

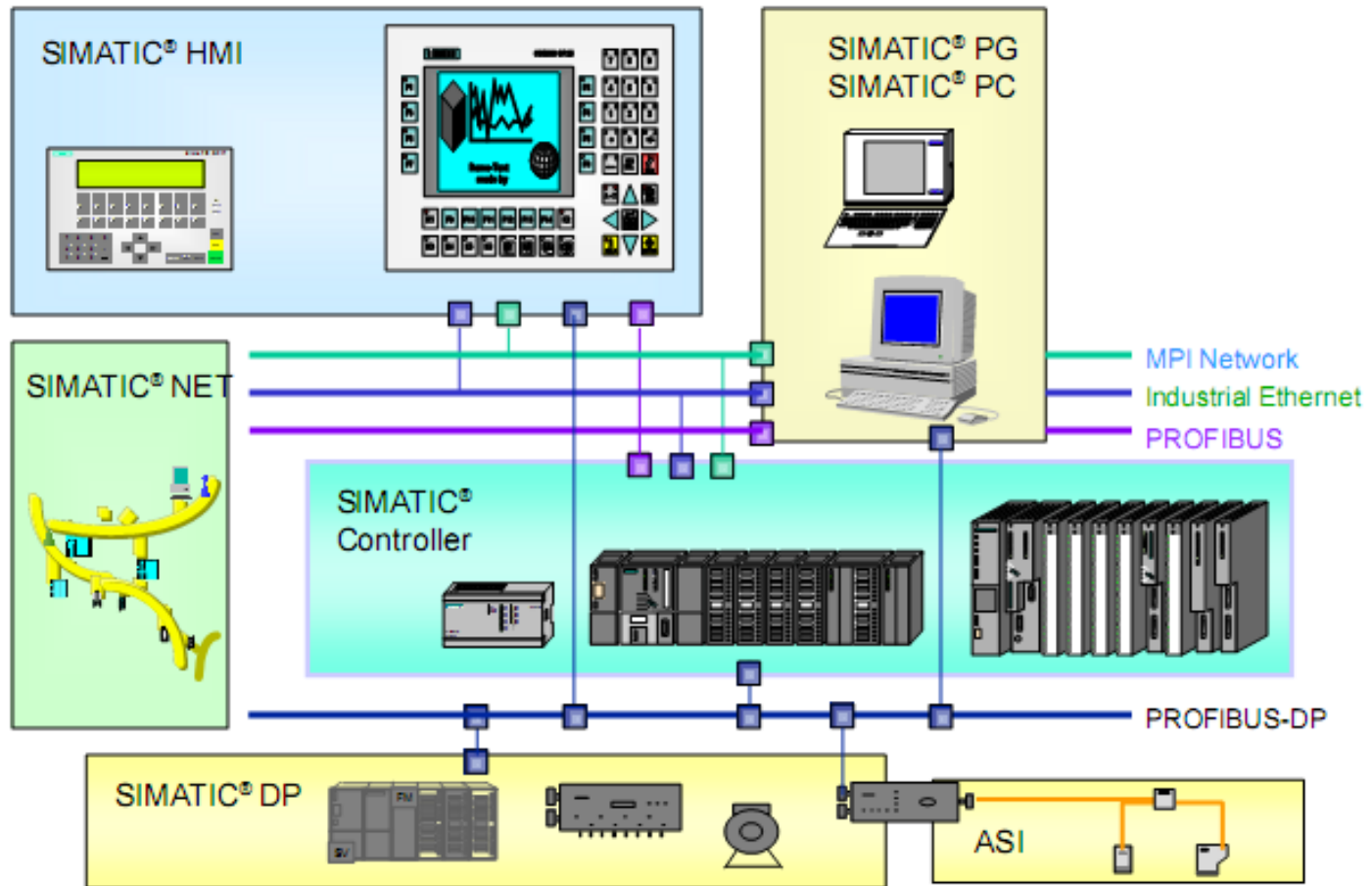
GIÁO TRÌNH LẬP TRÌNH PLC 2

CHƯƠNG I: TỔNG QUAN

1.1 GIỚI THIỆU PLC S7 - 300

GIỚI THIỆU PLC S7 - 300

Tổng quan về S7:



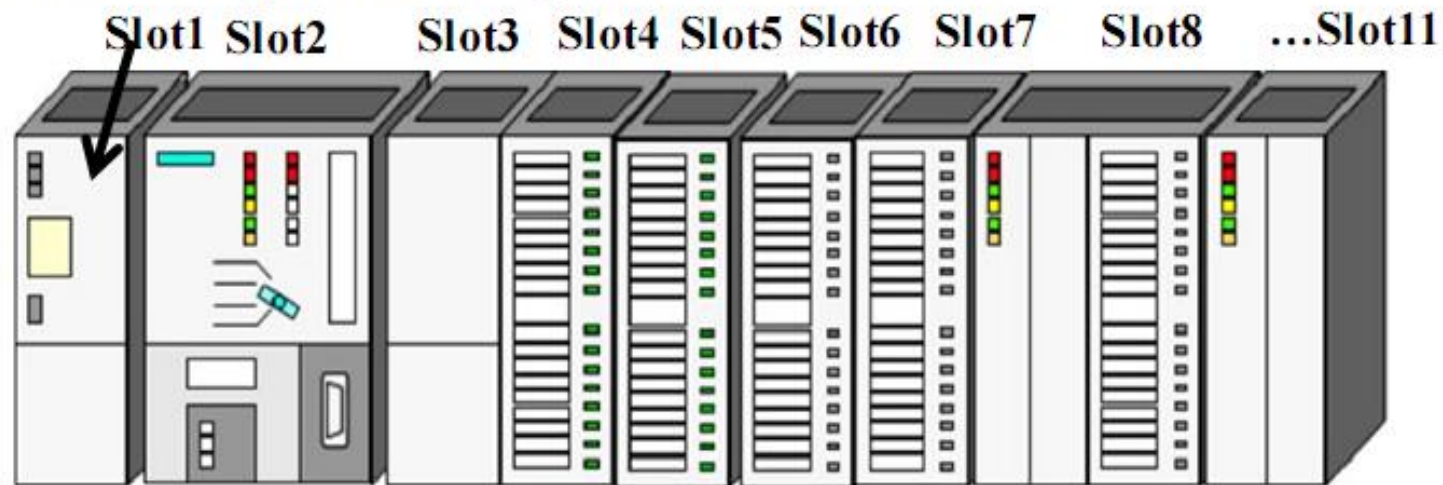
GIÁO TRÌNH LẬP TRÌNH PLC 2

CHƯƠNG I: TỔNG QUAN

1.2 PHẦN CỨNG BỘ ĐIỀU KHIỂN PLC S7 - 300

PHẦN CỨNG BỘ ĐIỀU KHIỂN PLC S7 - 300

Cấu trúc phần cứng của PLC S7 300



↓	↓	↓	↓	↓	↓	↓	↓	↓
PS	CP	IM	SM: DI	SM: DO	SM: AI	SM: AO	FM:	CP:
(tùy chọn)	U	(tùy chọn)					- Đếm - Định vị - Điều khiển hồi tiếp	- Nối điểm - PROFIBUS - Ethernet công nghiệp

Slot1: Tùy chọn

Slot2: Được sử dụng để khai báo CPU

Slot3: Interface Module dùng để mở rộng rack

Slot 4 đến Slot11: SM, FM, CP..

PHẦN CỨNG BỘ ĐIỀU KHIỂN PLC S7 - 300

Mở rộng Rack cho PLC S7 300



**S7300 có khả năng mở rộng 4 Rack, 32 module
IM(Interface Module) được sử dụng để mở rộng rack.**

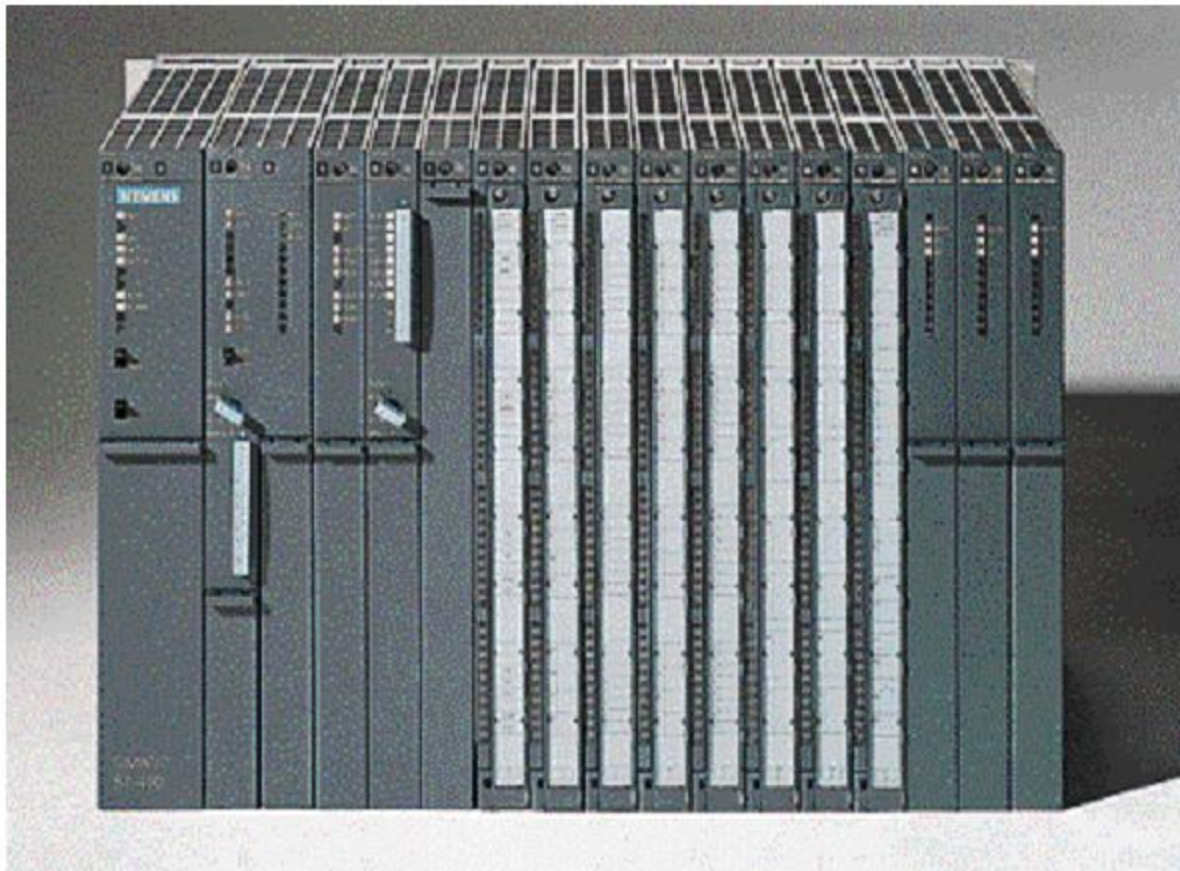
PHẦN CỨNG BỘ ĐIỀU KHIỂN PLC S7 - 300

Địa chỉ mặc định của các module

Slot	1	2	3	4	5	6	7	8	9	10	11
Rack 3	PS	IM (Receive)	96.0 to 99.7	100.0 to 103.7	104.0 to 107.7	108.0 to 111.7	112.0 to 115.7	116.0 to 119.7	120.0 to 123.7	124.0 to 127.7	
Rack 2	PS	IM (Receive)	64.0 to 67.7	68.0 to 70.7	72.0 to 75.7	76.0 to 79.7	80.0 to 83.7	84.0 to 87.7	88.0 to 91.7	92.0 to 95.7	
Rack 1	PS	IM (Receive)	32.0 to 35.7	36.0 to 39.7	40.0 to 43.7	44.0 to 47.7	48.0 to 51.7	52.0 to 55.7	56.0 to 59.7	60.0 to 63.7	
Rack 0	PS	CPU	IM (Send)	0.0 to 3.7	4.0 to 7.7	8.0 to 11.7	12.0 to 15.7	16.0 to 19.7	20.0 to 23.7	24.0 to 27.7	28.0 to 31.7

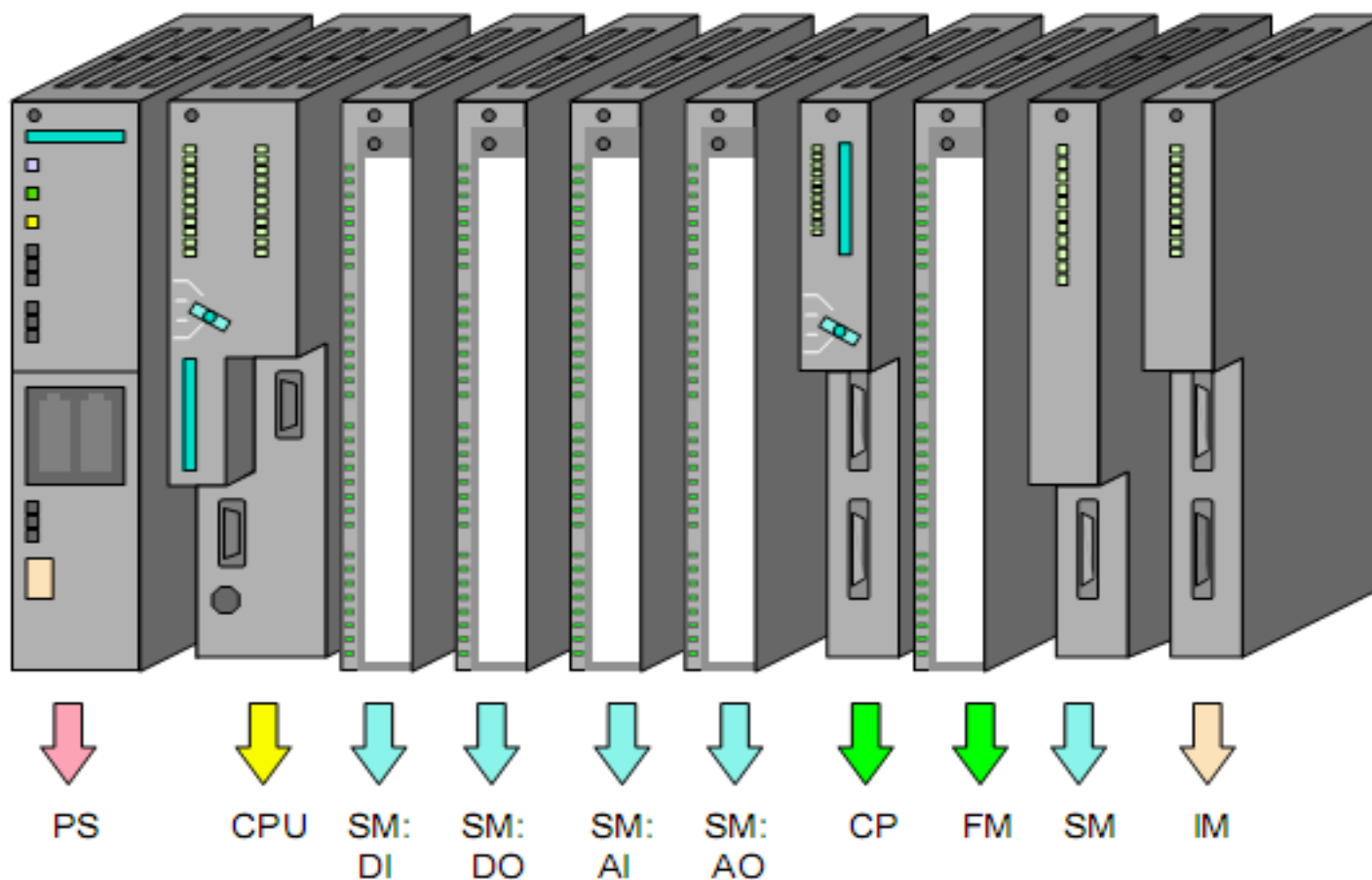
PHẦN CỨNG BỘ ĐIỀU KHIỂN PLC S7 - 300

S7- 400:



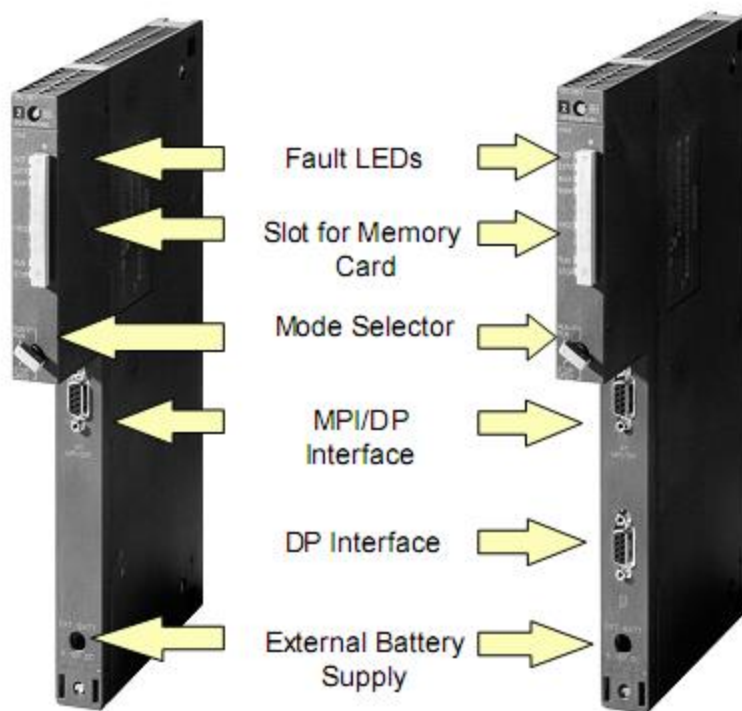
PHẦN CỨNG BỘ ĐIỀU KHIỂN PLC S7 - 300

S7-400: Modules



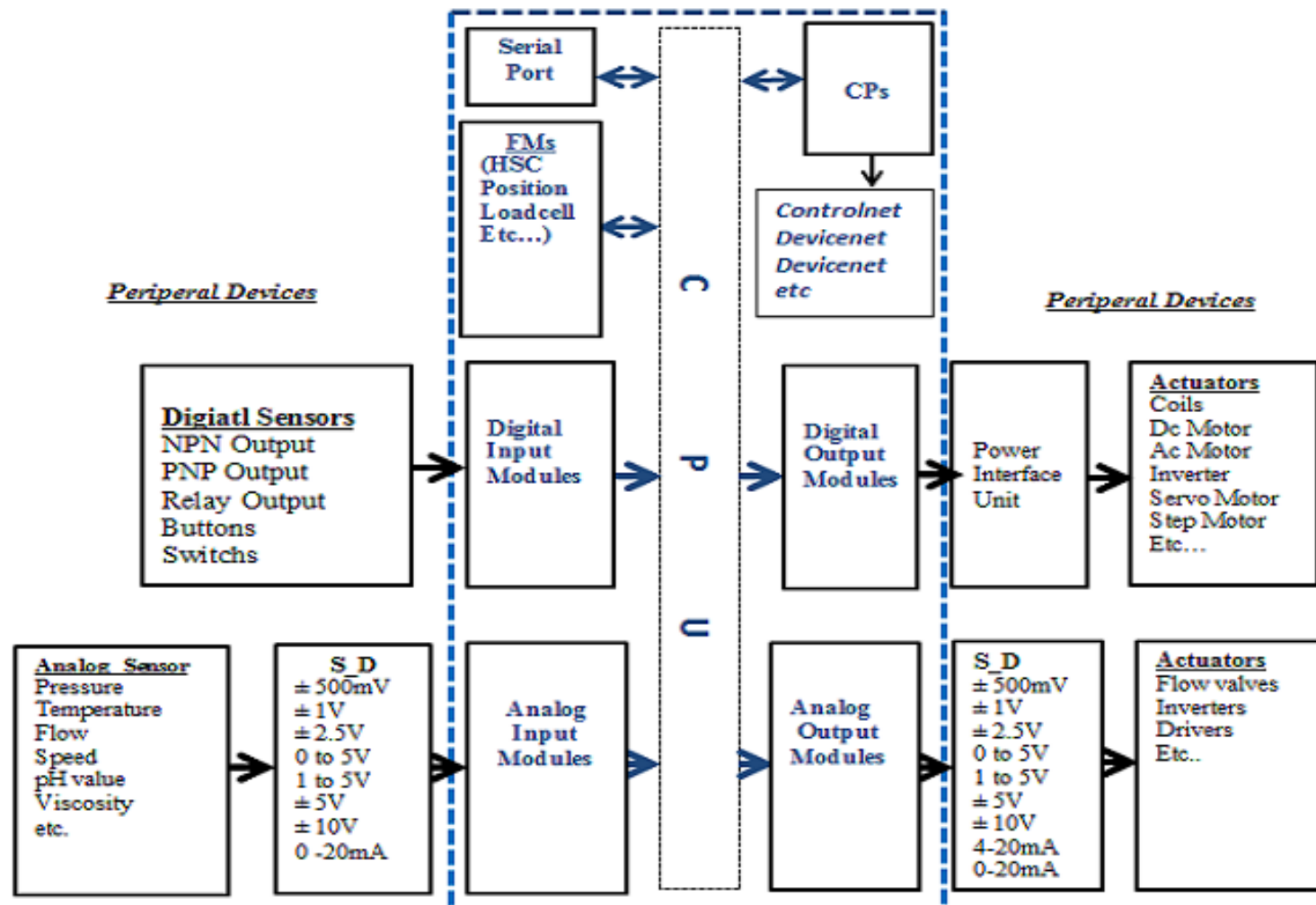
PHẦN CỨNG BỘ ĐIỀU KHIỂN PLC S7 - 300

S7-400: CPU Design



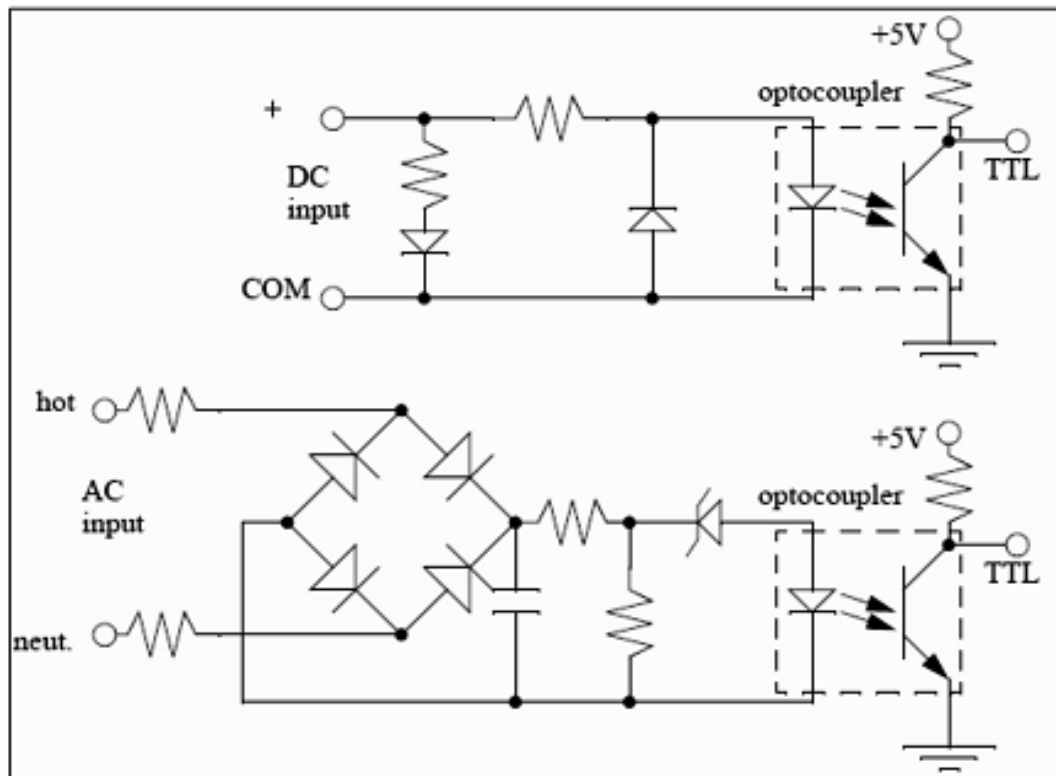
PHẦN CỨNG BỘ ĐIỀU KHIỂN PLC S7 - 300

CẤU TRÚC TỔNG QUÁT CỦA PLC



PHẦN CỨNG BỘ ĐIỀU KHIỂN PLC S7 - 300

CẤU TRÚC MẠCH NGÕ VÀO CỦA MODULE SỐ

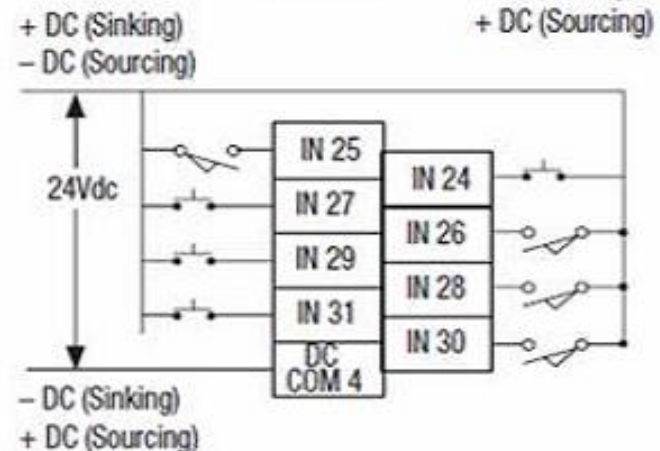
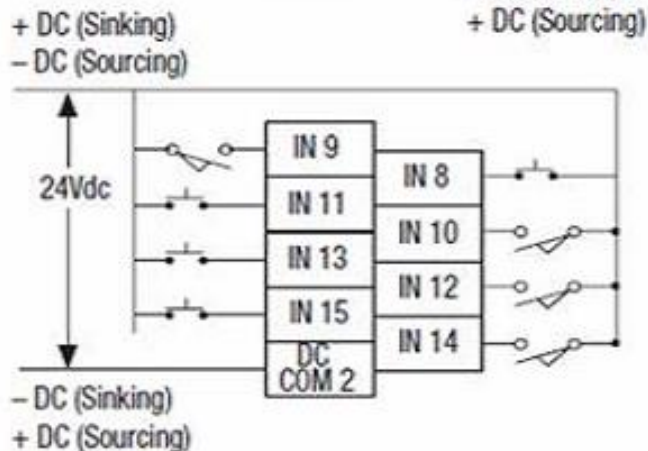
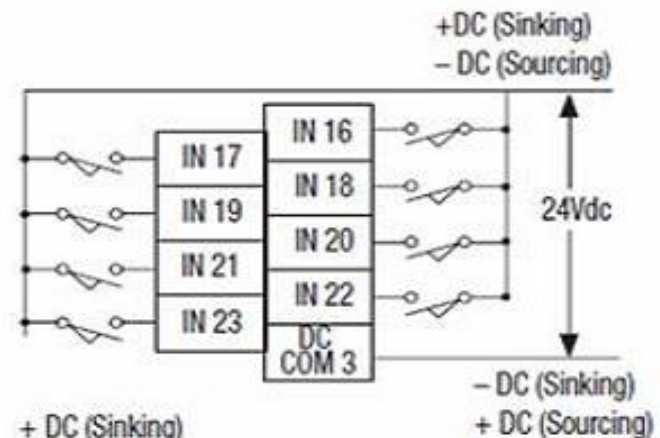
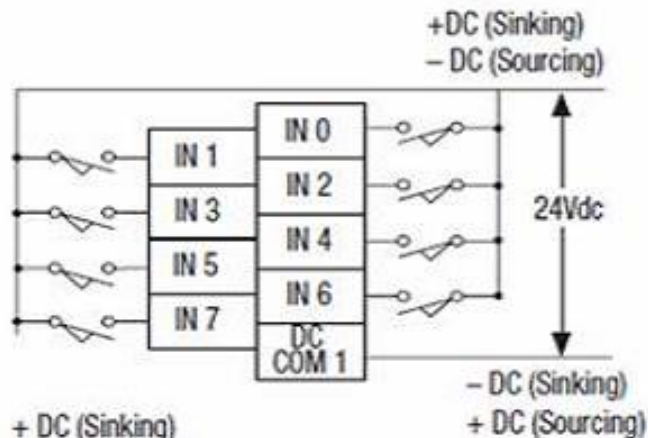


Mạch điện ngõ vào số của PLC Siemens

PHẦN CỨNG BỘ ĐIỀU KHIỂN PLC S7 - 300

KẾT NỐI NGÕ VÀO CHO MODULES

Kết nối kiểu Sinking/Sourcing cho module ngõ vào DC



PHẦN CỨNG BỘ ĐIỀU KHIỂN PLC S7 - 300

CẤU TRÚC MẠCH NGÕ VÀO CỦA MODULE SỐ

Nhận xét:

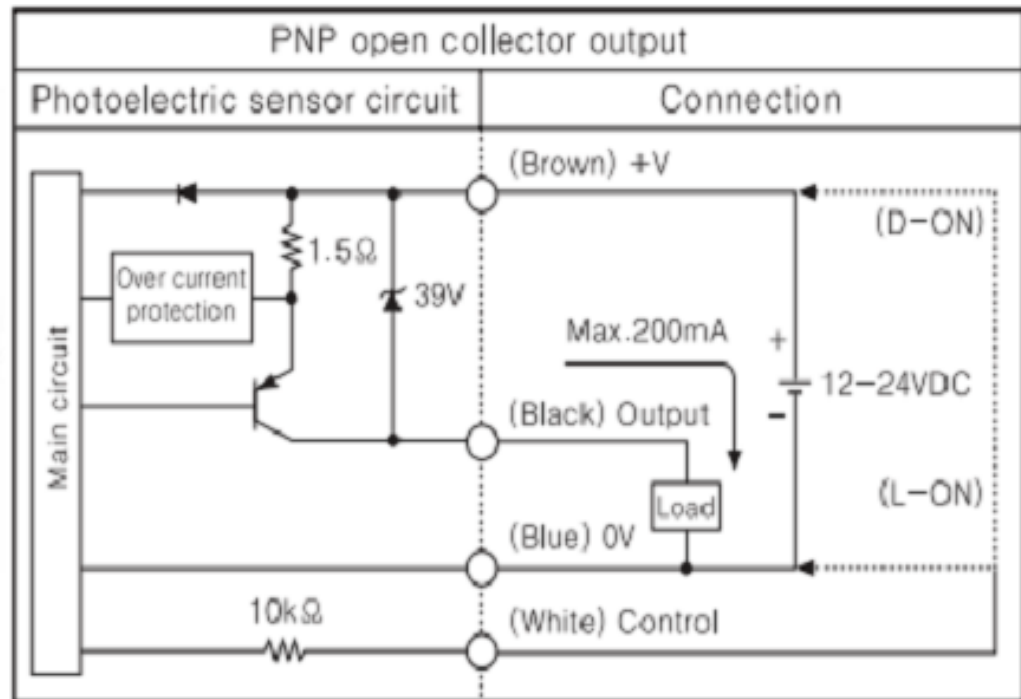
- Tất cả các ngõ vào của PLC đều cách ly.
- Dòng ngõ vào khoảng 10 đến 20mA.
- Các loại PLC khác nhau có thể sử dụng dây điện áp ngõ vào khác nhau.
- Một nhóm các ngõ vào thường được nối chung một đường tín hiệu.
- Có thể kết nối ngõ vào của PLC theo kiểu Sinking hay Sourcing

PHẦN CỨNG BỘ ĐIỀU KHIỂN PLC S7 - 300

KẾT NỐI NGÕ VÀO CHO MODULE SỐ

Ex1: Kết nối cảm biến có ngõ ra PNP với module ngõ vào số

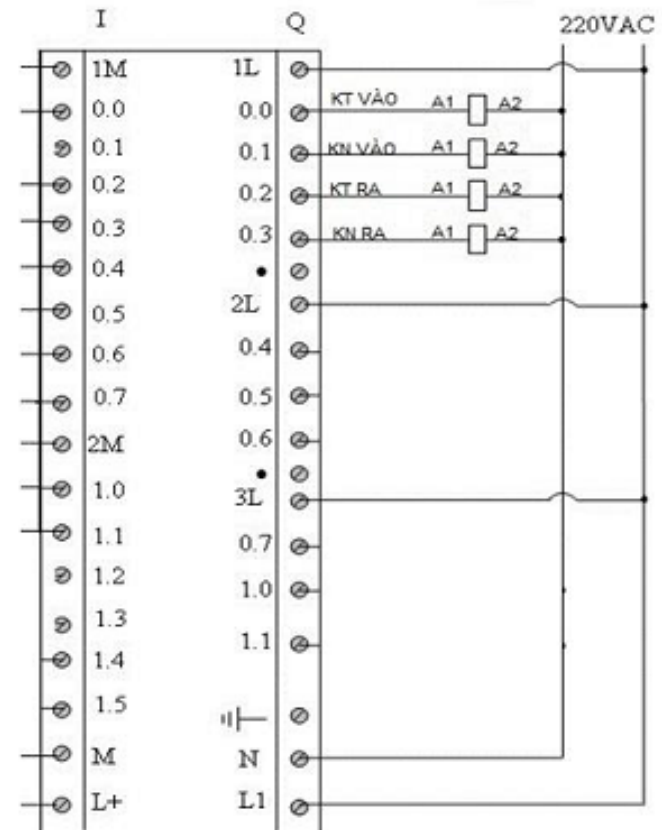
- BR(P)100-DDT-P / BR(P)200-DDTN-P / BR(P)400-DDT-P
- BR20M-TDTD2-P / BR20M-TDTL2-P (Receiver)



PHẦN CỨNG BỘ ĐIỀU KHIỂN PLC S7 - 300

KẾT NỐI NGÕ VÀO CHO MODULE SỐ

Ex1: Kết nối cảm biến có ngõ ra PNP với module ngõ vào số

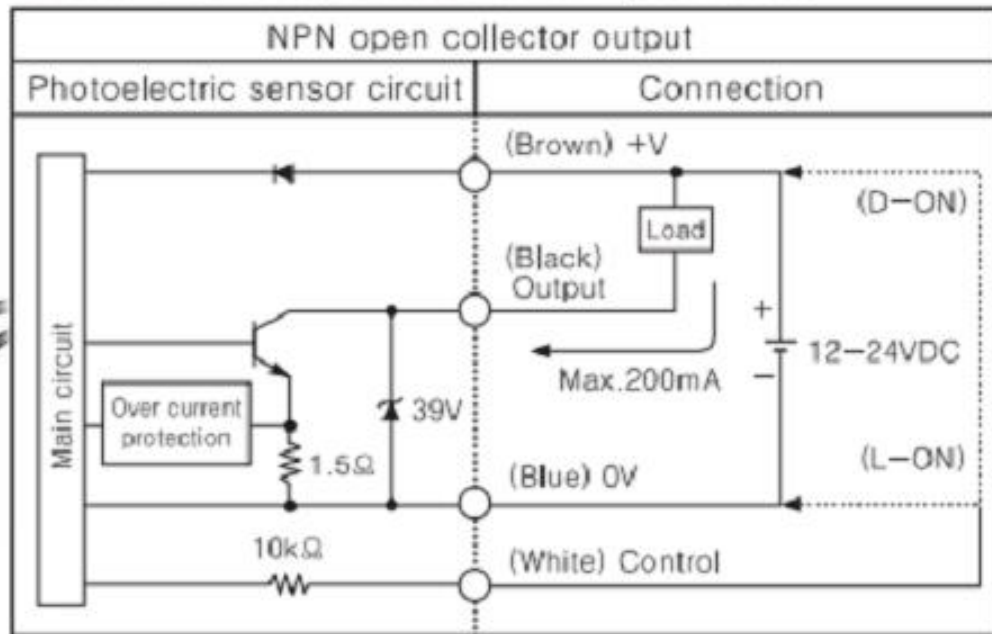


PHẦN CỨNG BỘ ĐIỀU KHIỂN PLC S7 - 300

KẾT NỐI NGÕ VÀO CHO MODULE SỐ

Ex2: Kết nối cảm biến có ngõ ra NPN với module ngõ vào số

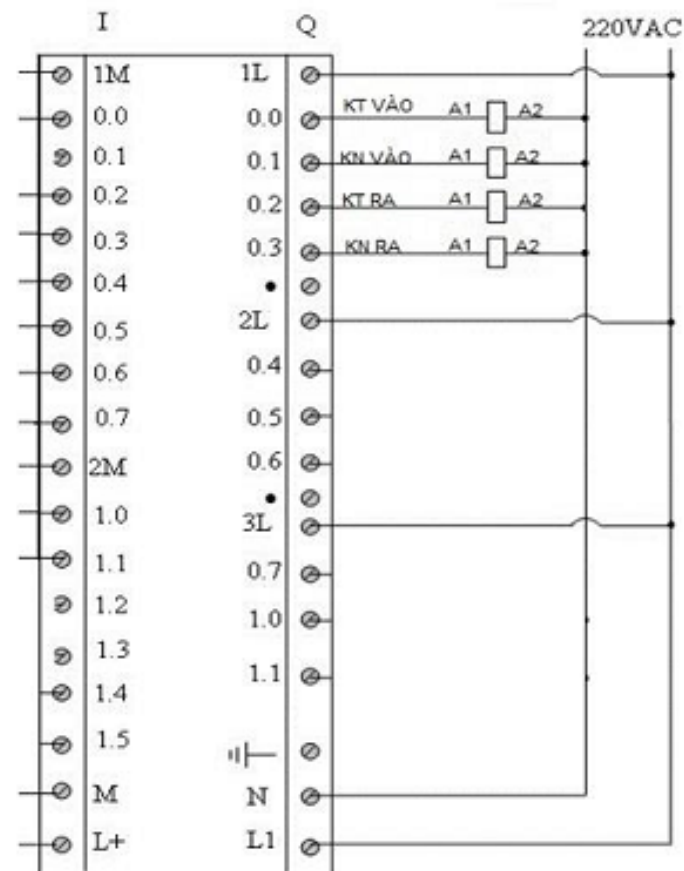
- BR(P)100-DDT / BR(P)200-DDTN / BR(P)400-DDT
- BR20M-TDTD2 / BR20M-TDTL2 (Receiver)



PHẦN CỨNG BỘ ĐIỀU KHIỂN PLC S7 - 300

KẾT NỐI NGÕ VÀO CHO MODULE SỐ

Ex2: Kết nối cảm biến có ngõ ra NPN với module ngõ vào số



PHẦN CỨNG BỘ ĐIỀU KHIỂN PLC S7 - 300

DIGITAL OUTPUT MODULES

- Những PLC cỡ nhỏ(S7200): Ngõ ra thường được tích hợp sẵn với CPU.
- Những PLC cỡ lớn(S7300): Ngõ ra thường được thiết kế dưới dạng module hoặc card.
- Có nhiều cấp điện áp khác nhau cho các ngõ ra cho các Module

120 Vac

24 Vdc

12-48 Vac

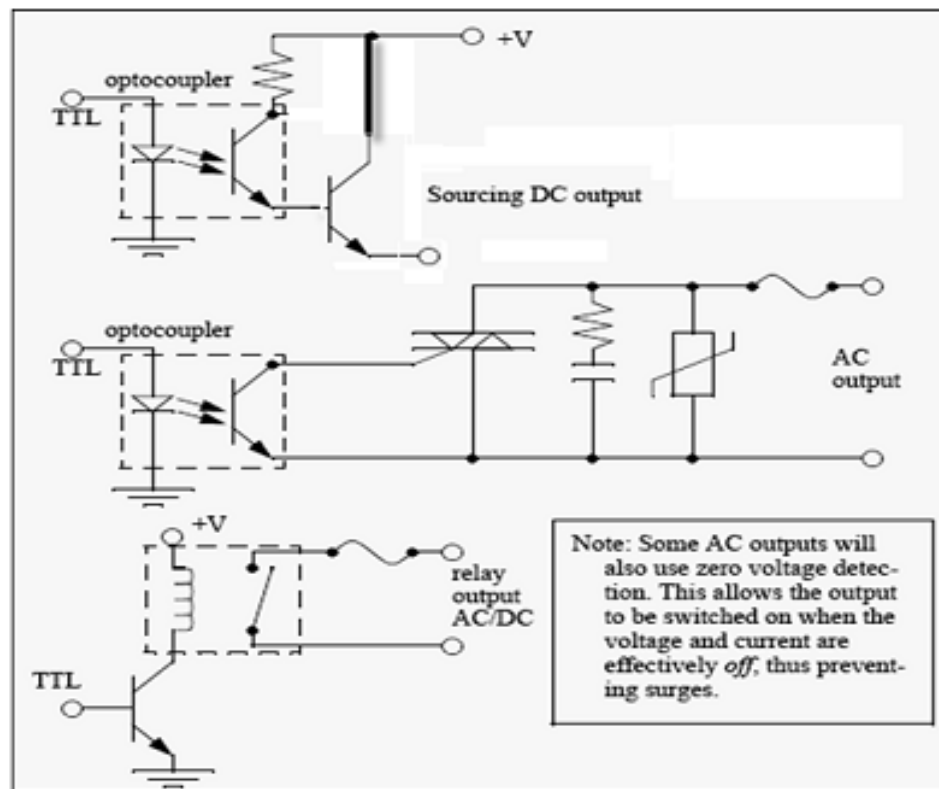
12-48 Vdc

5Vdc (TTL)

230 Vac

PHẦN CỨNG BỘ ĐIỀU KHIỂN PLC S7 - 300

CẤU TRÚC MẠCH NGÕ RA CỦA MODULE SỐ



Ngõ ra số của PLC siemens.

PHẦN CỨNG BỘ ĐIỀU KHIỂN PLC S7 - 300

CẤU TRÚC MẠCH NGÕ RA CỦA MODULE SỐ

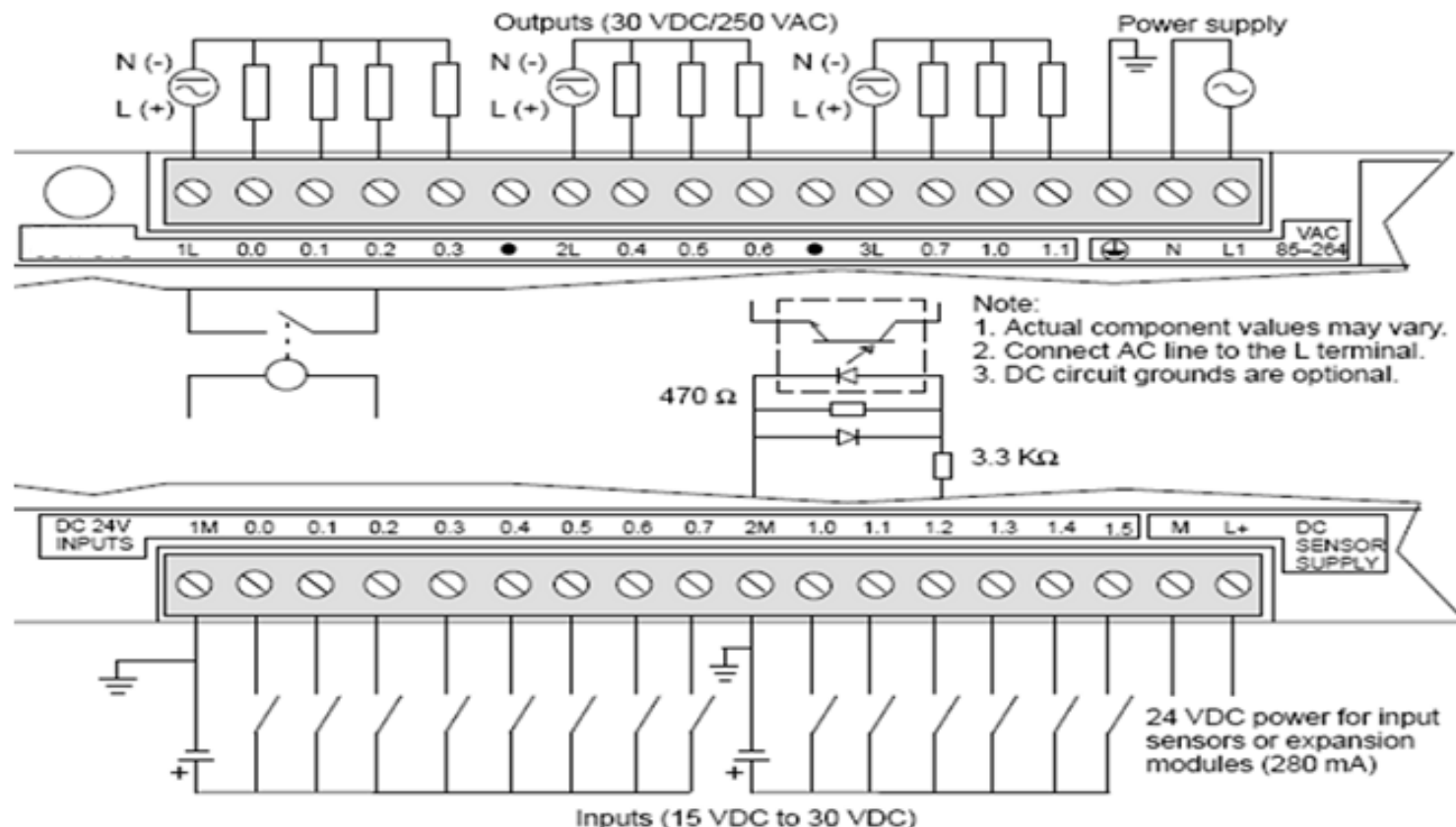
Nhận xét:

- Có 3 loại ngõ ra: DC, AC và RL
- Tất cả các ngõ ra của PLC đều cách ly
- Dòng ngõ ra khác nhau với các loại ngõ ra khác nhau.
- Các ngõ ra thực tế của PLC thường được nối chung một đường tín hiệu.

Tùy vào đối tượng tải và chế độ làm việc mà người sử dụng chọn loại ngõ ra nào cho phù hợp.

PHẦN CỨNG BỘ ĐIỀU KHIỂN PLC S7 - 300

KẾT NỐI PLC



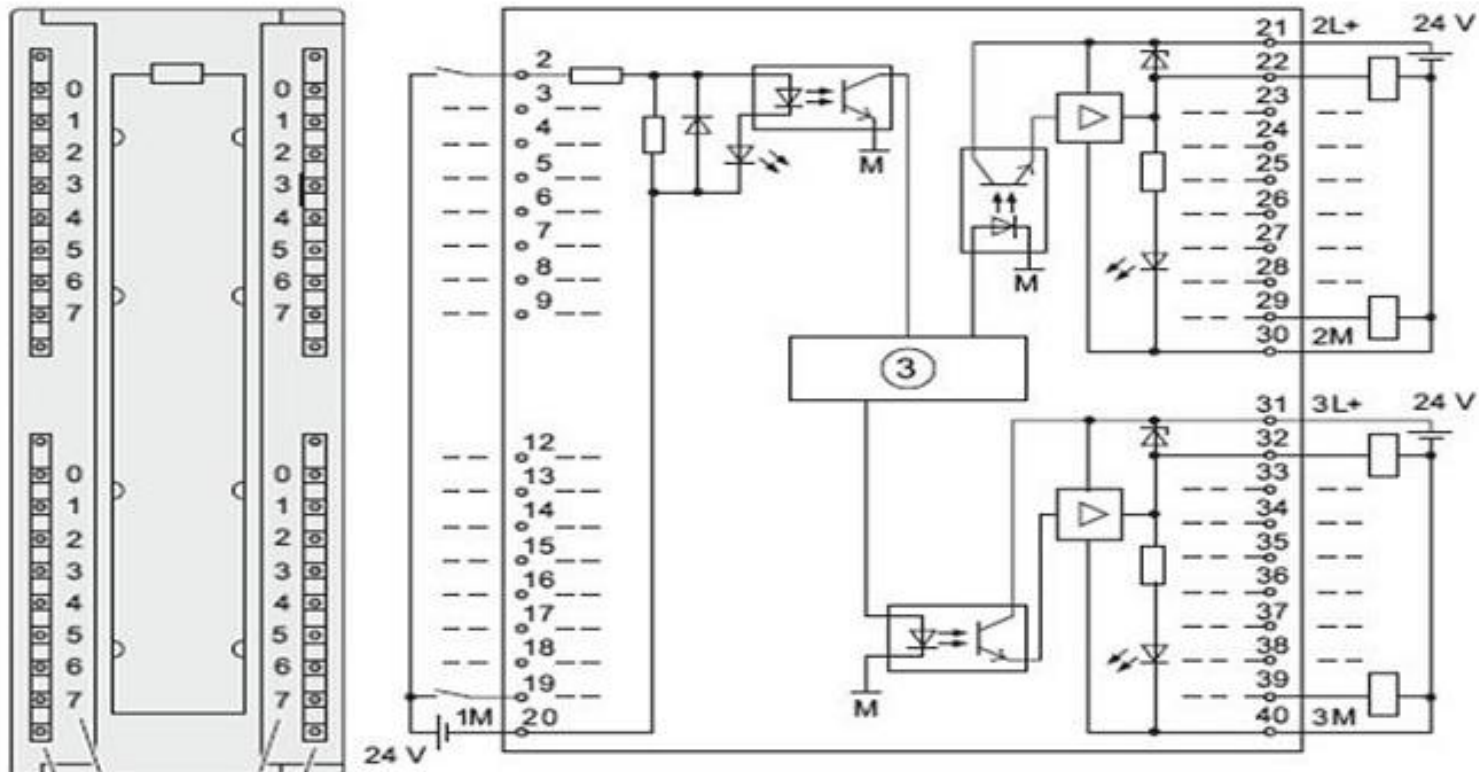
Plc này sử dụng nguồn AC hay DC?

PLC này có ngõ ra DC, AC hay RL?

Ngõ vào của PLC được kết nối theo kiểu Sinking hay Sourcing?

PHẦN CỨNG BỘ ĐIỀU KHIỂN PLC S7 - 300

KẾT NỐI PLC



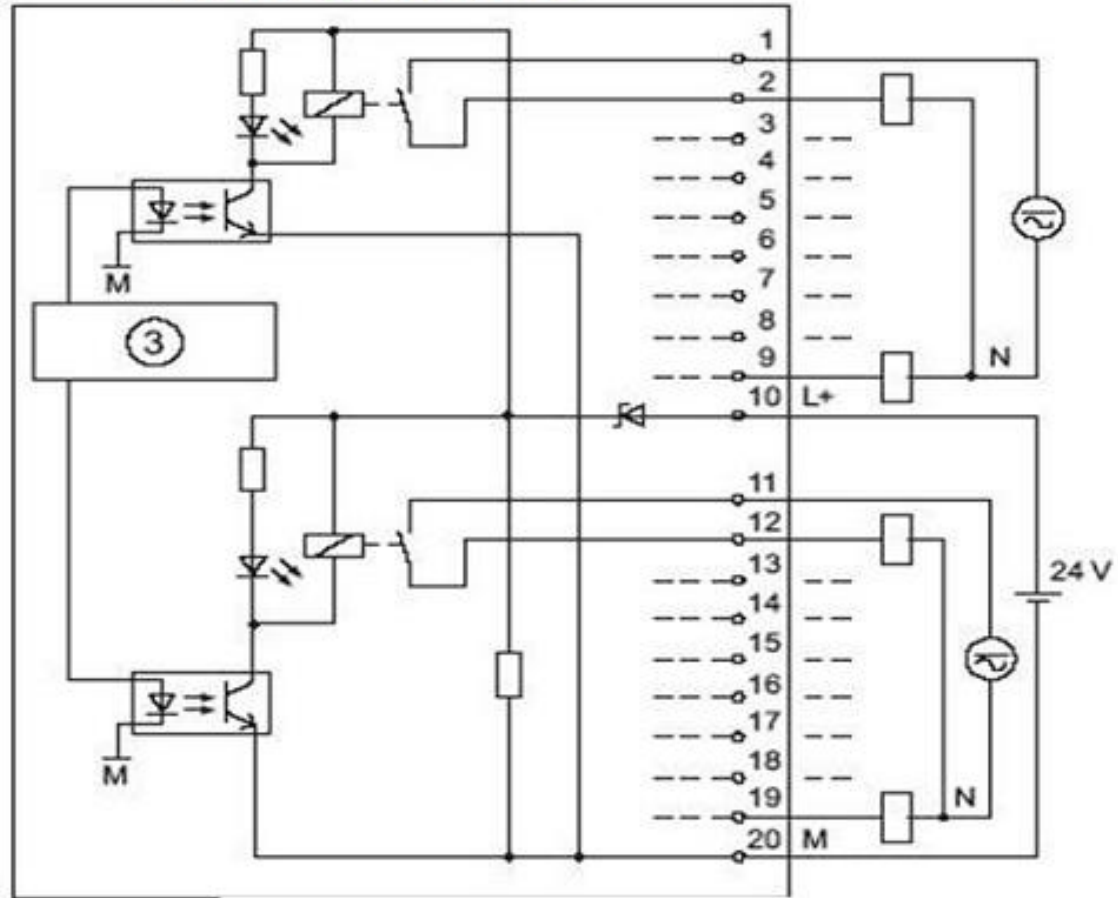
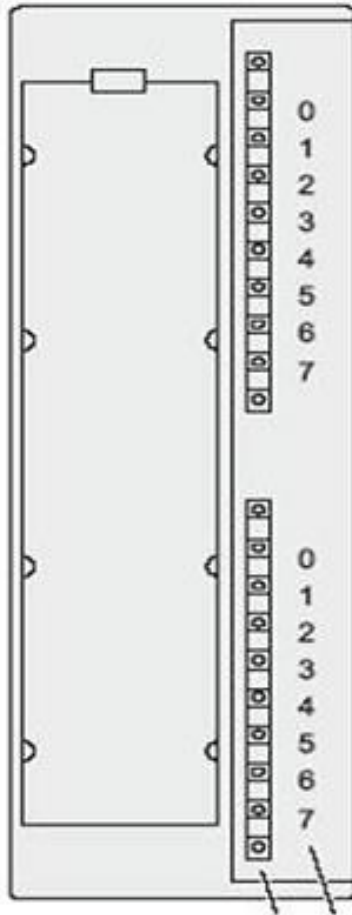
- ① Channel number
- ② Status displays - green
- ③ Backplane bus interface

Ngõ vào của module là AC hay DC?

Ngõ ra của của module là NPN hay PNP? PNP(source)

PHẦN CỨNG BỘ ĐIỀU KHIỂN PLC S7 - 300

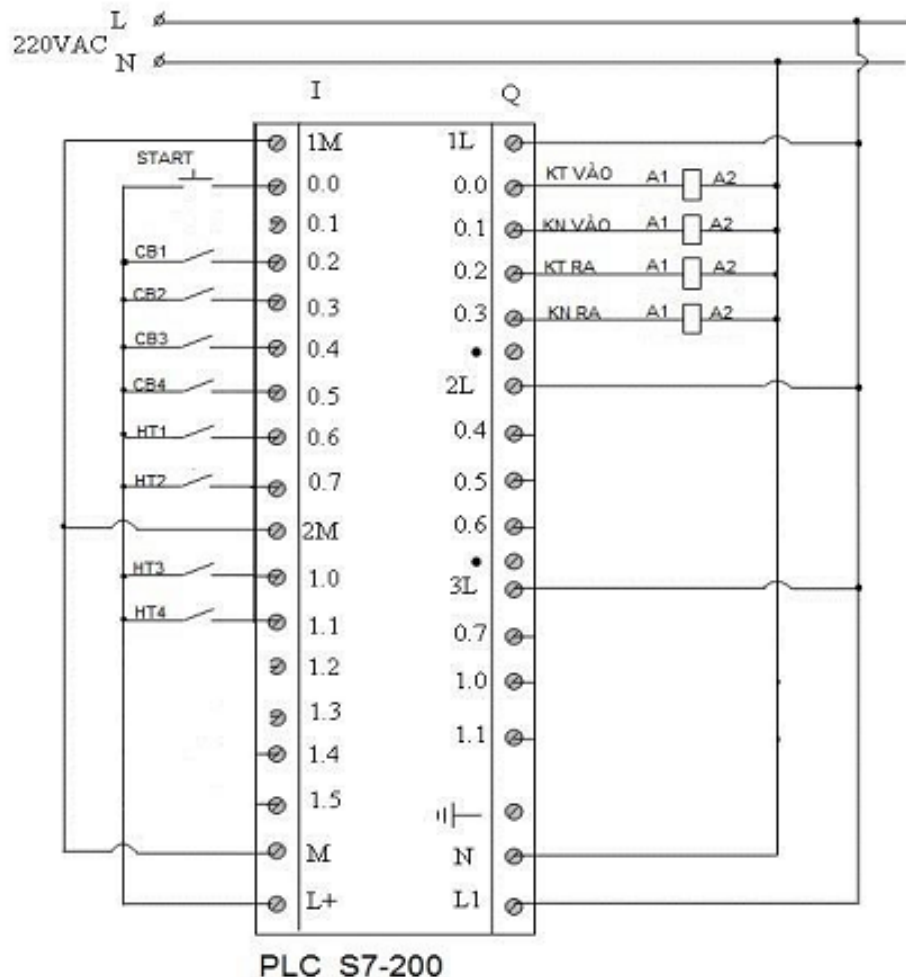
KẾT NỐI PLC



Ngõ ra của module số này là loại gì?

PHẦN CỨNG BỘ ĐIỀU KHIỂN PLC S7 - 300

KẾT NỐI PLC ĐIỀU KHIỂN BÃI ĐỒ XE



EX3: Nhận xét về sơ đồ kết nối plc điều khiển bãi đồ xe nhiều tầng.

Nguồn sử dụng cho PLC: AC hay DC?

PLC có ngõ ra AC, DC hay Relay?

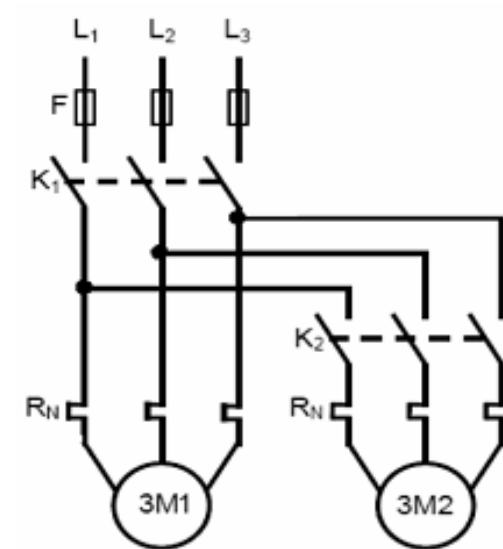
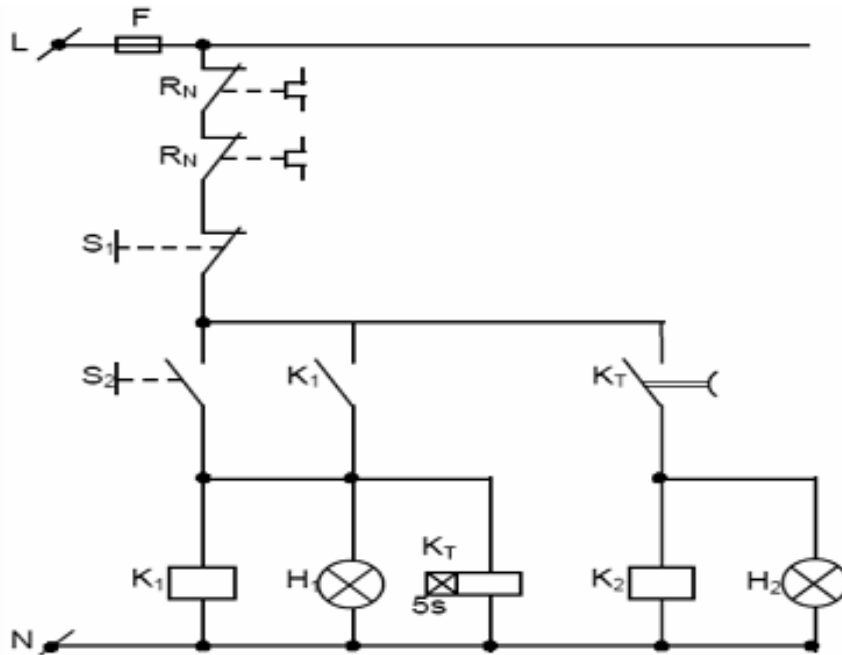
Cảm biến được sử dụng trong sơ đồ có ngõ ra là NPN hay PNP?

Sơ đồ kết nối đã phù hợp chưa? Tại sao?

PHẦN CỨNG BỘ ĐIỀU KHIỂN PLC S7 - 300

KẾT NỐI PHẦN CỨNG CHO PLC

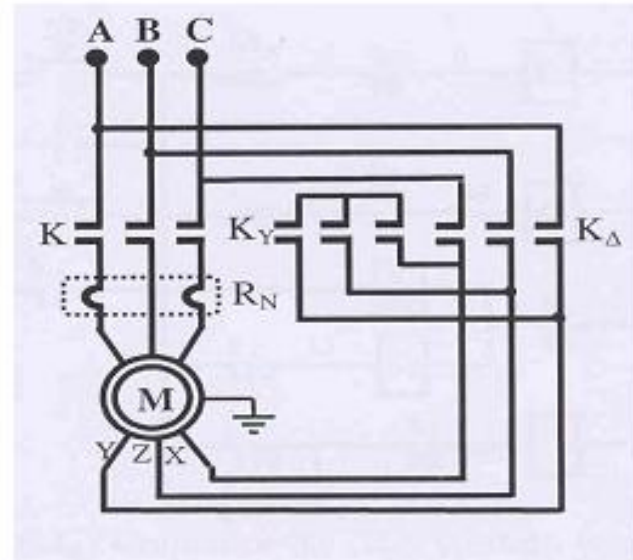
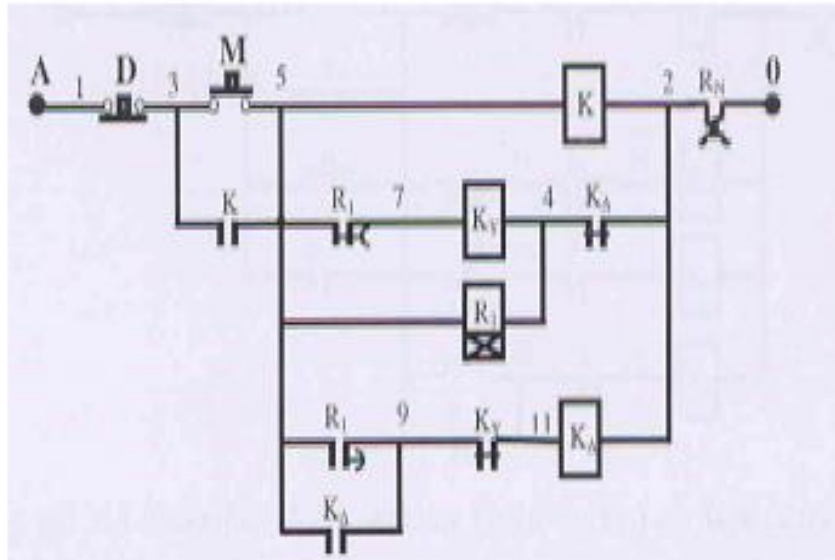
Ex4: Vẽ lại đầy đủ sơ đồ kết nối phần cứng cho PLC thay cho sơ đồ điều khiển khởi động tuần tự 2 động cơ dùng tiếp điểm như sau:



PHẦN CỨNG BỘ ĐIỀU KHIỂN PLC S7 - 300

KẾT NỐI PHẦN CỨNG CHO PLC

Ex5: Vẽ lại đầy đủ sơ đồ kết nối phần cứng dùng PLC thay cho sơ đồ điều khiển mạch khởi động Y- Δ dùng tiếp điểm như sau:

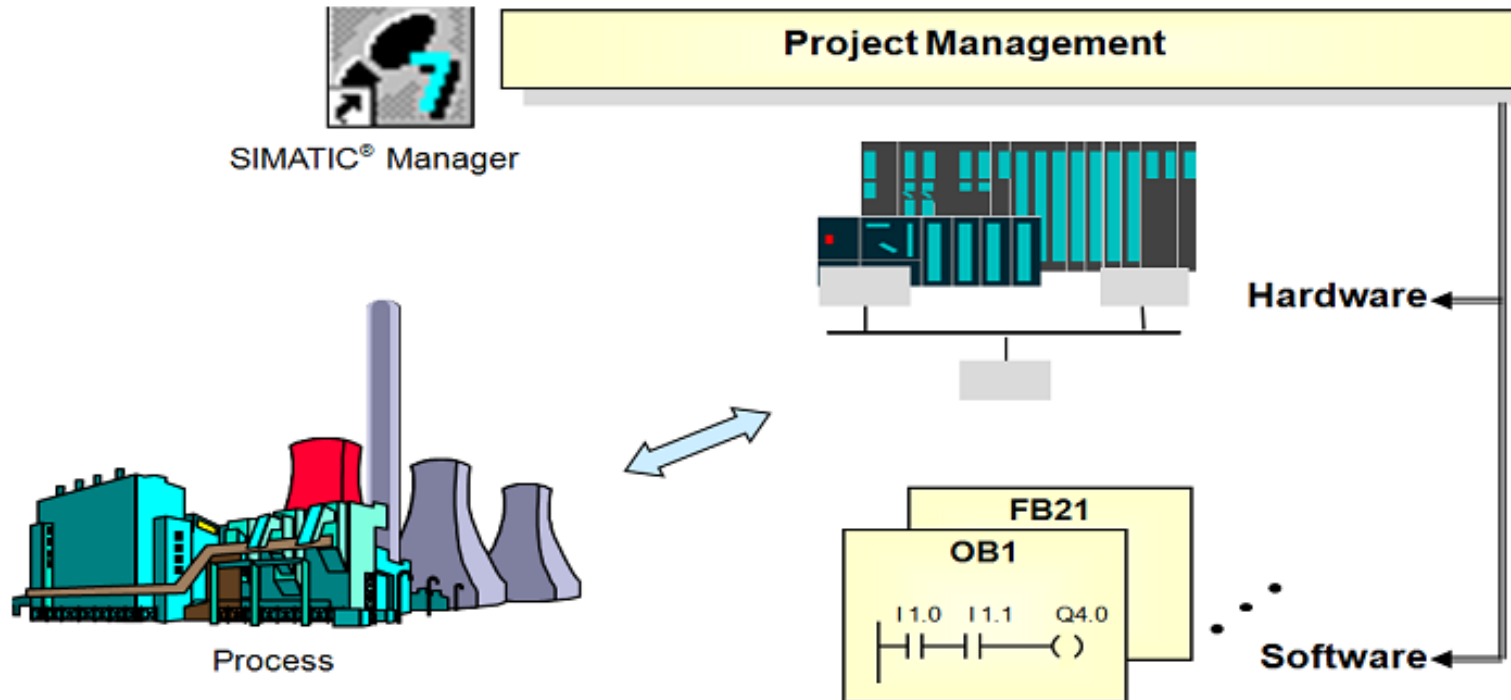


GIÁO TRÌNH LẬP TRÌNH PLC 2

CHƯƠNG II: THIẾT KẾ HỆ THỐNG VỚI SIMATIC MANAGER

THIẾT KẾ HỆ THỐNG VỚI SIMATIC MANAGER

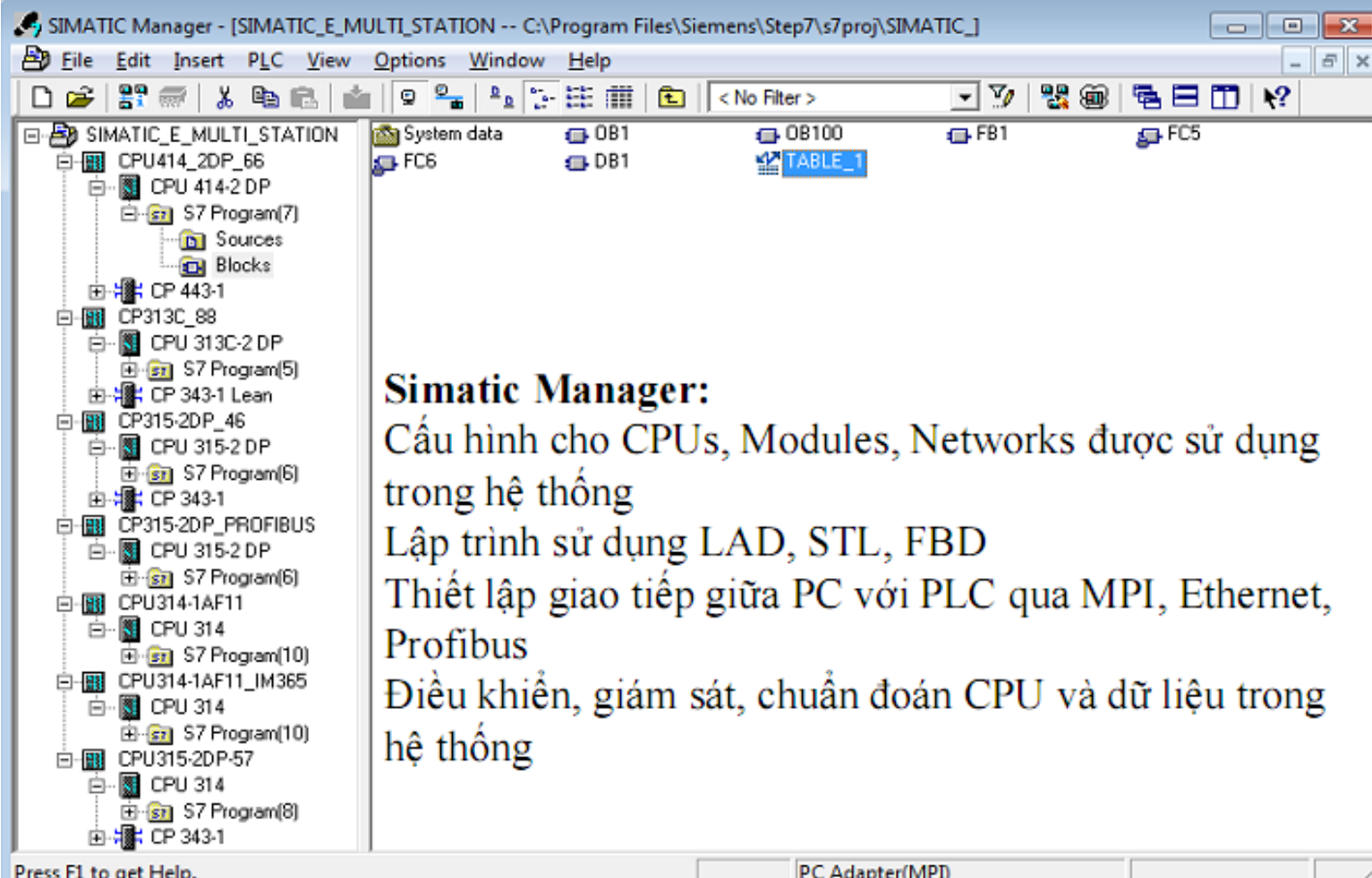
THIẾT KẾ HỆ THỐNG VỚI S7



- Xác định quy trình công nghệ của hệ thống xử lý
- Thiết kế và kết nối phần cứng.
- Cấu hình và lập trình điều khiển hệ thống dùng Simatic Manager

THIẾT KẾ HỆ THỐNG VỚI SIMATIC MANAGER

TỔ CHỨC CỦA PROJECT TRONG S7



The screenshot displays the SIMATIC Manager interface. On the left, a project tree shows a multi-station configuration with various CPU and CP modules. On the right, a table lists system data and variables:

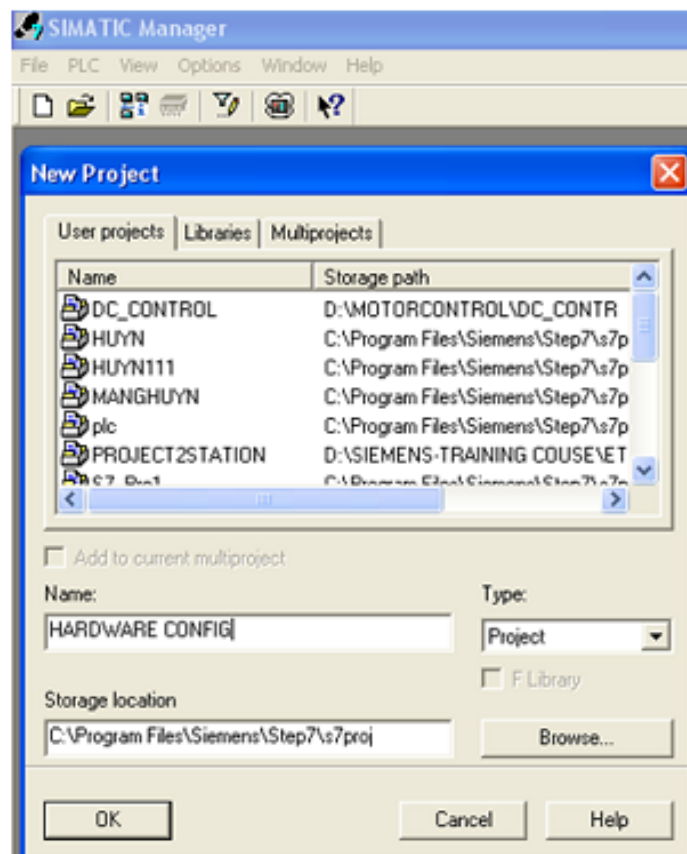
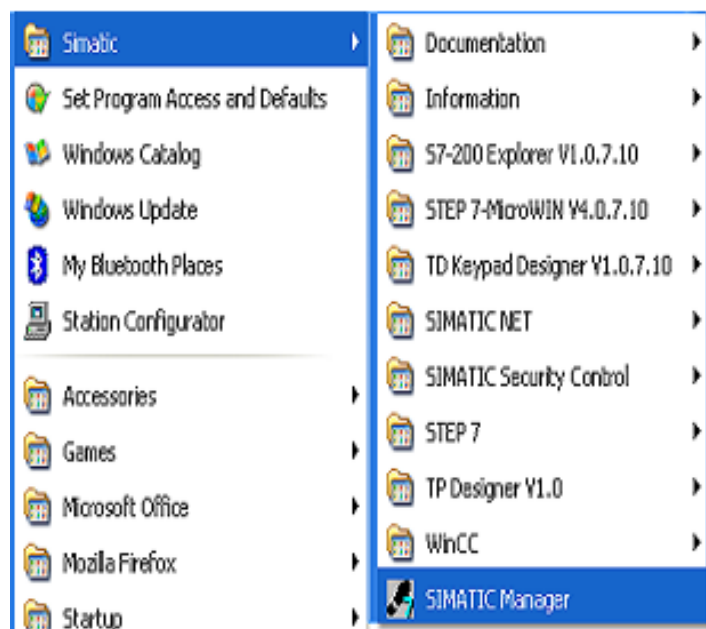
System data	OB1	OB100	FB1	FC5
FC6	DB1	TABLE_1		

Simatic Manager:
Cấu hình cho CPUs, Modules, Networks được sử dụng trong hệ thống
Lập trình sử dụng LAD, STL, FBD
Thiết lập giao tiếp giữa PC với PLC qua MPI, Ethernet, Profibus
Điều khiển, giám sát, chuẩn đoán CPU và dữ liệu trong hệ thống

THIẾT KẾ HỆ THỐNG VỚI SIMATIC MANAGER

LẬP TRÌNH SIMATIC S7

Tạo Project mới, đặt tên, chọn thư mục lưu project.



THIẾT KẾ HỆ THỐNG VỚI SIMATIC MANAGER

LẬP TRÌNH SIMATIC S7 300

Khai báo phần cứng cho S7 300

Lưu ý: Phải khai báo đúng và đủ với cấu hình thực tế, nếu khai báo sai thì CPU sẽ báo lỗi.

The image shows a screenshot of the SIMATIC Manager hardware configuration interface. The main window is titled 'HARDWARE CONFIG -- C:\Program Files\Siemens\Step7\s7proj\Hwa'. A context menu is open over the 'Hardware' folder, showing options like 'Cut', 'Copy', 'Paste', 'Delete', 'Insert New Object', 'PLC', 'Rename', and 'Object Properties...'. The 'Insert New Object' menu is expanded, showing options for 'SIMATIC 400 Station', 'SIMATIC 300 Station', 'SIMATIC H Station', 'SIMATIC PC Station', 'Other Station', 'SIMATIC S5', 'PG/PC', 'MPI', 'PROFIBUS', 'Industrial Ethernet', 'PTP', 'S7 Program', 'M7 Program', 'OS', and 'OS (Client)'. The 'SIMATIC 300 Station' option is selected. In the background, a hardware rack configuration is visible, showing a 'CPU 315-2 DP' and 'CP 343-1'. A second window titled 'HW Config - [SIMATIC 300(1) (Configuration) -- HARDWARE CONFIG]' shows a rack configuration table with the following components:

Slot	Component
1	PS 307 2A
2	CPU 315-2 DP
X2	DP
3	
4	DIB/D08xDC24V/0.5A
5	
6	
7	
8	
9	
10	
11	

THIẾT KẾ HỆ THỐNG VỚI SIMATIC MANAGER

Bài tập: khai báo phần cứng như sau:

CP313C_88 (Configuration) -- SIMATIC_E_MULTI_STATION

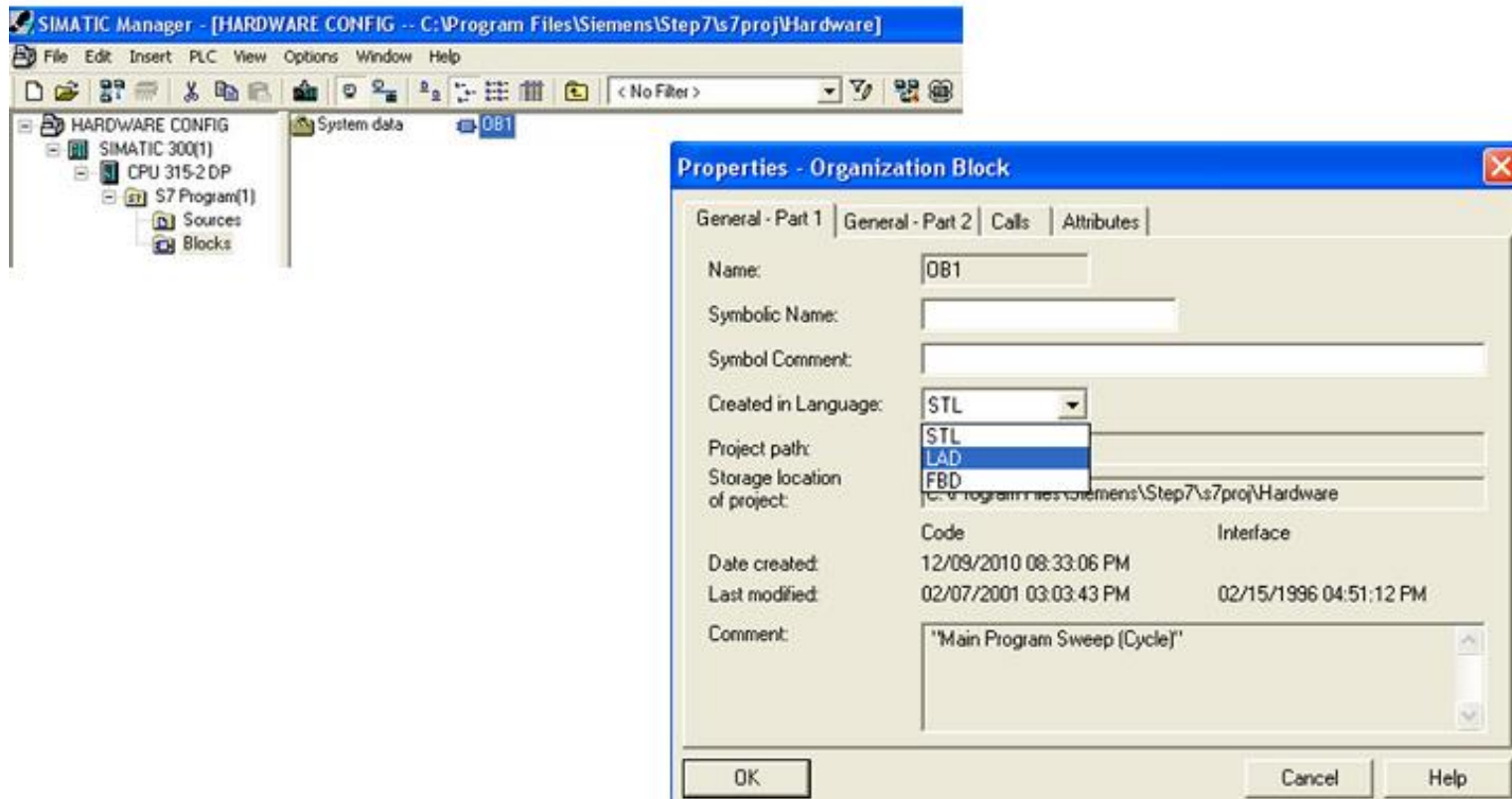
(0) UR

Slot	Module	Order number	Fit...	M...	I address	Q address
1	PS 307 2A	6ES7 307-1BA00-0AA0				
2	CPU 313C-2 DP	6ES7 313-6CF03-0AB0	V2.6	2		
X2	DP				1023"	
2.2	DI16/DO16				124...125	124...125
2.4	Count				768...783	768...783
3						
4	CP 343-1 Lean	6GK7 343-1CX10-0XE0	V2.0	3	256...271	256...271
5	AI4/AO2x8/8Bit	6ES7 334-0CE01-0AA0			272...279	272...275
6						
7						
8						
9						
10						
11						

THIẾT KẾ HỆ THỐNG VỚI SIMATIC MANAGER

LẬP TRÌNH SIMATIC S7300

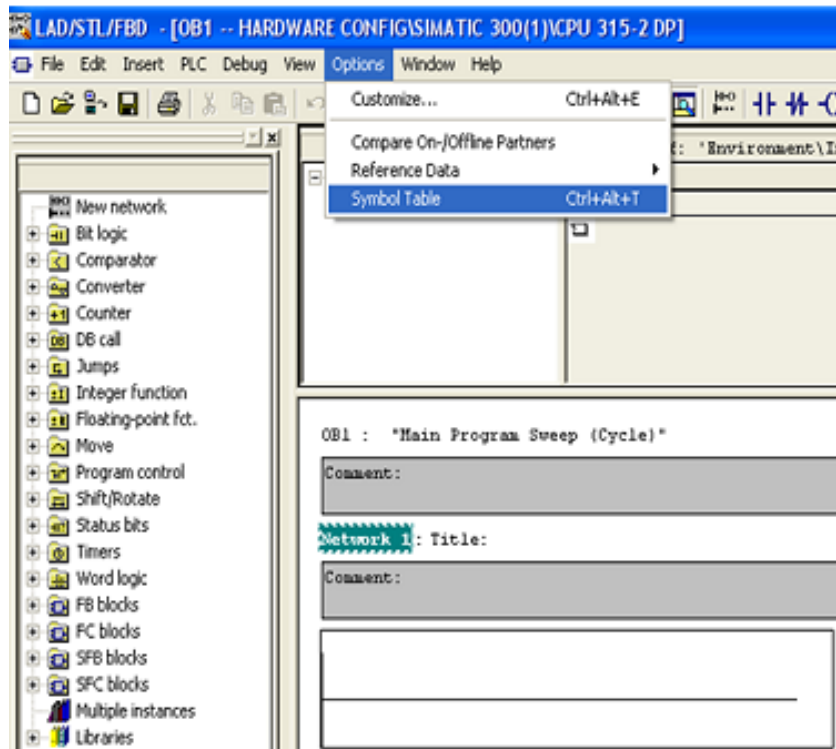
Viết chương trình và mô phỏng dùng simulink. Chọn OB1 và loại ngôn ngữ phù hợp để lập trình



THIẾT KẾ HỆ THỐNG VỚI SIMATIC MANAGER

LẬP TRÌNH S7300

Khai các biến sử dụng



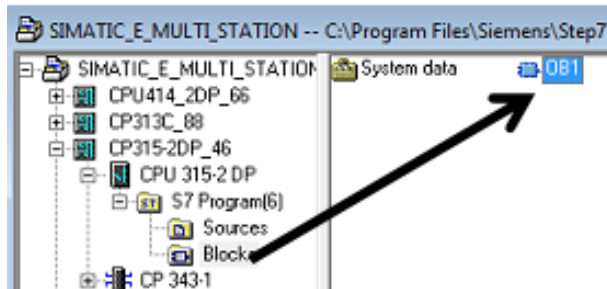
The screenshot shows the 'Symbol Editor - S7 Program(1) (Symbols)' window. The title bar includes 'Symbol Table', 'Edit', 'Insert', 'View', 'Options', 'Window', and 'Help'. The main area displays a table for 'S7 Program(1) (Symbols) -- HARDWARE CONFIG: SIMATIC 300(1) CPU 315-2 DP'. The table has columns for 'Status', 'Symbol', 'Address', 'Data type', and 'Comment'. The table content is as follows:

	Status	Symbol	Address	Data type	Comment
1		Start	I 0.0	BOOL	
2		Stop	I 0.1	BOOL	
3		Dongco	Q 0.0	BOOL	
4					

THIẾT KẾ HỆ THỐNG VỚI SIMATIC MANAGER

LẬP TRÌNH S7300

Mở khối OB1, viết chương trình điều khiển động cơ

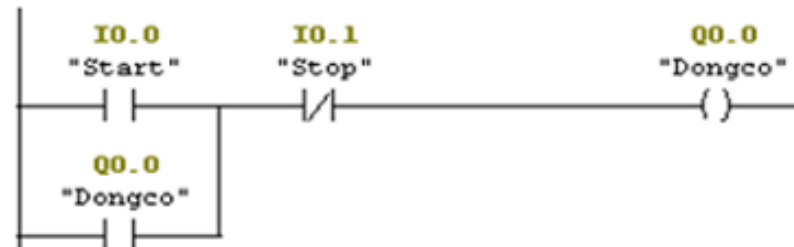


OB1 : "Main Program Sweep (Cycle)"

Comment:

Network 1: Title:

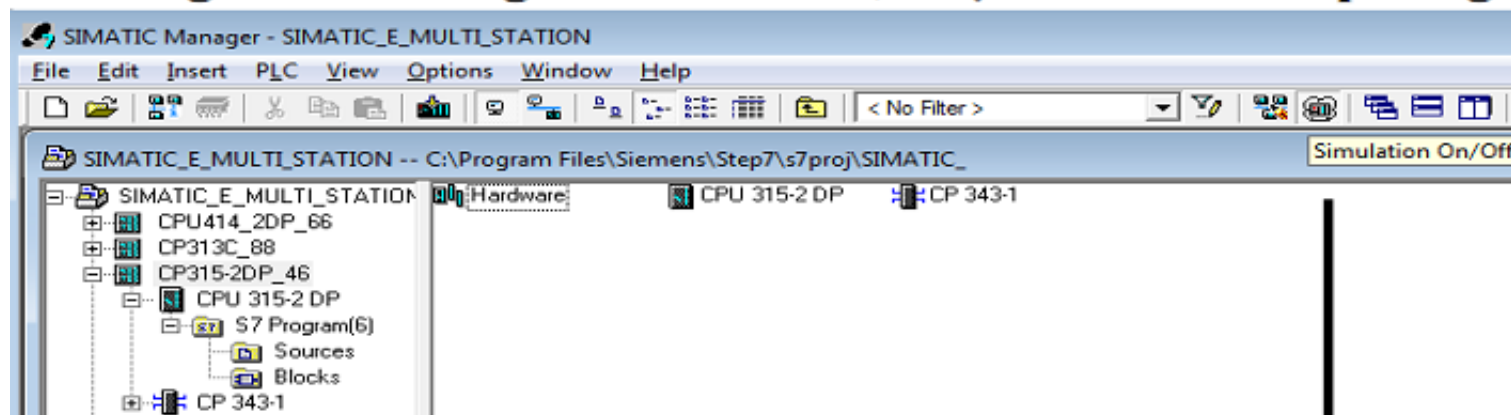
Comment:



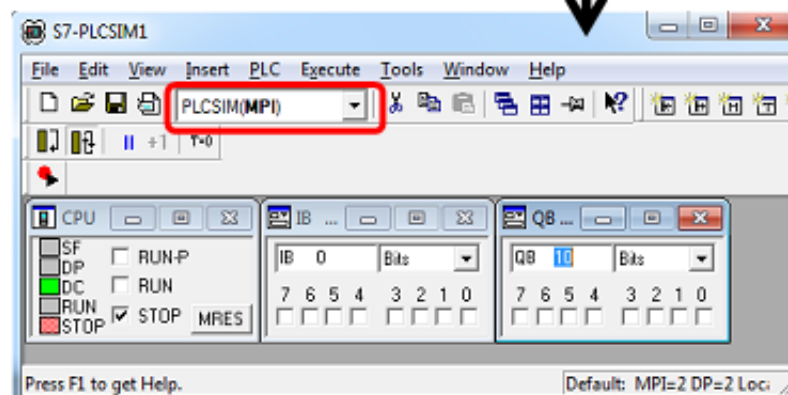
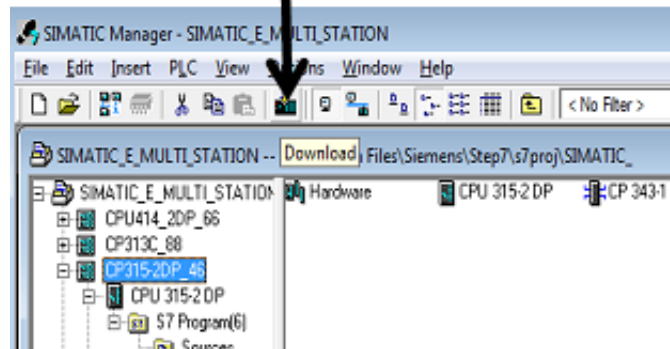
THIẾT KẾ HỆ THỐNG VỚI SIMATIC MANAGER

LẬP TRÌNH SIMATIC S7300

Mở phần mềm Simulink, thêm các module vào, download chương trình xuống S7 PLC SIM, chọn Run để mô phỏng



Download chương trình



THIẾT KẾ HỆ THỐNG VỚI SIMATIC MANAGER

MÔ PHỎNG S7300

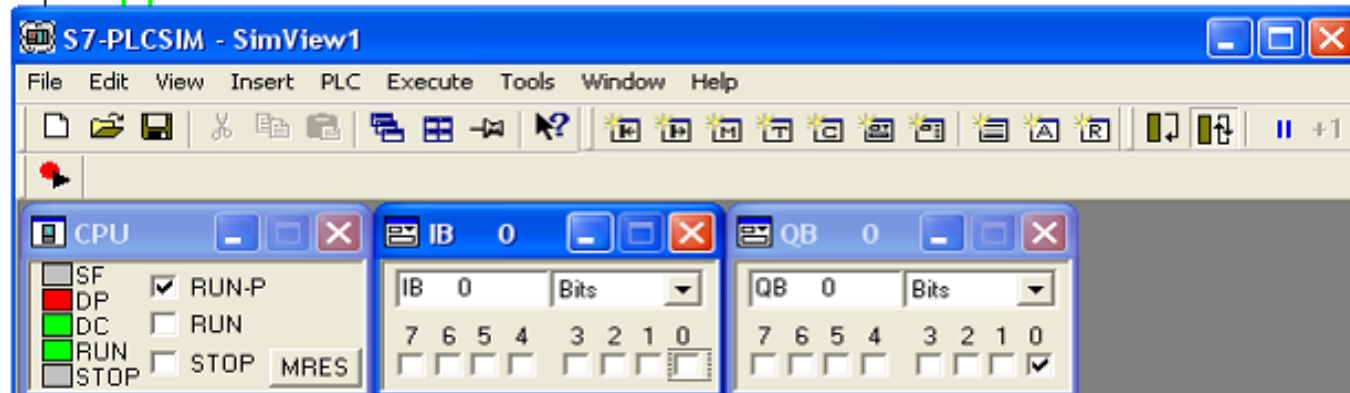
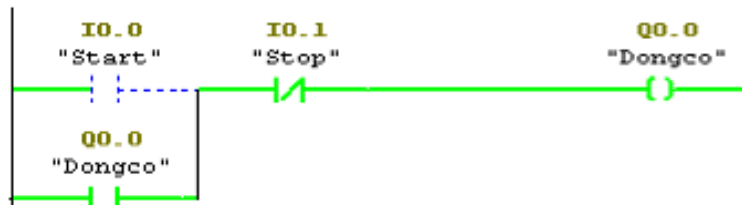
Download chương trình và chạy mô phỏng

OB1 : "Main Program Sweep (Cycle)"

Comment:

Network 1: Title:

Comment:

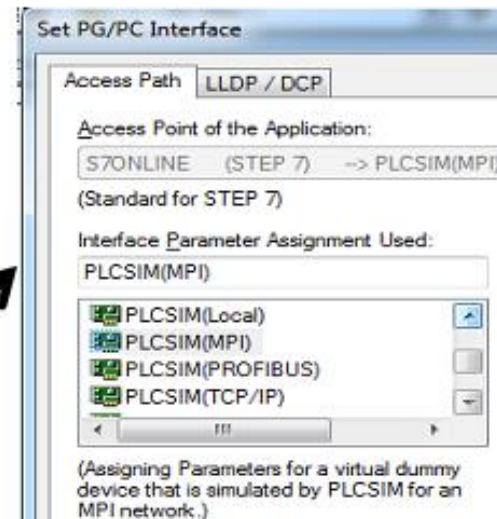
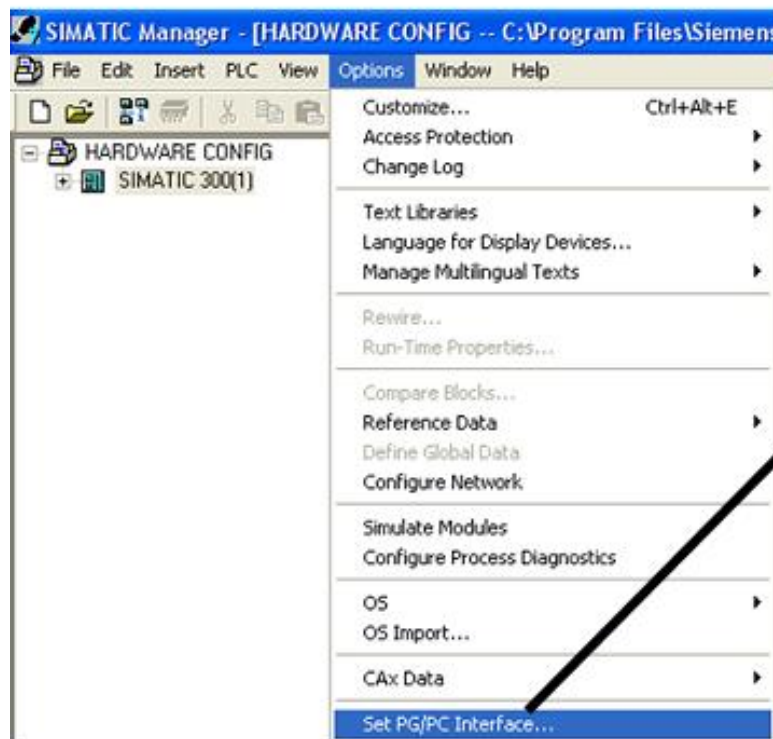


THIẾT KẾ HỆ THỐNG VỚI SIMATIC MANAGER

LẬP TRÌNH S7300

Download chương trình và chạy trên PLC thực

Lưu ý: Phải khai báo lại cấu hình phần cứng cho đúng với thực tế trước khi download



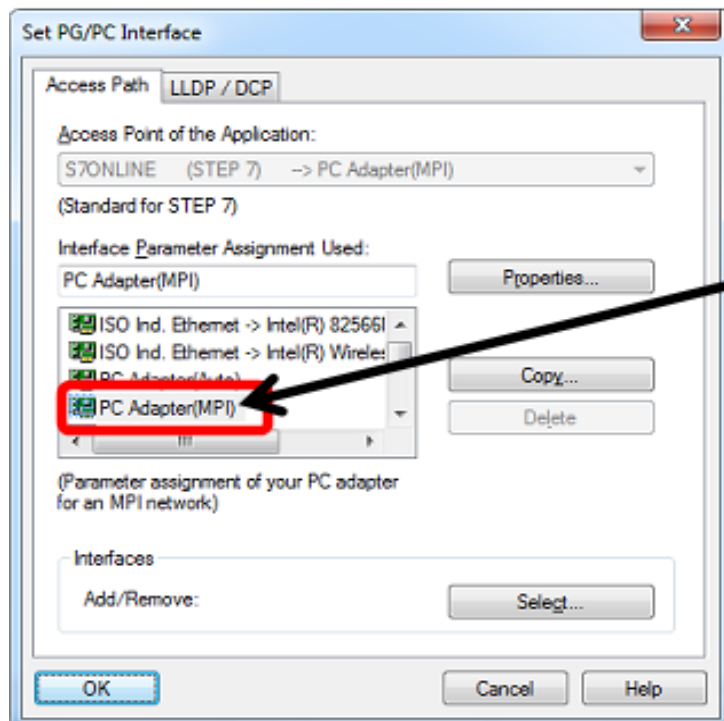
➤ Chọn giao tiếp giữa PC và PLC theo chuẩn MPI, Profibus hay Ethernet (Tùy thuộc vào kết nối thực tế giữa PC và PLC).

THIẾT KẾ HỆ THỐNG VỚI SIMATIC MANAGER

LẬP TRÌNH S7300

Download chương trình và chạy trên PLC thực

Lưu ý: Phải khai báo lại cấu hình phần cứng cho đúng với thực tế trước khi download



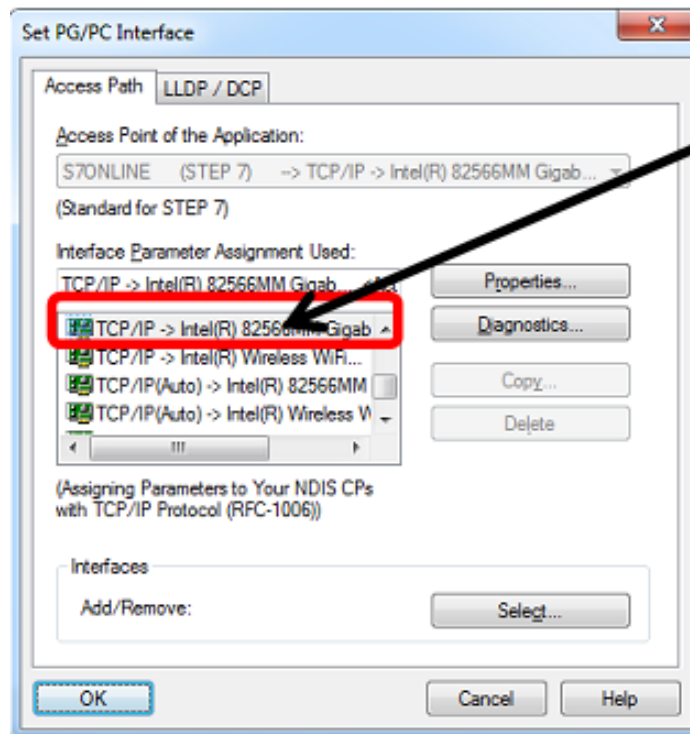
- Chọn giao tiếp giữa PC và PLC qua MPI
- Tắt phần mềm mô phỏng mới download chương trình đến PLC thực được

THIẾT KẾ HỆ THỐNG VỚI SIMATIC MANAGER

LẬP TRÌNH S7300

Download chương trình và chạy trên PLC thực

Lưu ý: Phải khai báo lại cấu hình phần cứng cho đúng với thực tế trước khi download

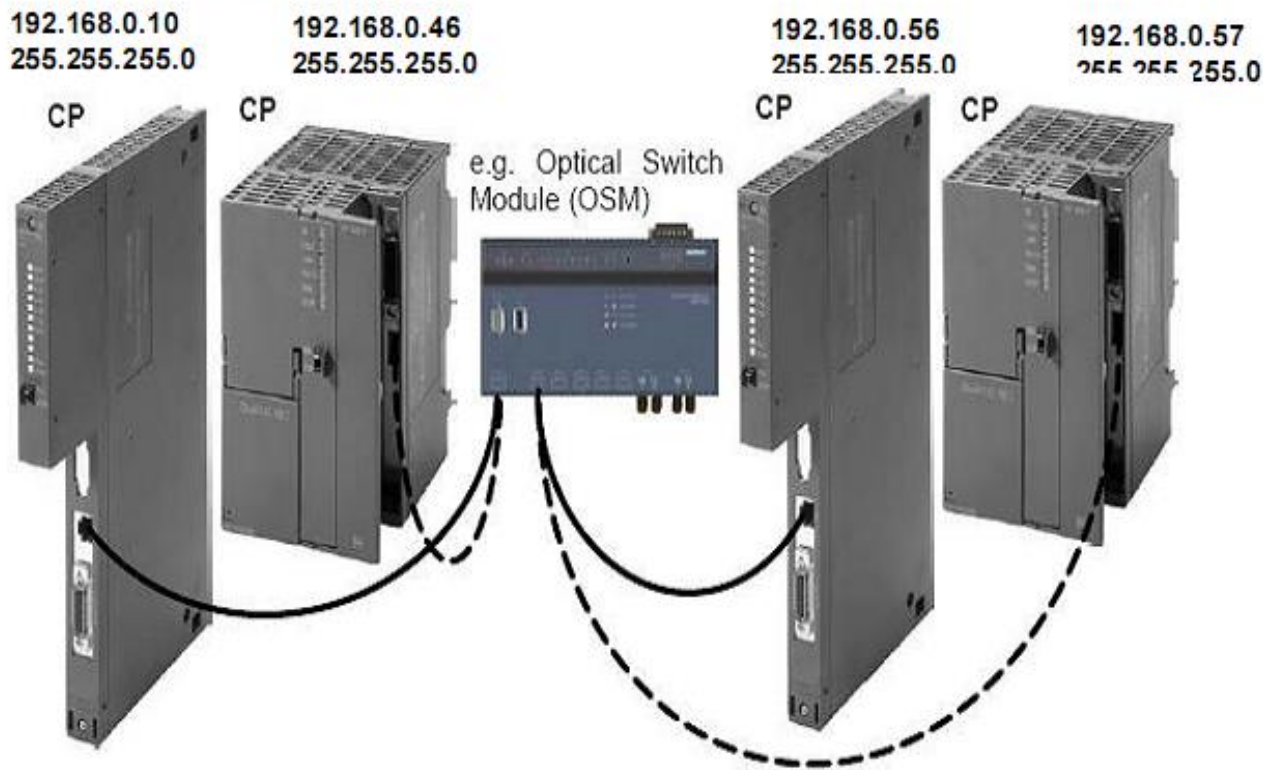


➤ Chọn giao tiếp giữa PC và PLC qua Ethernet
Lưu ý: IP của PC và PLC phải được đặt cùng lớp mạng và khác nhau về địa chỉ IP

THIẾT KẾ HỆ THỐNG VỚI SIMATIC MANAGER

LẬP TRÌNH VỚI S7

Download chương trình và chạy trên PLC thực
qua chuẩn ethernet



Notice: Các CP phải được đặt địa chỉ IP trước

THIẾT KẾ HỆ THỐNG VỚI SIMATIC MANAGER

LẬP TRÌNH VỚI S7

Đặt địa chỉ IP cho các CP: Sử dụng địa chỉ MAC

The screenshot displays the SIMATIC Manager interface. On the left, the 'Ethernet' menu is highlighted with a red circle labeled '1'. The main window shows the 'Edit Ethernet Node' dialog box. In this dialog, the 'MAC address' field is circled with a red '2'. The 'Set IP configuration' section is circled with a red '3', containing options for 'Use IP parameters', 'IP address' (192.168.0.56), 'Subnet mask' (255.255.255.0), and 'Gateway' (radio buttons for 'Do not use router' and 'Use router'). The 'Assign IP Configuration' button is circled with a red '4'. A black arrow points from the 'Ethernet' menu to the 'Edit Ethernet Node' dialog box.

THIẾT KẾ HỆ THỐNG VỚI SIMATIC MANAGER

LẬP TRÌNH VỚI S7

Đặt địa chỉ IP cho các CP: Đặt IP cho CP, download qua MPI

The screenshot displays the SIMATIC Manager HW Config interface. The main window shows a rack configuration for a SIMATIC E-Multi Station. The rack has 8 slots, with the following modules installed:

Slot	Module	Order number
1	PS 407 4A	6ES7 407-0DA00-0
2	CPU 414-2 DP	6ES7 414-2XG0
X2	DP	
X1	MPI/DP	
3	CP 443-1	6GK7 443-1EX11-0
4	DI32xDC 24V	6ES7 421-1BL00-0
5	DO32xDC 24V/0.5A	6ES7 422-1BL00-0
6	AI8x13Bit	6ES7 431-1KF00-0
7	AO8x13Bit	6ES7 432-1HF00-0AB0
8		

The 'Properties - CP 443-1 (R0/S3)' dialog box shows the following information:

- Short Description: CP 443-1
- Order No./firmware: 6GK7 443-1EX11-0XE0 / V1.1
- Name: CP 443-1
- Interface Type: Ethernet
- Address: 192.168.0.66
- Networked: No

The 'Properties - Ethernet interface CP 443-1 (R0/S3)' dialog box shows the following configuration:

- MAC address: 08-00-06-01-00-00
- IP protocol is being used
- IP address: 192.168.0.66
- Subnet mask: 255.255.255.0
- Gateway: Do not use router, Use router

THIẾT KẾ HỆ THỐNG VỚI SIMATIC MANAGER

LẬP TRÌNH S7 – 300:

Bài tập:

Bài 1:

Khai báo phần cứng cho bộ thí nghiệm S7-300 của PTHPLC.

Download cấu hình phần cứng đã khai báo xuống PLC

Bài 2:

Viết chương trình Start, Stop động cơ.

Download xuống PLC và kiểm tra, sửa sai.

LƯU Ý:

➤ *Phải tắt phần mềm mô phỏng trước khi tiến hành chọn chuẩn giao tiếp MPI hay Ethernet để giao tiếp*

➤ *Sau khi download, không có đèn nào trên CPUs sáng màu đỏ thì việc khai báo phần cứng mới đúng.*

GIÁO TRÌNH LẬP TRÌNH PLC 2

CHƯƠNG III: TẬP LỆNH CƠ BẢN TRONG S7-300

TẬP LỆNH CƠ BẢN TRONG S7-300

Memory areas in S7 300

I :Process-image input

Q :Process-image Output

M :Bit memory (Internal memory)

T :This area provides storage timers

C :This area provides storage counters

PI :Peripheral Memory Input

PQ :Peripheral Memory Output

DBs(Data Bocks): Contain information for program

TẬP LỆNH CƠ BẢN TRONG S7-300

Ladder Symbol

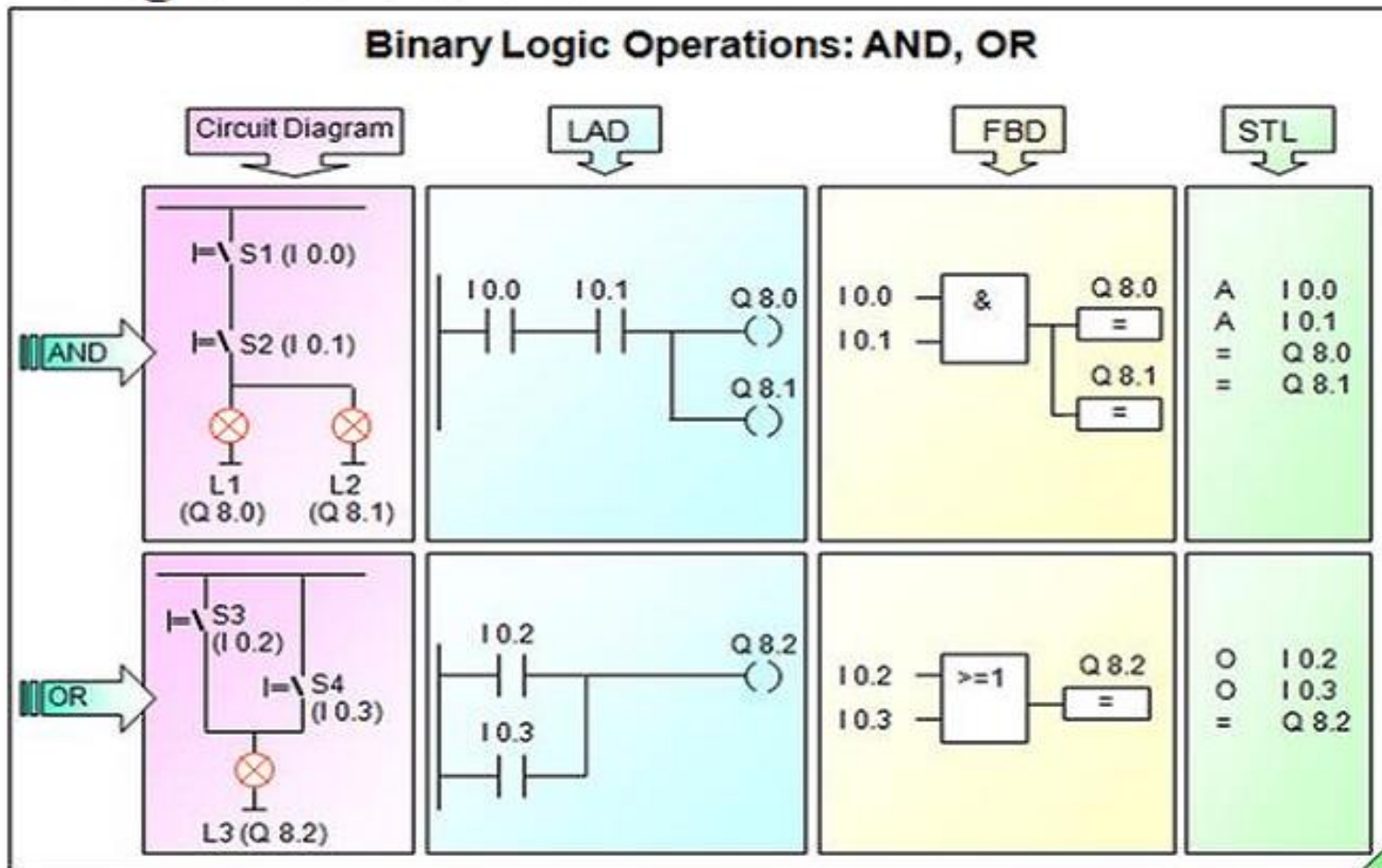
- ---| |--- Normally Open Contact (Address)
- ---| / |--- Normally Closed Contact (Address)
- ---(SAVE) Save RLO into BR Memory
- XOR Bit Exclusive OR
- ---() Output Coil
- ---(#)--- Midline Output
- ---|NOT|--- Invert Power Flow
- ---(S) Set Coil
- ---(R) Reset Coil
- SR Set-Reset Flip Flop
- RS Reset-Set Flip Flop
- ---(N)--- Negative RLO Edge Detection
- ---(P)--- Positive RLO Edge Detection
- NEG Address Negative Edge Detection
- POS Address Positive Edge Detection

Statement List Symbol

- A And
- AN And Not
- O Or
- ON Or Not
- X Exclusive Or
- XN Exclusive Or Not
- O And before Or
- A(And with Nesting Open
- AN(And Not with Nesting Open
- O(Or with Nesting Open
- ON(Or Not with Nesting Open
- X(Exclusive Or with Nesting Open
- XN(Exclusive Or Not with Nesting Open
-) Nesting Closed

TẬP LỆNH CƠ BẢN TRONG S7-300

Bit logic instructions

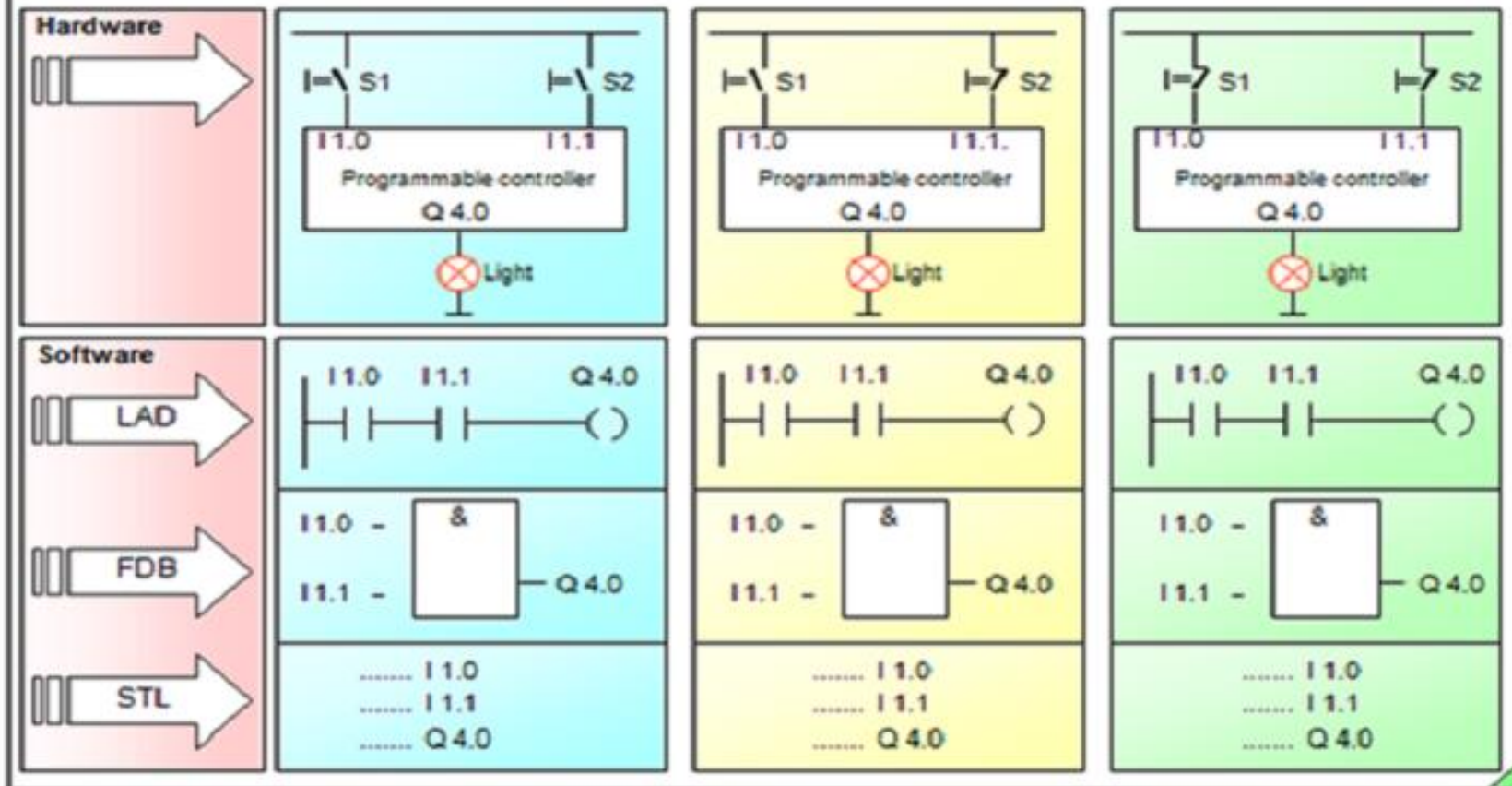


TẬP LỆNH CƠ BẢN TRONG S7-300

Bit logic instructions

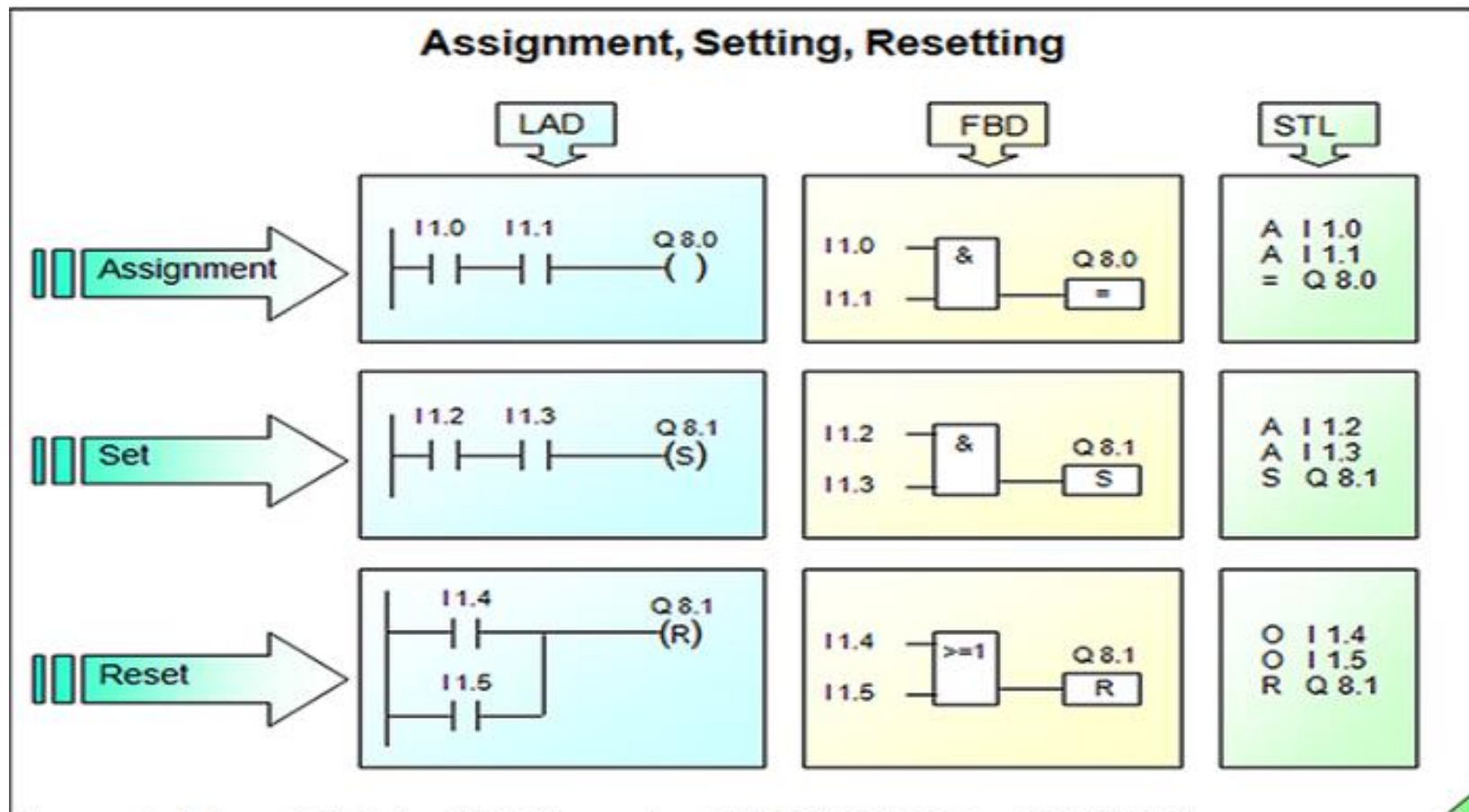
Exercise

Goal: In all three examples, the light should be on when S1 is activated and S2 is not activated!



TẬP LỆNH CƠ BẢN TRONG S7-300

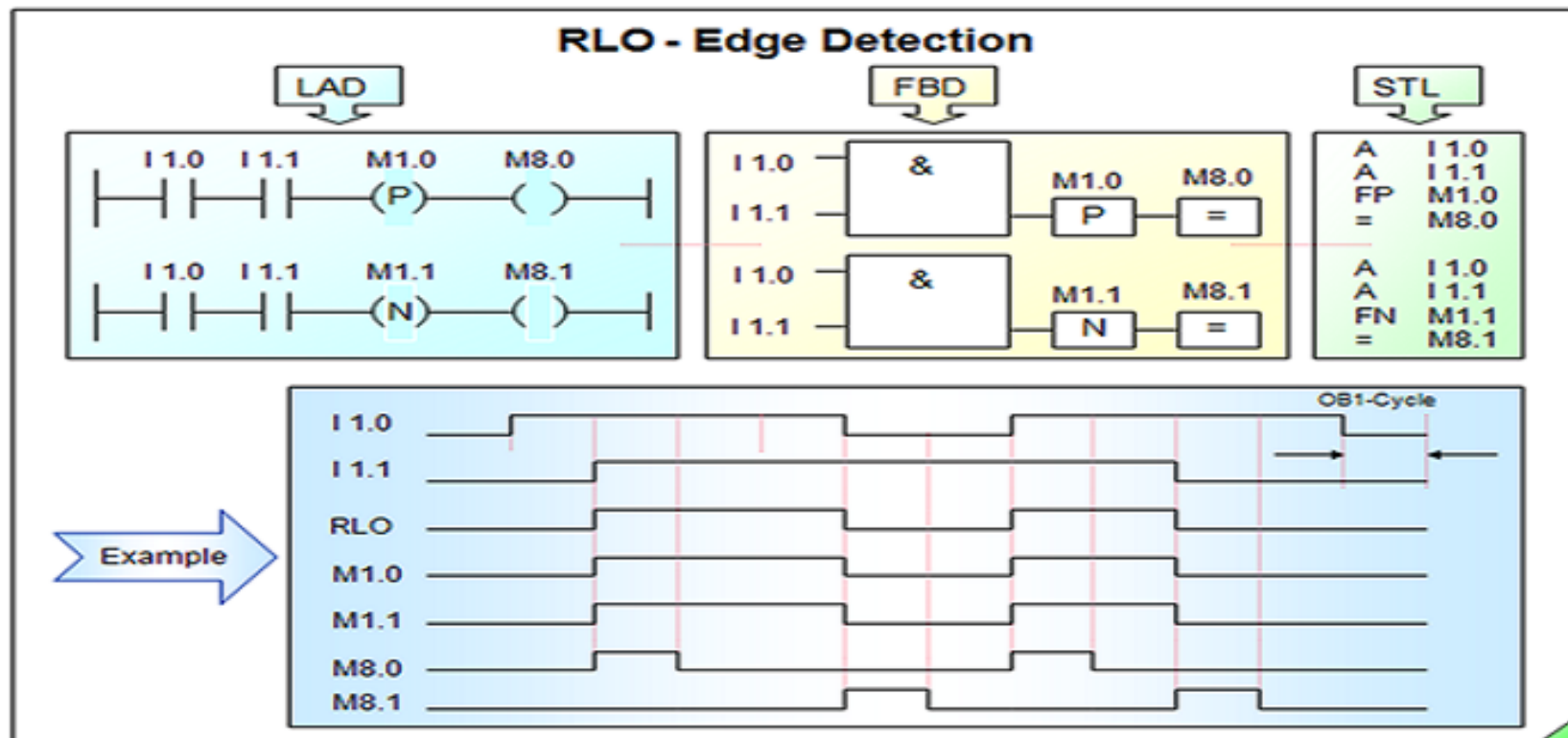
Bit logic instructions



A variable which is SET is only CLEARED by RESET

TẬP LỆNH CƠ BẢN TRONG S7-300

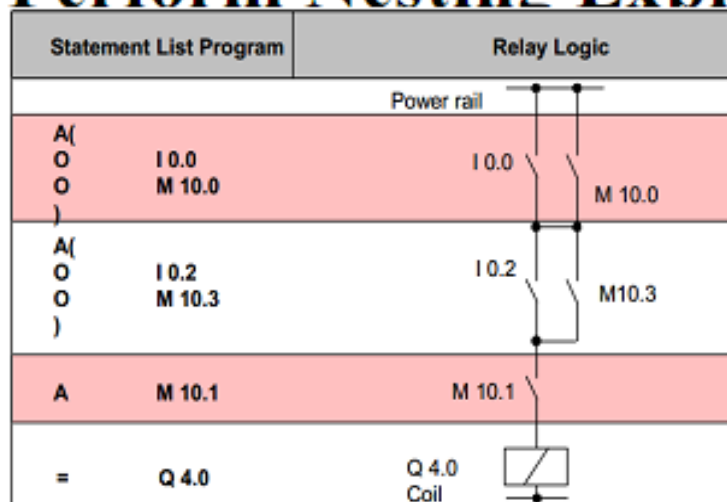
Bit logic instructions



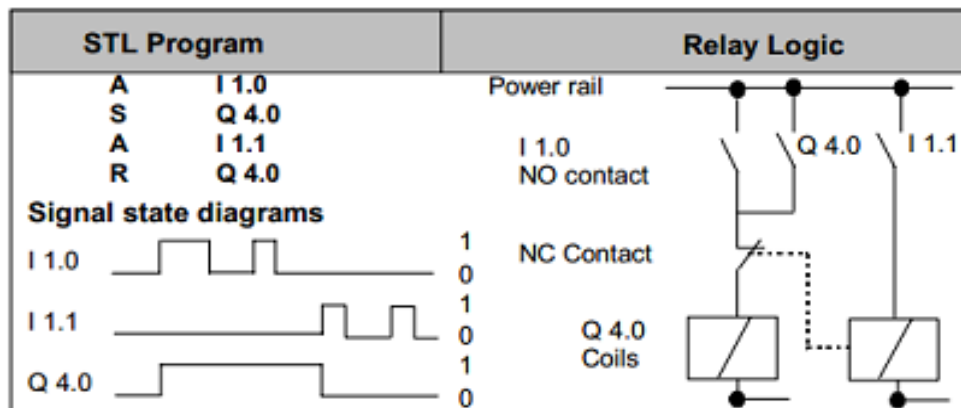
To check result of Edge Detection Instruction, Output variables should be Latched by Set instruction

TẬP LỆNH CƠ BẢN TRONG S7-300

Perform Nesting Expressions with STL

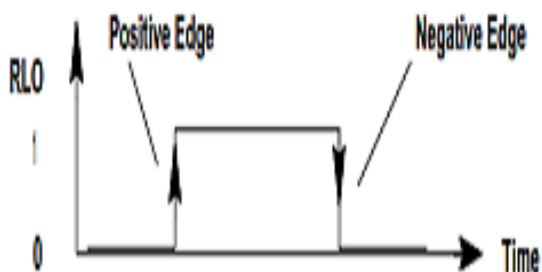


Perform Set and Reset instructions with STL



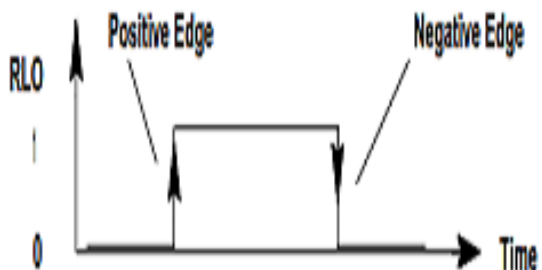
TẬP LỆNH CƠ BẢN TRONG S7-300

Edge Negative: FN



Statement List		Signal State Diagram										
A	I 1.0 I 1.0		1 0									
FN	M 1.0 M 1.0		1 0									
=	Q 4.0 Q 4.0		1 0									
OB1 Scan Cycle No:		<table border="1"> <tr> <td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td> </tr> </table>		1	2	3	4	5	6	7	8	9
1	2	3	4	5	6	7	8	9				

Edge Positive: FP

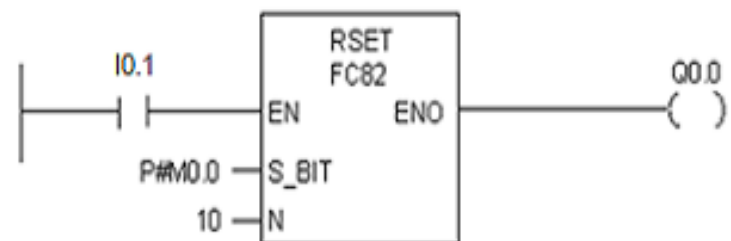
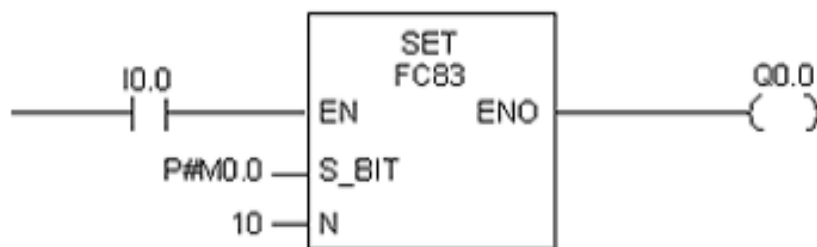


Statement List		Signal State Diagram										
A	I 1.0 I 1.0		1 0									
FP	M 1.0 M 1.0		1 0									
=	Q 4.0 Q 4.0		1 0									
OB1 Scan Cycle No:		<table border="1"> <tr> <td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td> </tr> </table>		1	2	3	4	5	6	7	8	9
1	2	3	4	5	6	7	8	9				

TẬP LỆNH CƠ BẢN TRONG S7-300

Bit instructions

Set and reset multi continuous bits FC83 (Set), FC82(Reset)



Before execution:



After execution:



Before execution:



After execution:



TẬP LỆNH CƠ BẢN TRONG S7-300

Compare Instructions in Ladder and STL

Ladder

- == IN1 is equal to IN2
- <> IN1 is not equal to IN2
- > IN1 is greater than IN2
- < IN1 is less than IN2
- >= IN1 is greater than or equal to IN2
- <= IN1 is less than or equal to IN2
- CMP ? I Compare Integer
- CMP ? D Compare Double Integer
- CMP ? R Compare Real

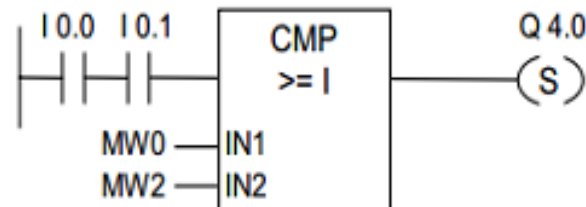
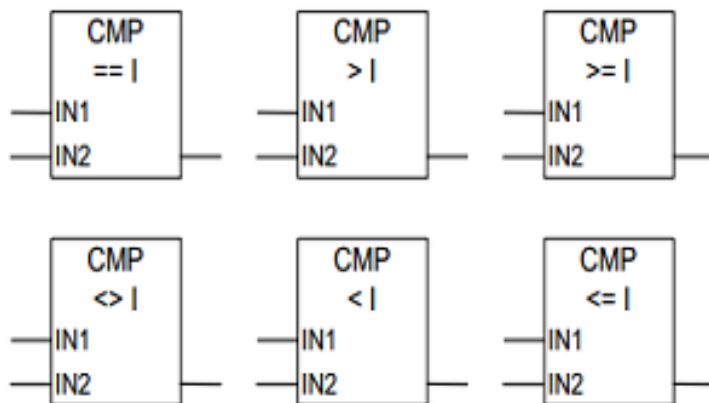
STL

- == ACCU1 is equal to ACCU2
- <> ACCU1 is not equal to ACCU2
- > ACCU1 is greater than ACCU2
- < ACCU1 is less than ACCU2
- >= ACCU1 is greater than or equal to ACCU2
- <= ACCU1 is less than or equal to ACCU2
- ? I Compare Integer (16-Bit)
- ? D Compare Double Integer (32-Bit)
- ? R Compare Floating-Point Number (32-Bit)

If the Comparison is true, the RLO of the function is “1” and network output is enabled

TẬP LỆNH CƠ BẢN TRONG S7-300

Compare Instructions in Ladder



Output Q4.0 is set if the following conditions exist:

- There is a signal state of "1" at inputs I0.0 and at I0.1
- AND MW0 >= MW2

Parameter	Data Type	Memory Area	Description
box input	BOOL	I, Q, M, L, D	Result of the previous logic operation
box output	BOOL	I, Q, M, L, D	Result of the comparison, is only processed further if the RLO at the box input = 1
IN1	INT	I, Q, M, L, D or constant	First value to compare
IN2	INT	I, Q, M, L, D or constant	Second value to compare

TẬP LỆNH CƠ BẢN TRONG S7-300

Compare Instructions in STL

	STL	Explanation
== , <> , > , < , >= , <=	L MW10	//Load contents of MW10 (16-bit integer).
	L IW24	//Load contents of IW24 (16-bit integer).
	>I	//Compare if ACCU 2-L (MW10) is greater (>) than ACCU 1- L (IW24).
	= M 2.0	//RLO = 1 if MW10 > IW24.

Notice:

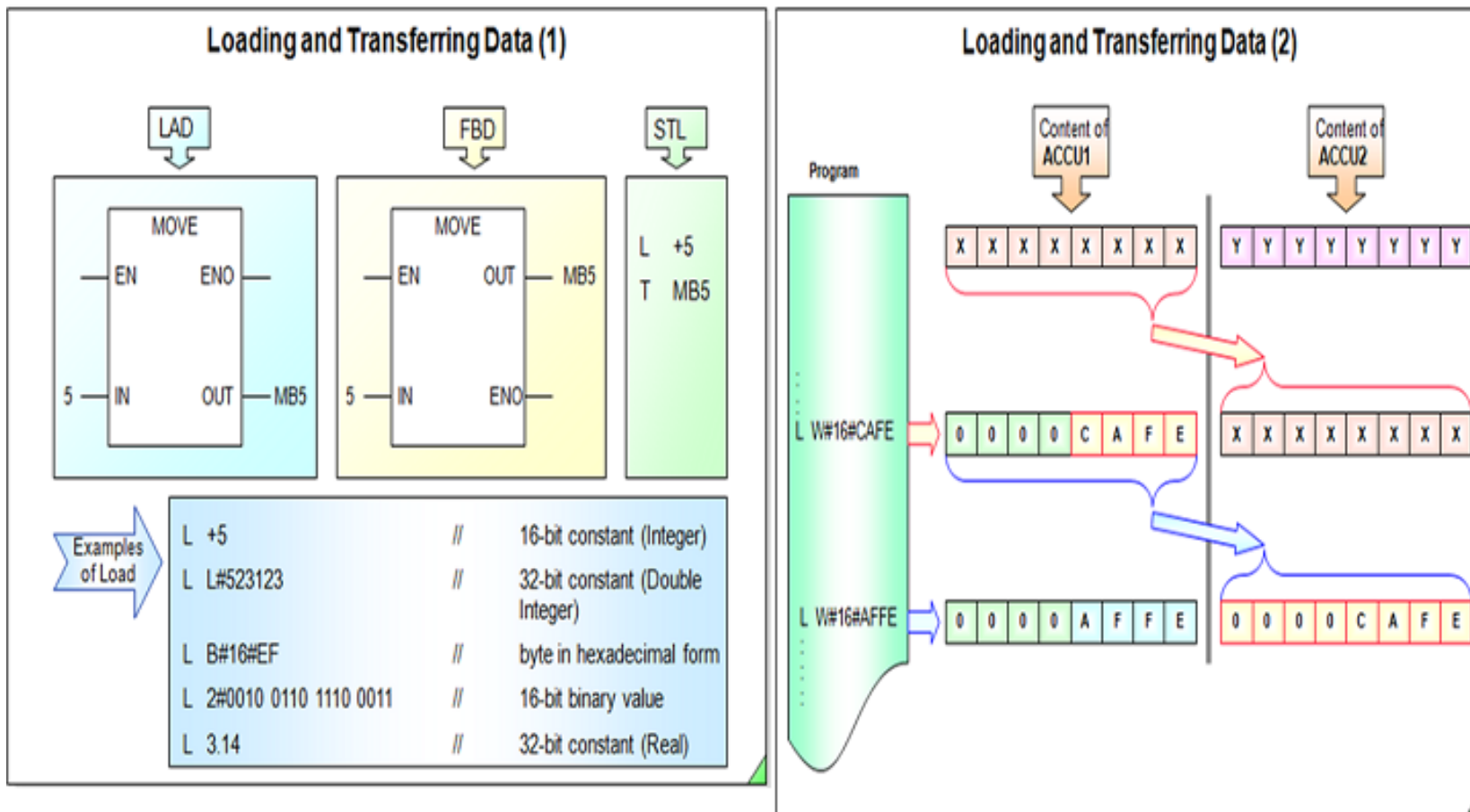
There are two Registers ACCU1 and ACCU2 in S7 300

L MW 10 // Load MW10 into accu1

L IW 24 // Load IW24 into accu1, beforehand contents of accu1 is moved to accu2

TẬP LỆNH CƠ BẢN TRONG S7-300

Loading and Transferring Data



TẬP LỆNH CƠ BẢN TRONG S7-300

Comparison Instructions in STL

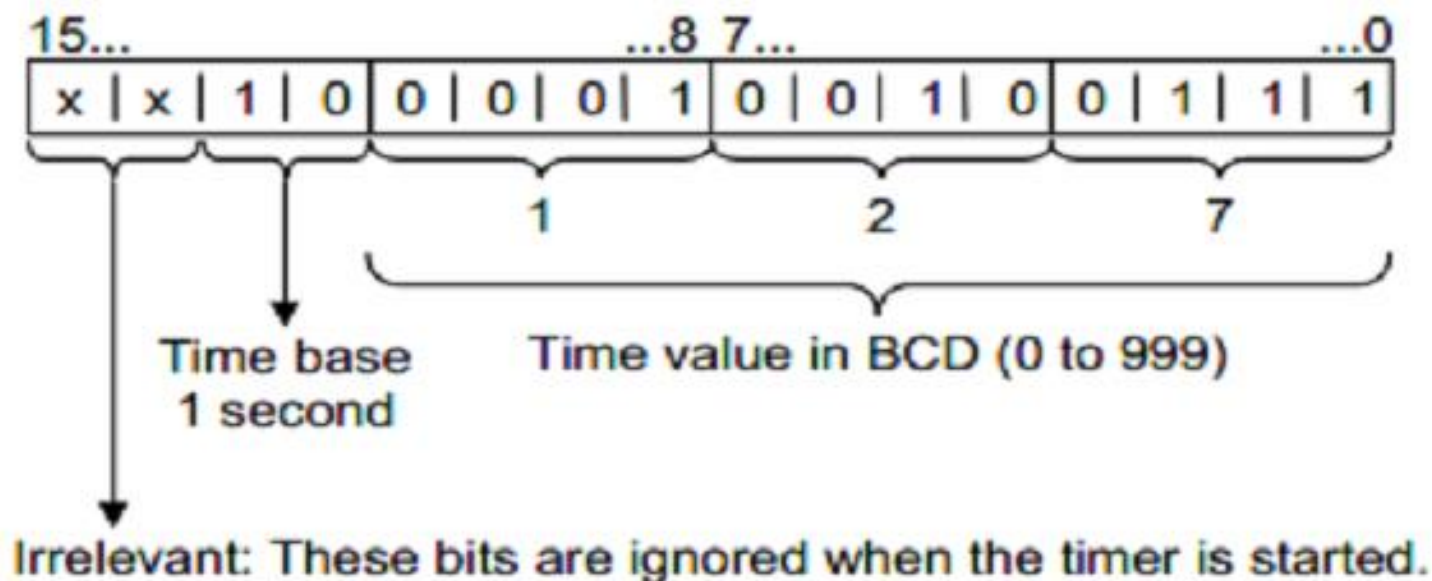
Comparison instruction executed	RLO Result if ACCU 2 > ACCU 1	RLO Result if ACCU 2 = ACCU 1	RLO Result if ACCU 2 < ACCU 1
==I	0	1	0
<>I	1	0	1
>I	1	0	0
<I	0	0	1
>=I	1	1	0
<=I	0	1	1

STL	Explanation
L MW10	//Load contents of MW10 (16-bit integer).
L IW24	//Load contents of IW24 (16-bit integer).
>I	//Compare if ACCU 2-L (MW10) is greater (>) than ACCU 1- L (IW24).
= M 2.0	//RLO = 1 if MW10 > IW24.

TẬP LỆNH CƠ BẢN TRONG S7-300

Timer Instructions

- Timers have a 16 bit memory area in the CPU to contain counter value as binary code
- S7300 supports 256 counter: T0 to T255
- The range of Timer value from 0 to 999



TẬP LỆNH CƠ BẢN TRONG S7-300

Timer Instructions

- Time updating decrements the time value by one unit at an interval designed by the Time Base
- Derementing continues until the time value is equal to zero
- Bits 12 and 13 of timer word contain the time base as binary, beside general format for S5TIME has limits to range and resolution as shown bellow

Value of Bits 12 and 13

Time Base	Binary Code for the Time Base
10 ms	00
100 ms	01
1 s	10
10 s	11

S5TIME format

Resolution	Range
0.01 second	10MS to 9S_990MS
0.1 second	100MS to 1M_39S_900MS
1 second	1S to 16M_39S
10 seconds	10S to 2H_46M_30S

TẬP LỆNH CƠ BẢN TRONG S7-300

Type of Timer Instructions

Timer Instructions are available in Ladder

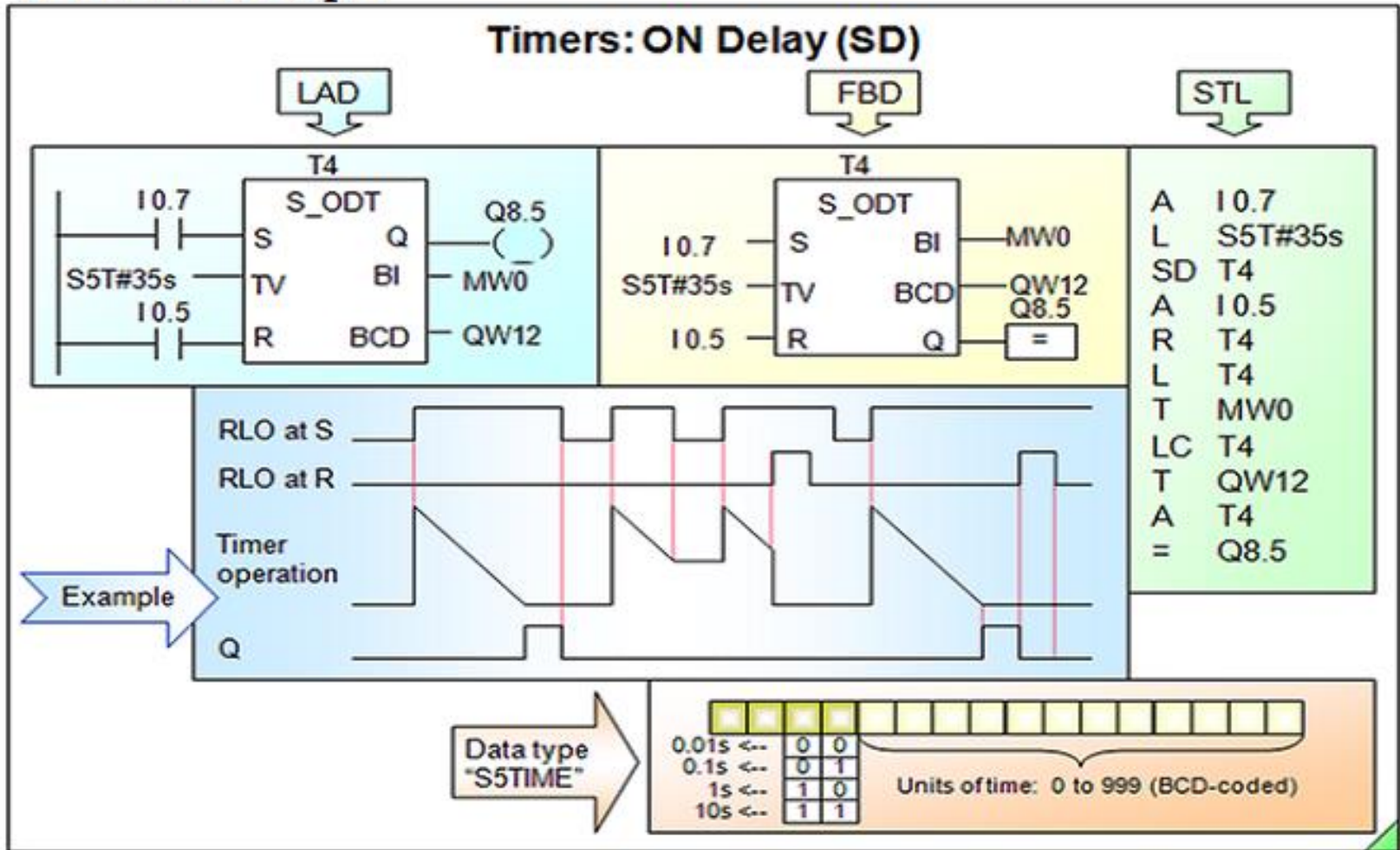
- S_PULSE Pulse S5 Timer
- S_PEXT Extended Pulse S5 Timer
- S_ODT On-Delay S5 Timer
- S_ODTS Retentive On-Delay S5 Timer
- S_OFFDT Off-Delay S5 Timer
- ---(SP) Pulse Timer Coil
- ---(SE) Extended Pulse Timer Coil
- ---(SD) On-Delay Timer Coil
- ---(SS) Retentive On-Delay Timer Coil
- ---(SA) Off-Delay Timer Coil

Timer Instructions are available in STL

- SD On-Delay Timer
- SE Extended Pulse Timer
- SF Off-Delay Timer
- SP Pulse Timer
- SS Retentive On-Delay Timer

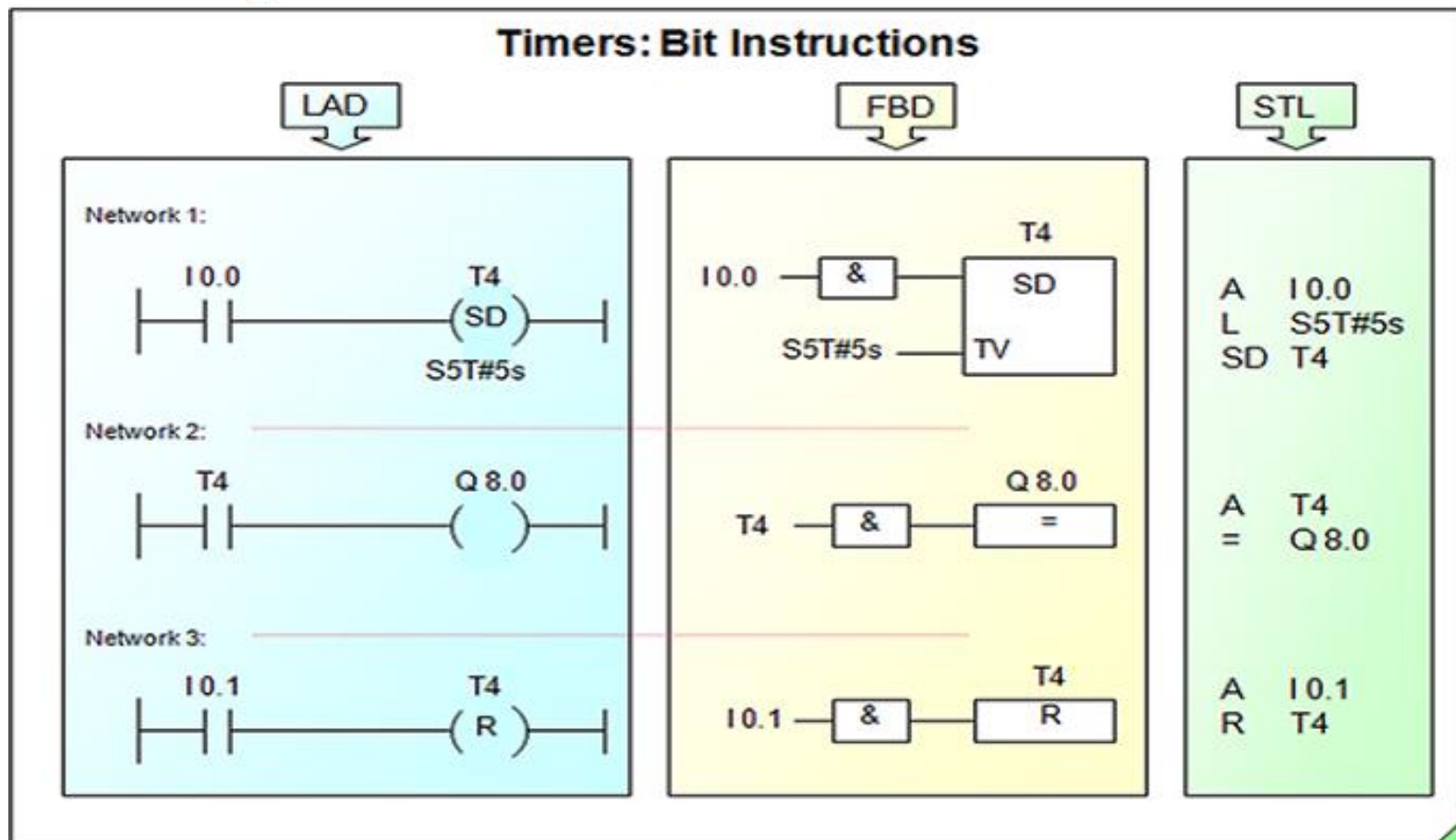
TẬP LỆNH CƠ BẢN TRONG S7-300

S_ODT Example



TẬP LỆNH CƠ BẢN TRONG S7-300

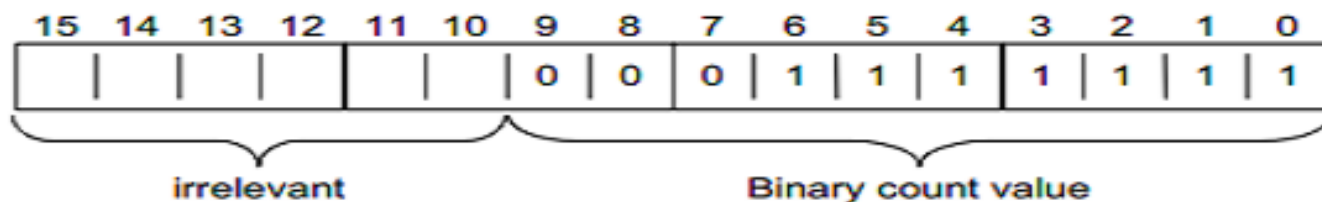
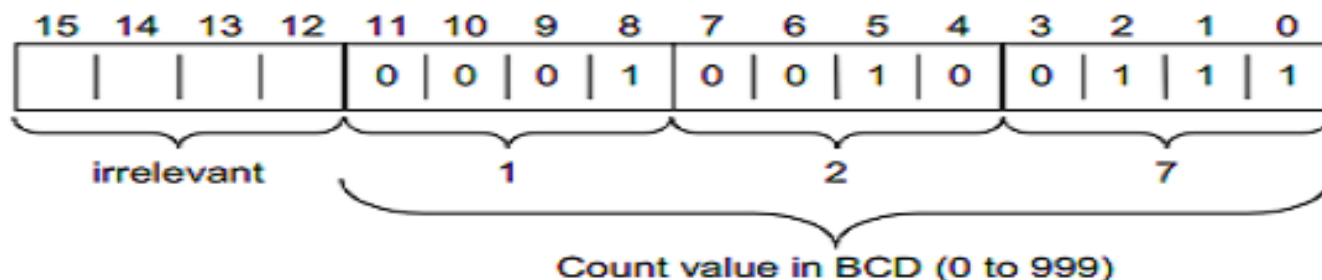
On delay Timer Coil



TẬP LỆNH CƠ BẢN TRONG S7-300

Counter Instructions

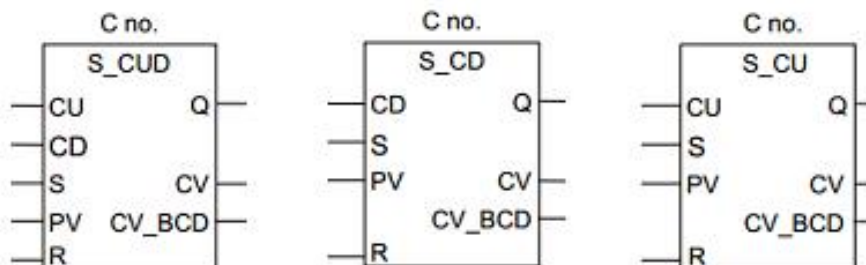
- Counters have a 16 bit memory area in the CPU to contain counter value as binary code
- S7300 supports 256 counter: C0 to C255
- The range of counter value from 0 to 999



TẬP LỆNH CƠ BẢN TRONG S7-300

Types of counter

- S_CUD Up-Down Counter
- S_CD Down Counter
- S_CU Up Counter
- ---(SC) Set Counter Coil
- ---(CU) Up Counter Coil
- ---(CD) Down Counter Coil

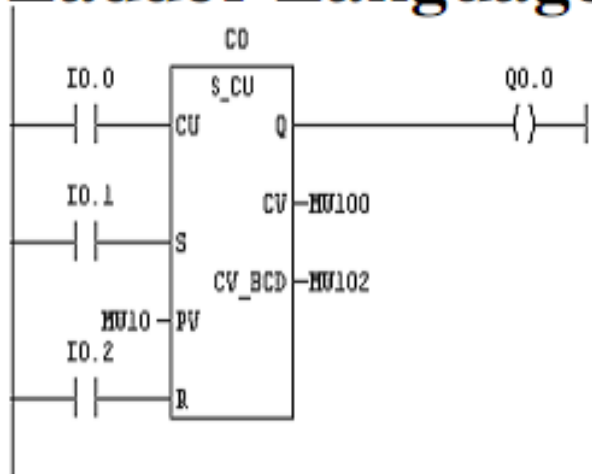


Parameter English	Data Type	Memory Area	Description
C no.	COUNTER	C	Counter identification number; range depends on CPU
CU	BOOL	I, Q, M, L, D	Count up input
CD	BOOL	I, Q, M, L, D	Count down input
S	BOOL	I, Q, M, L, D	Set input for presetting counter
PV	WORD	I, Q, M, L, D or constant	Enter counter value as C#<value> in the range from 0 to 999
PV	WORD	I, Q, M, L, D	Value for presetting counter
R	BOOL	I, Q, M, L, D	Reset input
CV	WORD	I, Q, M, L, D	Current counter value, hexadecimal number
CV_BCD	WORD	I, Q, M, L, D	Current counter value, BCD coded
Q	BOOL	I, Q, M, L, D	Status of the counter

TẬP LỆNH CƠ BẢN TRONG S7-300

S_CU example

Ladder Language



STL Language

```
A      I      0.0
CU      C      0
A      I      0.1
L      MW     10
S      C      10
A      I      0.2
R      C      0
L      C      0
T      MW     100
LC      C      0
T      MW     102
A      C      0
=      Q      0.0
```

If the signal state of I0.0 changes from "0" to "1", the value of counter C10 will be incremented by one.

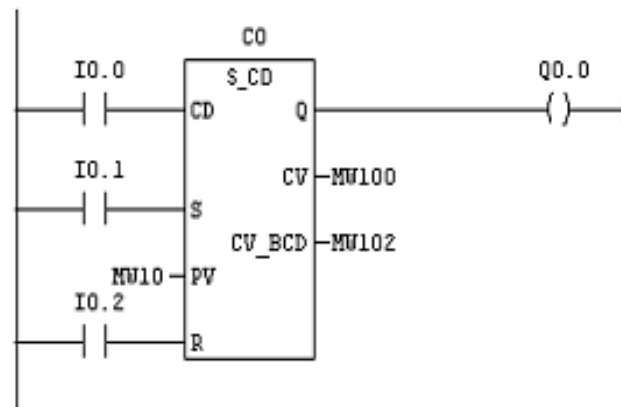
If I0.1 changes from "0" to "1", the counter is preset with the value of MW10. - unless the value of C0 is equal to "999". Q0.0 is "1" if C00 is not equal to zero.

MW100 is Counter value as binary, MW102 is counter value as BCD

TẬP LỆNH CƠ BẢN TRONG S7-300

S_CD example

Ladder Language



STL Language

```
A      I      U . 0
CD     C      0
A      I      0 . 1
L      MW     10
S      C      n
A      I      0 . 2
R      C      0
L      C      0
T      MW     100
LC     C      0
T      MW     102
A      C      0
=      Q      0 . 0
```

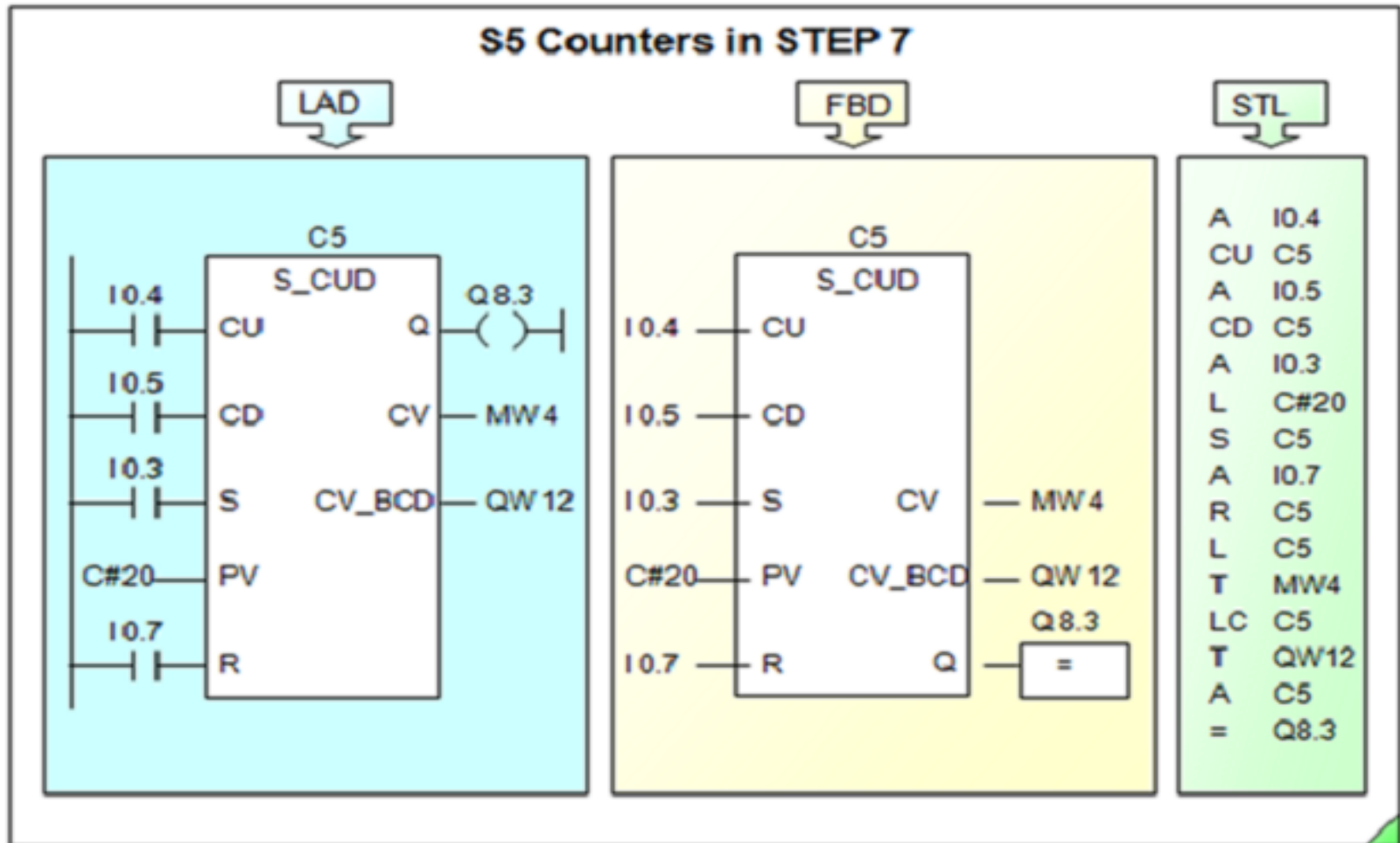
If the signal state of I0.0 changes from "0" to "1", the value of counter C10 will be decremented by one.

If I0.1 changes from "0" to "1", the counter is preset with the value of MW10. - unless the value of C0 is equal to "0". Q0.0 is "1" if C0 is not equal to zero.

MW100 is Counter value as binary, MW102 is counter value as BCD

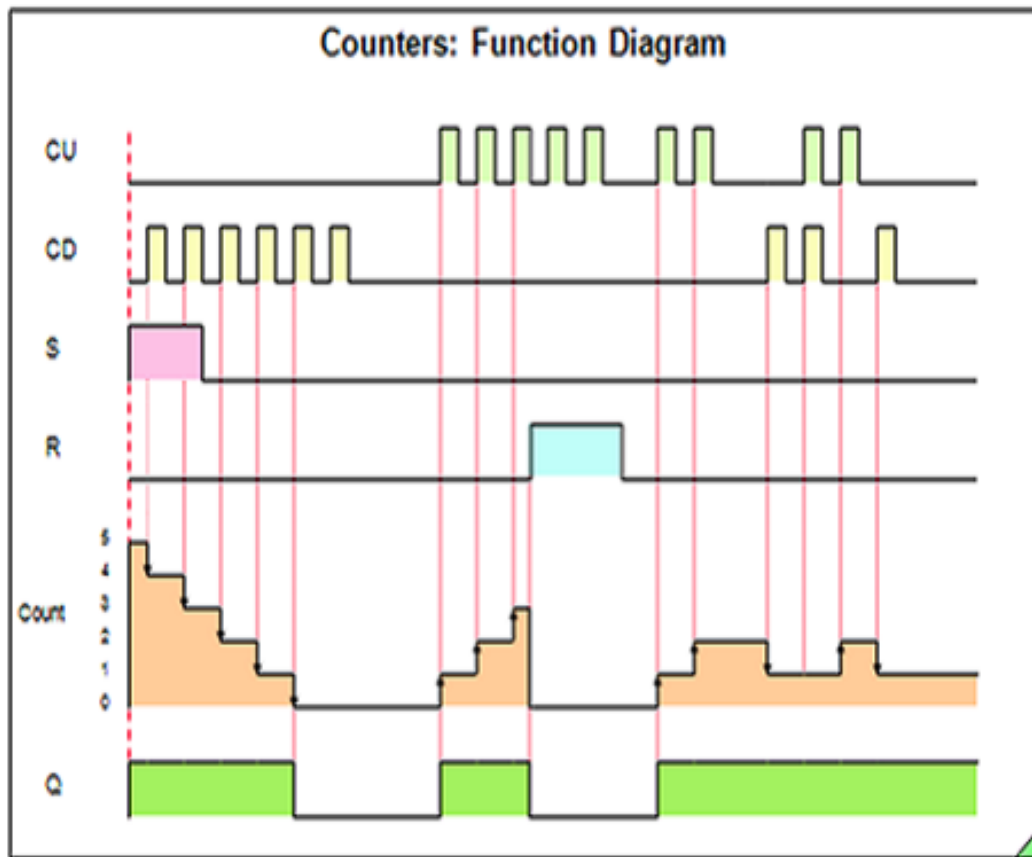
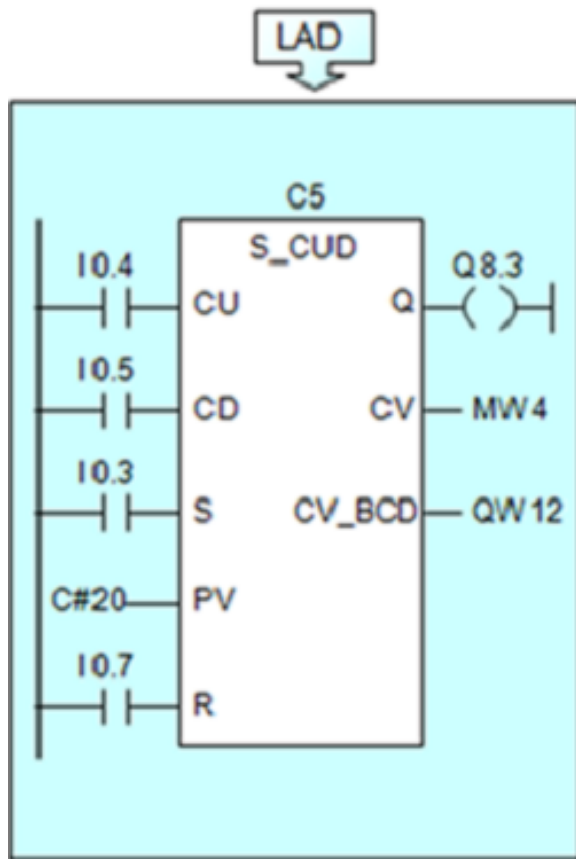
TẬP LỆNH CƠ BẢN TRONG S7-300

S_CUD Example



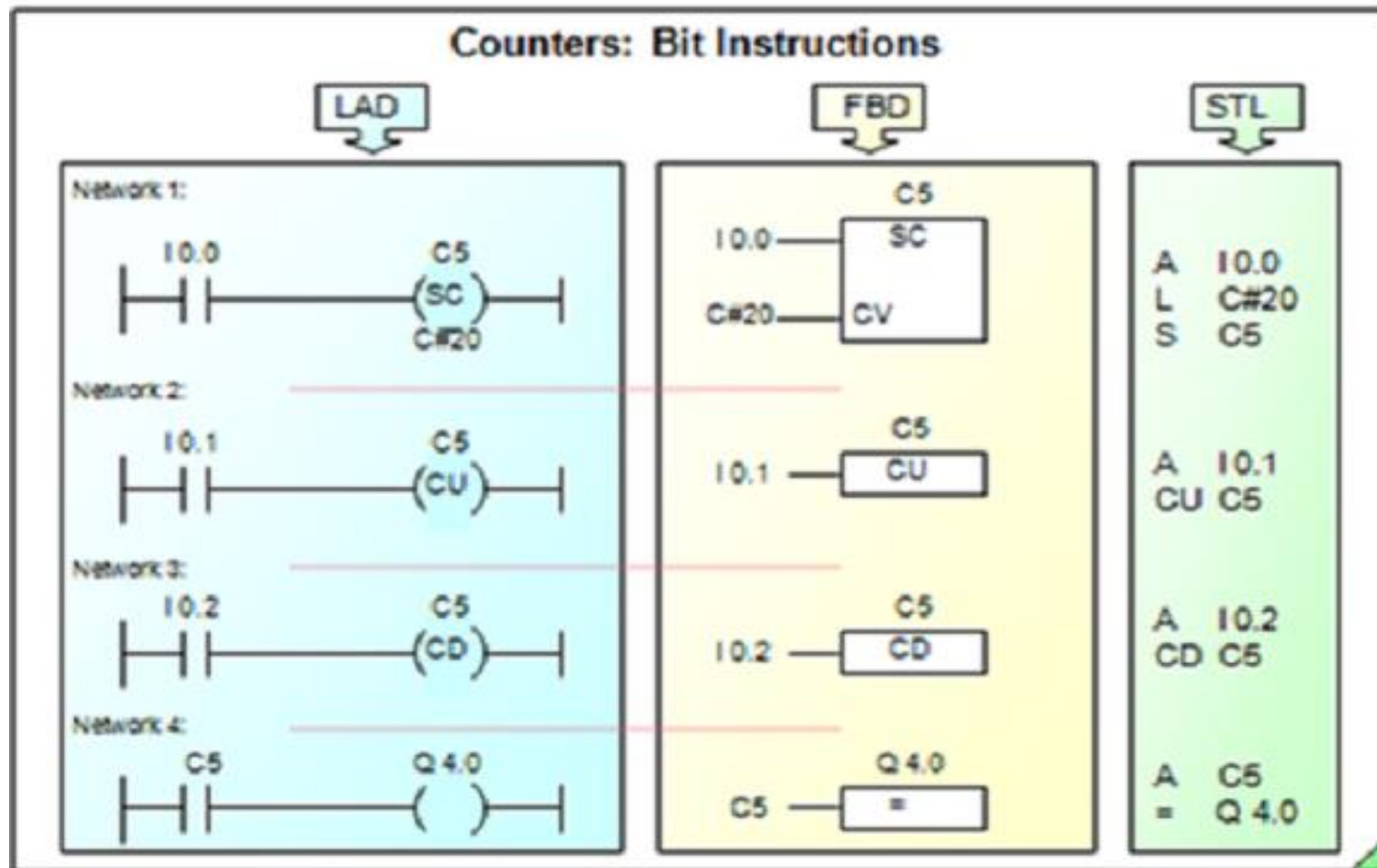
TẬP LỆNH CƠ BẢN TRONG S7-300

S_CUD Example



TẬP LỆNH CƠ BẢN TRONG S7-300

Counter: Bit instructions

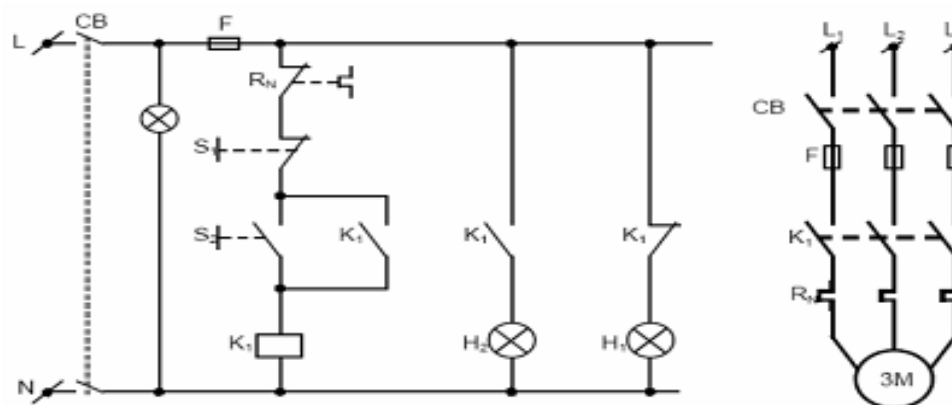


TẬP LỆNH CƠ BẢN TRONG S7-300

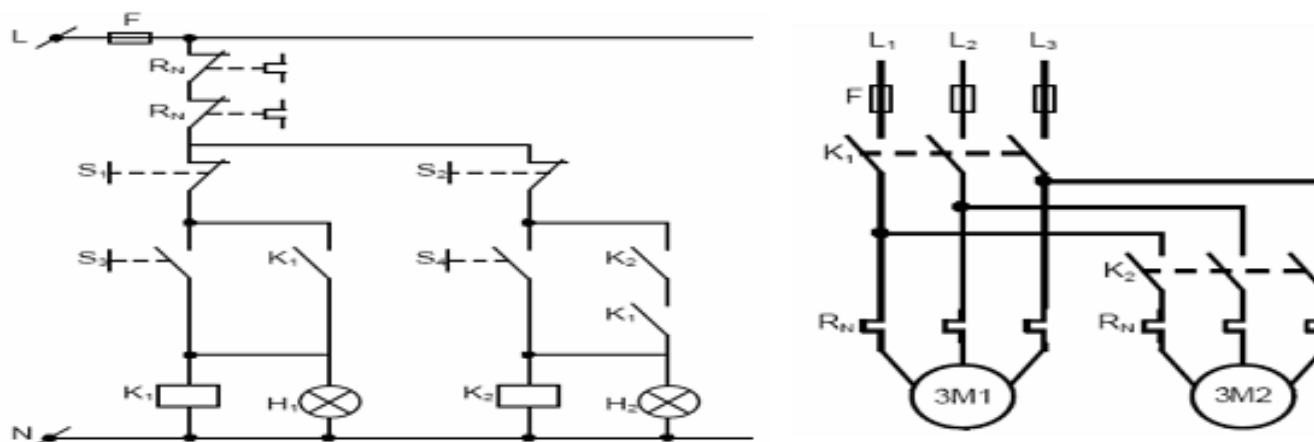
EXAMPLE OF INSTRUCTIONS

Using LAD, and STL to program for relay control circuits from Ex11 to Ex14

Ex11



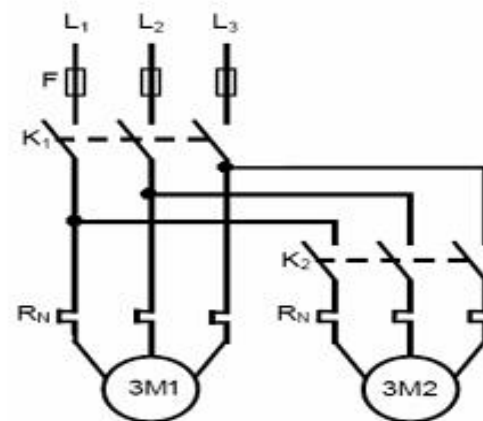
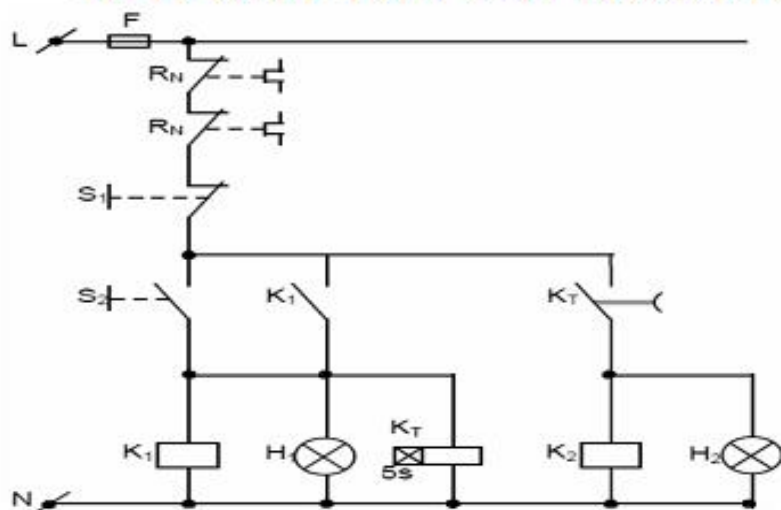
Ex12



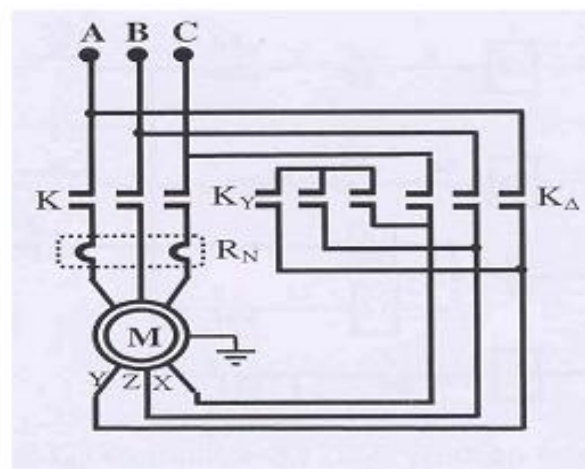
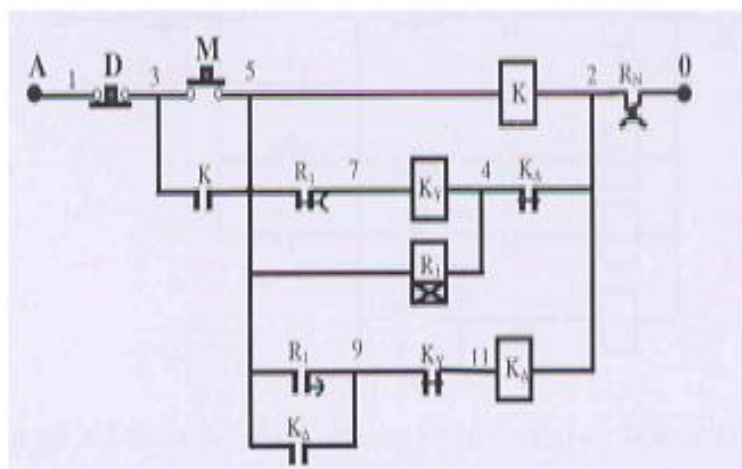
TẬP LỆNH CƠ BẢN TRONG S7-300

EXAMPLE OF INSTRUCTIONS

Ex13:



Ex14:

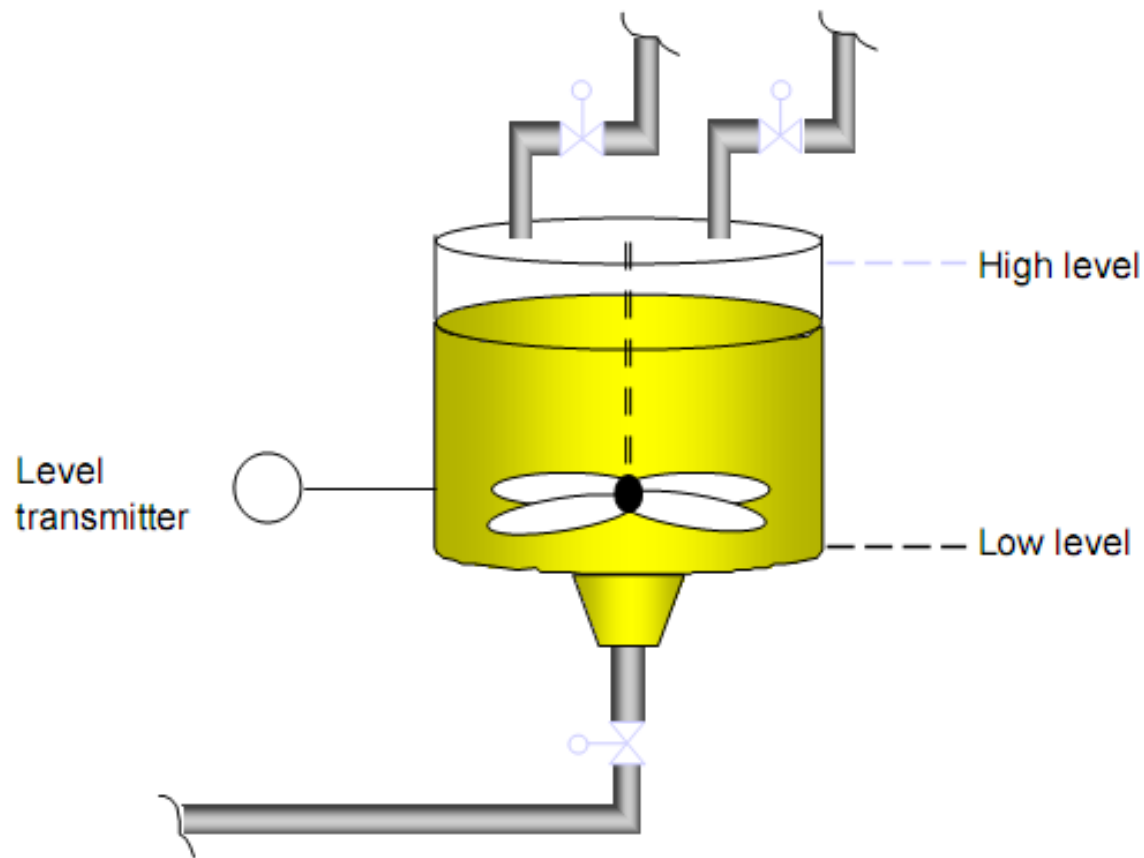


GIÁO TRÌNH LẬP TRÌNH PLC 2

CHƯƠNG IV: XỬ LÝ TÍN HIỆU ANALOG TRONG S7-300

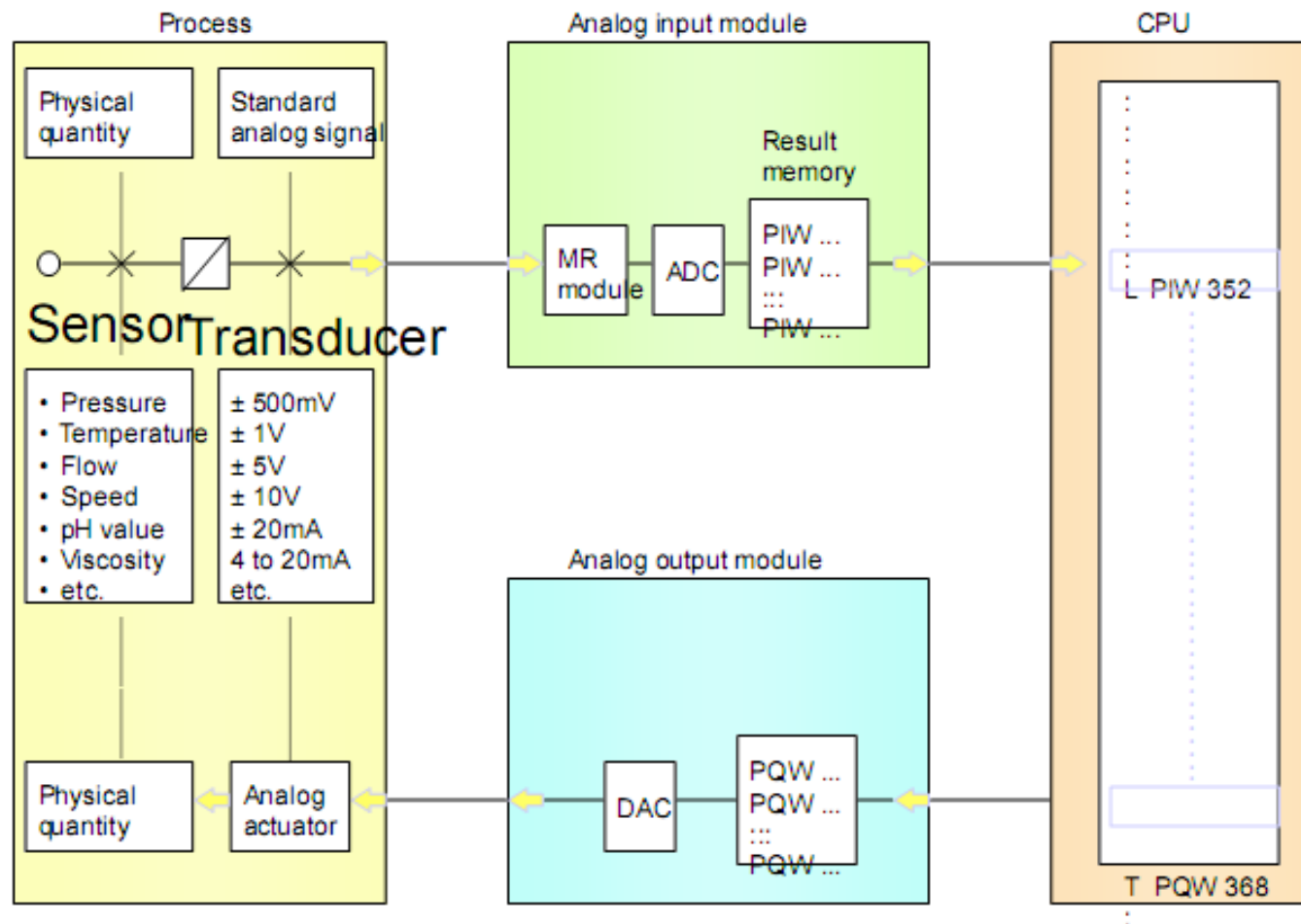
XỬ LÝ TÍN HIỆU ANALOG TRONG S7-300

ANALOG SIGNAL HANDLING



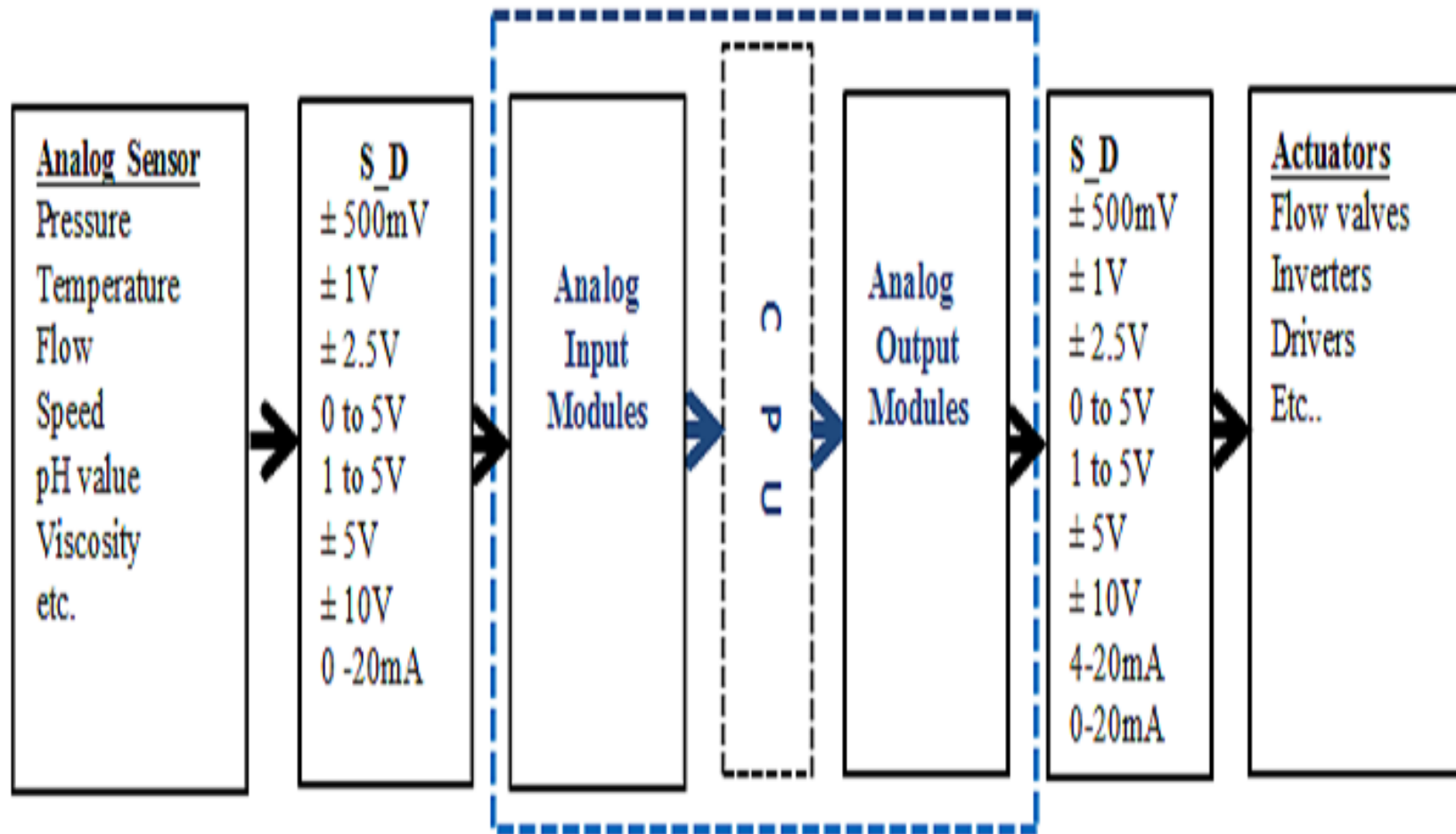
XỬ LÝ TÍN HIỆU ANALOG TRONG S7-300

ANALOG SIGNAL HANDLING



XỬ LÝ TÍN HIỆU ANALOG TRONG S7-300

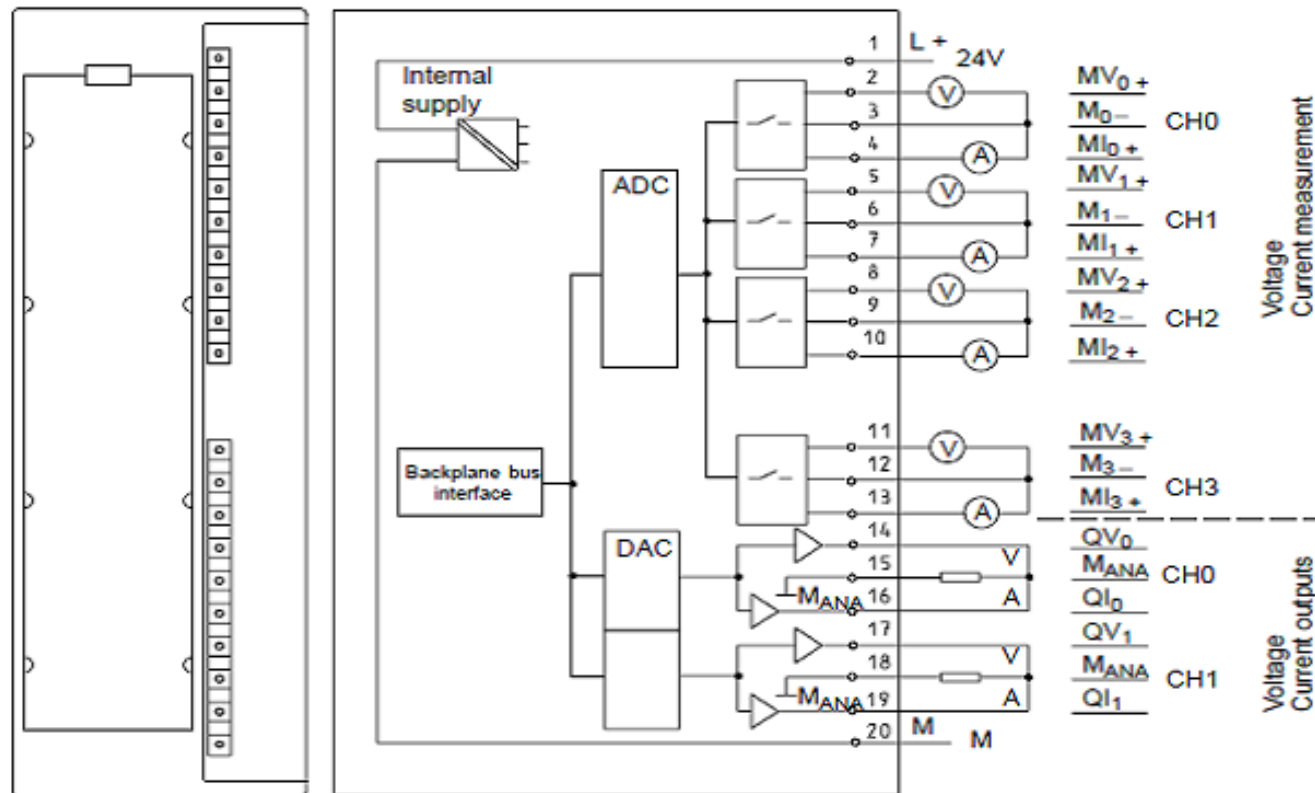
ANALOG SIGNAL HANDLING



XỬ LÝ TÍN HIỆU ANALOG TRONG S7-300

ANALOG SIGNAL HANDLING

Analog input, output signal connection

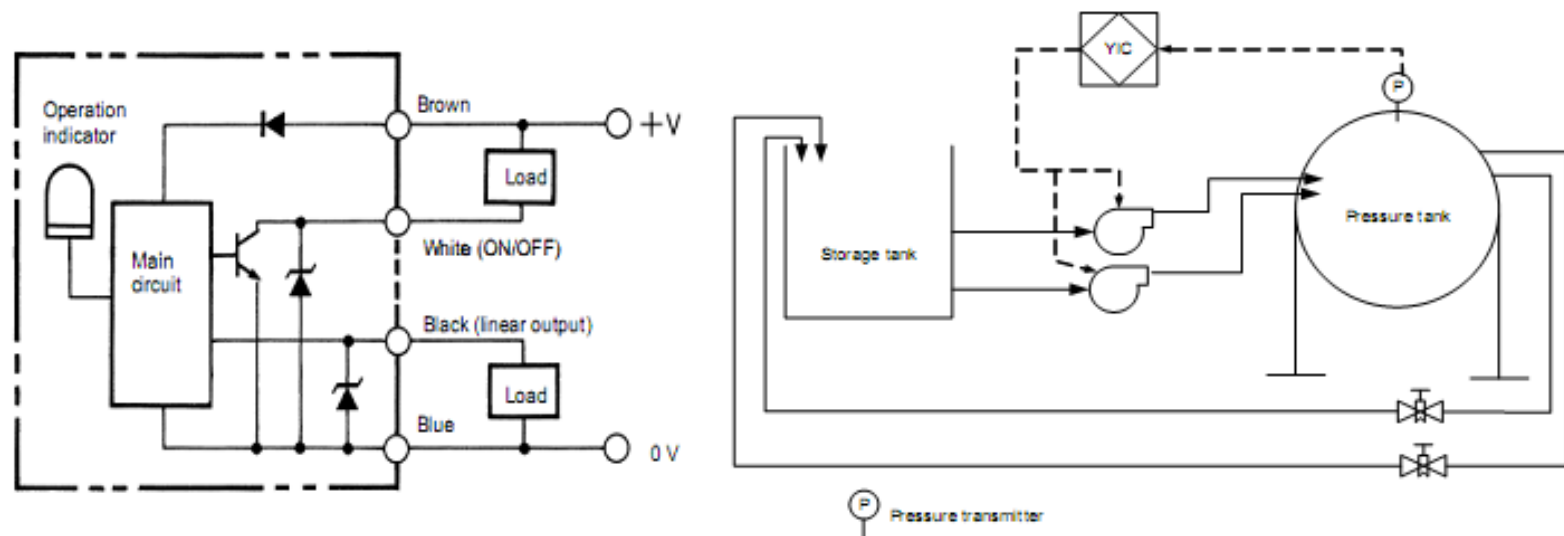


Module View and Block Diagram of the Analog Input/Output Module SM 334;
AI 4/AO 2 × 8/8 bits

XỬ LÝ TÍN HIỆU ANALOG TRONG S7-300

ANALOG MODULE APPLICATION

EX14: Pressure sensor



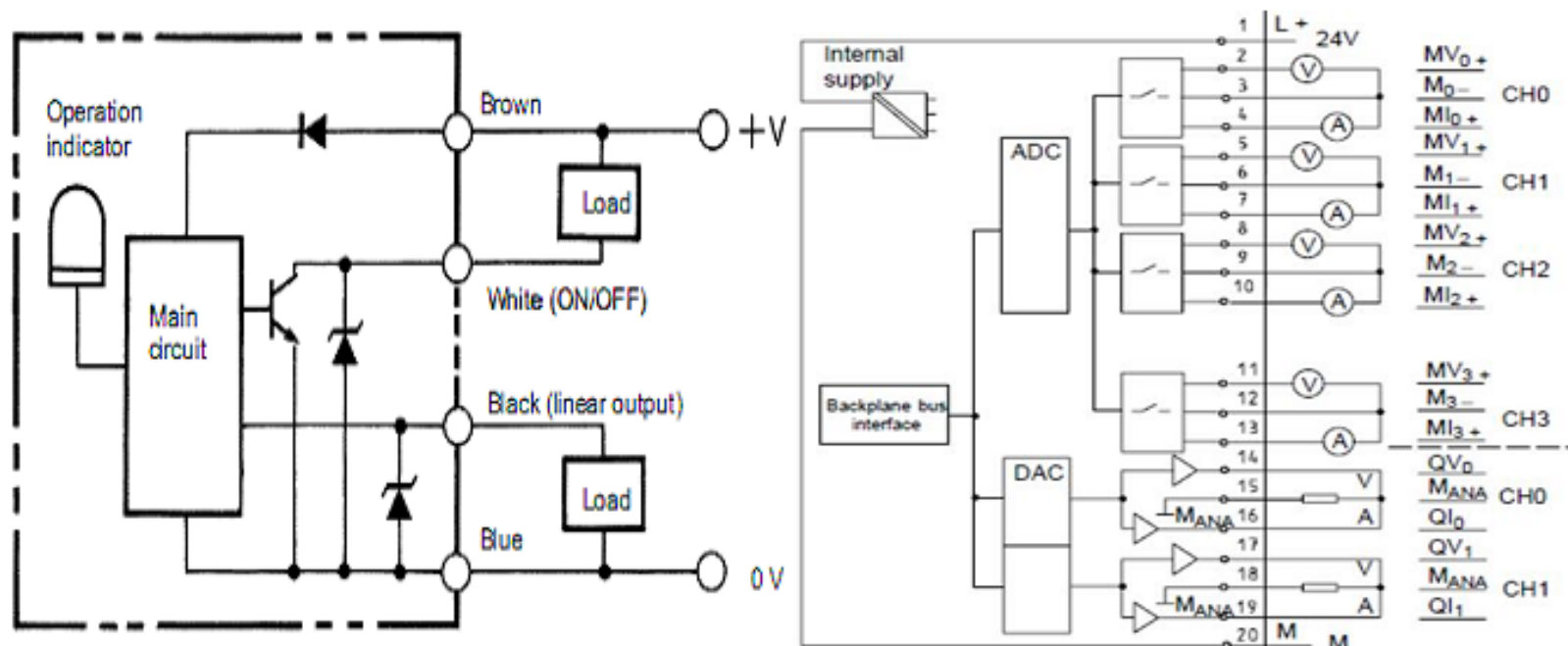
Pressure range		ON/OFF output		Linear output
		NPN open collector	PNP open collector	
Positive pressure	0 to 1 MPa	E8EB-10C	E8EB-10B	
Positive pressure	0 to 100 kPa	E8EB-01C	E8EB-01B	1 to 5 V
Negative pressure	0 to -100 kPa	E8EB-N0C2B	E8EB-N0B2B	

XỬ LÝ TÍN HIỆU ANALOG TRONG S7-300

ANALOG SIGNAL HANDLING

EX14: Connecting pressure sensor to Analog input module

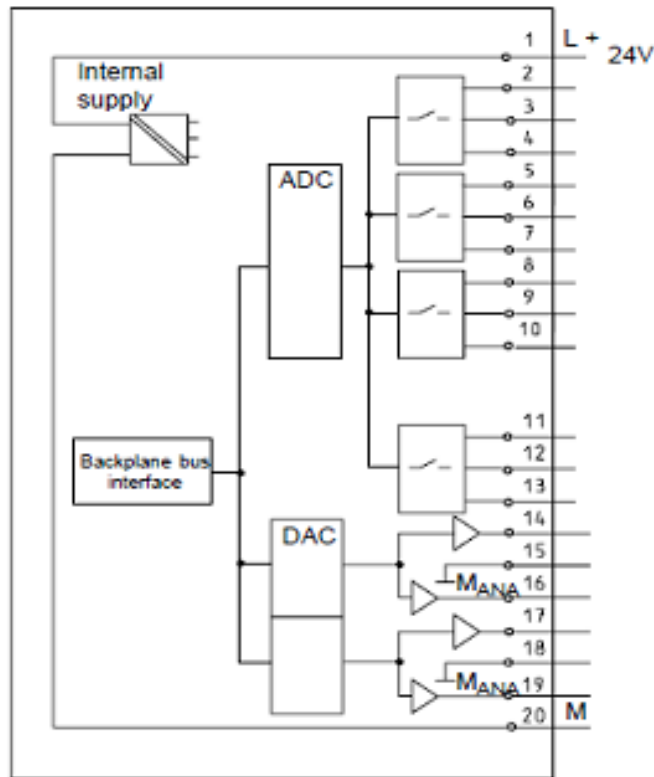
Pressure range		ON/OFF output		Linear output
		NPN open collector	PNP open collector	
Positive pressure	0 to 1 MPa	E8EB-10C	E8EB-10B	1 to 5 V
Positive pressure	0 to 100 kPa	E8EB-01C	E8EB-01B	
Negative pressure	0 to -100 kPa	E8EB-N0C2B	E8EB-N0B2B	



XỬ LÝ TÍN HIỆU ANALOG TRONG S7-300

ANALOG SIGNAL HANDLING

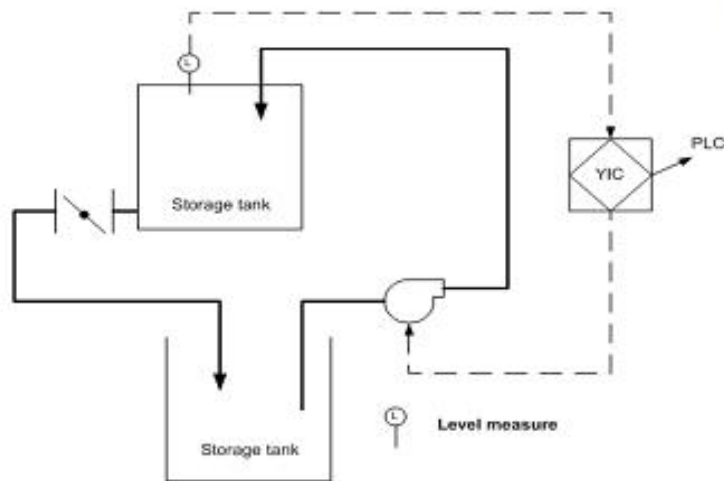
EX14: Connecting Voltage Sensors to Analog input module



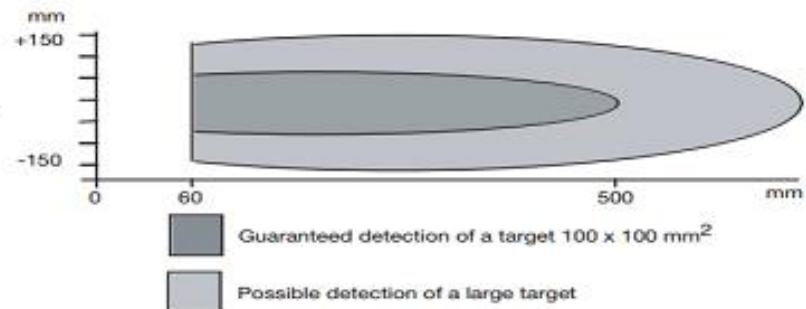
XỬ LÝ TÍN HIỆU ANALOG TRONG S7-300

ANALOG SIGNAL HANDLING

EX15: Ultrasonic Diffuse, Analog Output

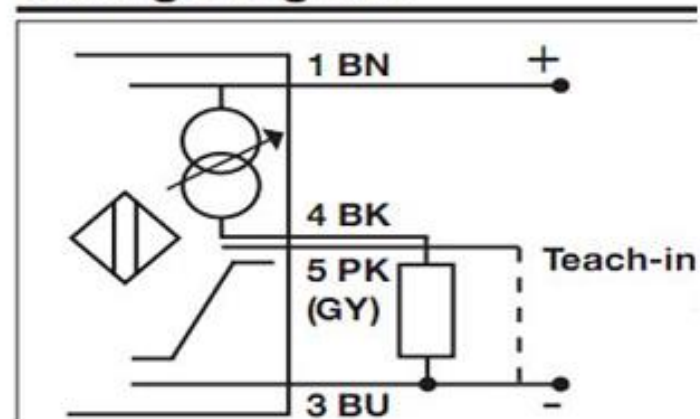


UA18CLD05



60-500 mm	0-10 V	UA18CLD05AKM1TR
60-500 mm	0-10 V	UA18CLD05AKTR
60-500 mm	4-20 mA	UA18CLD05AGM1TR
60-500 mm	4-20 mA	UA18CLD05AGTR

Wiring Diagram

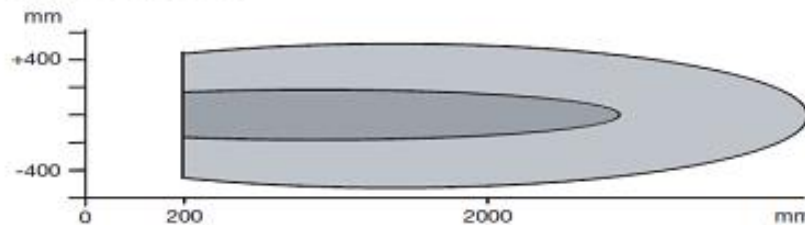




XỬ LÝ TÍN HIỆU ANALOG TRONG S7-300

ANALOG SIGNAL HANDLING

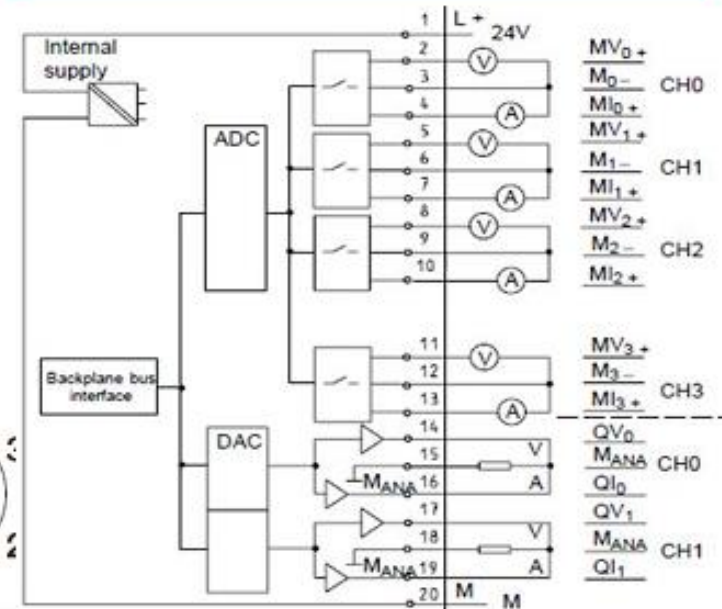
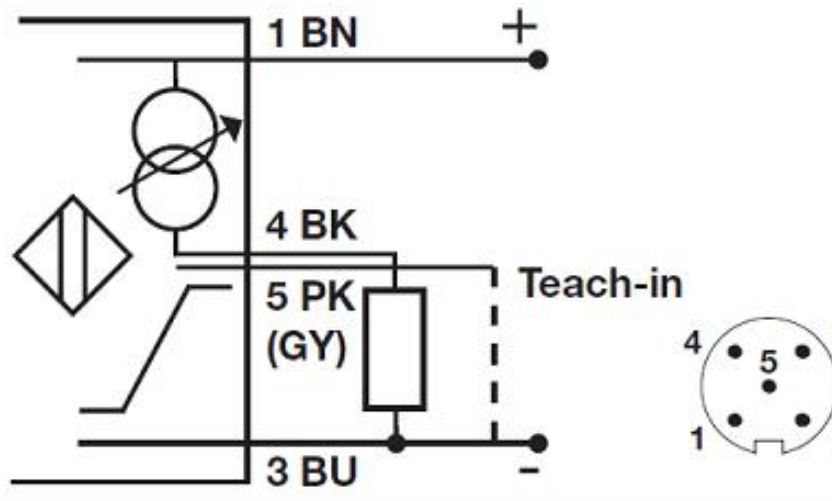
EX15: Connecting Ultrasonic sensor to Analog input module

UA18CLD20



 Guaranteed detection of a target 100 x 100 mm²
 Possible detection of a large target

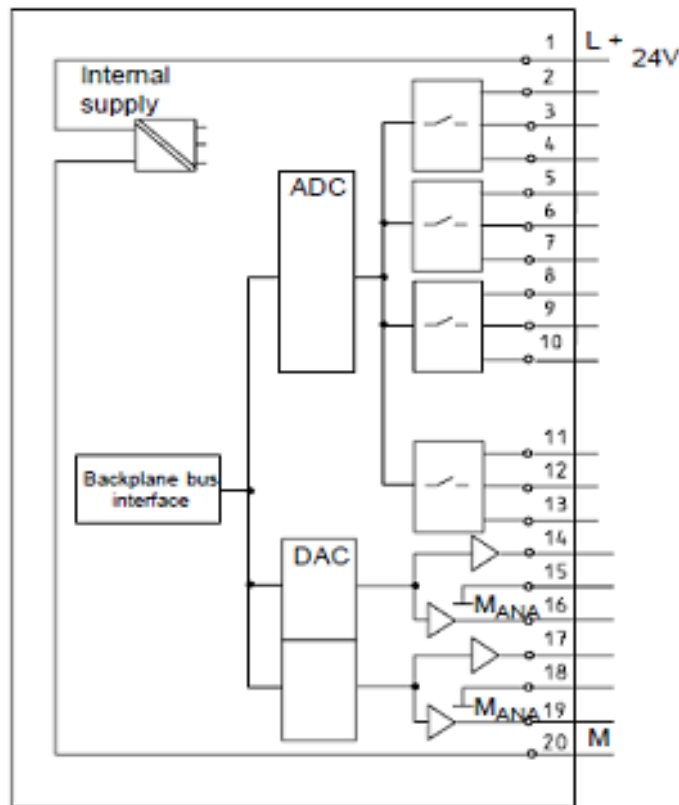
60-500 mm	0-10 V	UA18CLD05AKM1TR
60-500 mm	0-10 V	UA18CLD05AKTR
60-500 mm	4-20 mA	UA18CLD05AGM1TR
60-500 mm	4-20 mA	UA18CLD05AGTR



XỬ LÝ TÍN HIỆU ANALOG TRONG S7-300

ANALOG SIGNAL HANDLING

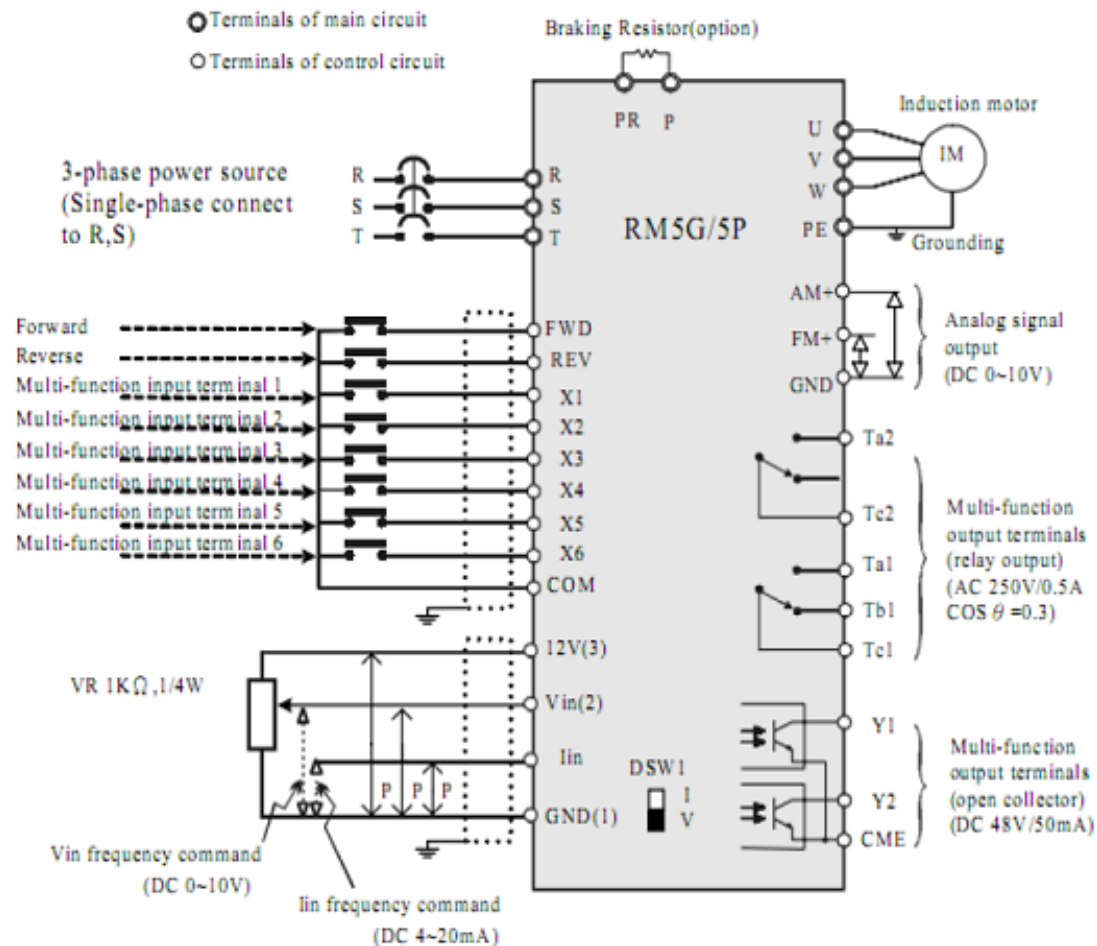
EX15: Connecting Current Sensors to Analog input module



XỬ LÝ TÍN HIỆU ANALOG TRONG S7-300

ANALOG SIGNAL HANDLING

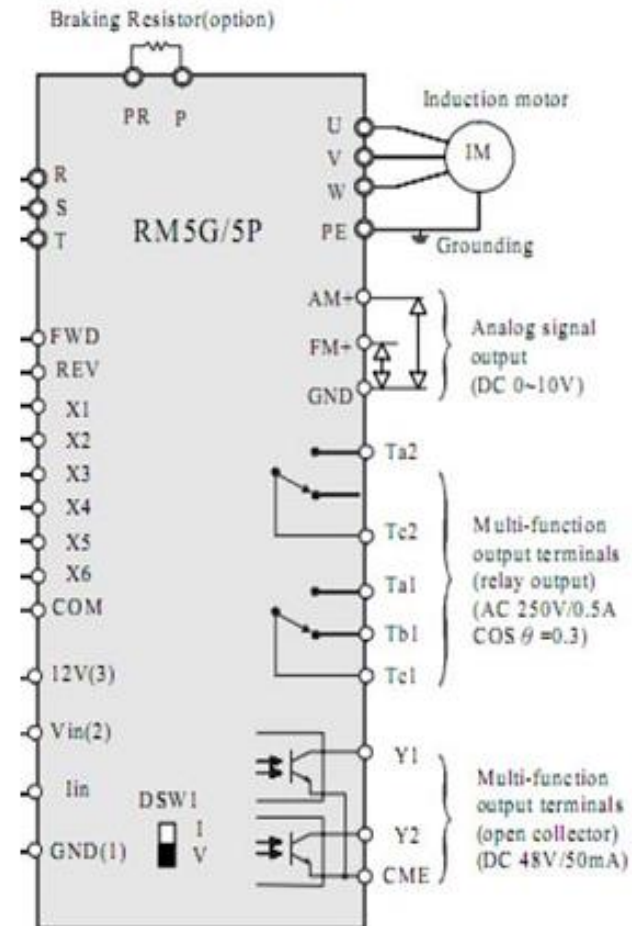
EX16: Connecting analog output module to control inverter



XỬ LÝ TÍN HIỆU ANALOG TRONG S7-300

ANALOG SIGNAL HANDLING

EX16: Connecting analog output module to control inverter



XỬ LÝ TÍN HIỆU ANALOG TRONG S7-300

ANALOG SIGNAL HANDLING

Configure analog input channels

The screenshot shows the SIMATIC Manager HW Config interface. On the left, a rack configuration table lists modules in slots 1 through 13. Slot 6 contains an AI8x13Bit module. The Properties dialog box for this module is open, showing the 'Inputs' tab. The 'Inputs' section has four channels (0, 1, 2, 3) with navigation arrows. Channel 0 is selected. The 'Measuring' section shows the following settings:

Measuring Type	Measuring Range	Interference frequency
R-4L	600 ohm	50 Hz
2DMU	4...20 mA	50 Hz
E	1.5 V	50 Hz

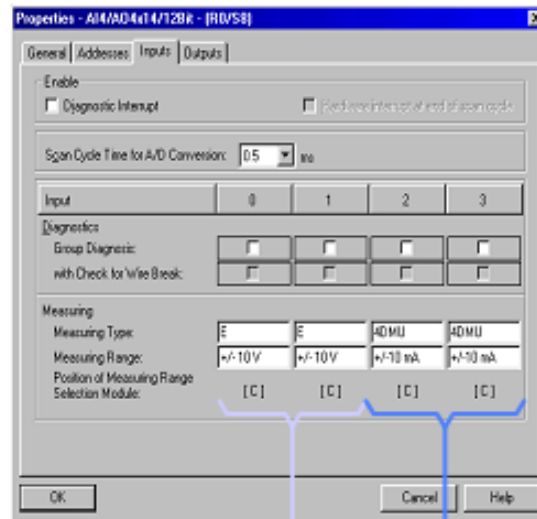
The 'OK' button is visible at the bottom of the dialog box.

XỬ LÝ TÍN HIỆU ANALOG TRONG S7-300

ANALOG SIGNAL HANDLING

Configure analog input channels

SM335 (Inputs)



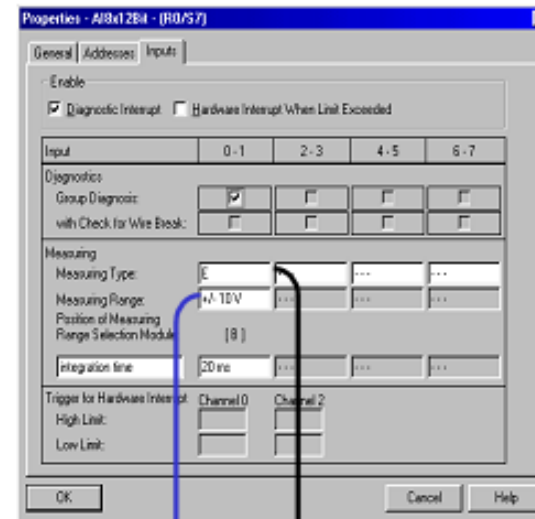
- +/- 1 V
- +/- 2.5 V
- 0.10 V
- +/- 10 V**
- 0.2 V

deactivated
E voltage

- +/- 10 mA
- 0.20 mA
- 4.20 mA**

deactivated
E voltage
4DMU current (4-wire transmitter)

SM331



- +/- 80 mV
- +/- 250 mV
- +/- 500 mV
- +/- 1 V
- +/- 2.5 V
- +/- 5 V
- 1.5 V
- +/- 10 V**

- deactivated
- E voltage**
 - 4DMU current (4-wire transmitter)
 - 2DMU current (2-wire transmitter)
 - Ri-4L resistor (4-conductor terminal)
 - RT resistor (thermal in.)
 - TC-I thermocouple (int. comp.)
 - TC-E thermocouple (ext. comp.)
 - TC-IL thermocouple (int. comp. linear.)
 - TC-EL thermocouple (ext. comp. linear.)

XỬ LÝ TÍN HIỆU ANALOG TRONG S7-300

ANALOG SIGNAL HANDLING

Binary representation of the input ranges

Units	Measured Value in %	Data Word																Range
		2 ¹⁵	2 ¹⁴	2 ¹³	2 ¹²	2 ¹¹	2 ¹⁰	2 ⁹	2 ⁸	2 ⁷	2 ⁶	2 ⁵	2 ⁴	2 ³	2 ²	2 ¹	2 ⁰	
32767	> 118.515	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	Overflow
32511	117.589	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	Overrange
27649	> 100.004	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	1	
27648	100.000	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	Rated range
1	0.003617	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
-1	-0.003617	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
-27648	-100.000	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	
-27649	≤ -100.004	1	0	0	1	0	0	1	1	1	1	1	1	1	1	1	1	Under-range
-32512	-117.593	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	
-32768	≤ -117.596	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Underflow

XỬ LÝ TÍN HIỆU ANALOG TRONG S7-300

ANALOG SIGNAL HANDLING

Analog value representation in voltage measuring ranges

	System		Voltage Measuring Range				
	Dec.	Hex.	±10 V	±5 V	±2.5 V	±1 V	
118.515 %	32767	7FFF	11.851 V	5.926 V	2.963 V	1.185 V	Overflow
117.593%	32512	7F00					
117.589%	32511	7EFF	11.759 V	5.879 V	2.940 V	1.176 V	Overrange
	27649	6C01					
100.000%	27648	6C00	10 V	5 V	2.5 V	1 V	Rated range
75.000 %	20736	5100	7.5 V	3.75 V	1.875 V	0.75 V	
0.003617%	1	1	361.7 μV	180.8 μV	90.4 μV	36.17 μV	
0 %	0	0	0 V	0 V	0 V	0 V	
	-1	FFFF					
-75.00 %	-20736	AF00	-7.5 V	-3.75 V	-1.875 V	-0.75 V	
-100.000%	-27648	9400	-10 V	-5 V	-2.5 V	-1 V	
	-27649	93FF					
-117.593%	-32512	8100	-11.759 V	-5.879 V	-2.940 V	-1.176 V	Underrange
-117.596 %	-32513	80FF					Underflow
-118.519%	-32768	8000	-11.851 V	-5.926 V	-2.963 V	-1.185 V	

XỬ LÝ TÍN HIỆU ANALOG TRONG S7-300

ANALOG SIGNAL HANDLING

Analog value representation in voltage measuring ranges

System			Voltage Measuring Range		
	Dec.	Hex.	1 to 5 V	0 to 10 V	
118.515 %	32767	7FFF	5.741 V	11.852 V	Overflow
117.593%	32512	7F00			
117.589%	32511	7EFF	5.704 V	11.759 V	Overrange
	27649	6C01			
100.000%	27648	6C00	5 V	10 V	Rated range
75%	20736	5100	3.75 V	7.5 V	
0.003617%	1	1	1 V + 144.7 μ V	0 V + 361.7 μ V	
0 %	0	0	1 V	0 V	
	-1	FFFF		Negative values not possible	Underrange
-17.593%	-4864	ED00	0.296 V		
	-4865	ECFF			Underflow
≤ -17.596 %	-32768	8000			

XỬ LÝ TÍN HIỆU ANALOG TRONG S7-300

ANALOG SIGNAL HANDLING

Analog value representation in current measuring ranges

	System		Current Measuring Range				
	Dec.	Hex.	± 20 mA	± 10 mA	± 3.2 mA		
118.515 %	32767	7FFF	23.70 mA	11.85 mA	3.79 mA	Overflow	
117.593%	32512	7F00					
117.589%	32511	7EFF	23.52 mA	11.76 mA	3.76 mA	Overrange	
	27649	6C01					
100.000%	27648	6C00	20 mA	10 mA	3.2 mA	Rated range	
75%	20736	5100	15 mA	7.5 mA	2.4 mA		
0.003617%	1	1	723.4 nA	361.7 nA	115.7 nA		
0 %	0	0	0 mA	0 mA	0 mA		
	-1	FFFF					
-75%%	-20736	AF00	-15 mA	-7.5 mA	-2.4 mA		
-100.000%	-27648	9400	-20 mA	-10 mA	-3.2 mA		
	-27649	93FF					Underrange
-117.593%	-32512	8100	-23.52 mA	-11.76 mA	-3.76 mA		
-117.596 %	-32513	80FF					Underflow
-118.519%	-32768	8000	-23.70 mA	-11.85 mA	-3.79 mA		

XỬ LÝ TÍN HIỆU ANALOG TRONG S7-300

ANALOG SIGNAL HANDLING

Analog value representation in current measuring ranges

System			Current Measuring Range		
	Dec.	Hex.	0 to 20 mA	4 to 20 mA	
118.515 %	32767	7FFF	23.70 mA	22.96 mA	Overflow
117.593%	32512	7F00			
117.589%	32511	7EFF	23.52 mA	22.81 mA	Overrange
	27649	6C01			
100.000%	27648	6C00	20 mA	20 mA	Rated range
75%	20736	5100	15 mA	15 mA	
0.003617%	1	1	723.4 nA	4 mA + 578.7 nA	
0 %	0	0	0 mA	4 mA	
	-1	FFFF			Underrange
-17.593%	-4864	ED00	-3.52 mA	1.185 mA	
	-4865	ECFF			Underflow
≤ -17.596 %	-32768	8000			

XỬ LÝ TÍN HIỆU ANALOG TRONG S7-300

ANALOG SIGNAL HANDLING

Analog value representation for Resistance Type Transmitters

System			Resistance-Type Transmitter Range				
	Dec.	Hex.	10 k Ω	150 Ω	300 Ω	600 Ω	
118.515 %	32767	7FFF	11.852k Ω	177.77 Ω	355.54 Ω	711.09 Ω	Overflow
117.593%	32512	7F00		150.01 Ω	300.01 Ω	600.02 Ω	
117.589%	32511	7EFF	11.759	176.38	352.77 Ω	705.53 Ω	Overrange
	27649	6C01					
100.000%	27648	6C00	10 k Ω	150 Ω	300 Ω	600 Ω	Rated range
75%	20736	5100	7.5 k Ω	112.5 Ω	225 Ω	450 Ω	
0.003617%	1	1	361.7m Ω	5.43 m Ω	10.85m Ω	21.70m Ω	
0 %	0	0	0 Ω	0 Ω	0 Ω	0 Ω	
			(neg. values physically not possible)				Underrange

XỬ LÝ TÍN HIỆU ANALOG TRONG S7-300

ANALOG SIGNAL HANDLING

Analog value representation for RTD:Pt100,200,500,1000

Pt x00 standard in °C (1 digit =0.1°C)	Units		Pt x00 standard in °F (1 digit =0.1 °F)	Units		Pt x00 standard in K (1 digit = 0.1 K)	Units		Range
	deci- mal	hexa- decimal		deci- mal	hexa- decimal		deci- mal	hexa- decimal	
> 1000.0	32767	7FFF _H	> 1832.0	32767	7FFF _H	> 1273.2	32767	7FFF _H	Overflow
1000.0	10000	2710 _H	1832.0	18320	4790 _H	1273.2	12732	31BC _H	Overrange
:	:	:	:	:	:	:	:	:	
850.1	8501	2135 _H	1562.1	15621	3D05 _H	1123.3	11233	2BE1 _H	Rated range
850.0	8500	2134 _H	1562.0	15620	3D04 _H	1123.2	11232	2BE0 _H	
:	:	:	:	:	:	:	:	:	Underrange
-200.0	-2000	F830 _H	-328.0	-3280	F330 _H	73.2	732	2DC _H	
-200.1	-2001	F82F _H	-328.1	-3281	F32F _H	73.1	731	2DB _H	Underflow
:	:	:	:	:	:	:	:	:	
-243.0	-2430	F682 _H	-405.4	-4054	F02A _H	30.2	302	12E _H	
< -243.0	-32768	8000 _H	< -405.4	-32768	8000 _H	< 30.2	32768	8000 _H	

XỬ LÝ TÍN HIỆU ANALOG TRONG S7-300

ANALOG SIGNAL HANDLING

Analog value representation in Voltage Output Ranges

System			Voltage Output Range		
	Dec.	hex.	0 to 10 V	1 to 5 V	
118.5149%	32767	7FFF	0.00 V	0.00 V	Overflow, off circuit and de-energized
	32512	7F00			
117.589%	32511	7EFF	11.76 V	5.70 V	Overrange
	27649	6C01			
100 %	27648	6C00	10 V	5 V	Rated range
75%	20736	5100	7.5 V	3.75 V	
0.003617%	1	1	361.7 μ V	1V+144.7 μ V	
0 %	0	0	0 V	1 V	
	-1	FFFF			Underrange
-25 %	-6912	E500		0 V	
	-6913	E4FF			Not possible. The output value is limited to 0 V.
-117.593%	-32512	8100			
	-32513	80FF			Underflow, off circuit and de-energized
-118.519%	-32768	8000	0.00 V	0.00 V	

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ANALOG SIGNAL HANDLING

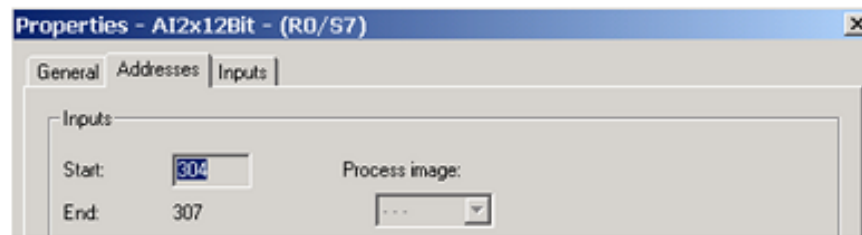
Analog value representation Current Output Ranges

System			Current Output Range		
	Dec.	Hex.	0 to 20 mA	4 to 20 mA	
118.5149%	32767	7FFF	0.00 mA	0.00 mA	Overflow, off circuit and de-energized
	32512	7F00			
117.589%	32511	7EFF	23.52 mA	22.81 mA	Overrange
	27649	6C01			
100 %	27648	6C00	20 mA	20 mA	Rated range
75%	20736	5100	15 mA	15 mA	
0.003617%	1	1	723.4 nA	4mA+578.7 nA	
0 %	0	0	0 mA	4 mA	
	-1	FFFF			Underrange
-25 %	-6912	E500		0 mA	
	-6913	E4FF			Not possible. The output value is limited to 0 mA.
-117.593%	-32512	8100			
	-32513	80FF			Underflow, off circuit and de-energized
-118.519%	-32768	8000	0.00 mA	0.00 mA	

XỬ LÝ TÍN HIỆU ANALOG TRONG S7-300

ANALOG SIGNAL HANDLING

Analog module addresses for the S7-300

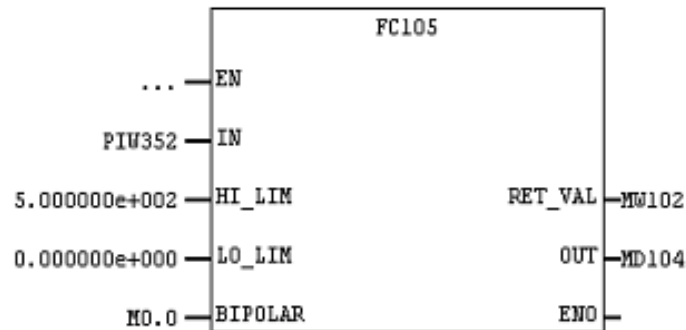


Rack	Slot	Module	Start Address	End Address	Start Address	End Address	Start Address	End Address	Start Address	End Address	Start Address	End Address
Rack 3	1	Power Supply										
	2	IM (Receive)	640	654	656	670	672	686	688	702	704	718
Rack 2	1	Power Supply										
	2	IM (Receive)	512	526	528	542	544	558	560	574	576	590
Rack 1	1	Power Supply										
	2	IM (Receive)	384	398	400	414	416	430	432	446	448	462
R 0	1	Power Supply										
	2	CPU										
	3	IM (Send)	256	270	272	286	288	302	304	318	320	334
	4											
	5											
	6											
	7											
	8											
	9											
	10											
	11											

XỬ LÝ TÍN HIỆU ANALOG TRONG S7-300

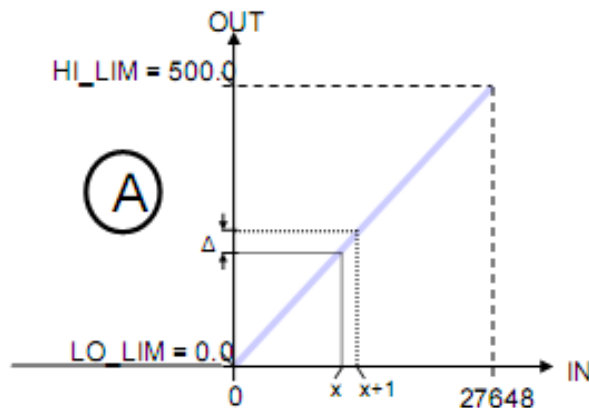
Scaling Analog Input Values using FC105

Network 5: Scale Analog Input Value



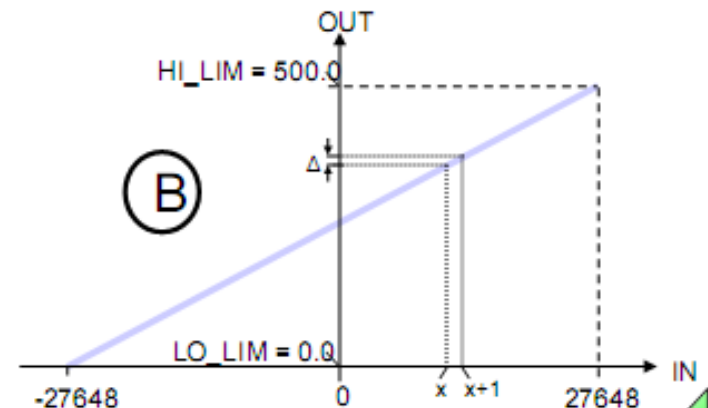
unipolar (M 0.0 = '0')

(Sensor supplies only positive voltage)



bipolar (M 0.0 = '1')

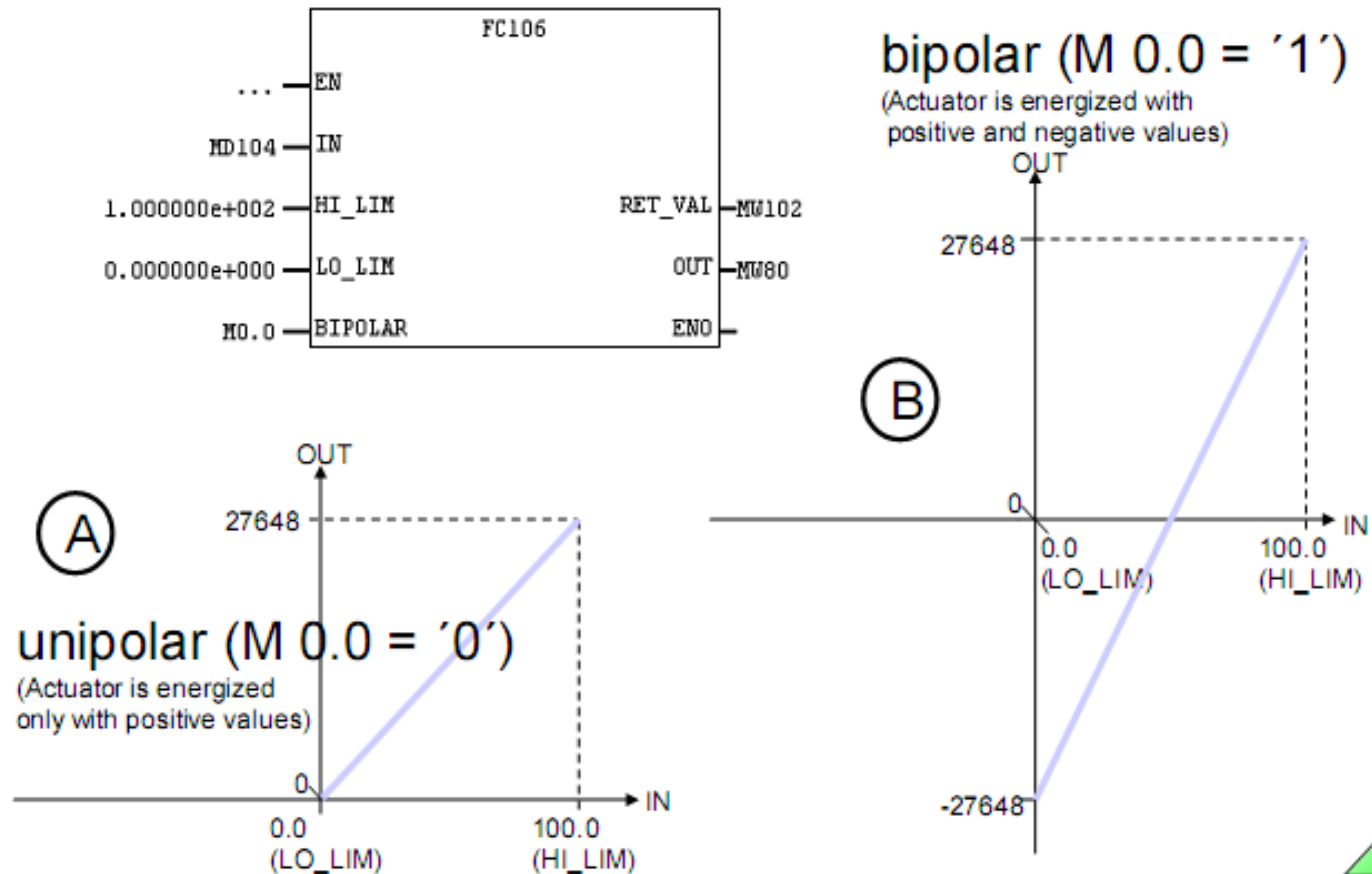
(Sensor also supplies negative voltage)



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Unscaling Analog Output Values using FC106

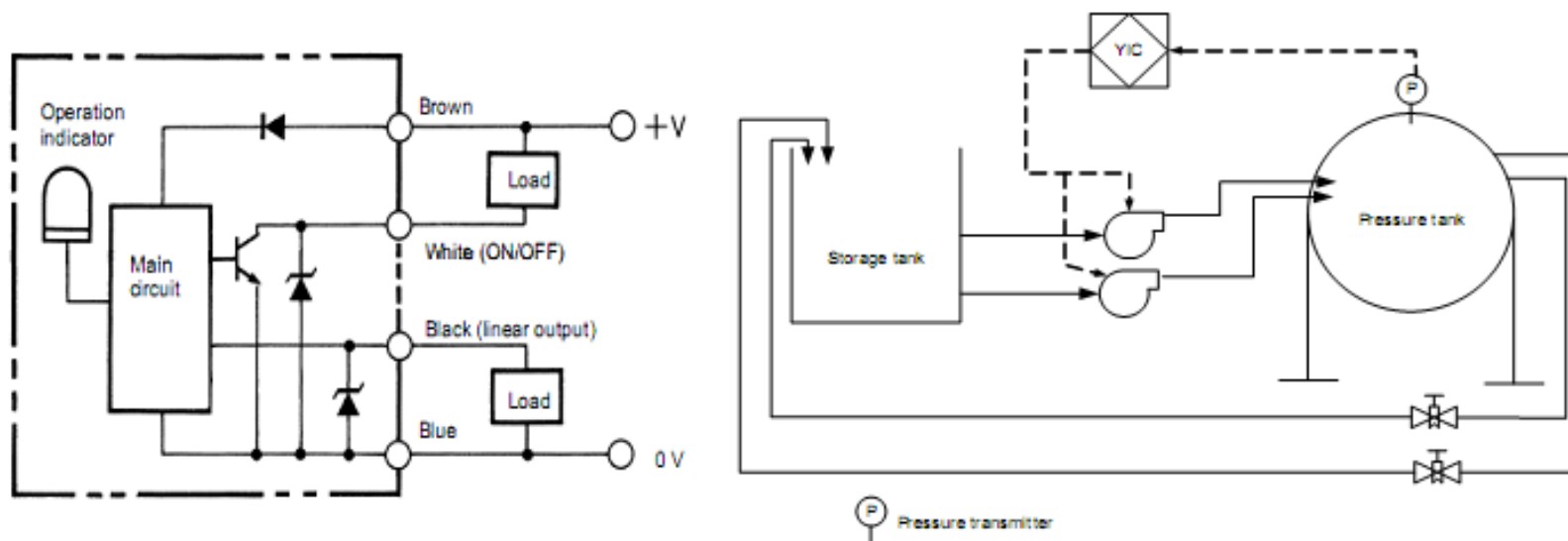
Network 5: Unscale Analog Output Value



XỬ LÝ TÍN HIỆU ANALOG TRONG S7-300

ANALOG MODULE APPLICATION

EX16: Using Scaling Analog Input Value Function (FC105) to display measured pressure value from sensor

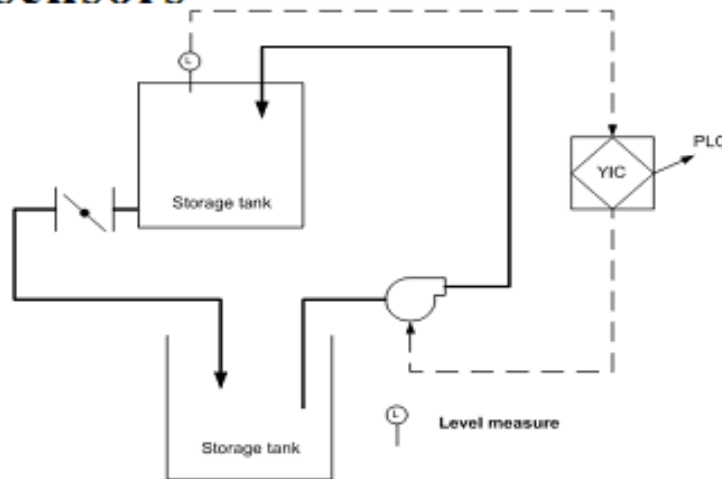


Pressure range		ON/OFF output		Linear output
		NPN open collector	PNP open collector	
Positive pressure	0 to 1 MPa	E8EB-10C	E8EB-10B	
Positive pressure	0 to 100 kPa	E8EB-01C	E8EB-01B	1 to 5 V
Negative pressure	0 to -100 kPa	E8EB-N0C2B	E8EB-N0B2B	

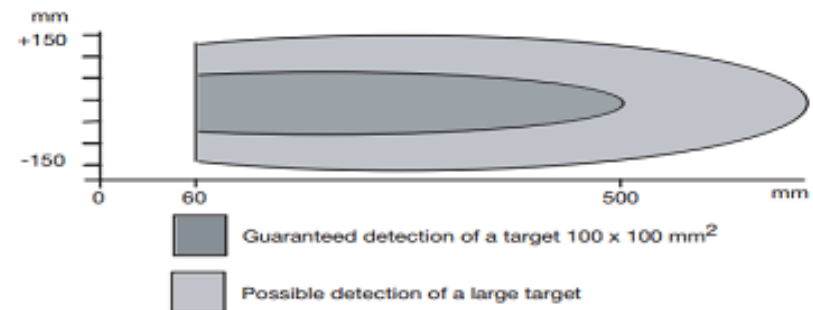
XỬ LÝ TÍN HIỆU ANALOG TRONG S7-300

ANALOG MODULE APPLICATIONS

EX17: Using Scaling Analog Input Value Function (FC105) to display measured distance from Ultrasonic sensors

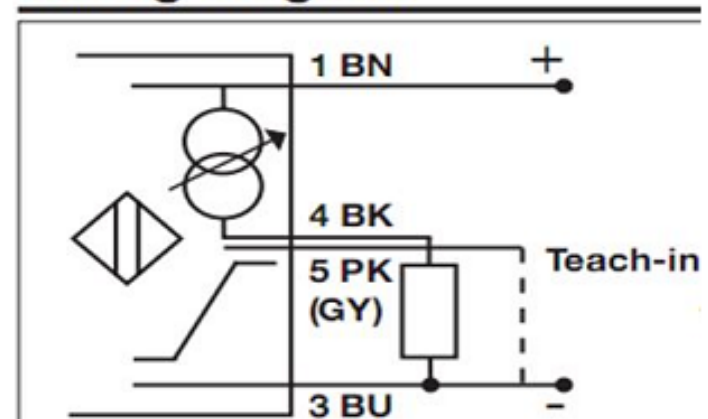


UA18CLD05



60-500 mm	0-10 V	UA18CLD05AKM1TR
60-500 mm	0-10 V	UA18CLD05AKTR
60-500 mm	4-20 mA	UA18CLD05AGM1TR
60-500 mm	4-20 mA	UA18CLD05AGTR

Wiring Diagram





TRƯỜNG ĐẠI HỌC BÀ RỊA VŨNG TÀU

KHOA ĐIỆN – ĐIỆN TỬ

GIÁO TRÌNH LẬP TRÌNH PLC 2

CHƯƠNG V: CÁC KHỐI TRONG S7-300

CÁC KHỐI TRONG S7-300

BLOCK ARCHITECTURE IN S7

- **Type of Blocks in Step 7**
- **Block Organization :OB**
- **Function :FC**
- **Function Block :FB**
- **System Function :FC**
- **System Function Block: SFC**
- **Data Block :DB**
- **PID Blocks**

CÁC KHỐI TRONG S7-300

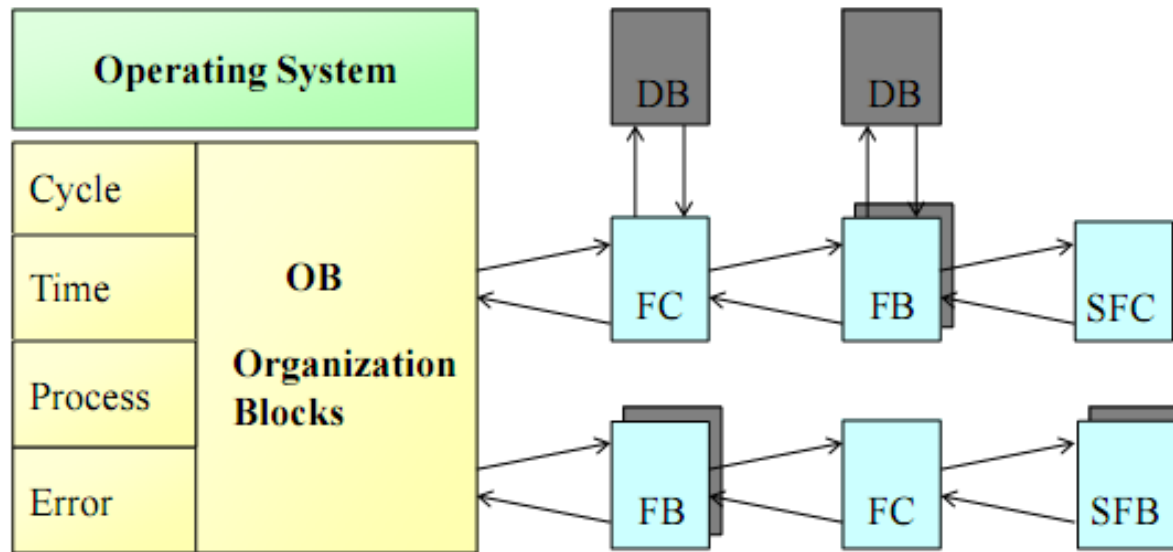
Type of Blocks in S7

OB = Organization Block
FB = Function Block
FC = Function
SFB = System Function Block
SFC = System Function
DB = Data Block

Block Name	Block Name	Block Name	Block Name	Block Name
OB1	OB34	OB35	OB40	OB82
OB66	OB100	OB121	FB14	FB43
FB50	FB51	FB52	FB61	FB62
FB64	FB102	FB105	FB106	FB108
FB110	FB115	FB400	FC1	FC3
FC4	FC5	FC6	FC10	FC12
FC13	FC15	FC40	FC41	FC2
FC90	FC100	FC101	FC102	FC11
FC105	FC106	FC107	FC201	FC103
FC305	FC306	FC308	FC400	FC202
FC403	FC405	FC500	DB2	FC401
DB12	DB13	DB14	DB15	FC203
DB19	DB20	DB21	DB43	DB11
DB51	DB52	DB60	DB61	DB18
DB101	DB102	DB105	DB110	DB50
DB116	DB150	DB151	DB152	DB62
DB156	DB157	DB158	DB160	DB64
DB163	DB170	DB200	DB201	DB111
DB601	UDT1	UDT2	UDT3	DB154
UDT99	UDT100	UDT200	AXE Y	DB161
Carres Zone	CMD_TRIGGER_HOP1	CMD_TRIGGER_HOP2	AXE Z	DB162
Fault messages	General check	Interface CCR	Slackness Param	DB400
VAT_E	VAT_SIMU	VAT_WorkingTable	VAT_CARTO	UDT18
SFB15	SFB52	SFB53	SFB9	UDT98
SFC17	SFC18	SFC20	SFC14	Axle Table
SFC41	SFC42	SFC51	SFC37	Codeurs
SFC64			SFC58	VAT_DIV
				SFB14
				SFC15
				SFC38
				SFC59

CÁC KHỐI TRONG S7-300

Types of Program Blocks



Legend:

OB = Organization Block
FB = Function Block
FC = Function
SFB = System Function Block
SFC = System Function
DB = Data Block



FB with
instance DB

Maximum nesting depth:

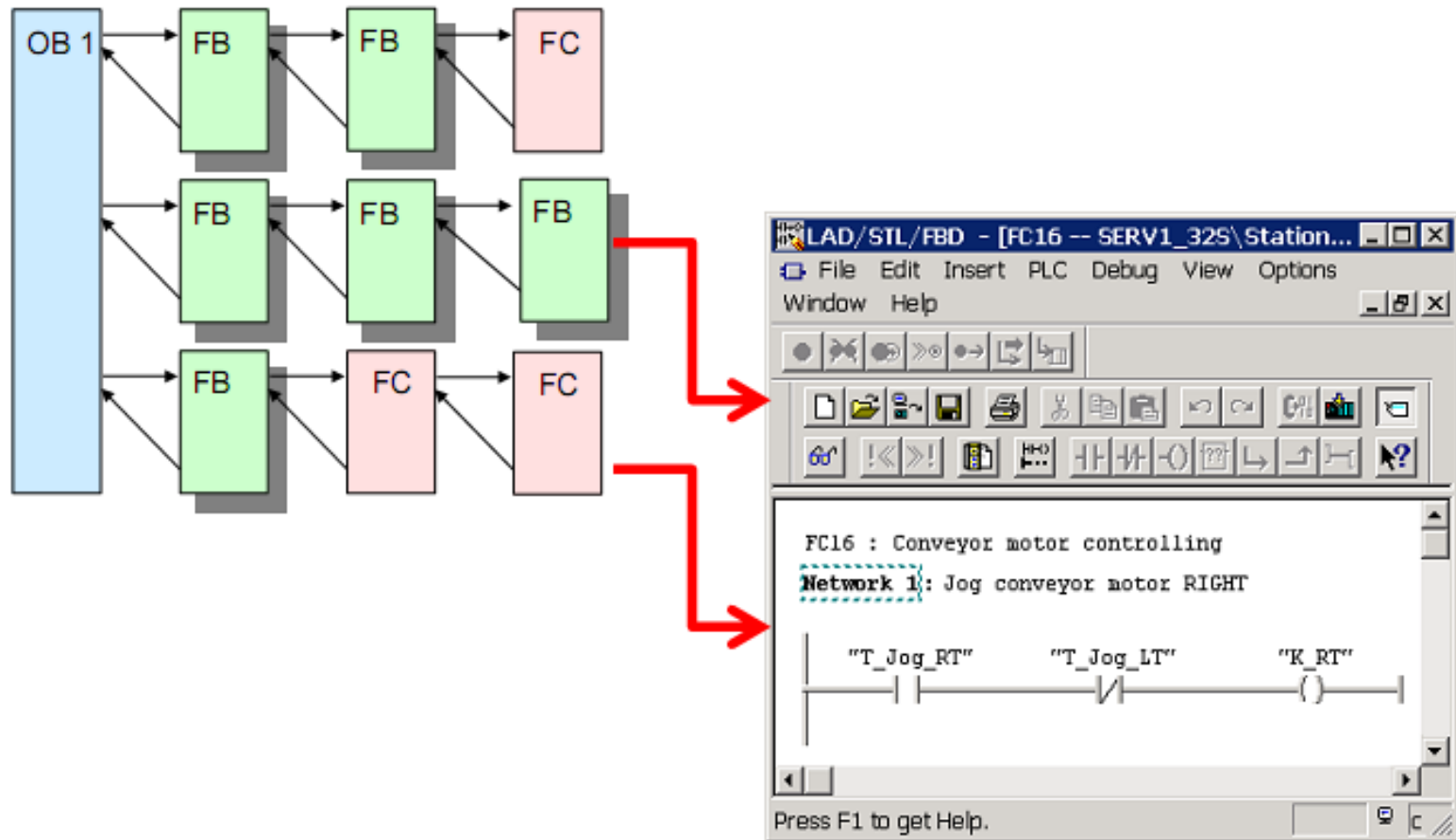
S7-300: 8 (16 for CPU 318)

S7-400: 24



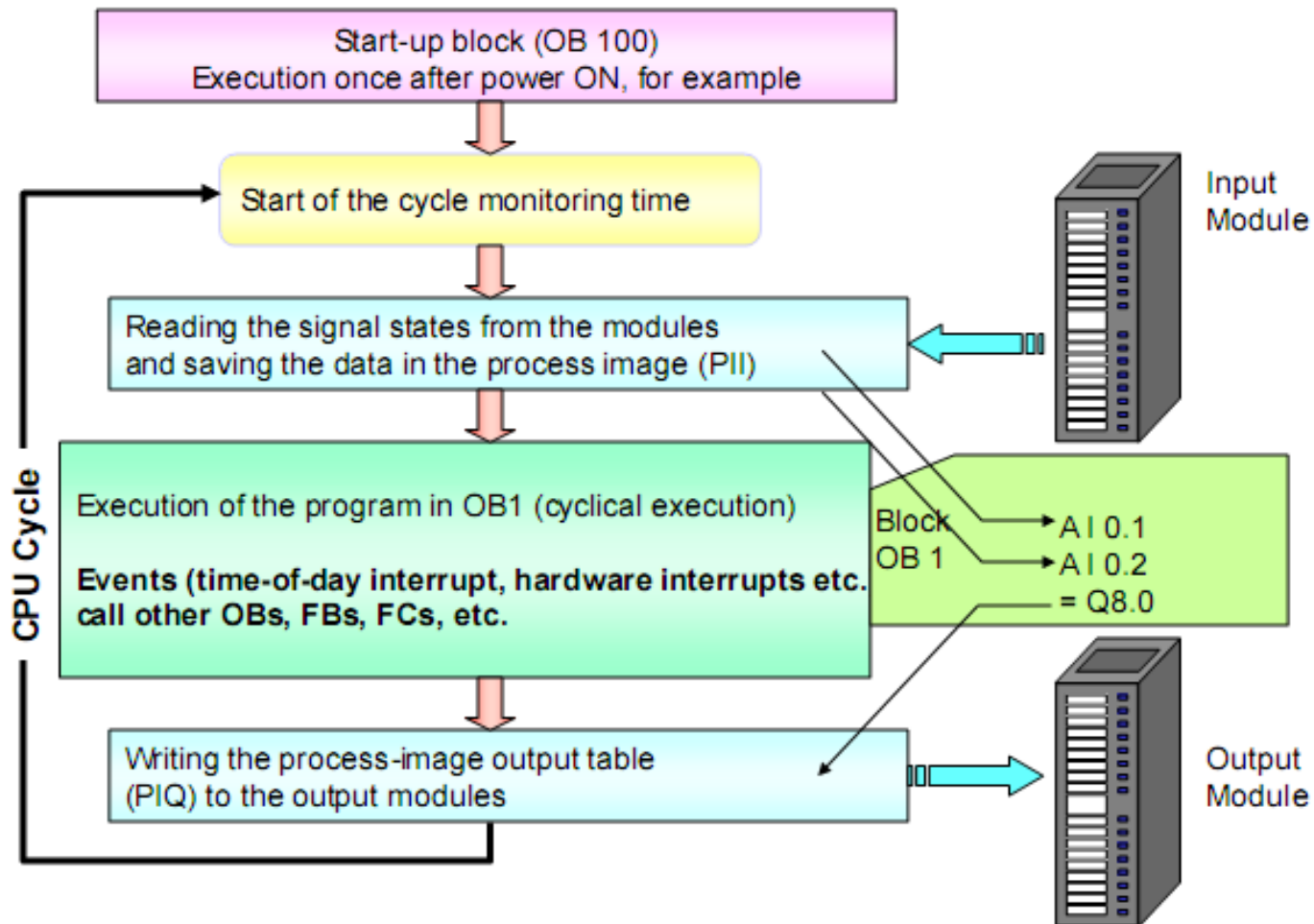
CÁC KHỐI TRONG S7-300

Block Architecture and Block Editor



CÁC KHỐI TRONG S7-300

Cyclic Program Execution



CÁC KHỐI TRONG S7-300

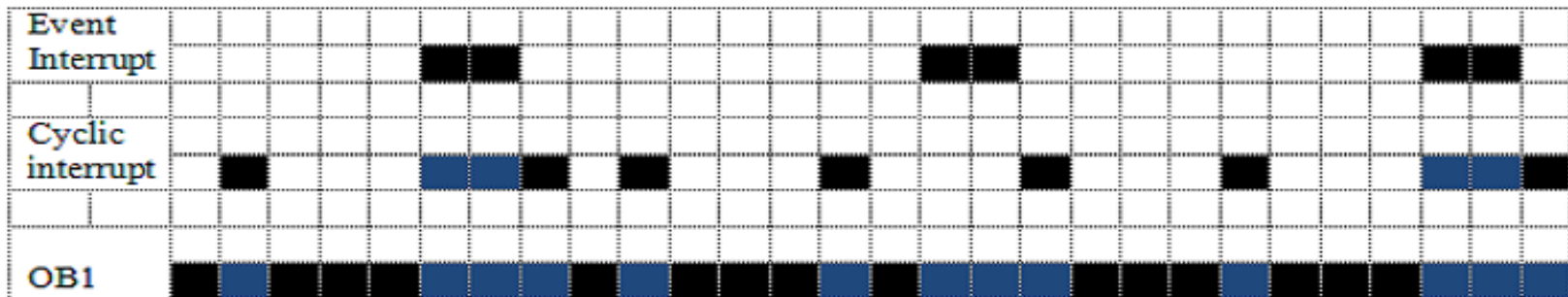
Organization Blocks

Organization Blocks are the interface between the operation system of the CPU and the user program.

OBs are used to executed specific program sections:

- At the start up of the CPU
- In a cyclic or clocked execution
- Whenever error occur
- Whenever hardware interrupts occur

OBs are executed according to the priority the OBs are allocated



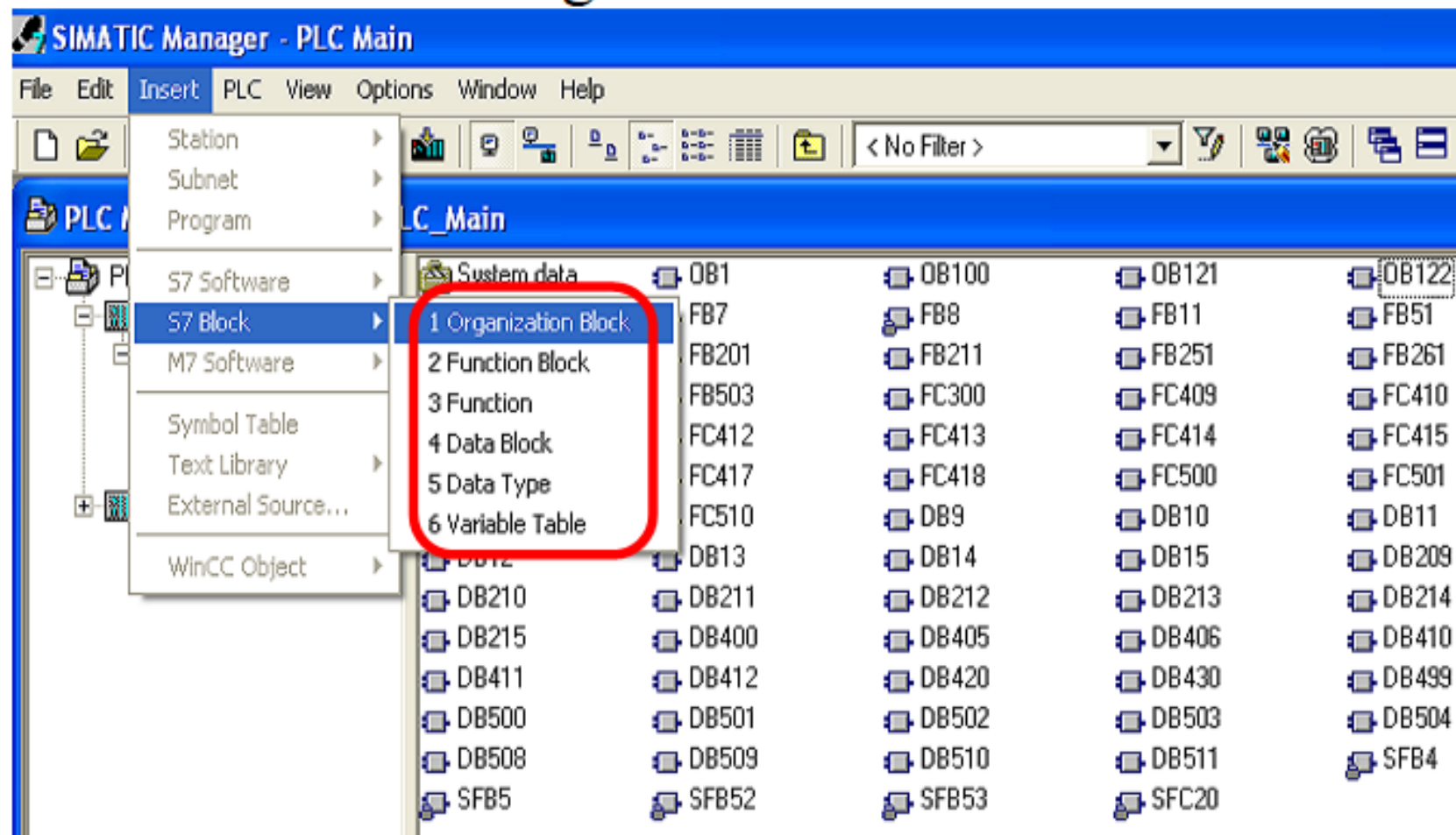
CÁC KHỐI TRONG S7-300

Organization Blocks in S7

- 1 Organization Blocks
 - 1.1 Overview of the Organization Blocks (OBs)
 - 1.2 Program Cycle Organization Block (OB1)
 - 1.3 Time-of-Day Interrupt Organization Blocks (OB10 to OB17)
 - 1.4 Time-Delay Interrupt Organization Blocks (OB20 to OB23)
 - 1.5 Cyclic Interrupt Organization Blocks (OB30 to OB38)
 - 1.6 Hardware Interrupt Organization Blocks (OB40 to OB47)
 - 1.7 Status Interrupt OB (OB 55)
 - 1.8 Update Interrupt OB (OB 56)
 - 1.9 Manufacturer Specific Interrupt OB (OB57)
 - 1.10 Multicomputing Interrupt Organization Block (OB60)
 - 1.11 Synchronous Cycle Interrupt OB (OB61)
 - 1.12 I/O Redundancy Error OB (OB70)
 - 1.13 CPU Redundancy Error OB (OB72)
 - 1.14 Communication Redundancy Error OB (OB73)
 - 1.15 Time Error Organization Block (OB80)
 - 1.16 Power Supply Error Organization Block (OB81)
 - 1.17 Diagnostic Interrupt Organization Block (OB82)
 - 1.18 Insert / Remove Module Interrupt Organization Block (OB83)
 - 1.19 CPU Hardware Fault Organization Block (OB84)
 - 1.20 Priority Class Error Organization Block (OB85)
 - 1.21 Rack Failure Organization Block (OB86)
 - 1.22 Communication Error Organization Block (OB87)
 - 1.23 Background Organization Block (OB90)
 - 1.24 Startup Organization Blocks (OB100, OB101 and OB102)
 - 1.25 Programming Error Organization Block (OB121)
 - 1.26 I/O Access Error Organization Block (OB122)

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Insert Organization Blocks in S7



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Cyclic Blocks (Cyclic Interrupt Blocks)

The screenshot shows the SIMATIC Manager HW Config interface. The 'Properties - CPU 314C-2 PN/DP - (R0/S2)' dialog box is open, displaying the 'Cyclic Interrupts' tab. A table lists the configuration for cyclic interrupt blocks OB30 through OB38. OB32, OB33, OB34, and OB35 are highlighted with a red box. OB35 is further detailed in a separate dialog box, showing its title as 'Cyclic Interrupt' and its network configuration.

Block	Priority	Execution	Phase offset	Unit	Process image partition
OB30	7	5000	0	ms	
OB31	8	2000	0	ms	
OB32	9	1000	0	ms	
OB33	10	500	0	ms	
OB34	11	200	0	ms	
OB35	12	1000	0	ms	
OB36	13	50	0	ms	
OB37	14	20	0	ms	
OB38	15	10	0	ms	

OB35 : "Cyclic Interrupt"

Comment:

Network 1: Title:

Comment:

```
L    QW    2
INVI
T    QW    2
```

OB32, OB33, OB34 Blocks are the same function as OB35

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Organization Blocks in S7

Startup Organization Blocks (OB100, OB101, OB102)

Types of Startup	OBs is called	Description
Warm restart	OB100	Program processing starts anew. Retentive data is retained
Cold restart	OB101	Current data is discarded and program processing begins again with start values
Hot restart	OB102	Once power is resumed, the program continues at the point at which it was interrupted.

Warm Restart (OB100)

Trigger a manual restart

- Via the mode selector switch
- Via menu command from the PG or via communication functions (if the mode selector switch is set to RUN or RUN-P).

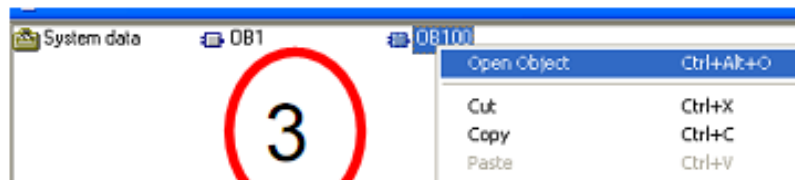
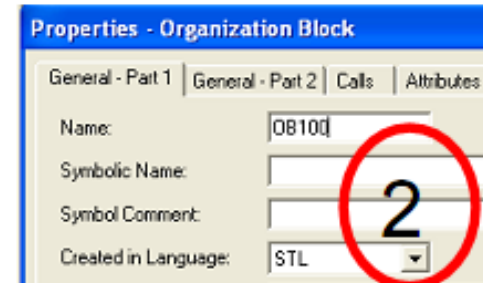
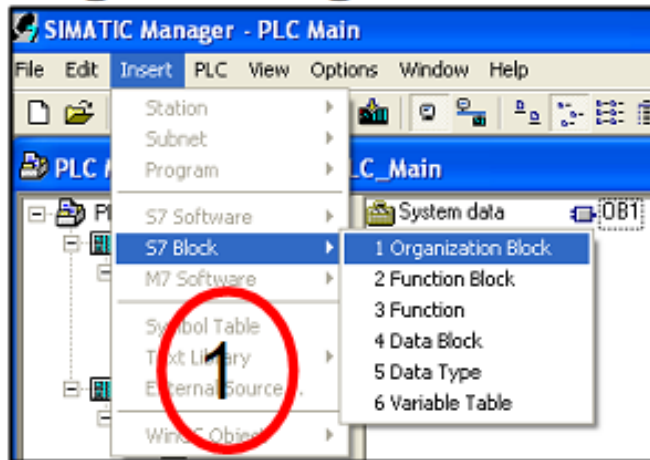
An **automatic restart**(warm restart) can be triggered at POWER ON if:

- The CPU was not in STOP at POWER OFF.
- The mode selector switch is set to RUN or RUN-P.

CÁC KHỐI TRONG S7-300

Organization Blocks in S7

Programming for OB100



```
OB100 : "Complete Restart"  
Comment:  
Network 1: Title:  
Comment:  
// CLEAR BITS FROM NO.0 TO NO.2  
CLR  
= M 0.0  
= M 0.1  
= M 0.2  
// SET BITS FROM M1.0 TO M1.2  
SET  
= M 1.0  
= M 1.1  
= M 1.2  
// RESET TO, CO  
R T 0  
R C 0  
// SET TIME VALUE TO T10  
L S5T#10S  
SD T 10
```



initial values of the system are programmed in OB100 ▲

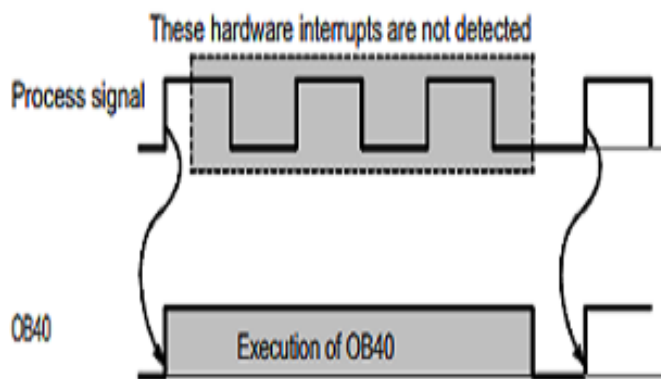
CÁC KHỐI TRONG S7-300

Organization Blocks in S7

Hardware Interrupt Organization Blocks(OB40 to OB47)

S7 provides up to eight independent hardware interrupts each with its own OB. By assigning parameters with STEP 7, you specify the following for each signal module that will trigger hardware interrupts:

- Which channels trigger a hardware interrupt under what conditions.
- Which hardware interrupt OB is assigned to the individual groups of channels (as default, all hardware interrupts are processed by OB40).



Properties - CPU 313C-2 DP - (R0/S7)

Time-of-Day Interrupts | Cyclic Interrupts | Diagnostics/Clock | Protection | Communication
General | Startup | Cycle/Clock Memory | Retentive Memory | **Interrupts**

Hardware Interrupts:

OB	Priority	Process image partition
OB40:	1E	---
OB41:	0	---
OB42:	0	---
OB43:	0	---
OB44:	0	---
OB45:	0	---
OB46:	0	---
OB47:	0	---

Time-Delay Interrupts:

OB	Priority	Process image partition
OB20:	3	---
OB21:	0	---
OB22:	0	---
OB23:	0	---

Async. Error Interrupts:

OB	Priority
OB81:	0
OB82:	26
OB83:	0
OB84:	0
OB85:	26
OB86:	26
OB87:	26
OB70:	
OB72:	
OB73:	

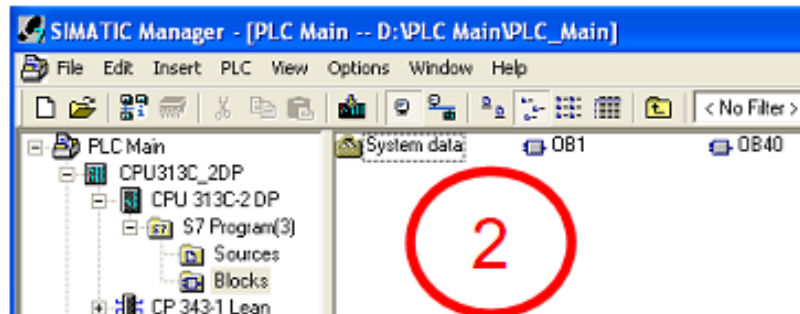
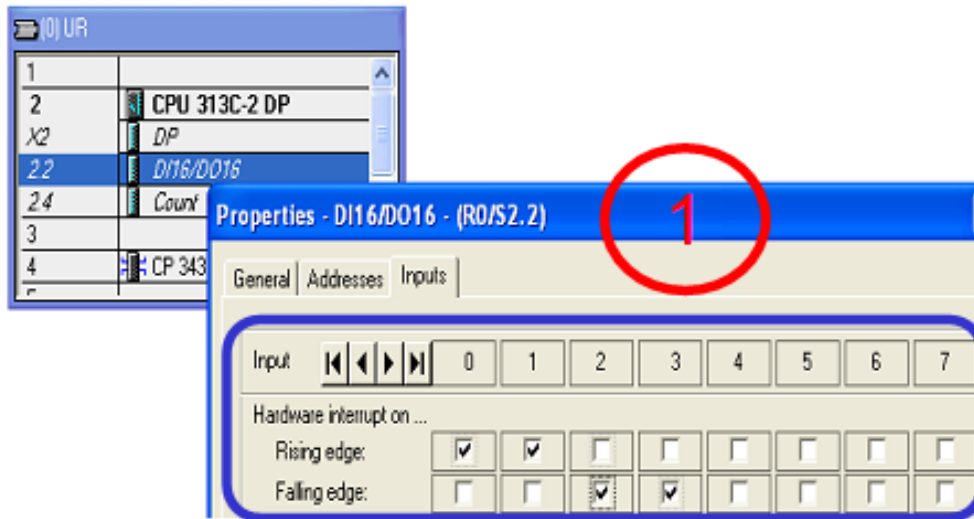
Interrupts for DPV1:

OB	Priority
OB55:	2
OB56:	2
OB57:	2

CÁC KHỐI TRONG S7-300

Organization Blocks in S7

Configuring, inserting and programming for hardware interrupt



OB40 : "Hardware Interrupt"

Comment:

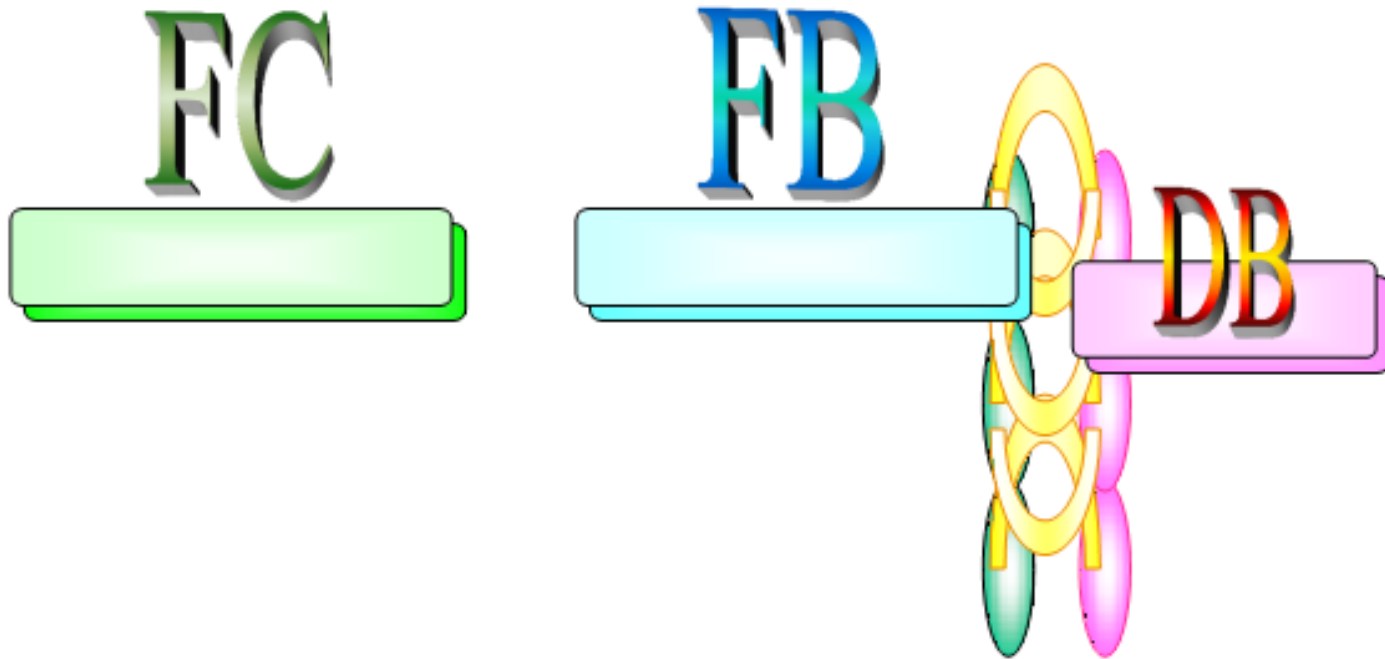
Network 1: Title:

Comment:

```
L      255
T      QB   124
// CHECK INPUT
L      #OB40_IN_ADDR
T      HW   100
// TEST INPUT 1
L      HW   100
L      1
==I
=      Q    125.0
// TEST INPUT 2
L      HW   100
L      2
==I
=      Q    125.1
```

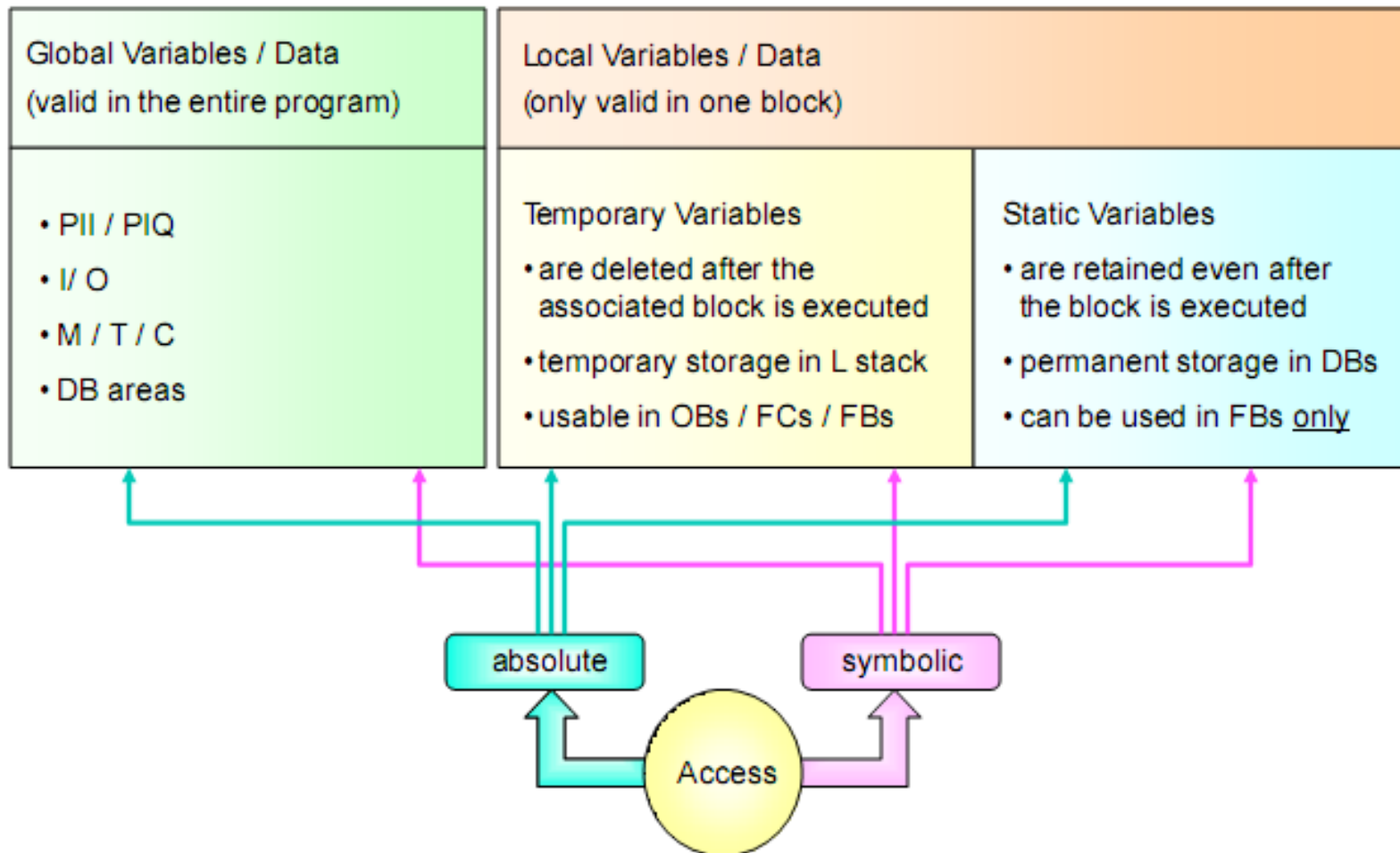

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Functions and Function Blocks



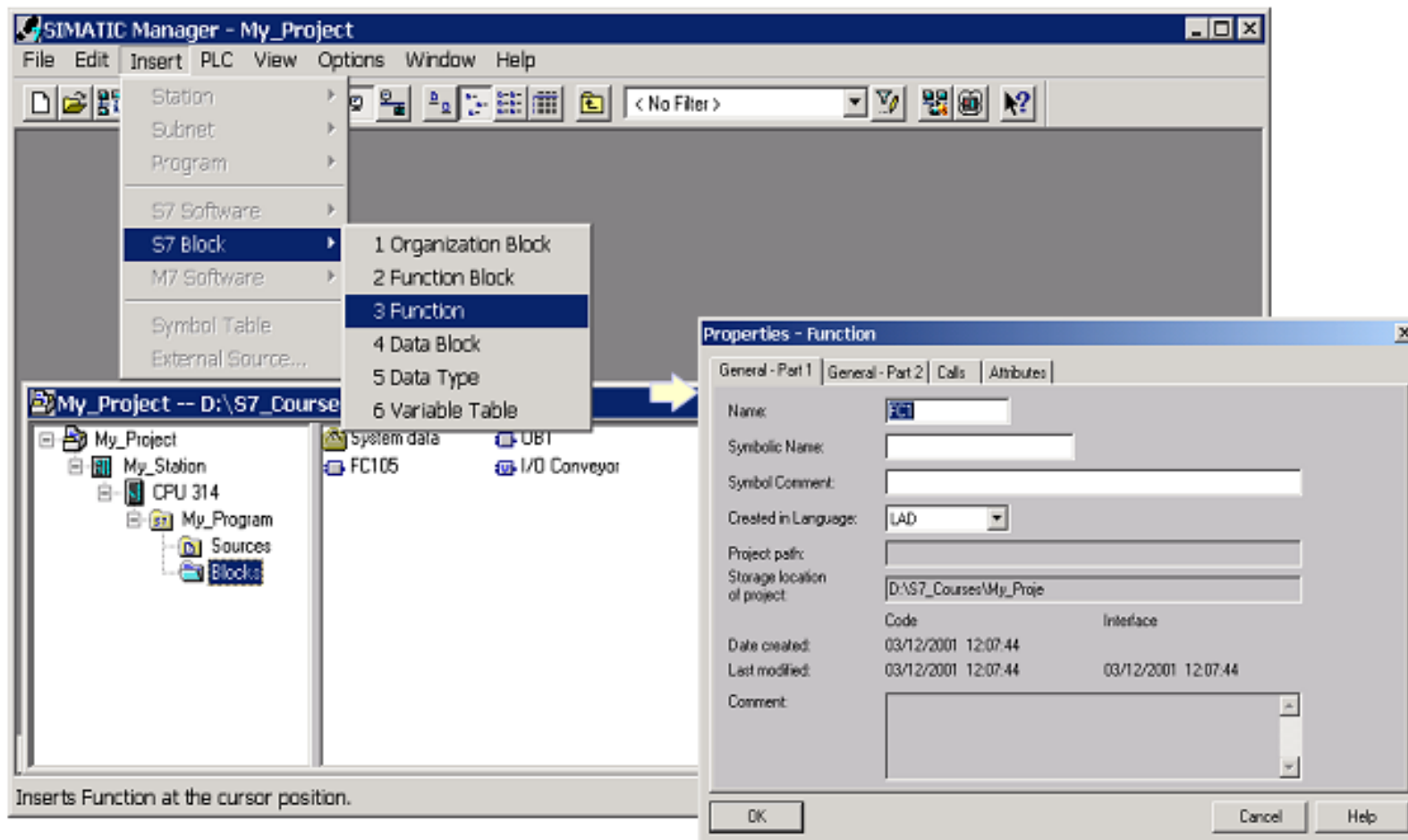
CÁC KHỐI TRONG S7-300

Variable Types



CÁC KHỐI TRONG S7-300

Inserting an Function



CÁC KHỐI TRONG S7-300

Starting the LAD/STL/FBD Editor

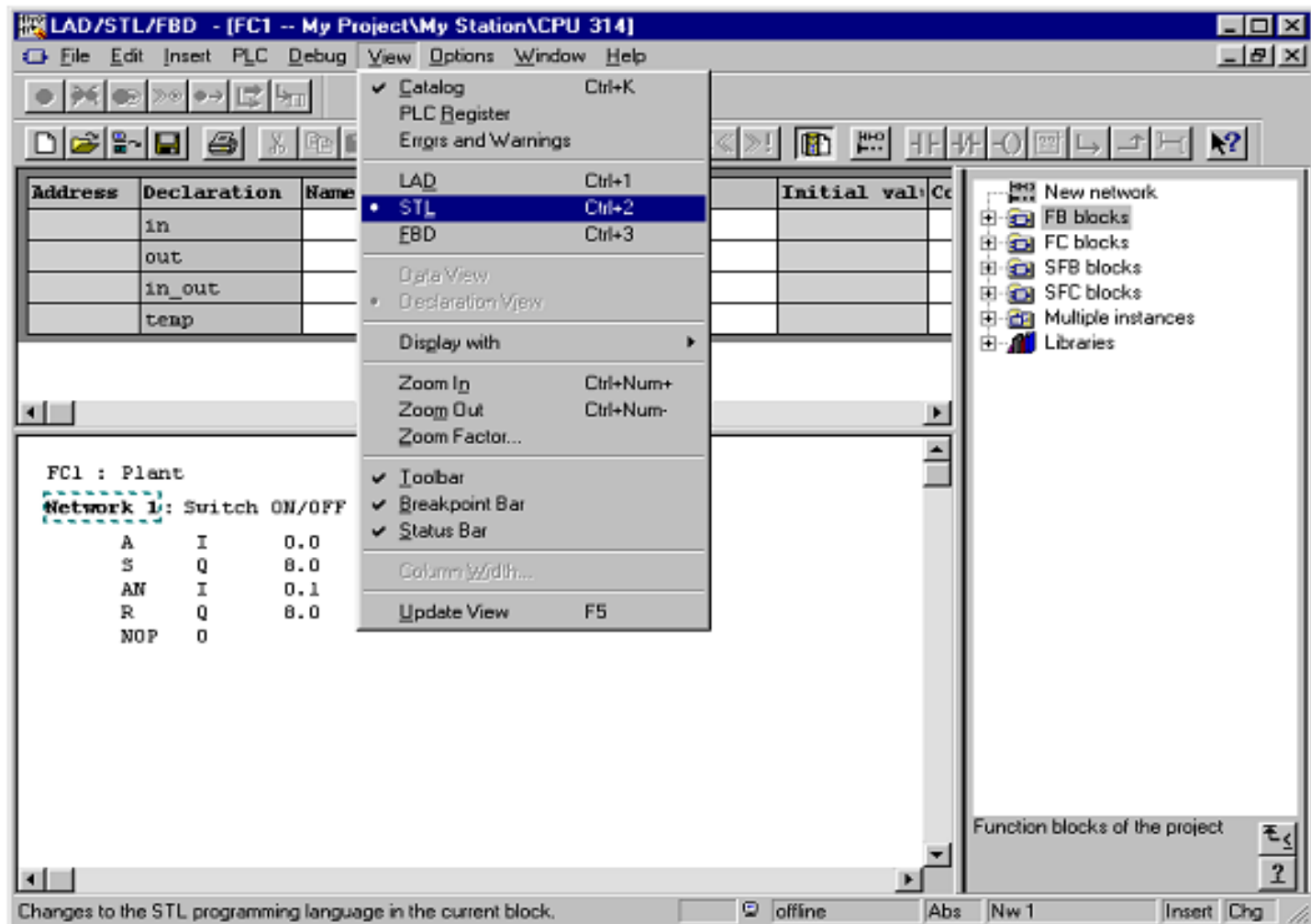
The screenshot displays the SIMATIC Manager interface for a project named 'My_Project'. The main window shows the LAD/STL/FBD Editor for a specific network. The interface is divided into several sections:

- Project Tree (1):** Located on the left, it shows the project structure including 'My_Project', 'My_Station', 'CPU 314', 'My_Program', 'Sources', and 'Blocks'. A red circle labeled '1' highlights this tree.
- Main Editor Window:** The central window displays the LAD/STL/FBD Editor for 'FC1'. It includes a table for variable declarations and a network editor area.
- Table:** A table with columns for 'Address', 'Declaration', 'Name', 'Type', 'Initial val.', and 'Comment'. The rows contain: 'in', 'out', 'in_out', and 'temp'.
- Network Editor:** Below the table, there are input fields for 'FC1 : Title:', 'Comment:', 'Network 1: Title:', and 'Comment:'. A red circle labeled '2' highlights the 'Network 1: Title:' field.
- Program Elements Palette (3):** A separate window on the right lists various logic blocks and functions. A red circle labeled '3' highlights this palette.

Arrows indicate the flow of information: a blue arrow points from the project tree to the main editor window, and a green arrow points from the main editor window to the 'Program elements' palette.

CÁC KHỐI TRONG S7-300

Selecting the Programming Language and write logic



CÁC KHỐI TRONG S7-300

Programming in Ladder and Statement list

The image displays two windows from the SIMATIC Manager software, illustrating the Ladder and Statement list views for a PLC program.

Top Window (Ladder View): The title bar reads "LAD/STL/FBD - [FC1 -- My_Project\My_Station\CPU 315-2 DP]". The main area shows a Ladder Logic network labeled "Network 1: System ON". It features two normally open contacts labeled "I0.0" and "I0.1" connected in parallel to the "S" (Set) input of a Set-Reset (SR) coil. The coil is labeled "Q4.1". A normally closed contact labeled "I0.1" is connected to the "R" (Reset) input of the same SR coil. The output of the coil is labeled "Q". A red box labeled "Ladder" is overlaid on the diagram.

Bottom Window (Statement List View): The title bar also reads "LAD/STL/FBD - [FC1 -- My_Project\My_Station\CPU 315-2 DP]". The main area shows the Statement List (STL) for "Network 1: System ON". The code is as follows:

Address	Declaration	Name	Type	Initial value	Comment
	in				
	out				
	in_out				
	temp				

Address	Declaration	Name	Type	Initial value	Comment
	in				
	out				
	in_out				
	temp				


```
FC1 : Operating Mode Section
Network 1: System ON
A   I   0.0
S   Q   4.1
AN  I   0.1
R   Q   4.1
NOP  0
```

A red box labeled "Statement list" is overlaid on the code.

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Calling a Block in OB1

LAD/STL/FBD - [OB1 -- My_Project\My_Station\CPU 314]

File Edit Insert PLC Debug View Options Window Help

OB1 : "Main Program Sweep (Cycle)"

Network 1: Call FC 1 in LAD

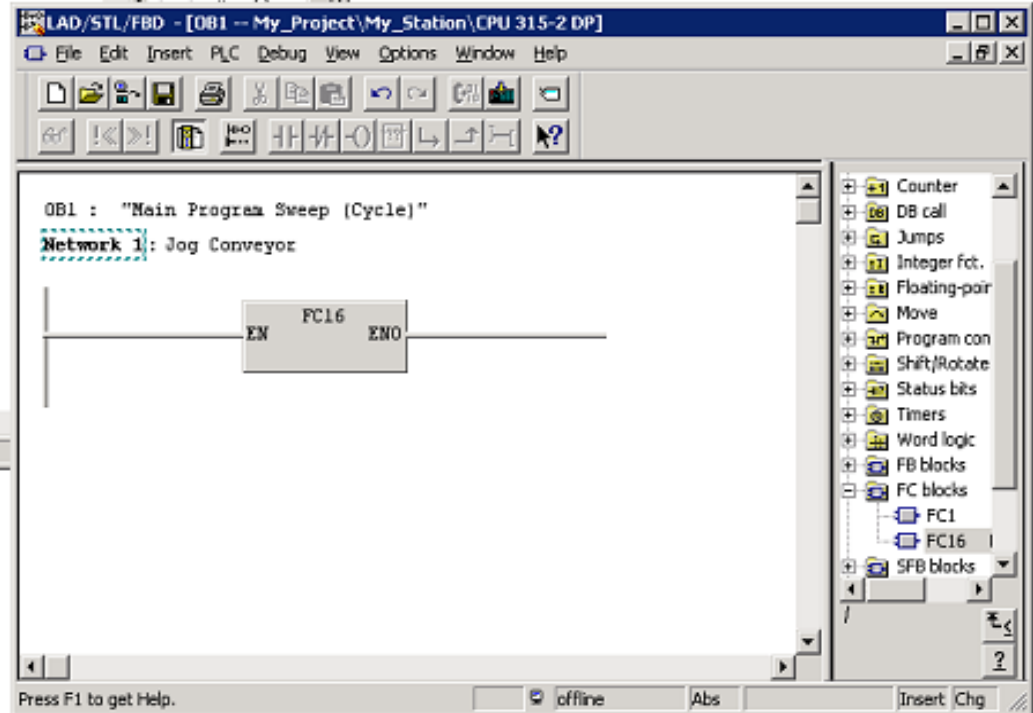
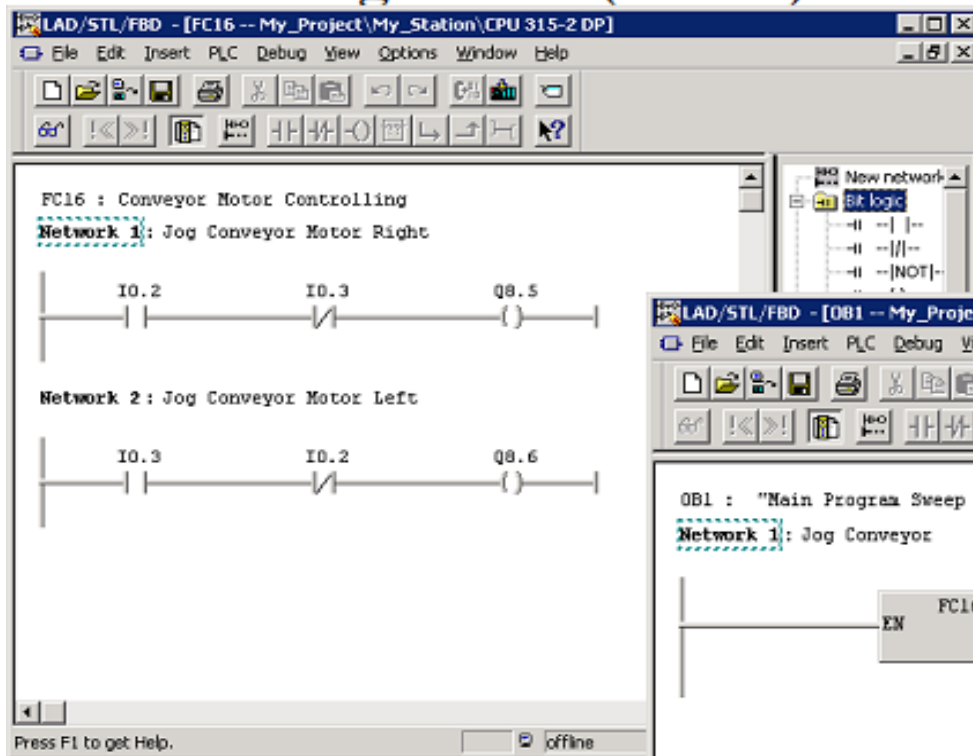
Network 2: Call FC 1 in STL

```
CALL FC 1
```

Press F1 to get Help. offline Abs Nw 1 Insert Chg

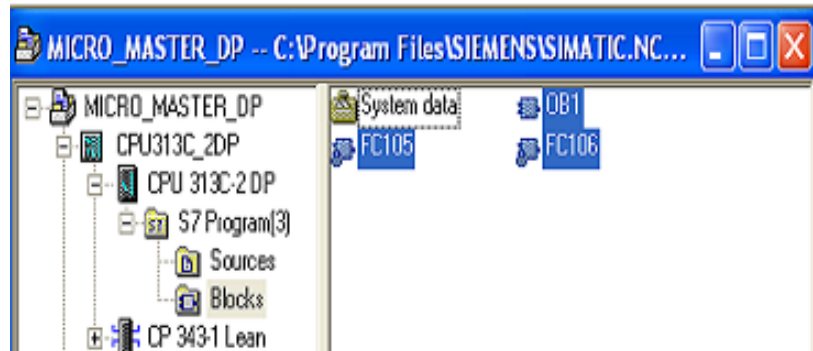
CÁC KHỐI TRONG S7-300

Exercise: Jog Motor (FC 16)



CÁC KHỐI TRONG S7-300

Exercise: Calling FC105 and FC106 from OB1



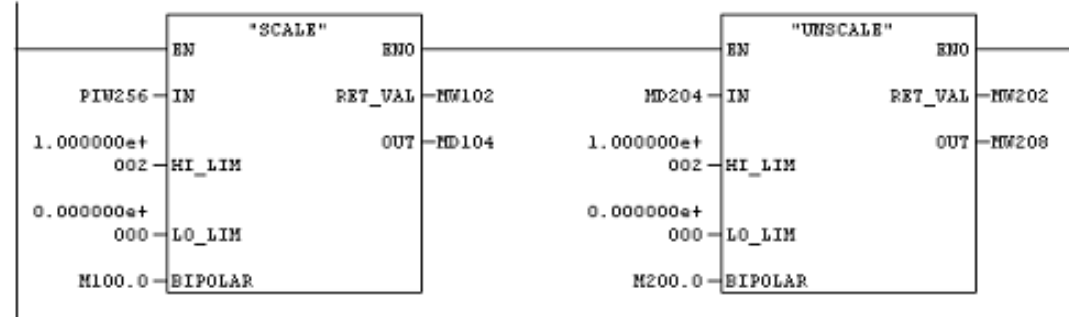
- FC84 ATT TABLE
- FC85 FIFO TABLE
- FC86 TBL_FIND TABL
- FC87 LIFO TABLE
- FC88 TBL TABLE
- FC89 TBL_WRD TABL
- FC90 WSR SHIFT
- FC91 WRD_TBL TABL
- FC92 SHRB SHIFT
- FC93 SEG CONVERT
- FC94 ATH CONVERT
- FC95 HTA CONVERT
- FC96 ENCO CONVER1
- FC97 DECO CONVER1
- FC98 BCDCPL CONVE
- FC99 BITSUM CONVEI
- FC100 RSETI BIT_LO
- FC101 SETI BIT_LOGI
- FC102 DEV MATH_FP
- FC103 CDT TABLE
- FC104 TBL_TBL TABL
- FC105 SCALE CONVE
- FC106 UNSCALE CON

OB1 : "Main Program Sweep (Cycle)"

Comment:

Network 1: Title:

Comment:



CÁC KHỐI TRONG S7-300

System Function Blocks in S7

Reading the time with SFC 1_READ-CLOCK

SFC1: Read System Clock, current day and time of the system clock are read out and stored in the BCD format in 8 bytes

This data covers the range **DT#1990-1-1-0:0:0.0 to DT#2089-12-31-23:59:59.999**

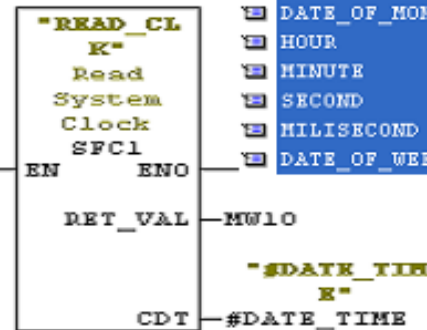
Byte	Contents	Example
0	Year	B#16#04
1	Month	B#16#08
2	Day	B#16#05
3	Hour	B#16#08
4	Minute	B#16#05
5	Second	B#16#05
6	The two highest value digits of MSEC	B#16#25
7 (4 MSB)	The two lowest value digits of MSEC	B#16#0
7 (4 LSB)	Day of week: 1: Sunday, 2: Monday, 3: Tuesday, 4: Wednesday, 5: Thursday, 6: Friday, 7: Saturday	B#16#5

CÁC KHỐI TRONG S7-300

System Function Blocks in S7

Calling SFC 1 READ-CLK

The screenshot shows the SIMATIC Manager interface. On the left, the project tree is visible, with 'S7 Program(3)' highlighted under 'CPU 313C-2 DP'. On the right, the 'Blocks' view shows 'SFC1' selected. Below the blocks view, a list of system function blocks (SFC1 to SFC13) is shown, with 'SFC1 READ_CLK CLK' highlighted.



DATE_TIME	Date And Time	20.0
YEAR	Byte	28.0
MONTH	Byte	29.0
DATE_OF_MONTH	Byte	30.0
HOURL	Byte	31.0
MINUTE	Byte	32.0
SECOND	Byte	33.0
MILLISECOND	Byte	34.0
DATE_OF_WEEK	Byte	35.0

Network 2: Title:

Comment:

```

LARI P#DATE_TIME
L B [AR1,P#0.0]
T #YEAR
L B [AR1,P#1.0]
T #MONTH
L B [AR1,P#2.0]
T #DATE_OF_MONTH
L B [AR1,P#3.0]
T #HOURL
L B [AR1,P#4.0]
T #MINUTE
L B [AR1,P#5.0]
T #SECOND
L B#16#F
L B [AR1,P#7.0]
AW
T #DATE_OF_WEEK
    
```

CÁC KHỐI TRONG S7-300

System Function Blocks in S7

Calling SFC 1 READ-CLOCK

The screenshot displays the SIMATIC Manager interface for configuring a System Function Block (SFC1) in an S7-300 PLC. The left pane shows the project tree with 'S7 Program(3)' selected. The middle pane lists available SFCs, with 'SFC1 READ_CLK CLK' highlighted. The right pane shows the configuration table for SFC1, listing parameters such as DATE_TIME, YEAR, MONTH, DATE_OF_MONTH, HOUR, MINUTE, SECOND, MILLISECOND, and DATE_OF_WEEK with their respective data types and addresses. Below the configuration table, the ladder logic for the SFC1 call is shown, including a network with a title and a comment, and a ladder logic network with logic involving DATE_TIME and various bit addresses.

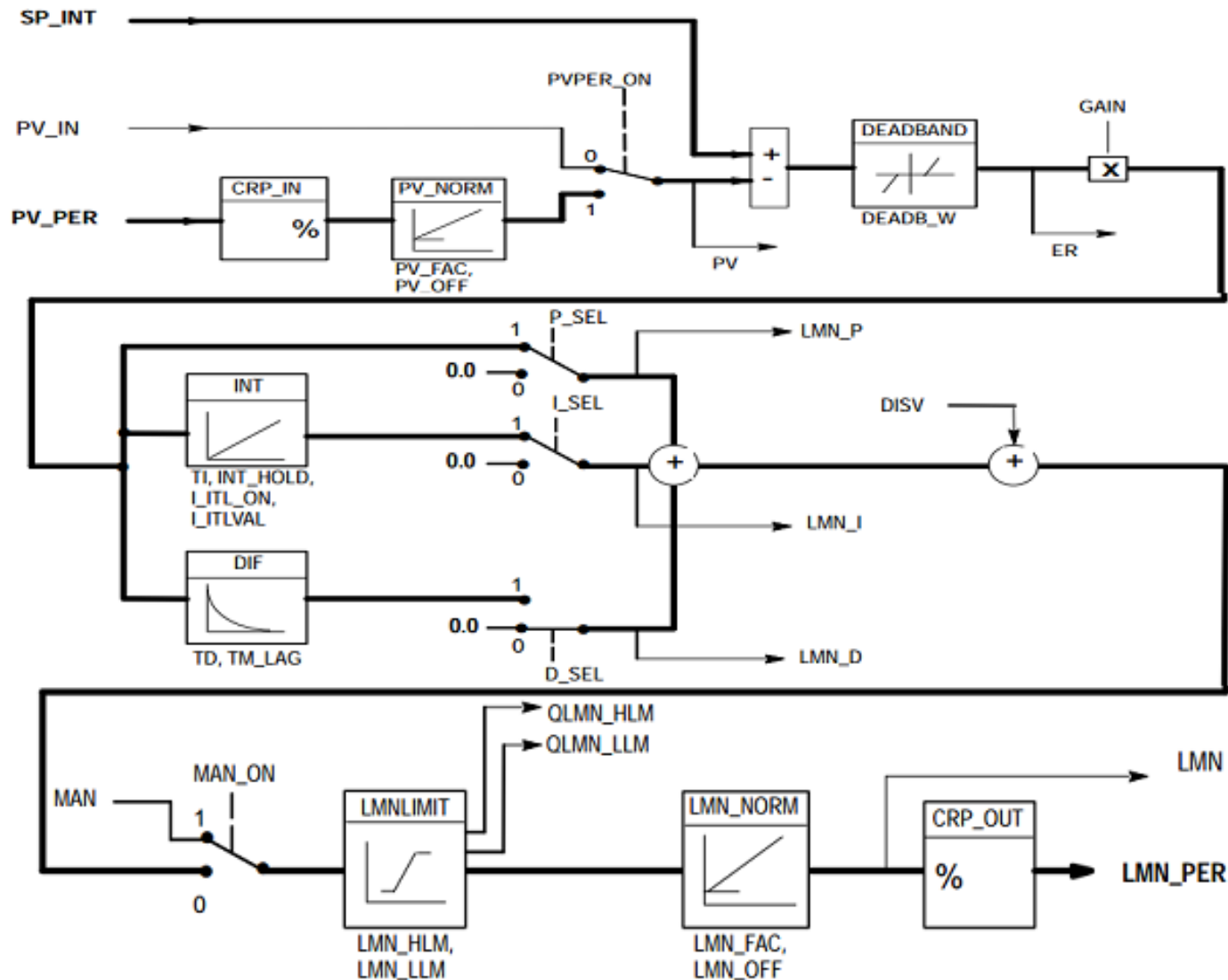
Parameter	Data Type	Address
DATE_TIME	Date And Time	20.0
YEAR	Byte	28.0
MONTH	Byte	29.0
DATE_OF_MONTH	Byte	30.0
HOUR	Byte	31.0
MINUTE	Byte	32.0
SECOND	Byte	33.0
MILLISECOND	Byte	34.0
DATE_OF_WEEK	Byte	35.0

```
CALL SFC 1          READ_CLK          -- Read System Clock
RBT_VAL:=MW10
CDT    :=#DATE_TIME #DATE_TIME
NOP    0
```

Network 2: Title:
Comment:

```
LARI P#DATE_TIME
L   B [ARI,P#0.0]
T   #YEAR
L   B [ARI,P#1.0]
T   #MONTH
L   B [ARI,P#2.0]
T   #DATE_OF_MONTH
L   B [ARI,P#3.0]
T   #HOUR
L   B [ARI,P#4.0]
T   #MINUTE
L   B [ARI,P#5.0]
T   #SECOND
L   B#16#F
L   B [ARI,P#7.0]
AN
T   #DATE_OF_WEEK
```


CÁC KHỐI TRONG S7-300



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The screenshot displays the SIMATIC Manager interface. On the left, the project tree shows the hierarchy: PLC Main > CPU313C_20P > CPU 313C-2 DP > S7 Program(3) > Sources > Blocks. The 'System data' window is open, showing OB1, OB35, FB41, and DB41. The 'FB41' block is selected, and its parameter list is shown on the right.

FB41
Continuous Control
"CONT_C"

Parameter	Value
EN	BNO
M100.0 - COM_RST	LMN - MD210
M100.1 - MAN_ON	LMN_PER - MW220
M100.2 - PVPER_ON	QLMN_HLM - ...
M100.3 - P_SEL	QLMN_LLM - ...
M100.4 - I_SEL	LMN_P - ...
M100.5 - INT_HOLD	LMN_I - ...
M100.6 - I_ITL_ON	LMN_D - ...
M100.7 - D_SEL	PV - MD200
... - CYCLE	ER - ...
MD160 - SP_INT	
MD150 - PV_IN	
MW148 - PV_PER	
MD140 - MAN	
MD130 - GAIN	
MD150 - TI	