8 Click  to download the program to the PLC.

If the download is successful, the program will run automatically.

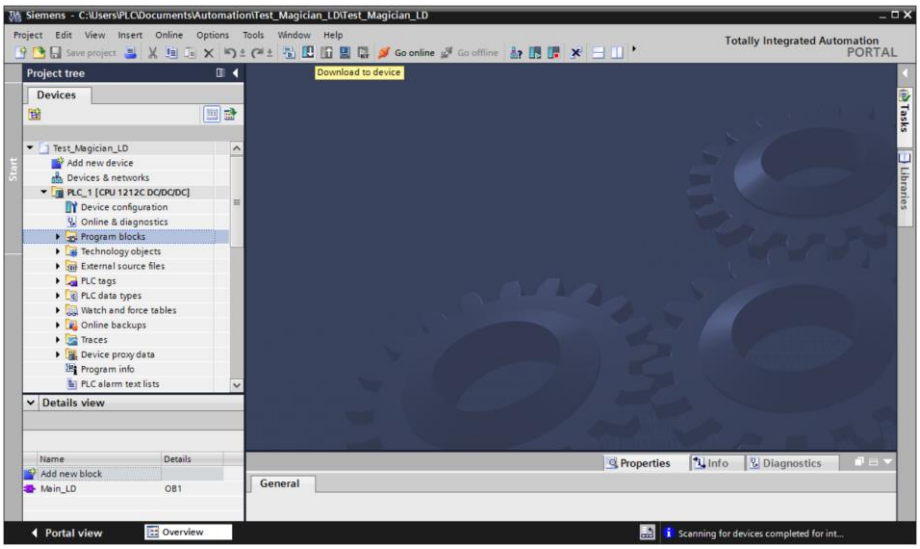


Figure 1.11 Download the program to the PLC

2. I/O Connection

This topic describes how to connect Dobot Magician and PLC with I/O interface. You can use PLC to control Dobot Magician with the operations shown in this topic. If you need to modify or customize the functionality, please modify the codes.

2.1 Dobot Magician I/O Interface Description

The I/O interface of Dobot Magician will be used when connecting PLC and Dobot Magician. In this section, we only list the PINs with 3.3V output/input. For details about I/O interface, please see *Dobot Magician User Guide*.

2.1.1 Forearm I/O Interface Description

Figure 2.1 shows the Forearm I/O interface.

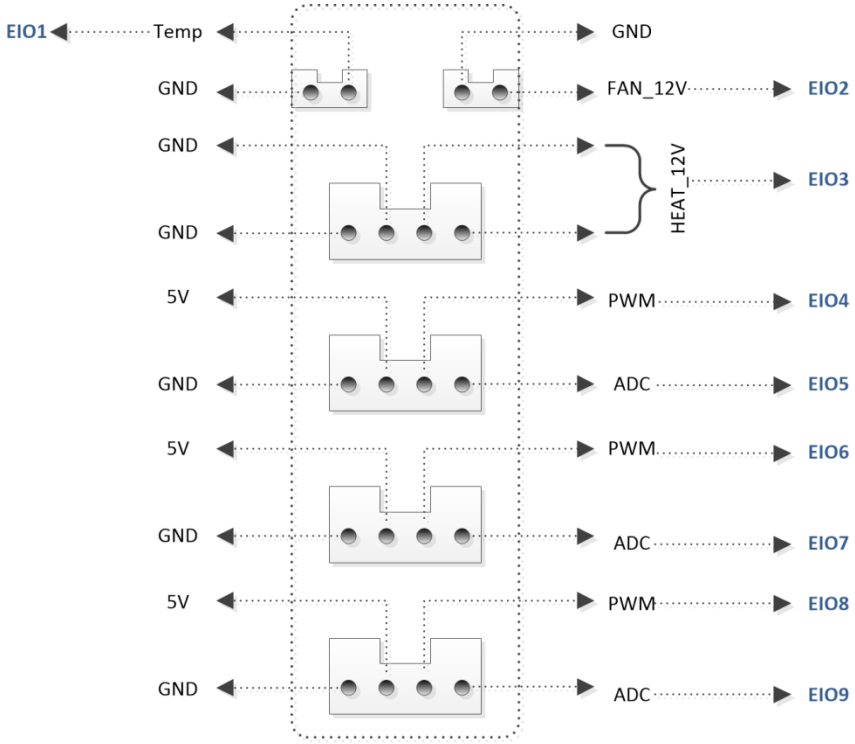


Figure 2.1 Forearm I/O interface

Table 2.1 lists the I/O interface with 3.3V output/input on the Forearm. Since the I/O interface is located on the Forearm, the connection between Dobot Magician and the external device may be affected when Dobot Magician moves. In our demo, the I/O interface on the Forearm will not be selected.

Table 2.1 Multiplexed 3.3V I/O description on the Forearm

I/O addressing	Voltage	Level Output	PWM	Level Input	ADC
I/O 1	3.3V	✓	-	✓	✓
I/O 4	3.3V	✓	✓	✓	-
I/O 5	3.3V	✓	-	✓	✓
I/O 6	3.3V	✓	✓	✓	-
I/O 7	3.3V	✓	-	✓	✓

I/O addressing	Voltage	Level Output	PWM	Level Input	ADC
I/O 8	3.3V	✓	✓	✓	-
I/O 9	3.3V	✓	-	✓	✓

2.1.2 Base I/O Interface Description

Figure 2.2 shows the peripheral interface on the base and Figure 2.3 shows the UART interface.

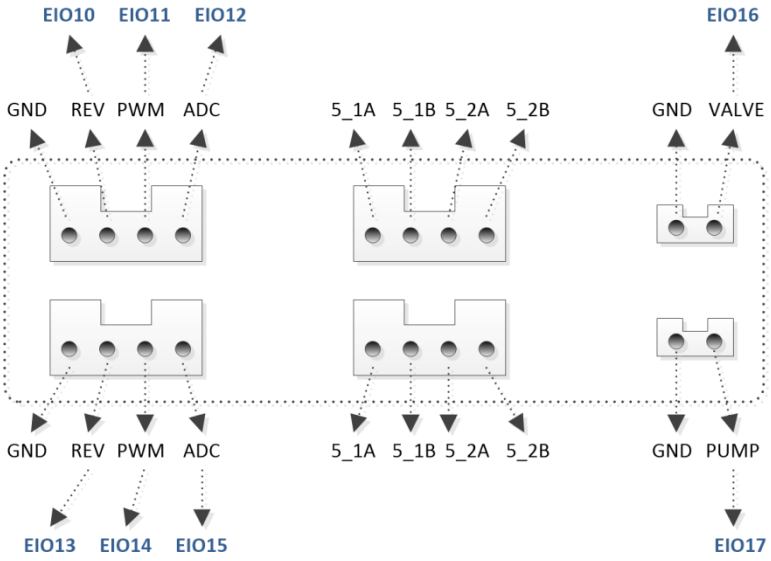


Figure 2.2 Base peripheral I/O interface

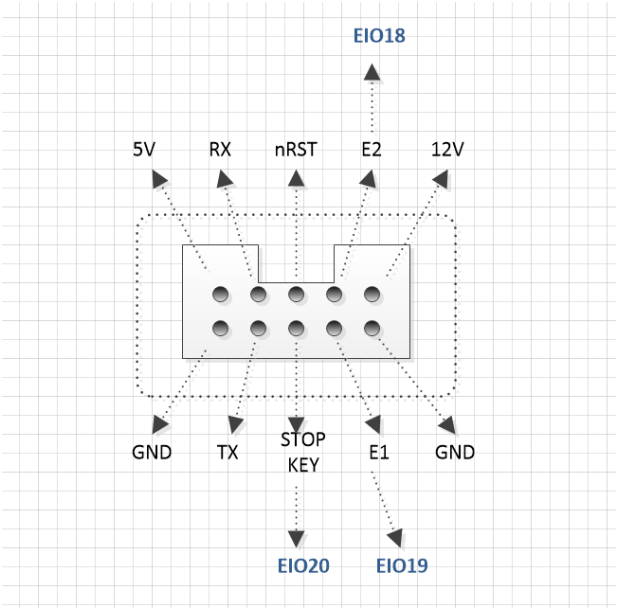


Figure 2.3 Base UART I/O interface

The I/O interface which is located on the base is suitable for connecting to external devices. Table 2.2 lists the I/O interface with 3.3V output/input on the base.

Table 2.2 Multiplexed 3.3V I/O description on the base

I/O addressing	Voltage	Level Output	PWM	Level Input	ADC
I/O 11	3.3V	✓	✓	✓	-
I/O 12	3.3V	✓	-	✓	✓
I/O 14	3.3V	✓	✓	✓	-
I/O 15	3.3V	✓	-	✓	✓
I/O 18	3.3V	✓	-	✓	-
I/O 19	3.3V	✓	-	✓	-
I/O 20	3.3V	✓	-	✓	-

In our demo, the suction cup kit is used. The matched air pump is connected to the **SW1** and **GP1** interfaces on the Dobot Magician. GP1 interface has occupied I/O 11 and I/O 12. Therefore, Only I/O 14, I/O15, I/O 18, I/O 19 and GND can be used.

2.1.3 I/O Function Allocation

Table 2.3 lists the I/O function allocation when Dobot Magician is connected to PLC.

Table 2.3 I/O function allocation

I/O addressing (Dobot Magician)	I/O Function	Corresponding PLC I/O addressing
I/O 14	Output: Send Ready signal	DI 0.0
I/O 15	Output: Send Completion signal	DI 0.1
I/O 18	Input: Receive Start signal	DQ 0.0
I/O 19	Input: Receive Stop signal	DQ 0.1
I/O 20	Output: Provide 3.3V high level	-
GND	Provide low level	-

The details are shown as follows.

- I/O 14 is used for sending the **Ready** signal to PLC, and high level indicates that Dobot Magician has been ready to work.
- I/O 15 is used for sending the **Completion** signal to PLC, and high level indicates that the action of Dobot Magician is successfully completed.
- I/O 18 is used for receiving the **Start** signal from PLC, and high level indicates that Dobot Magician starts moving.
- I/O 19 is used for receiving the **Stop** signal from PLC, and high level indicates that Dobot Magician stops moving.
- I/O 20 is used for providing 3.3V high level for 24V to 3.3V level translator.
- GND is used for providing low level. There are multiplex GND PINs on the I/O interface of base, please select one of them.

2.2 PLC I/O Interface Description

This topic describes how to connect **S7-1200** PLC to Dobot Magician.

Figure 2.4 shows the connection frame.

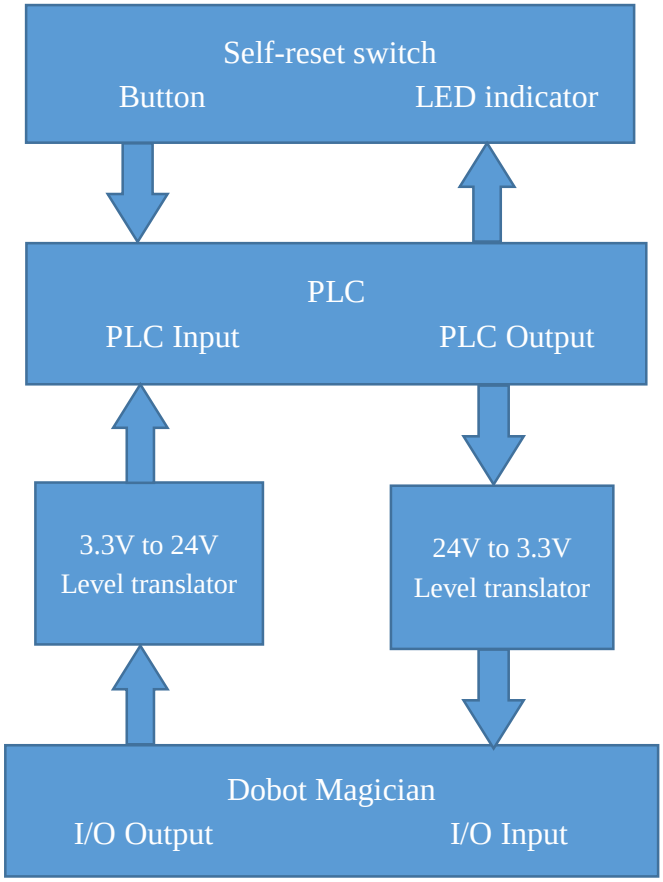


Figure 2.4 System connection frame

2.2.1 PLC I/O Function Allocation

Table 2.4 lists the PLC I/O function allocation.

Table 2.4 PLC I/O function allocation

Input	Description	Output	Description
I0.0	Receive the Ready signal from Dobot Magician	Q0.0	Send the Start signal to Dobot Magician
I0.1	Receive the Completion signal from Dobot Magician	Q0.1	Send the Stop signal to Dobot Magician
I0.2	Receive the input signal of the started-button	Q0.2	Control the green LED indicator
I0.3	Receive the input signal of the stopped-button	Q0.3	Control the red LED indicator

The details are shown as follows.

- I0.0 is used for receiving the Ready signal from Dobot Magician, and high level indicates that Dobot Magician has been ready to work.
- I0.1 is used for receiving the Completion signal from Dobot Magician, and high level indicates that the previous action has been completed.

- I0.2 is used for input of start-button, of which high level indicates that the start-button is pressed downs.
- I0.3 is used for input of the stop-button, and high level indicates that the stop-button is pressed down.
- Q0.0 is used for sending Start signal, and high level indicates that Dobot Magician starts moving.
- Q0.1 is used for sending Stop signal. High level indicates that Dobot Magician stops moving while low level indicates that Dobot Magician continues moving.
- Q0.2 is used for controlling the green LED indicator on the start-button. High level indicates that the green LED indicator is on.
- Q0.3 is used for controlling the red LED indicator on the stop-button. High level indicates that the red LED indicator is on.

2.2.2 Power Cable Connection of PLC

To make PLC work normally, please make sure that the connection is correct. Figure 2.5 shows the power interface of PLC. **DC** is the 24V DC power supply, and **L+** where is located on the left of X10 interface is the positive pole of 24V DC and M is the negative pole.

⚠NOTICE

In the red box of Figure 2.5, the **L+** and **M** PINs are used for connecting sensors with 24V DC. Please DO NOT connect the wrong cable. Otherwise, the PLC will be damaged.

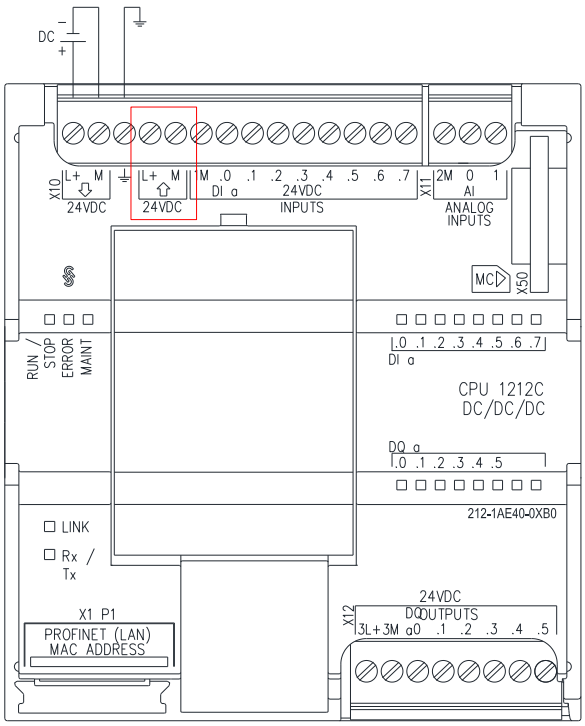


Figure 2.5 PLC power interface

2.2.3 Connection between PLC and Switch

In our demo, we use the self-reset switch with two LED indicators for sending signals to PLC and showing working status, as shown in Figure 2.6.

Figure 2.6 Self-reset button

Figure 2.7 shows the connection between PLC and self-reset switch.

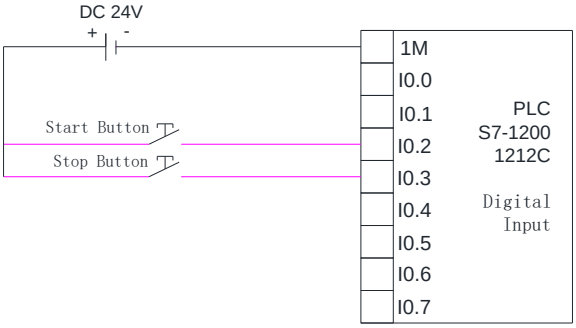


Figure 2.7 Connection between PLC and self-reset switch

- The green button is the started-button used for sending Start signal.
- The red button is the stopped-button used for sending Stop signal.
- If the two buttons are pressed down at the same time, Dobot Magician will not move.

Figure 2.8 shows the connection between LED indicators and PLC.

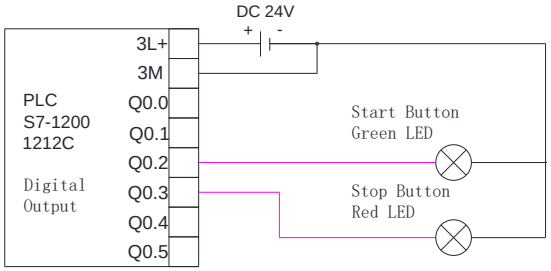


Figure 2.8 Connection of LED indicators

- If the green LED indicator is on, the Dobot Magician is in the running status.
- If the red LED indicator is on, the Dobot Magician is in the stopped status.
- If the two LED indicators are off, the PLC is in the initial status.

2.2.4 Digital Input Connection

When the PLC is connected to Dobot Magician with I/O interface, the input voltage of I/O interface of PLC is 24V, while the output voltage of the I/O interface that Dobot Magician uses is 3.3V. Therefore, you need to select a 3.3V to 24V level translator.

Figure 2.9 shows the 3.3V to 24V level translator, of which the output type is PNP. Namely, if the signal of the input terminal is high, that of the output terminal will be high too.

Figure 2.9 3.3V to 24V level translator

- **Input 1** is connected to I/O 14 of Dobot Magician, and **Output 1** is connected to PLC I0.0.
- **Input 2** is connected to I/O 15 of Dobot Magician, and **Output 2** is connected to PLC I0.1.

Table 2.5 lists the connection relationship of Dobot Magician, level translator and PLC, and Figure 2.10 shows the connection of them.

Table 2.5 The connection relationship of Dobot Magician, Level translator and PLC

Input (Level translator)	Corresponding I/O interface (Dobot Magician)	Output (Level translator)	Corresponding I/O interface (PLC)
Input 1	I/O14	Output 1	I0.0
Input 2	I/O15	Output 2	I0.1
GND	GND	VCC	the positive pole of 24V DC (L+)
-	-	GND	the negative pole of 24V DC (M)

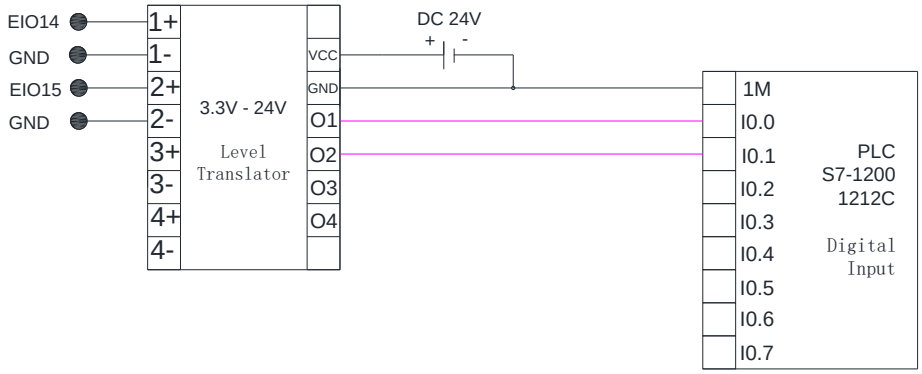


Figure 2.10 The connection of Dobot Magician, Level translator and PLC

⚠NOTICE

The connection diagram is non-standard electrical drawing, which is for reference only.

2.2.5 Digital Output Connection

When the PLC is connected to Dobot Magician with I/O interface, the output voltage of I/O interface of PLC is 24V, while the input voltage of I/O interface that Dobot Magician uses is 3.3V. Therefore, you need to select a 24V to 3.3V level translator.

Since the level is uncertain when the I/O PINs of Dobot Magician are dangled, you need to connect I/O 20 (3.3V level signal) and GND to the 24V to 3.3V level translator.

Figure 2.11 shows the 24V to 3.3V level translator, of which the output type is PNP. Namely, if the signal of the input terminal is high, that of the output terminal will be high too.

⚠NOTICE

The 24V to 3.3V level translator resembles the 3.3V to 24V level translator in appearance. Before connecting, please confirm the model number, to avoid connection error.

Figure 2.11 24V to 3.3V level translator

- **Input 1** is connected to PLC Q0.0, and **Output 1** is connected to I/O 18 of Dobot Magician.
- **Input 2** is connected to PLC Q0.1, and **Output 2** is connected to I/O 19 of Dobot Magician.

Table 2.6 lists the connection relationship of Dobot Magician, level translator and PLC, and Figure 2.12 shows the connection of them.

Table 2.6 The connection relationship of Dobot Magician, Level translator and PLC

Input (Level translator)	Corresponding I/O interface (PLC)	Output (Level translator)	Corresponding I/O interface (Dobot Magician)
Input 1	Q0.0	Output 1	I/O 18
Input 2	Q0.1	Output 2	I/O 19
GND	3M or the negative pole of 24V DC (M)	VCC	I/O 20（provide 3.3V）
-	-	GND	GND

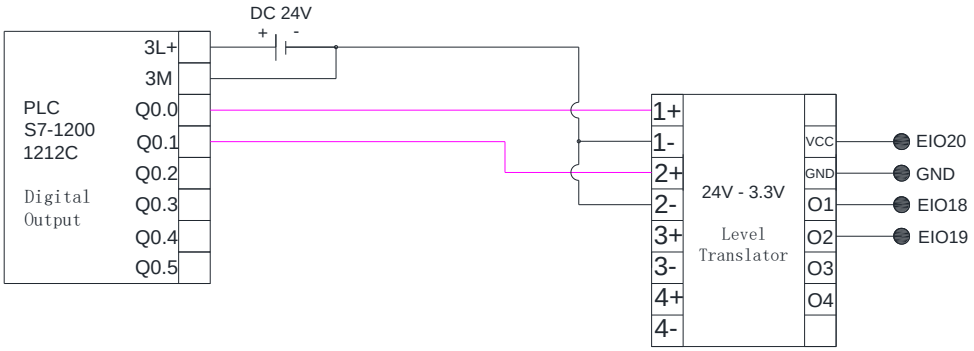


Figure 2.12 The connection of Dobot Magician, Level translator and PLC

3. Demo Description

This topic explains the PLC Demo codes.

3.1 Teaching and Saving Description

	MotionStyle	Name	X	Y	Z	R	PauseTime	SuctionCup	EIO14	EIO15	EIO20	Trigger_IO	Condition	Value
1	MOVJ	START	200.0	0.0	0.0	0.0	0.0	SuctionCupOff	High	Low	High			
2	MOVJ	Step2	200.0	0.0	0.0	0.0	0.5	SuctionCupOff	Low			EIO18_Input	=	1
3	MOVJ	l1	199.1685	118.5345	-3.5632	0.0	0.0	SuctionCupOff				EIO19_Input	=	0
4	MOVJ	l2	200.899	124.3916	-58.3699	0.0	0.0	SuctionCupOn				EIO19_Input	=	0
5	MOVJ	l1	199.1685	118.5345	-3.5632	0.0	0.0	SuctionCupOn				EIO19_Input	=	0
6	MOVJ	r1	201.183	-109.7554	1.1202	0.0	0.0	SuctionCupOn				EIO19_Input	=	0
7	MOVJ	r2	204.251	-114.6339	-58.0847	0.0	0.0	SuctionCupOff				EIO19_Input	=	0
8	MOVJ	r1	201.183	-109.7554	1.1202	0.0	0.0	SuctionCupOff				EIO19_Input	=	0
9	MOVJ	r2	204.251	-114.6339	-58.0847	0.0	0.0	SuctionCupOn				EIO19_Input	=	0
10	MOVJ	r1	201.183	-109.7554	1.1202	0.0	0.0	SuctionCupOn				EIO19_Input	=	0
11	MOVJ	l1	199.1685	118.5345	-3.5632	0.0	0.0	SuctionCupOn				EIO19_Input	=	0
12	MOVJ	l2	200.899	124.3916	-58.3699	0.0	0.0	SuctionCupOff				EIO19_Input	=	0
13	MOVJ	l1	199.1685	118.5345	-3.5632	0.0	0.0	SuctionCupOff				EIO19_Input	=	0
14	MOVJ	END	200.0	0.0	0.0	0.0	0.5	SuctionCupOff		High				

Figure 3.1 Saved-points list description

Program interpretation:

（1） The first line: **EIO14**, **EIO15** and **EIO18** are set as output signals. Set **EIO20** to **High** to provide 3.3V high level, Set **EIO14** to High to send Ready signal and set **EIO15** to **LOW** to close Completion signal.

（2） The second line: **EIO18** is set as input signal. When the input is high, this saved point is triggered. After it t is executed, the **EIO14** is set to **Low**, to make the Ready signal closed. And the procedure will be executed in order.

（3） From the third line to the next-to-last line: These saved points are user-defined. There is a Stop signal (**EIO19**) in every saved point. If the input of **EIO19** is high, the procedure will be stopped.

（4） The last line: End the program and Set **EIO15** to **High** to send Completion signal.

3.2 PLC Code Description

The PLC program in our demo is implemented by **LD** language. Table 3.1 lists the input/output variable definitions used in PLC program.

Table 3.1 Variable Definition

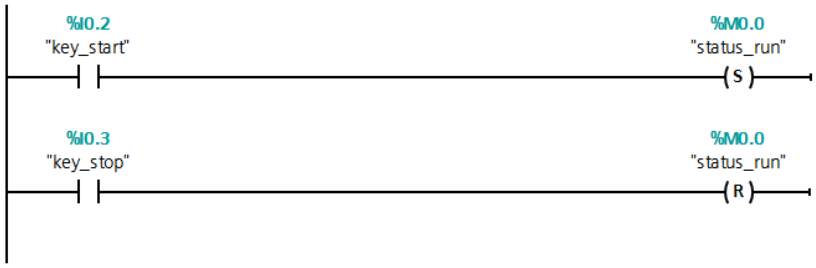
Variable name	Variable address	Function Description
dobot_ready	%I0.0	Receive Ready signal from Dobot Magician
dobot_done	%I0.1	Receive Completion signal from Dobot Magician
key_start	%I0.2	Receive the input signal of the started-button
key_stop	%I0.1	Receive the input signal of the stopped-button
dobot_start	%Q0.0	Send the Start signal to Dobot Magician
dobot_stop	%Q0.1	Send the Stop signal to Dobot Magician
light_start	%Q0.2	Control the green LED indicator
light_stop	%Q0.3	Control the red LED indicator

（1） Program 1: Obtain the status of the buttons. If the started-button is pressed down, the

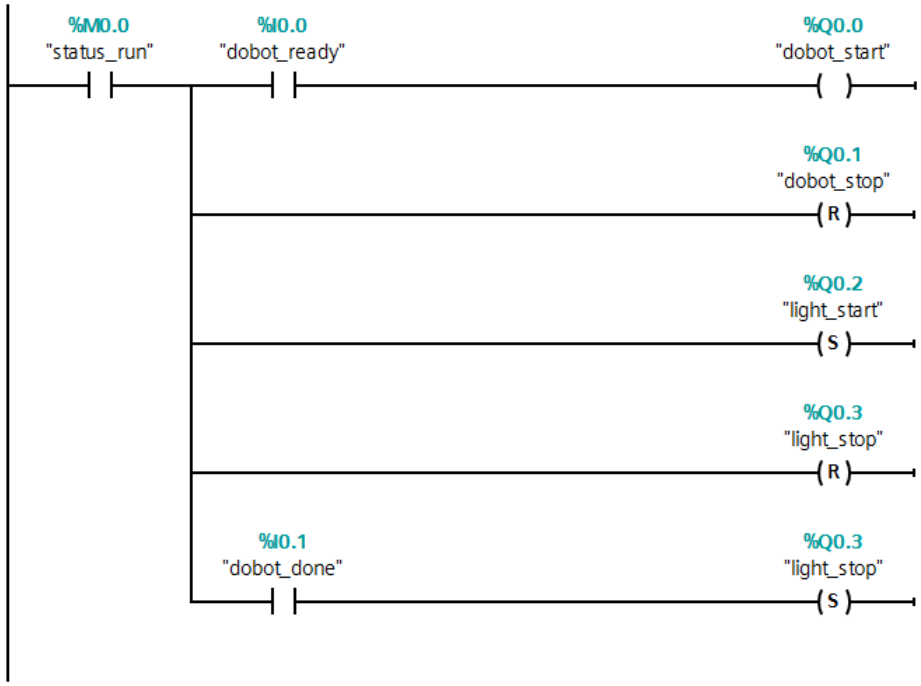
status_run is set to **1**. While the stopped-button is pressed down, the **status_run** is set to **0**.

Running Status: **status_run (M0.0) = 1**

Stopped Status: **status_run (M0.0) = 0**



（2） Program 2: Running Status. If the PLC receives the Ready signal from the Dobot Magician, the PLC will send the Start signal to Dobot Magician. In the meantime the green LED indicator is on and the red one is off. If the PLC receives the Completion signal from Dobot Magician, the red LED indicator will be on about one second.



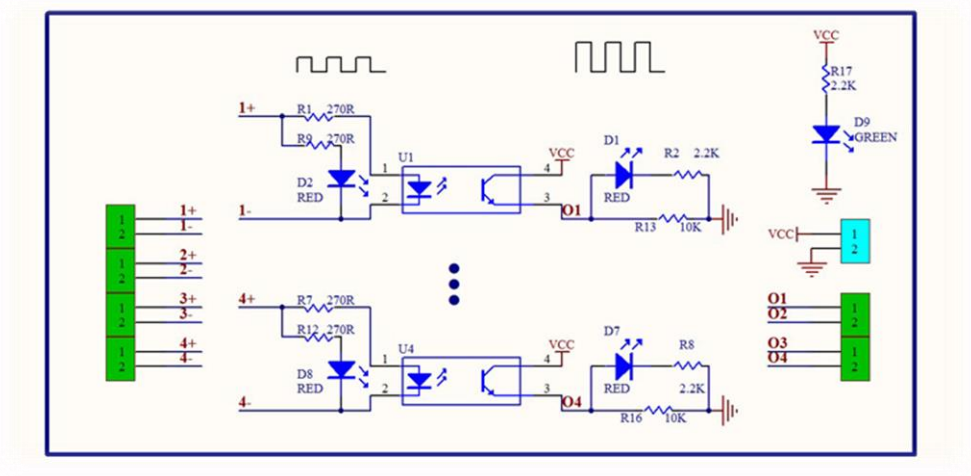
（3） Program 3: Stopped status. If the PLC sends Stop signal to Dobot Magician, the red LED indicator is on while the green one is off,


%M0.0
"status_run"
%Q0.3
"light_stop"
S
%Q0.1
"dobot_stop"
S
%Q0.2
"light_start"
R

Appendix A Other Description

Level Translator Information

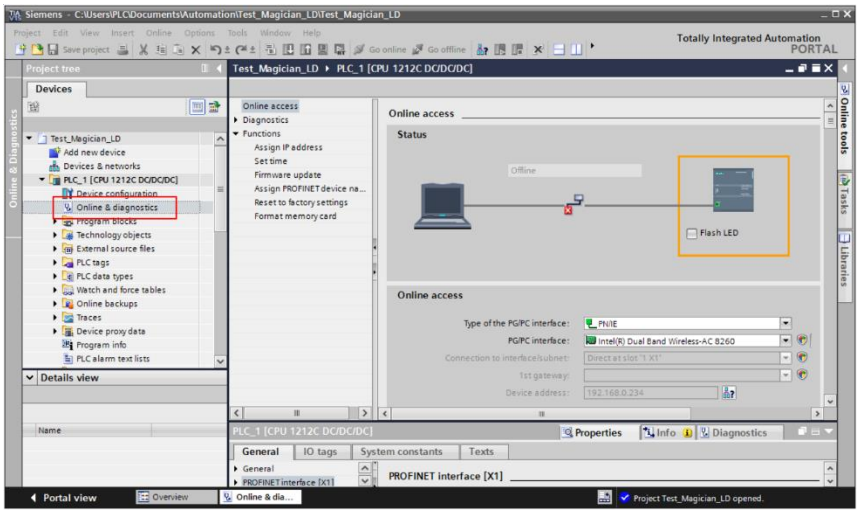
Appendix Figure 1 shows the schematic diagram of level translator which is from the third party. This is for reference only, you can select or design the appropriate one based on site requirements.



Appendix Figure 1 Schematic diagram of level translator

How to Modify the PLC IP Address

Step 1 Click **Online&Diagnostics** on the device configuration page, as shown in Appendix Figure 2.



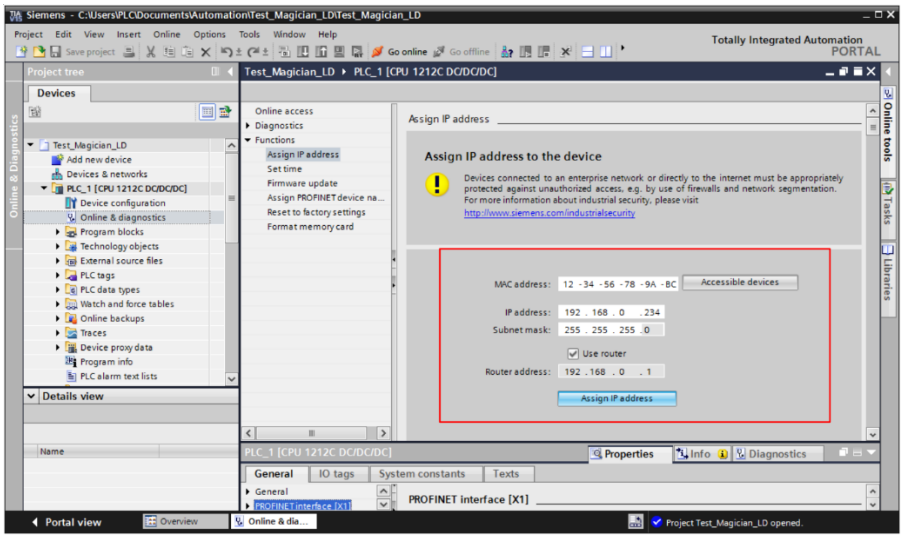
Appendix Figure 2 Click Online&Diagnostics

Step 2 Click **Functions > Assign IP address** on the device configuration page, set the IP address in the box of Appendix Figure 3 and click **Assign IP address.**

Please check the MAC address from the Ethernet interface of PLC.

⚠NOTICE

Please make sure that the IP address of the PLC and your computer is on the same network segment.



Appendix Figure 3 Modify the IP address