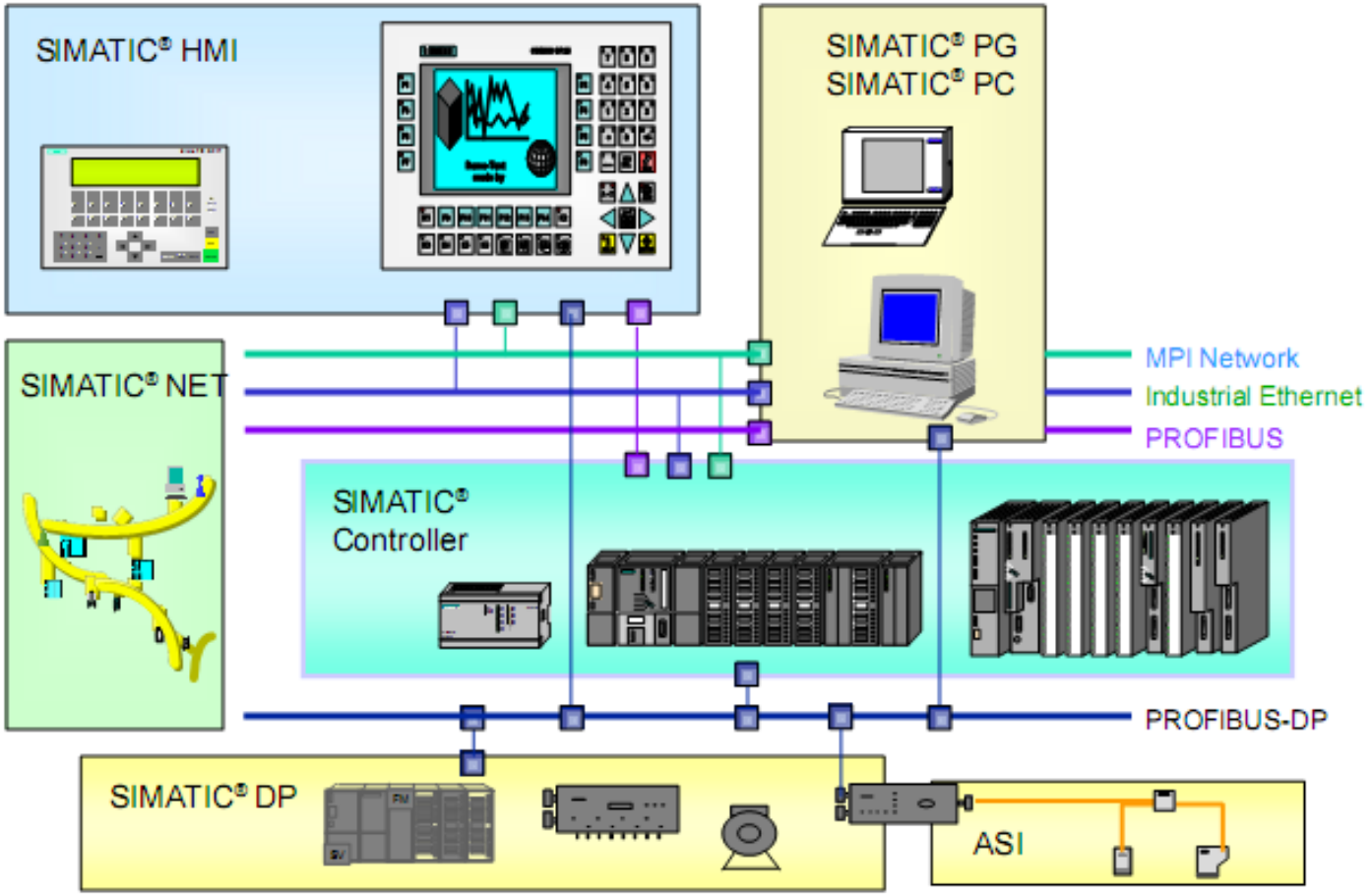
GIÁO TRÌNH LẬP TRÌNH PLC 2

CHƯƠNG I: TỔNG QUAN

1.1 GIỚI THIỆU PLC S7 - 300

GIỚI THIỆU PLC S7 - 300

Tổng quan về S7:



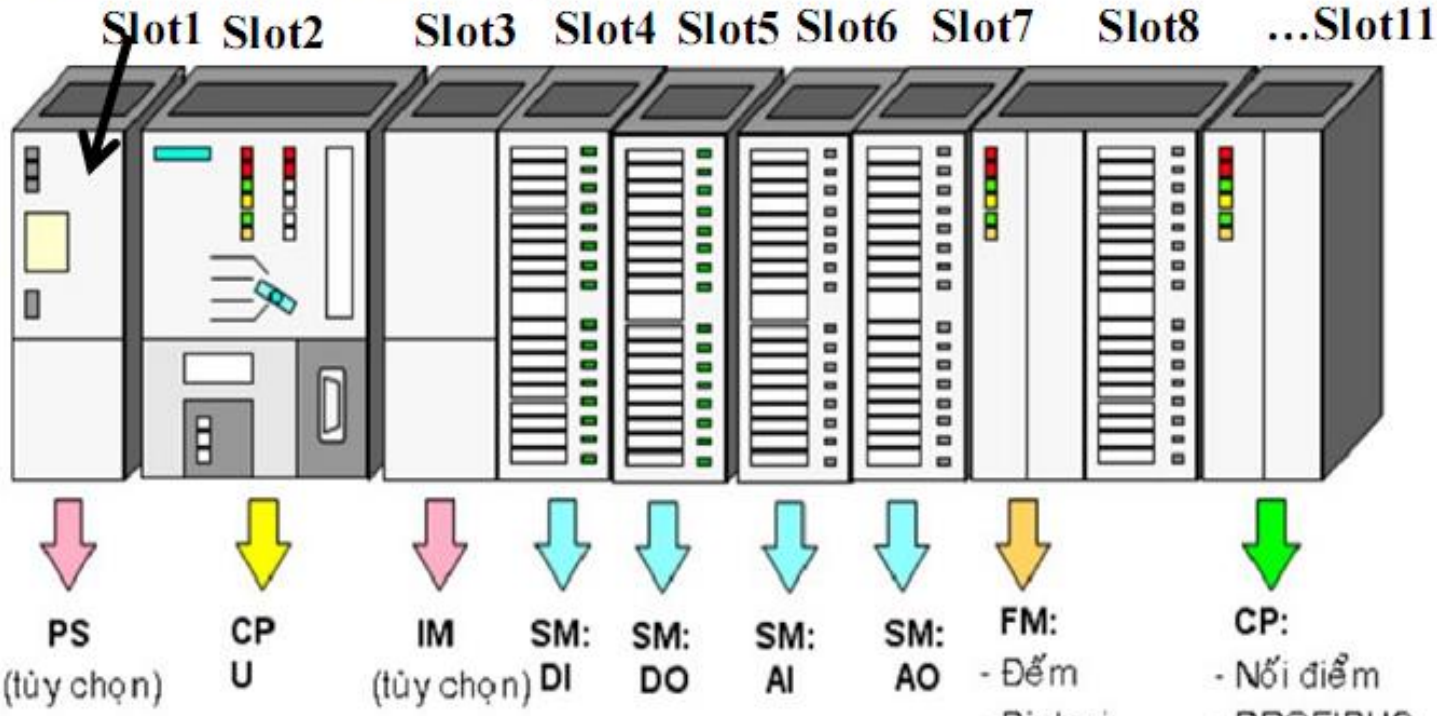
GIÁO TRÌNH LẬP TRÌNH PLC 2

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



Slot1: Tùy chọn

Slot2: Được sử dụng để khai báo CPU

Slot3: Interface Moule dùng để mở rộng rack

Slot1 4 đến Slot11: SM,FM,CP..

PHẦN CỨNG BỘ ĐIỀU KHIỂN PLC S7 - 300

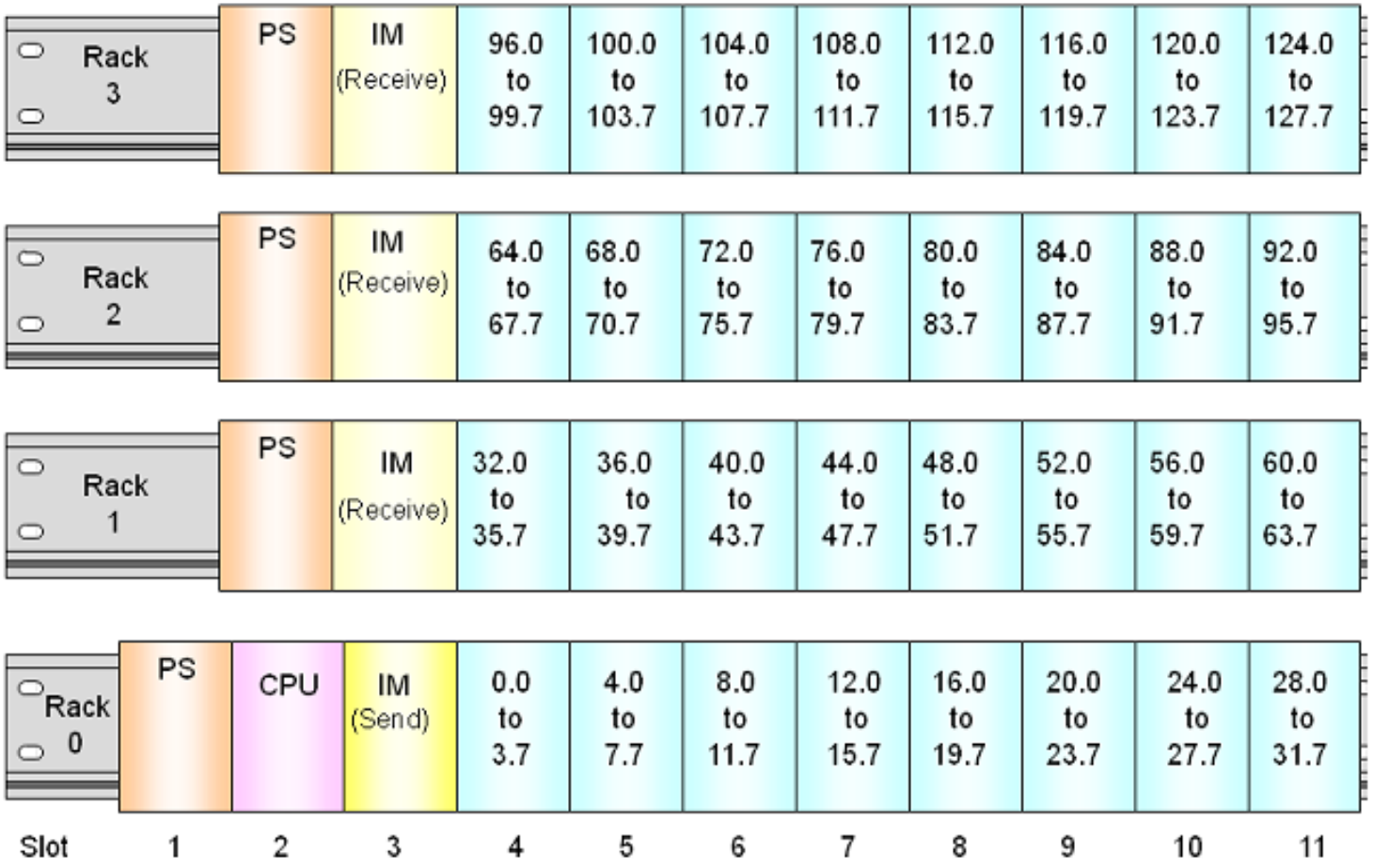
Mở rộng Rack cho PLC S7 300

S7300 có khả năng mở rộng 4 Rack, 32 moulde

IM(Interface Module) được sử dụng để mở rộng rack.

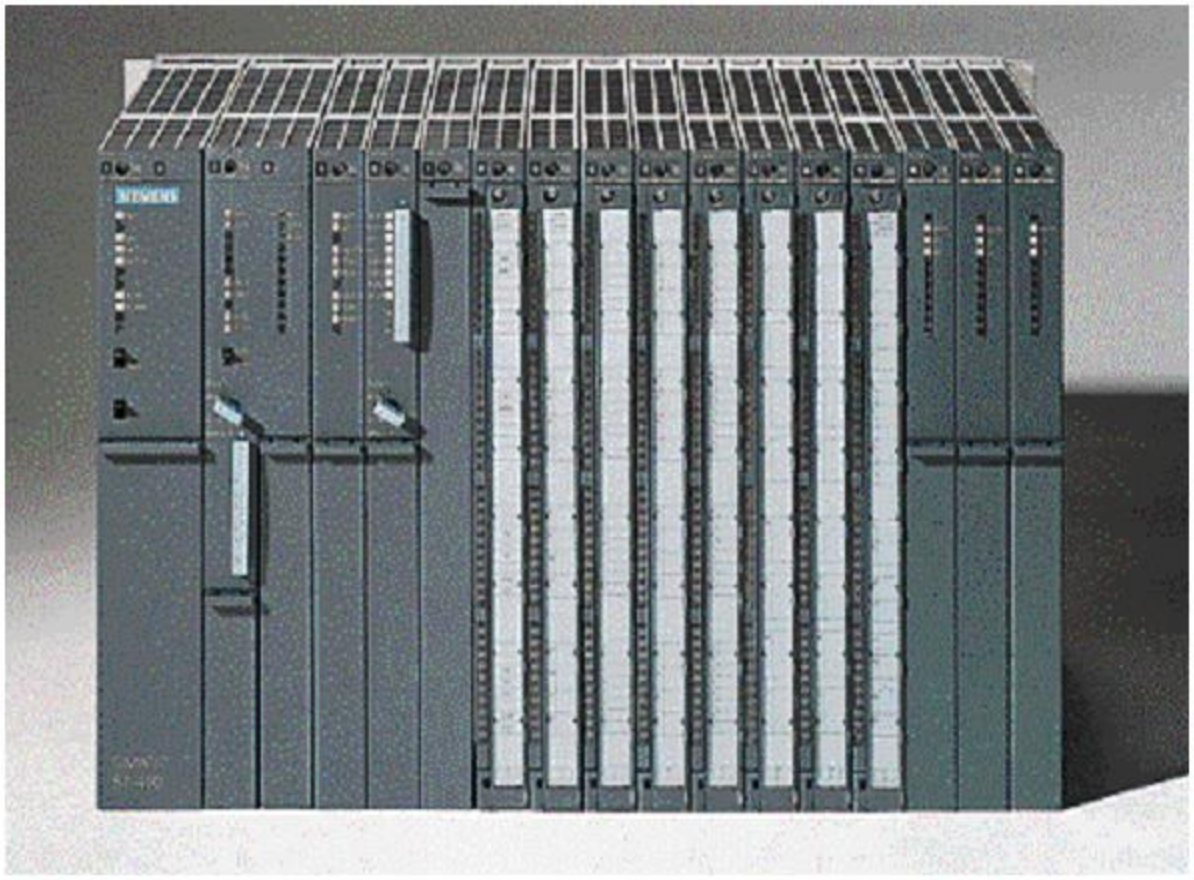
PHẦN CỨNG BỘ ĐIỀU KHIỂN PLC S7 - 300

Địa chỉ mặc định của các module



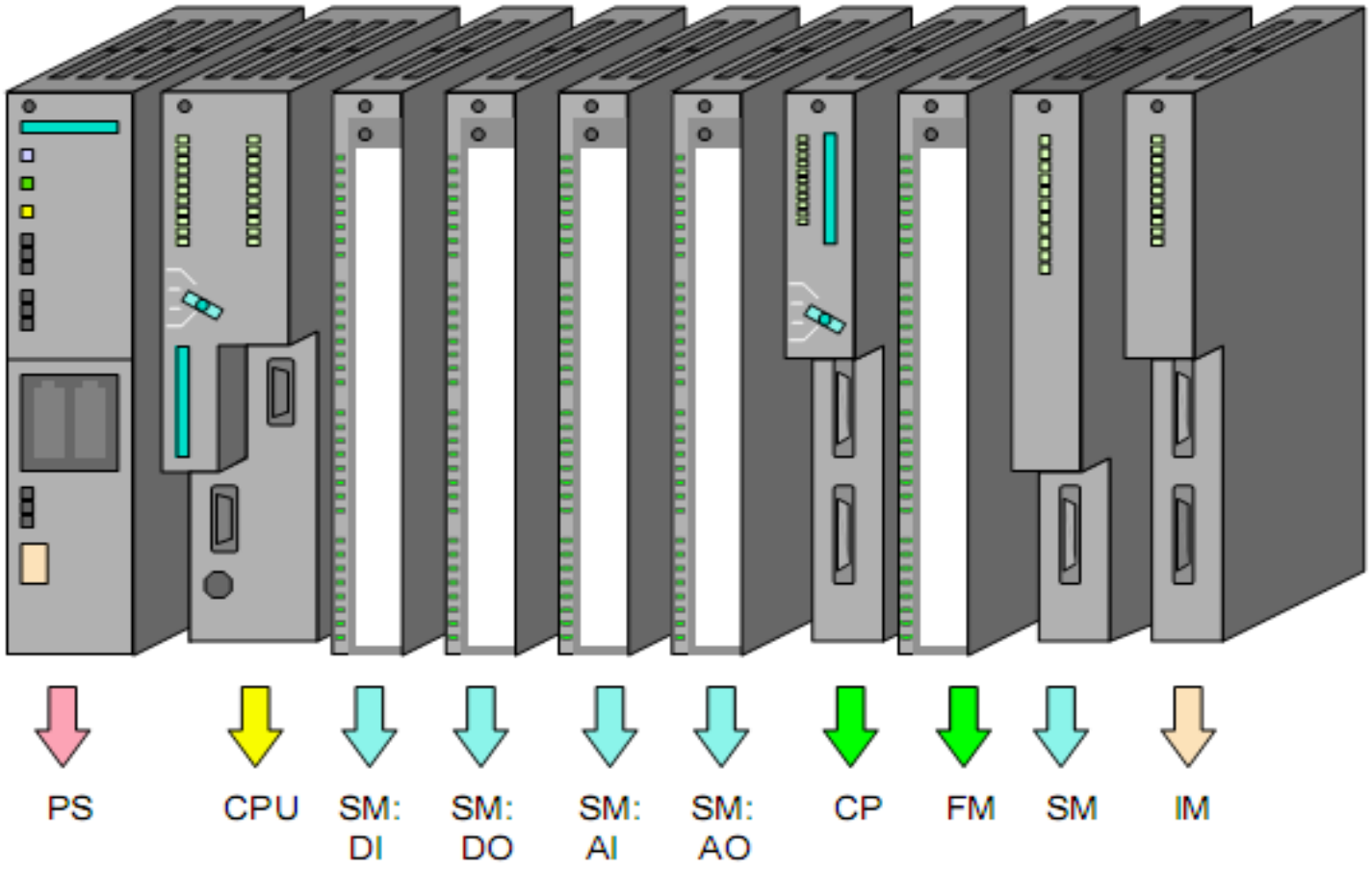
PHẦN CỨNG BỘ ĐIỀU KHIỂN PLC S7 - 300

S7- 400:



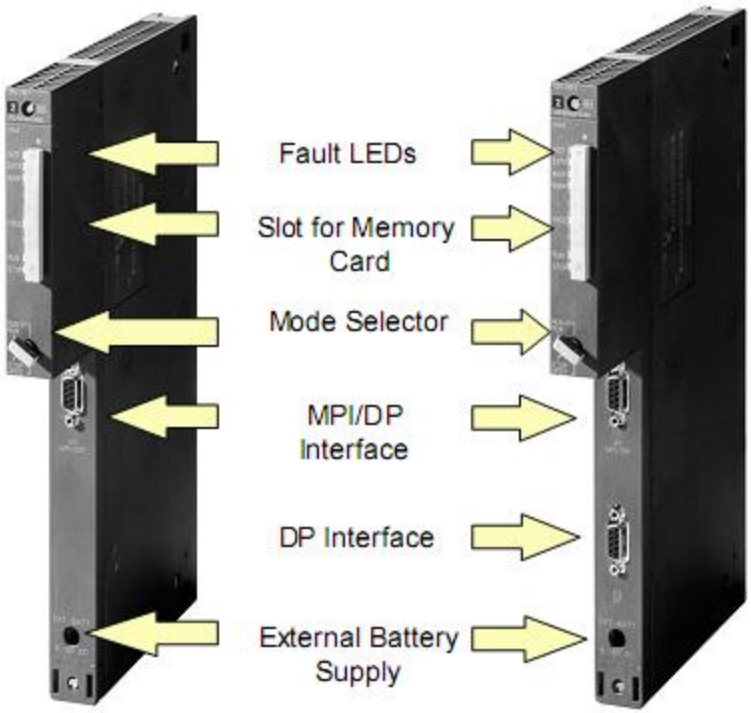
PHẦN CỨNG BỘ ĐIỀU KHIỂN PLC S7 - 300

S7-400: Modules



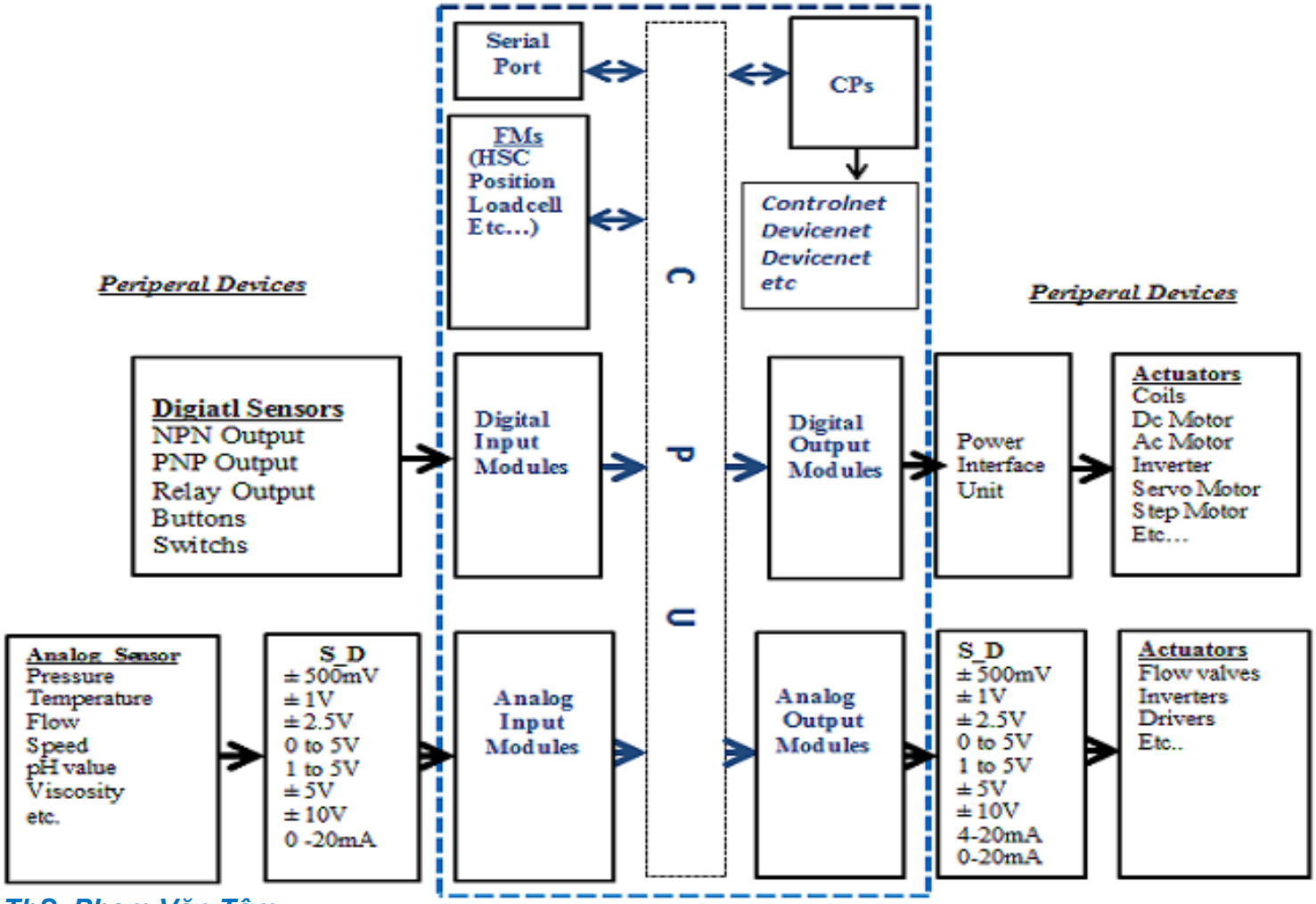
PHẦN CỨNG BỘ ĐIỀU KHIỂN PLC S7 - 300

S7-400: CPU Design

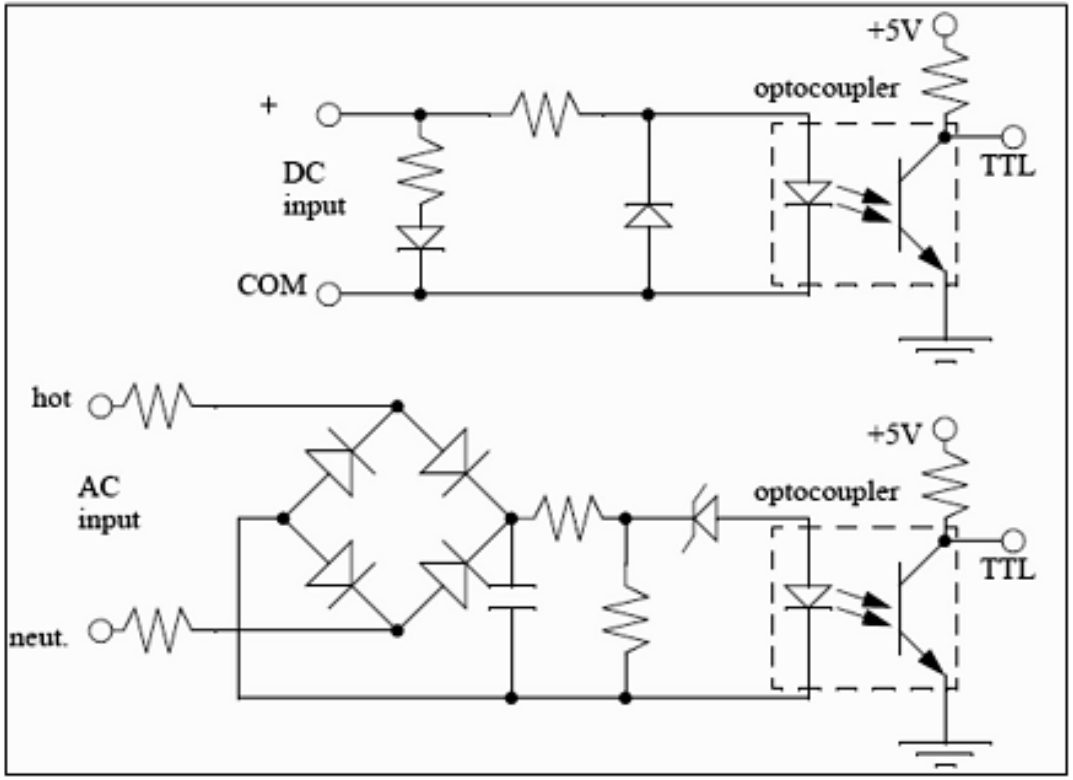


PHẦN CỨNG BỘ ĐIỀU KHIỂN PLC S7 - 300

CẤU TRÚC TỔNG QUÁT CỦA PLC



CẤU TRÚC MẠCH NGÕ VÀO CỦA MODULE SỐ

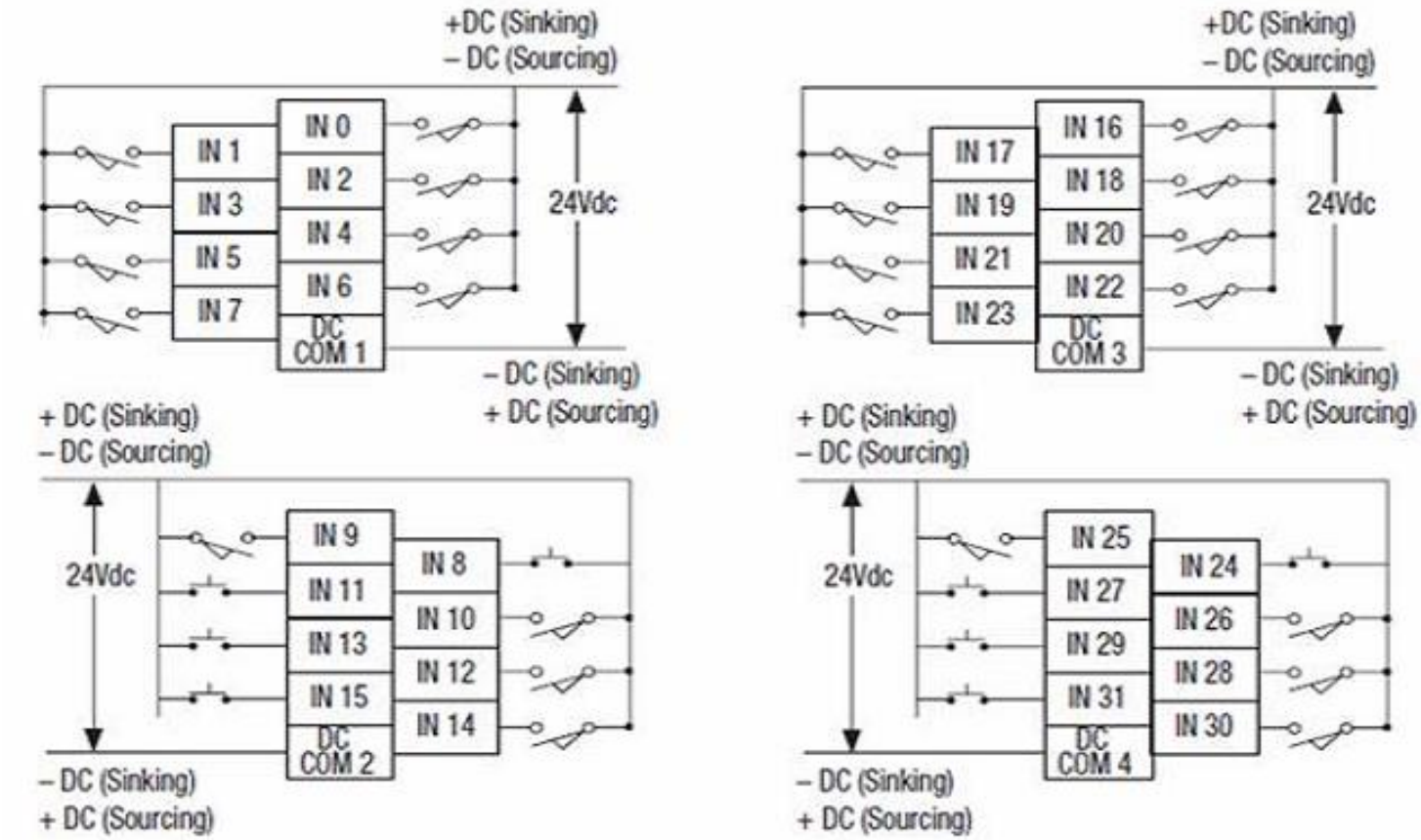


Mạch điện ngõ vào số của PLC Siemens

PHẦN CỨNG BỘ ĐIỀU KHIỂN PLC S7 - 300

KẾT NỐI NGÕ VÀO CHO MODULES

Kết nối kiểu Sinking/Sourcing cho module ngõ vào DC



CẤU TRÚC MẠCH NGÕ VÀO CỦA MODULE SỐ

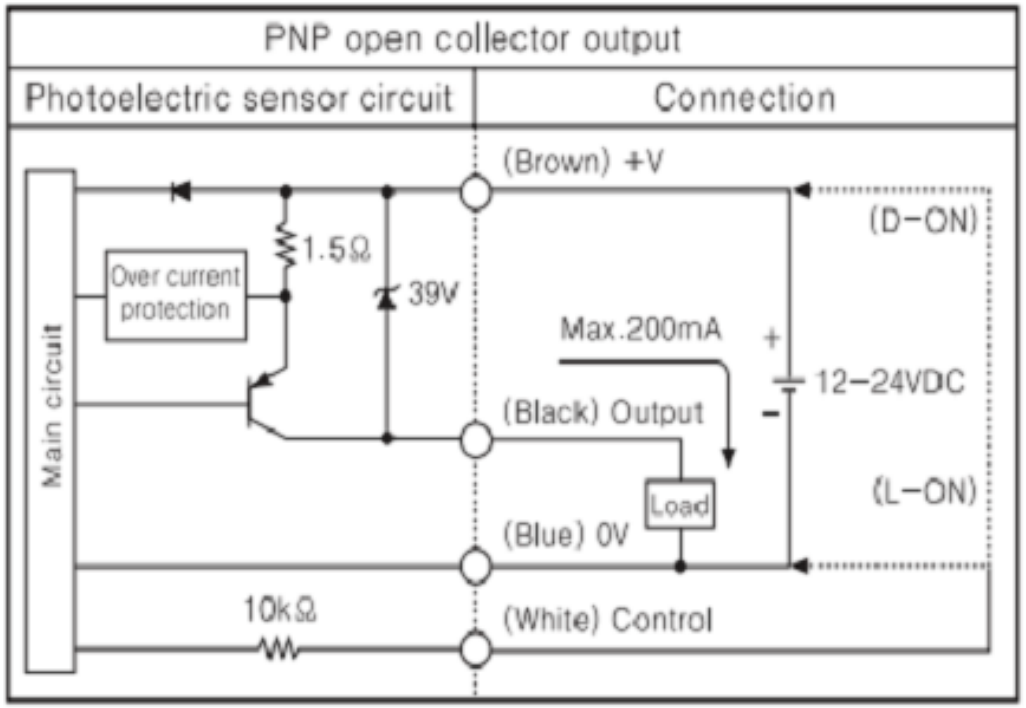
Nhận xét:

- 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 dãy 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

KẾT NỐI NGÕ VÀO CHO MODULE SỐ

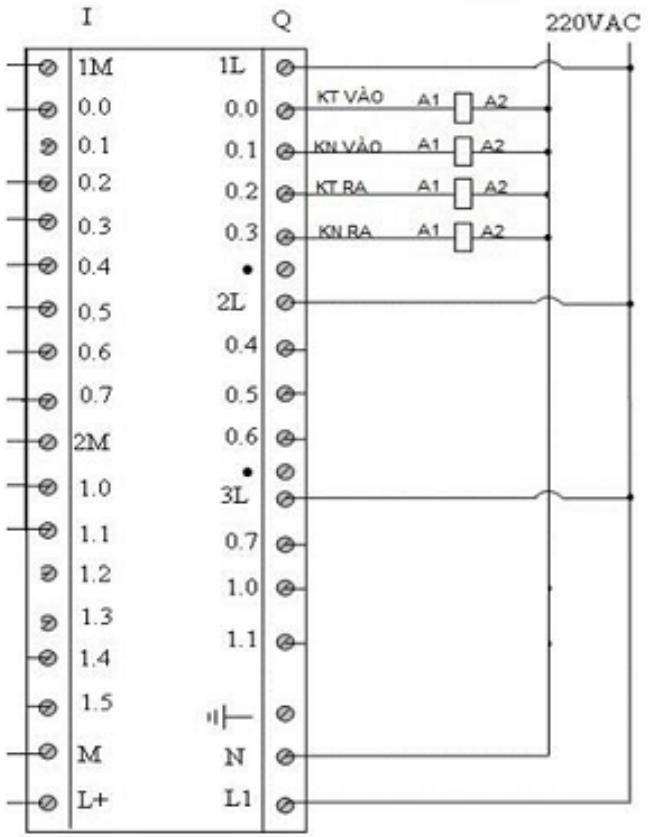
Ex1: Kết nối cảm biến có ngõ ra PNP với module ngõ vào số

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



KẾT NỐI NGÕ VÀO CHO MODULE SỐ

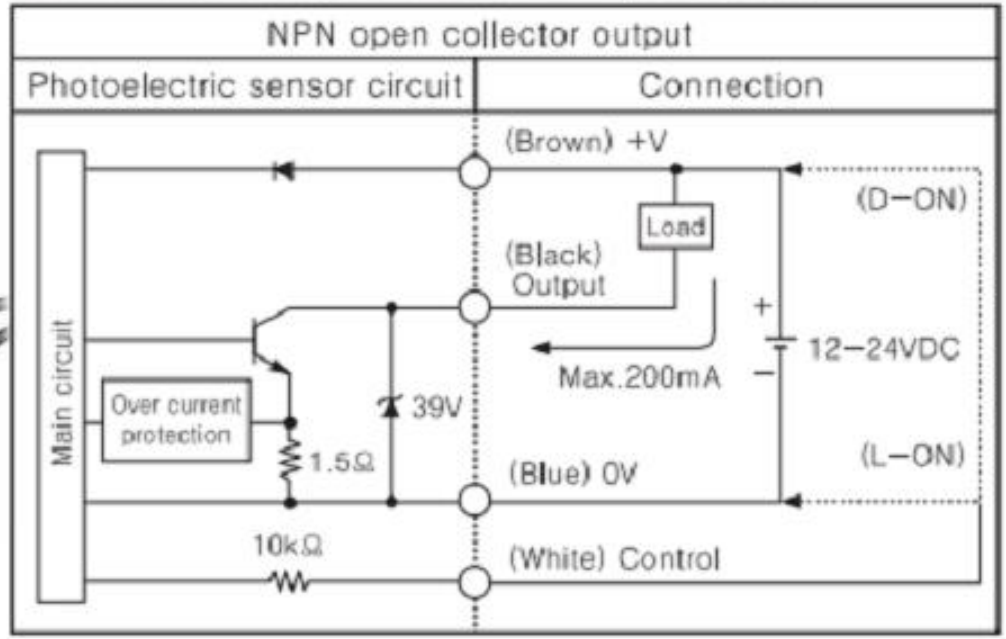
Ex1: Kết nối cảm biến có ngõ ra PNP với module ngõ vào số



KẾT NỐI NGÕ VÀO CHO MODULE SỐ

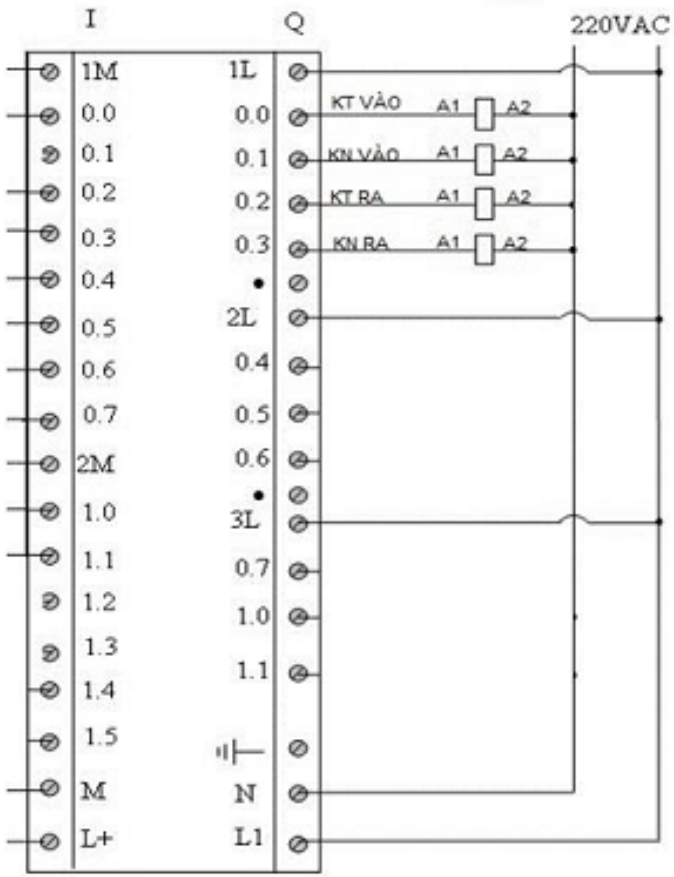
Ex2: Kết nối cảm biến có ngõ ra NPN với module ngõ vào số

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



KẾT NỐI NGÕ VÀO CHO MODULE SỐ

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



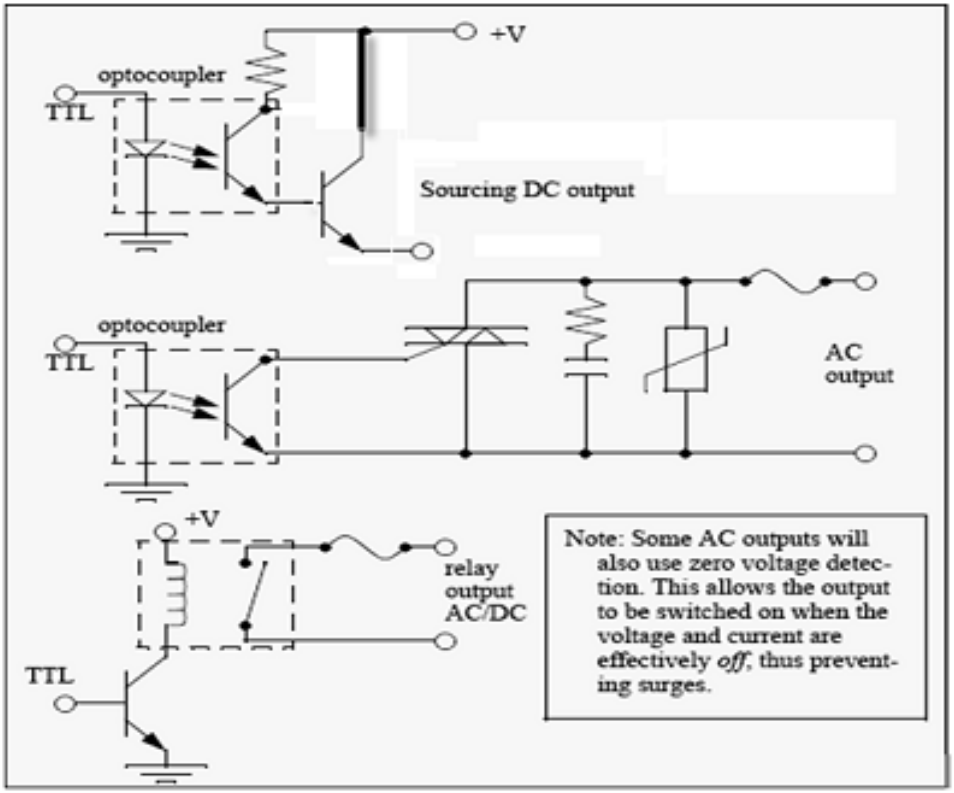
PHẦN CỨNG BỘ ĐIỀU KHIỂN PLC S7 - 300

DIGITAL OUPUT MODULES

- Những PLC cở nhỏ(S7200): Ngõ ra thường được tích hợp sẳn với CPU.
- Những PLC cở 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

CẤU TRÚC MẠCH NGÕ RA CỦA MODULE SỐ



Ngõ ra số của PLC siemens.

CẤU TRÚC MẠCH NGÕ RA CỦA MODULE SỐ

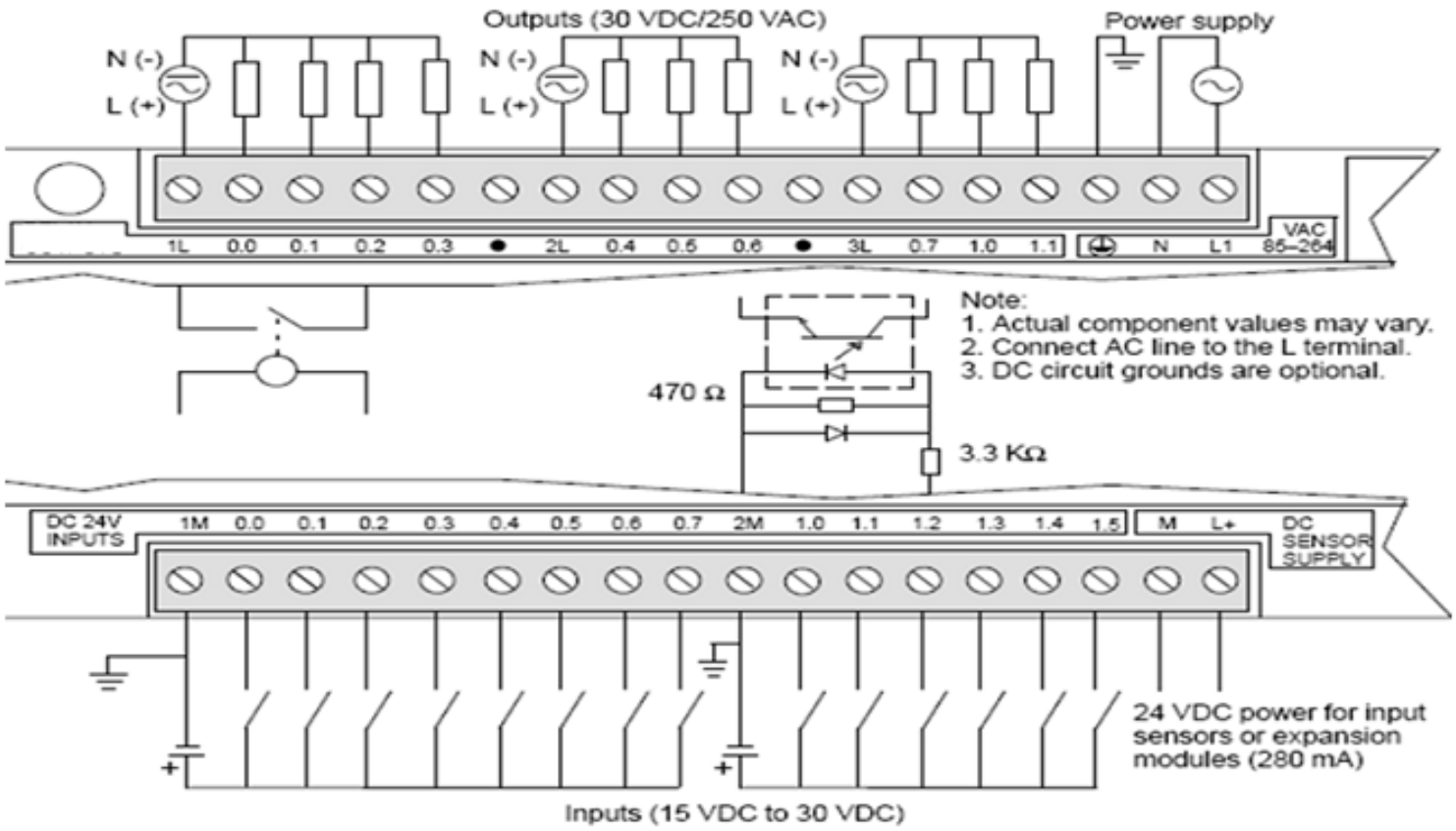
Nhận xét:

- 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



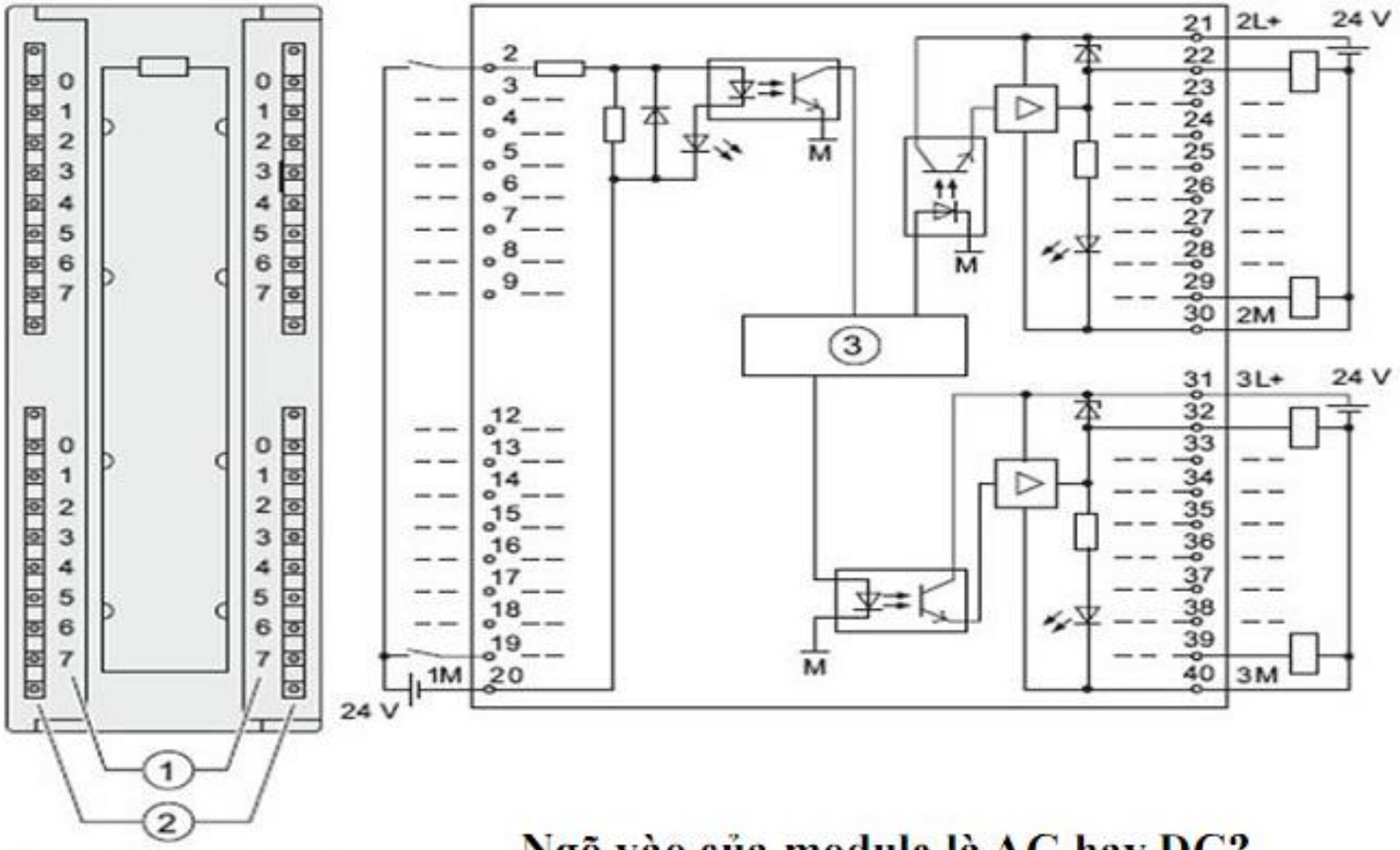
Plc này sử dụng nguồn AC hay DC?

PLC ngày 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

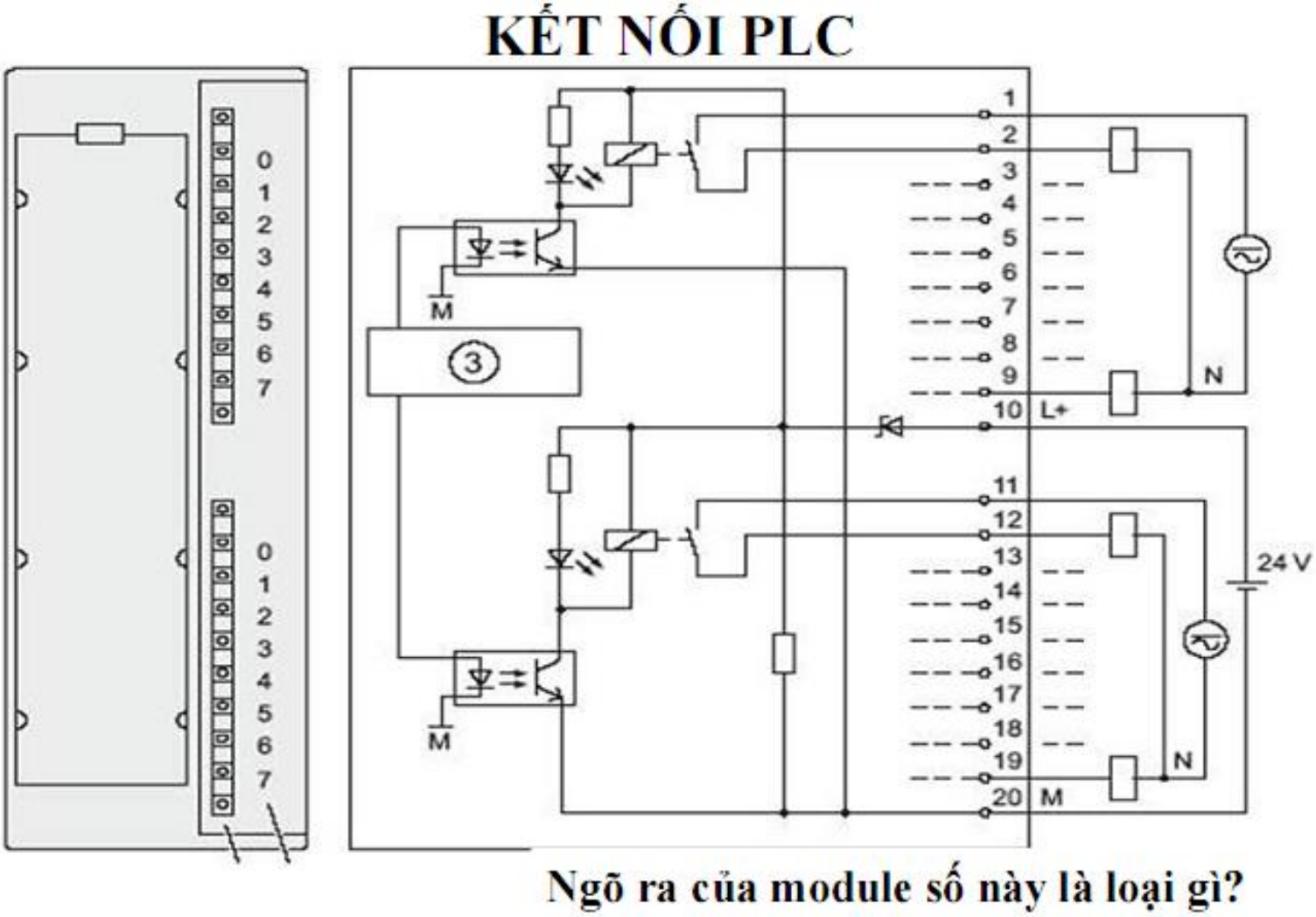


① Channel number
② Status displays - green
③ Backplane bus interface

Ngõ vào của module là AC hay DC?

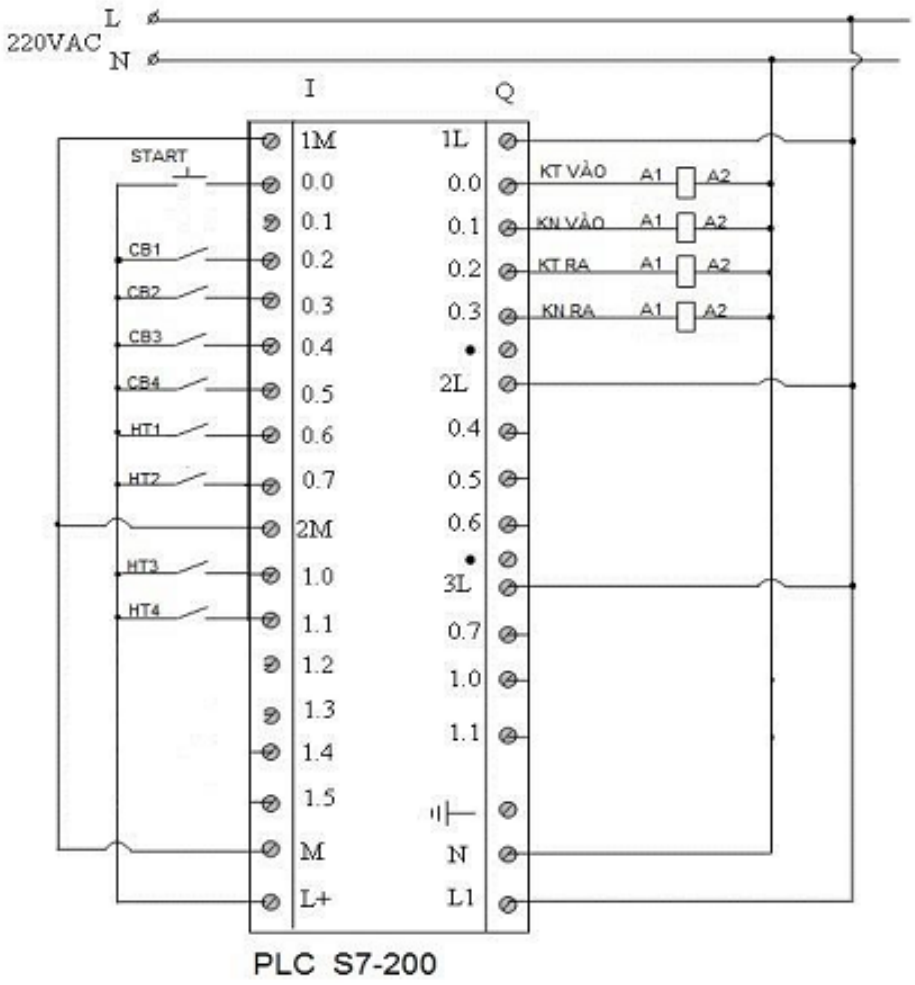
Ngõ ra của của module là NPN hay PNP? PNP(source)

PHẦN CỨNG BỘ ĐIỀU KHIỂN PLC S7 - 300



PHẦN CỨNG BỘ ĐIỀU KHIỂN PLC S7 - 300

KẾT NỐI PLC ĐIỀU KHIỂN BÃI ĐỖ XE



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

Nguồn sử dụng cho PLC: AC hay DC?

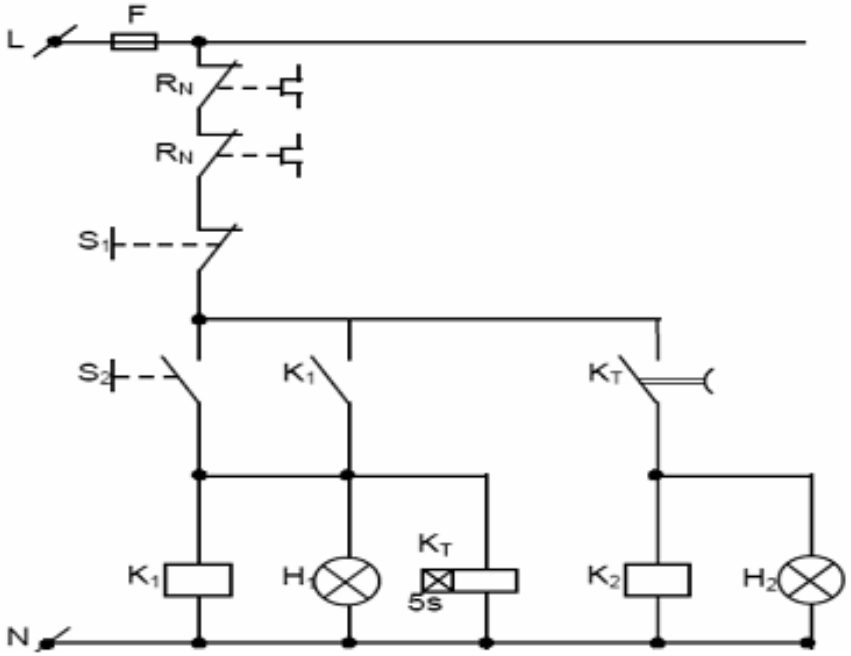
PLC có ngõ ra AC, DC hay Relay?

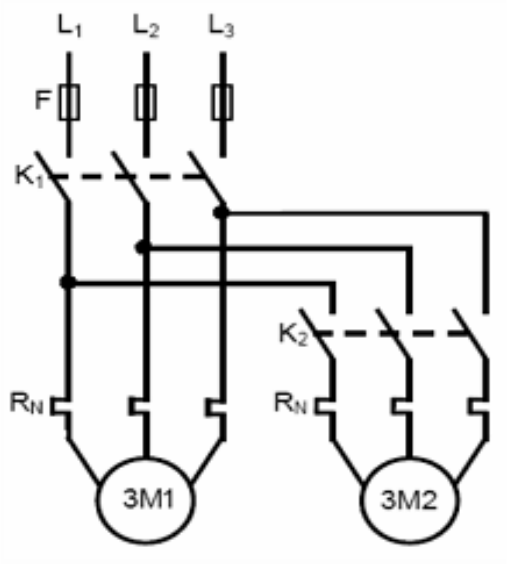
Cảm biến được sử dụng trong sơ đồ có ngõ ra là NPN hay PNP?

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

KẾT NỐI PHẦN CỨNG CHO PLC

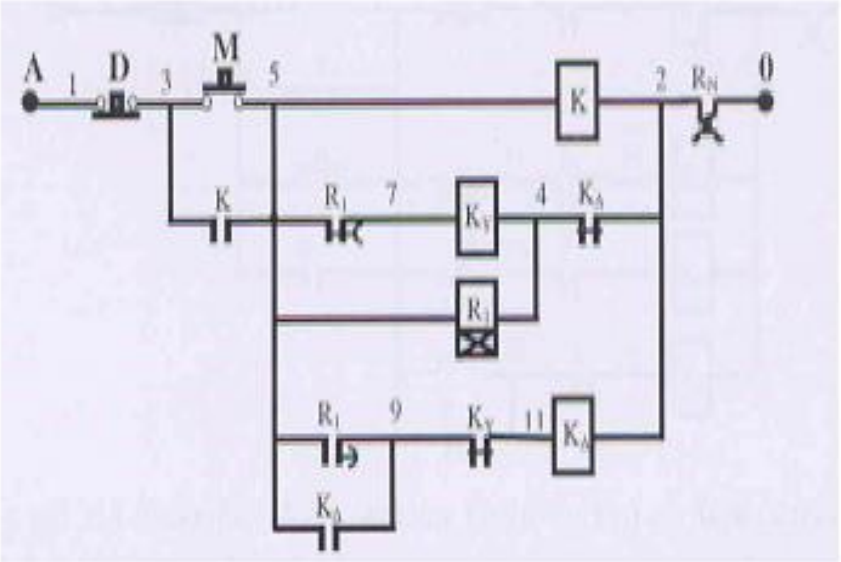
Ex4: Vẽ lại đầy đủ sơ đồ kết nối phần cứng cho PLC thay cho sơ đồ điều khiển khởi động tuần tự 2 động cơ dùng tiếp điểm như sau:

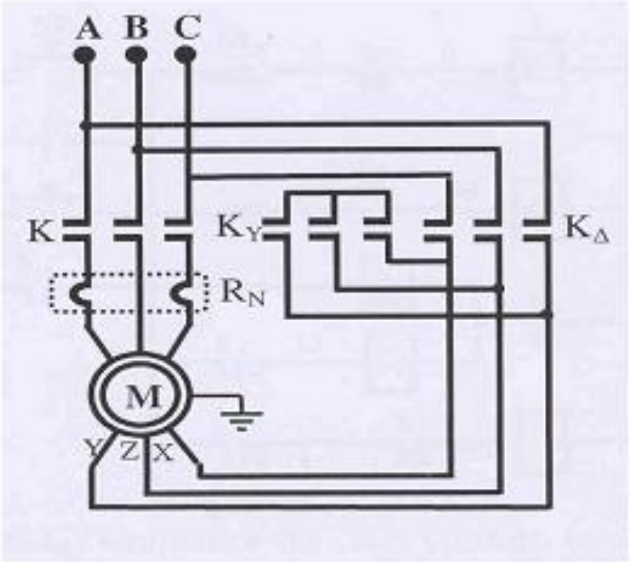




KẾT NỐI PHẦN CỨNG CHO PLC

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:

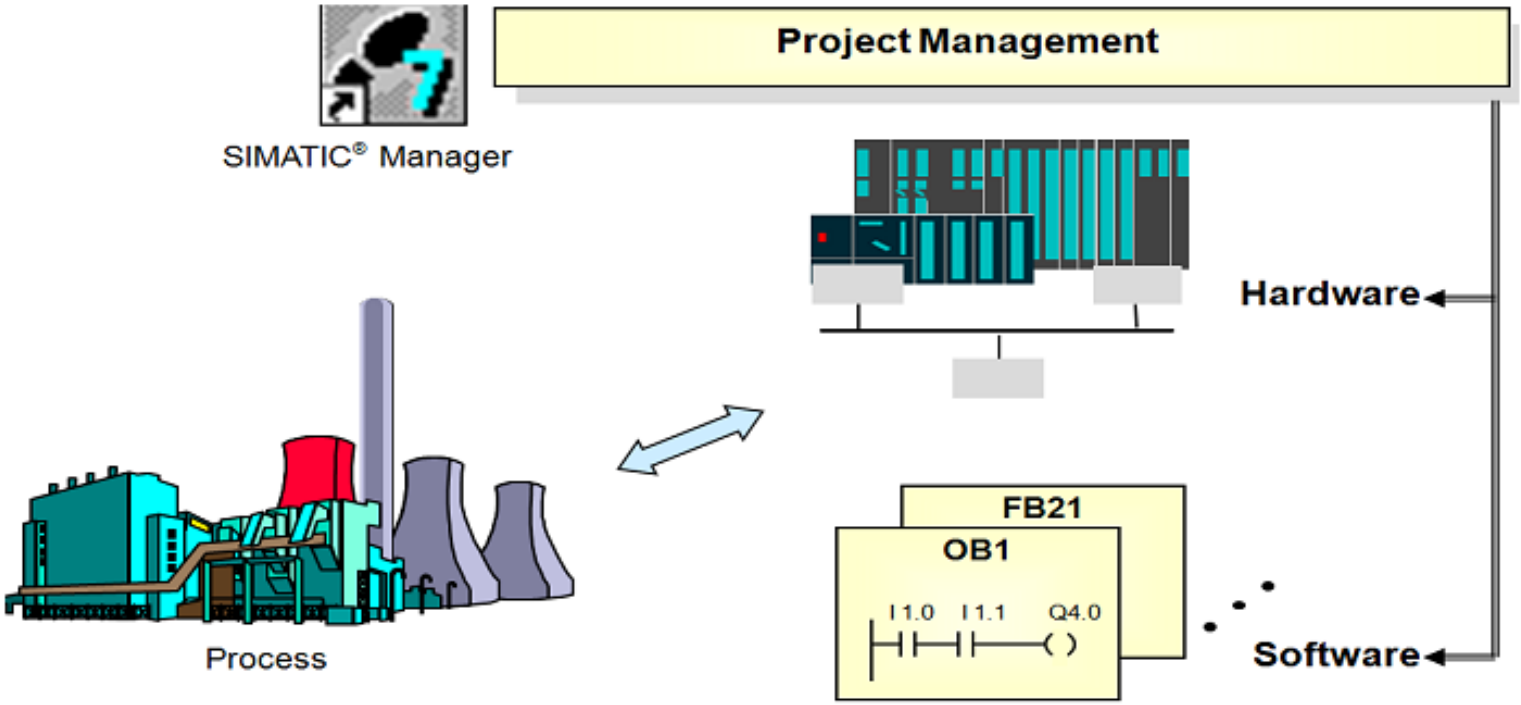




GIÁO TRÌNH LẬP TRÌNH PLC 2

CHƯƠNG II: THIẾT KẾ HỆ THỐNG VỚI SIMATIC MANAGER

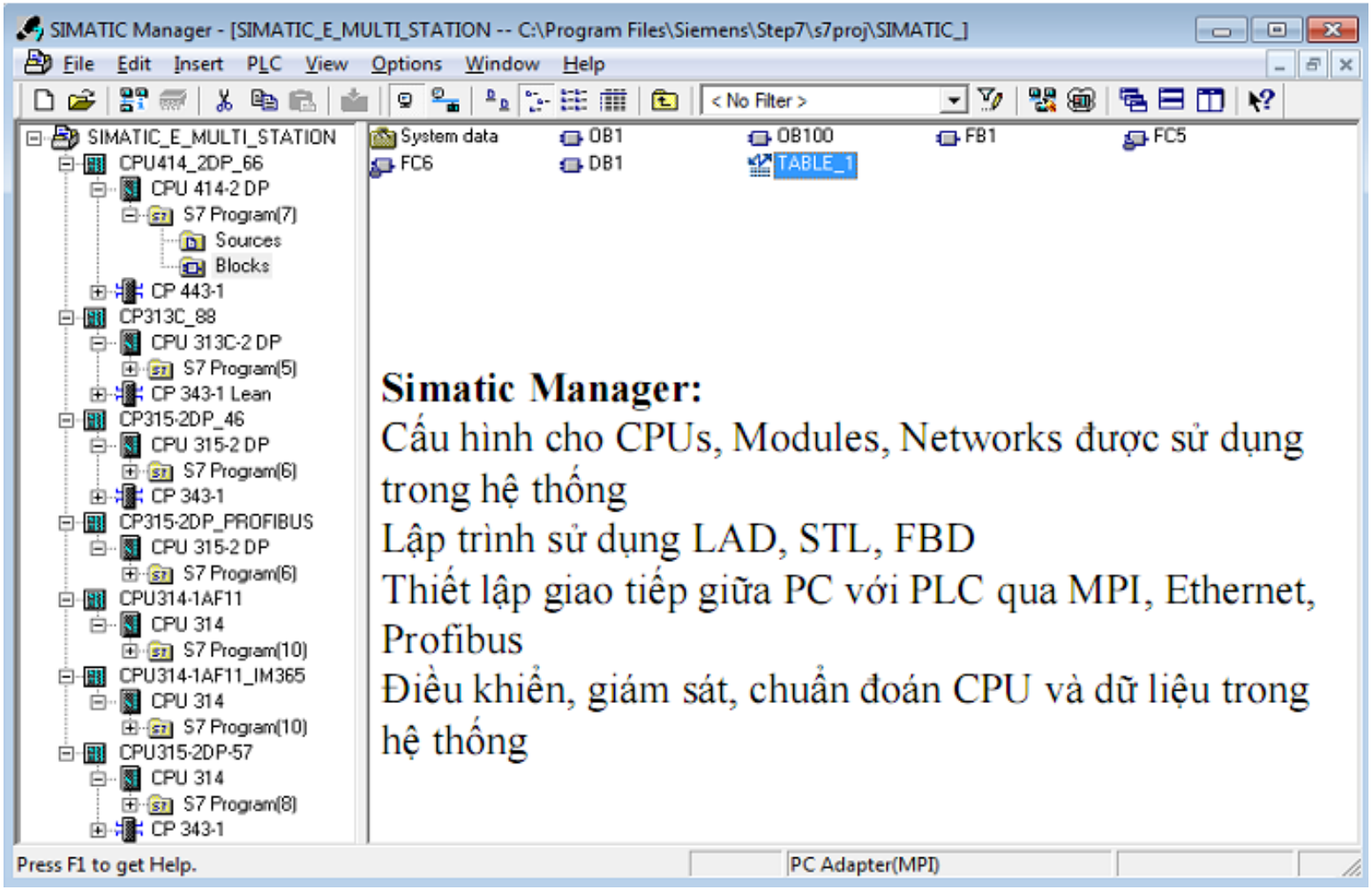
THIẾT KẾ HỆ THỐNG VỚI S7



- 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



Simatic Manager:

Cấu hình cho CPUs, Modules, Networks được sử dụng trong hệ thống

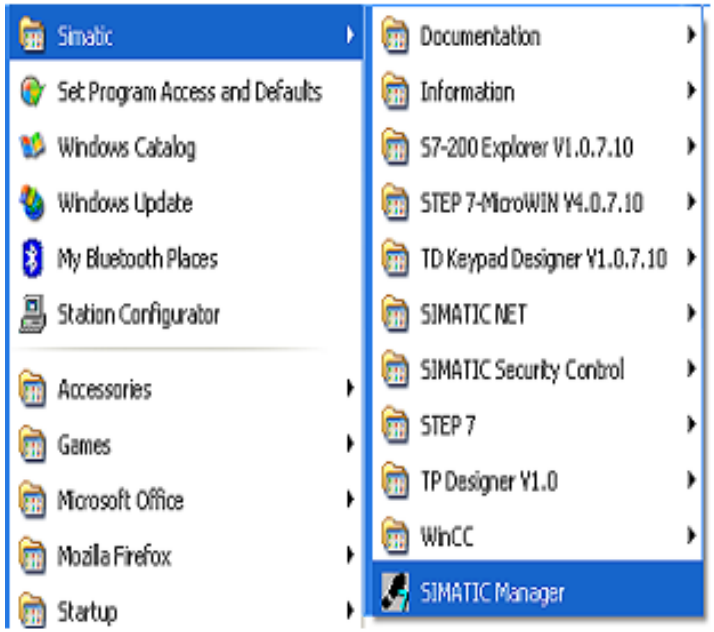
Lập trình sử dụng LAD, STL, FBD

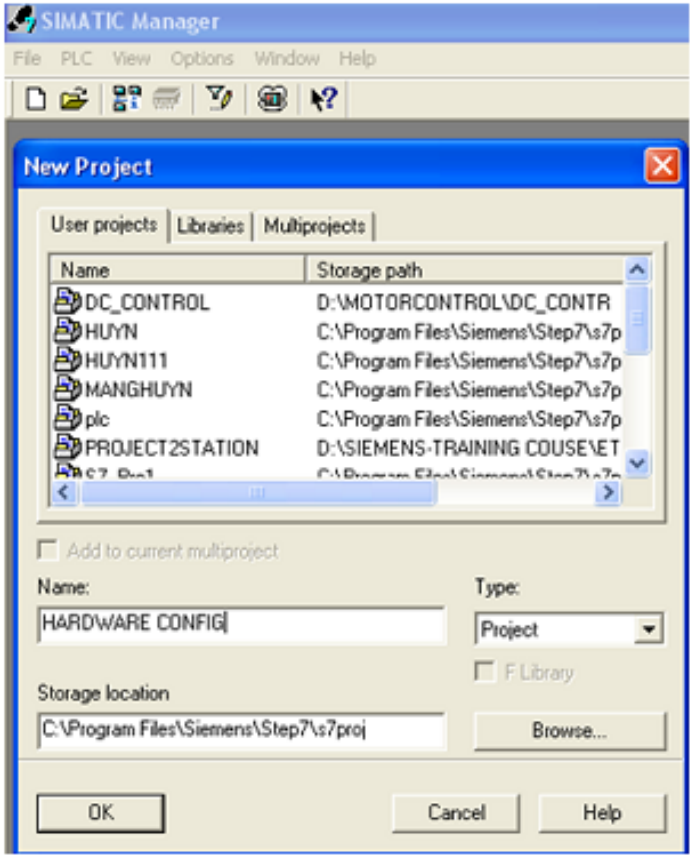
Thiết lập giao tiếp giữa PC với PLC qua MPI, Ethernet, Profibus

Điều khiển, giám sát, chuẩn đoán CPU và dữ liệu trong hệ thống

LẬP TRÌNH SIMATIC S7

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



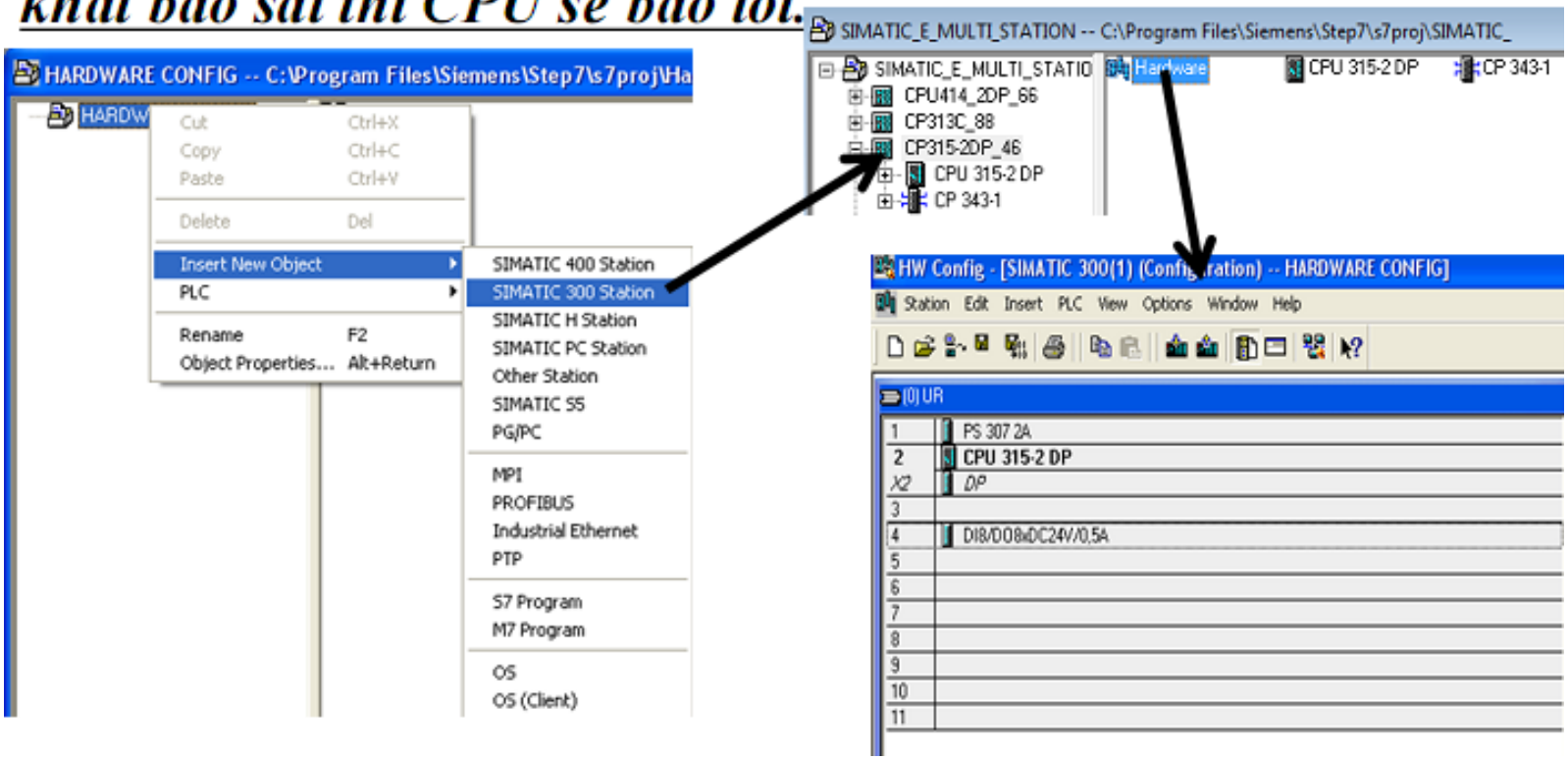


THIẾT KẾ HỆ THỐNG VỚI SIMATIC MANAGER

LẬP TRÌNH SIMATIC S7 300

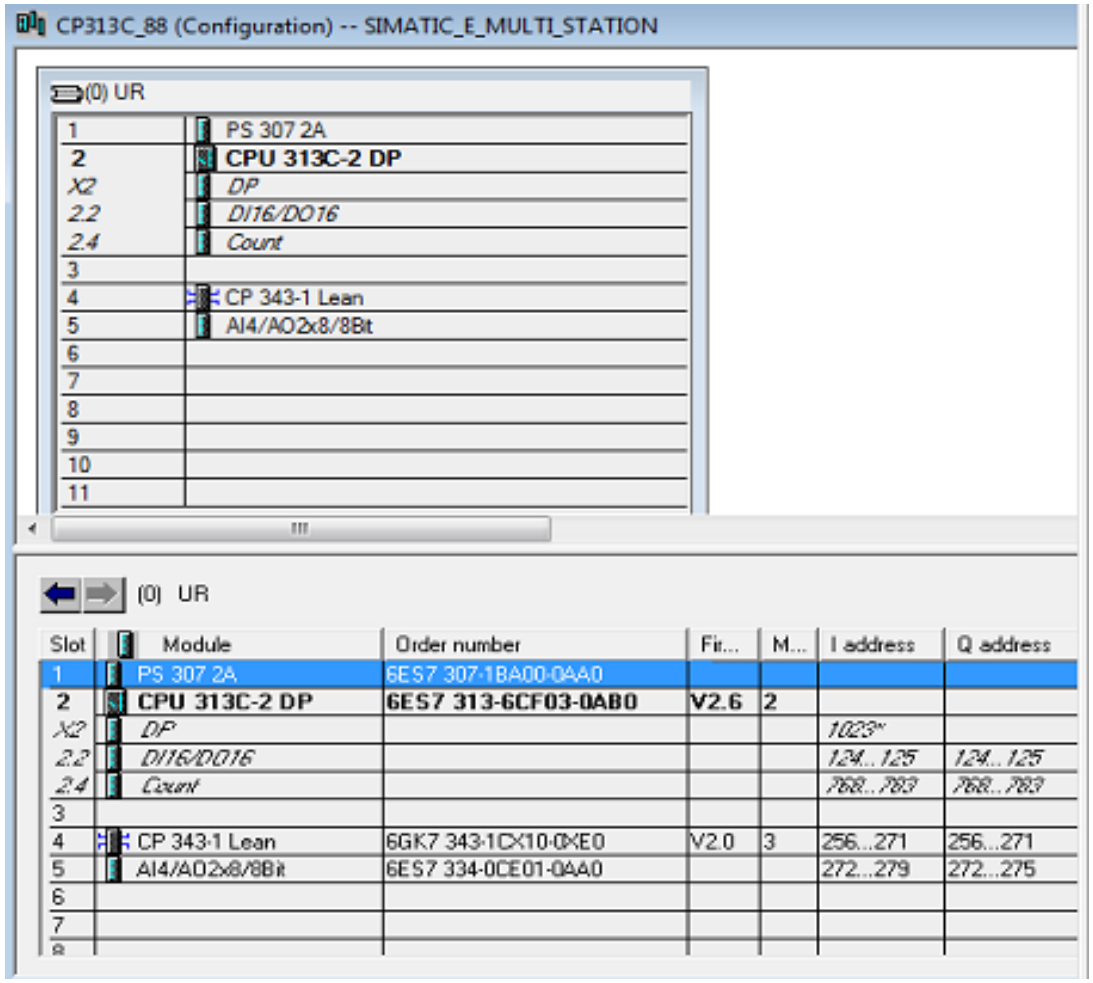
Khai báo phần cứng cho S7 300

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



THIẾT KẾ HỆ THỐNG VỚI SIMATIC MANAGER

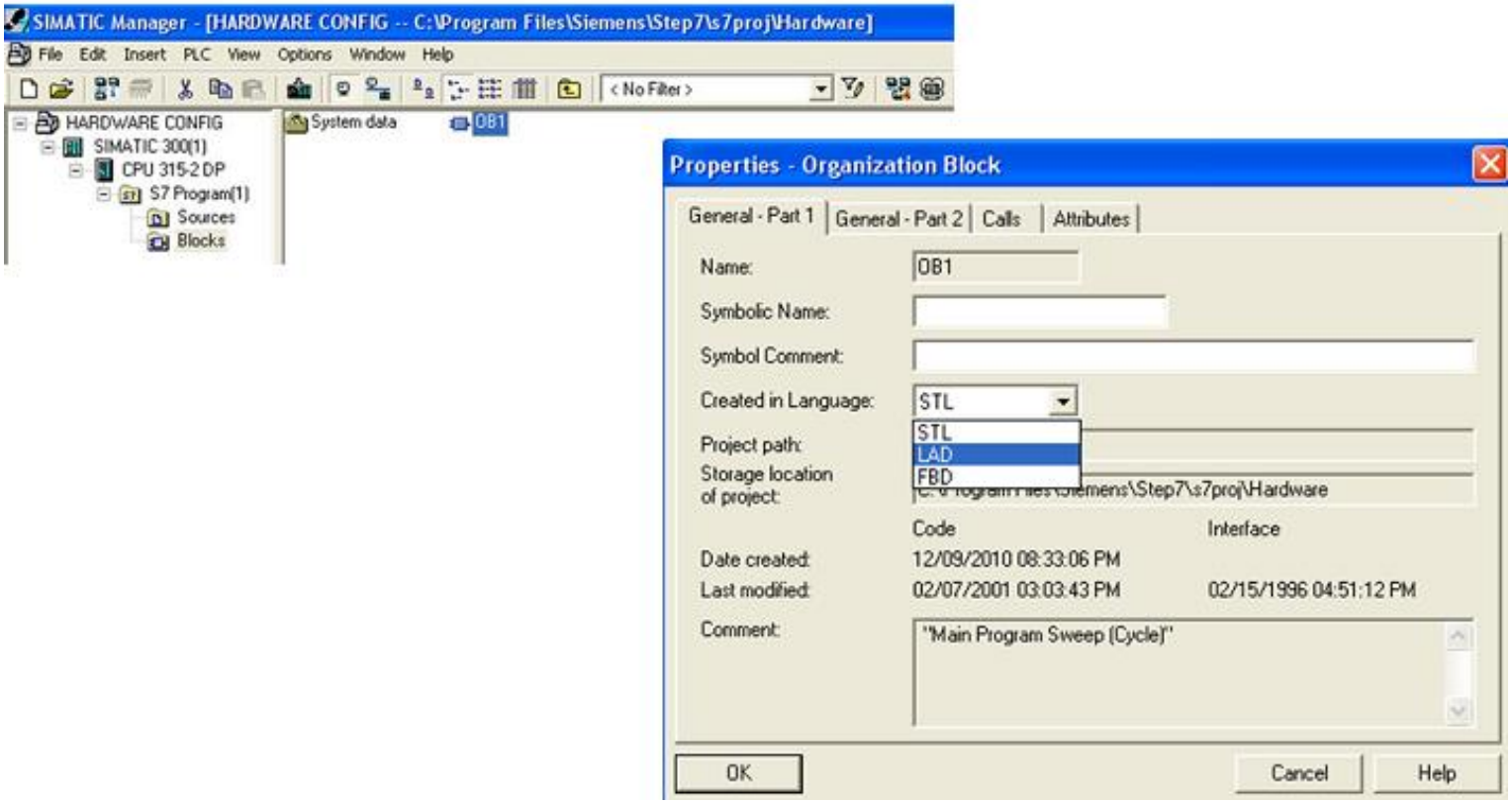
Bài tập: khai báo phần cứng như sau:



THIẾT KẾ HỆ THỐNG VỚI SIMATIC MANAGER

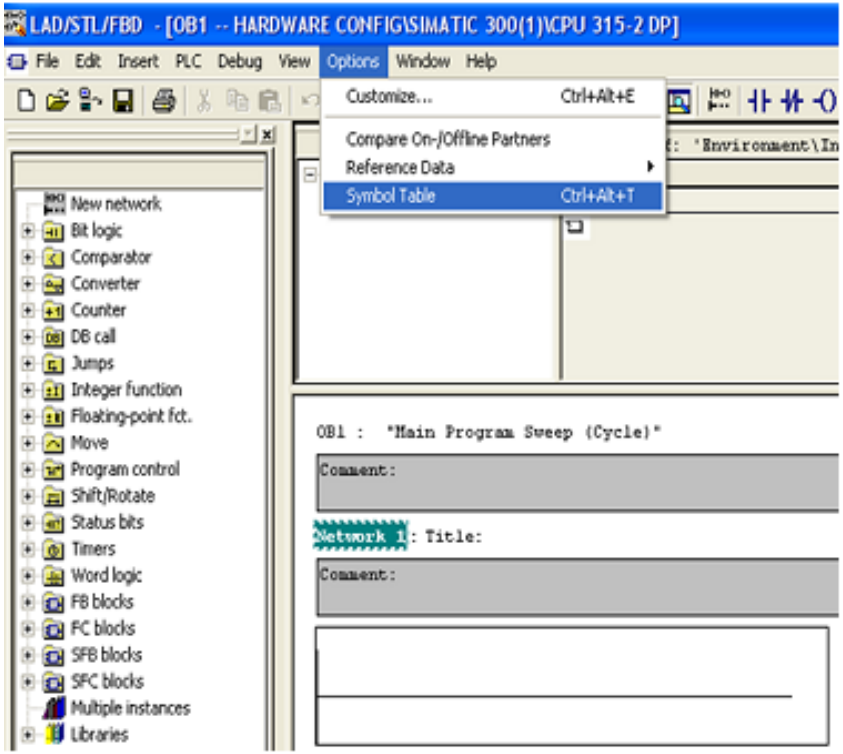
LẬP TRÌNH SIMATIC S7300

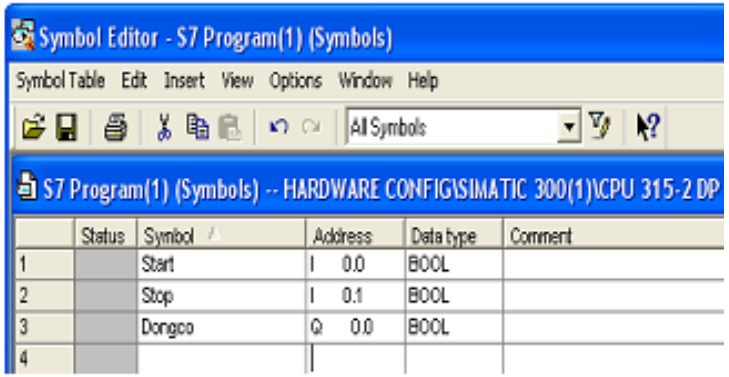
Viết chương trình và mô phỏng dùng simulink. Chọn OB1 và loại ngôn ngữ phù hợp để lập trình



LẬP TRÌNH S7300

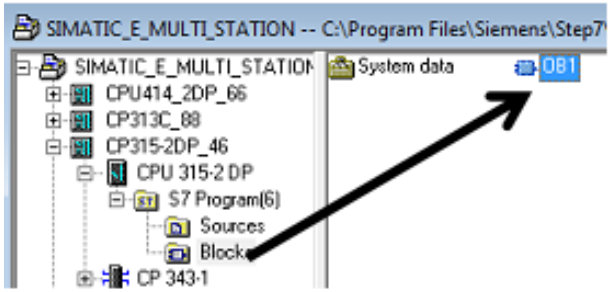
Khai các biến sử dụng

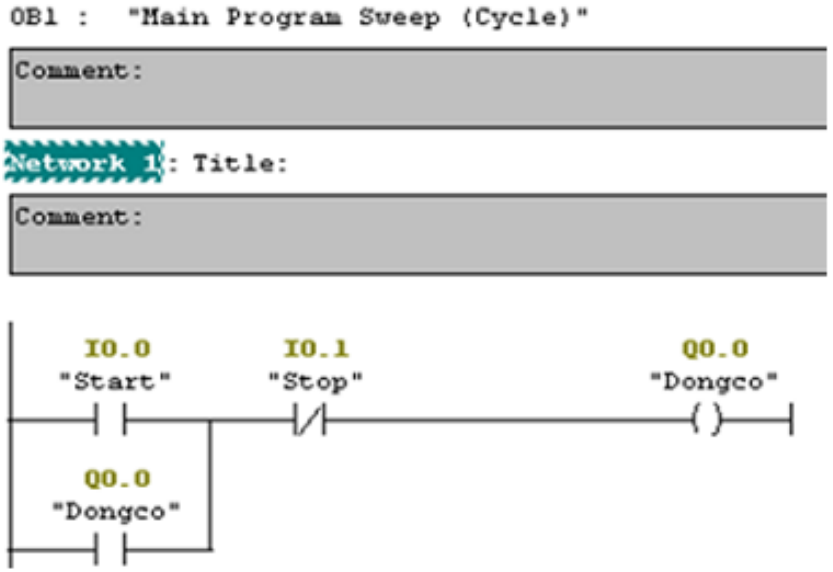




LẬP TRÌNH S7300

Mở khối OB1, viết chương trình điều khiển động cơ

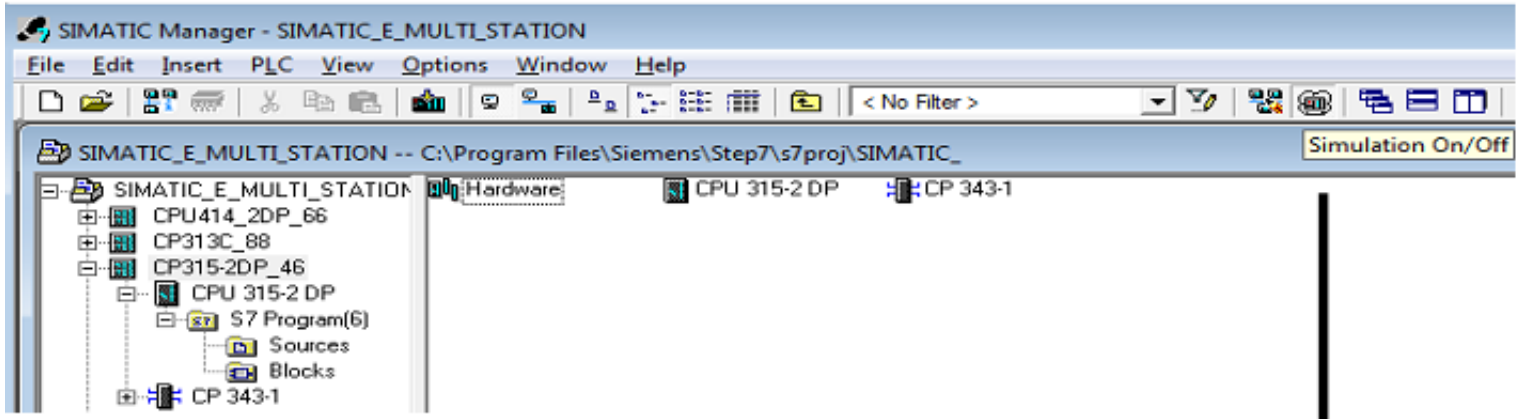




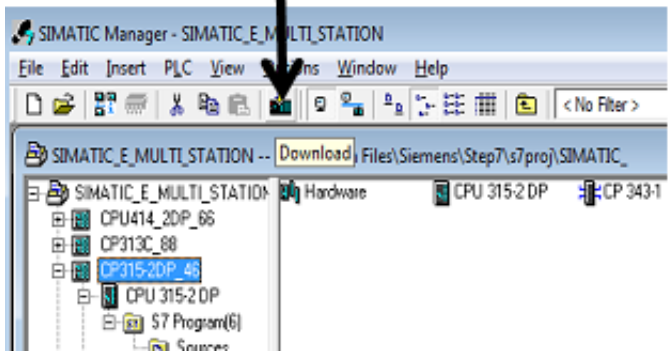
THIẾT KẾ HỆ THỐNG VỚI SIMATIC MANAGER

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



MÔ PHỎNG S7300

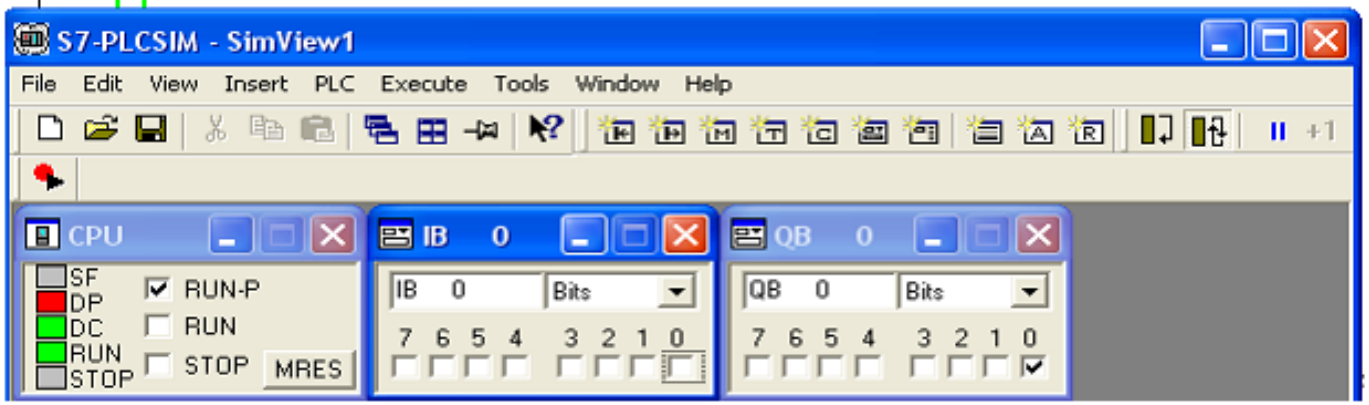
Download chương trình và chạy mô phỏng

OB1 : "Main Program Sweep (Cycle)"

Comment:

Network 1: Title:

Comment:

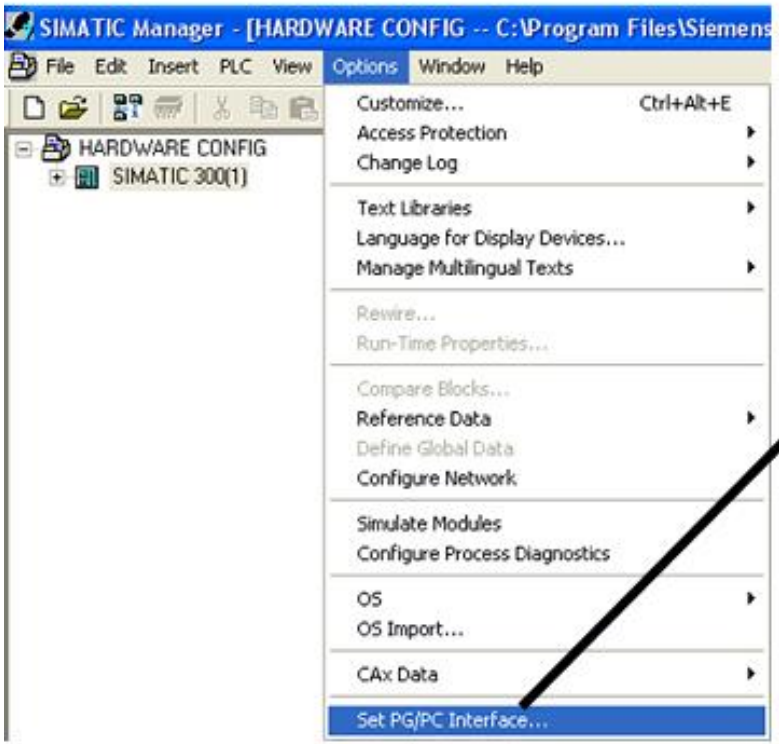


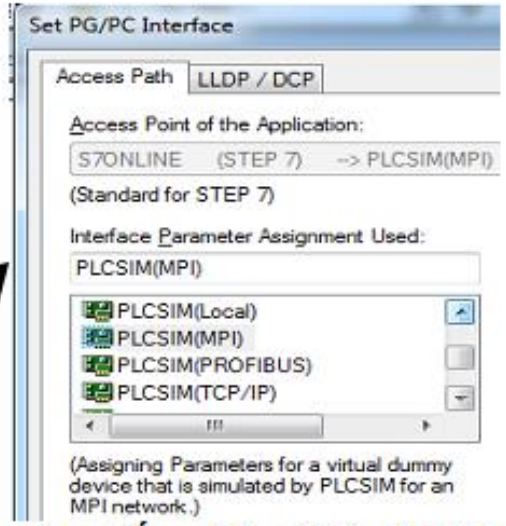
THIẾT KẾ HỆ THỐNG VỚI SIMATIC MANAGER

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



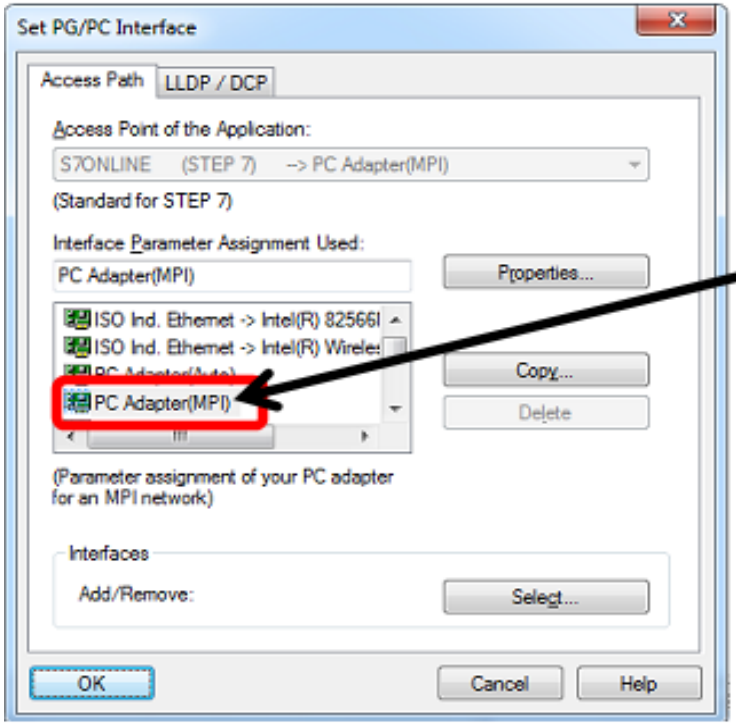


➢**Chọn giao tiếp giữa PC và PLC theo chuẩn MPI, Profibus hay Ethernet (Tùy thuộc vào kết nối thực tế giữa PC và PLC).**

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

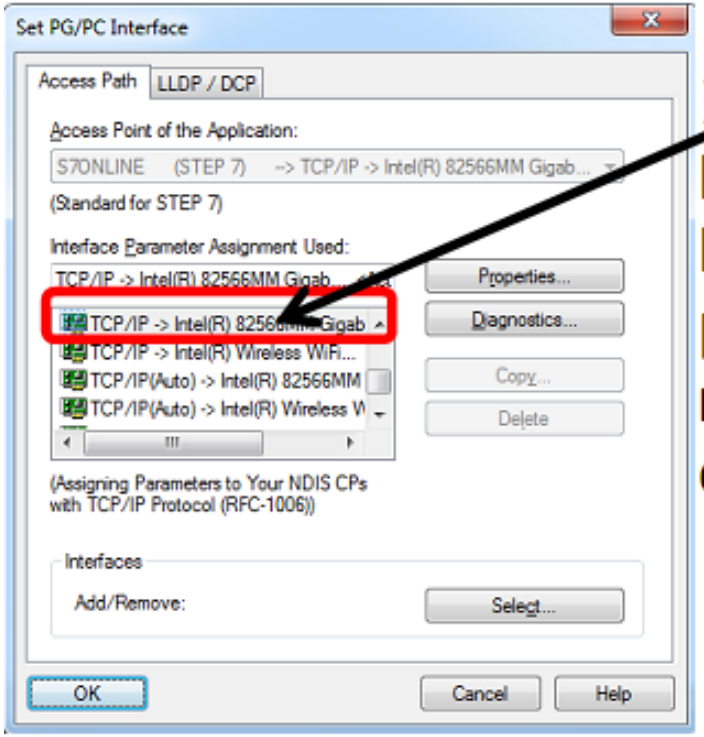


- Chọn giao tiếp giữa PC và PLC qua MPI
- Tắt phần mềm mô phỏng mới download chương trình đến PLC thực được

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

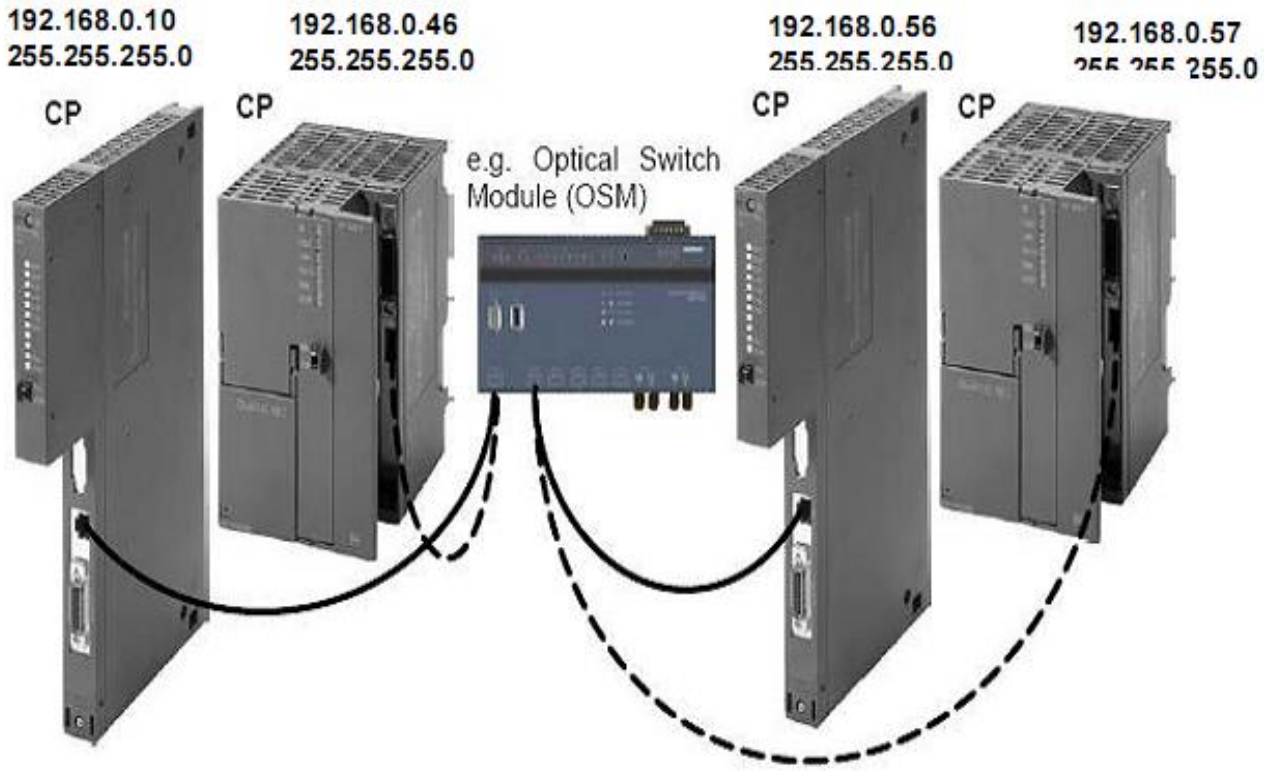


➢Chọn giao tiếp giữa PC và PLC qua Ethernet

Lưu ý: IP của PC và PLC phải được đặt cùng lớp mạng và khác nhau về địa chỉ IP

LẬP TRÌNH VỚI S7

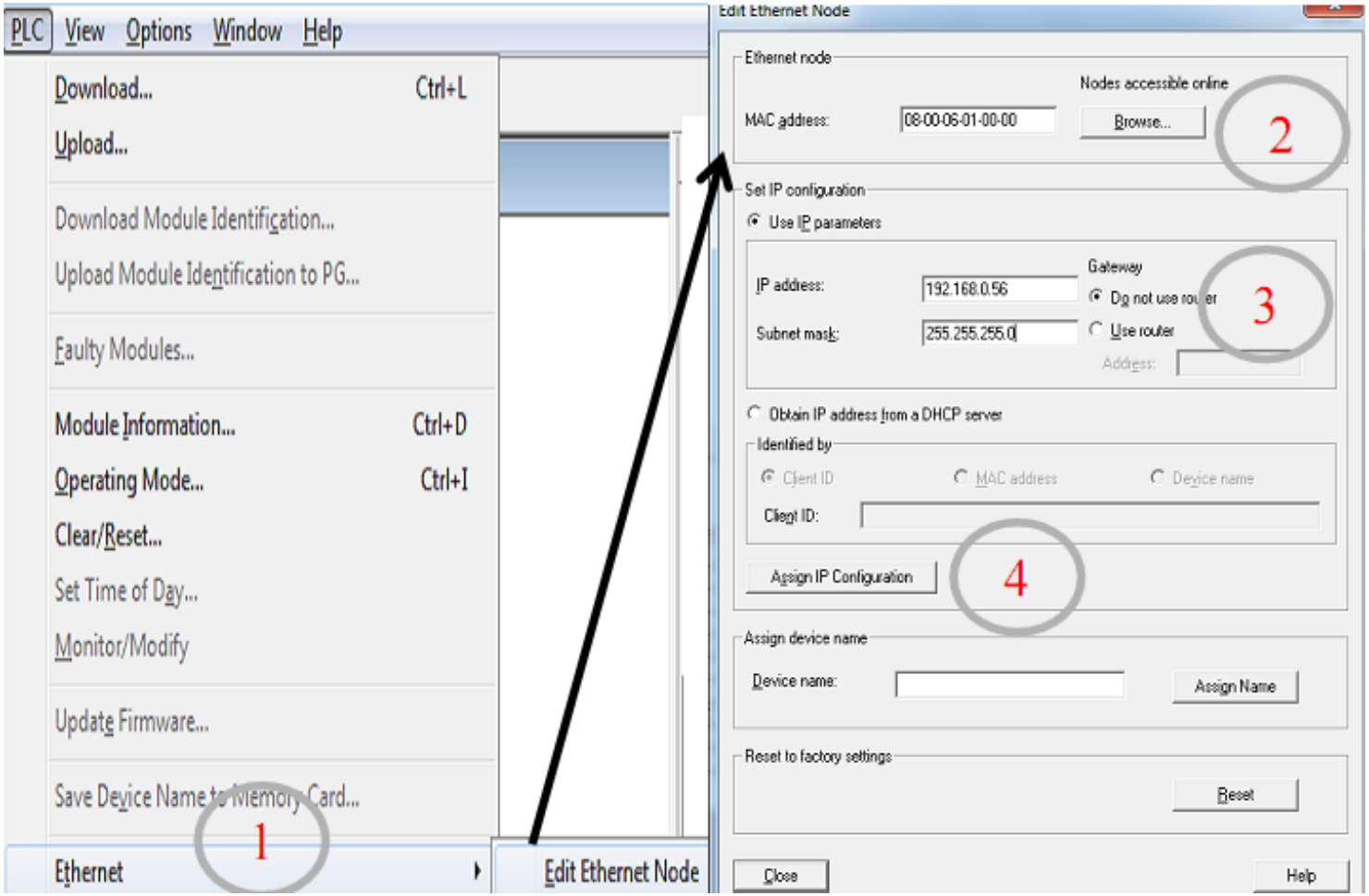
Download chương trình và chạy trên PLC thực *qua chuẩn ethernet*



Notice: Các CP phải được đặt địa chỉ IP trước

LẬP TRÌNH VỚI S7

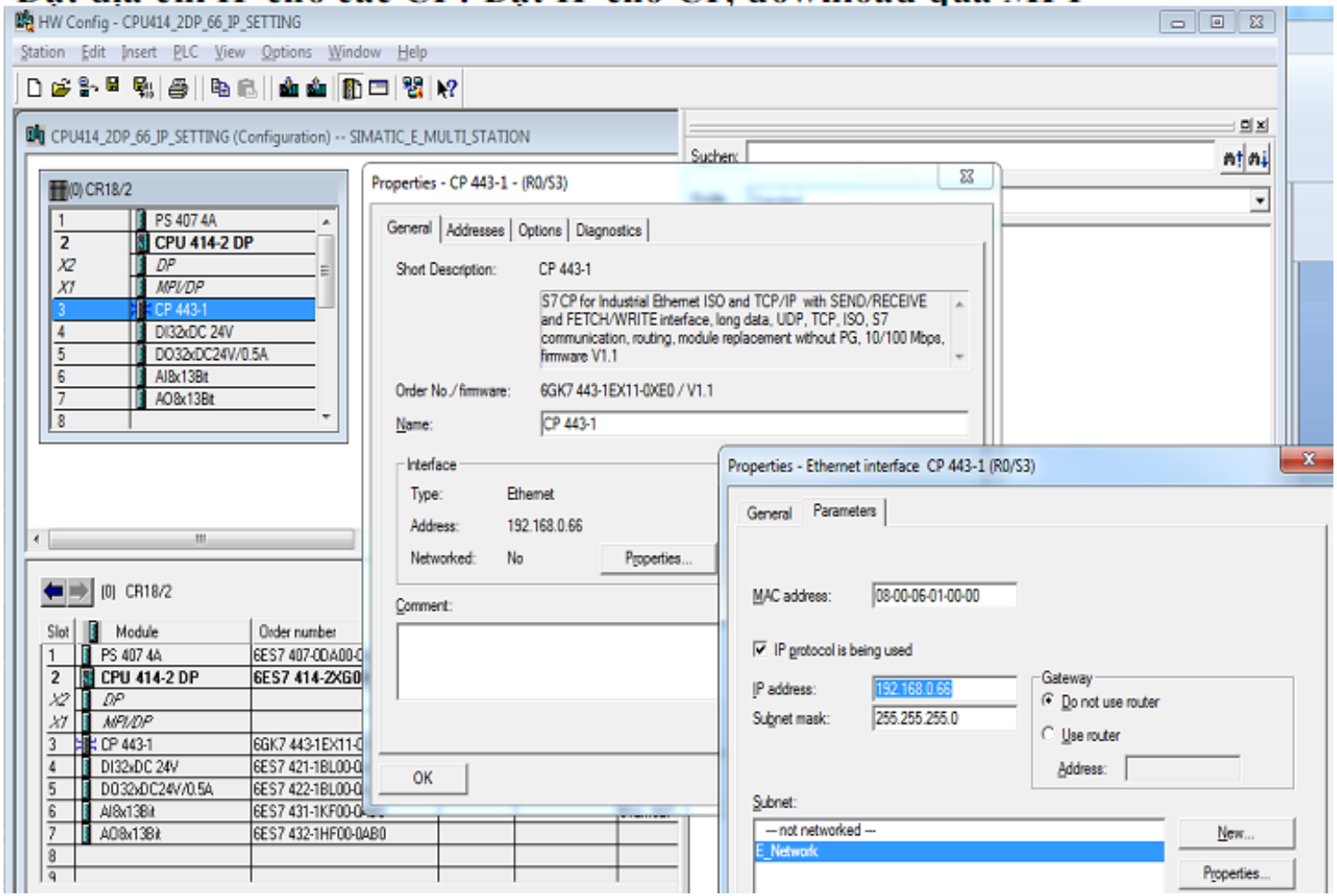
Đặt địa chỉ IP cho các CP: Sử dụng địa chỉ MAC



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



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

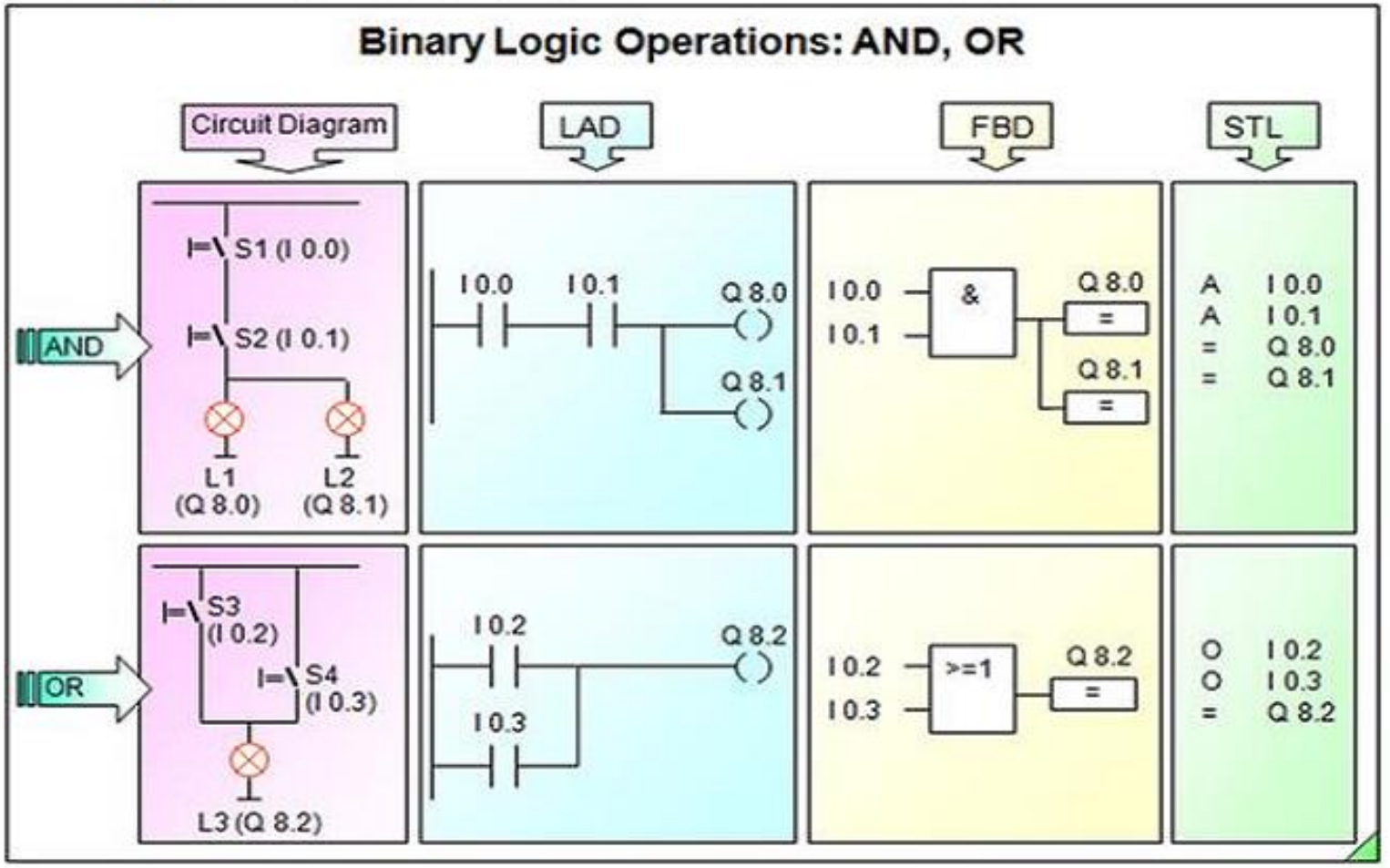
- ---| |--- Normally Open Contact (Address)
- ---| / |--- Normally Closed Contact (Address)
- ---(SAVE) Save RLO into BR Memory
- XOR Bit Exclusive OR
- ---( ) Output Coil
- ---(#)--- Midline Output
- ---|NOT|--- Invert Power Flow
- ---(S) Set Coil
- ---(R) Reset Coil
- SR Set-Reset Flip Flop
- RS Reset-Set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

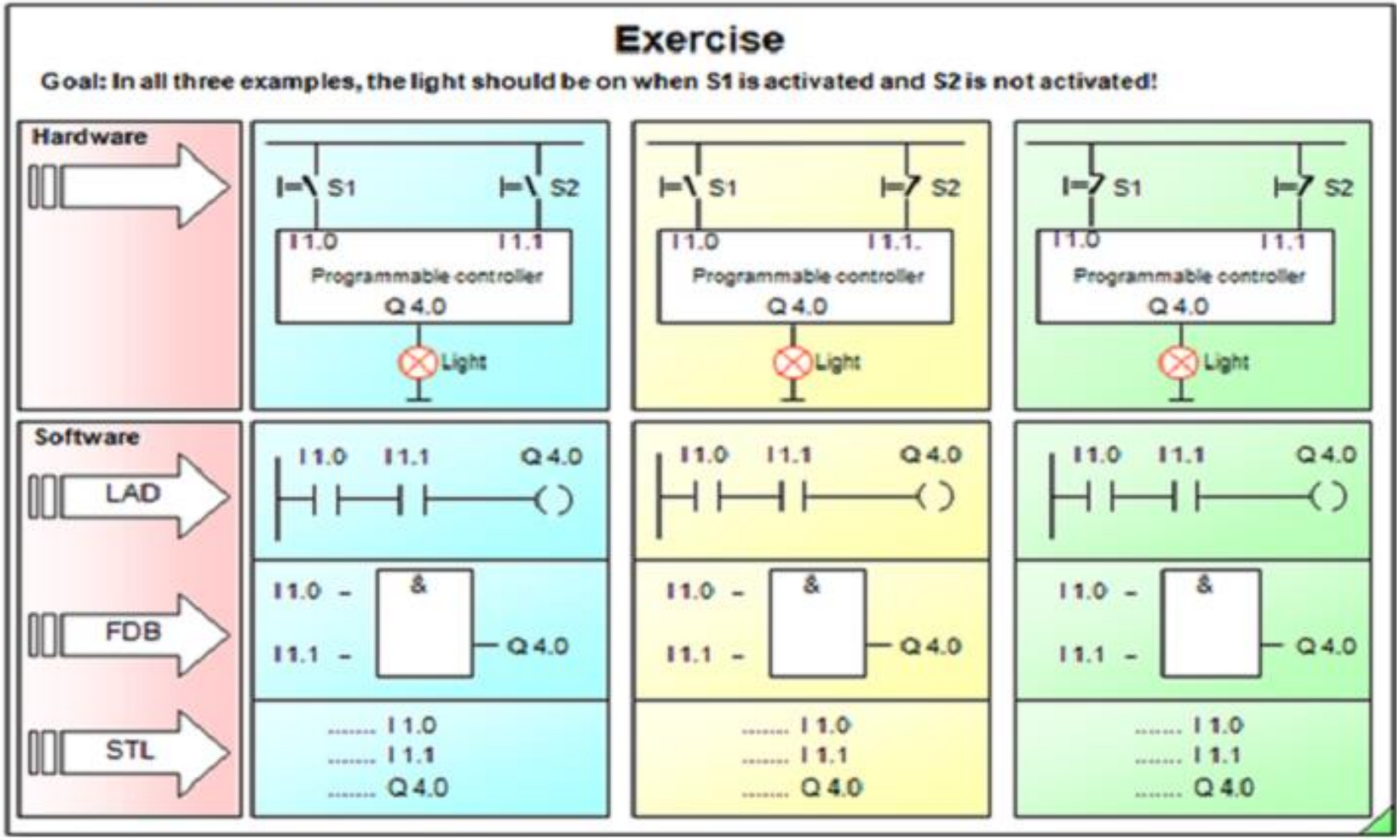
TẬP LỆNH CƠ BẢN TRONG S7-300

Bit logic instructions



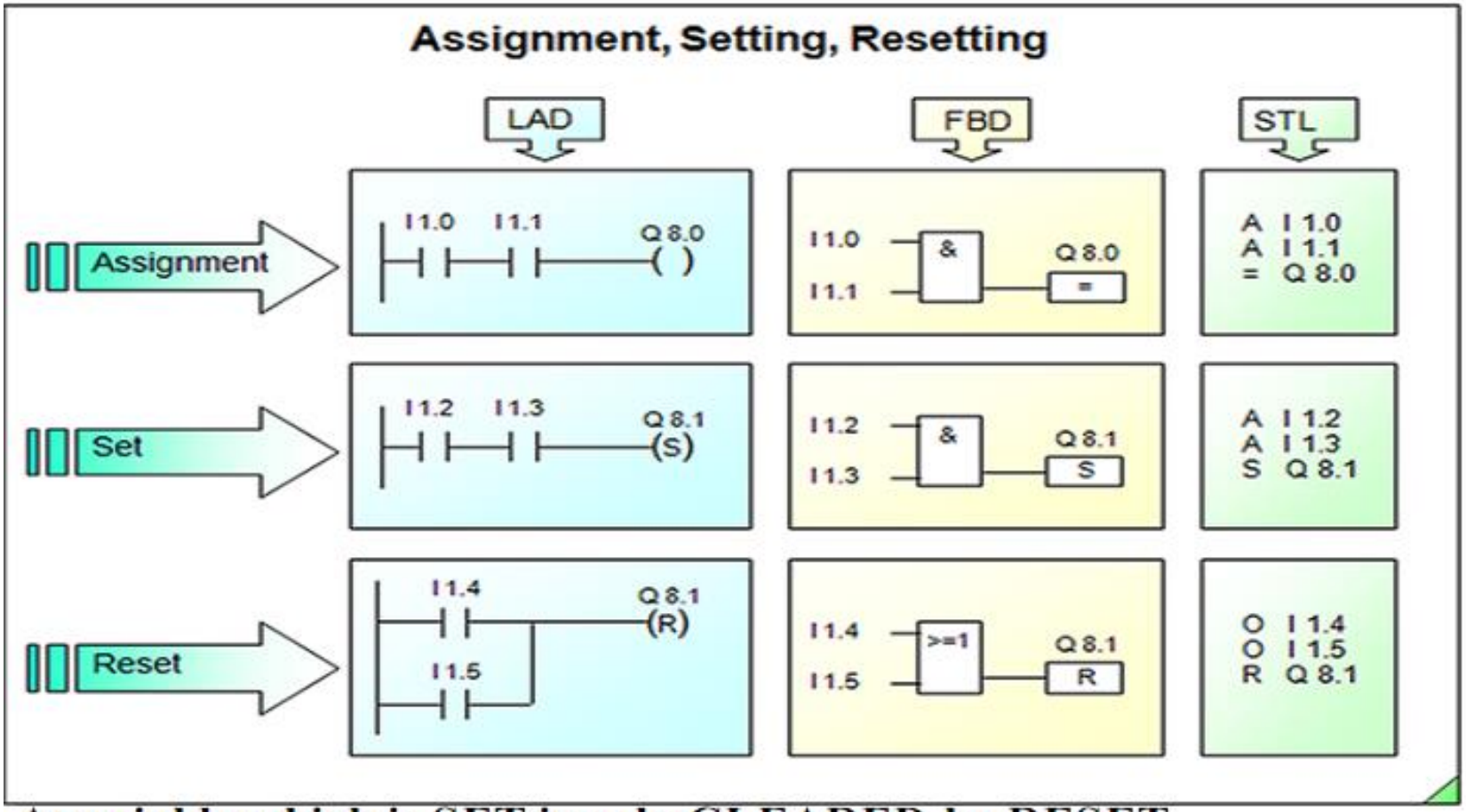
TẬP LỆNH CƠ BẢN TRONG S7-300

Bit logic instructions



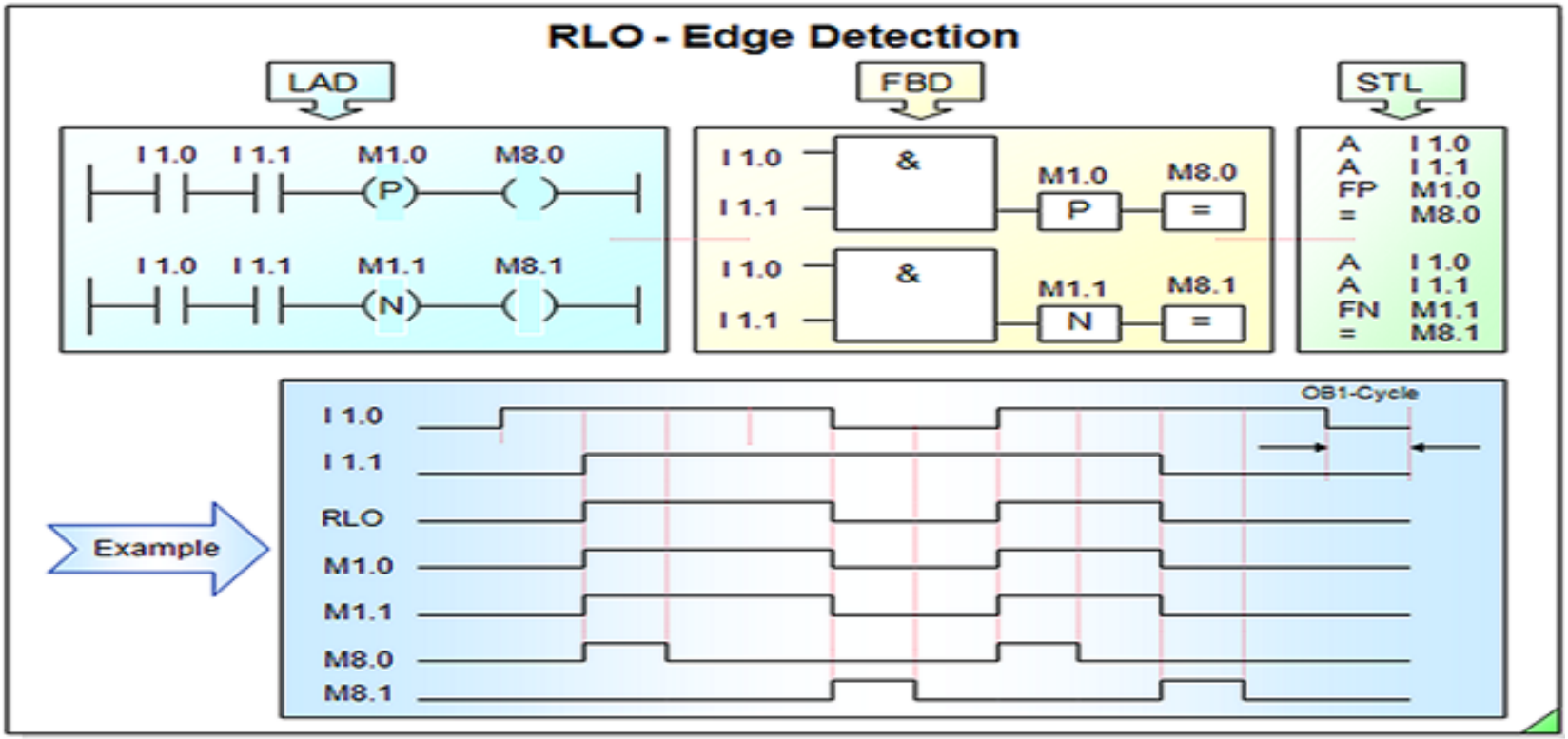
TẬP LỆNH CƠ BẢN TRONG S7-300

Bit logic instructions



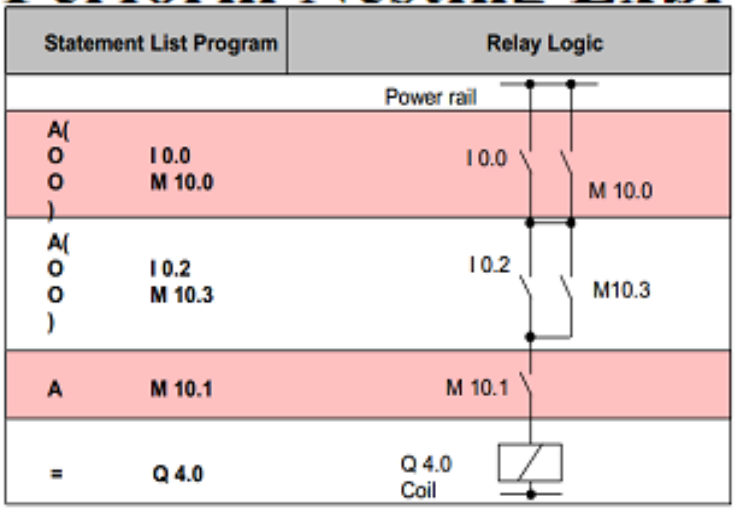
A variable which is SET is only CLEARED by RESET

Bit logic instructions

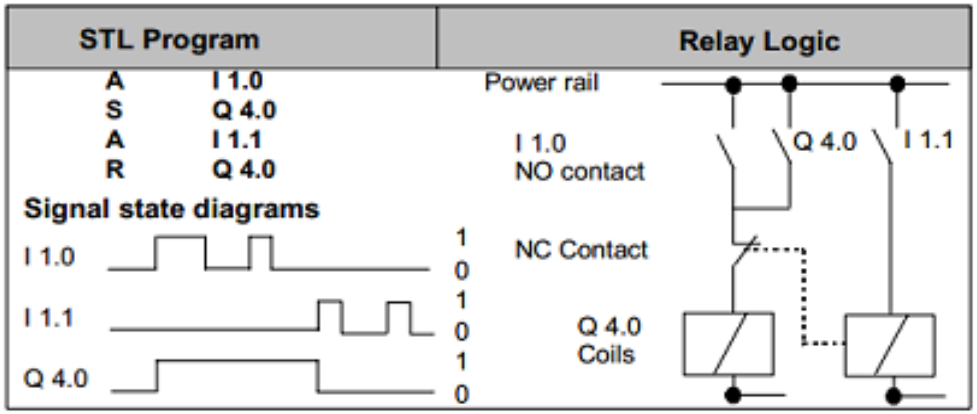


To check result of Edge Detection Instruction, Output variables should be Latched by Set instruction

Perform Nesting Expressions with STL

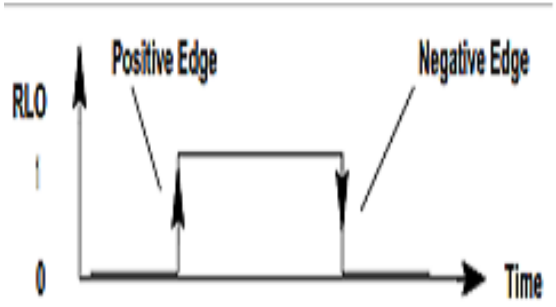


Perform Set and Reset instructions with STL



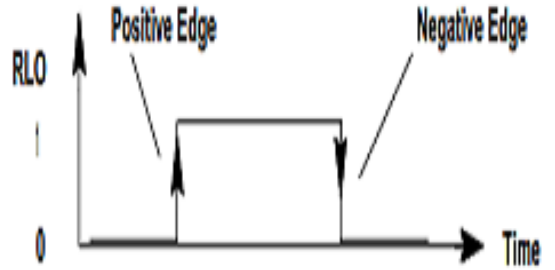
TẬP LỆNH CƠ BẢN TRONG S7-300

Edge Negative: FN



Statement List		Signal State Diagram
A	I 1.0	I 1.0
FN	M 1.0	M 1.0
=	Q 4.0	Q 4.0
OB1 Scan Cycle No:		1 2 3 4 5 6 7 8 9

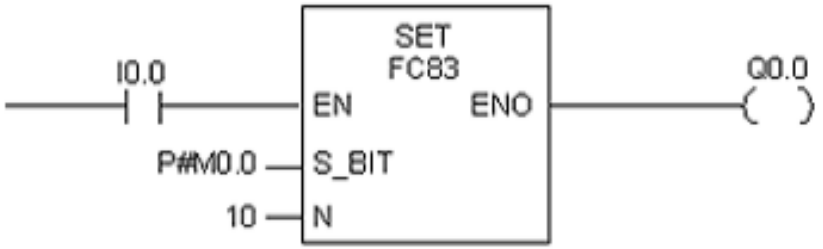
Edge Positive: FP

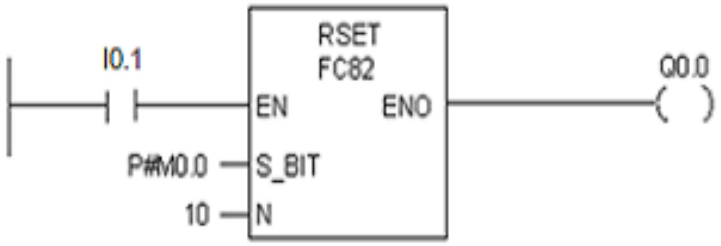


Statement List		Signal State Diagram
A	I 1.0	I 1.0
FP	M 1.0	M 1.0
=	Q 4.0	Q 4.0
OB1 Scan Cycle No:		1 2 3 4 5 6 7 8 9

Bit instructions

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



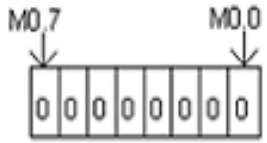


Before execution:

After execution:

Before execution:

After execution:



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

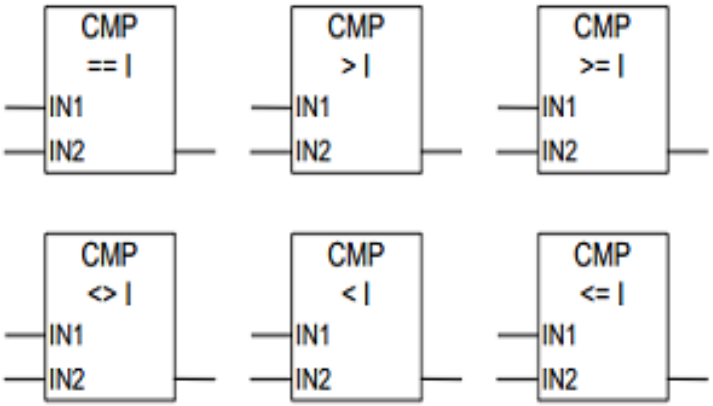
STL

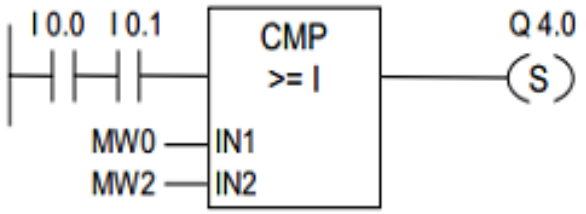
== ACCU1 is equal to ACCU2
<> ACCU1 is not equal to ACCU2
> ACCU1 is greater than ACCU2
< ACCU1 is less than ACCU2
>= ACCU1 is greater than or equal to ACCU2
<= ACCU1 is less than or equal to ACCU2

- ? 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

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

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.

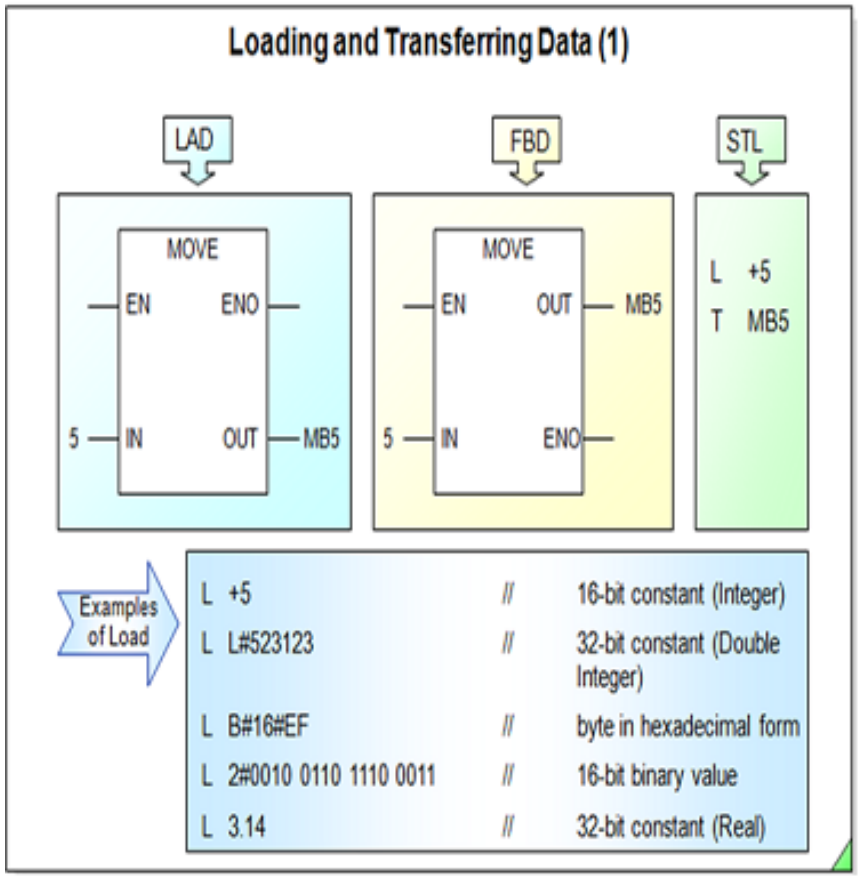
Notice:

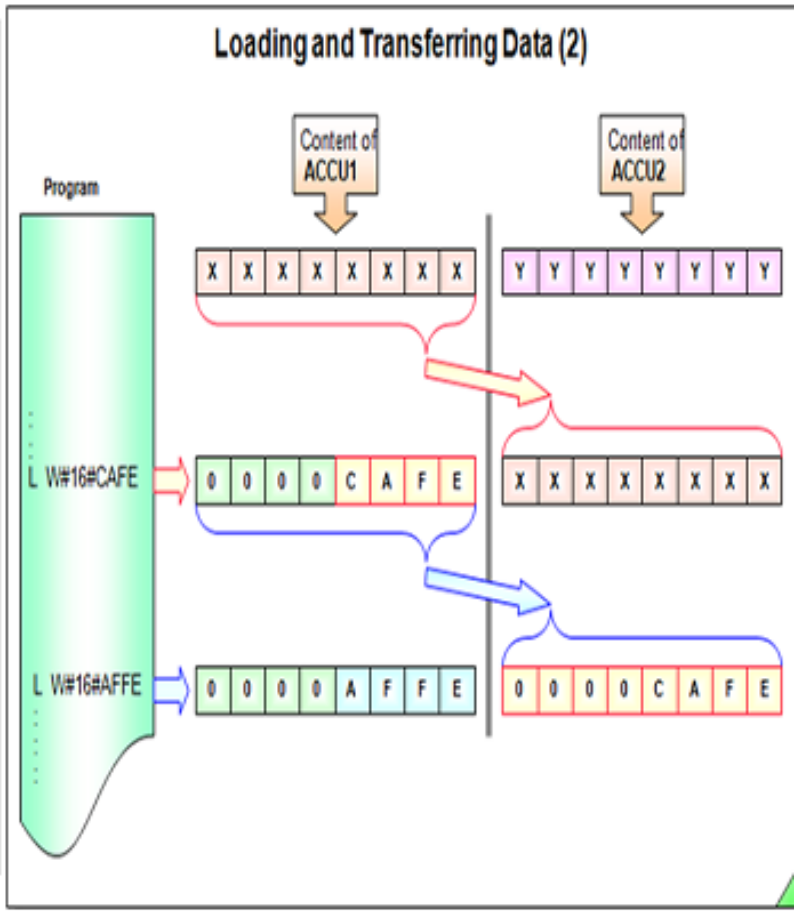
There are two Resisters ACCU1 and ACCU2 in S7 300

L MW 10 // Load MW10 into accu1

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

Loading and Transferring Data





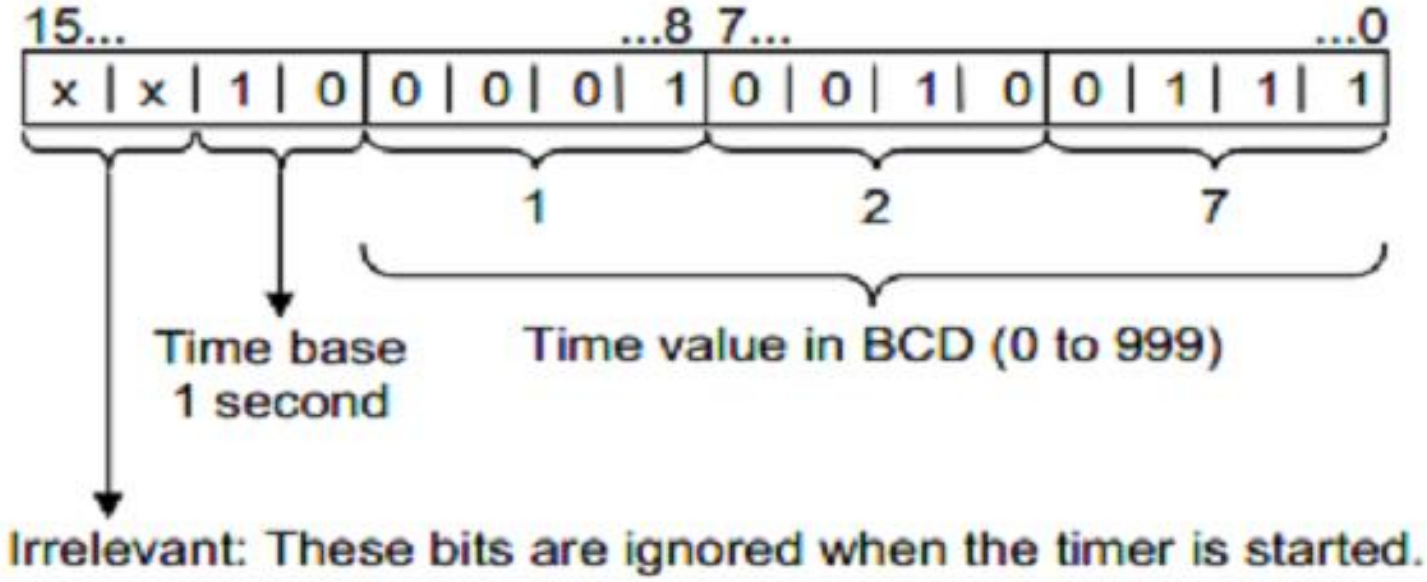
Comparison Instructions in STL

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.
```

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



Timer Instructions

- Time updating decrements the time value by one unit at an interval designed by the Time Base
- Derementing continouses 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

Type of Timer Instructions

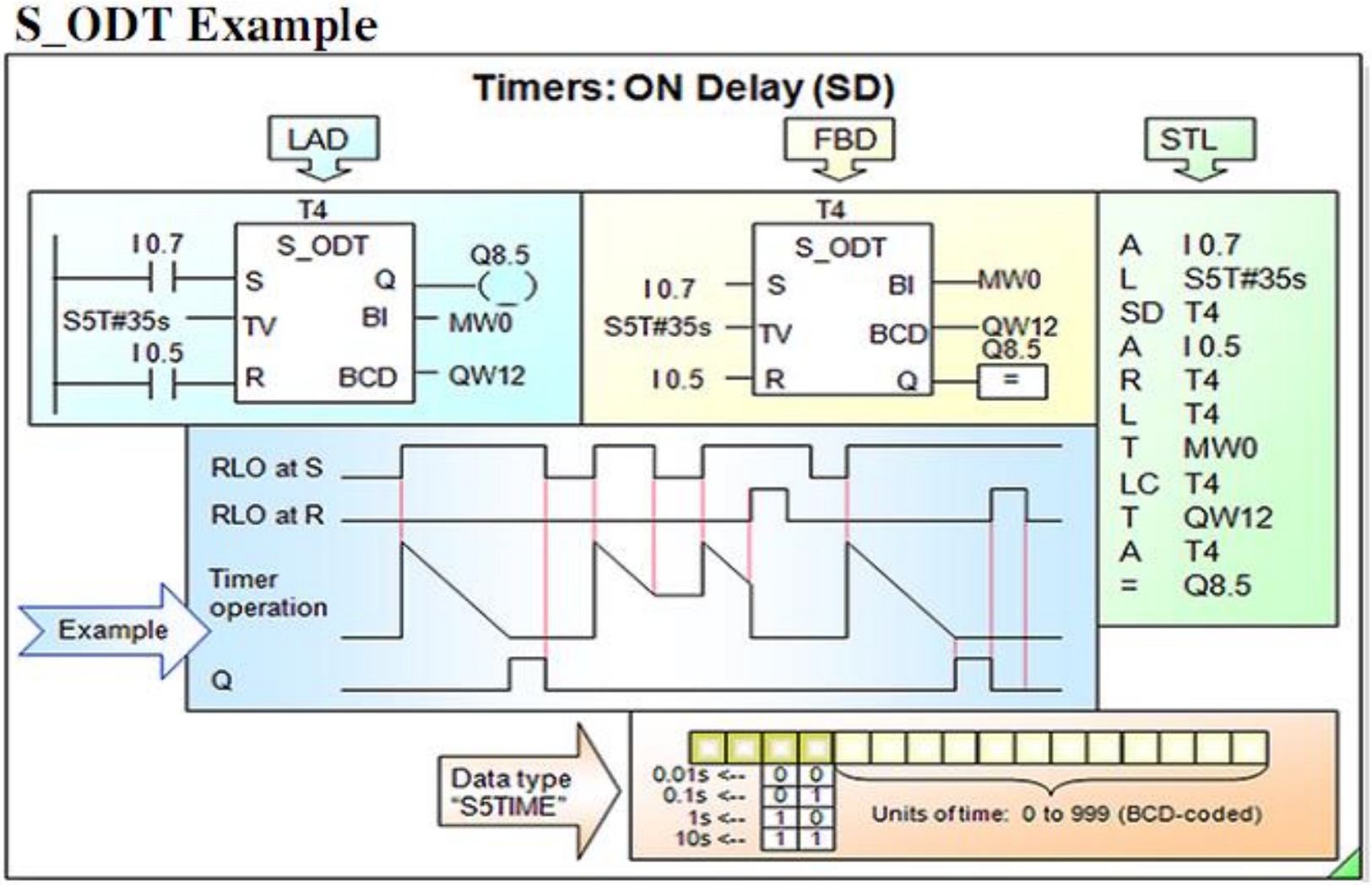
Timer Instructions are available in Ladder

- 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

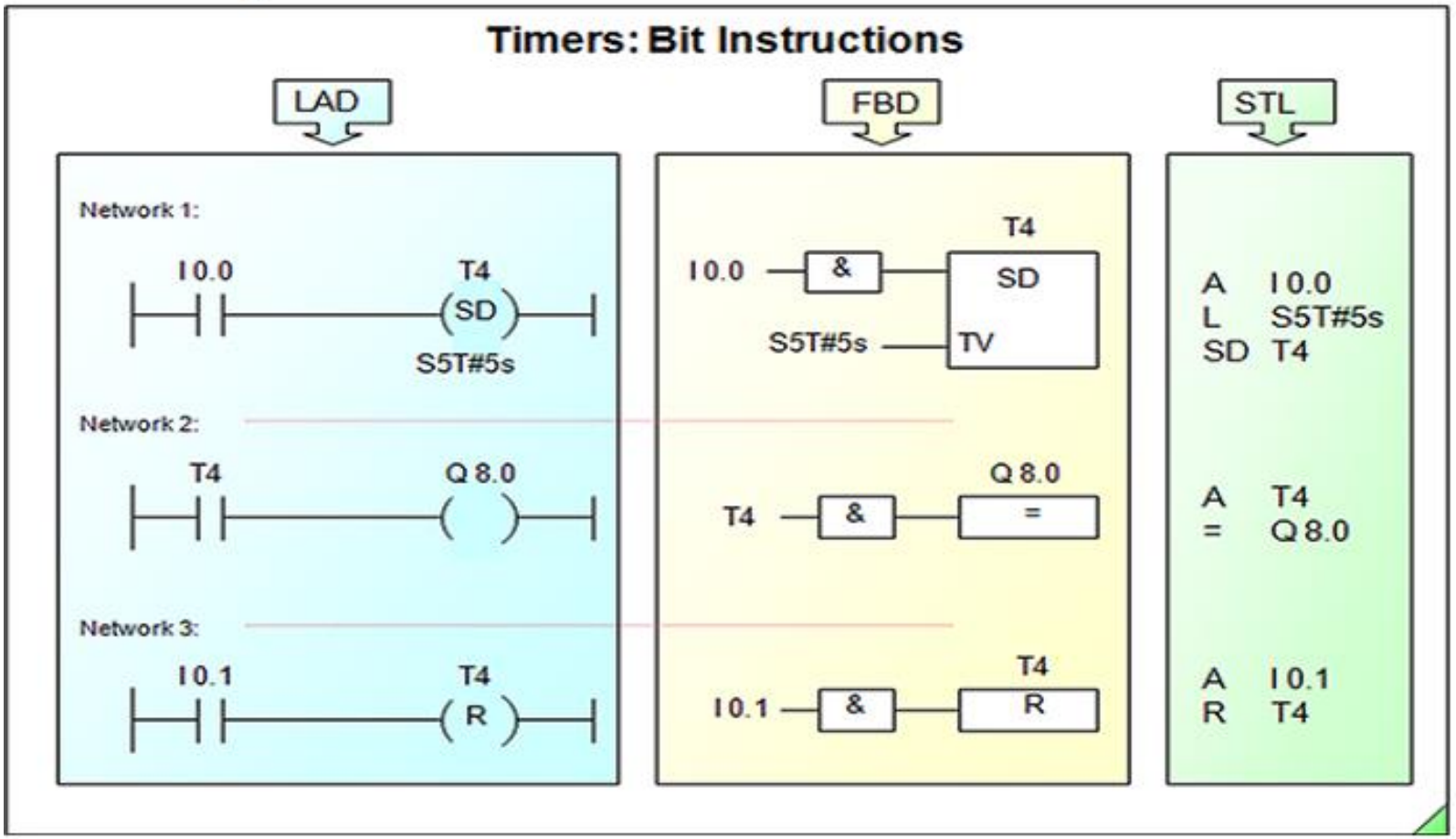
- SD On-Delay Timer
- SE Extended Pulse Timer
- SF Off-Delay Timer
- SP Pulse Timer
- SS Retentive On-Delay Timer

TẬP LỆNH CƠ BẢN TRONG S7-300



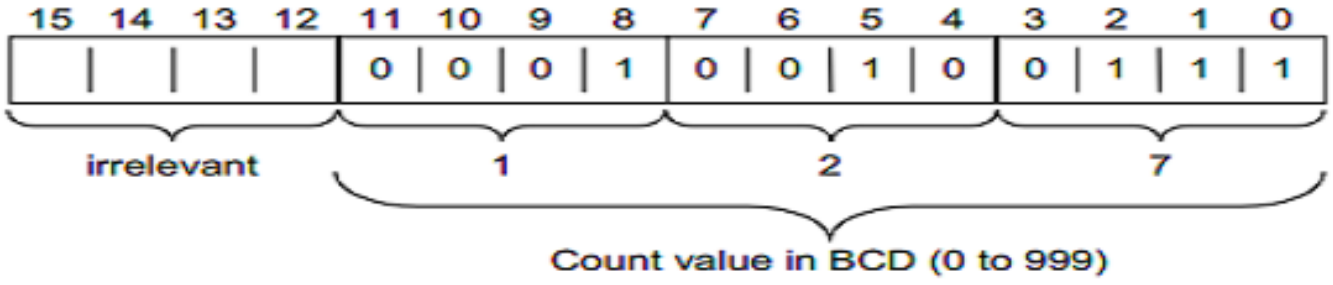
TẬP LỆNH CƠ BẢN TRONG S7-300

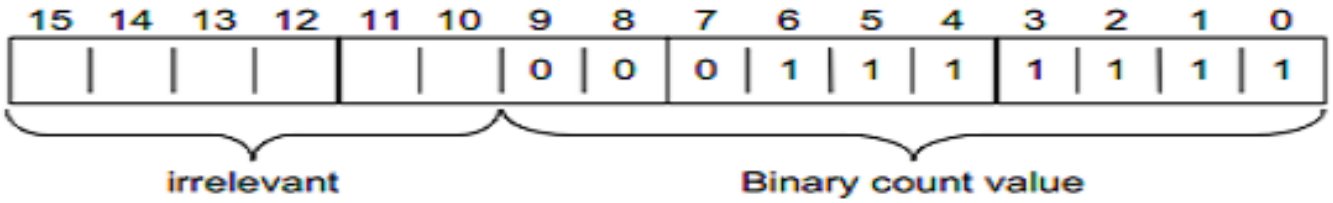
On delay Timer Coil



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

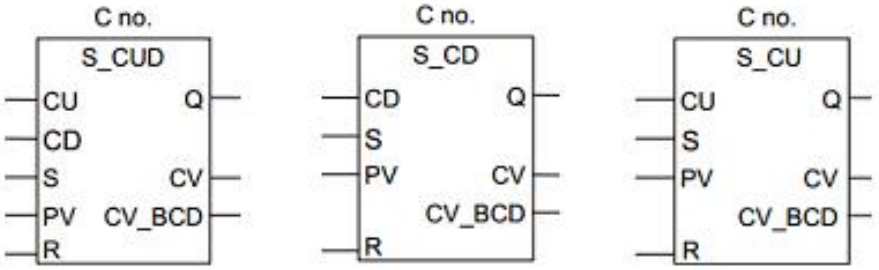




TẬP LỆNH CƠ BẢN TRONG S7-300

Types of counter

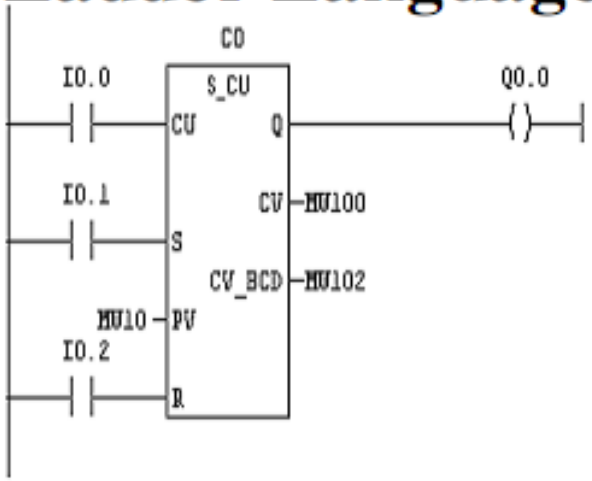
- S_CUD Up-Down Counter
- S_CD Down Counter
- S_CU Up Counter
- ---(SC) Set Counter Coil
- ---(CU) Up Counter Coil
- ---(CD) Down Counter Coil



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

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
```

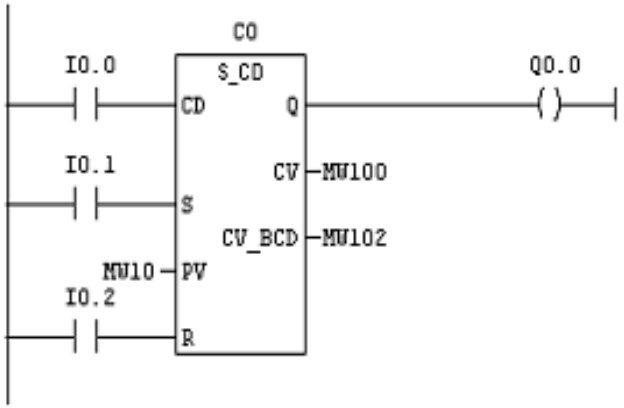
If the signal state of I0.0 changes from "0" to "1", the value of counter C10 will be incremented by one.

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

S_CD example

Ladder Language



STL Language

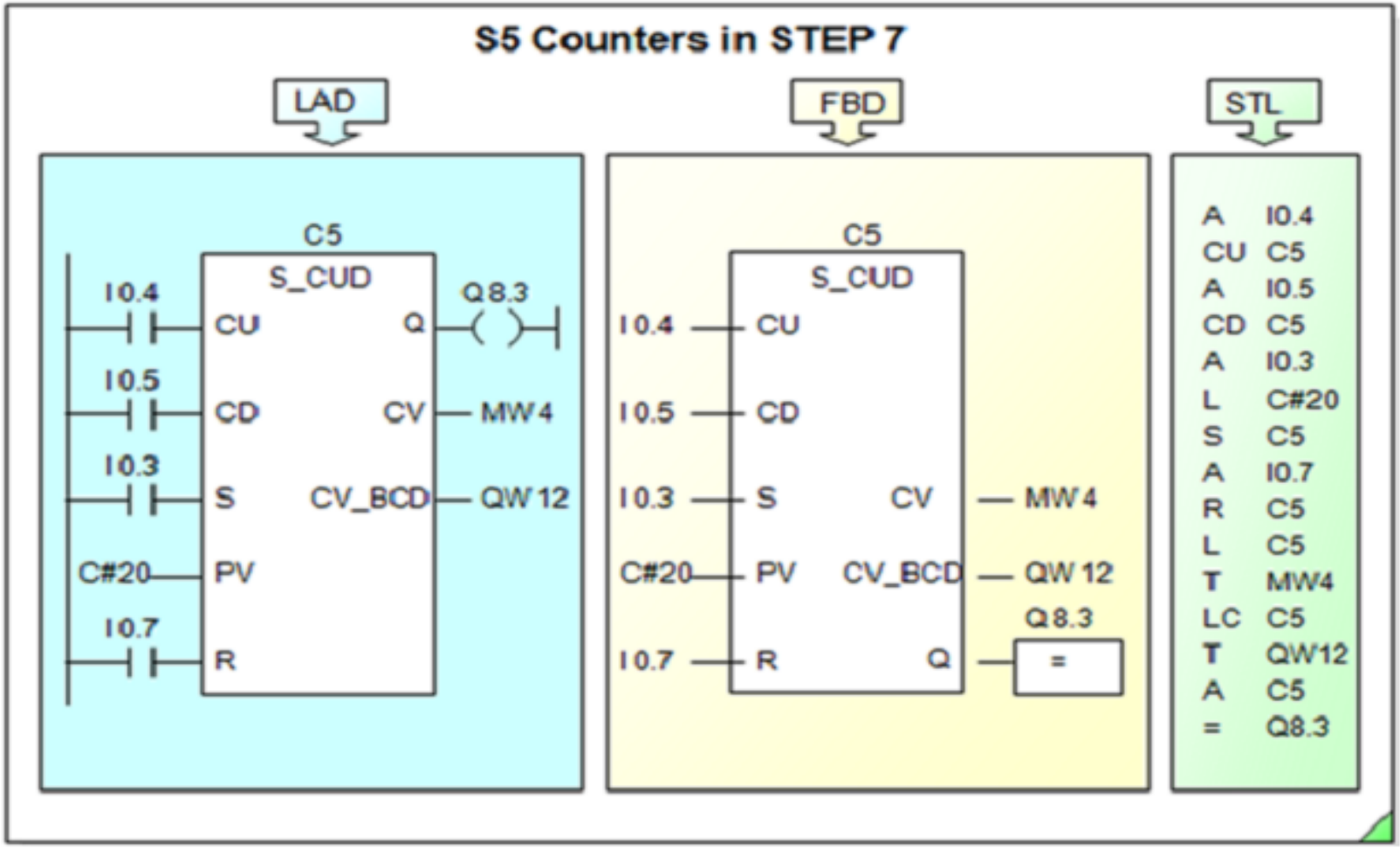
```
A     I     0.0
CD    C     0
A     I     0.1
L     MW    10
S     C     0
A     I     0.2
R     C     0
L     C     0
T     MW    100
LC    C     0
T     MW    102
A     C     0
=     Q     0.0
```

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.

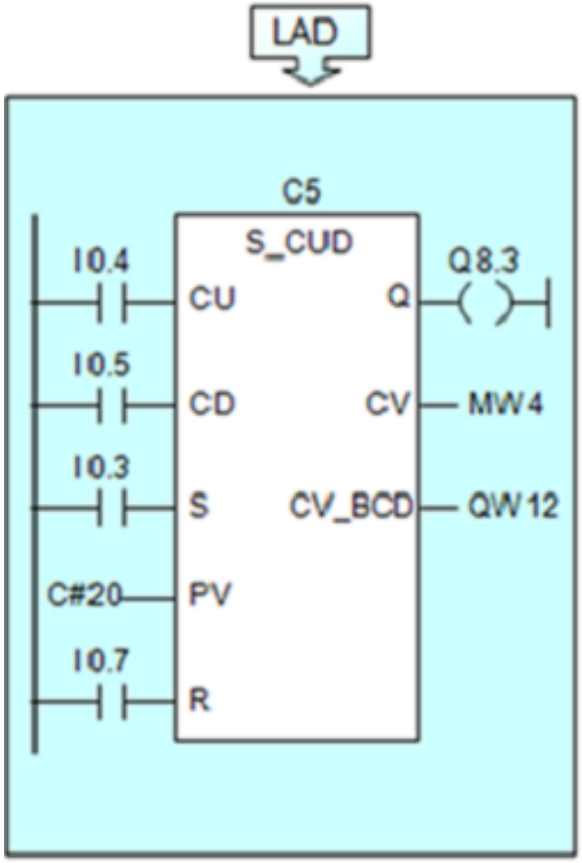
MW100 is Counter value as binary, MW102 is counter value as BCD

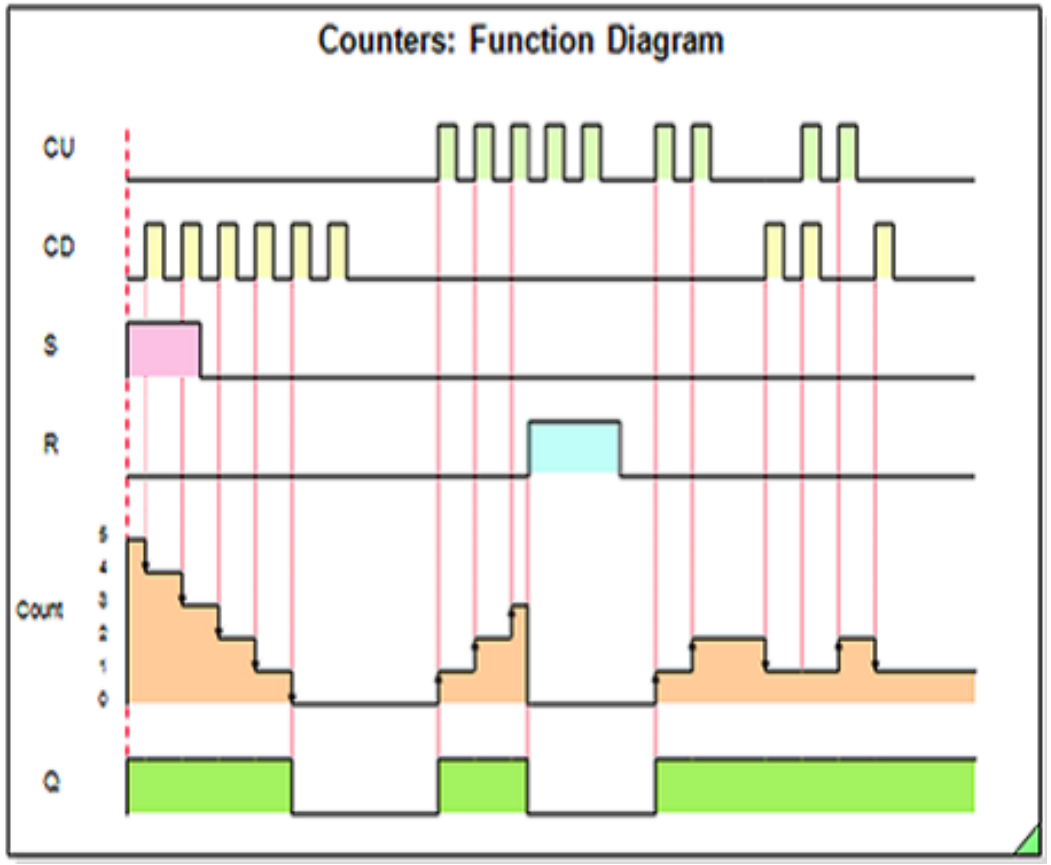
S_CUD Example



TẬP LỆNH CƠ BẢN TRONG S7-300

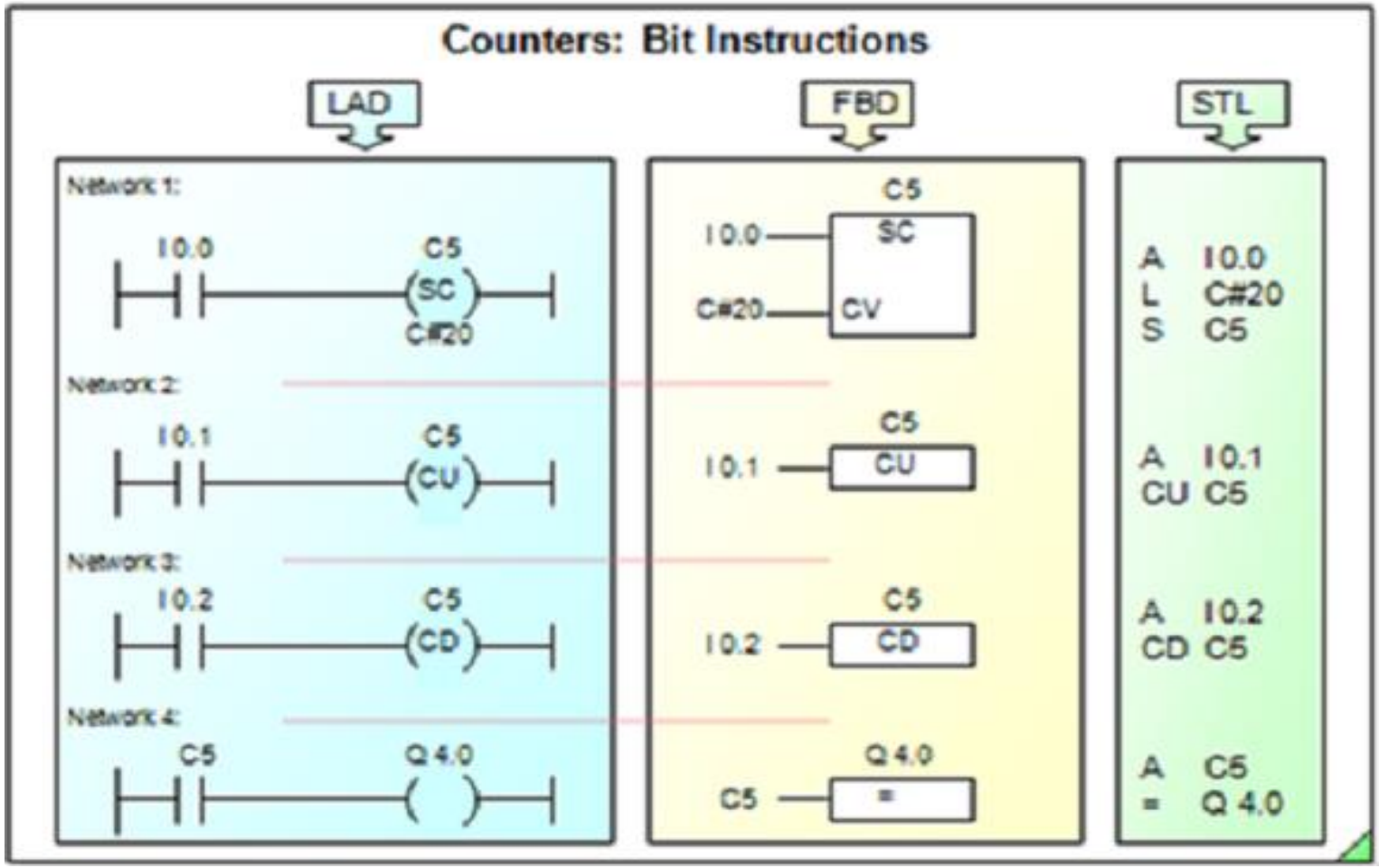
S_CUD Example





TẬP LỆNH CƠ BẢN TRONG S7-300

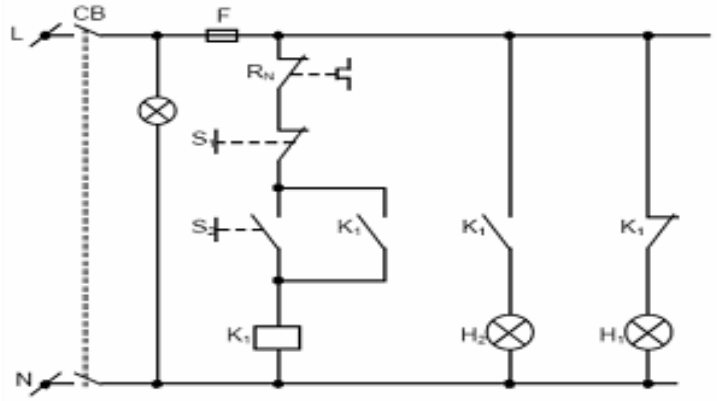
Counter: Bit instructions

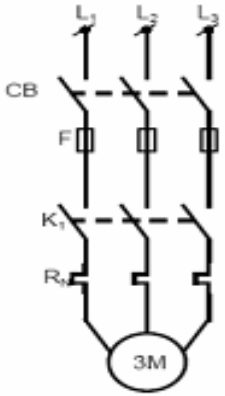


EXAMPLE OF INSTRUCTIONS

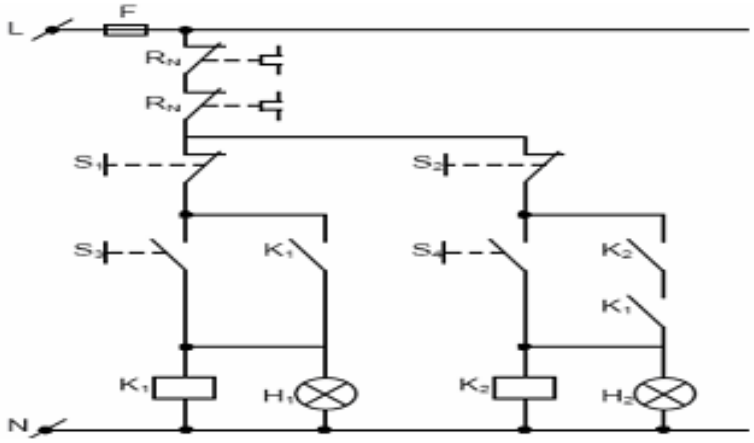
Using LAD, and STL to program for relay control circuits from Ex11 to Ex14

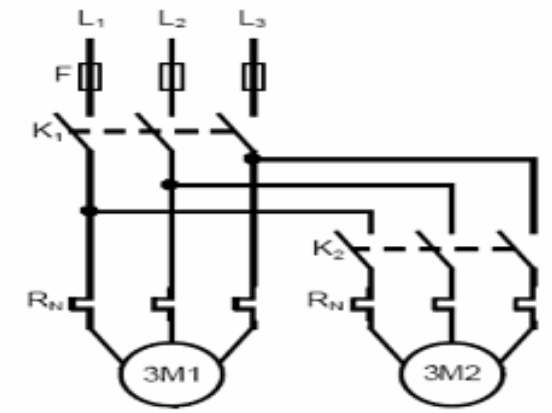
Ex11





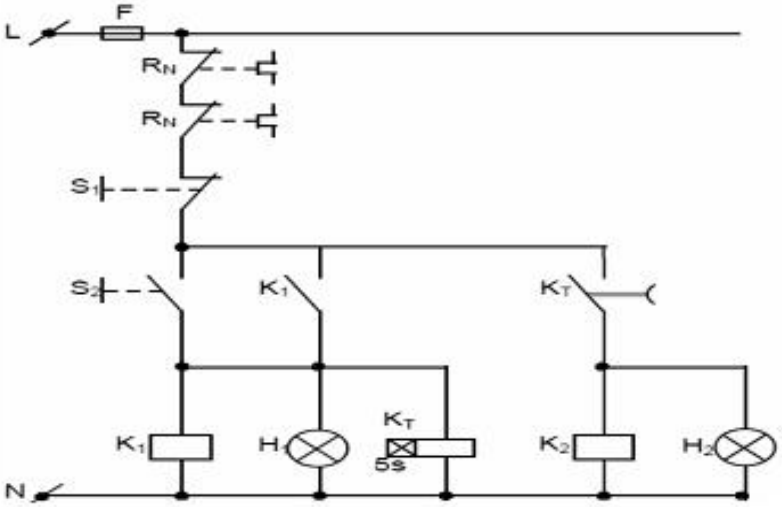
Ex12

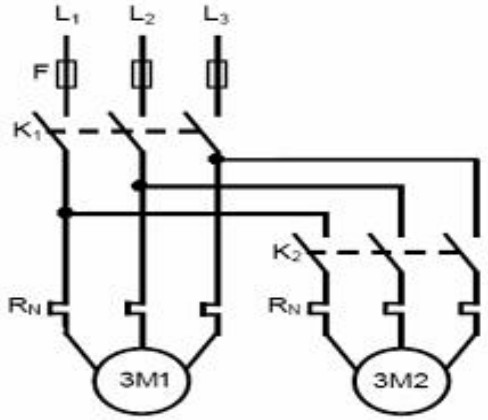




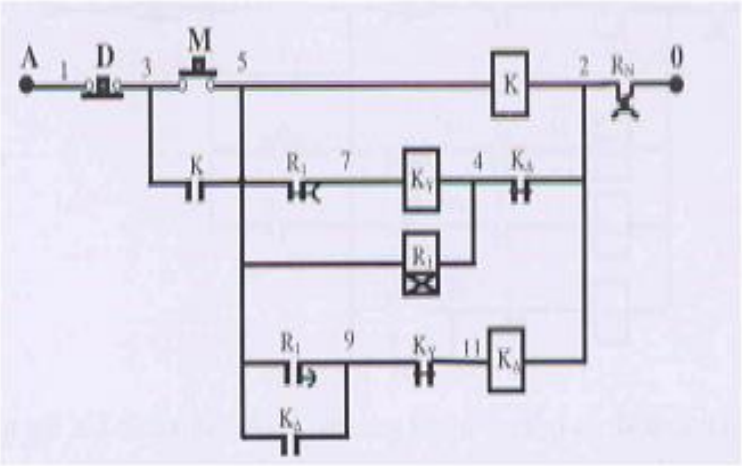
EXAMPLE OF INSTRUCTIONS

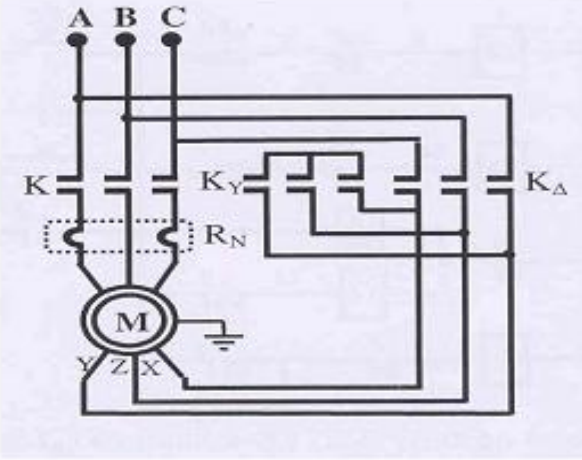
Ex13:





Ex14:

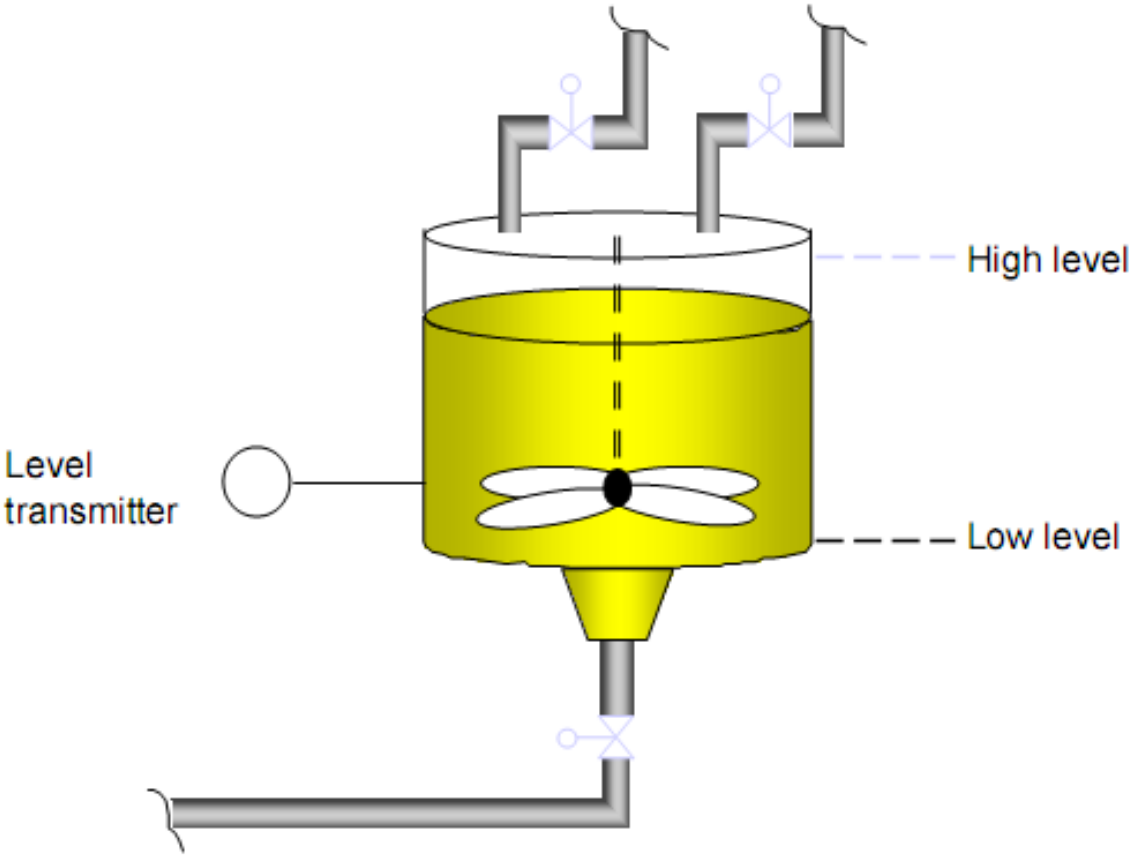




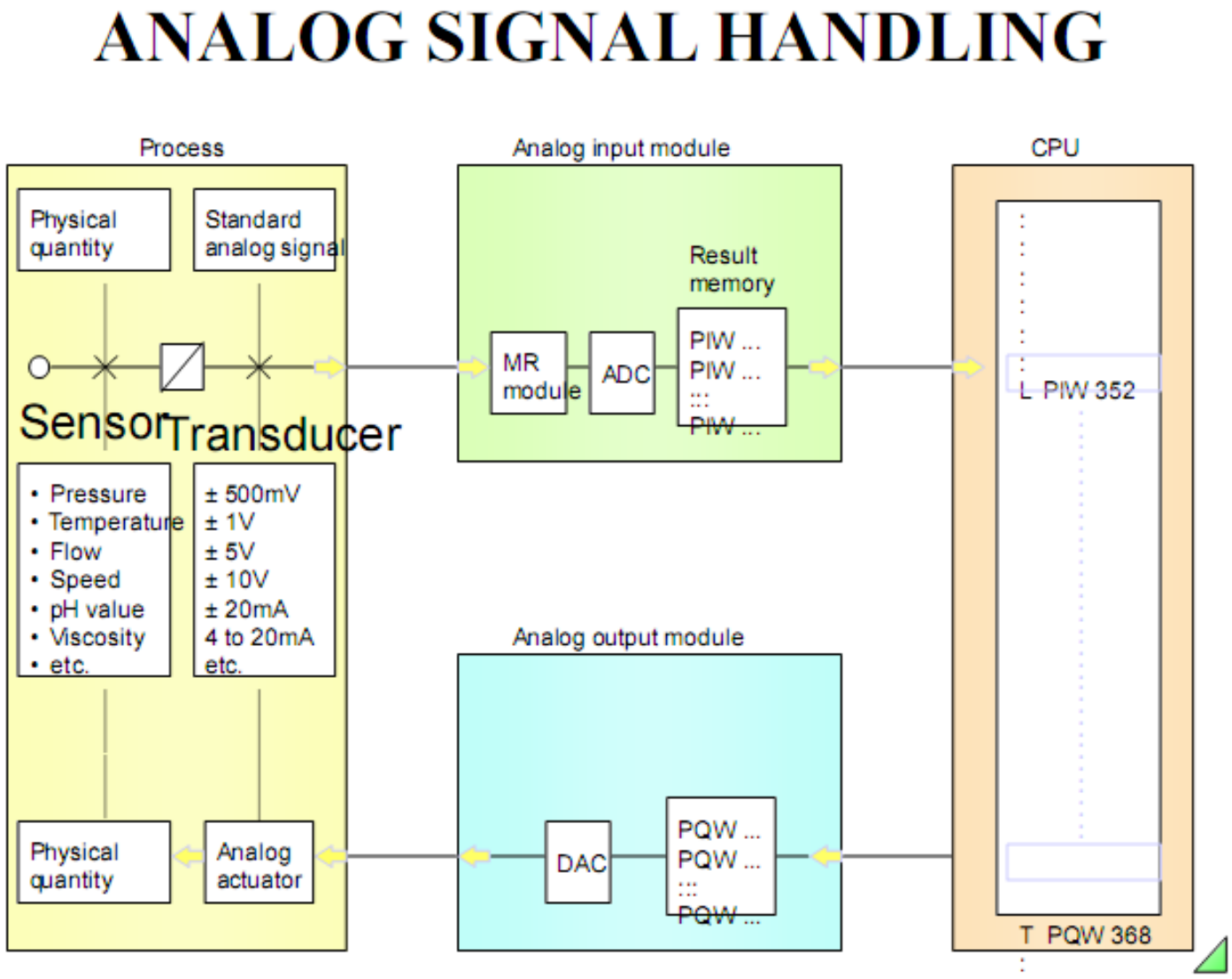
GIÁO TRÌNH LẬP TRÌNH PLC 2

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

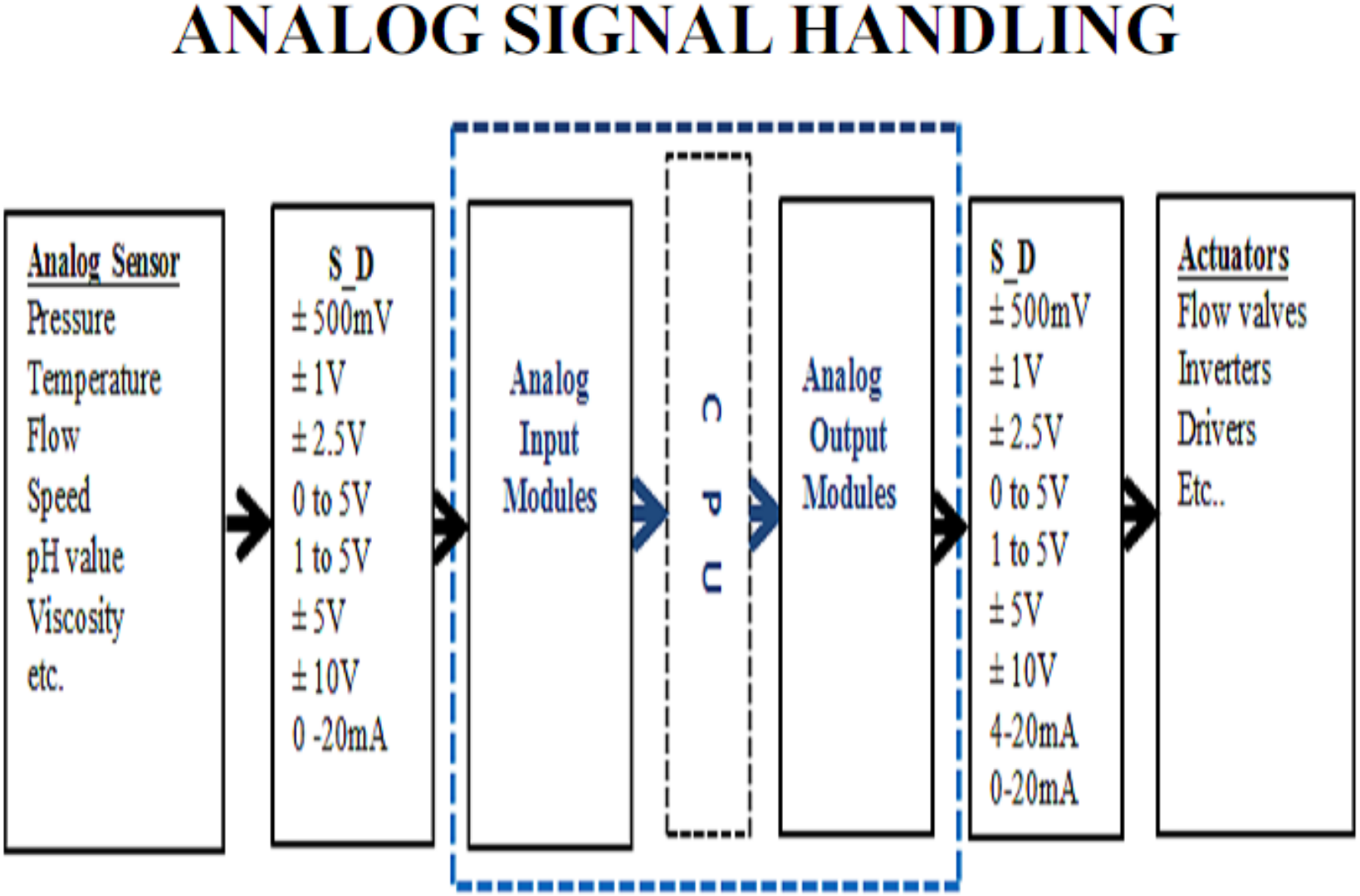
ANALOG SIGNAL HANDLING



XỬ LÝ TÍN HIỆU ANALOG TRONG S7-300

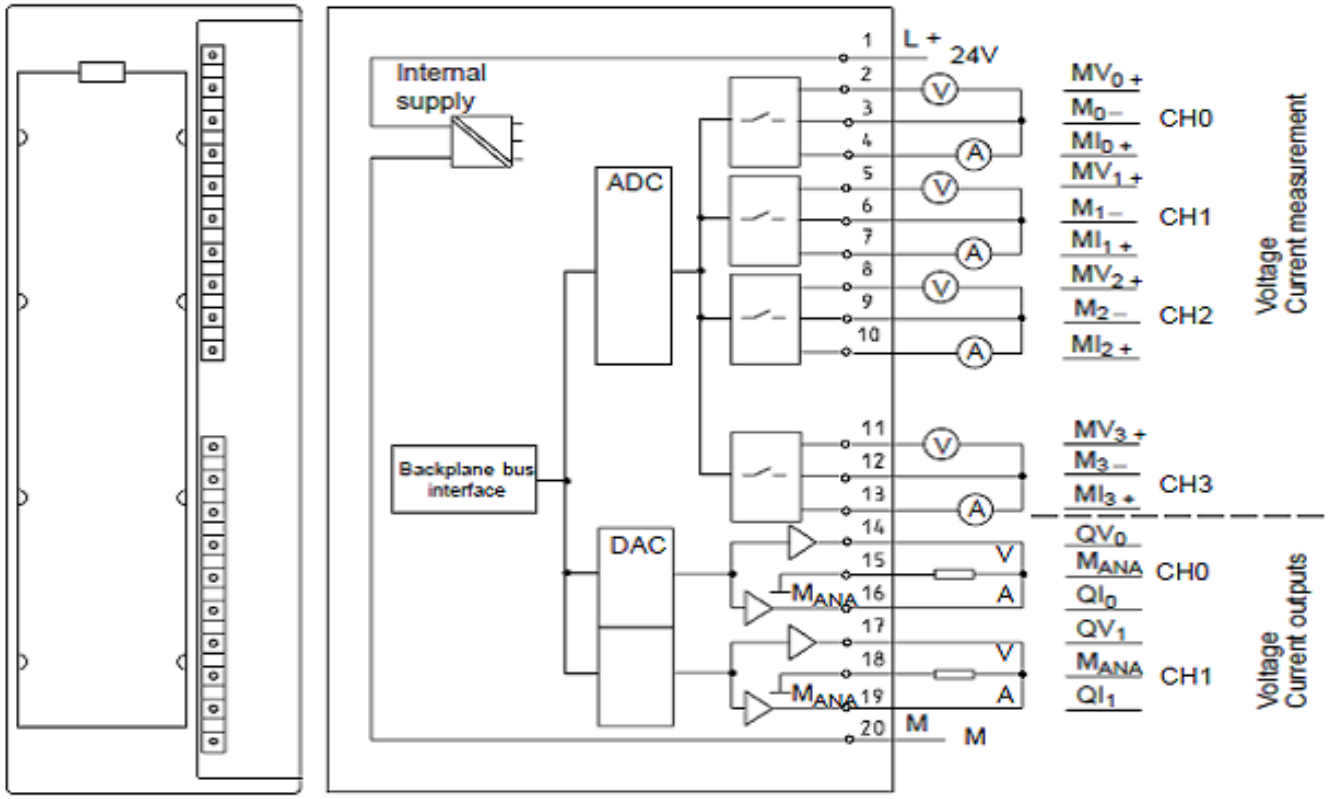


XỬ LÝ TÍN HIỆU ANALOG TRONG S7-300



ANALOG SIGNAL HANDLING

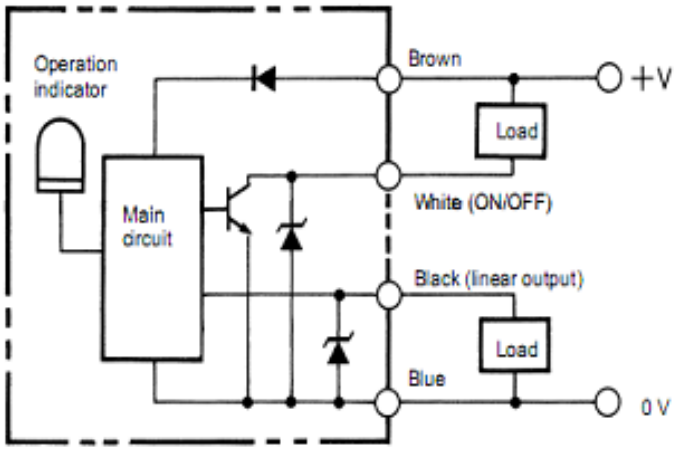
Analog input, output signal connection

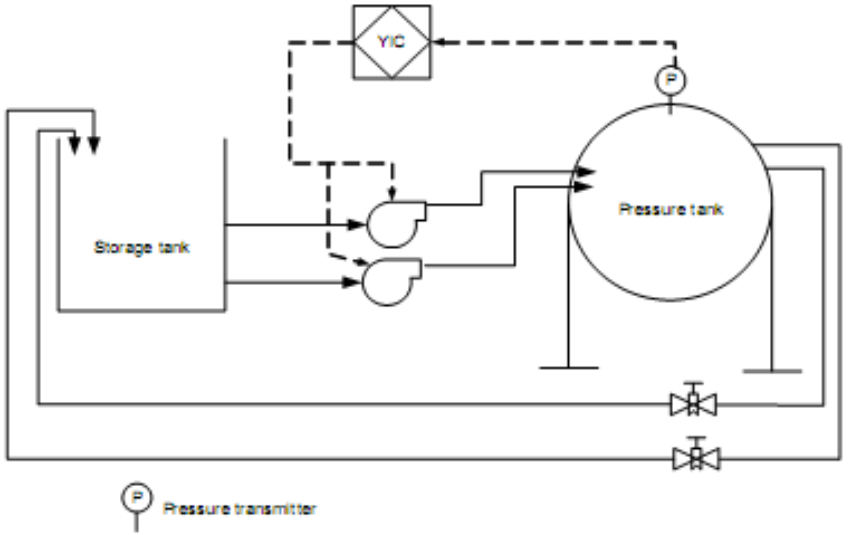


Module View and Block Diagram of the Analog Input/Output Module SM 334;
AI 4/AO 2 × 8/8 bits

ANALOG MODULE APPLICATION

EX14: Pressure sensor



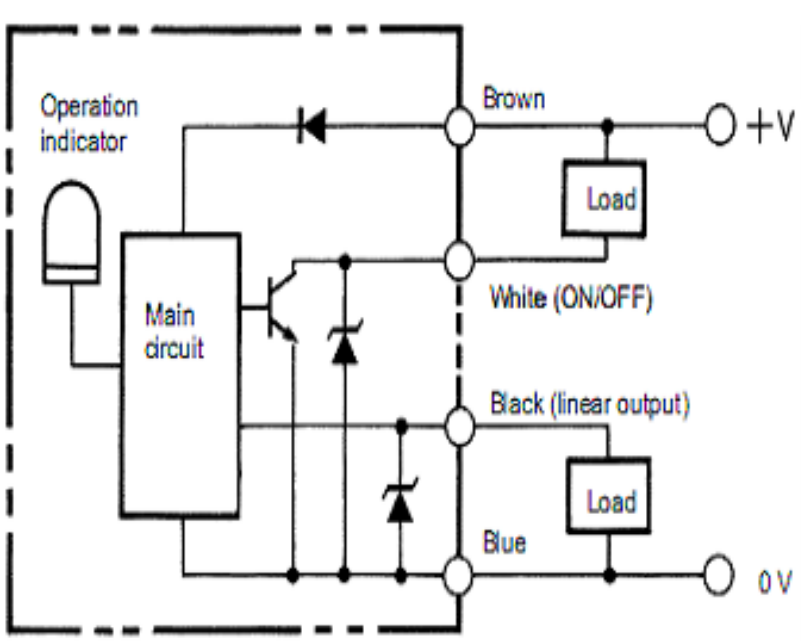


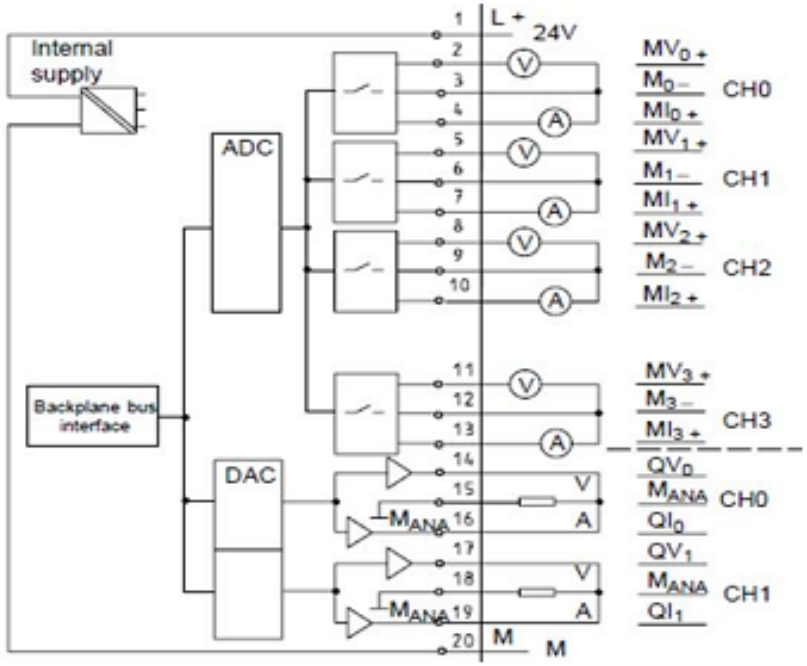
Pressure range		ON/OFF output		Linear output
		NPN open collector	PNP open collector	
Positive pressure	0 to 1 MPa	E8EB-10C	E8EB-10B	
Positive pressure	0 to 100 kPa	E8EB-01C	E8EB-01B	1 to 5 V
Negative pressure	0 to –100 kPa	E8EB-N0C2B	E8EB-N0B2B	

ANALOG SIGNAL HANDLING

EX14: Connecting pressure sensor to Analog input module

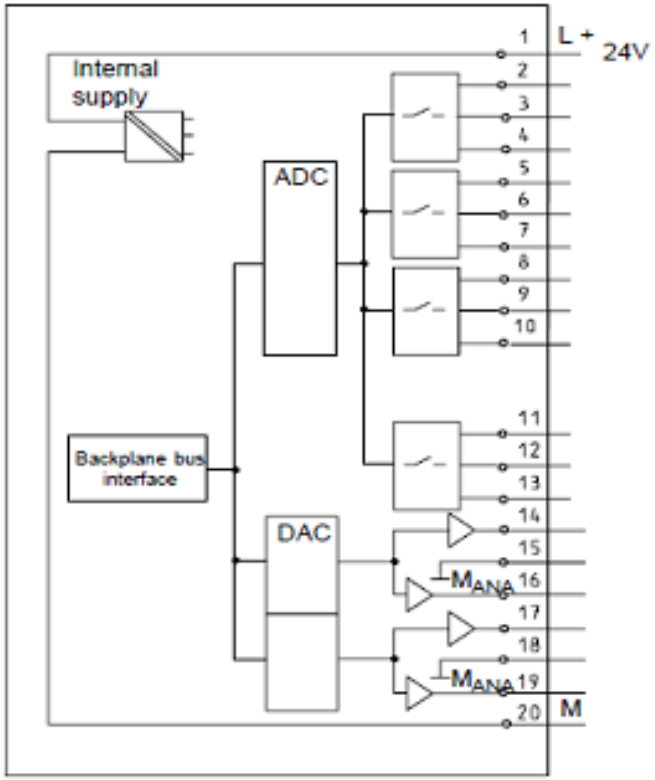
Pressure range		ON/OFF output		Linear output
		NPN open collector	PNP open collector	
Positive pressure	0 to 1 MPa	E8EB-10C	E8EB-10B	1 to 5 V
Positive pressure	0 to 100 kPa	E8EB-01C	E8EB-01B	
Negative pressure	0 to –100 kPa	E8EB-N0C2B	E8EB-N0B2B	





ANALOG SIGNAL HANDLING

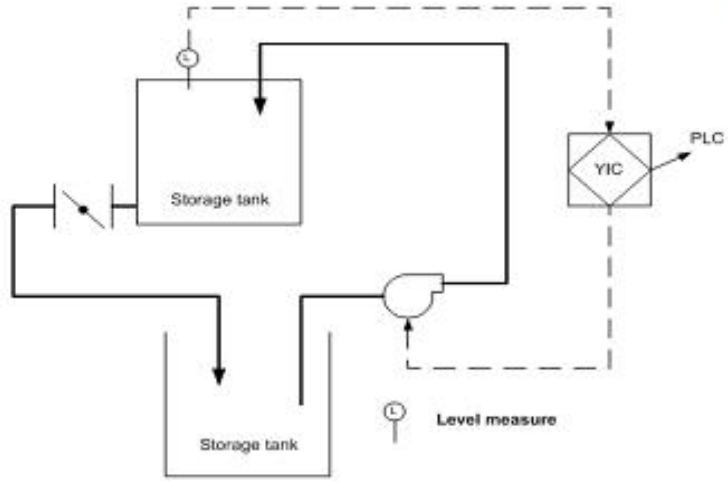
EX14: Connecting Voltage Sensers to Analog input module



XỬ LÝ TÍN HIỆU ANALOG TRONG S7-300

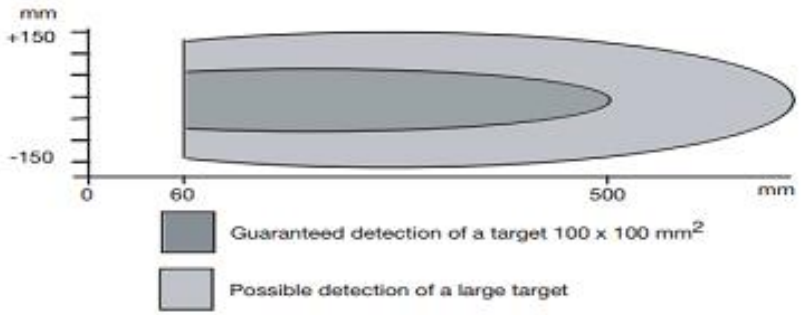
ANALOG SIGNAL HANDLING

EX15: Ultrasonic Diffuse, Analog Output

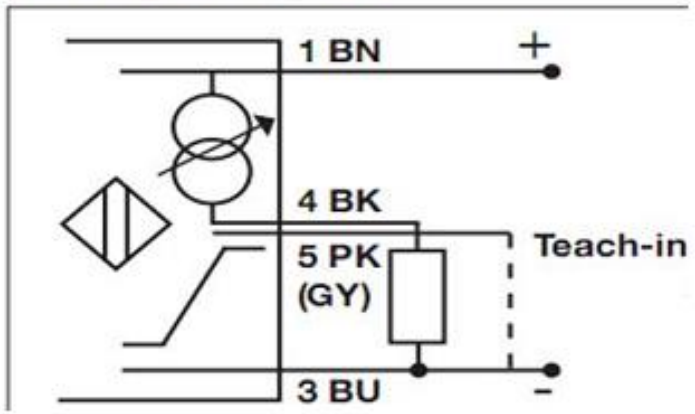


60-500 mm	0-10 V	UA18CLD05AKM1TR
60-500 mm	0-10 V	UA18CLD05AKTR
60-500 mm	4-20 mA	UA18CLD05AGM1TR
60-500 mm	4-20 mA	UA18CLD05AGTR

UA18CLD05



Wiring Diagram

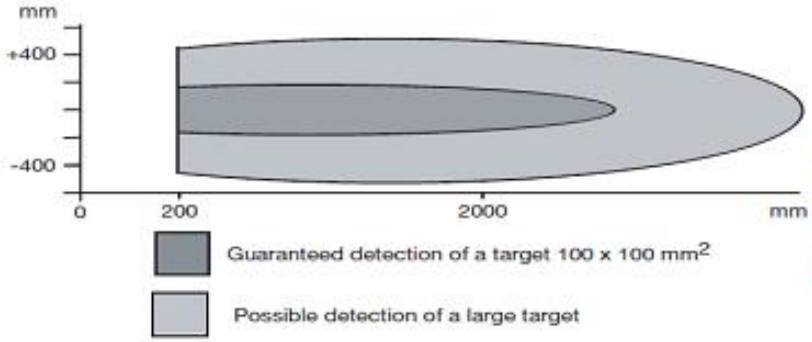


XỬ LÝ TÍN HIỆU ANALOG TRONG S7-300

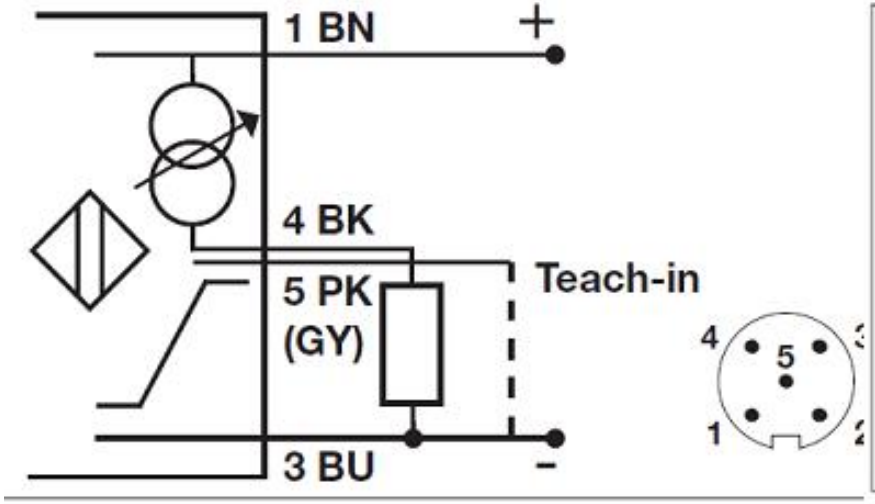
ANALOG SIGNAL HANDLING

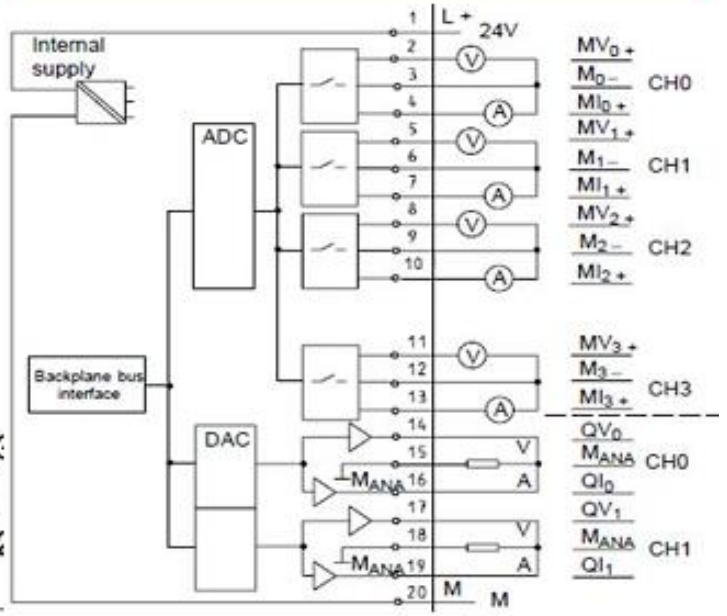
EX15: Connecting Ultrasonic sensor to Analog input module

UA18CLD20



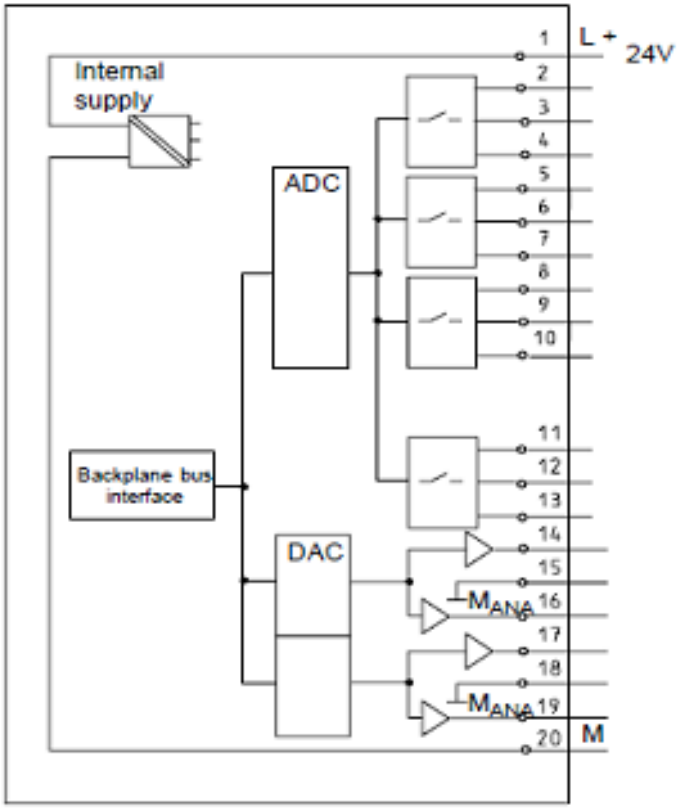
60-500 mm	0-10 V	UA18CLD05AKM1TR
60-500 mm	0-10 V	UA18CLD05AKTR
60-500 mm	4-20 mA	UA18CLD05AGM1TR
60-500 mm	4-20 mA	UA18CLD05AGTR





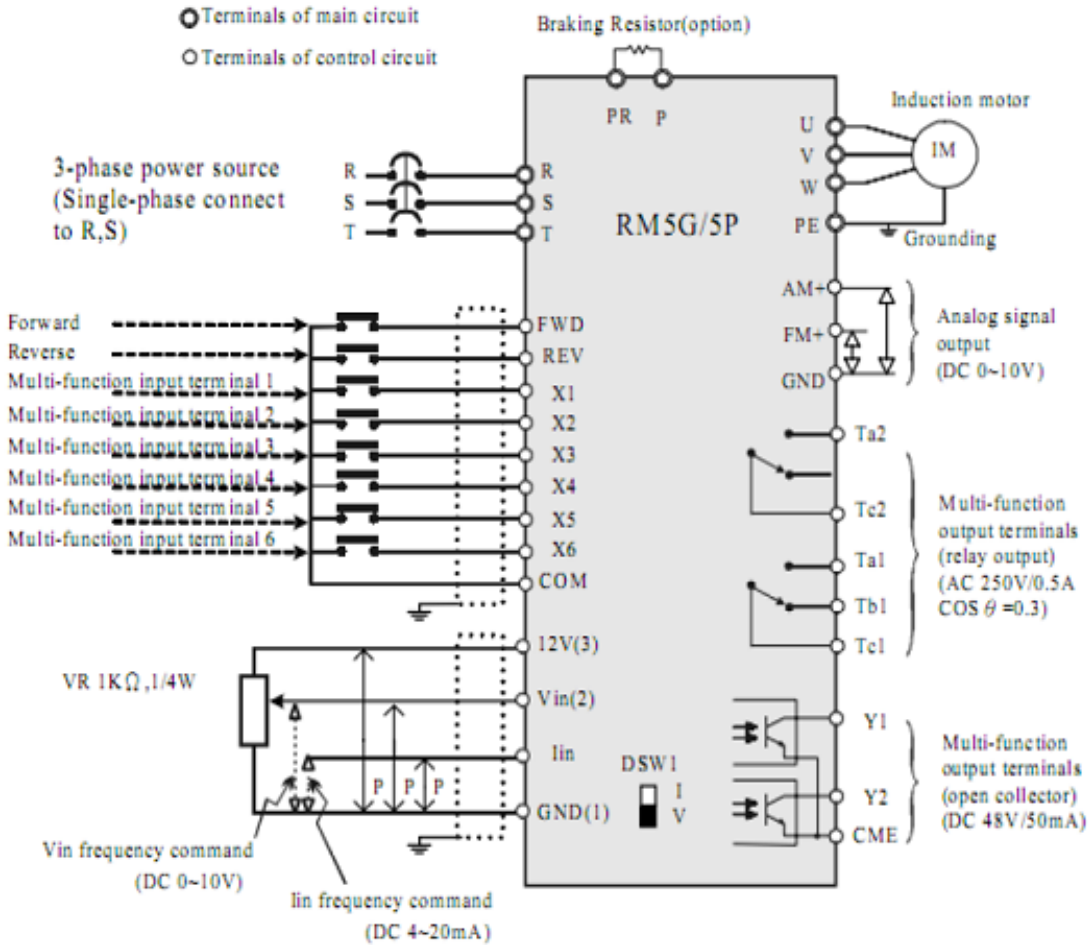
ANALOG SIGNAL HANDLING

EX15: Connecting Current Sensers to Analog input module



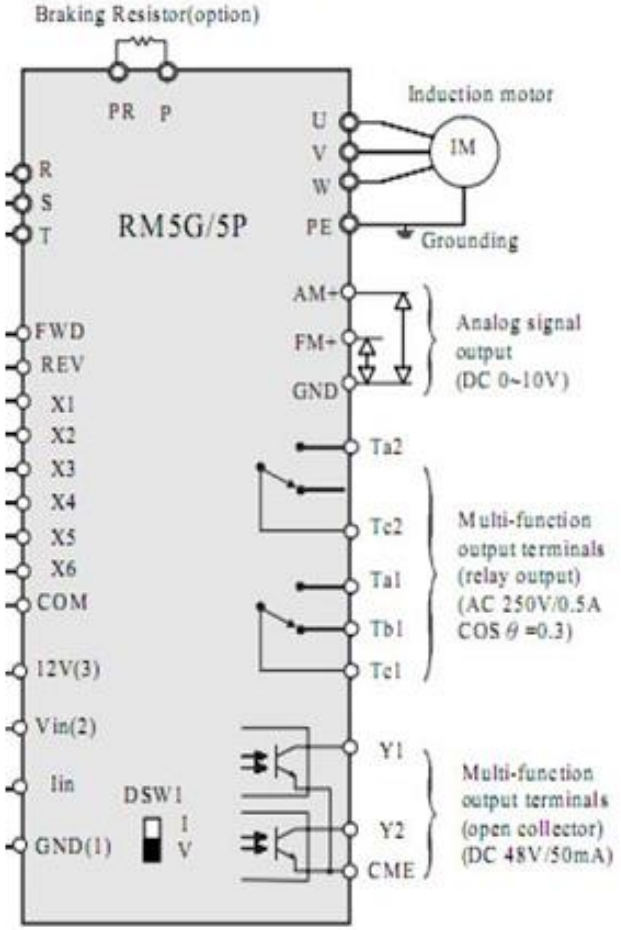
ANALOG SIGNAL HANDLING

EX16: Connecting analog output module to control inverter



ANALOG SIGNAL HANDLING

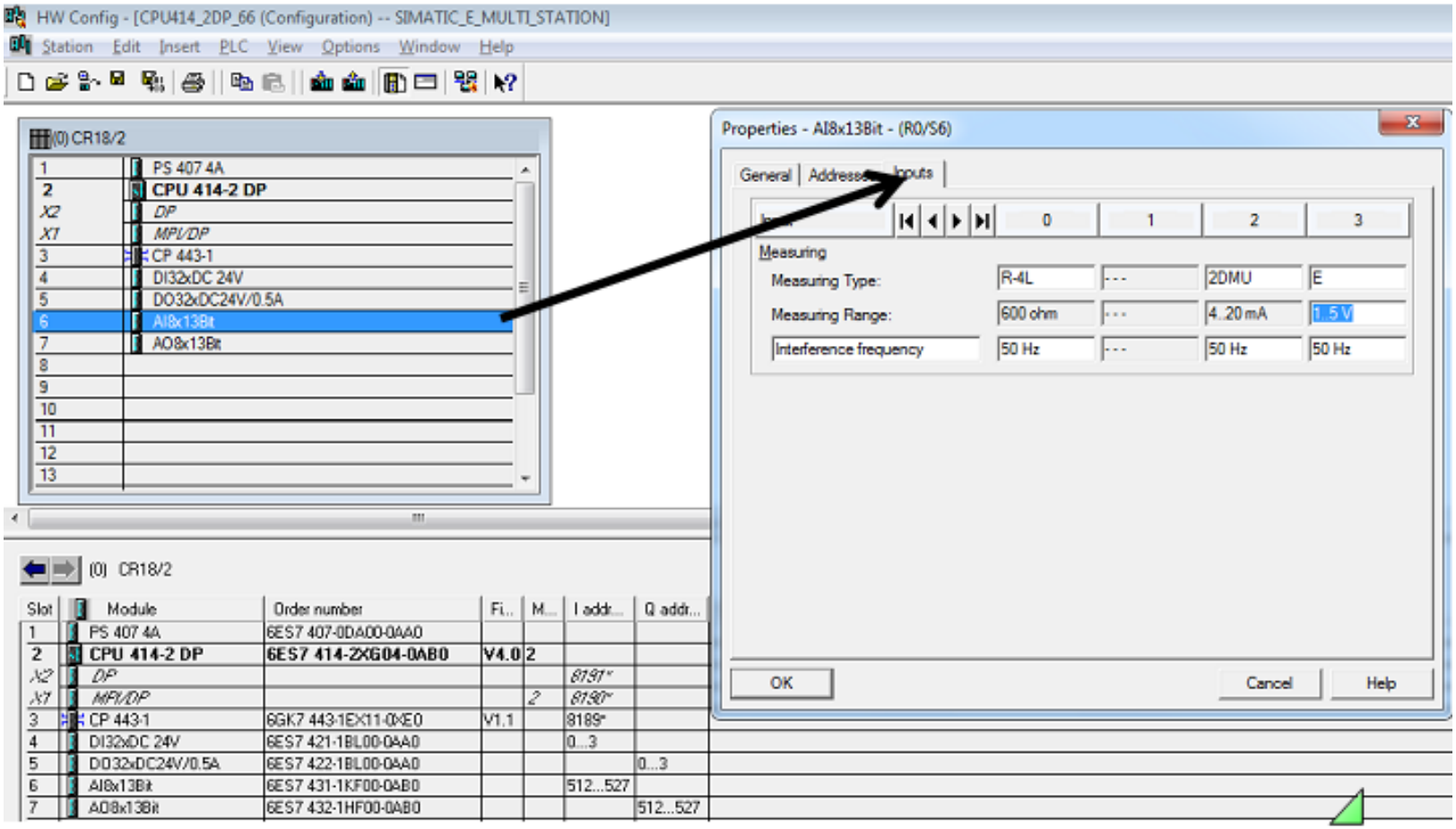
EX16: Connecting analog output module to control inverter



XỬ LÝ TÍN HIỆU ANALOG TRONG S7-300

ANALOG SIGNAL HANDLING

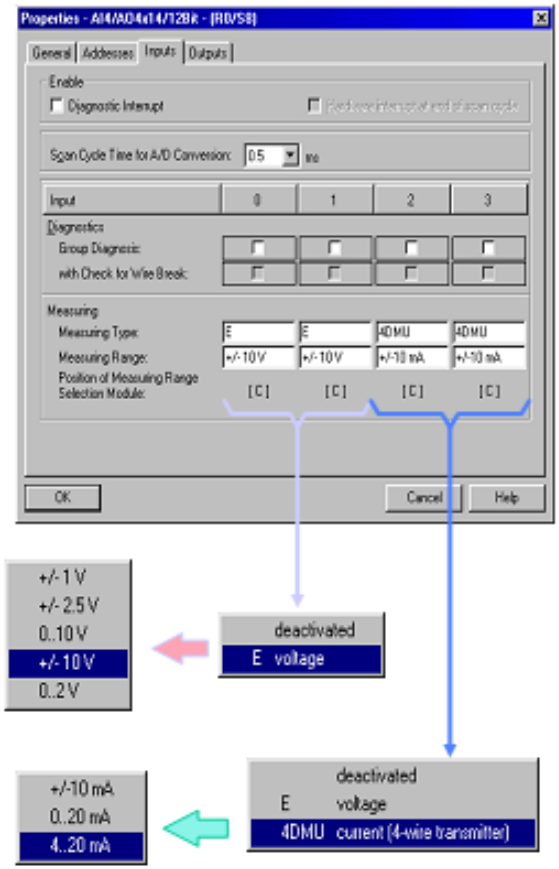
Configure analog input channels



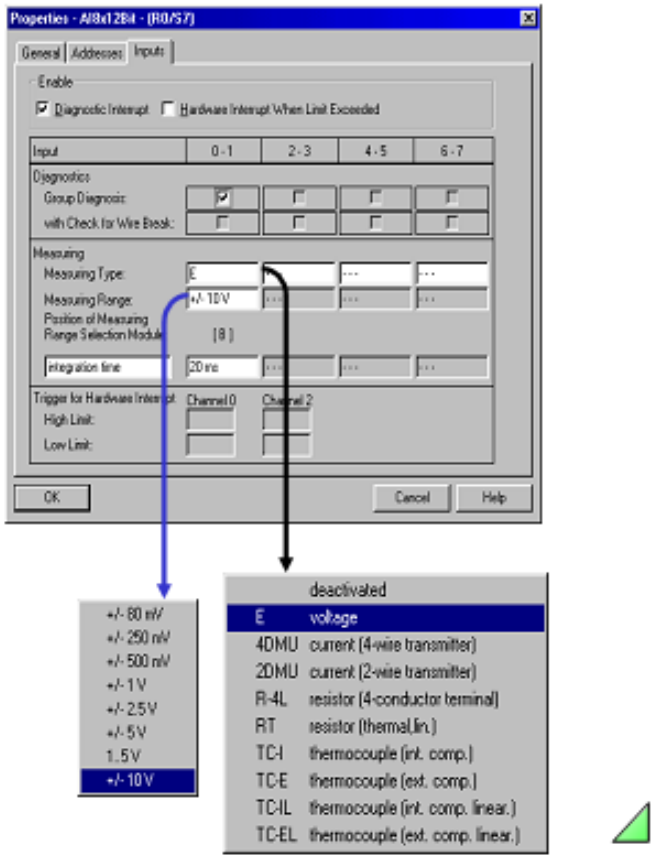
ANALOG SIGNAL HANDLING

Configure analog input channels

SM335 (Inputs)



SM331



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

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 µ V	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					Underrange
–117.593%	–32512	8100	–11.759 V	–5.879 V	–2.940 V	–1.176 V	
–117.596 %	–32513	80FF					Underflow
–118.519%	–32768	8000	–11.851 V	–5.926 V	–2.963 V	–1.185 V	

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 µV	0 V + 361.7 µV	
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			

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	
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	Rated range
	–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	

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 kΩ	150 Ω	300 Ω	600 Ω	
118.515 %	32767	7FFF	11.852kΩ	177.77Ω	355.54 Ω	711.09 Ω	Overflow
117.593%	32512	7F00		150.01Ω	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 kΩ	150 Ω	300 Ω	600 Ω	
75%	20736	5100	7.5 kΩ	112.5 Ω	225 Ω	450 Ω	
0.003617%	1	1	361.7mΩ	5.43 mΩ	10.85mΩ	21.70mΩ	Rated range
0 %	0	0	0 Ω	0 Ω	0 Ω	0 Ω	
			(neg. values physically not possible)				Underrange

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
	decimal	hexadecimal		decimal	hexadecimal		decimal	hexadecimal	
> 1000.0	32767	$7FFF_H$	> 1832.0	32767	$7FFF_H$	> 1273.2	32767	$7FFF_H$	Overflow
1000.0 : 850.1	10000 : 8501	2710_H : 2135_H	1832.0 : 1562.1	18320 : 15621	4790_H : $3D05_H$	1273.2 : 1123.3	12732 : 11233	$31BC_H$: $2BE1_H$	Overrange
850.0 : –200.0	8500 : –2000	2134_H : $F830_H$	1562.0 : –328.0	15620 : –3280	$3D04_H$: $F330_H$	1123.2 : 73.2	11232 : 732	$2BE0_H$: $2DC_H$	Rated range
–200.1 : –243.0	–2001 : –2430	$F82F_H$: $F682_H$	–328.1 : –405.4	–3281 : –4054	$F32F_H$: $F02A_H$	73.1 : 30.2	731 : 302	$2DB_H$: $12E_H$	Underrange
< –243.0	–32768	8000_H	< –405.4	–32768	8000_H	< 30.2	32768	8000_H	Underflow

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	361.7µV	1V+144.7µV	
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	

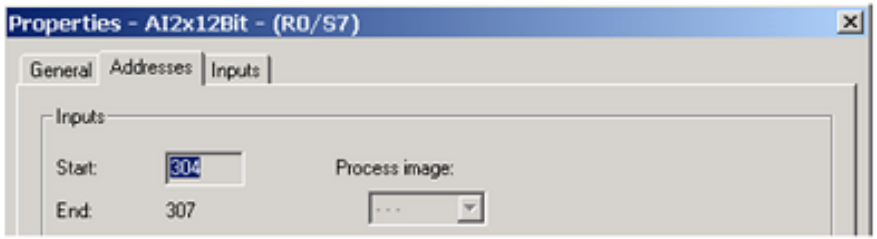
ANALOG SIGNAL HANDLING

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	

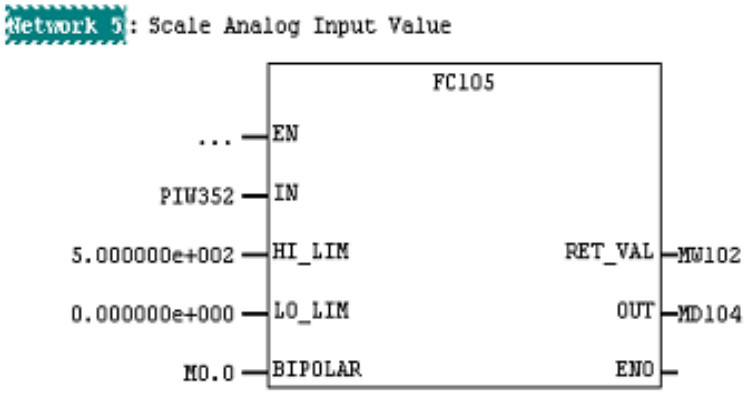
ANALOG SIGNAL HANDLING

Analog module addresses for the S7-300



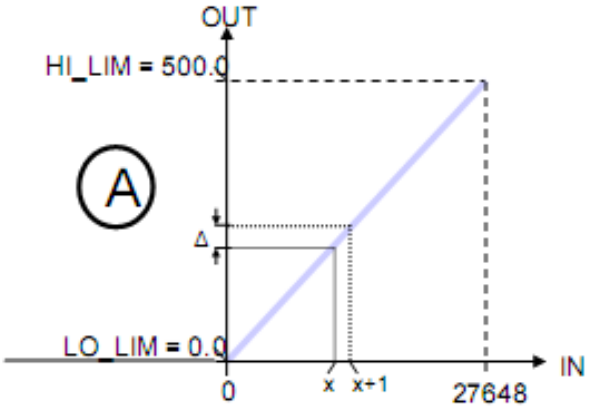
Rack 3	Power Supply	IM (Receive)	640 to 654	656 to 670	672 to 686	688 to 702	704 to 718	720 to 734	736 to 750	752 to 766
Rack 2	Power Supply	IM (Receive)	512 to 526	528 to 542	544 to 558	560 to 574	576 to 590	592 to 606	608 to 622	624 to 638
Rack 1	Power Supply	IM (Receive)	384 to 398	400 to 414	416 to 430	432 to 446	448 to 462	464 to 478	480 to 494	496 to 510
R 0	Power Supply	CPU	IM (Send)	256 to 270	272 to 286	288 to 302	304 to 318	320 to 334	336 to 350	352 to 366	368 to 382
Slot	2	3	4	5	6	7	8	9	10	11

Scaling Analog Input Values using FC105



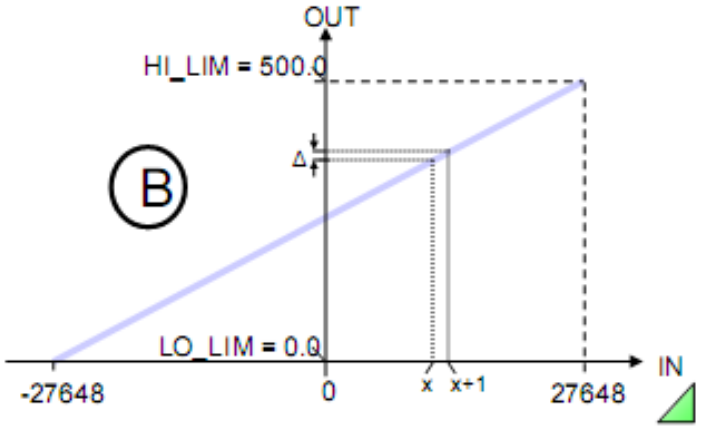
unipolar (M 0.0 = ´0´)

(Sensor supplies only positive voltage)

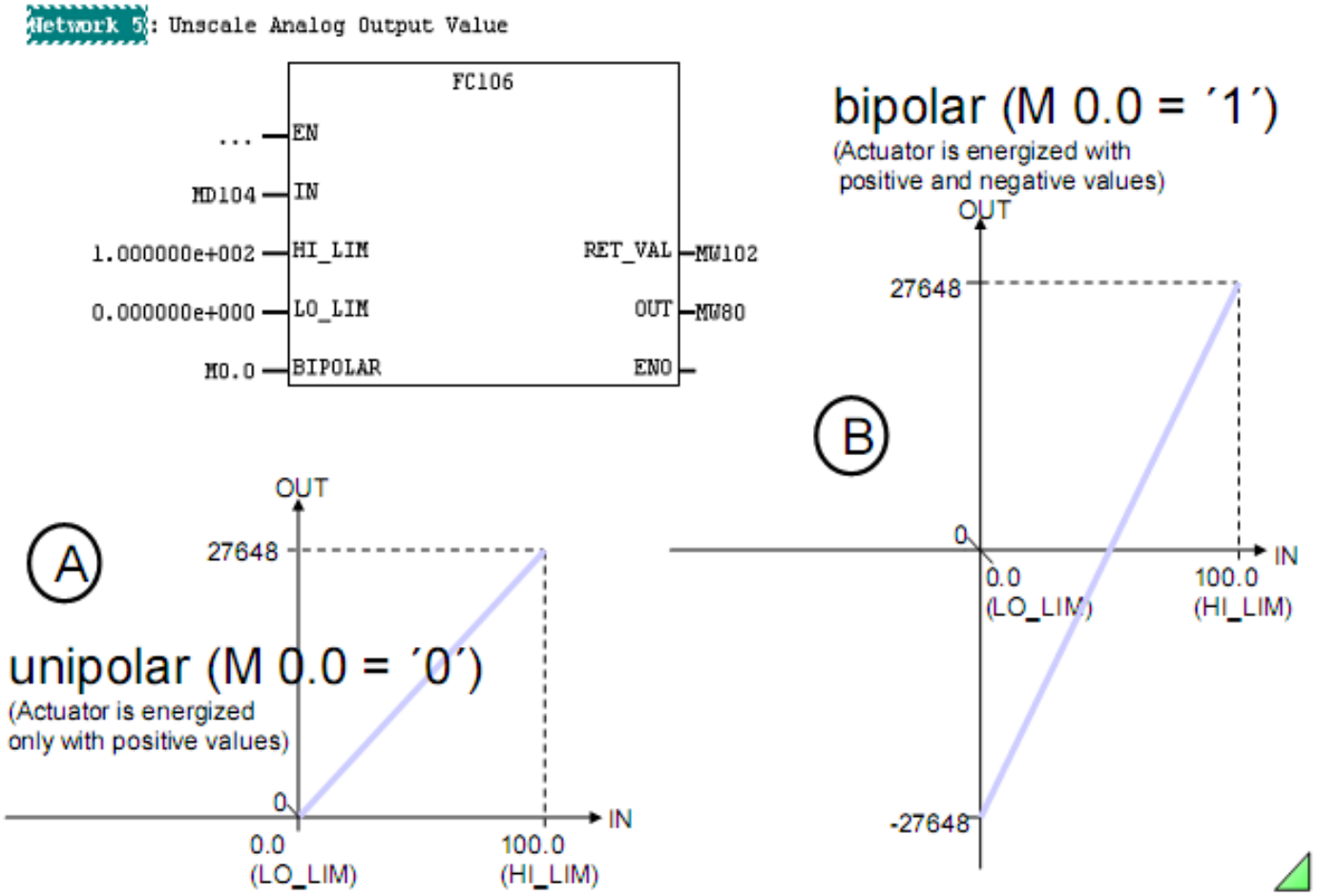


bipolar (M 0.0 = ´1´)

(Sensor also supplies negative voltage)

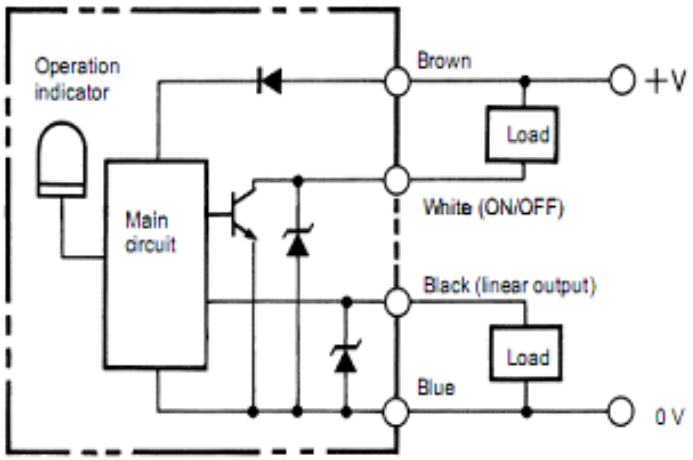


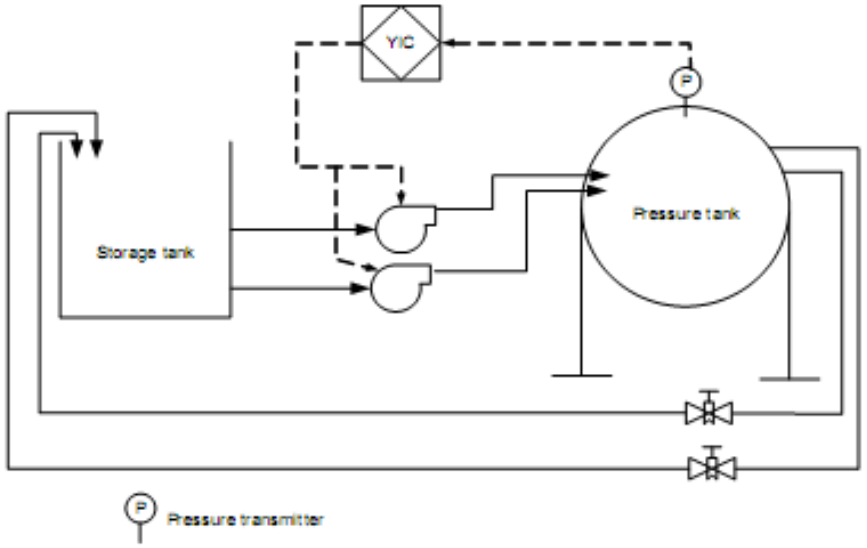
Unscaling Analog Output Values using FC106



ANALOG MODULE APPLICATION

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

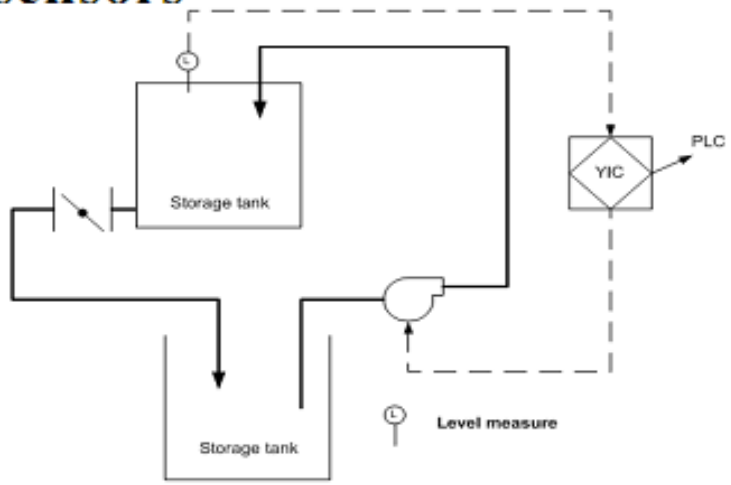




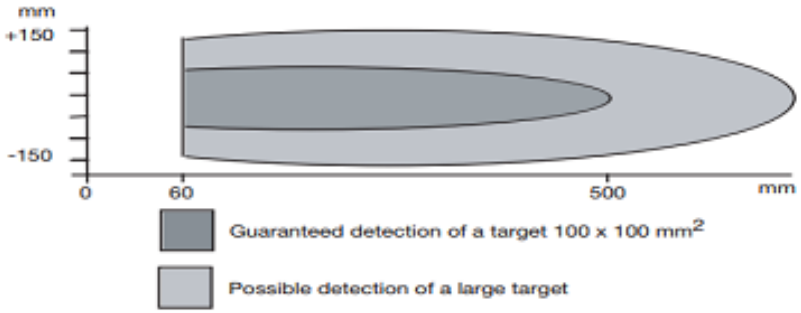
Pressure range		ON/OFF output		Linear output
		NPN open collector	PNP open collector	
Positive pressure	0 to 1 MPa	E8EB-10C	E8EB-10B	
Positive pressure	0 to 100 kPa	E8EB-01C	E8EB-01B	1 to 5 V
Negative pressure	0 to –100 kPa	E8EB-N0C2B	E8EB-N0B2B	

ANALOG MODULE APPLICATIONS

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

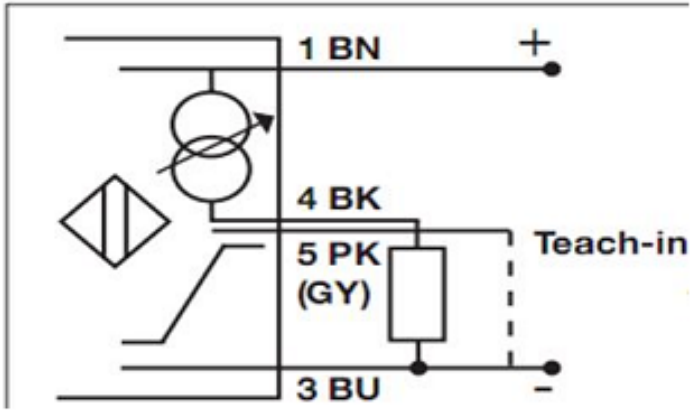


UA18CLD05



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



GIÁO TRÌNH LẬP TRÌNH PLC 2

CHƯƠNG V: CÁC KHỐI TRONG S7-300

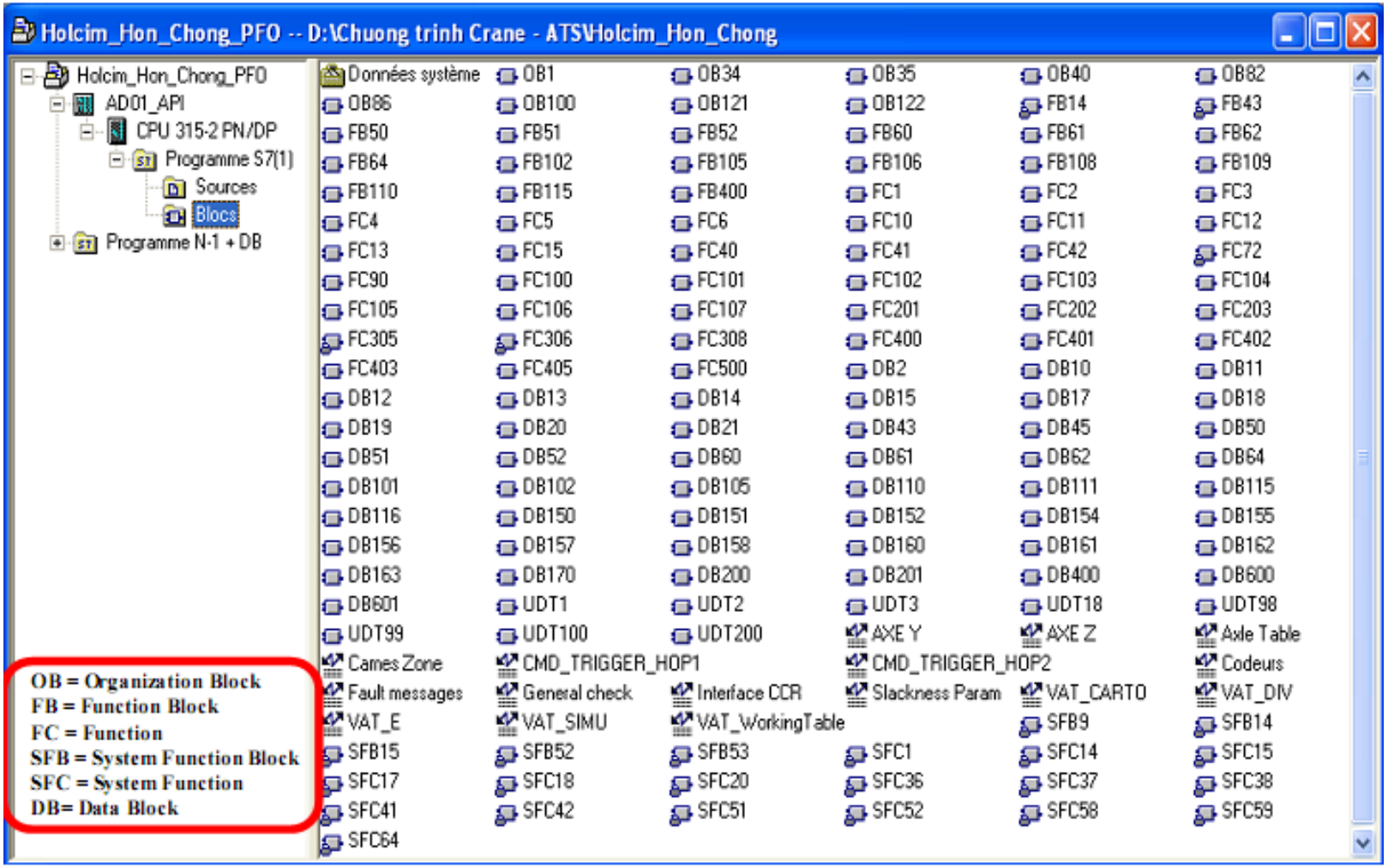
CÁC KHỐI TRONG S7-300

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

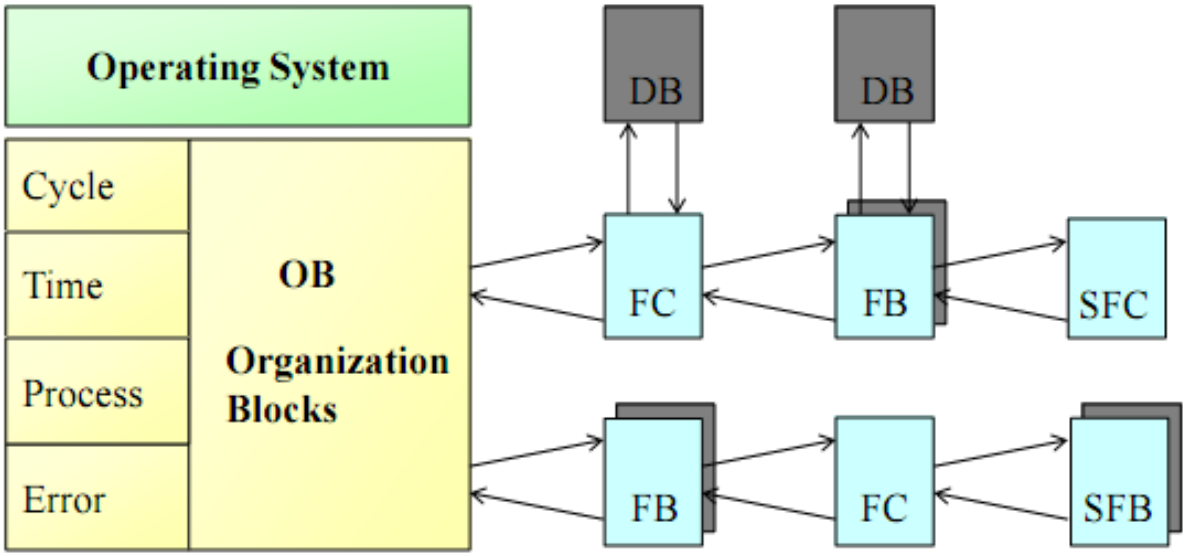
CÁC KHỐI TRONG S7-300

Type of Blocks in S7



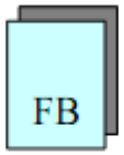
CÁC KHỐI TRONG S7-300

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

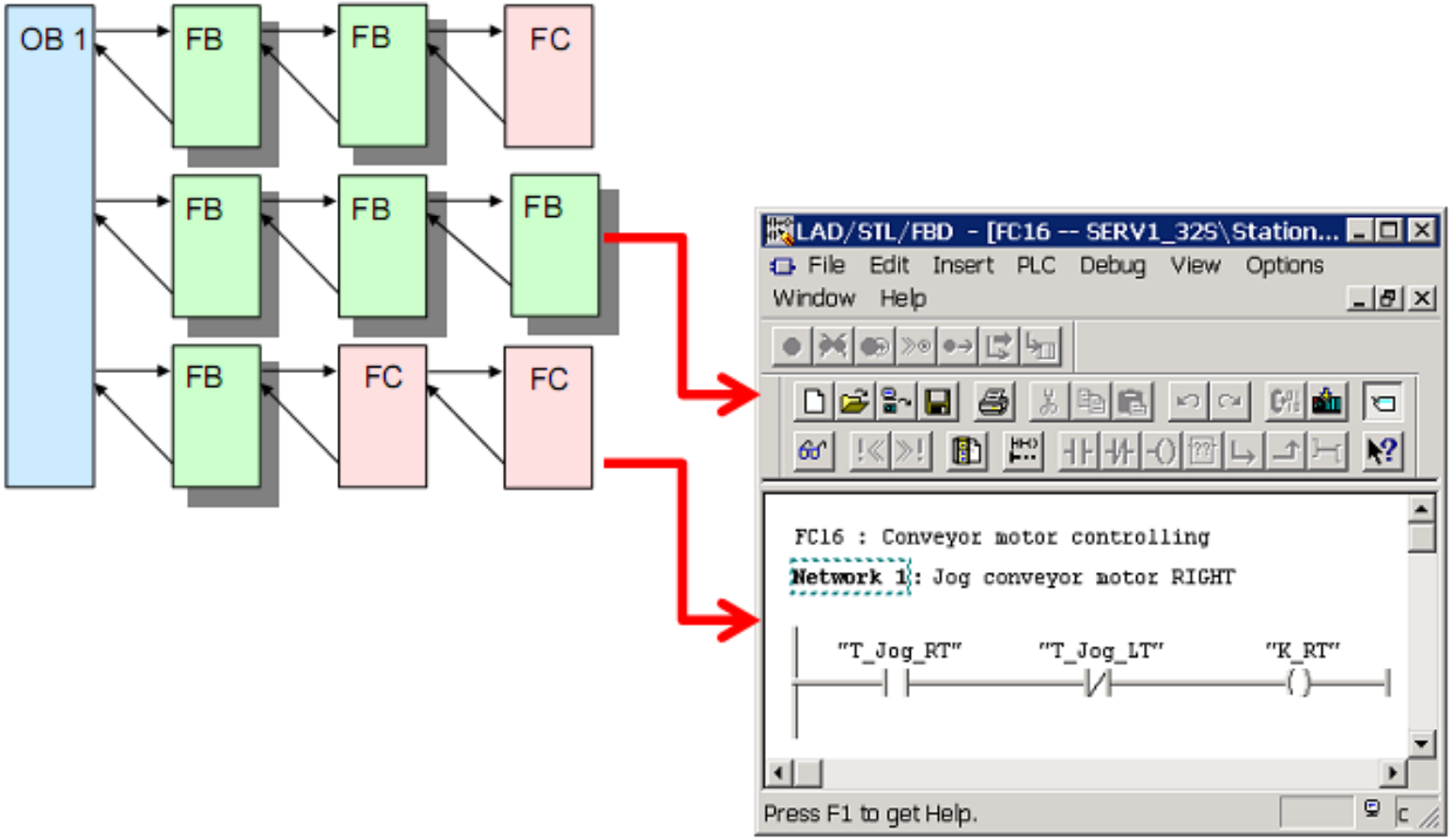
Maximum nesting depth:

S7-300: 8 (16 for CPU 318)

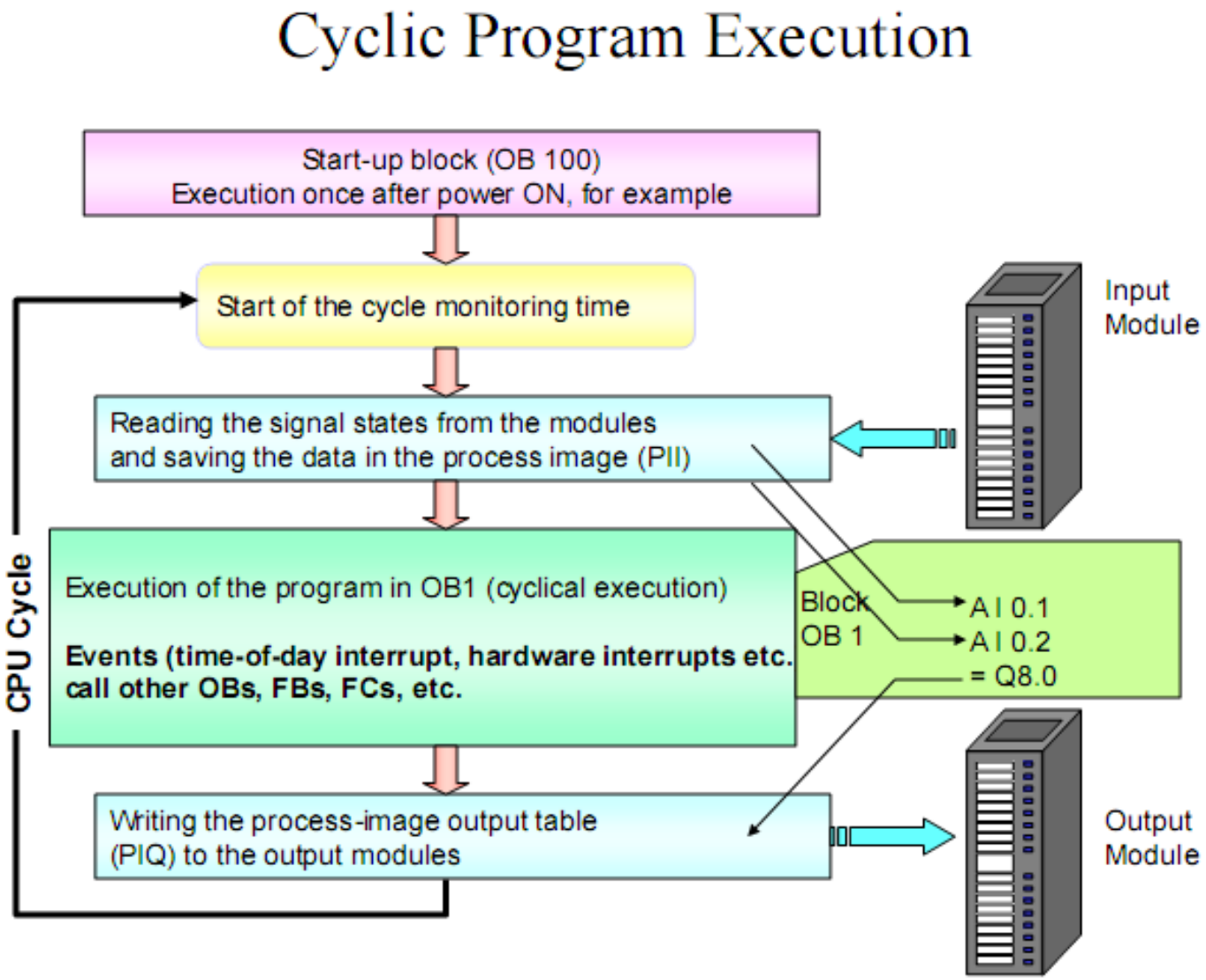
S7-400: 24

CÁC KHỐI TRONG S7-300

Block Architecture and Block Editor



CÁC KHỐI TRONG S7-300



CÁC KHỐI TRONG S7-300

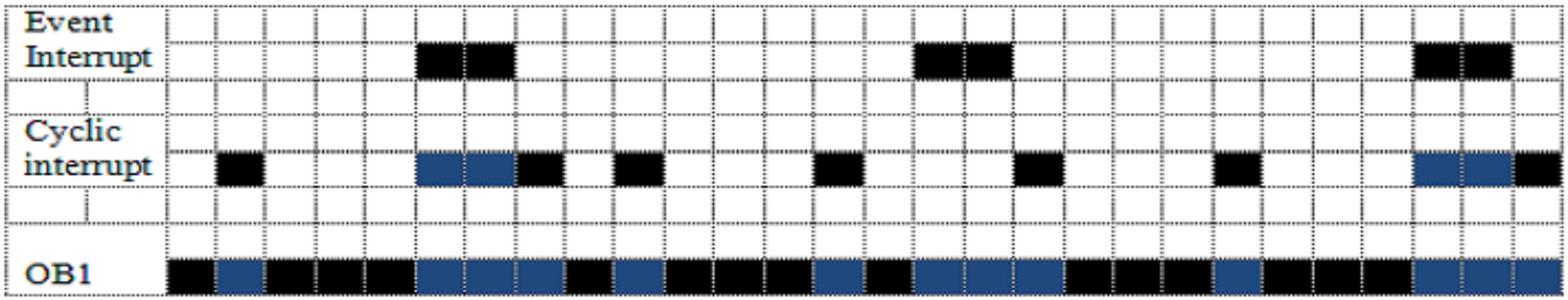
Organization Blocks

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

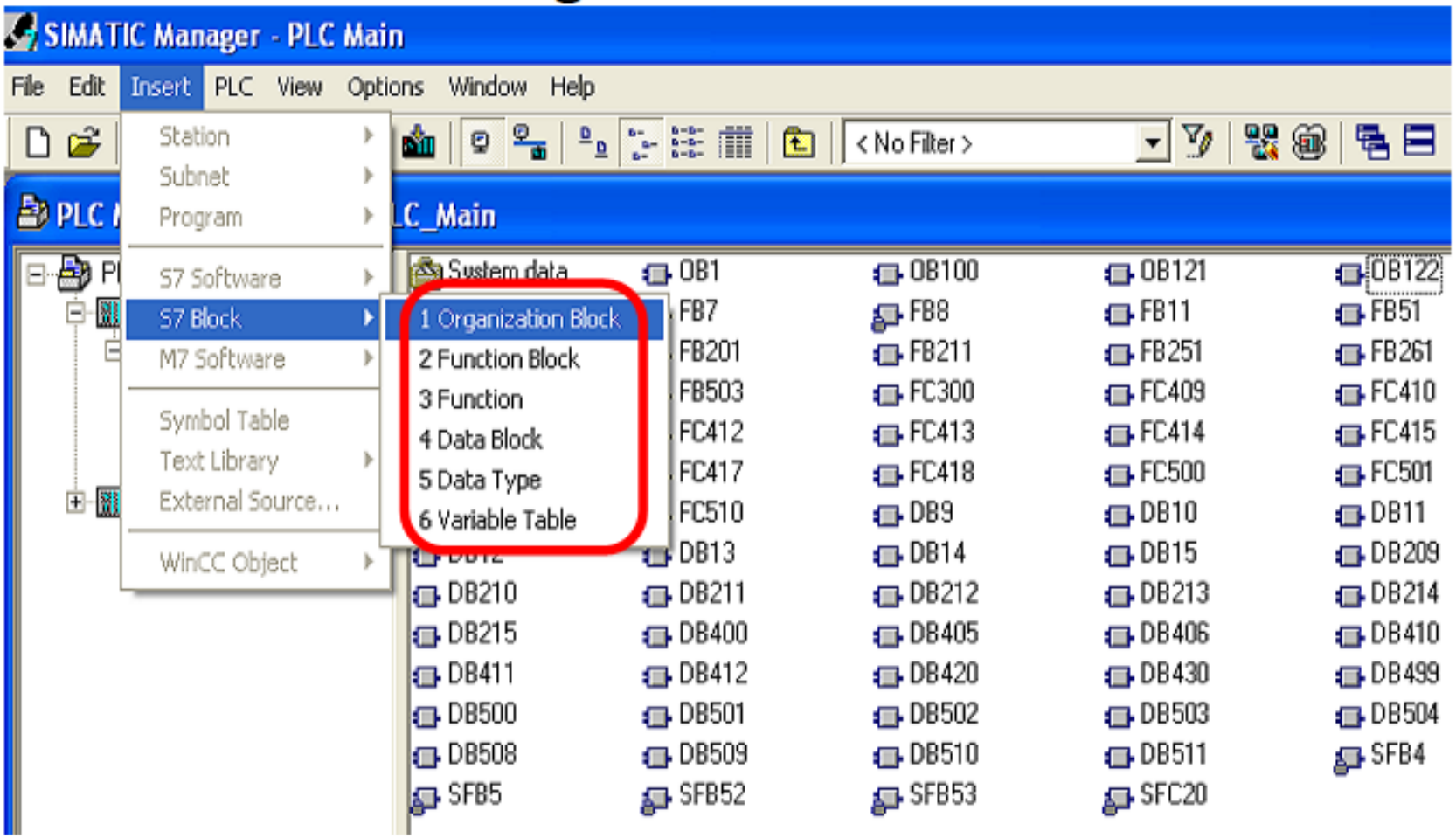
OBs are executed acording to the priority the OBs are allocated



CÁC KHỐI TRONG S7-300

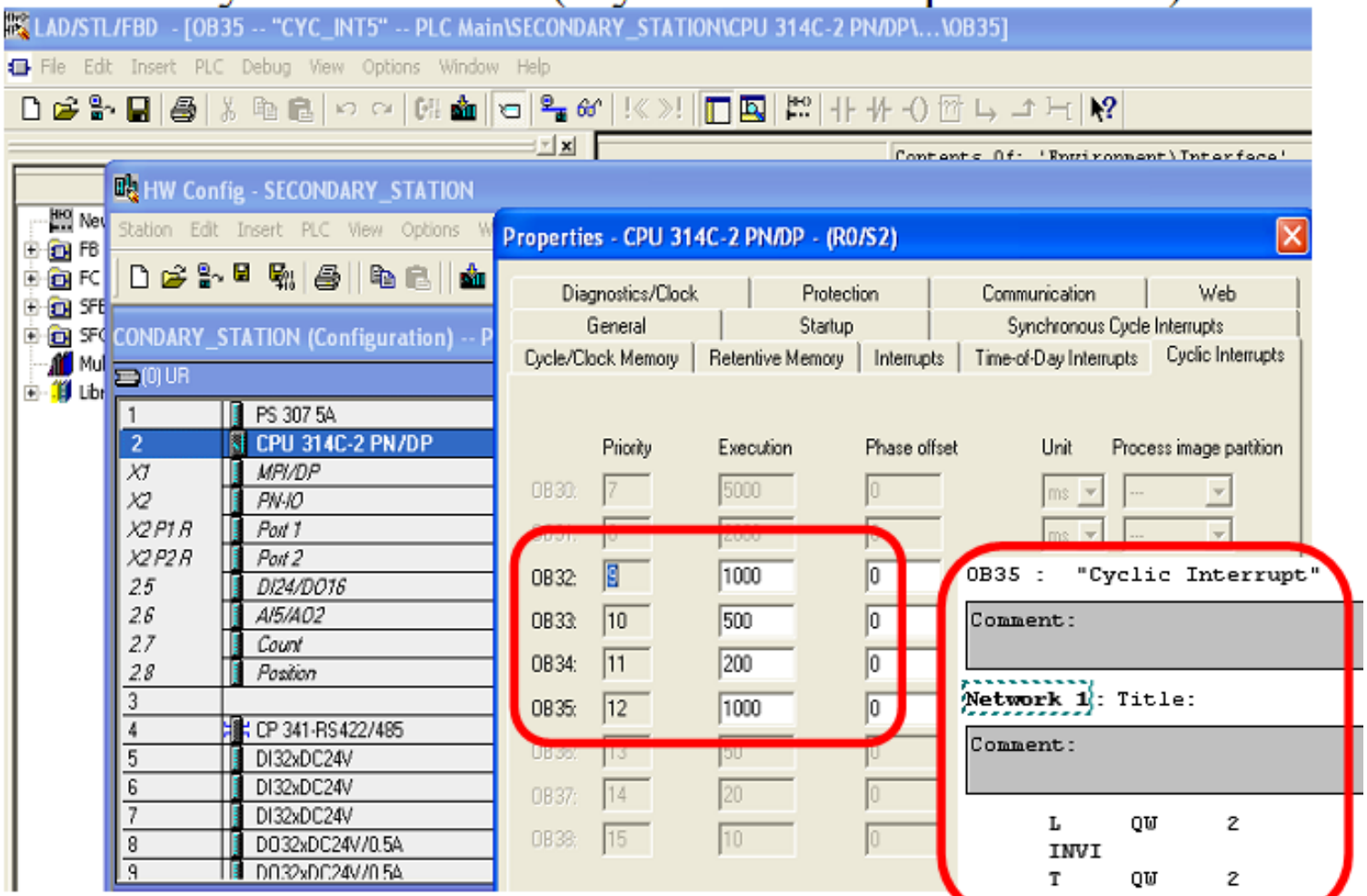
CÁC KHỐI TRONG S7-300

Insert Organization Blocks in S7



CÁC KHỐI TRONG S7-300

Cyclic Blocks (Cyclic Interrupt Blocks)



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

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).

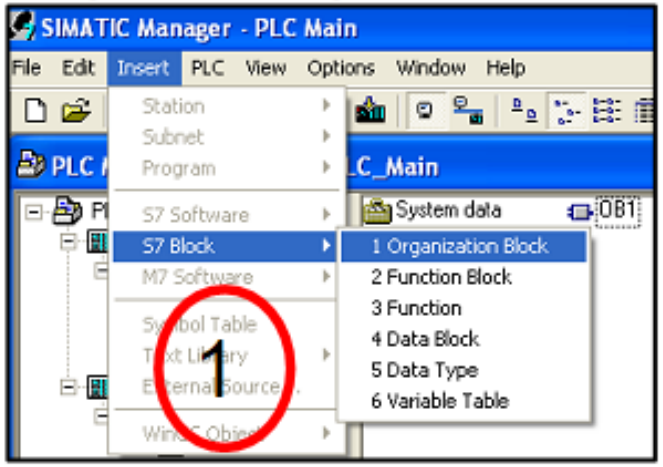
An **automatic restart**(warm restart) can be triggered at POWER ON if:

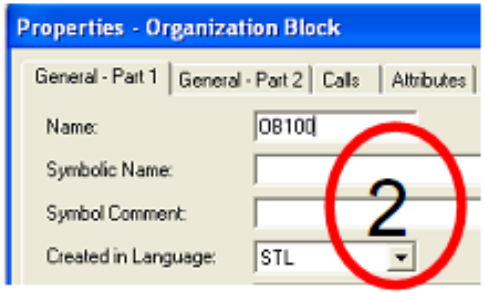
- The CPU was not in STOP at POWER OFF.
- The mode selector switch is set to RUN or RUN-P.

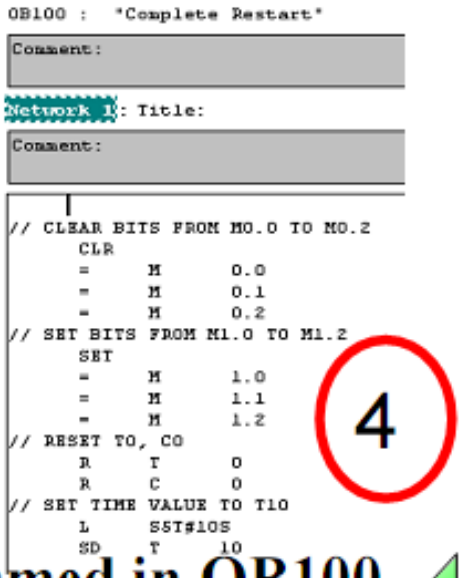
CÁC KHỐI TRONG S7-300

Organization Blocks in S7

Programming for OB100







inital values of the system are programmed in OB100

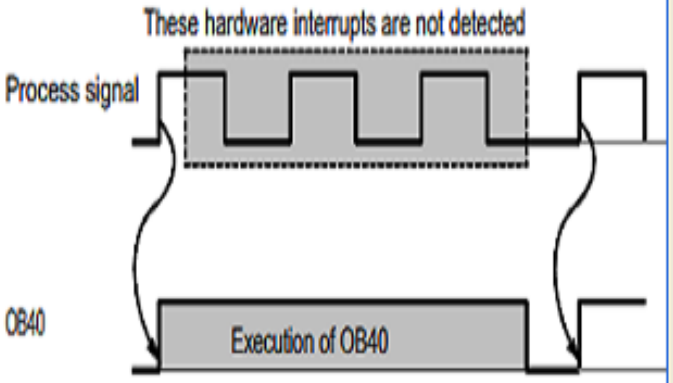
CÁC KHỐI TRONG S7-300

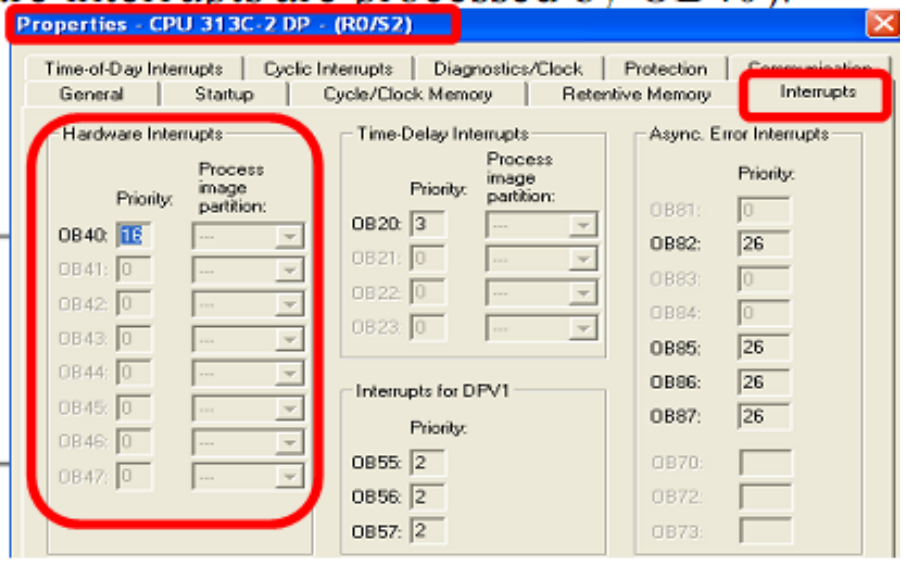
Organization Blocks in S7

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).

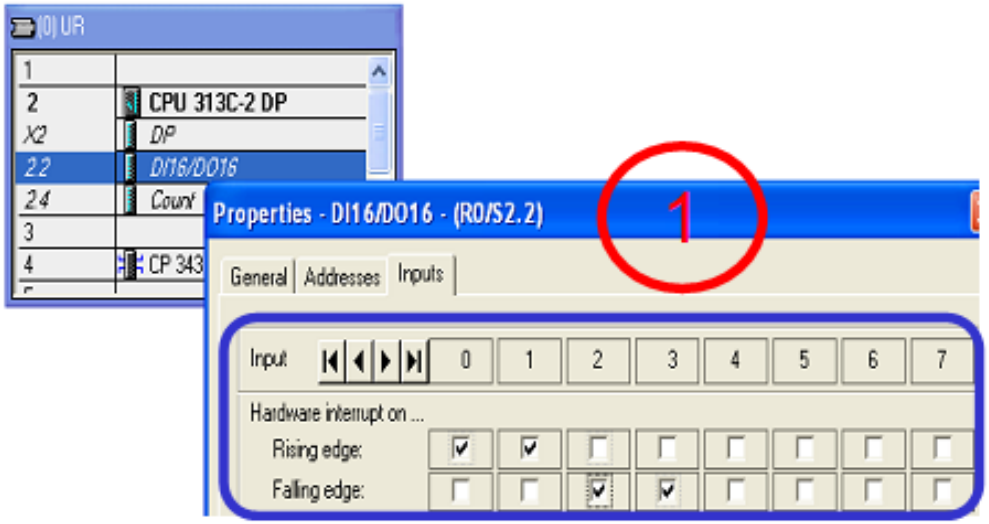


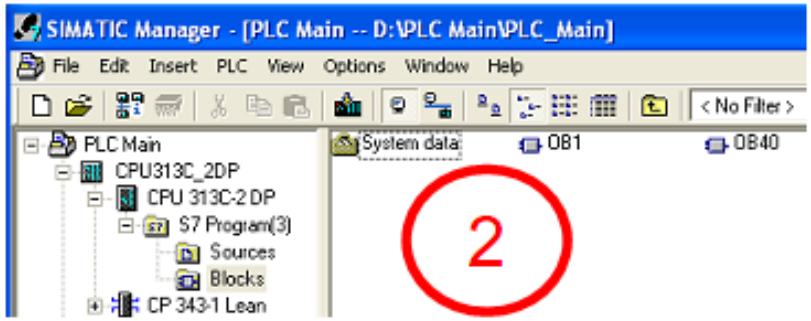


CÁC KHỐI TRONG S7-300

Organization Blocks in S7

Configuring, inserting and programming for hardware interrupt



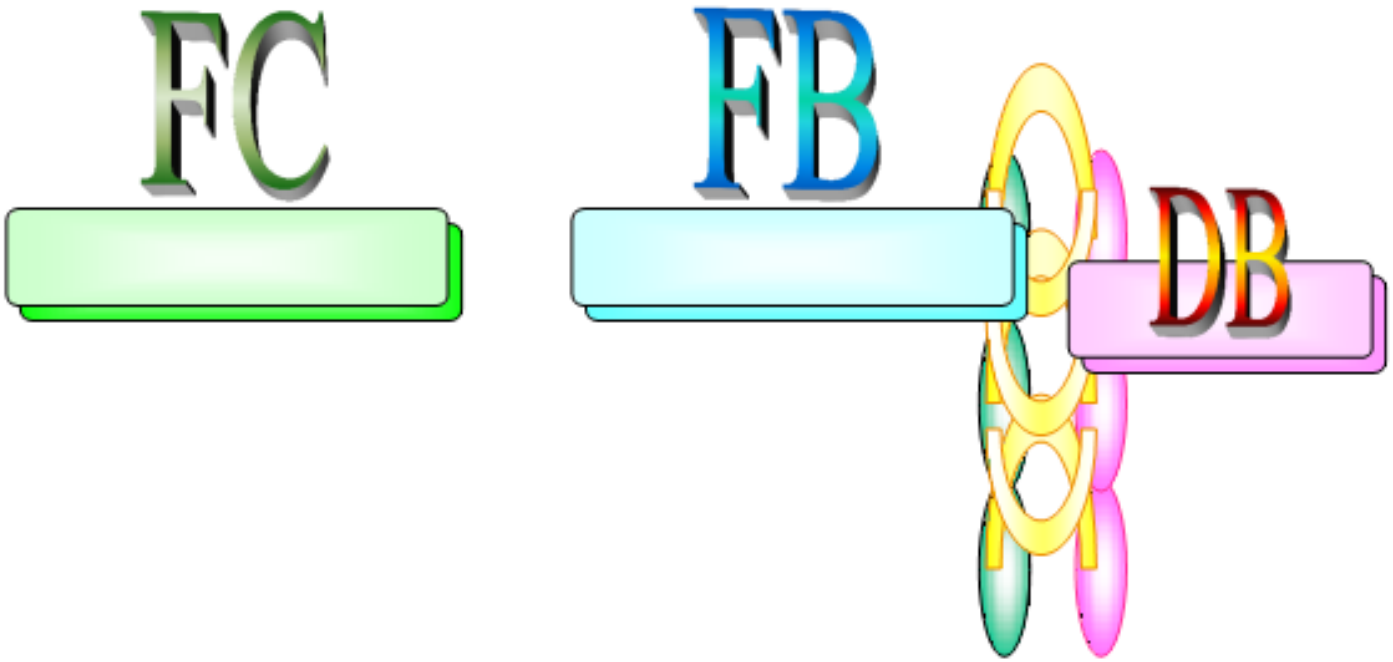



```
OB40 :   "Hardware Interrupt"
Comment:
Network 1: Title:
Comment:

      L     255
      T     QB    124
// CHECK INPUT
      L     #OB40_IN_ADDR
      T     MW    100
// TEST INPUT  1
      L     MW    100
      L     1
      ==I
      =     Q     125.0

// TEST INPUT  2
      L     MW    100
      L     2
      ==I
      =     Q     125.1
```

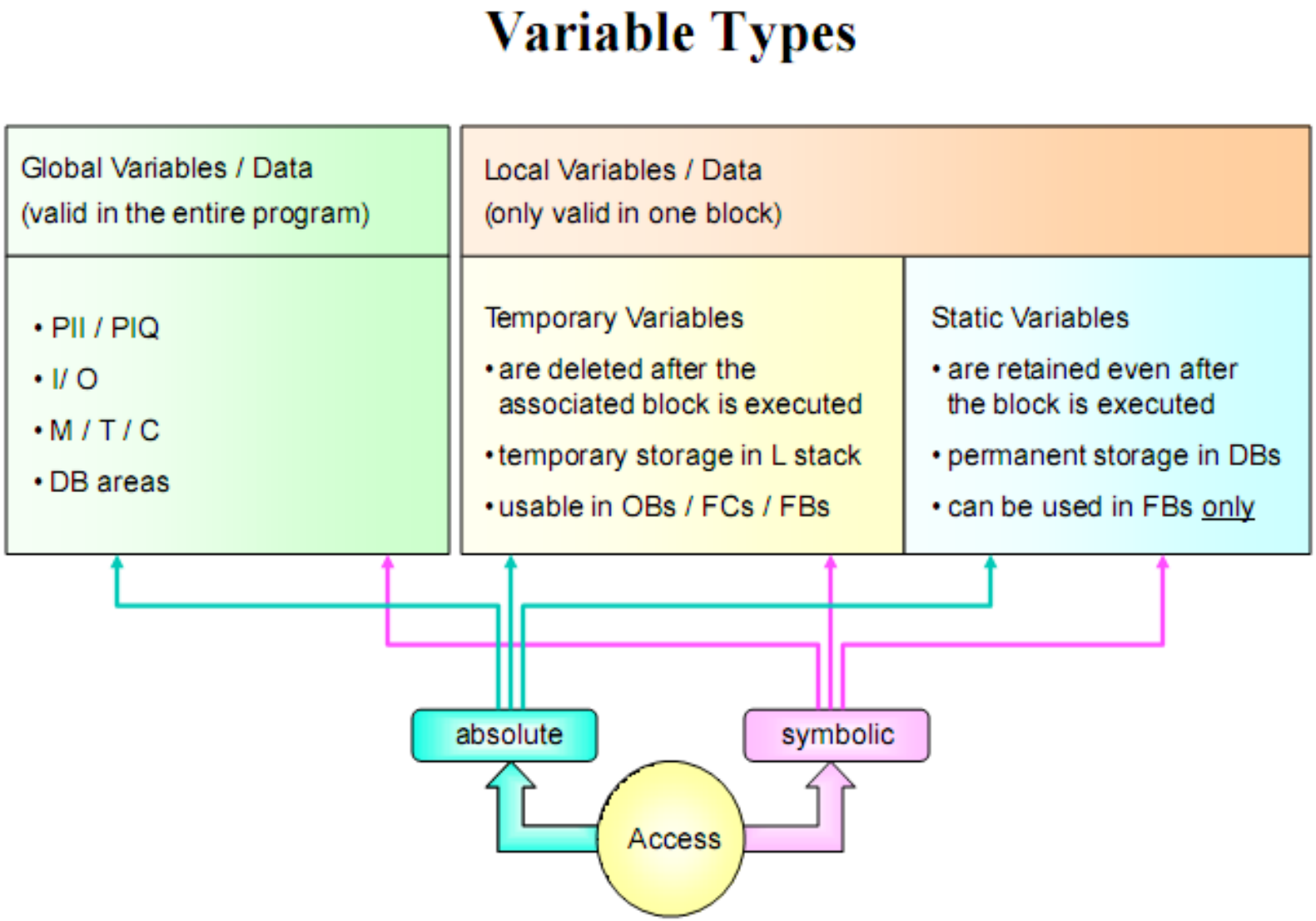
3

CÁC KHỐI TRONG S7-300

Functions and Function Blocks

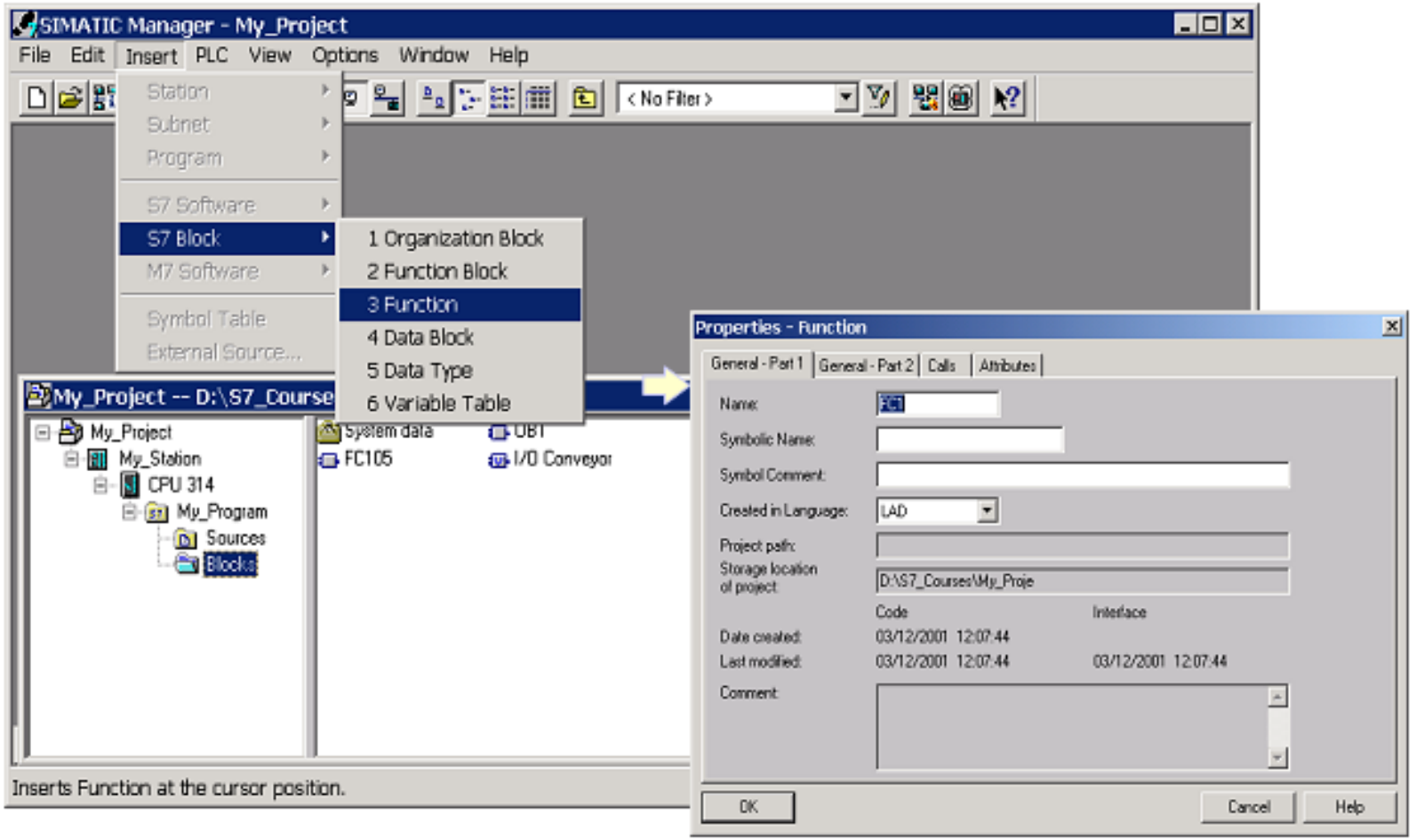


CÁC KHỐI TRONG S7-300



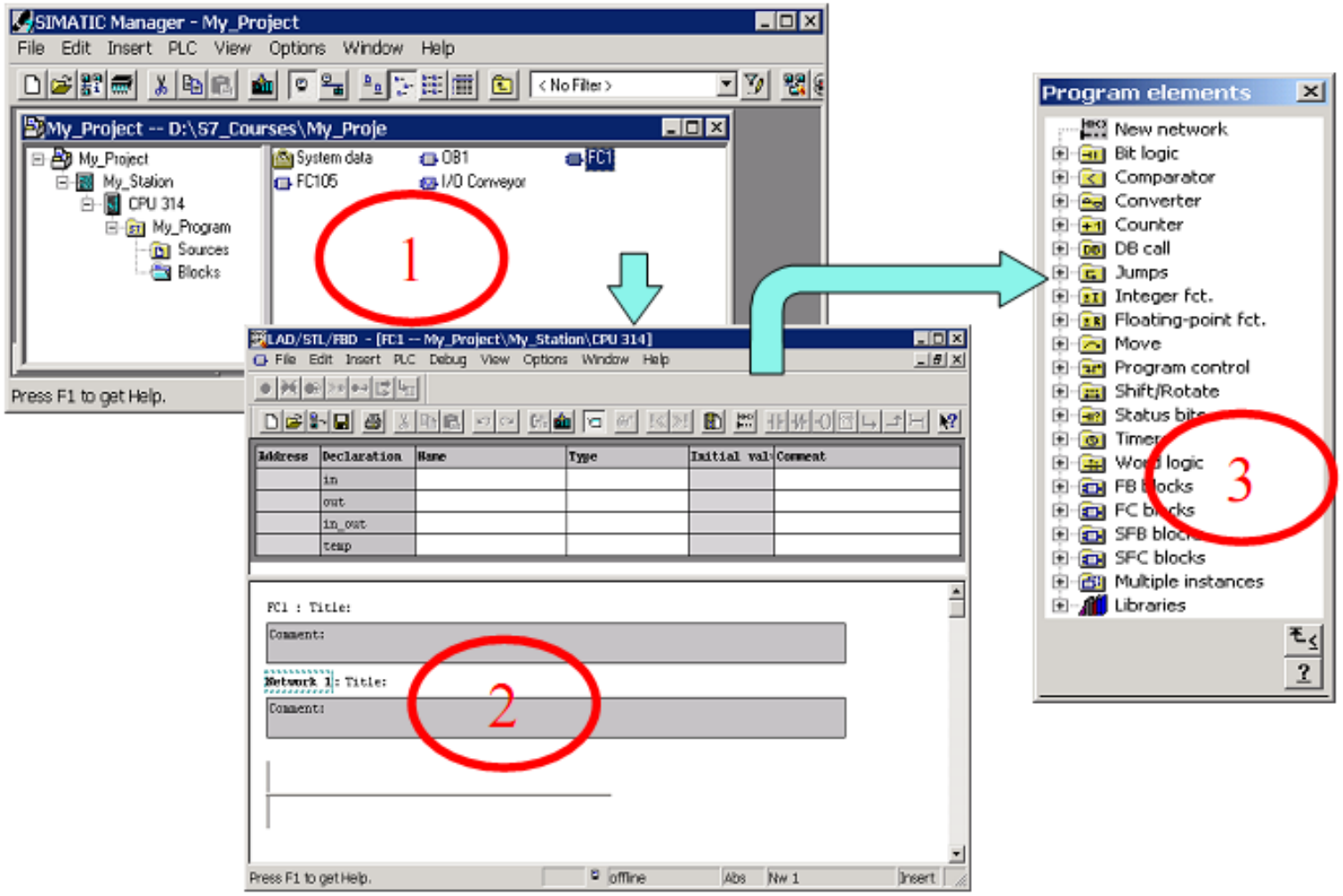
CÁC KHỐI TRONG S7-300

Inserting an Function



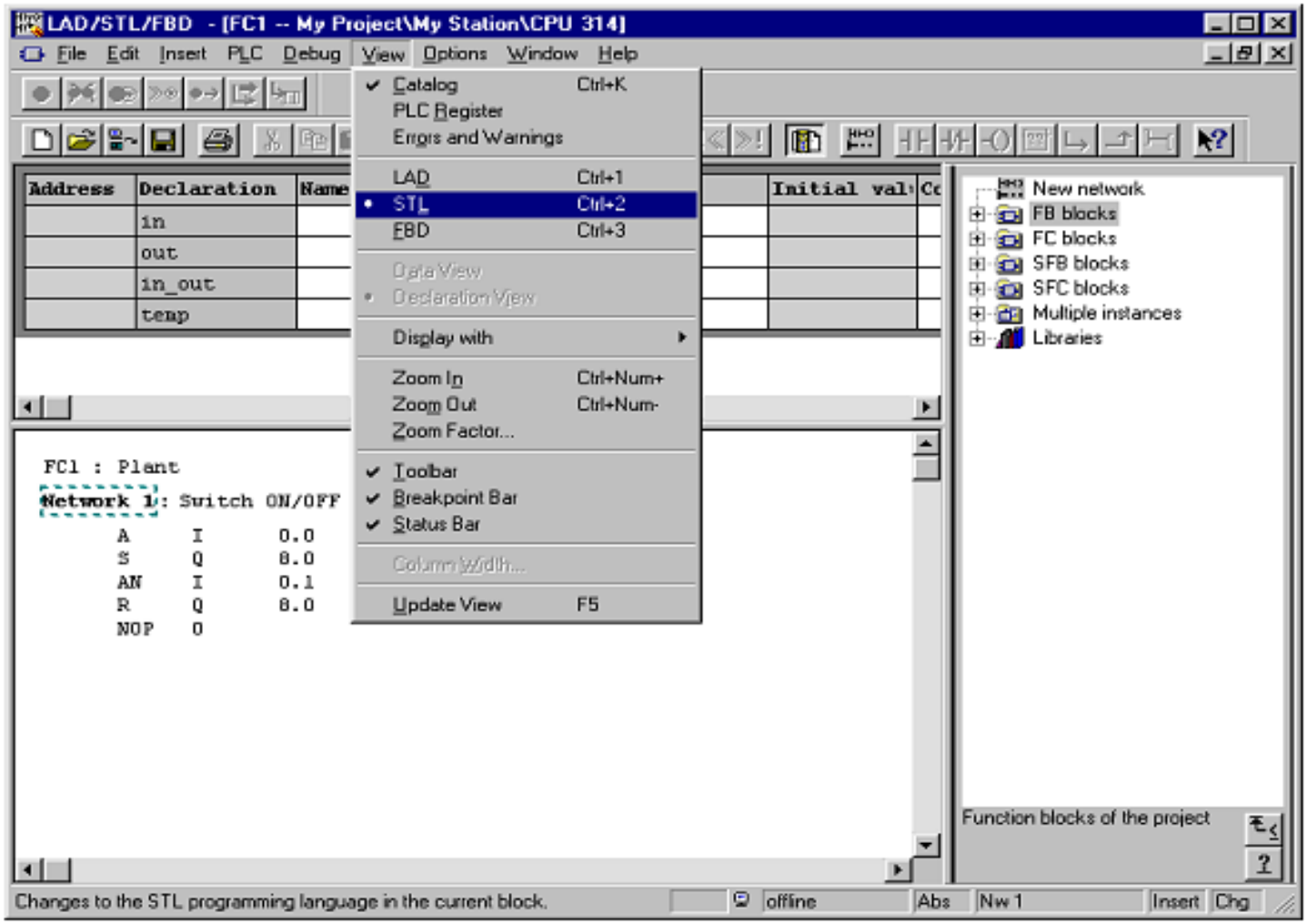
CÁC KHỐI TRONG S7-300

Starting the LAD/STL/FBD Editor



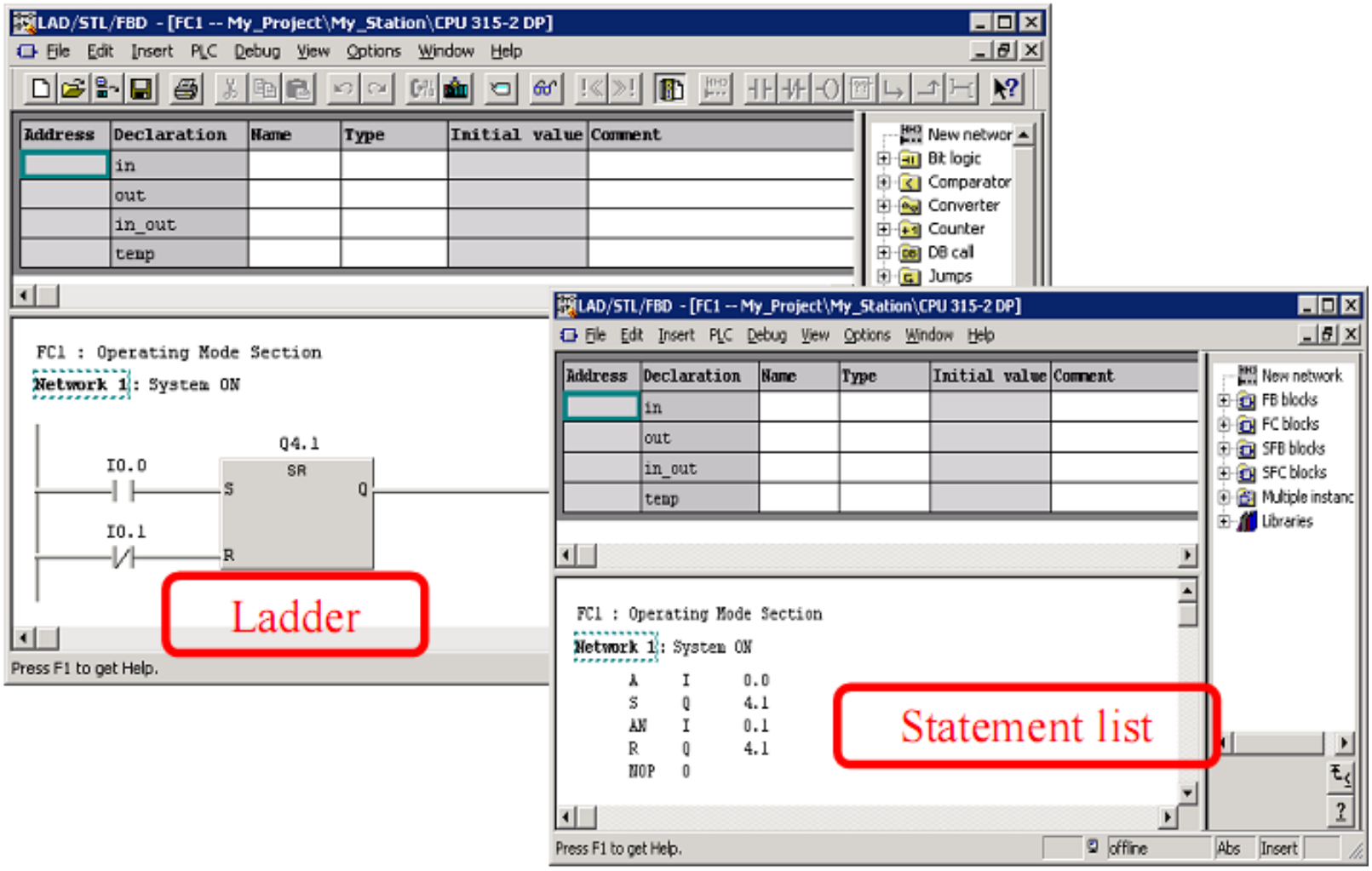
CÁC KHỐI TRONG S7-300

Selecting the Programming Language and write logic



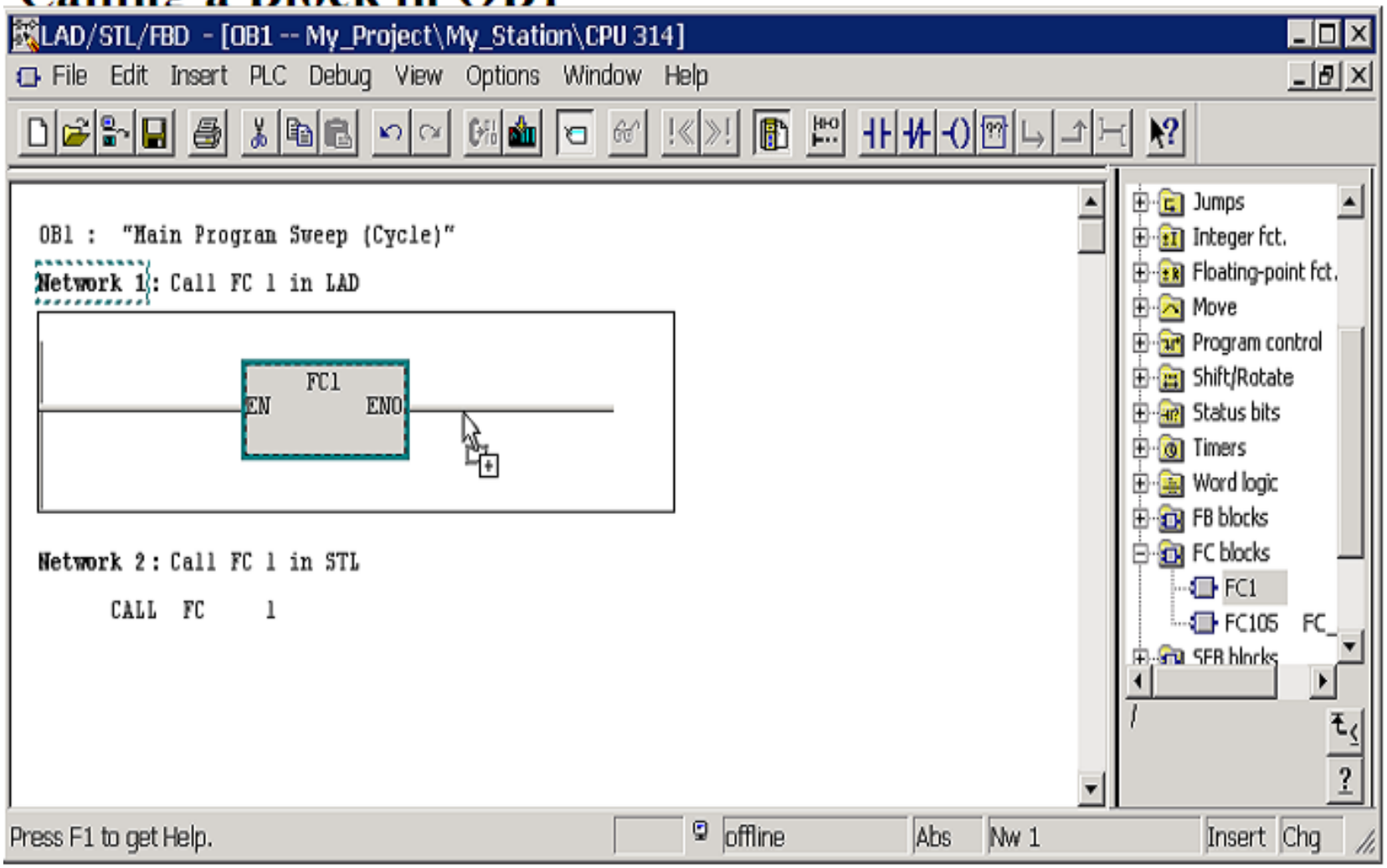
CÁC KHỐI TRONG S7-300

Programming in Ladder and Statement list



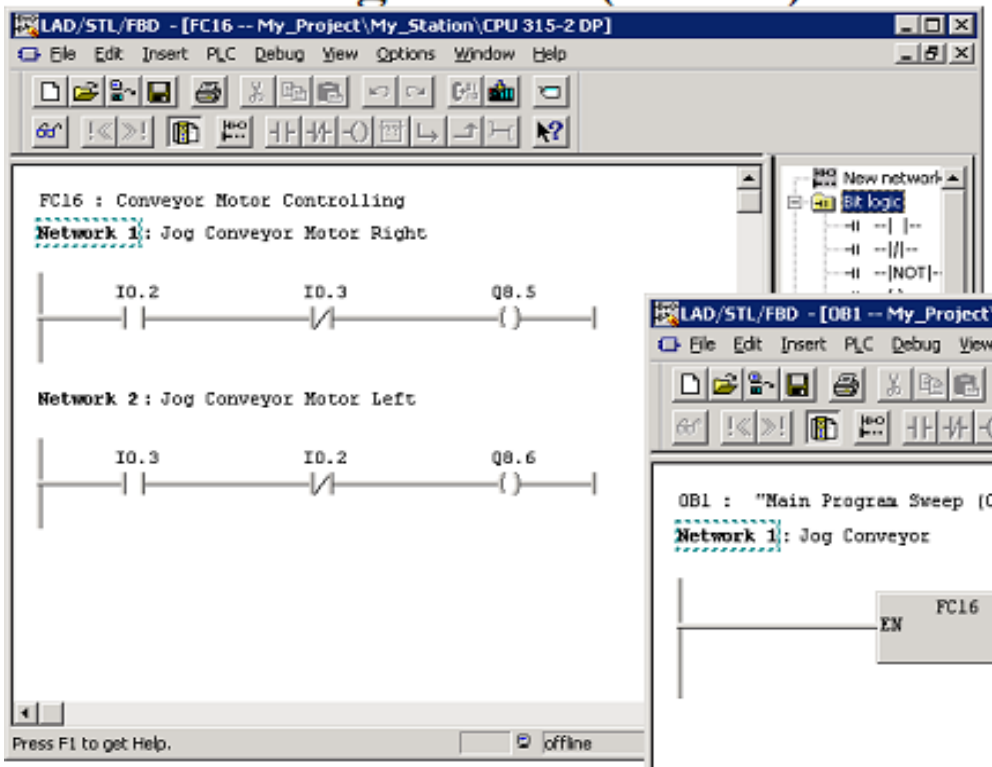
CÁC KHỐI TRONG S7-300

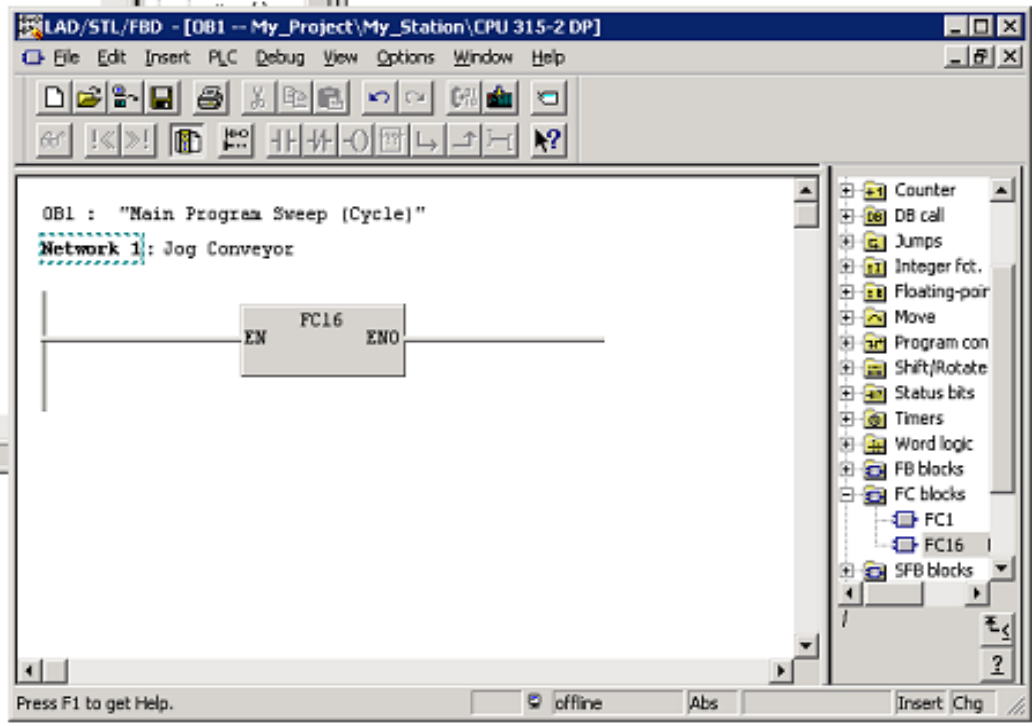
Calling a Block in OB1



CÁC KHỐI TRONG S7-300

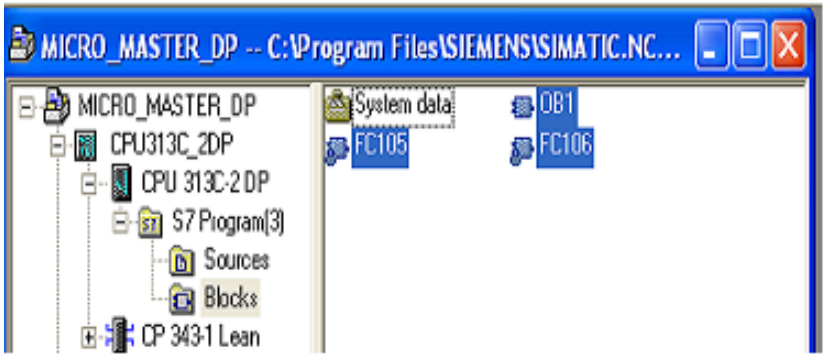
Exercise: Jog Motor (FC 16)

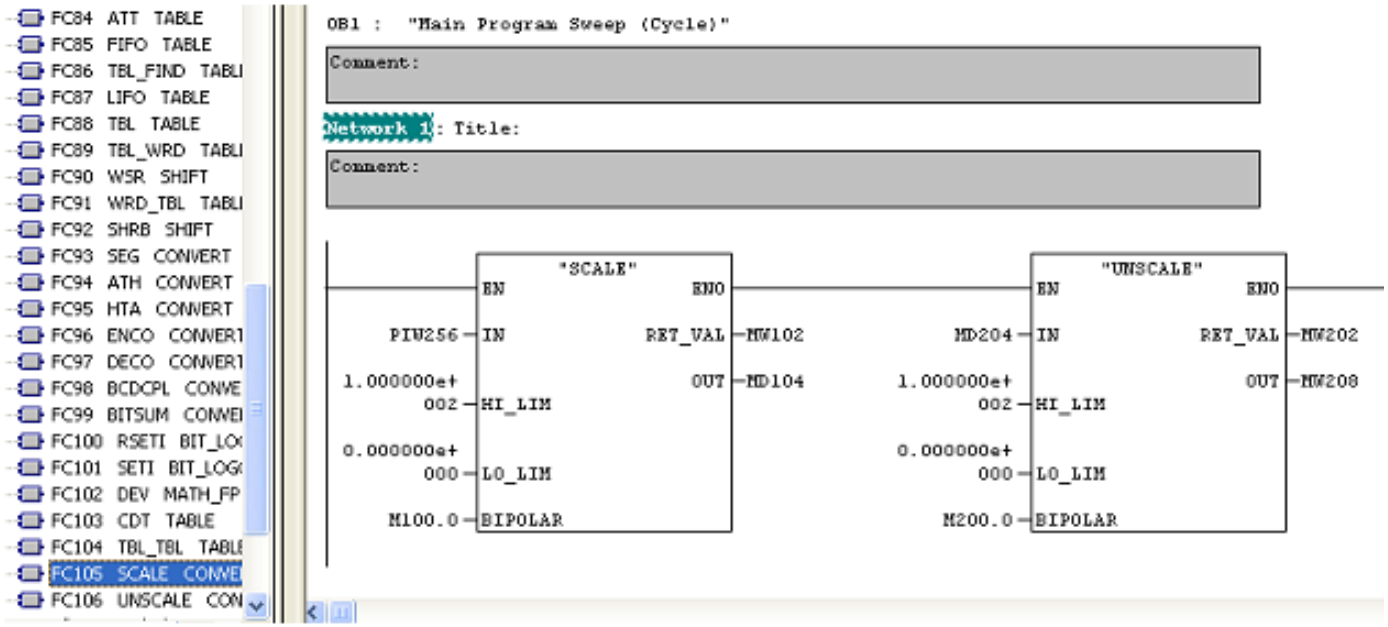




CÁC KHỐI TRONG S7-300

Exercise: Calling FC105 and FC106 from OB1





System Function Blocks in S7

Reading the time with SFC 1_READ-CLOK

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

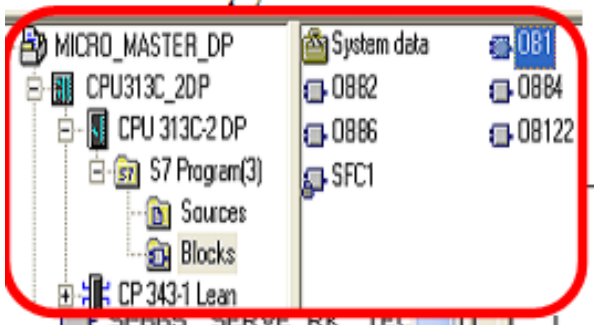
This data covers the range **DT#1990-1-1-0:0:0.0 to DT#2089-12-31-23:59:59.999**

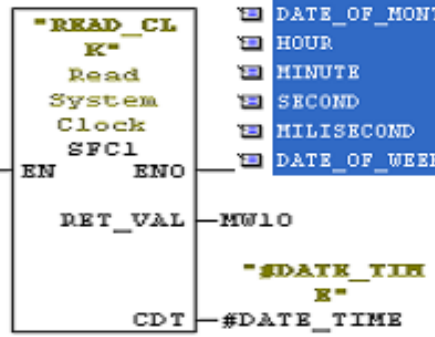
Byte	Contents	Example
0	Year	B#16#04
1	Month	B#16#08
2	Day	B#16#05
3	Hour	B#16#08
4	Minute	B#16#05
5	Second	B#16#05
6	The two highest value digits of MSEC	B#16#25
7 (4 MSB)	The two lowest value digits of MSEC	B#16#0
7 (4 LSB)	Day of week: 1: Sunday, 2:Monday, 3: Tuesday, 4: Wednesday, 5: Thursday, 6: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

CÁC KHỐI TRONG S7-300

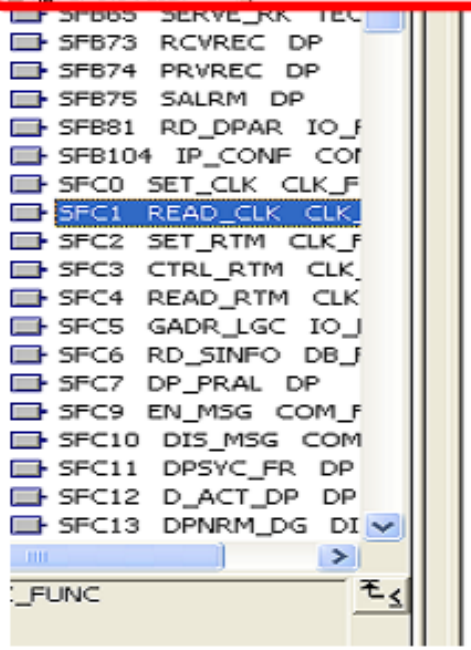
System Function Blocks in S7

Calling SFC 1 READ-CLOK





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
MILISECOND	Byte	34.0
DATE_OF_WEEK	Byte	35.0



Network 2: Title:

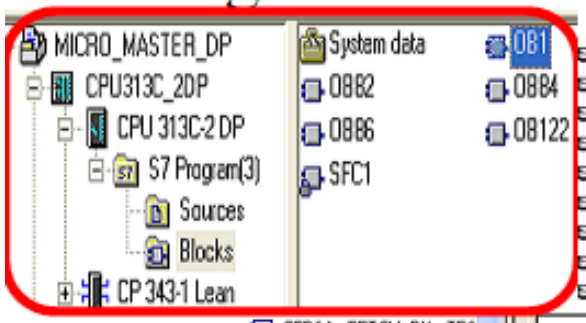
Comment:

```
      LAR1   P##DATE_TIME
      L      B [AR1,P#0.0]
      T      #YEAR                    #YEAR
      L      B [AR1,P#1.0]
      T      #MONTH                   #MONTH
      L      B [AR1,P#2.0]
      T      #DATE_OF_MONTH           #DATE_OF_MONTH
      L      B [AR1,P#3.0]
      T      #HOUR                    #HOUR
      L      B [AR1,P#4.0]
      T      #MINUTE                  #MINUTE
      L      B [AR1,P#5.0]
      T      #SECOND                  #SECOND
      L      B#16#F
      L      B [AR1,P#7.0]
      AW
      T      #DATE_OF_WEEK            #DATE_OF_WEEK
```

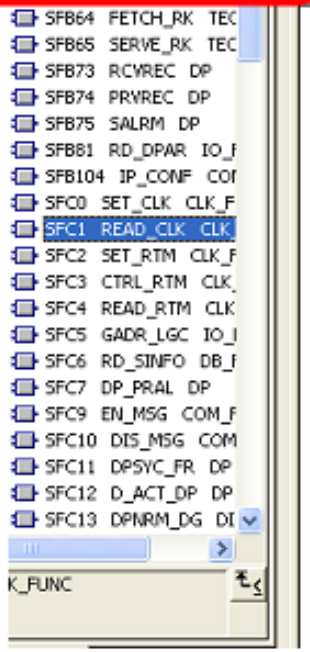
CÁC KHỐI TRONG S7-300

System Function Blocks in S7

Calling SFC 1 READ-CLOK

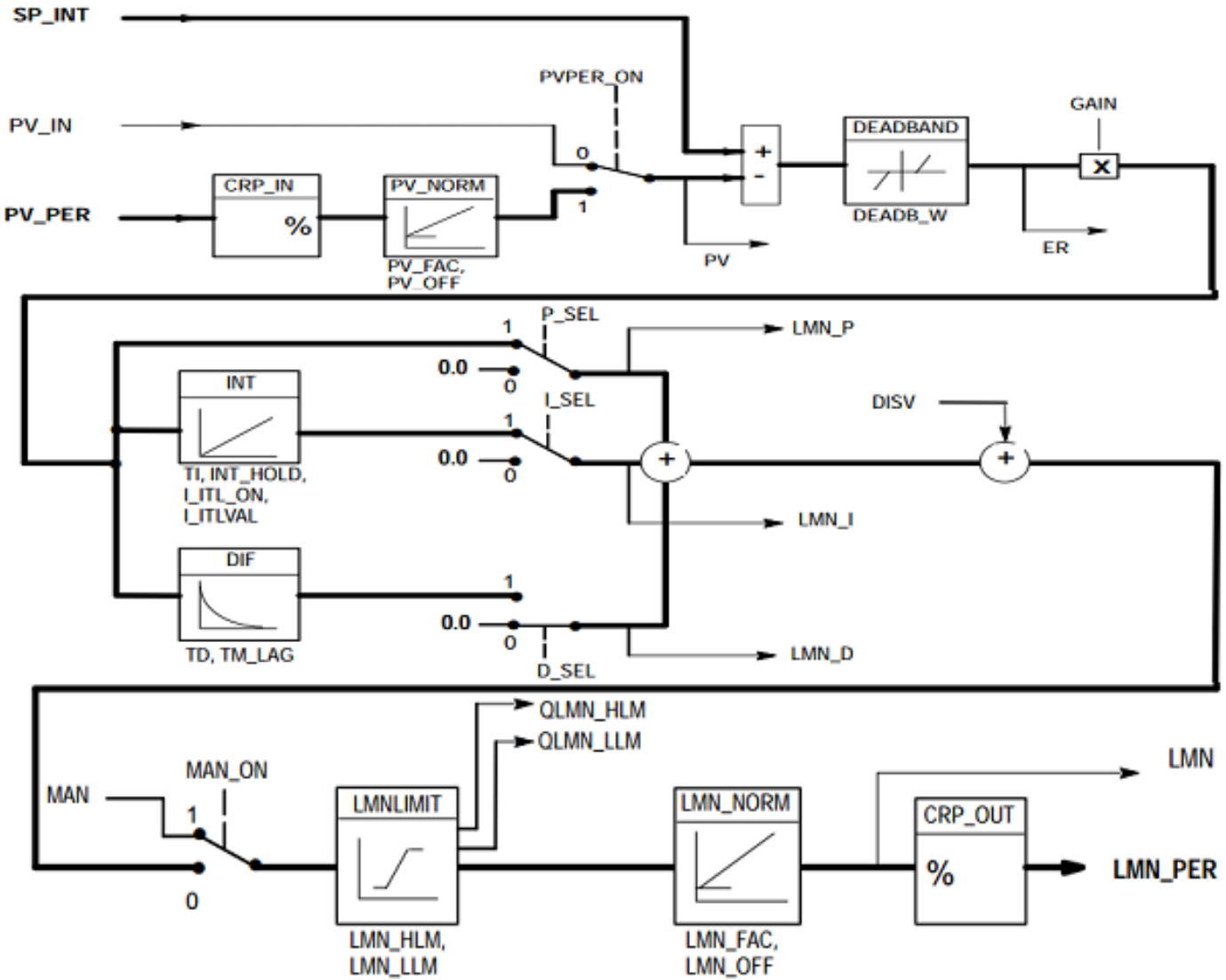


DATE_TIME	Date_And_Time	20.0
YEAR	Byte	28.0
MONTH	Byte	29.0
DATE_OF_MONTH	Byte	30.0
HOUR	Byte	31.0
MINUTE	Byte	32.0
SECOND	Byte	33.0
MILISECOND	Byte	34.0
DATE_OF_WEEK	Byte	35.0




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

Network 2: Title:
Comment:

      LAR1  P##DATE_TIME
      L     B [AR1,P#0.0]
      T     #YEAR               #YEAR
      L     B [AR1,P#1.0]
      T     #MONTH              #MONTH
      L     B [AR1,P#2.0]
      T     #DATE_OF_MONTH      #DATE_OF_MONTH
      L     B [AR1,P#3.0]
      T     #HOUR               #HOUR
      L     B [AR1,P#4.0]
      T     #MINUTE             #MINUTE
      L     B [AR1,P#5.0]
      T     #SECOND             #SECOND
      L     B#16#F
      L     B [AR1,P#7.0]
      AW
      T     #DATE_OF_WEEK       #DATE_OF_WEEK
```

CÁC KHỐI TRONG S7-300



CÁC KHỐI TRONG S7-300