

Industrijski sistemi i protokoli

■ Predavači:

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- Asistenti: Isakov Ivana ivana.isakov@uns.ac.rs dogovor NTP 207(208L)

■ Organizacija nastave:

- Vežbe:
 - 13 (+/- 1) termina
 - Uživo (7 termina) – auditorne vežbe
 - NTP 210L (6 termina, minimalno) – laboratorijske vežbe (OBAVEZNE)

Industrijski sistemi i protokoli

Način polaganja ispita

■ Teorijski deo

- Teorija 1 (25p)
- Teorija 2 (25p)
- Polaže se preko kolokvijuma

■ Praktični deo

- Laboratorija (20p) – obavezno prisustvo
- „Mali“ zadatak (10p) – **radi se poslednje nedelje u semestru**
- „Veliki“ zadatak (20p) – radi se u ispitnom roku na papiru

■ Uvod - oprema

■ Uvod - Primer raspoloživih maketa

PLC S7-200

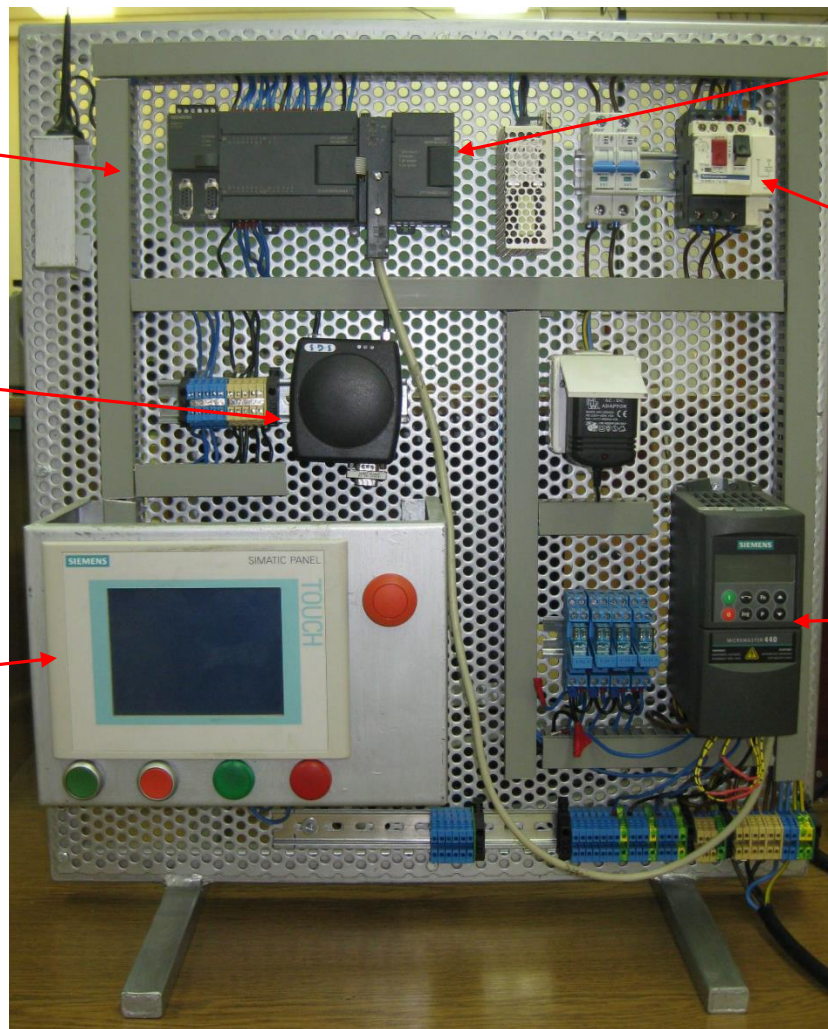
GSM modem
Mc39i

Touch panel
TP177micro

Profibus modul
EM277

Motorna
zaštitna sklopka

Frekventni
regulator
MM430



■ Uvod - Primer raspoloživih maketa

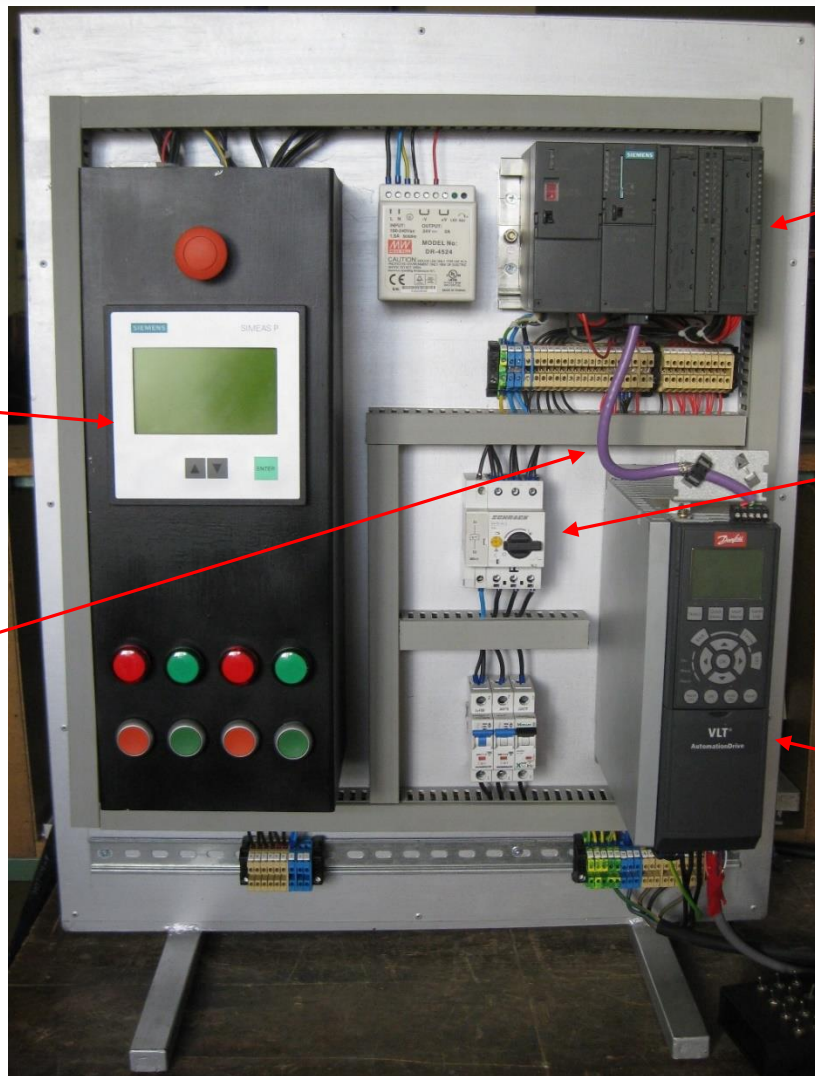
**Analizator kvaliteta
električne energije
Simens Q**

Profibus kabel

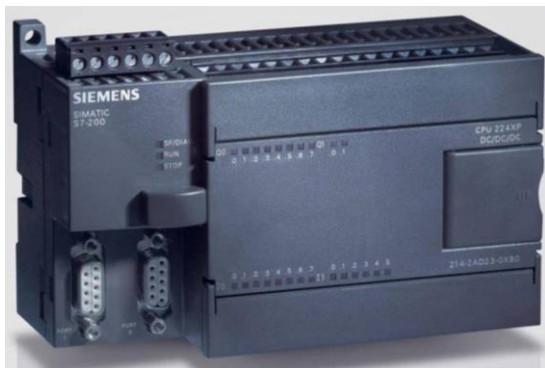
PLC S7-314DP

**Motorna
zaštitna
sklopka**

**Frekventni
regulator
FC300**



■ Uvod - Primer raspoložive opreme



← Centralna jedinica
(PLC)



← Decentralizovana
Profibus periferija
EM200



← Internet/ethernet
modul CP-243 1-IT

Tekstualni display
TD200



■ Sklopna oprema - osnovno

■ Sklopna oprema

■ Normalno otvoren i normalno zatvoren kontakt

■ Pojam „*normalno*“:

Stanje u kom se kontakt nalazi dok se na njega ne deluje spolja silom (odnosno dok je u nepobuđenom stanju).

■ NO (taster): provodi kada je pritisnut

NO (relej, kontaktor): kontakt provodi kada ima napajanja na namotaju

NC: ?

■ Sklopna oprema

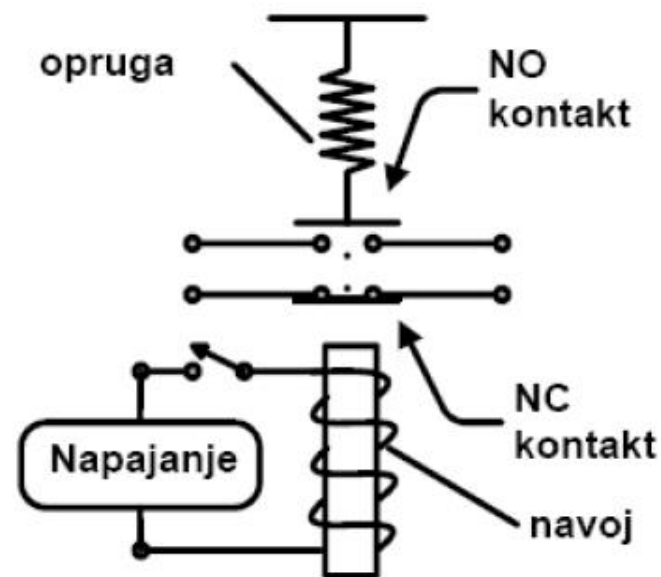
■ Normalno otvoren i zatvoren kontakt

■ NO – Normally Opened = Radni (zvono na vratima)

NC – Normally Closed = Mirni (alarm, zaštita rukovaoca)

■ Primer:

NO i NC kontakti upravljani relejem



■ Sklopna oprema

■ Tasteri

Prekidaju signalne struje (sklopna oprema male prekidne moći).



■ Sklopna oprema

■ Grebenaste sklopke

Prekidač (u zidu), kontaktor – nisu namenjeni za prekidanje struje kratkog spoja i struja preopterećenja.



■ Prekidači, granični prekidači

■ Industrijski sistemi i protokoli

■ Blizinski

- Induktivni - beskontaktna detekcija metalnih objekata
- Kapacitivni - detekcija nivoa, protoka fluida, granula i praškastog materijala
- Magnetni - detekcija magnetnog polja (npr. kod klipa)

■ Fotoelektrični

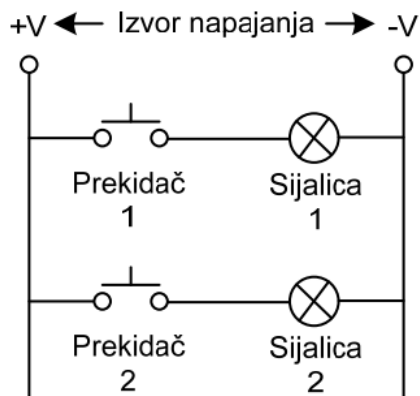
- Nadgledanje proizvodnje i linija za pakovanje; detekcija napunjenosti proizvoda kroz prozirna pakovanja

■ VISION - prepoznavanje slike

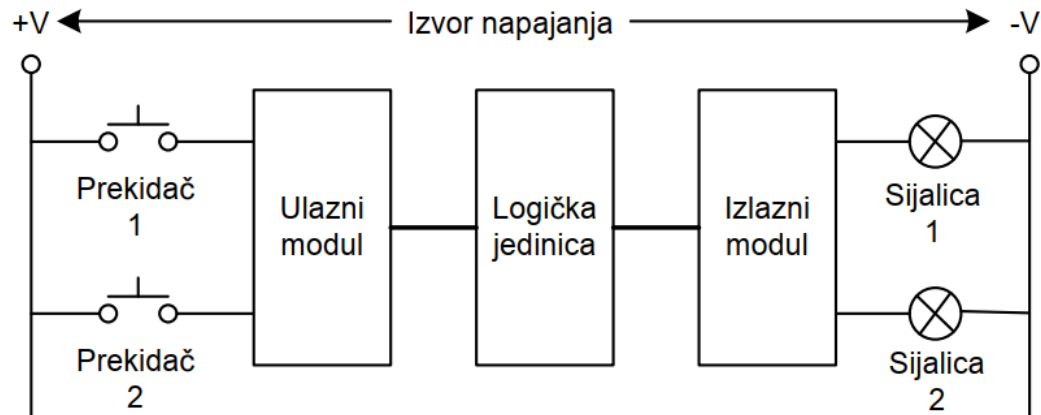
■ Enkoderi

■ Sistemi identifikacije (RFID, Barcode)

■ Fleksibilnost u izmenama programa



Relejni sistem



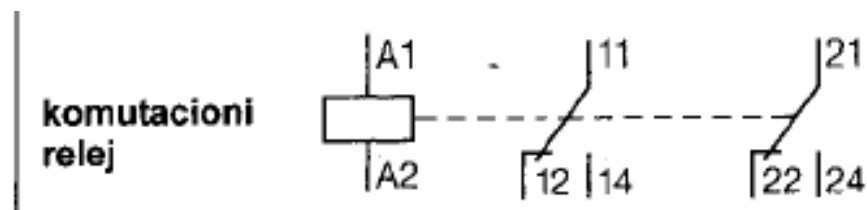
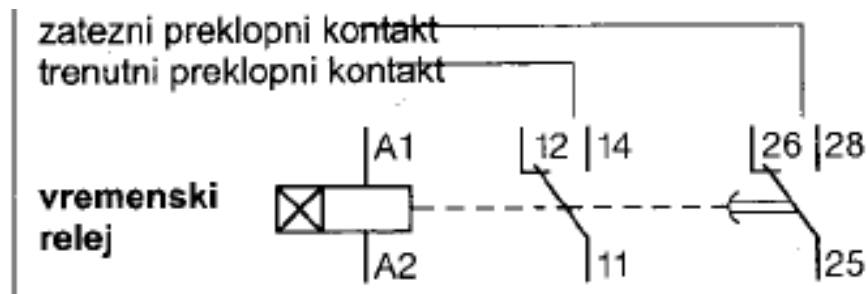
PLC sistem

■ Sklopna oprema

■ Releji

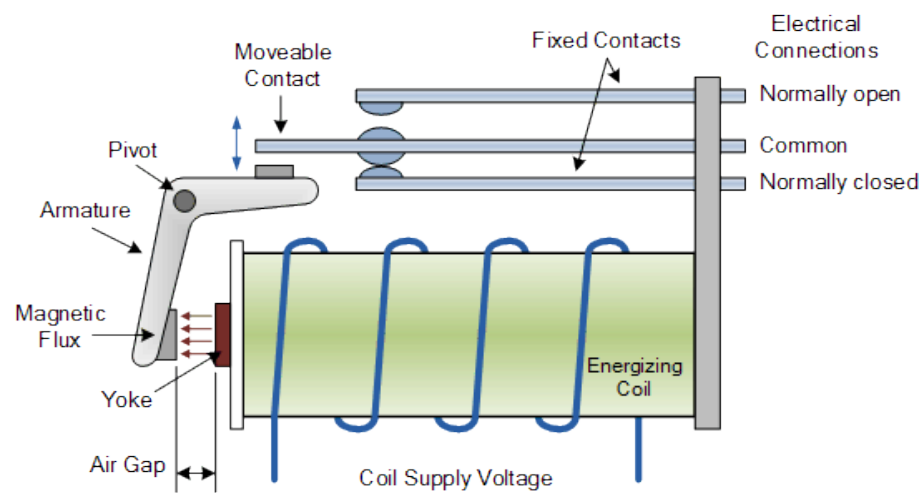
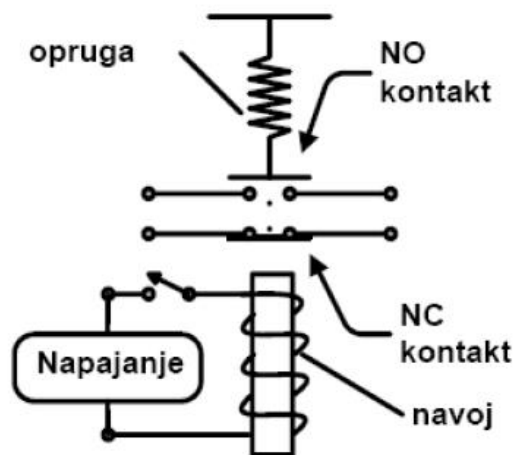
Releji su rasklopni elementi za upravljanje, koji nakon promene fizičkih veličina, kao što su vreme, temperatura, struja i slično aktiviraju pomoćna strujna kola.

Komutacioni releji se aktiviraju pomoćnim naponom. Oni funkcionalno odgovaraju pomoćnim kontaktorima.



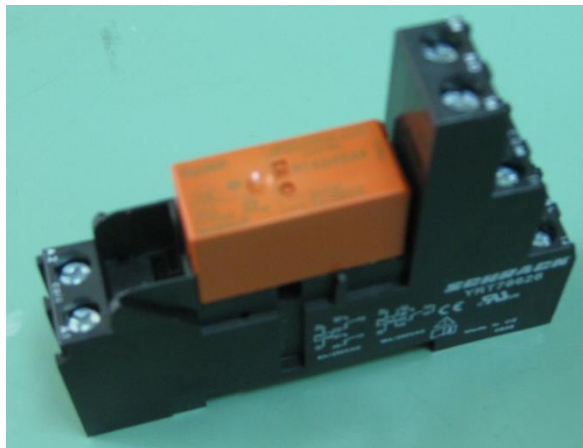
■ Sklopna oprema

■ Releji



■ Sklopna oprema

■ Releji



■ Industrijski sistemi i protokoli

■ Sklopna oprema

■ Releji

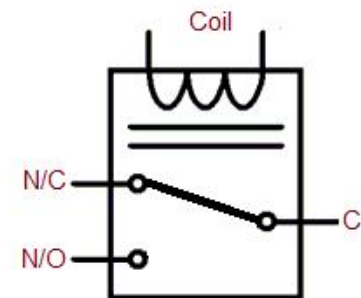


Pin Details



Physical View

Coil - Electromagnetic Coil Terminal
C - Common Terminal
N/C - Normally Close Terminal
N/O - Normally Open Terminal

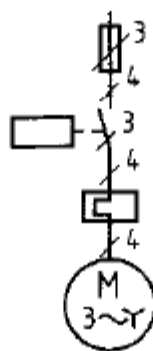
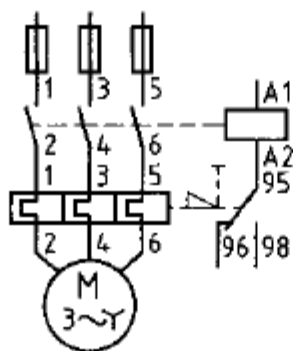
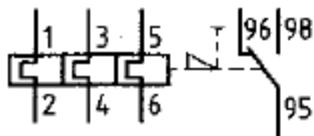




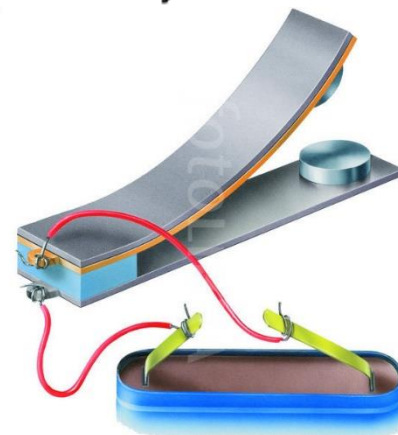
■ Sklopna oprema

■ Bimetalni zaštitni relej

**zaštitni relej
motora**

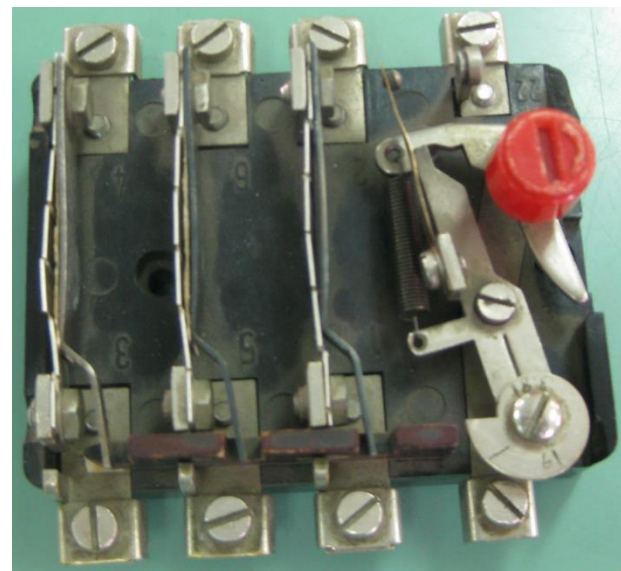
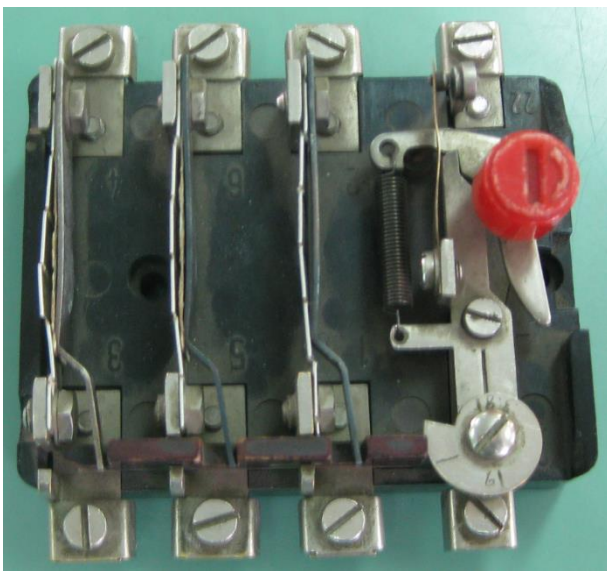


pri upravljanjima sa davačima trajnog kontakta moraju zaštitni releji motora biti opremljeni mehaničkim zaporom za ponovno uključivanje, jer inače kod hlađenja bimetala dolazi do automatskog ponovnog uključivanja; blokada se može ponovo eliminisati tasterom za deblokiranje



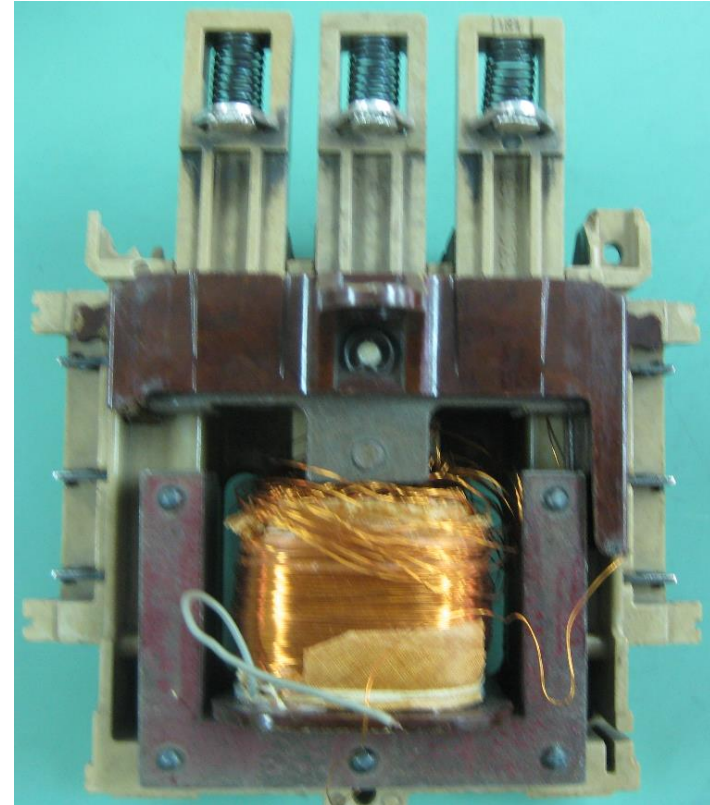
■ Sklopna oprema

■ Bimetalni zaštitni relej



■ Sklopna oprema

■ Kontaktor

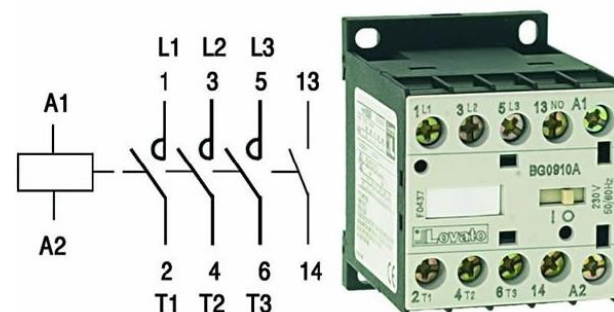
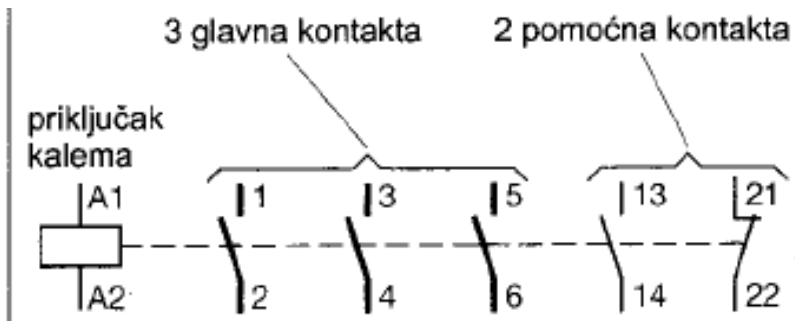


■ Sklopna oprema

■ Kontaktor

Glavni kontaktori se proizvode kao troljni za naizmeničnu, a dvopolni za jednosmernu struju. Pored **osnovnih**, oni imaju i **pomoćne** preklopne elemente.

Oni se ne smeju koristiti kao glavne sklopke za stavljanje pod napon pa zahtevaju prethodno ugrađenu zaštitu od kratkog spoja

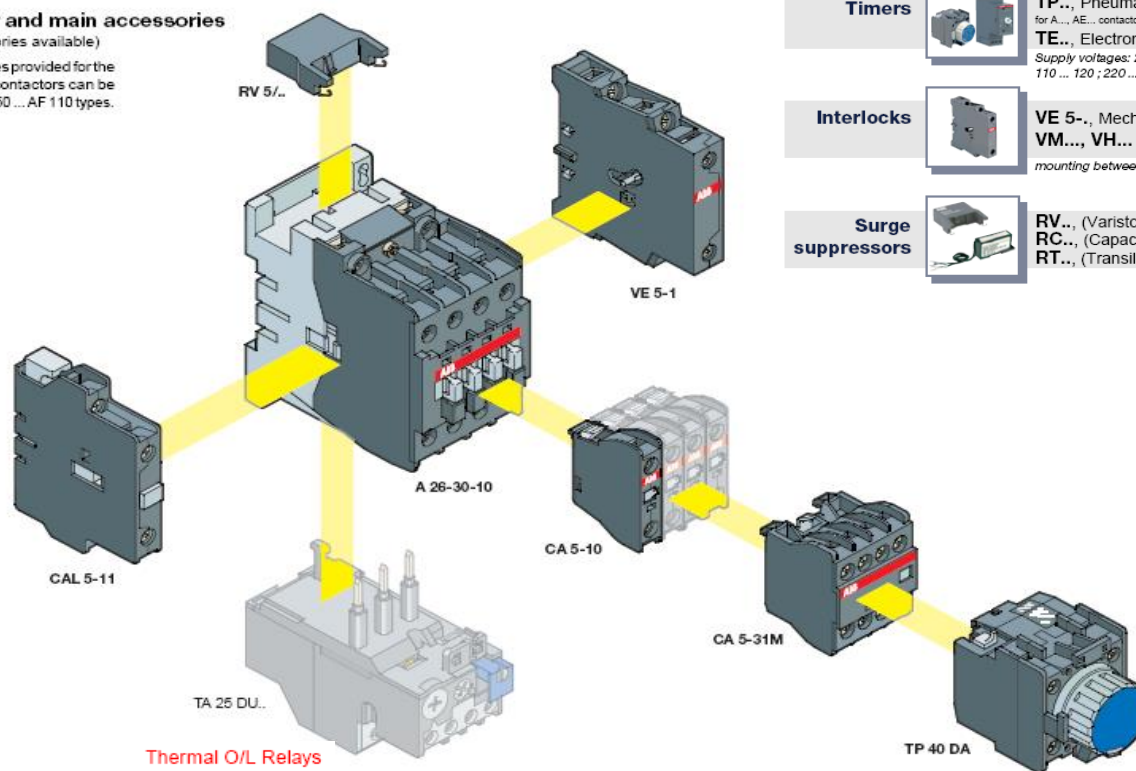


■ Kontaktor

Contactor and main accessories

(other accessories available)

The accessories provided for the A 50 ... A 110 contactors can be used for the AF 50 ... AF 110 types.



Auxiliary contacts



CA 5-..., 1-pole
CAL ...-..., 2-pole

Timers



TP..., Pneumatic
for A... AE... contactors only
TE..., Electronic
Supply voltages: 24 V a.c./d.c.,
110 ... 120 ; 220 ... 240 ; 380 ... 440 V a.c.

Interlocks



VE 5-..., Mechanical / Electrical
VM..., VH... Mechanical
mounting between 2 contactors

Surge suppressors



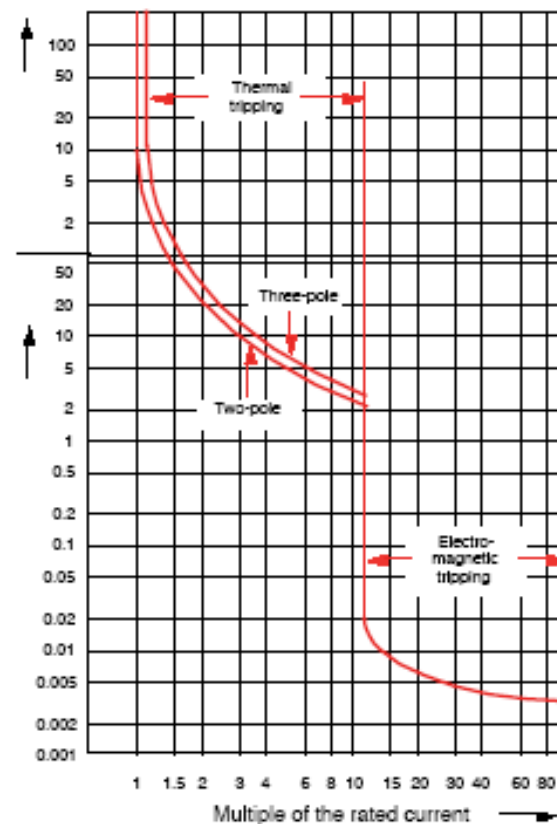
RV..., (Varistor) a.c./d.c.
RC..., (Capacitor) a.c.
RT..., (Transil diode) d.c.

■ Sklopna oprema

■ Motorna zaštitna sklopka



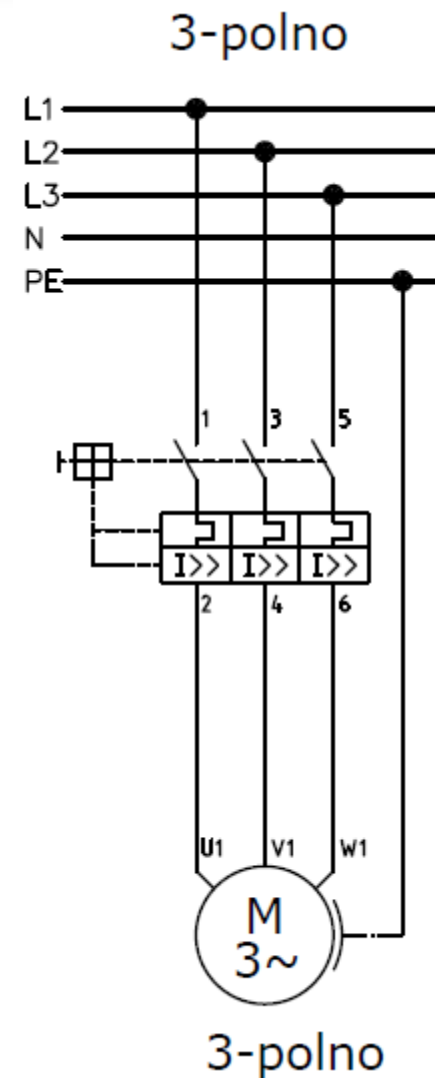
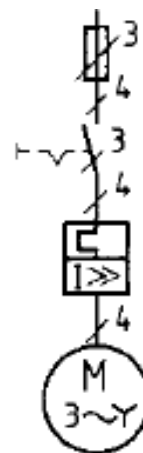
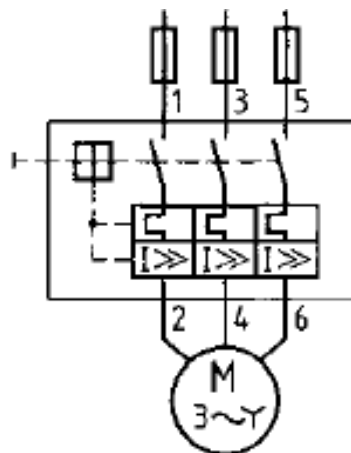
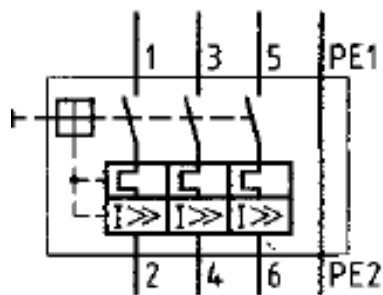
MSx Tripping curves



■ Sklopna oprema

■ Motorna zaštitna sklopka

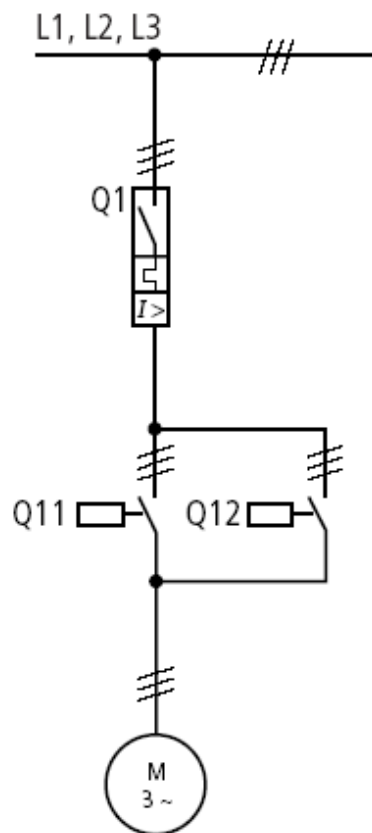
zaštitna sklopka motora



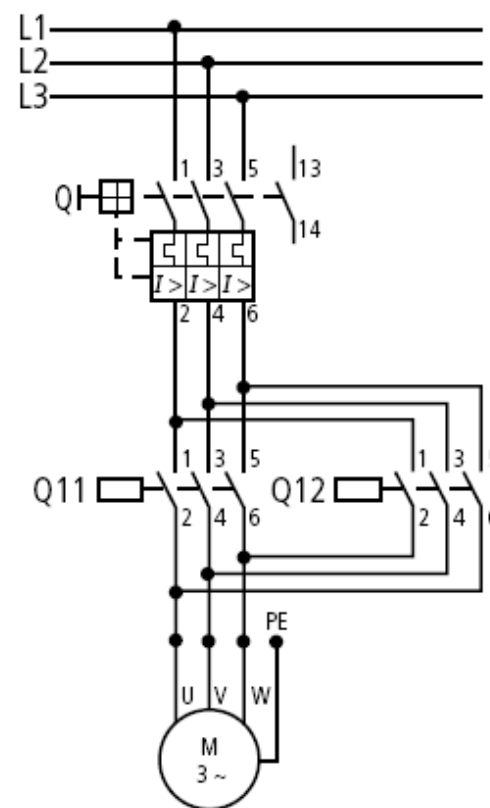
■ Sklopna oprema

■ Motorna zaštitna sklopka

Reversiranje:



jednopolna šema



tropolna šema

■ Sklopna oprema

■ Motorna zaštitna sklopka (prekidač)



MS116

8ST11601

- motorni zaštitni
prekidač



HKF1-11

8T020014

- pomoćni kontakti



HK1

8T02002



SK1

8T02102

- pomoćni kontakti



UA1

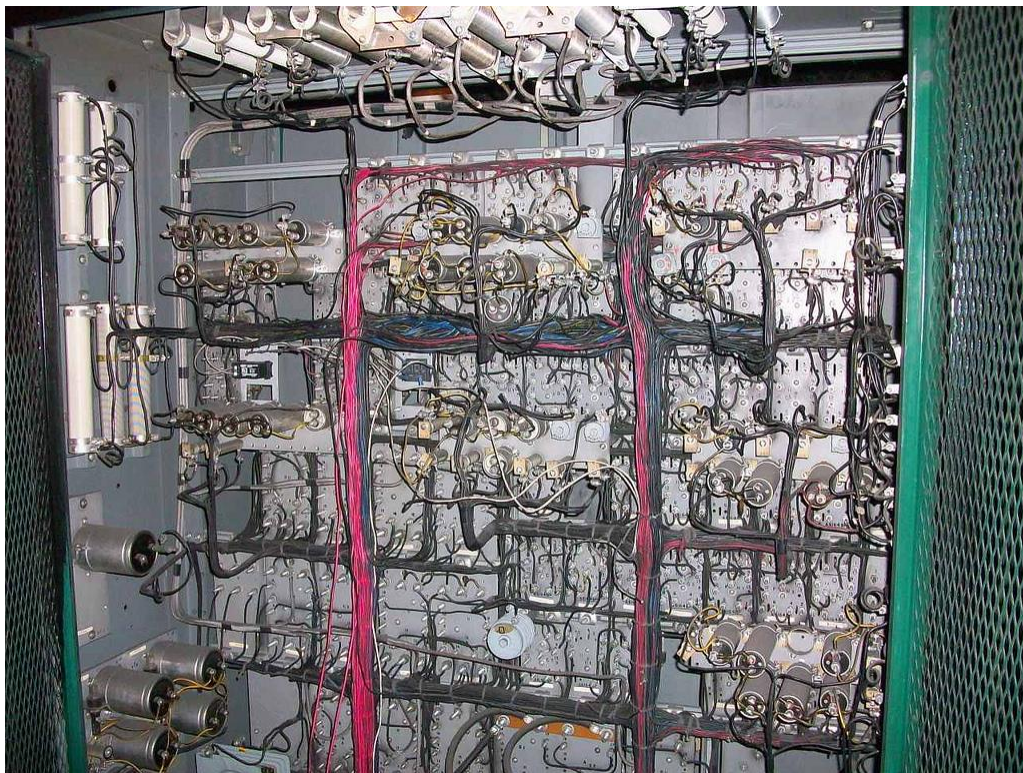
8T19-02

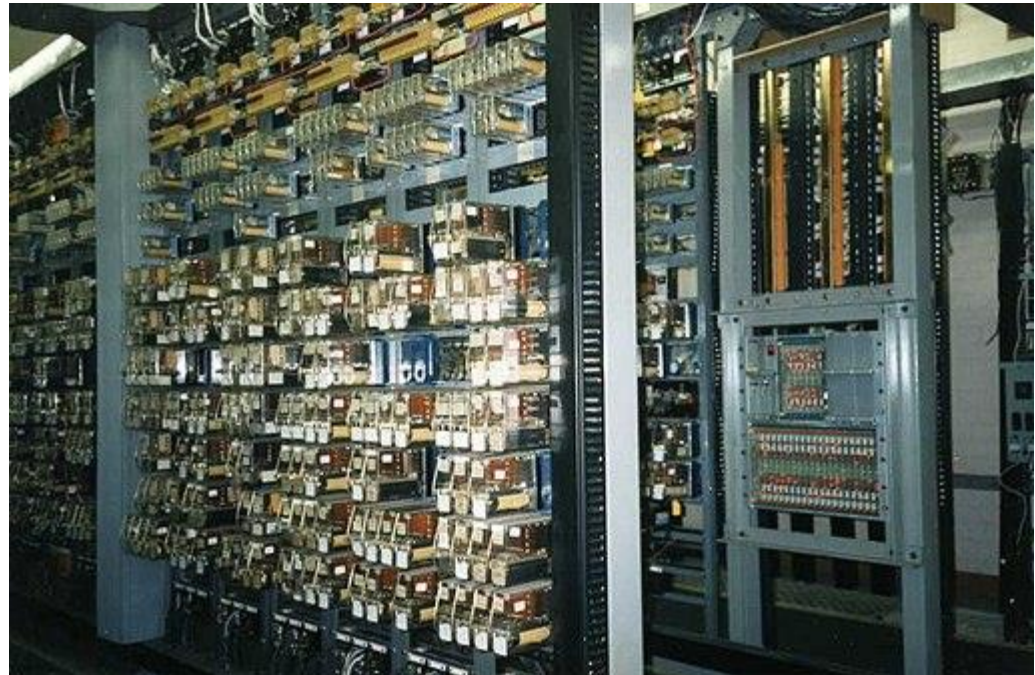
- podnaponska
sklopka

■ PLC

Šta je PLC?

- PLC (programabilni logički kontroler) je mikroprocesorski sistem u kome su hardver i softver specifično adaptirani industrijskom okruženju.
- Element automatizovanog sistema, koji na osnovu signala sa ulaznih uređaja, po određenom programu, izvršava različite logičke i sekvencionalne funkcije, na osnovu kojih formira izlazne signale kojima upravlja izlaznim uređajima; istovremeno može da obavlja komunikaciju sa udaljenim računarom, kontrolerom, operatorskim panelom ili drugim pokazivačkim uređajem.
- Prvobitno je osmišljen kao zamena za relejnu logiku, ali sada pored logičkih funkcija može da obavlja i aritmetička izračunavanja i složeno, potpuno digitalno upravljanje.





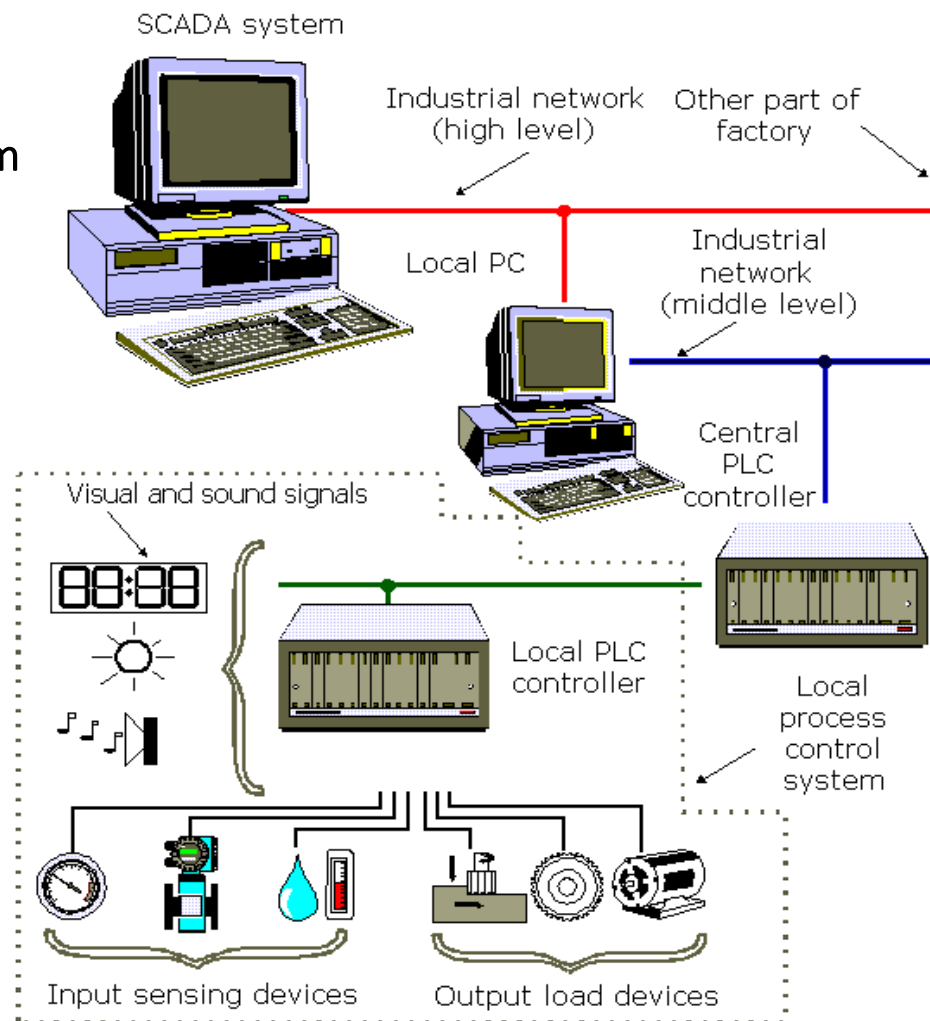


- Jednostavna ugradnja
- Modularna organizacija, lako proširenje i adaptacija
- Potrebno je mnogo manje (80%) provodnika za povezivanje
- Dijagnostikovanje - brzo i jednostavno otkrivanje grešaka

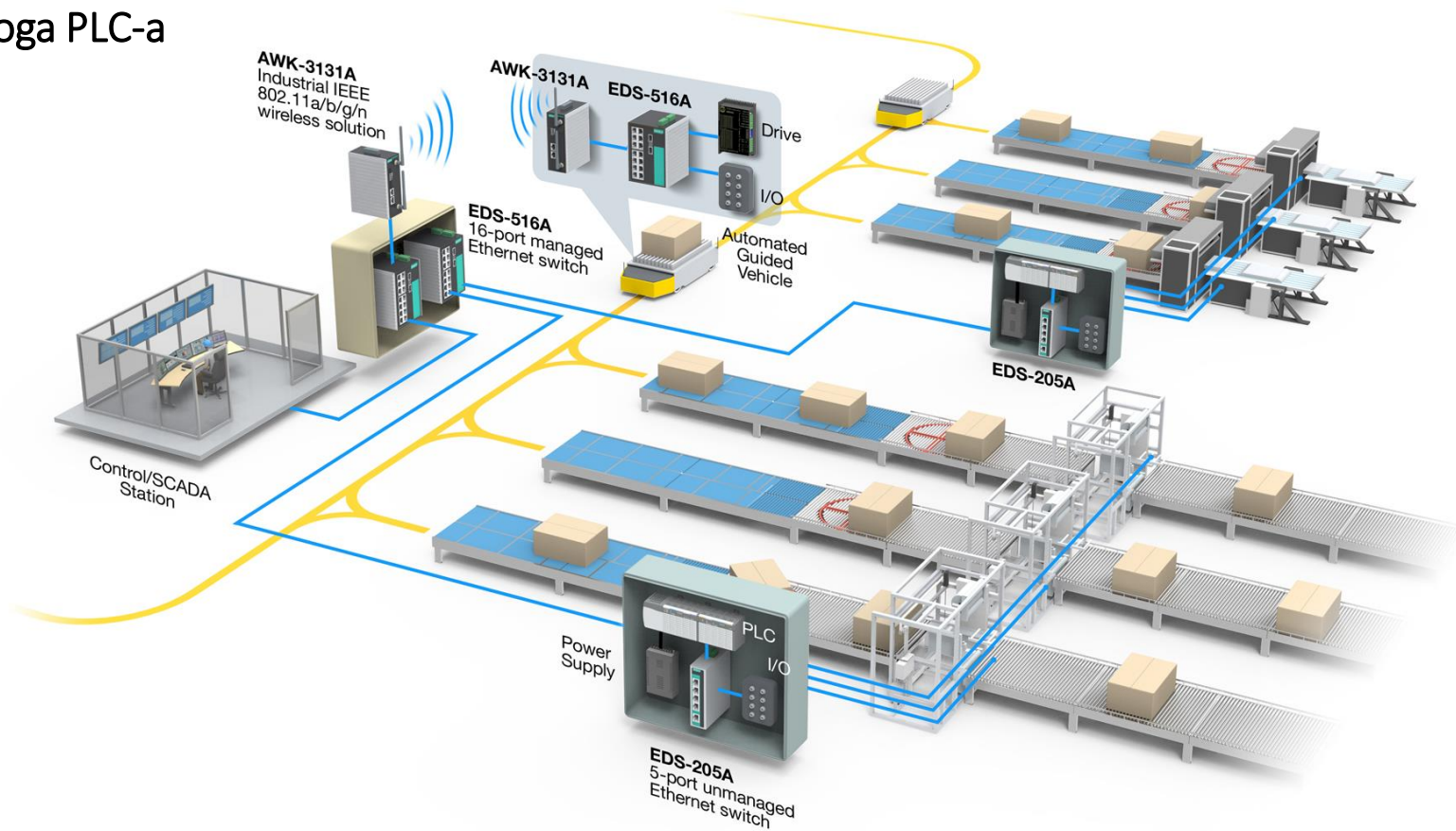
- Potrošnja je značajno smanjena
- Male dimenzije, mali broj rezervnih delova, lakše održavanje
- Jednostavno programiranje i održavanje programa
- Visok stepen dokumentovanosti programa
- Mogućnost povezivanja u hijerarhijski nadređeni sistem upravljanja
- Mogućnost instalacije i testiranja na samoj mašini
- Prihvatljiva cena, naročito kod složenih sistema sa velikim brojem U/I



■ Hijerarhijski sistem upravljanja



■ Uloga PLC-a



■ PLC aplikacije

■ Samostalna (*single-ended*)

- jedan PLC upravlja jednim procesom kao samostalna jedinica koja ne komunicira s drugim računarima, niti PLC uređajima
- najčešće zahteva PLC sa manjim brojem ulaza/izlaza

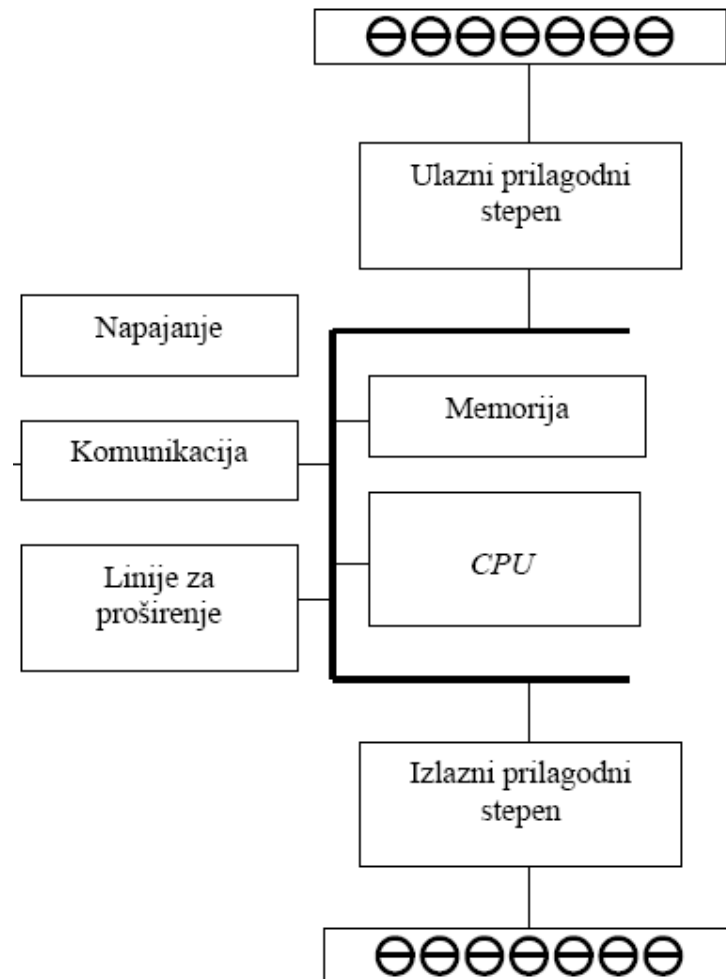
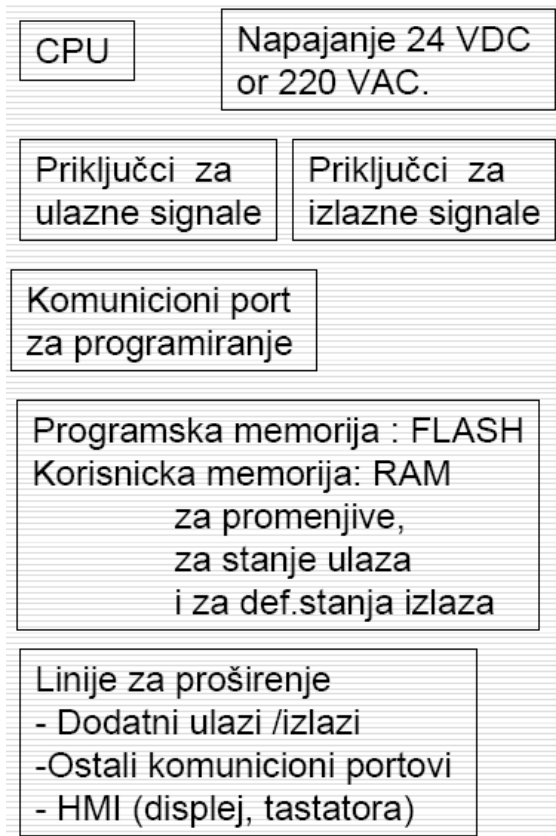
■ Višeprogramska (*multitask*)

- jedan PLC upravlja s više procesa, značajan faktor je broj ulaza/izlaza i postojanje mreže za prenos podataka

■ Nadzorna (*control management*)

- jedan PLC upravlja s više drugih PLC, najčešće zahteva jači procesor

■ Hardverska organizacija (!)



■ CPU (Central Processing Unit)

Ranije su to bili 8-bitni, danas 16-bitni i 32-bitni

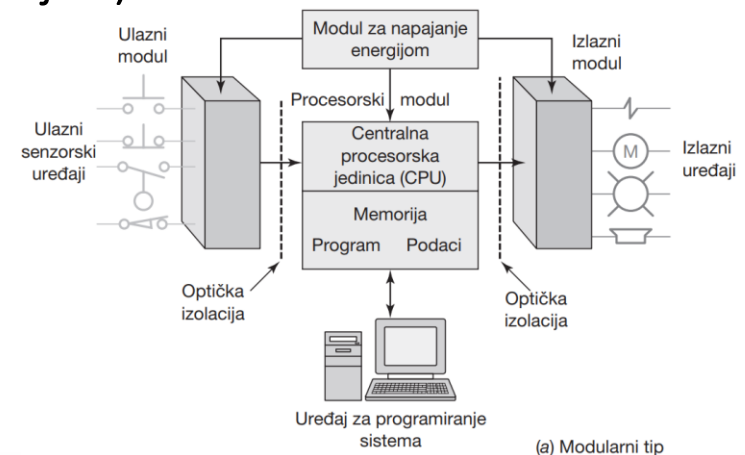
Uloga CPU-a: Izvršava **program** (+upravljanje memorijom)

Nadgleda ulaze (+upravljanje memorijom)

Postavlja izlaze (+upravljanje memorijom)

Brine o komunikaciji

Vrši samodijagnostiku



■ Digitalni i analogni ulazi i izlazi

- Digitalni ulazi

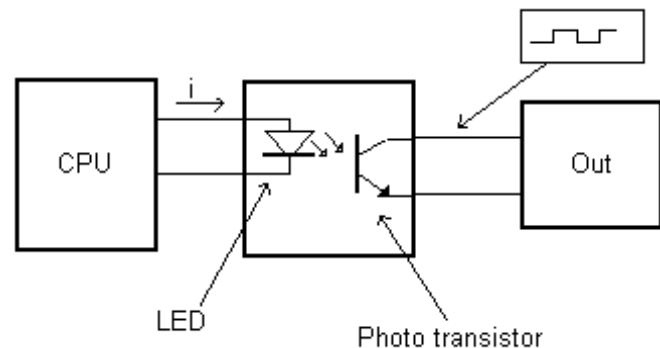
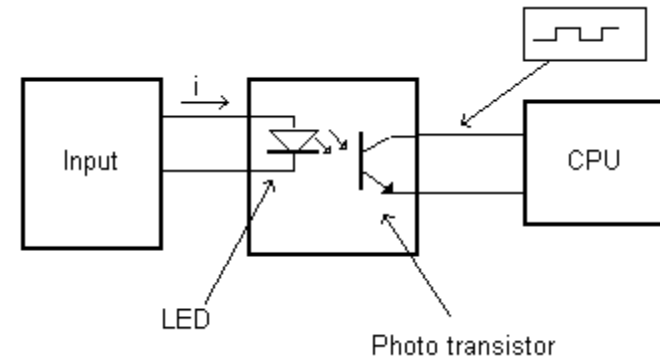
(Primer: tasteri, prekidači...)

- Ugrađena zaštita od treperenja signala (kako se treptaj ne bi protumačio kao nova aktivacija ulaznog signala).

- Digitalni izlazi

(Primer: upravljaju kontaktorima, relejima, LED diodama...)

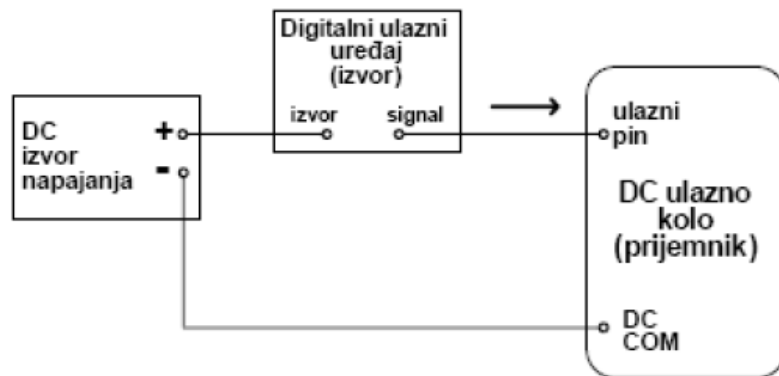
- Vrste: 1. tranzistorski (PNP, NPN)
2. relejni



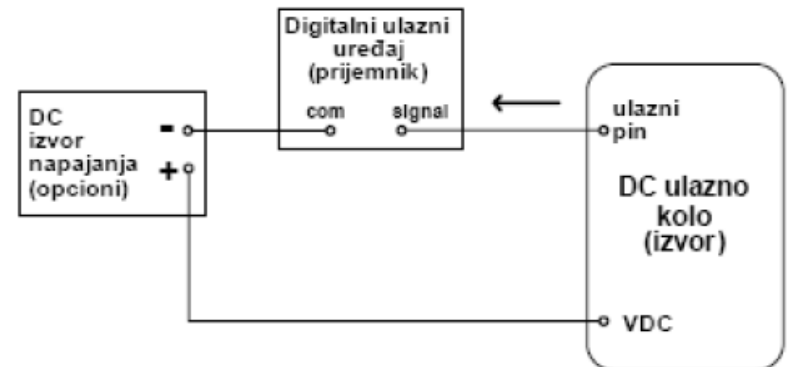
Galvanska izolacija

■ Digitalni i analogni ulazi i izlazi

Digitalni ulazi



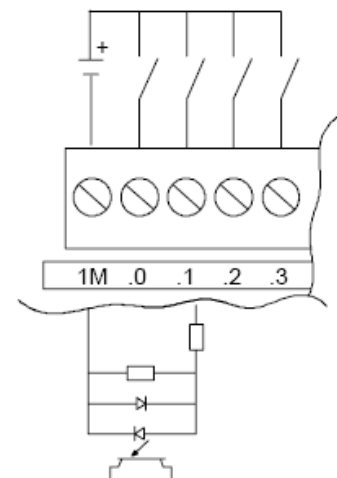
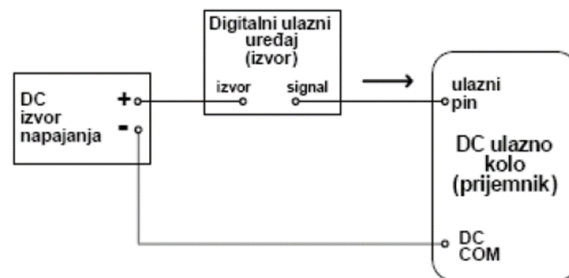
Sink koncept



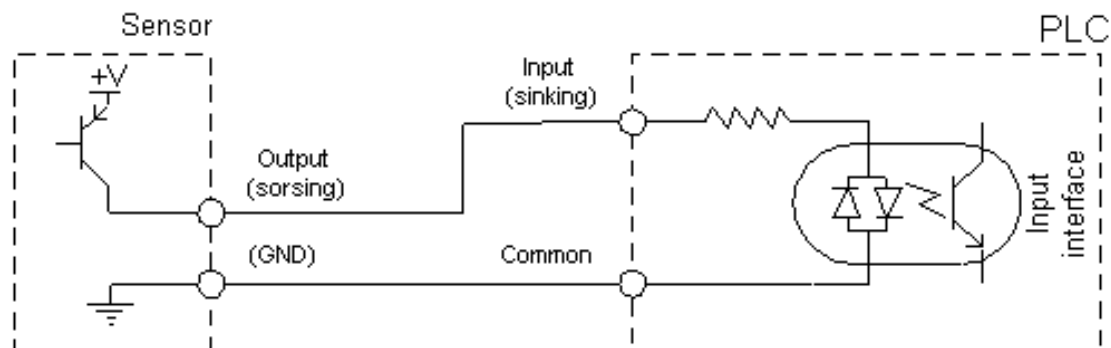
Source koncept

■ Digitalni i analogni ulazi i izlazi

Digitalni ulazi

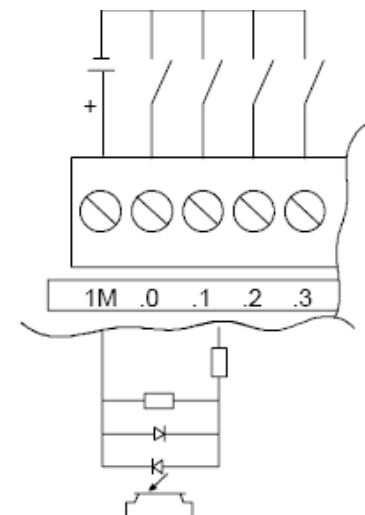
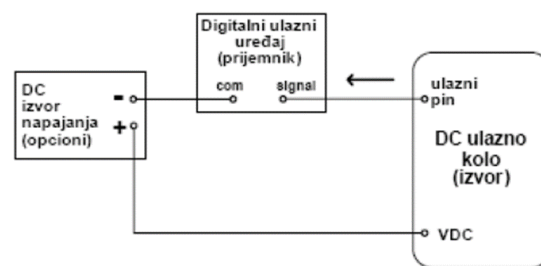


Sink koncept

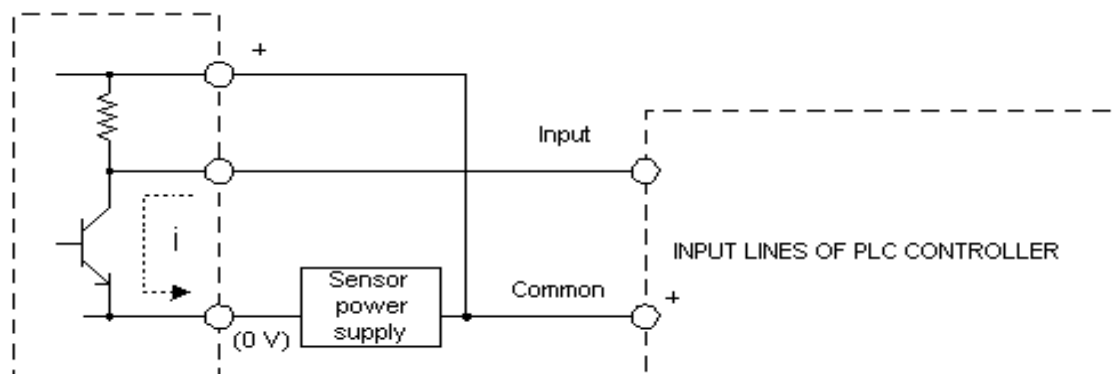


■ Digitalni i analogni ulazi i izlazi

Digitalni ulazi



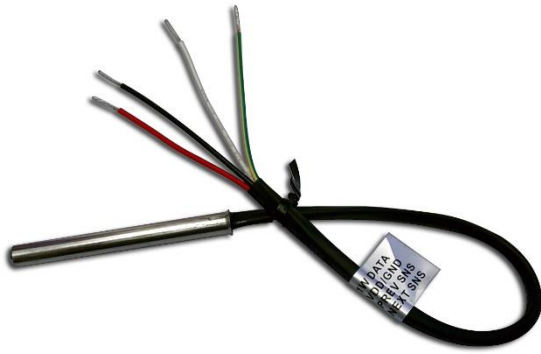
Source koncept



■ Digitalni i analogni ulazi i izlazi

Digitalni ulazi - simboli

Opis	Simbol	
	Normalno otvoren	Normalno zatvoren
Običan prekidač		
Granični prekidač		
Prekidač sa oprugom		
Taster		
Temperaturni prekidač		
Prekidač aktiviran protokom		
Prekidač aktiviran nivoom		
Prekidač aktiviran pritiskom		
Prekidač aktiviran rastojanjem		
Relejni kontakt		
Osigurač		



temperaturni senzor



senzor pritiska



taster za nužni stop



senzor blizine



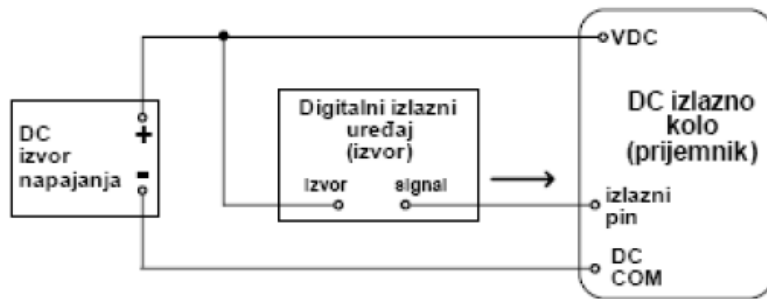
senzor nivoa tečnosti



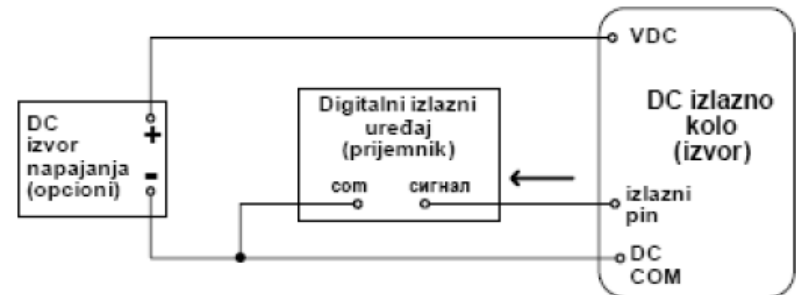
strujni senzor

■ Digitalni i analogni ulazi i izlazi

Digitalni izlazi

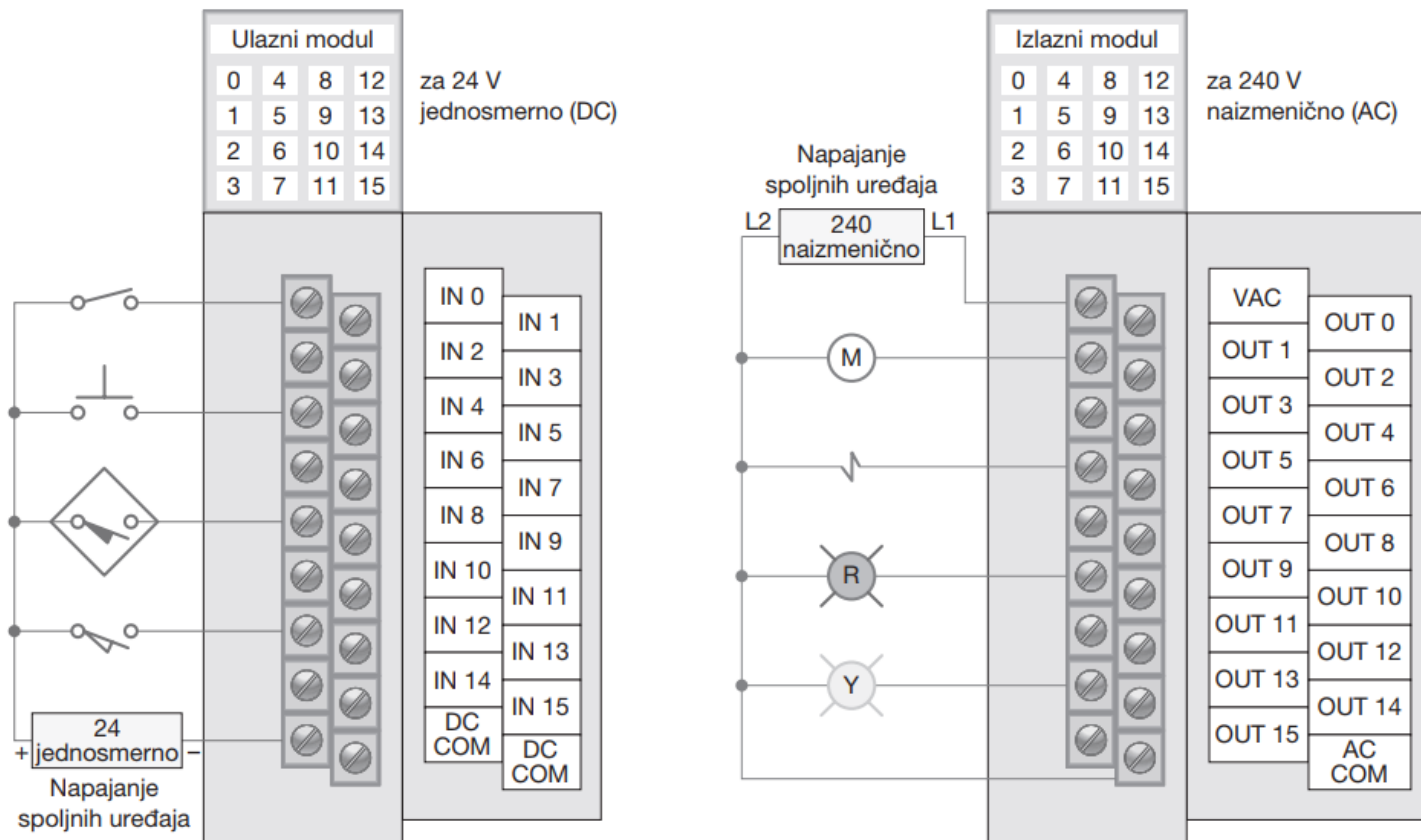


Sink koncept



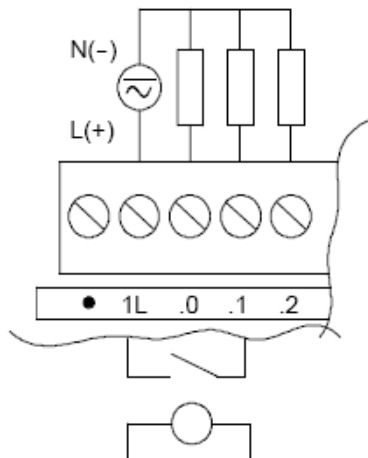
Source koncept

■ Primer povezivanja ulaznih i izlaznih uređaja sa PLC

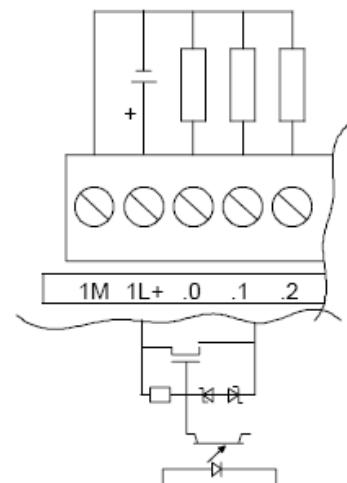


■ Digitalni i analogni ulazi i izlazi

Digitalni izlazi (source)



Relajni



Tranzistorski

■ Digitalni i analogni ulazi i izlazi

Analogni ulazi i izlazi

Ulazi

- Ulazi sa raznih senzora: temperatura, napon, protok, pritisak...

Izlazi

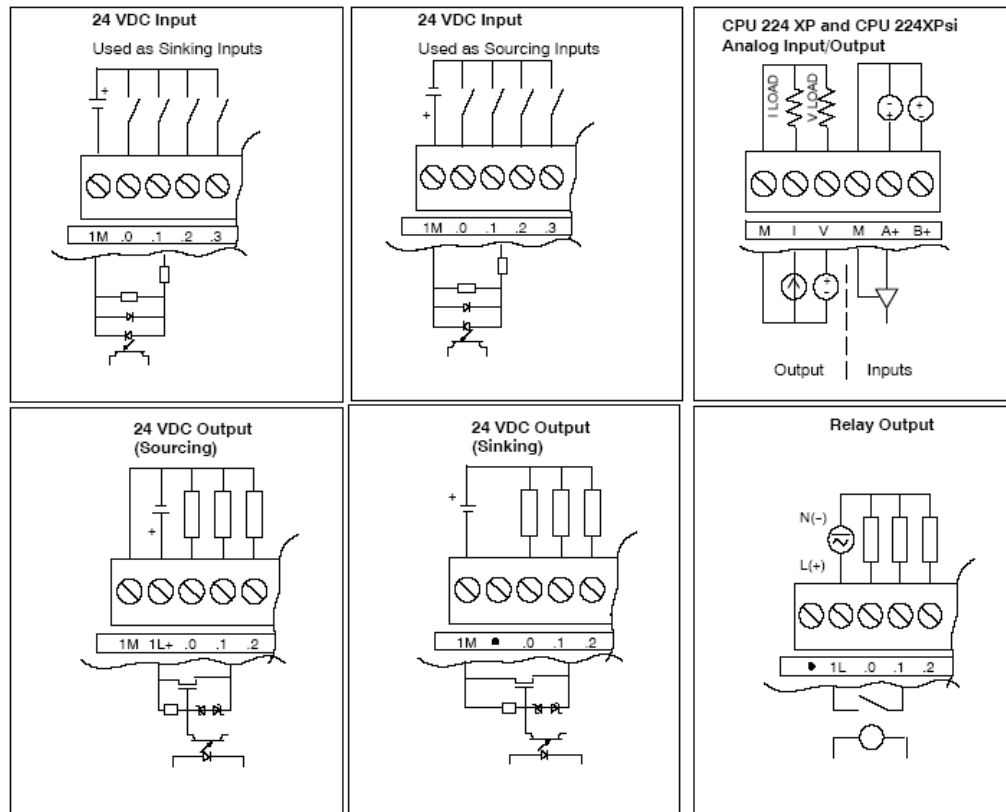
- Promenjivi analogni signal za regulaciju, npr. servo ventil, frekventni regulator...

Opsezi

- strujni 0mA – 20mA
- strujni 4mA – 20mA
- naponski 0-10V
- naponski -10-+10V

Najčešće 12 bitni

■ Digitalni i analogni ulazi i izlazi



■ Siemens SIMATIC S7-200 PLC serija



- **Različite CPU i broj ulaza/izlaza u S7-200 seriji**

- | | |
|---|---|
| • CPU 221 DC/DC/DC 6 Inputs/4 Outputs | CPU 221 AC/DC/Relay 6 Inputs/4 Relays |
| • CPU 222 DC/DC/DC 8 Inputs/6 Outputs | CPU 222 AC/DC/Relay 8 Inputs/6 Relays |
| • CPU 224 DC/DC/DC 14 Inputs/10 Outputs | CPU 224 AC/DC/Relay 14 Inputs/10 Relays |
| • CPU 224XP DC/DC/DC 14 Inputs/10 Outputs | CPU 224XP AC/DC/Relay 14 Inputs/10 Relays |
| • CPU 226 DC/DC/DC 24 Inputs/16 Outputs | CPU 226 AC/DC/Relay 24 Inputs/16 Relays |

■ Siemens SIMATIC S7-1200 PLC serija



CPU models		Order Number
CPU 1211C	CPU 1211C DC/DC/DC	6ES7 211-1AE31-0XB0
	CPU 1211C AC/DC/Relay	6ES7 211-1BE31-0XB0
	CPU 1211C DC/DC/Relay	6ES7 211-1HE31-0XB0
CPU 1212C	CPU 1212C DC/DC/DC	6ES7 212-1AE31-0XB0
	CPU 1212C AC/DC/Relay	6ES7 212-1BE31-0XB0
	CPU 1212C DC/DC/Relay	6ES7 212-1HE31-0XB0
CPU 1214C	CPU 1214C DC/DC/DC	6ES7 214-1AG31-0XB0
	CPU 1214C AC/DC/Relay	6ES7 214-1BG31-0XB0
	CPU 1214C DC/DC/Relay	6ES7 214-1HG31-0XB0
CPU 1215C	CPU 1215C DC/DC/DC	6ES7 215-1AG31-0XB0
	CPU 1215C AC/DC/Relay	6ES7 215 -1BG31-0XB0
	CPU 1215C DC/DC/Relay	6ES7 215-1HG31-0XB0

Feature	CPU 221	CPU 222	CPU 224	CPU 224XP	CPU 226
Physical size (mm)	90 x 80 x 62	90 x 80 x 62	120.5 x 80 x 62	140 x 80 x 62	190 x 80 x 62
Program memory: with run mode edit without run mode edit	4096 bytes 4096 bytes	4096 bytes 4096 bytes	8192 bytes 12288 bytes	12288 bytes 16384 bytes	16384 bytes 24576 bytes
Data memory	2048 bytes	2048 bytes	8192 bytes	10240 bytes	10240 bytes
Memory backup	50 hours typical	50 hours typical	100 hours typical	100 hours typical	100 hours typical
Local on-board I/O Digital Analog	6 In/4 Out -	8 In/6 Out -	14 In/10 Out -	14 In/10 Out 2 In/1 Out	24 In/16 Out -
Expansion modules	0 modules	2 modules ¹	7 modules ¹	7 modules ¹	7 modules ¹
High-speed counters Single phase Two phase	4 at 30 kHz 2 at 20 kHz	4 at 30 kHz 2 at 20 kHz	6 at 30 kHz 4 at 20 kHz	4 at 30 kHz 2 at 200 kHz 3 at 20 kHz 1 at 100 kHz	6 at 30 kHz 4 at 20 kHz
Pulse outputs (DC)	2 at 20 kHz	2 at 20 kHz	2 at 20 kHz	2 at 100 kHz	2 at 20 kHz
Analog adjustments	1	1	2	2	2
Real-time clock	Cartridge	Cartridge	Built-in	Built-in	Built-in
Communications ports	1 RS-485	1 RS-485	1 RS-485	2 RS-485	2 RS-485
Floating-point math	Yes				
Digital I/O image size	256 (128 in, 128 out)				
Boolean execution speed	0.22 microseconds/instruction				

Feature		CPU 1211C	CPU 1212C	CPU 1214C	CPU 1215C
Physical size (mm)		90 x 100 x 75	90 x 100 x 75	110 x 100 x 75	130 x 100 x 75
User memory	Work	30 Kbytes	50 Kbytes	75 Kbytes	100 Kbytes
	Load	1 Mbyte	1 Mbyte	4 Mbytes	4 Mbytes
	Retentive	10 Kbytes	10 Kbytes	10 Kbytes	10 Kbytes
Local on-board I/O	Digital	6 inputs/4 outputs	8 inputs/6 outputs	14 inputs/10 outputs	14 inputs/10 outputs
	Analog	2 inputs	2 inputs	2 inputs	2 inputs / 2 outputs
Process image size	Inputs (I)	1024 bytes	1024 bytes	1024 bytes	1024 bytes
	Outputs (Q)	1024 bytes	1024 bytes	1024 bytes	1024 bytes
Bit memory (M)		4096 bytes	4096 bytes	8192 bytes	8192 bytes
Signal module (SM) expansion		None	2	8	8
Signal board (SB), Battery board (BB), or communication board (CB)		1	1	1	1
Communication module (CM) (left-side expansion)		3	3	3	3
High-speed counters	Total	3 built-in I/O, 5 with SB	4 built-in I/O, 6 with SB	6	6
	Single phase	3 at 100 kHz	3 at 100 kHz	3 at 100 kHz	3 at 100 kHz
		SB: 2 at 30 kHz	1 at 30 kHz SB: 2 at 30 kHz	3 at 30 kHz	3 at 30 kHz
	Quadrature phase	3 at 80 kHz SB: 2 at 20 kHz	3 at 80 kHz 1 at 20 kHz SB: 2 at 20 kHz	3 at 80 kHz 3 at 20 kHz	3 at 80 kHz 3 at 20 kHz
Pulse outputs ¹		4	4	4	4
Memory card		SIMATIC Memory card (optional)			
Real time clock retention time		20 days, typ. / 12 day min. at 40 degrees C (maintenance-free Super Capacitor)			
PROFINET		1 Ethernet communication port			2 Ethernet communication ports
Real math execution speed		2.3 µs/instruction			
Boolean execution speed		0.08 µs/instruction			

¹ For CPU models with relay outputs, you must install a digital signal board (SB) to use the pulse outputs.

■ Napajanje

Technical data		CPU 1211C AC/DC/Relay	CPU 1211C DC/DC/Relay	CPU 1211C DC/DC/DC
Voltage range		85 to 264 VAC	20.4 VDC to 28.8 VDC 22.0 VDC to 28.8 VDC for ambient temperature -20° C to 0° C	
Line frequency		47 to 63 Hz	--	--
Input current	CPU only at max. load	60 mA at 120 VAC 30 mA at 240 VAC	300 mA at 24 VDC	300 mA at 24 VDC
	CPU with all expansion accessories at max. load	180 mA at 120 VAC 90 mA at 240 VAC	900 mA at 24 VDC	900 mA at 24 VDC
Inrush current (max.)		20 A at 264 VAC	12 A at 28.8 VDC	12 A at 28.8 VDC
Isolation (input power to logic)		1500 VAC	Not isolated	Not isolated
Ground leakage, AC line to functional earth		0.5 mA max.	--	--
Hold up time (loss of power)		20 ms at 120 VAC 80 ms at 240 VAC	10 ms at 24 VDC	10 ms at 24 VDC
Internal fuse, not user replaceable		3 A, 250 V, slow blow	3 A, 250 V, slow blow	3 A, 250 V, slow blow

■ Digitalni ulazi

Technical data	CPU 1211C AC/DC/Relay, CPU 1211C DC/DC/Relay, and CPU 1211C DC/DC/DC
Number of inputs	6
Type	Sink/Source (IEC Type 1 sink)
Rated voltage	24 VDC at 4 mA, nominal
Continuous permissible voltage	30 VDC, max.
Surge voltage	35 VDC for 0.5 sec.
Logic 1 signal (min.)	15 VDC at 2.5 mA
Logic 0 signal (max.)	5 VDC at 1 mA
Isolation (field side to logic)	500 VAC for 1 minute
Isolation groups	1
Filter times	0.2, 0.4, 0.8, 1.6, 3.2, 6.4, and 12.8 ms (selectable in groups of 4)
HSC clock input rates (max.) (Logic 1 Level = 15 to 26 VDC)	Single phase: 100 KHz Quadrature phase: 80 KHz
Number of inputs on simultaneously	6 at 60° C horizontal, 50° C vertical
Cable length (meters)	500 m shielded, 300 m unshielded, 50 m shielded for HSC inputs

Technical data	CPU 1211C AC/DC/Relay and CPU 1211C DC/DC/Relay	CPU 1211C DC/DC/DC
Number of outputs	4	4
Type	Relay, dry contact	Solid state - MOSFET (sourcing)
Voltage range	5 to 30 VDC or 5 to 250 VAC	20.4 to 28.8 VDC
Logic 1 signal at max. current	--	20 VDC min.
Logic 0 signal with 10 K Ω load	--	0.1 VDC max.
Current (max.)	2.0 A	0.5 A
Lamp load	30 W DC / 200 W AC	5 W
ON state resistance	0.2 Ω max. when new	0.6 Ω max.
Leakage current per point	Technical data	CPU 1211C AC/DC/Relay and CPU 1211C DC/DC/Relay
Surge current		CPU 1211C DC/DC/DC
Overload protection	Maximum relay switching frequency	1 Hz
Isolation (field side to logic)	Switching delay (Qa.0 to Qa.3)	10 ms max.
	Pulse Train Output rate (Qa.0 and Qa.2)	Not recommended ¹
	Lifetime mechanical (no load)	10,000,000 open/close cycles
	Lifetime contacts at rated load	100,000 open/close cycles
	Behavior on RUN to STOP	Last value or substitute value (default value 0)
	Number of outputs on simultaneously	4 at 60° C horizontal, 50° C vertical
	Cable length (meters)	500 m shielded, 150 m unshielded

■ Analogni ulazi

Technical data	Description
Number of inputs	2
Type	Voltage (single-ended)
Full-scale range	0 to 10 V
Full-scale range (data word)	0 to 27648
Overshoot range	10.001 to 11.759 V
Overshoot range (data word)	27,649 to 32,511
Overflow range	11.760 to 11.852 V
Overflow range (data word)	32,512 to 32,767
Resolution	10 bits
Maximum withstand voltage	35 VDC
Smoothing	None, Weak, Medium, or Strong See the table for step response (ms) for the analog inputs of the CPU (Page 711).
Noise rejection	10, 50, or 60 Hz
Impedance	$\geq 100 \text{ K}\Omega$
Isolation (field side to logic)	None
Accuracy (25°C / -20 to 60°C)	3.0% / 3.5% of full-scale
Cable length (meters)	100 m, shielded twisted pair

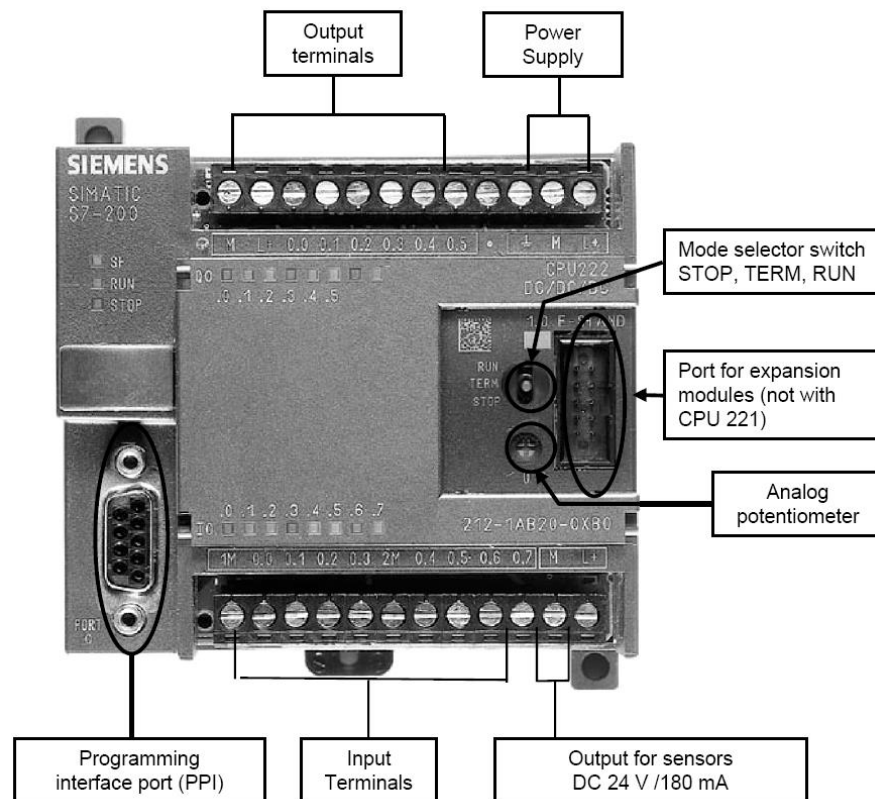
■ Moduli za proširenja

Expansion Modules		Types		
Discrete modules	Input	8 x DC In	8 x AC In	16 x DC In
	Output	4 x DC	4 x Relays	
		8 x DC Out	8 x AC Out	8 x Relay
	Combination	4 x DC In / 4 x DC Out 4 x DC In / 4 x Relay	8 x DC In / 8 x DC Out 8 x DC In / 8 x Relay	16 x DC In/16 x DC Out 16 x DC In/16 x Relay
Analog modules	Input	4 x Analog In	4 x Thermocouple In	2 x RTD In
	Output	2 x Analog Out		
	Combination	4 x Analog In / 1 Analog Out		
Intelligent modules		Position Ethernet	Modem Internet	PROFIBUS-DP
Other modules		AS-Interface		

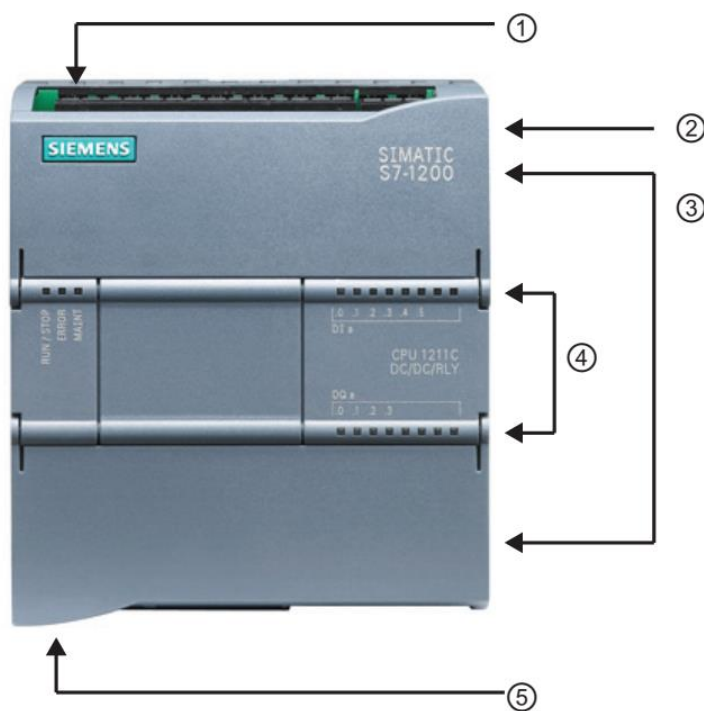
■ Moduli za proširenja



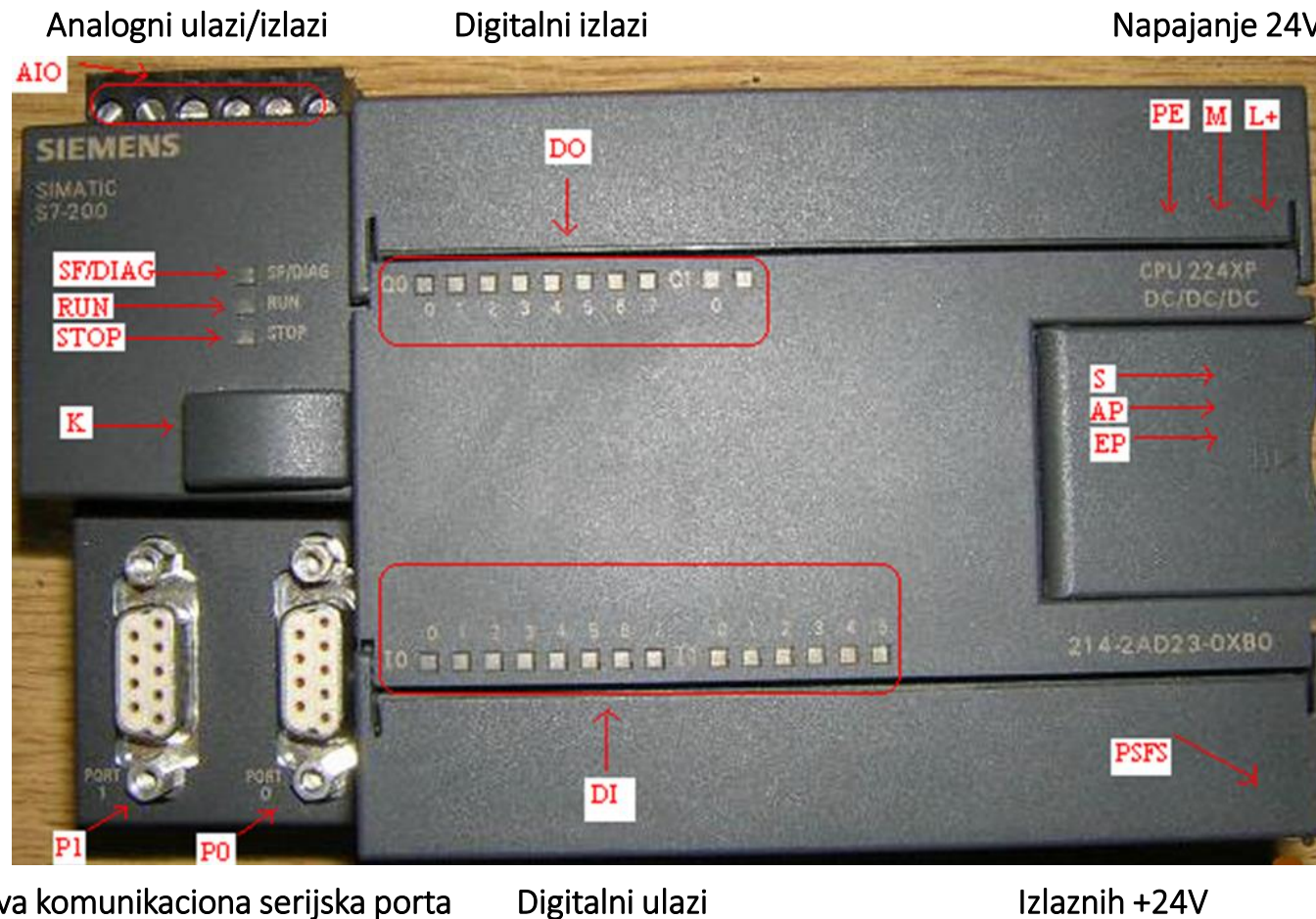
■ PLC S7-200 - osnovni model (prednja ploča)



■ PLC S7-1200 - osnovni model (prednja ploča)



- ① Power connector
- ② Memory card slot under top door
- ③ Removable user wiring connectors (behind the doors)
- ④ Status LEDs for the on-board I/O
- ⑤ PROFINET connector (on the bottom of the CPU)



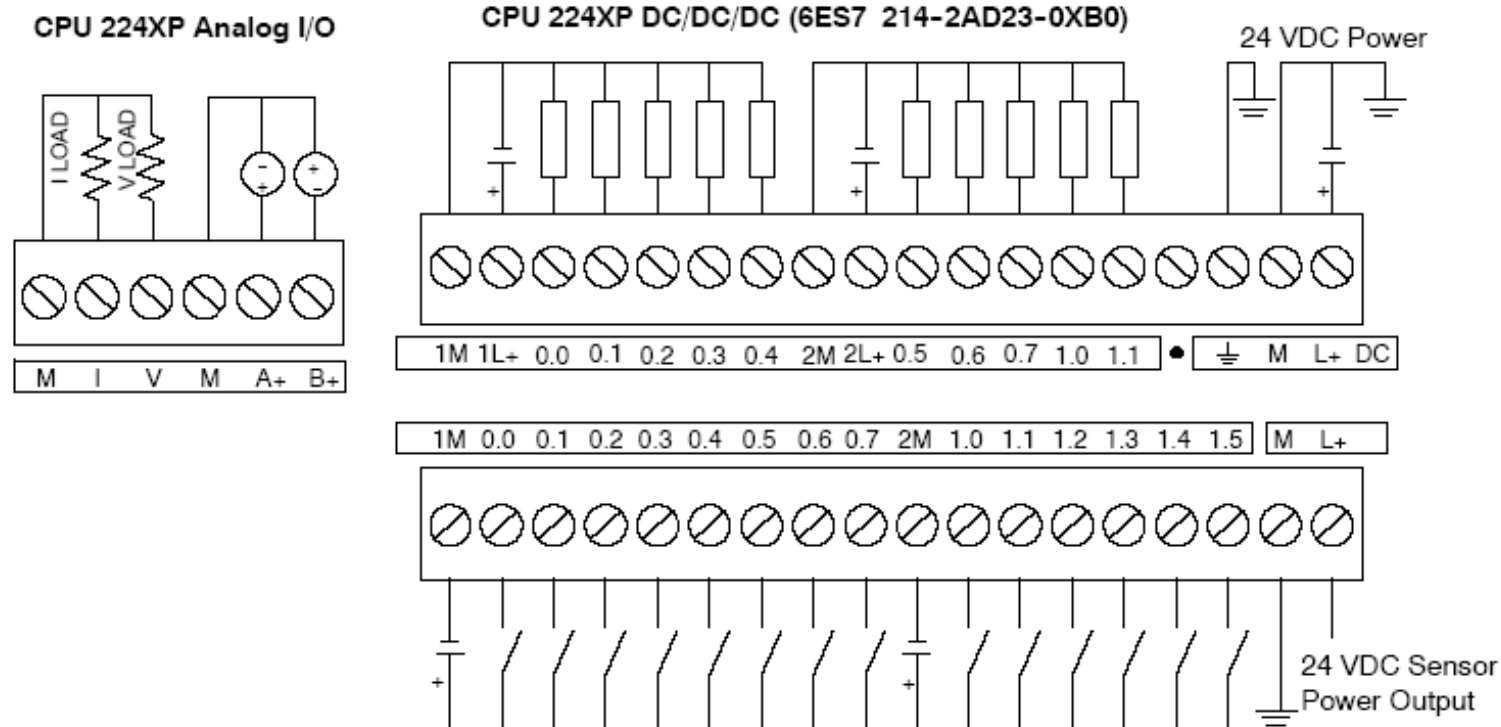
■ PLC S7-200 CPU 224XP - Prednja ploča

■ PLC S7-200 - osnovni model (prednja ploča)

Oznake imaju značenje:

AIO	– analogni ulazi i izlazi
DO	– digitalni izlazi
DI	– digitalni ulazi
PE, M, L+	– napajanje PLC-a: zaštitni (uzemljenje), “-” i “+” kraj jednosmernog naponskog izvora, respektivno
SF/DIAG	– LED dioda za signalizaciju u slučaju systemske greške
RUN	– LED dioda za signalizaciju radnog režima PLC-a
STOP	– LED dioda za signalizaciju stop režima PLC-a
K	– konektor za nadogradnju uređaja (memorijskim kertridžom, tajmerom, spoljnom baterijom)
S	– prekidač za biranje željenog radnog režima uređaja
AP	– potenciometri za regulaciju raspoloživog internog analognog signala
EP	– port za povezivanje sa modulima za proširenje
PO,P1	– portovi za povezivanje sa računarom, tekst displej jedinicom, touch panelom
PSFS	– jednosmerni naponski izvor od 24V, napajanje senzora

■ Siemens S7-200 (CPU 224XP)



■ Siemens S7-200 (CPU 224XP)

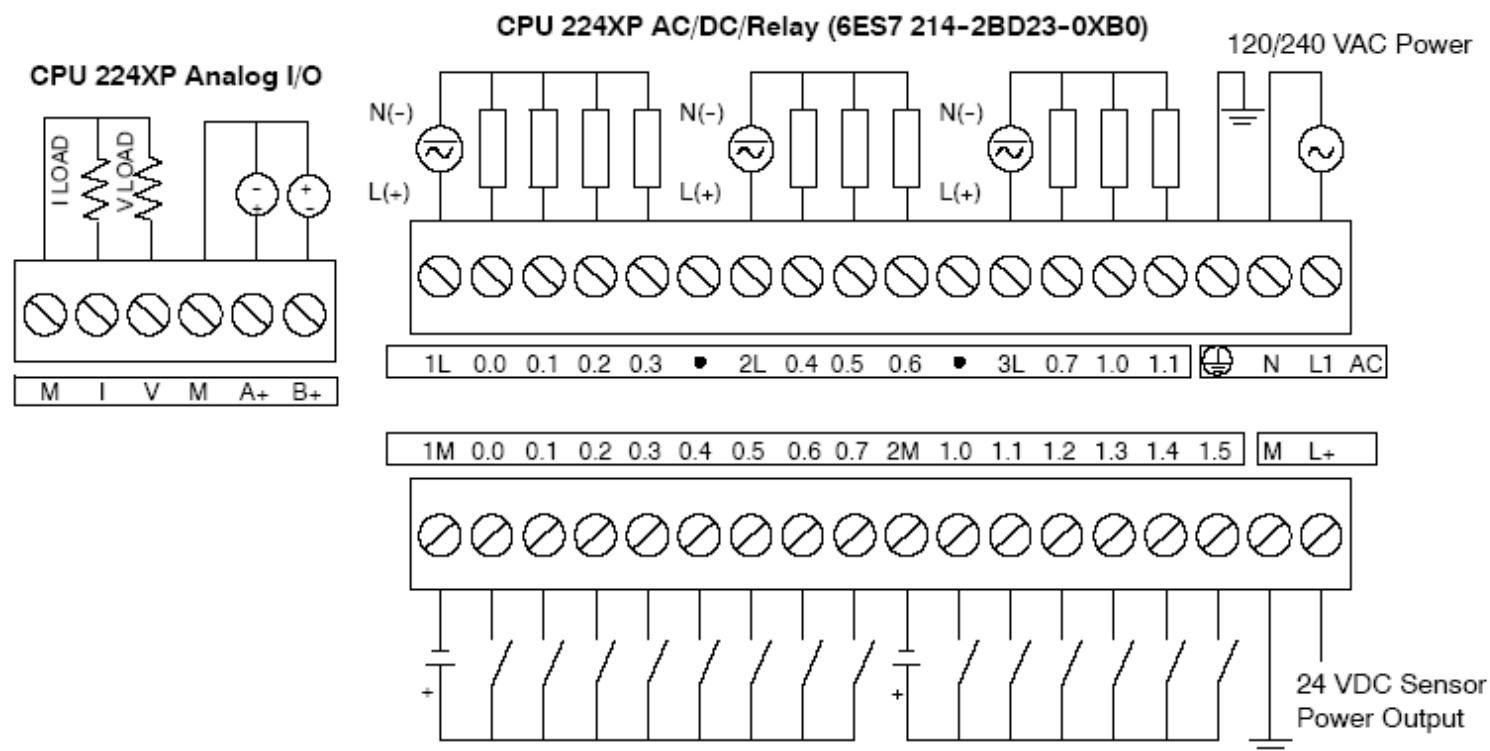
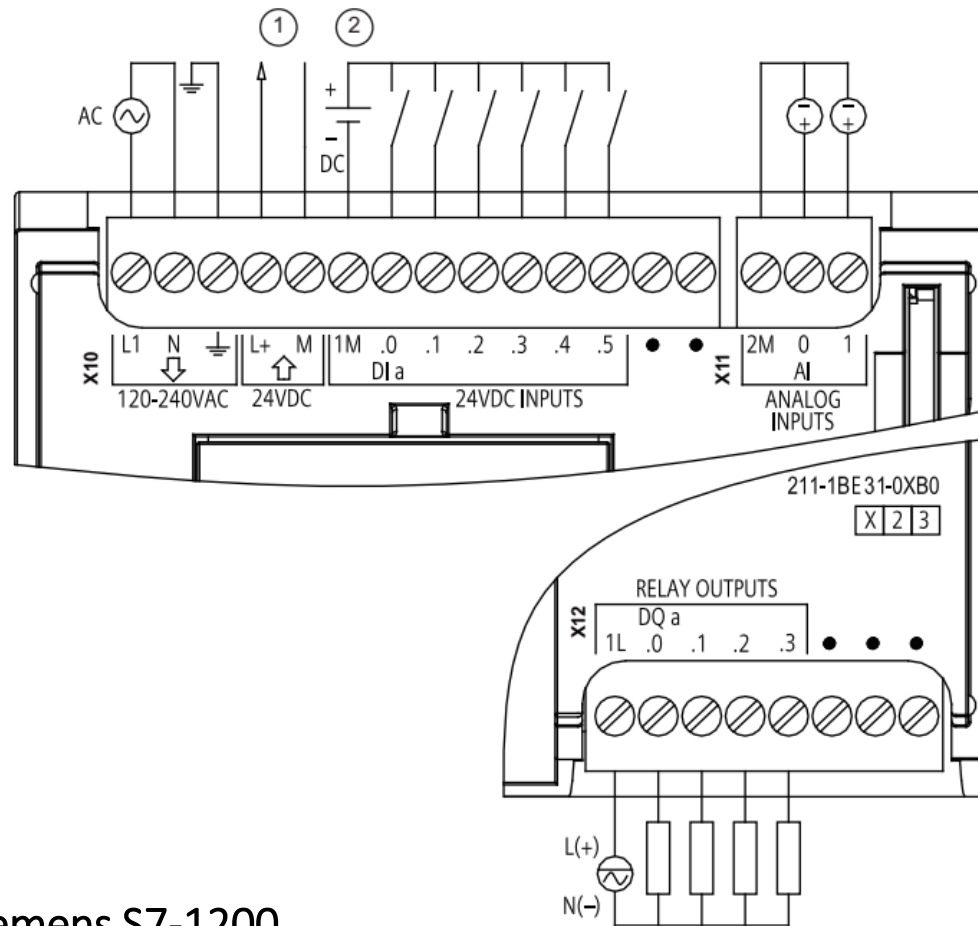


Table A- 20 CPU 1211C AC/DC/Relay (6ES7 211-1BE31-0XB0)



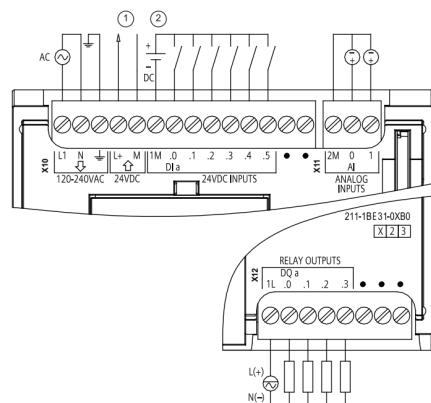
① 24 VDC Sensor Power Out
For additional noise immunity, connect "M" to chassis ground even if not using sensor supply.

② For sinking inputs, connect "-" to "M" (shown).

For sourcing inputs, connect "+" to "M".

Note: X11 connectors must be gold. See Appendix C, Spare Parts for order number.

Table A- 20 CPU 1211C AC/DC/Relay (6ES7 211-1BE31-0XB0)



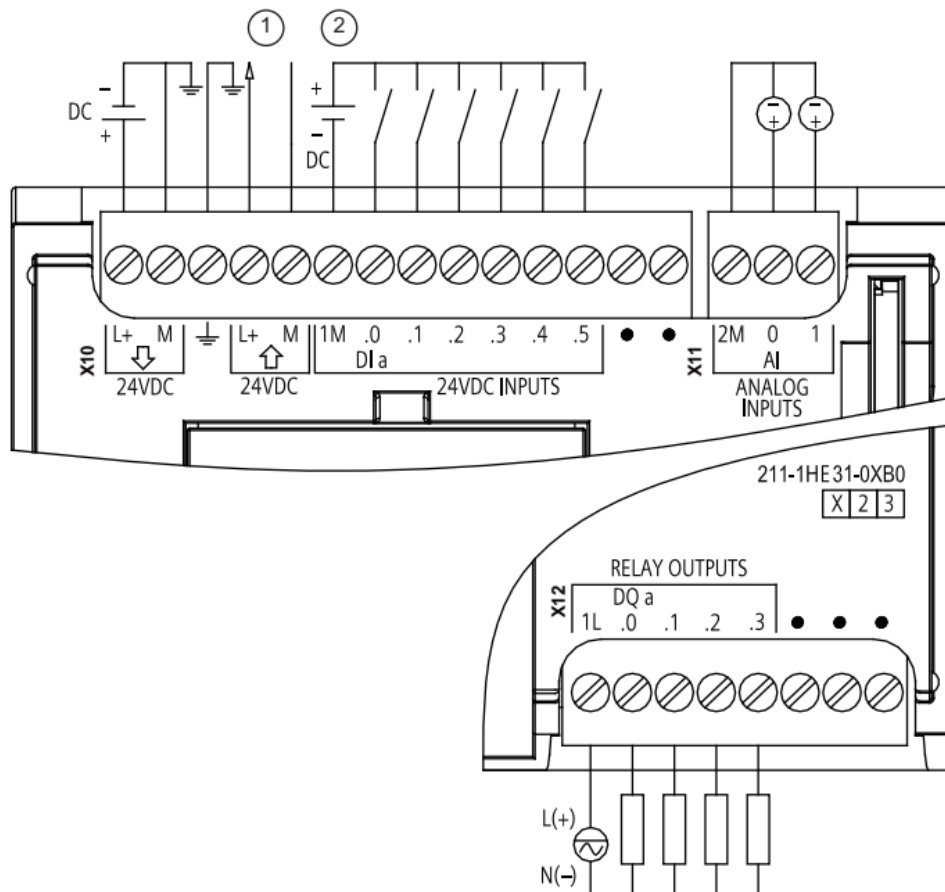
- ① 24 VDC Sensor Power Out
For additional noise immunity, connect "M" to chassis ground even if not using sensor supply.
- ② For sinking inputs, connect "-" to "M" (shown).
For sourcing inputs, connect "+" to "M".

Note: X11 connectors must be gold. See Appendix C, Spare Parts for order number.

Table A- 21 Connector pin locations for CPU 1211C AC/DC/Relay (6ES7 211-1BE31-0XB0)

Pin	X10	X11 (gold)	X12
1	L1 / 120-240 VAC	2 M	1L
2	N / 120-240 VAC	AI 0	DQ a.0
3	Functional Earth	AI 1	DQ a.1
4	L+ / 24VDC Sensor Out	--	DQ a.2
5	M / 24VDC Sensor Out	--	DQ a.3
6	1M	--	No connection
7	DI a.0	--	No connection
8	DI a.1	--	No connection
9	DI a.2	--	--
10	DI a.3	--	--
11	DI a.4	--	--
12	DI a.5	--	--
13	No connection	--	--
14	No connection	--	--

Table A- 22 CPU 1211C DC/DC/Relay (6ES7 211-1HE31-0XB0)



① 24 VDC Sensor Power Out

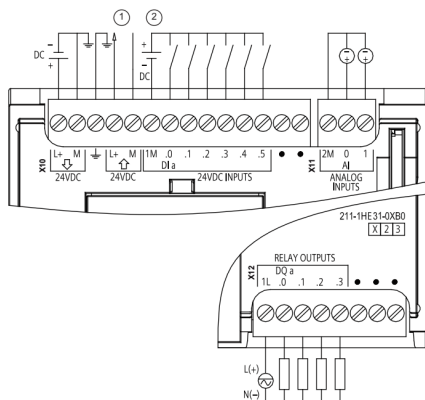
For additional noise immunity, connect "M" to chassis ground even if not using sensor supply.

② For sinking inputs, connect "-" to "M" (shown).

For sourcing inputs, connect "+" to "M".

Note: X11 connectors must be gold. See Appendix C, Spare Parts for order number.

Table A- 22 CPU 1211C DC/DC/Relay (6ES7 211-1HE31-0XB0)



① 24 VDC Sensor Power Out

For additional noise immunity, connect "M" to chassis ground even if not using sensor supply.

② For sinking inputs, connect "-" to "M" (shown).

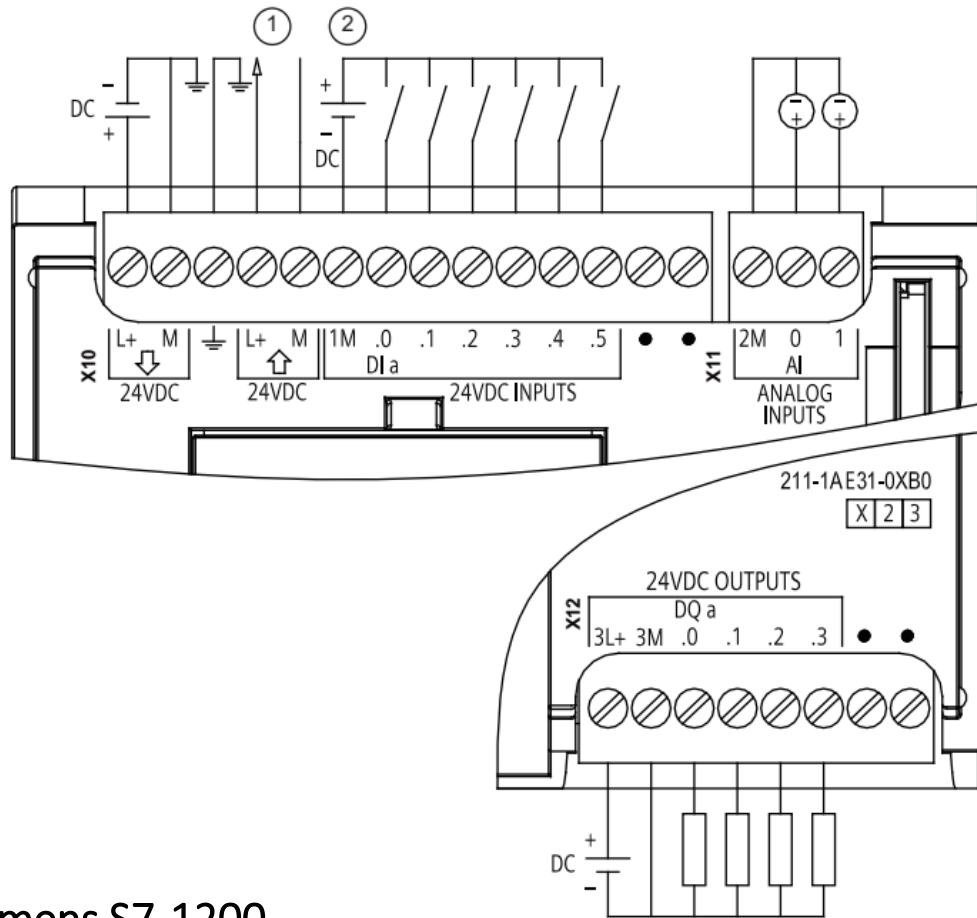
For sourcing inputs, connect "+" to "M".

Note: X11 connectors must be gold. See Appendix C, Spare Parts for order number.

Table A- 23 Connector pin locations for CPU 1211C DC/DC/Relay (6ES7 211-1HE31-0XB0)

Pin	X10	X11 (gold)	X12
1	L+ / 24VDC	2 M	1L
2	M / 24VDC	AI 0	DQ a.0
3	Functional Earth	AI 1	DQ a.1
4	L+ / 24VDC Sensor Out	--	DQ a.2
5	M / 24VDC Sensor Out	--	DQ a.3
6	1M	--	No connection
7	DI a.0	--	No connection
8	DI a.1	--	No connection
9	DI a.2	--	--
10	DI a.3	--	--
11	DI a.4	--	--
12	DI a.5	--	--
13	No connection	--	--
14	No connection	--	--

Table A- 24 CPU 1211C DC/DC/DC (6ES7 211-1AE31-0XB0)



① 24 VDC Sensor Power Out

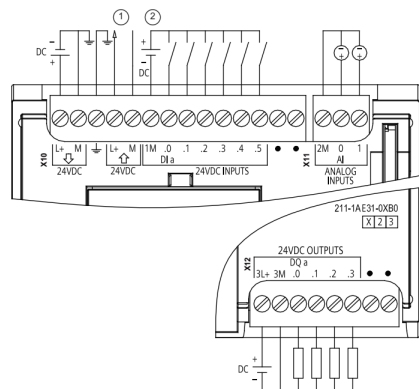
For additional noise immunity, connect "M" to chassis ground even if not using sensor supply.

② For sinking inputs, connect "-" to "M" (shown).

For sourcing inputs, connect "+" to "M".

Note: X11 connectors must be gold. See Appendix C, Spare Parts for order number.

Table A- 24 CPU 1211C DC/DC/DC (6ES7 211-1AE31-0XB0)



① 24 VDC Sensor Power Out

For additional noise immunity, connect "M" to chassis ground even if not using sensor supply.

② For sinking inputs, connect "-" to "M" (shown).

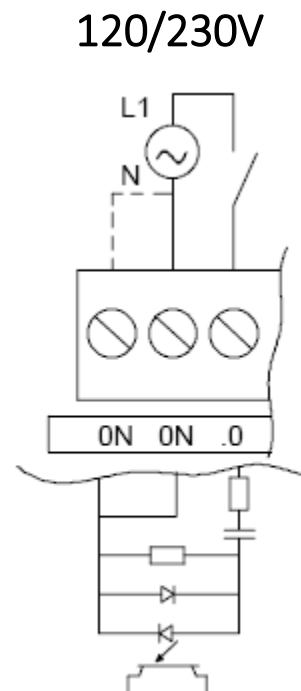
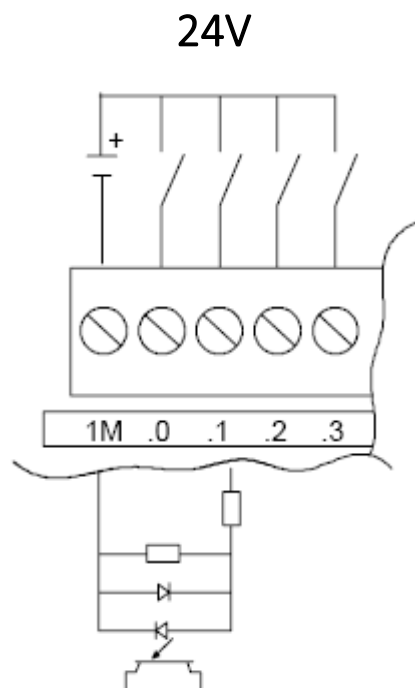
For sourcing inputs, connect "+" to "M".

Note: X11 connectors must be gold. See Appendix C, Spare Parts for order number.

Table A- 25 Connector pin locations for CPU 1211C DC/DC/DC (6ES7 211-1AE31-0XB0)

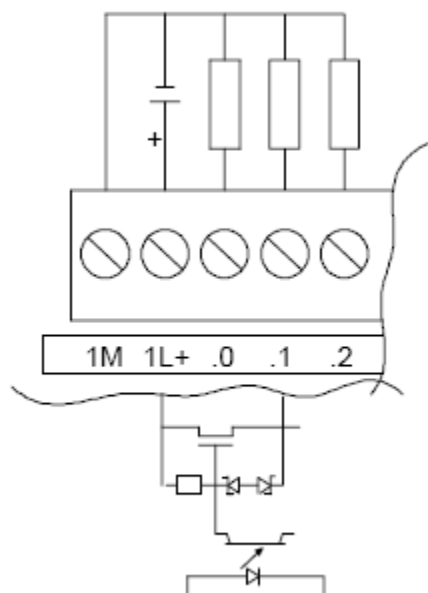
Pin	X10	X11 (gold)	X12
1	L+ / 24VDC	2 M	3L+
2	M / 24VDC	AI 0	3M
3	Functional Earth	AI 1	DQ a.0
4	L+ / 24VDC Sensor Out	--	DQ a.1
5	M / 24VDC Sensor Out	--	DQ a.2
6	1M	--	DQ a.3
7	DI a.0	--	No connection
8	DI a.1	--	No connection
9	DI a.2	--	--
10	DI a.3	--	--
11	DI a.4	--	--
12	DI a.5	--	--
13	No connection	--	--
14	No connection	--	--

■ Dodatni moduli (ulazi)

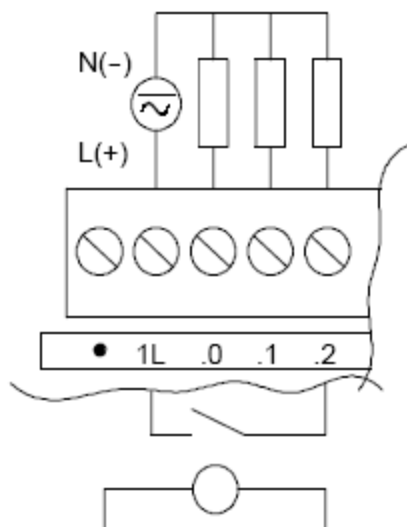


■ Dodatni moduli (izlazi)

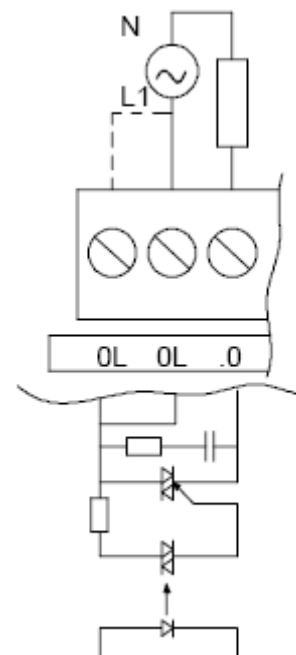
24V



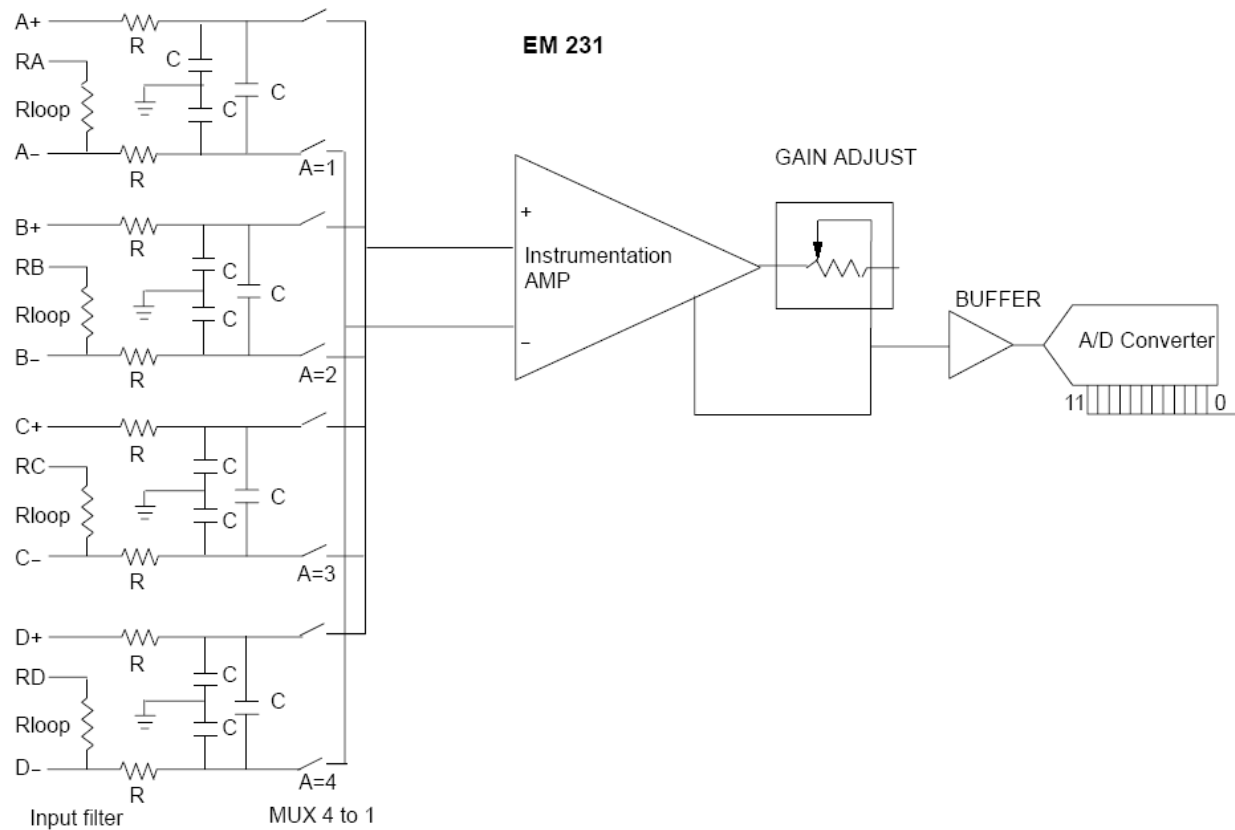
Relejni



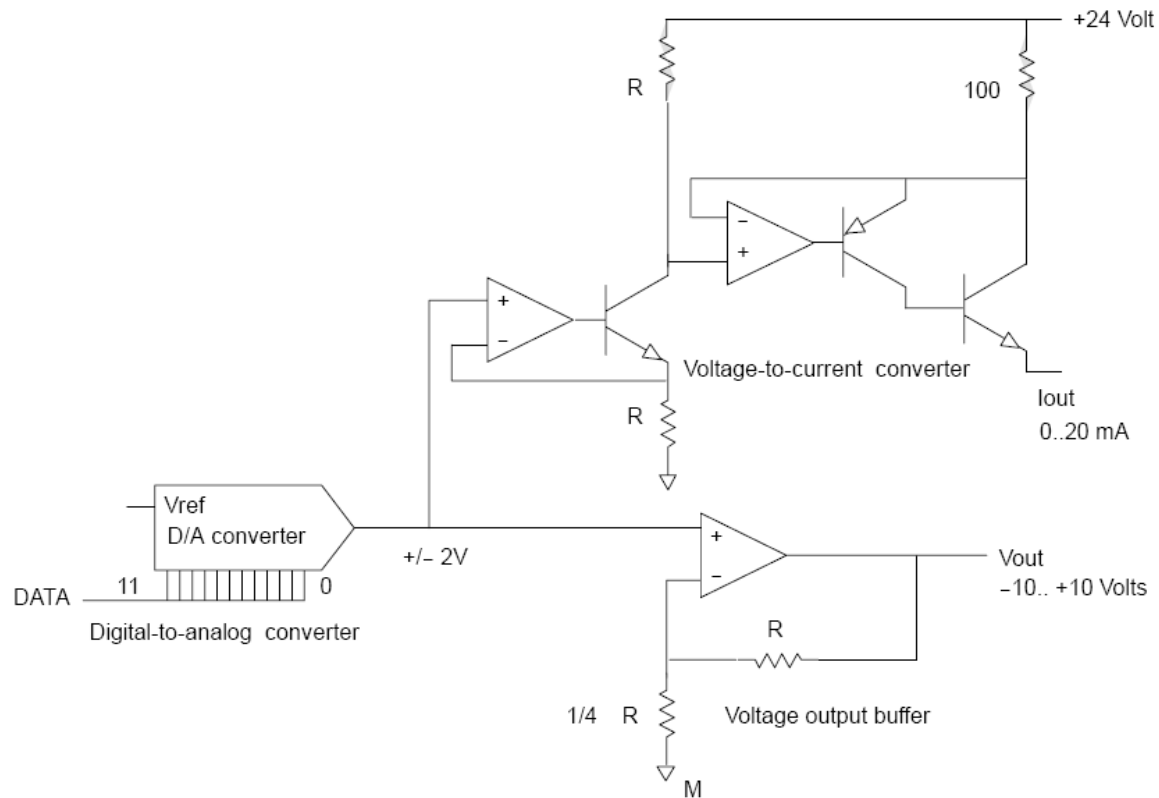
Trijak



■ Dodatni moduli (analogni ulaz)

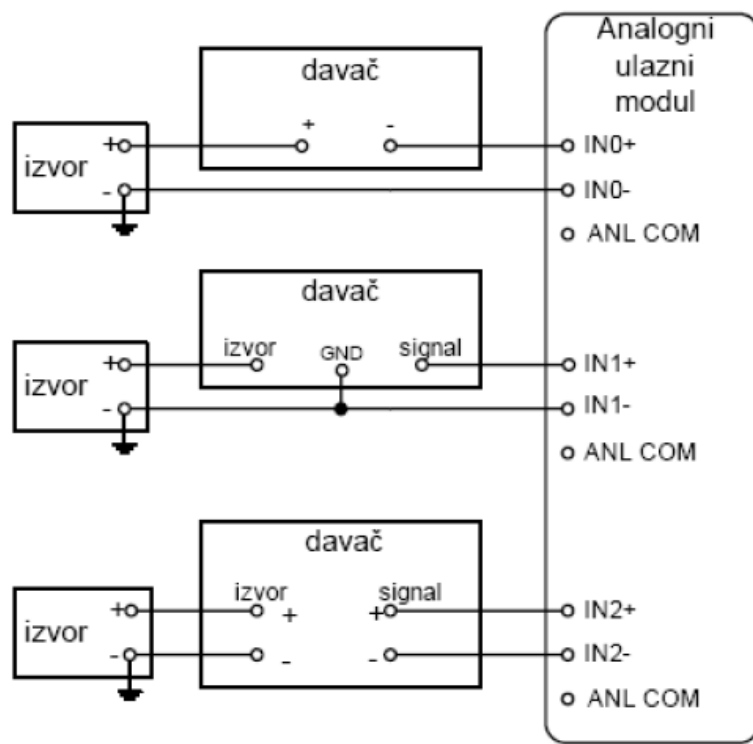


■ Dodatni moduli (analogni izlaz)

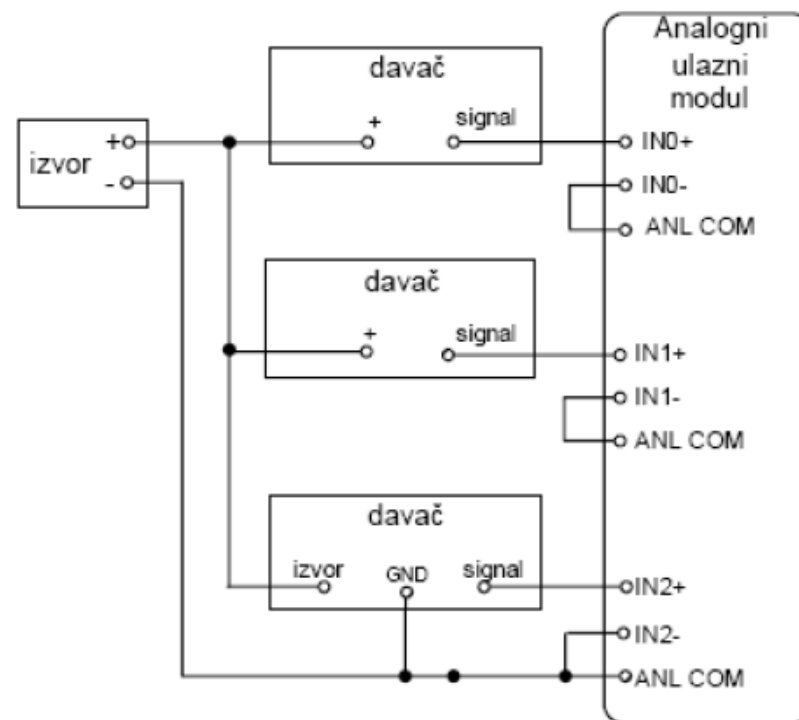


■ Načini vezivanja analognih ulaza

Diferencijalno



Sa zajedničkim krajem



■ S7-200 – primer povezivanja ulaza/izlaza

Ulazni portovi

I0.0 – kontroliše motor

I0.1 – kontroliše smer

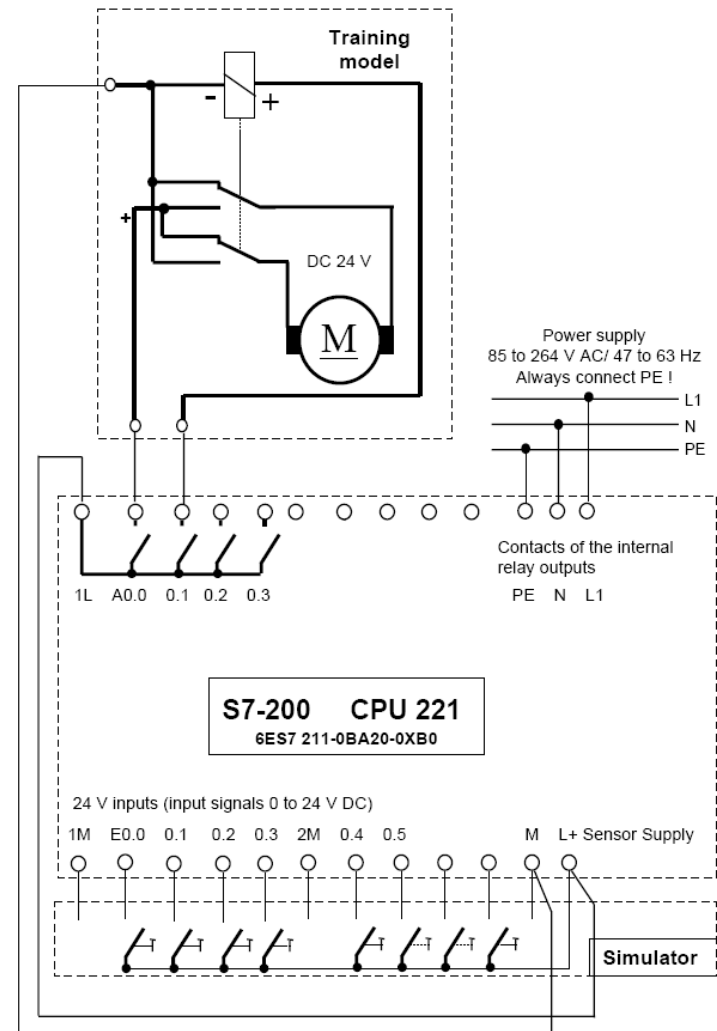
- ulazi primaju +24V i to opet iz PLC
- pritisnut taster dovodi 24V na ulaz
- nepritisnut ostavlja ulaz bez napona

Izlazni portovi

Q0.0 – kontroliše motor (ON/OFF)

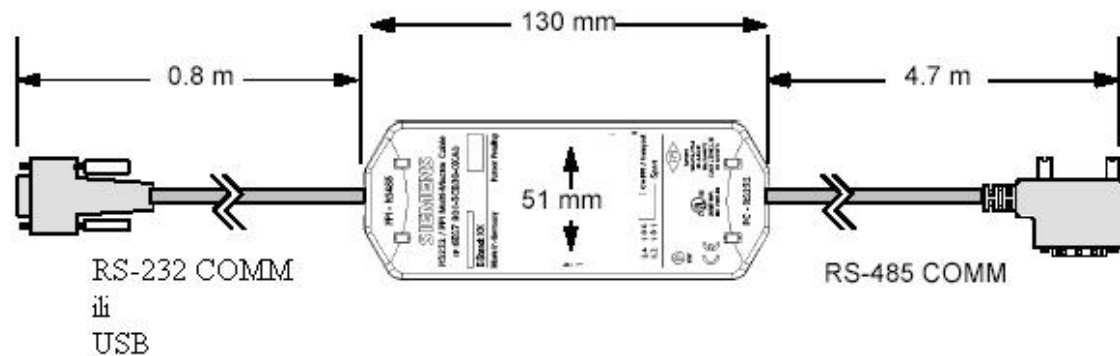
Q0.1 – kontroliše smer

- Koriste +24V iz PLC
- Relejni izlazi spoje +24V
- na motor ili na rele za smer



■ S7-200 – primer povezivanje ulaza/izlaza

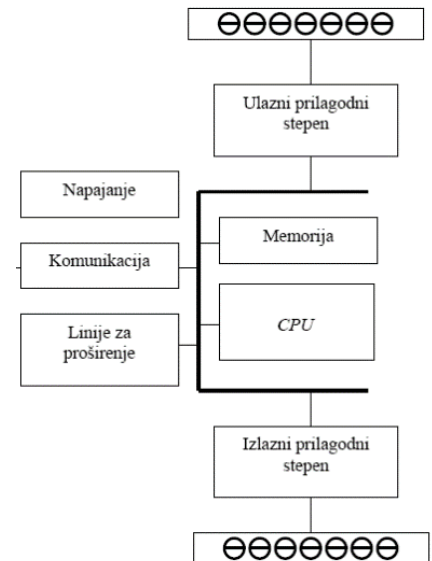
RS-232 ili USB/PPI
Multi-Master kabel



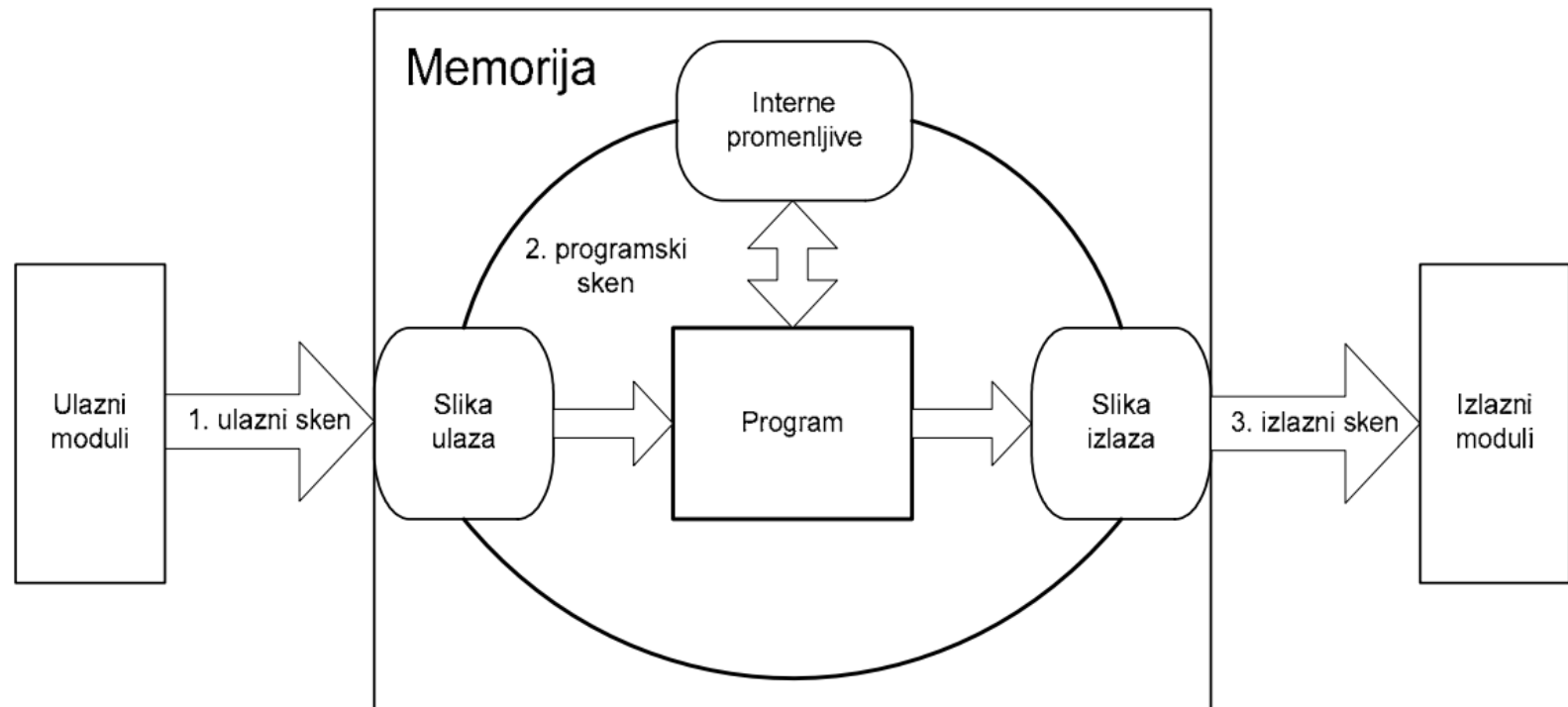
Izgled USB/PPI
Multi-Master kabla



■ Softverska organizacija



■ Struktura scan ciklusa



■ Način rada PLC-a

1. Prihvat stanja ulaza (senzor, prekidač...) u memoriju, u posebno područje koje predstavlja sliku ulaza
2. Izvršenje programa - Ulazni operandi: memorija (slika ulaza). Rezultati: u memoriju (slika izlaza). Dakle, podaci ne direktno sa ulaznih modula, niti se direktno iznose na izlazne module, već program razmenjuje podatke isključivo sa memorijom!
3. Ispis stanja izlaza - prenos podataka iz slike izlaza na izlazne linije (registre izlaznih modula)
4. Komunikacija
5. Održavanje – ažuriranje internih časovnika i registara, upravljanje memorijom, kontrola ispravnosti PLC-a, kao i niz drugih poslova vezanih za održavanje sistema

■ Način rada PLC-a

Posle izvršenja petog koraka PLC se vraća na početak ciklusa i neprekidno ponavlja sve korake.

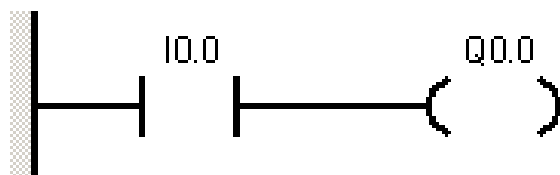
Osnovni sken ciklus može biti modifikovan pomoću zahteva za prekid ili nekih drugih specijalnih programskih naredbi.

Prihvat ulaza, obrada, ispis izlaza, komunikacija i održavanje se ciklički ponavljaju i u skladu sa unesenim programom, njihovo pojedinačno trajanje zavisi od broja ulaza i izlaza i složenosti algoritma i vrste primenjenog procesora. Ciklusi obrade obično traju od 0,1 ms do nekoliko desetina ms.

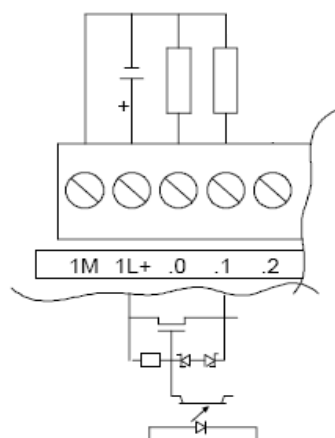
■ Programiranje PLC-a

■ Programiranje PLC-a

- Svaka promenljiva ima svoje ime (*tag*), tip i adresu

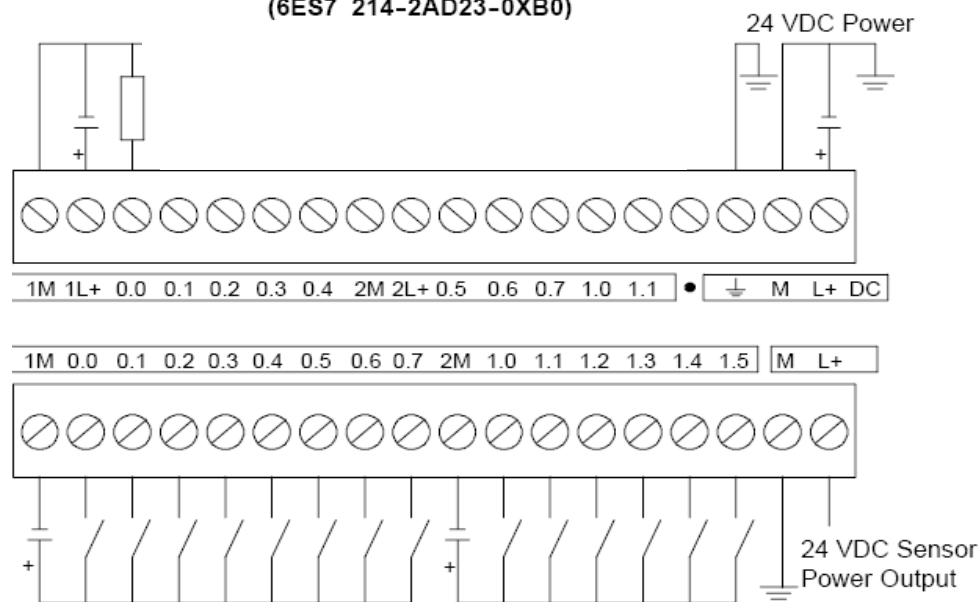


Symbol	Address
sijalica	Q0.0
taster	I0.0



Taster povezan na ulaz I0.0 uključuje sijalicu povezanu na izlaz Q0.0. Sijalica svetli dok je taster pritisnut.

CPU 224XP DC/DC/DC
(6ES7 214-2AD23-0XB0)



■ Programiranje PLC-a

■ Stare relejne šeme vs PLC program

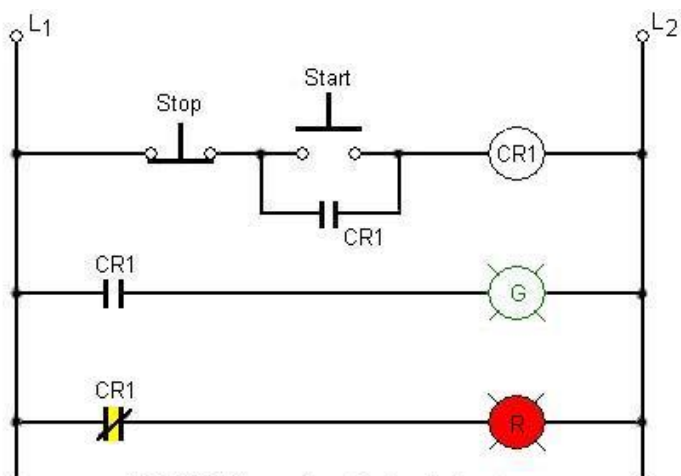
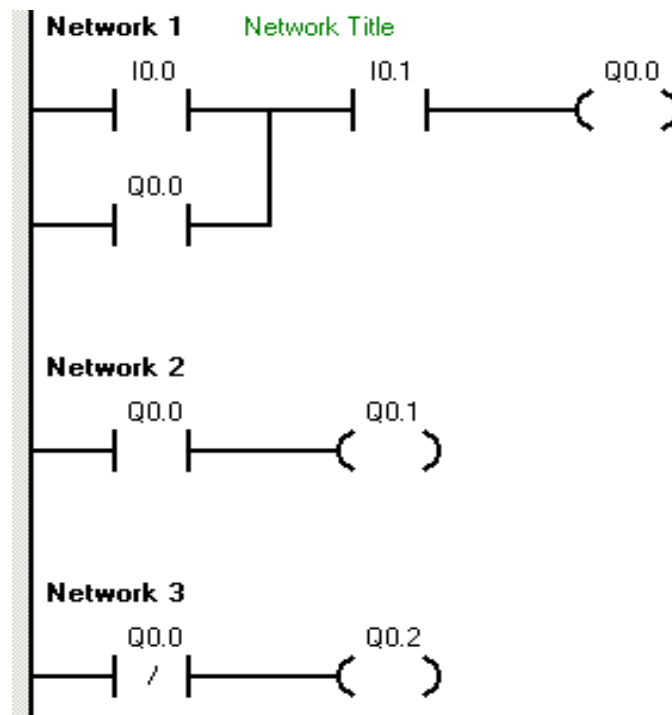


FIGURE 1 Example of relay logic diagram.



■ Programiranje PLC-a

■ Načini programiranja PLC-a

GRAFIČKI

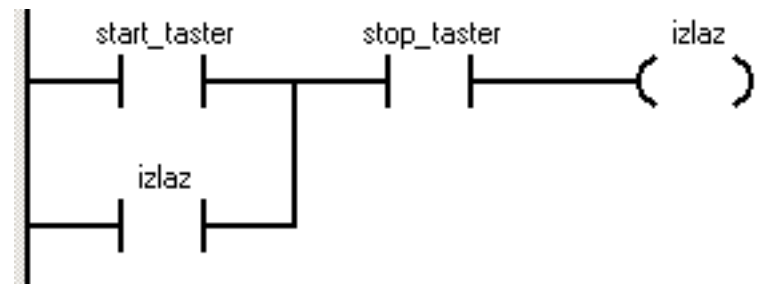
Ladder logic (lestvičasta logika) je način crtanja el. logičkih šema.

To je grafički jezik, veoma popular kod PLC.

Originalno je izmišljen da zameni relejnu logiku.

Ime je dobio jer program podseća na merdevine.

-alternativa je **Function Block Diagram** (funkcionalni blok dijagram).



■ Programiranje PLC-a

■ Načini programiranja PLC-a

TEKSTUALNI

Structured text (higher level programski jezik)

-alternativa je **Instruction List** (asemblerski jezik)

LD	start_taster
O	izlaz
A	stop_taster
=	izlaz

Programming language	S7-1200	S7-1500
Ladder (LAD)	✓	✓
Function block diagram (FBD)	✓	✓
Structured control language (SCL)	✓	✓
Graph	✗	✓
Statement list (STL)	✗	✓

■ Programiranje PLC-a

Ranije pomenuto:

Pojam **normalno**

stanje u kom se kontakt nalazi dok se na njega ne deluje spolja silom (odnosno dok je u **nepobuđenom** stanju)

Primer:

NO (taster): provodi kada je pritisnut

NO (relej, kontaktor): kontakt provodi kada ima napajanja na namotaju

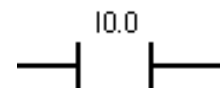
NC obratno

■ Programiranje PLC-a

■ PLC S7 osnovni *Ladder* dijagram blokovi - Kontakti

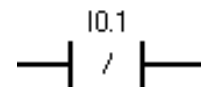
NO

simbolički, energija teče kroz kontakt kada je zatvoren. NO je zatvoren kada je statusni bit koji kontroliše taj kontakt 1 (npr. kada je spoljni prekidač zatvoren, tj. ima se 24V na ulazu PLC-a)



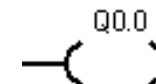
NC

obratno: provodan kada je statusni bit 0 (tj. kada je prekidač otvoren)



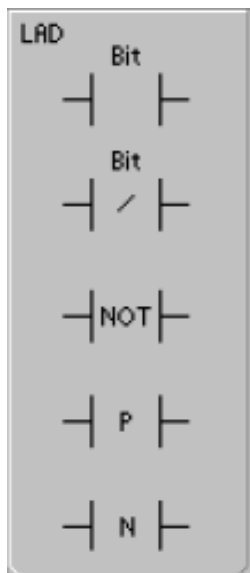
Namotaj (Coil)

simbolički predstavlja relej koji je pobuđen (*energized*) kada energija teče prema njemu. Kada je pobuđen, on uključuje statusni bit odgovarajućeg **izlaza**. Isti statusni bit može biti korišćen da kontroliše NO i NC kontakte **bilo gde u programu**



■ Programiranje PLC-a

■ PLC S7 osnovni *Ladder* dijagram blokovi



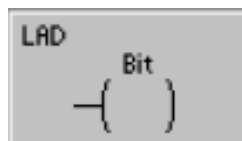
NO

NC

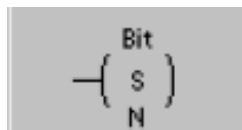
negacija

pozitivna ivica

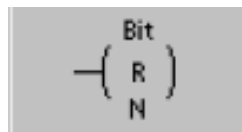
negativna ivica



namotaj (coil)



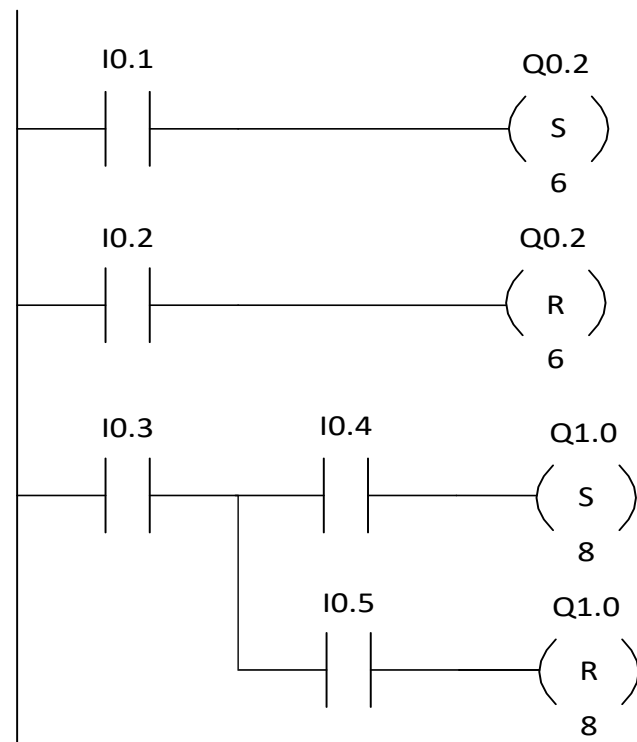
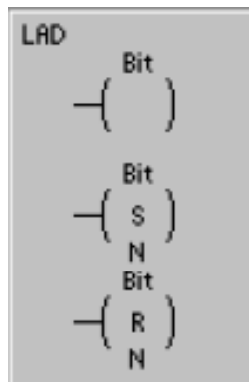
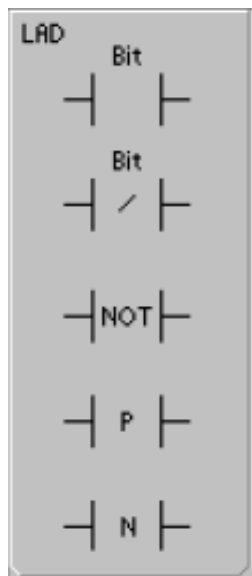
set N bitova počev od Bit



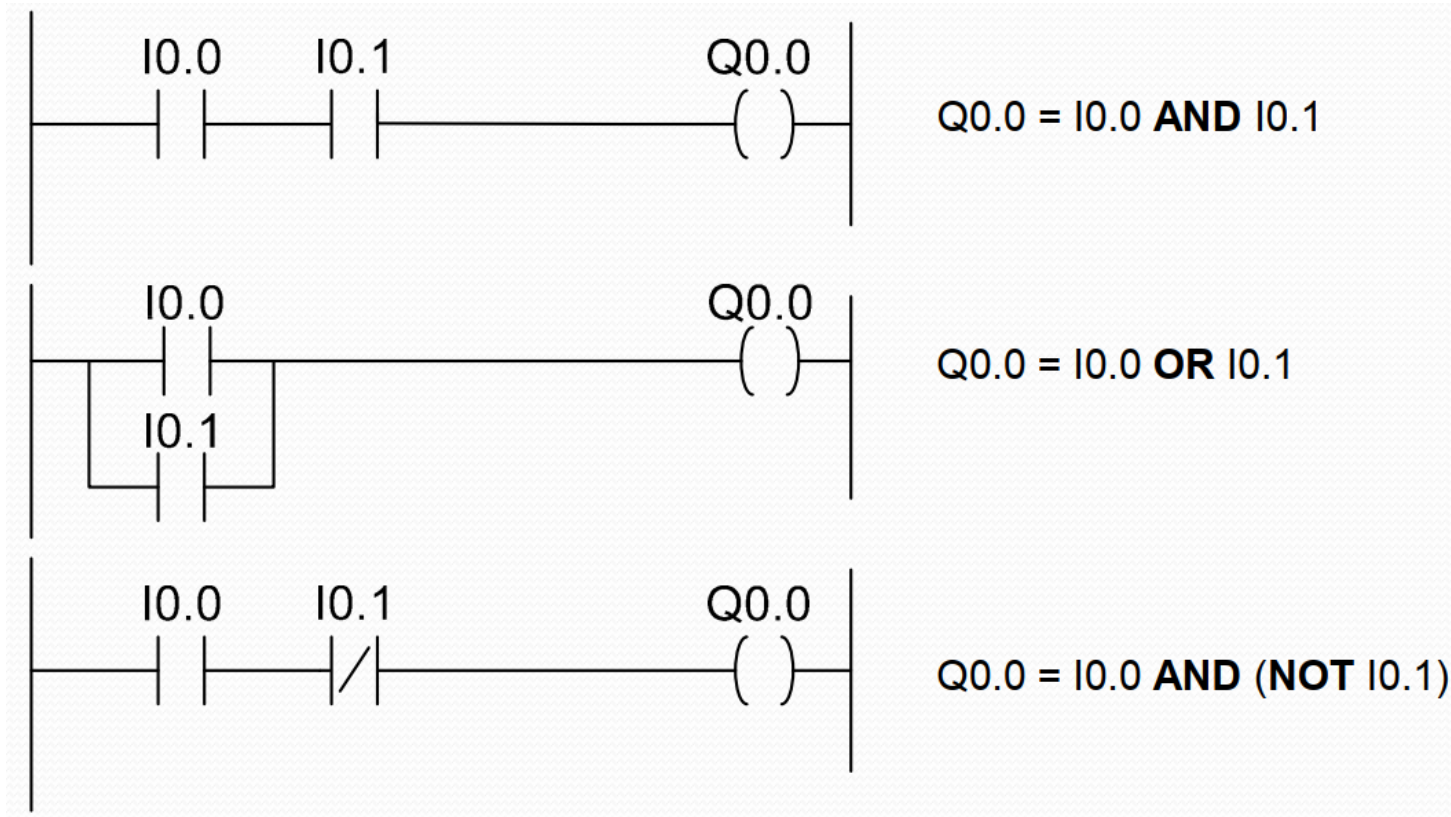
reset N bitova počev od Bit

■ Programiranje PLC-a

■ PLC S7 osnovni *Ladder* dijagram blokovi

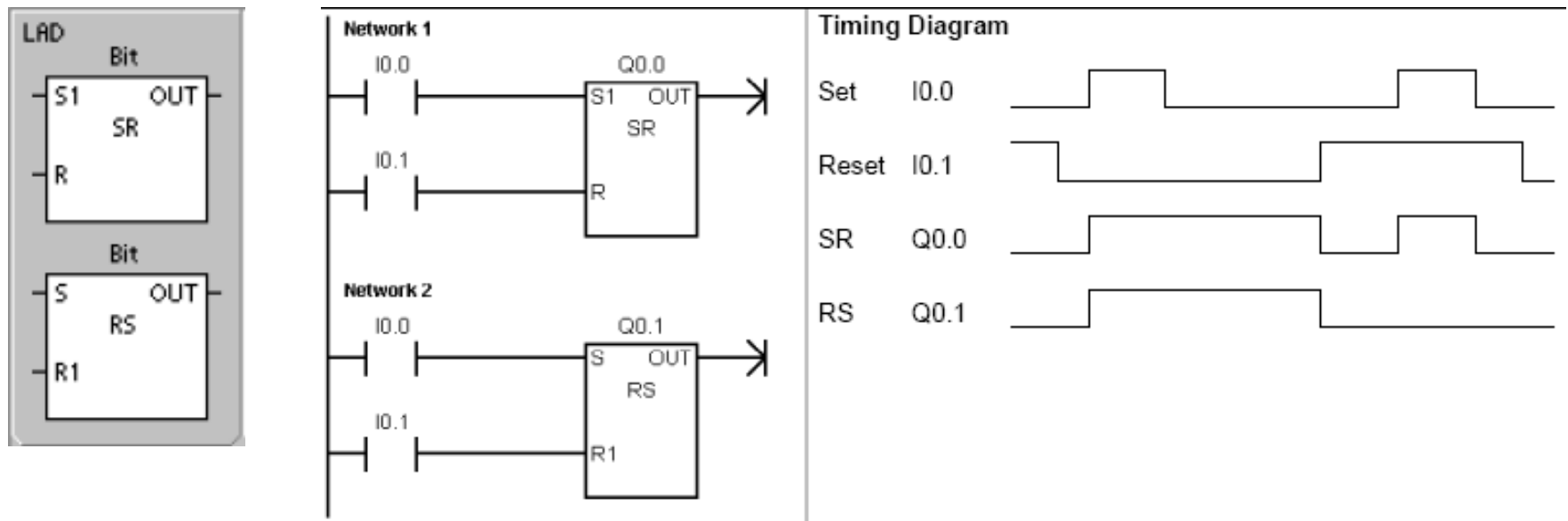


■ Osnovne logičke operacije



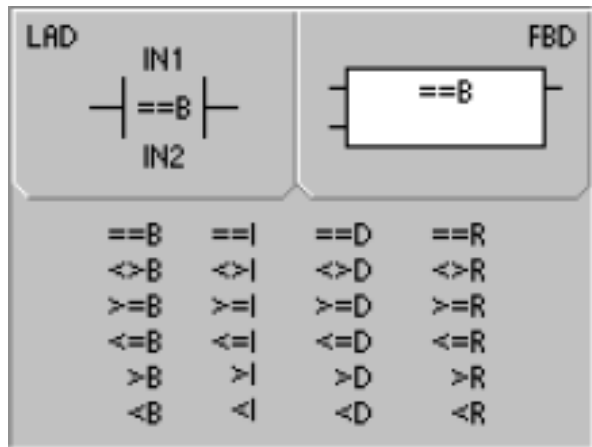
■ Programiranje PLC-a

■ Set ili Reset dominantan bistabil

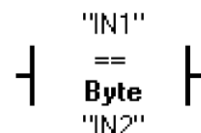


■ Programiranje PLC-a

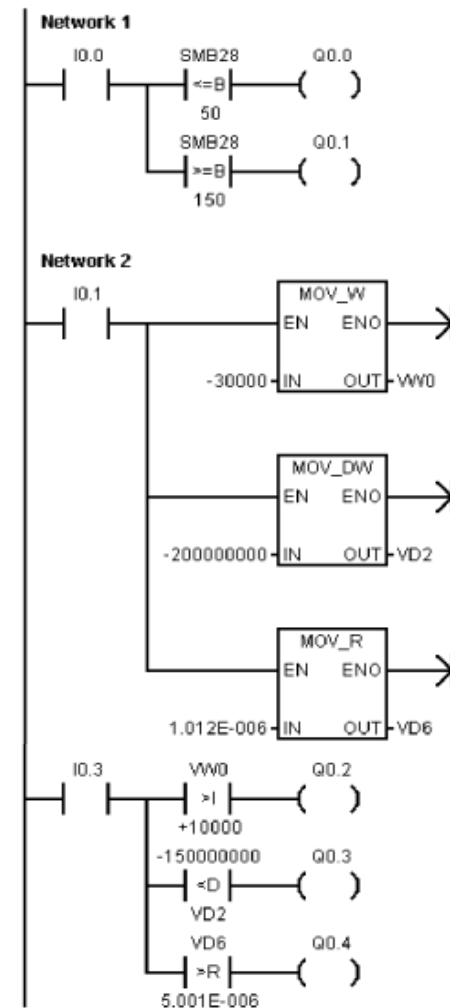
- Compare
 - byte
 - integer
 - double
 - real



S7-200



S7-1200



■ Programiranje PLC-a

■ Counter (brojači)

- Count **up**
- Count **down**
- Count **up-down**

Oznake:

Cxx – C0 do C255

CU, CD - brojački ulazi (uvek broje na **uzlaznu** tranziciju!)

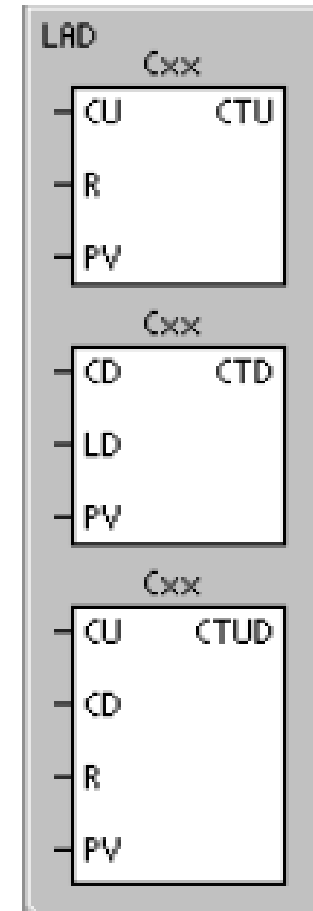
R – reset

LD – load

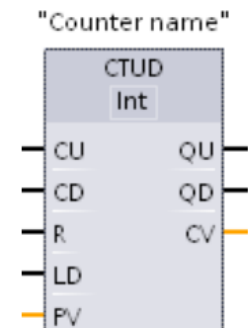
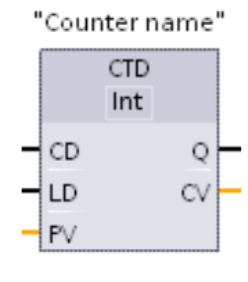
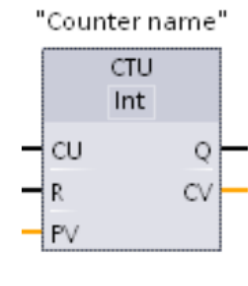
PV – preset value

Counter bit:

1. $Cxx \geq PV \rightarrow Cxx \text{ bit} = 1$
2. $Cxx \leq 0 \rightarrow Cxx \text{ bit} = 1$
3. $Cxx \geq PV \rightarrow Cxx \text{ bit} = 1$



S7-200

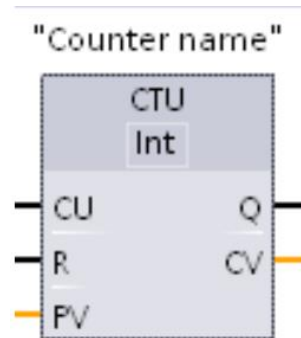


S7-1200

■ Programiranje PLC-a

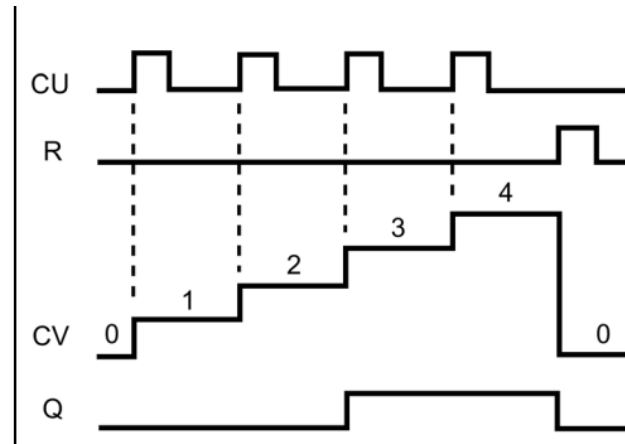
■ Counter (brojači)

- Count up



The CTU counter counts up by 1 when the value of parameter CU changes from 0 to 1. The CTU timing diagram shows the operation for an unsigned integer count value (where PV = 3).

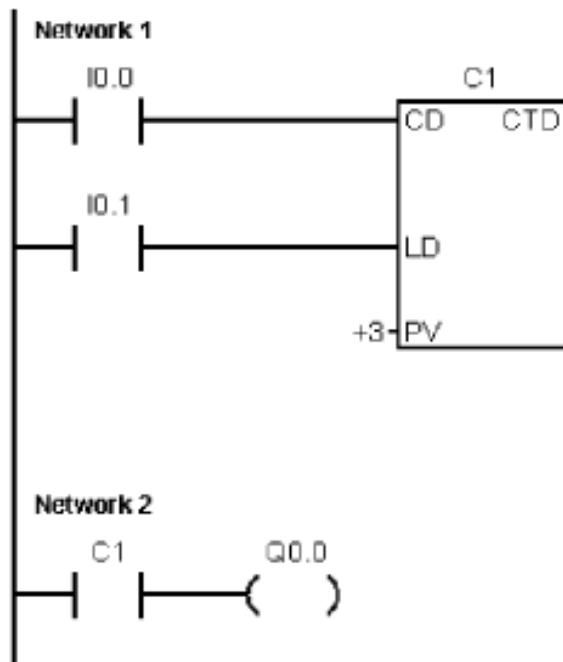
- If the value of parameter CV (current count value) is greater than or equal to the value of parameter PV (preset count value), then the counter output parameter Q = 1.
- If the value of the reset parameter R changes from 0 to 1, then the current count value is reset to 0.



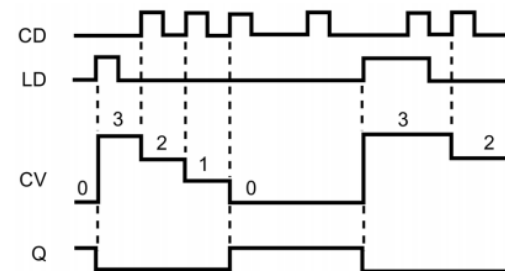
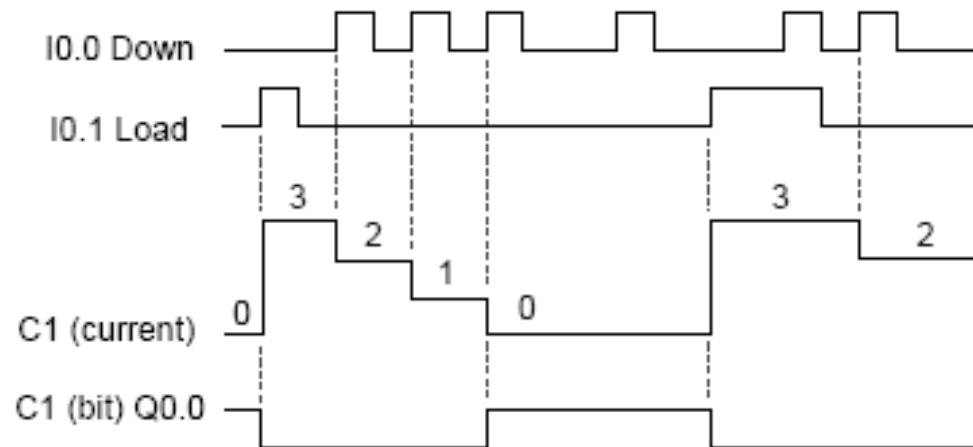
■ Programiranje PLC-a

■ Counter (brojači)

- Count down



S7-200

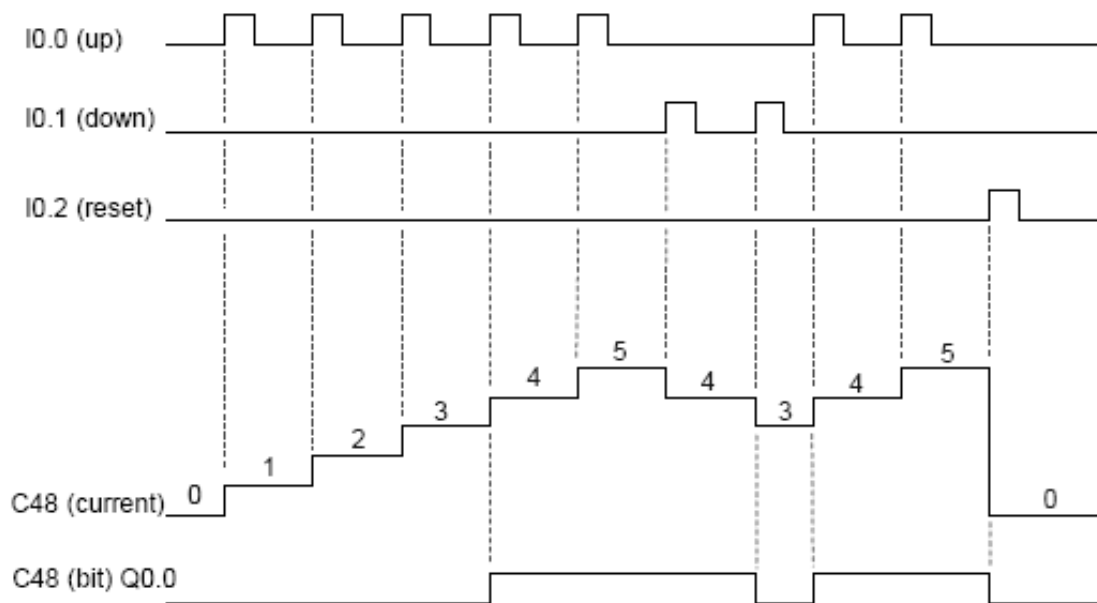
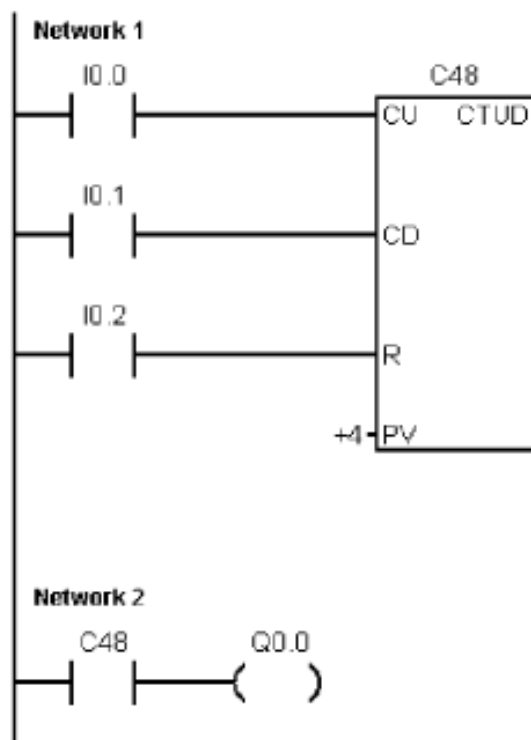


S7-1200

■ Programiranje PLC-a

■ Counter (brojači)

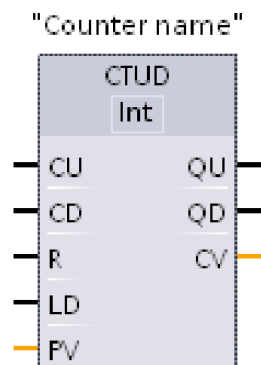
- Count up-down



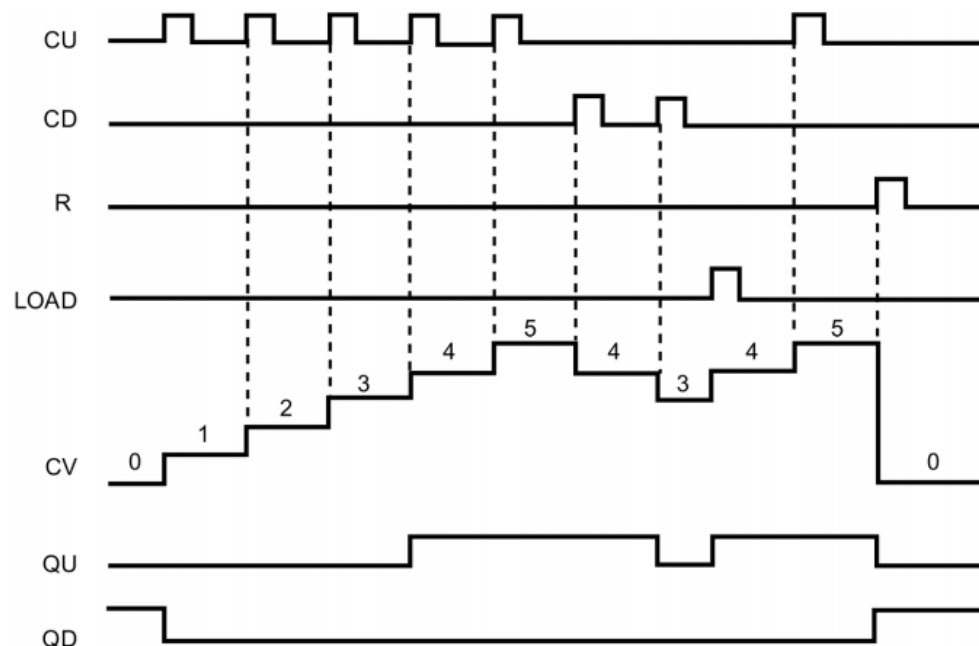
S7-200

■ Programiranje PLC-a

- Counter (brojači)
 - Count up-down



S7-1200



■ Programiranje PLC-a

■ Timer

- TON
- TOFF
- TON Retentive

Oznake:

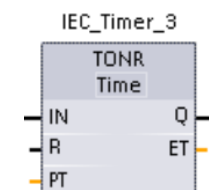
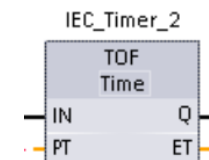
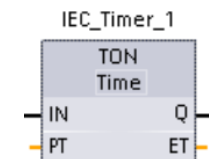
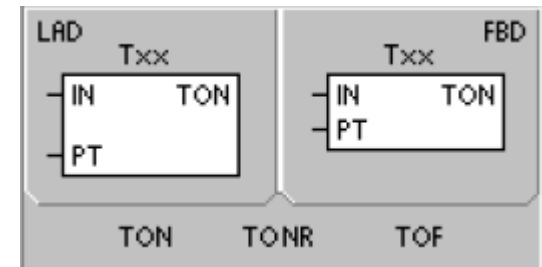
Txx – T0 do T255

IN – dozvola rada (+reset)

PT – preset time

Timer **bit**:

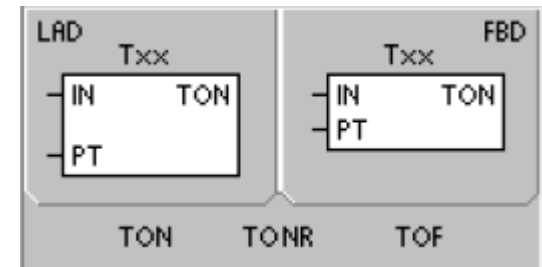
1. $Txx \geq PT \rightarrow Txx \text{ bit} = 1$
2. $Txx \leq PT \rightarrow Txx \text{ bit} = 1$
3. $Txx \geq PT \rightarrow Txx \text{ bit} = 1$ (bez reseta)



■ Programiranje PLC-a

■ Timer

- TON
- TOFF
- TON Retentive



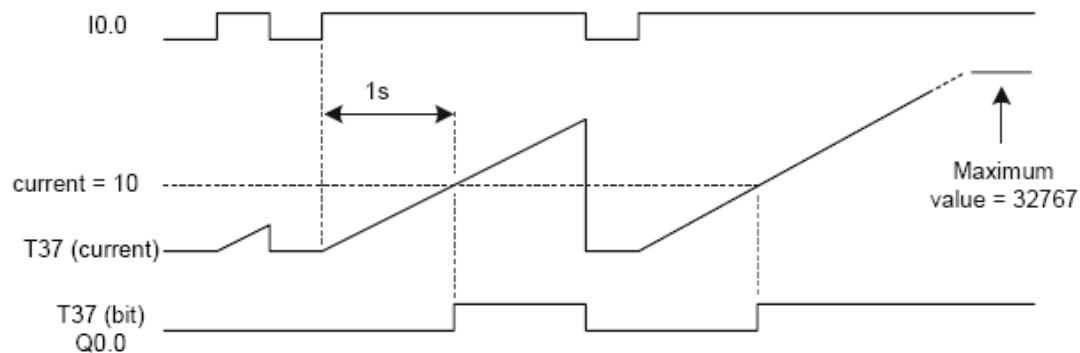
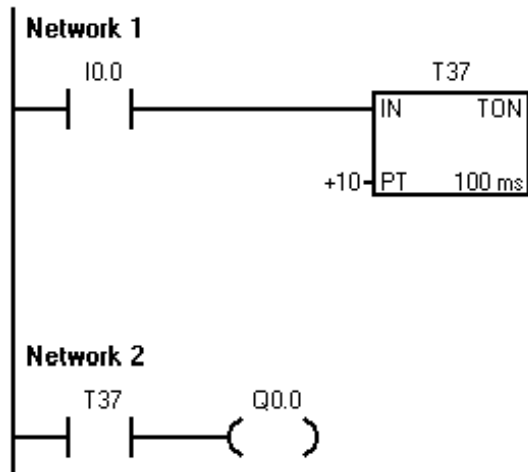
Timer Type	Resolution	Maximum Value	Timer Number
TONR	1 ms	32.767 s (0.546min)	T0, T64
	10 ms	327.67 s (5.46min)	T1-T4, T65-T68
	100 ms	3276.7 s (54.6min)	T5-T31, T69-T95
TON, TOFF	1 ms	32.767 s (0.546min)	T32, T96
	10 ms	327.67 s (5.46min)	T33-T36, T97-T100
	100 ms	3276.7 s (54.6min)	T37-T63, T101-T255

■ Programiranje PLC-a

■ Timer

- TON

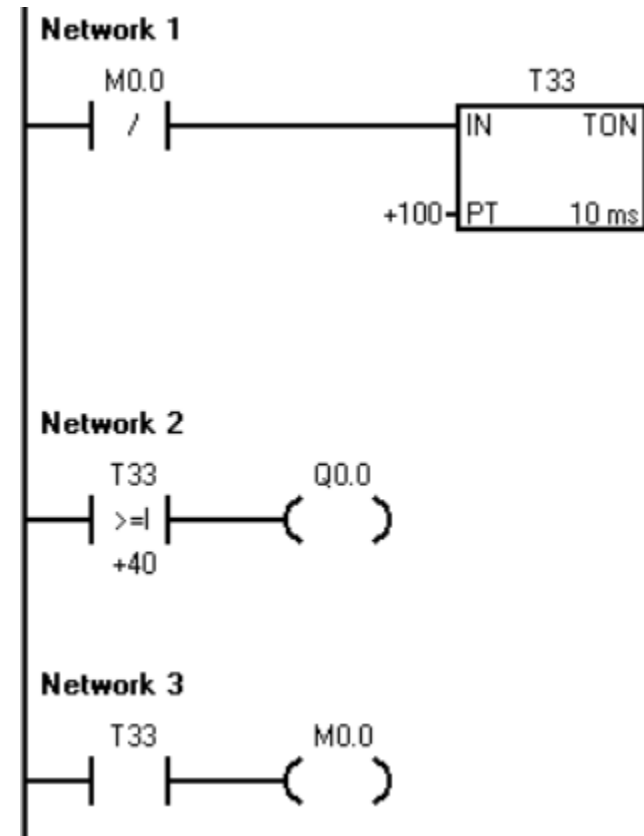
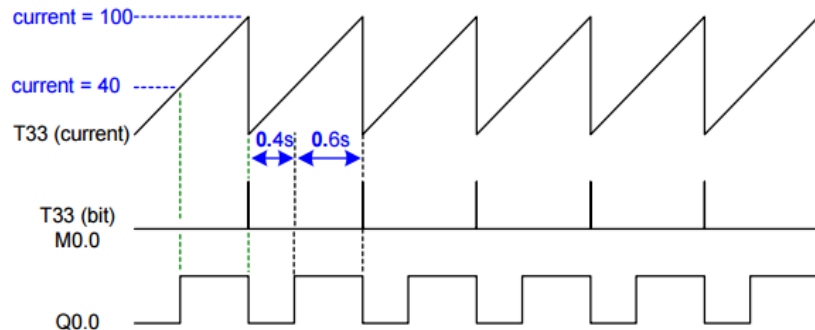
- Broji vreme kada je IN ulaz ON
- Kada je $T_{xx} \geq PT \rightarrow T_{xx} \text{ bit} = 1$
- Reset: kada je IN ulaz OFF



■ Programiranje PLC-a

■ Timer

- TON (autoreset)

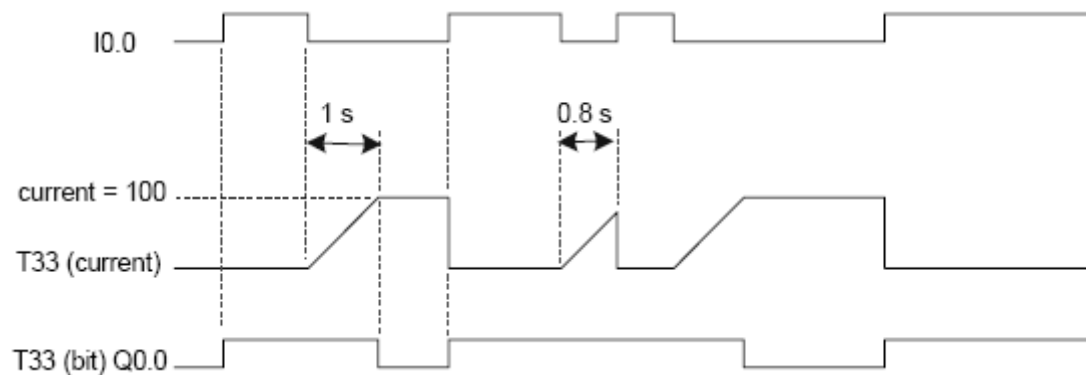
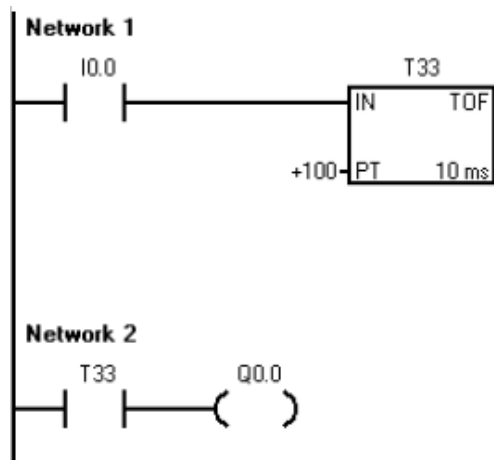


■ Programiranje PLC-a

■ Timer

- TOFF

- Broji vreme kad je IN ulaz OFF
- Kada je $T_{xx} \geq PT \rightarrow T_{xx} \text{ bit} = 0$
- Reset: kada je IN ulaz ON

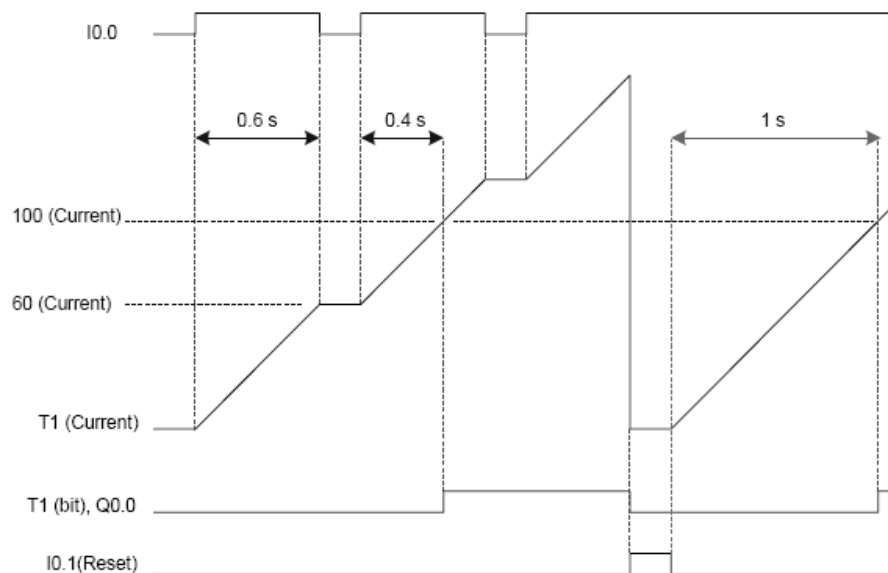
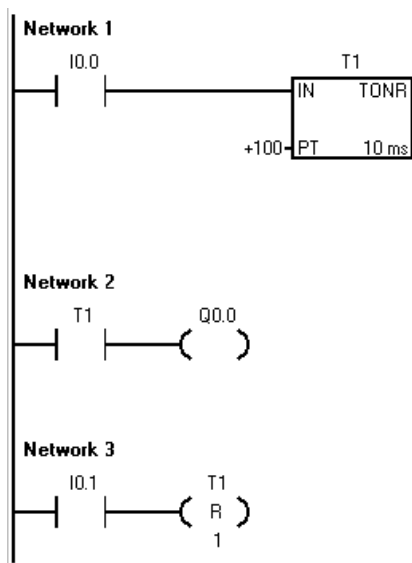


■ Programiranje PLC-a

■ Timer

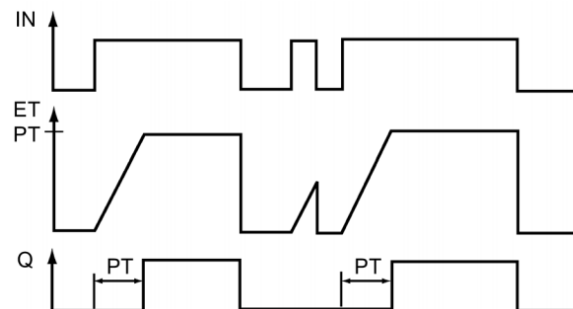
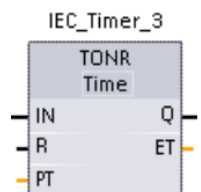
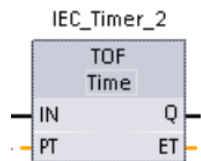
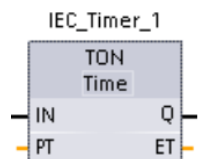
- TON Retentive

- Isti kao TON, samo se ne resetuje kada je IN ulaz OFF, već samo R instrukcijom

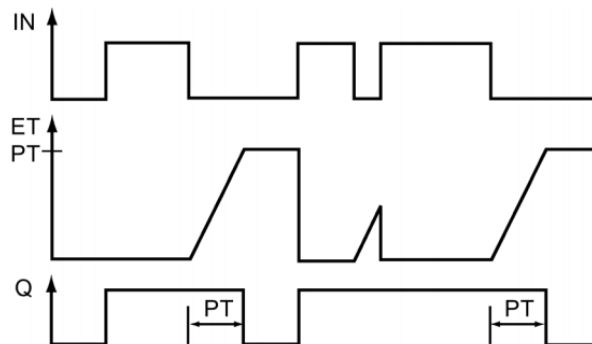


■ Programiranje PLC-a

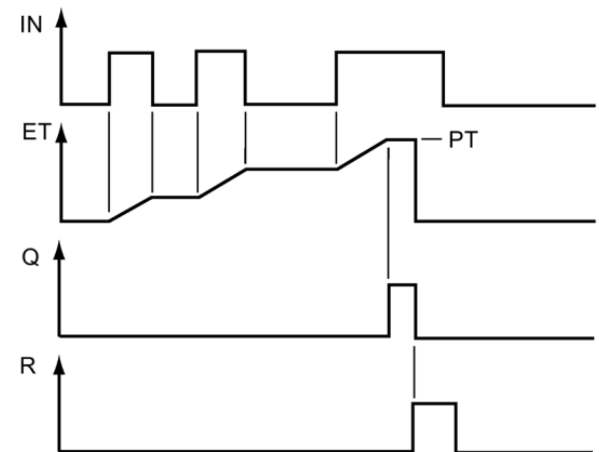
■ Timeri u S7-1200



TON



TOF

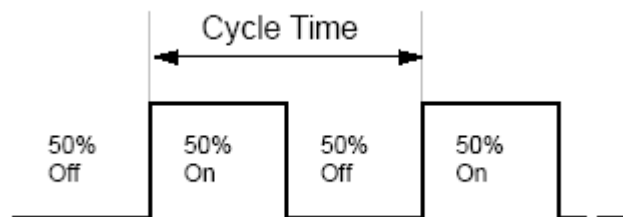


TONR

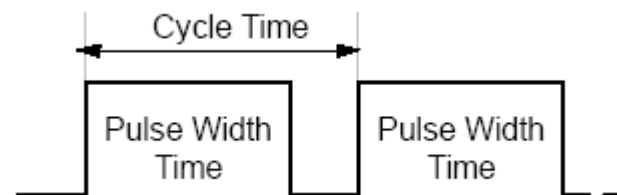
■ Programiranje PLC-a

■ Pulse Output Instruction

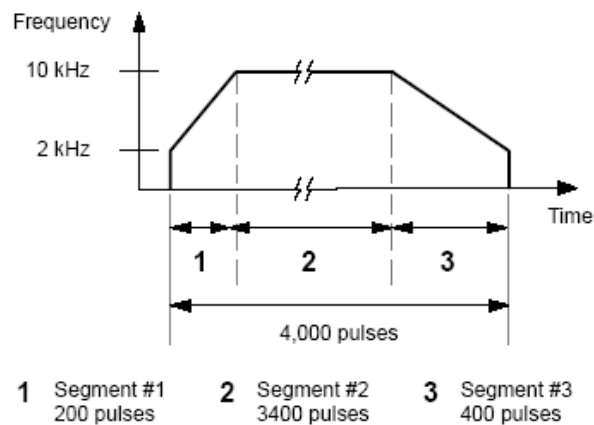
PTO (pulse train output)



PWM (Pulse width modulation)

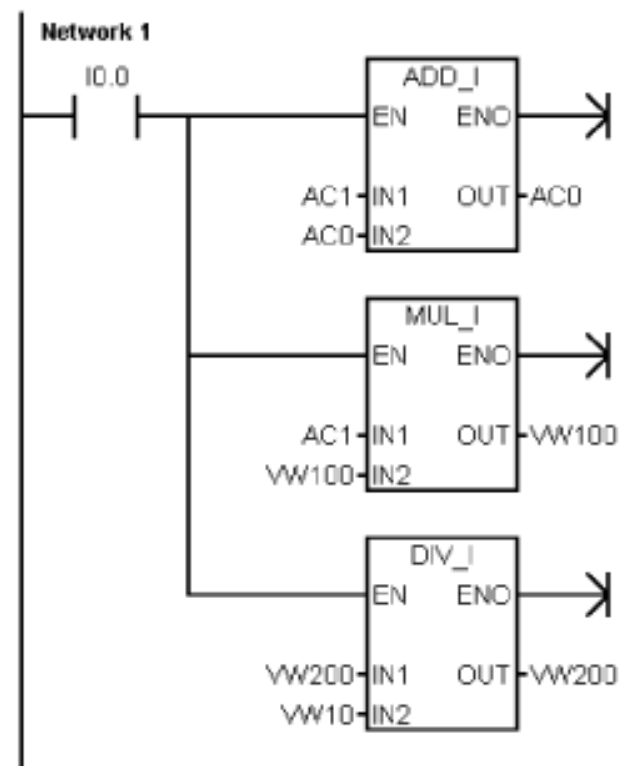
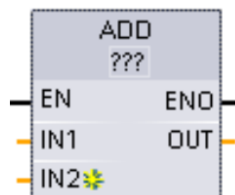
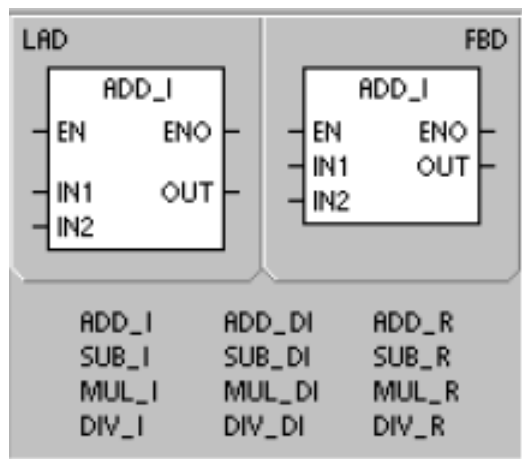


Za **Step** motor:



■ Programiranje PLC-a

■ Osnovne matematičke instrukcije



Add

$$\boxed{40} + \boxed{60} = \boxed{100}$$

AC1 AC0 AC0

Multiply

$$\boxed{40} * \boxed{20} = \boxed{800}$$

AC1 VW100 VW100

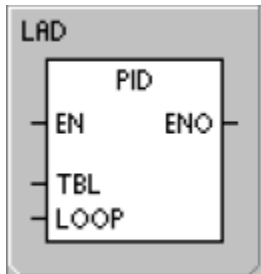
Divide

$$\boxed{4000} / \boxed{40} = \boxed{100}$$

VW200 VW10 VW200

■ Programiranje PLC-a

■ PID regulator

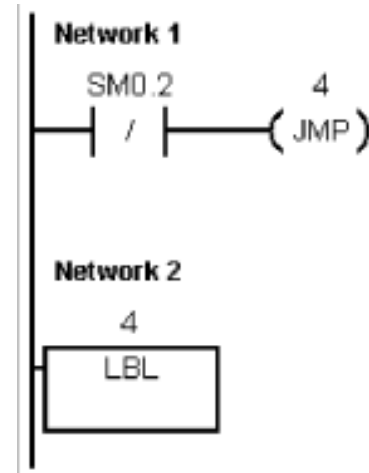
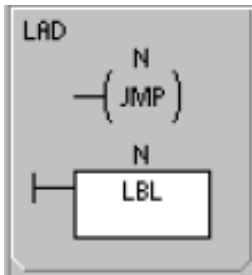


$$M(t) = K_p \cdot e + K_i \cdot \int e \cdot dt + K_d \cdot \frac{de}{dt}$$

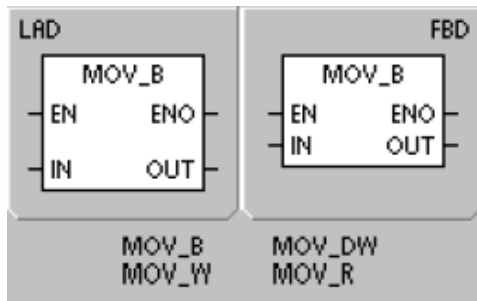
$$M(n) = K_p \cdot e(n) + K_i \cdot \sum e(n) + \frac{K_d}{T} [e(n) - e(n-1)]$$

■ Programiranje PLC-a

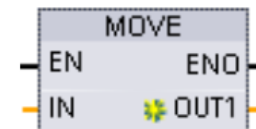
■ Kontrola toka programa (JMP and LBL)



■ Dodela vrednosti (MOV)



- byte
- integer
- double
- real



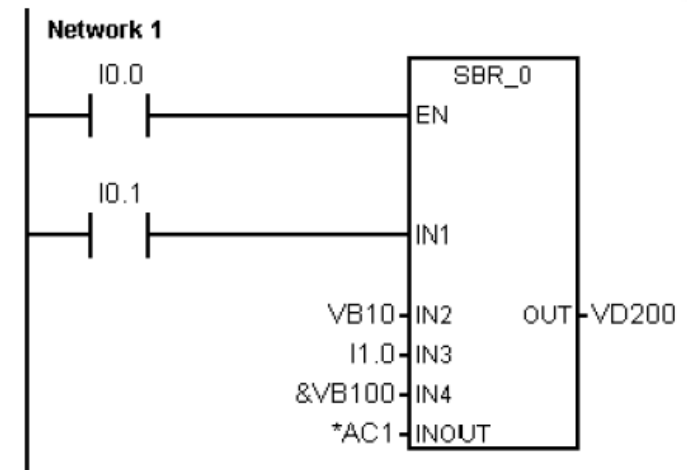
■ Programiranje PLC-a

■ Potprogram (subroutine)

Iz glavnog programa PLC skače u potprogram, izvršava ga i vraća se nazad, na mesto odakle je imao skok

Parametar	Opis
IN	Ulaz u pp
IN_OUT	ulazi u rutinu i vraća se kao njen rezultat
OUT	izlaz

- Modularnost
- Sekvencijalnost



■ Programiranje PLC-a

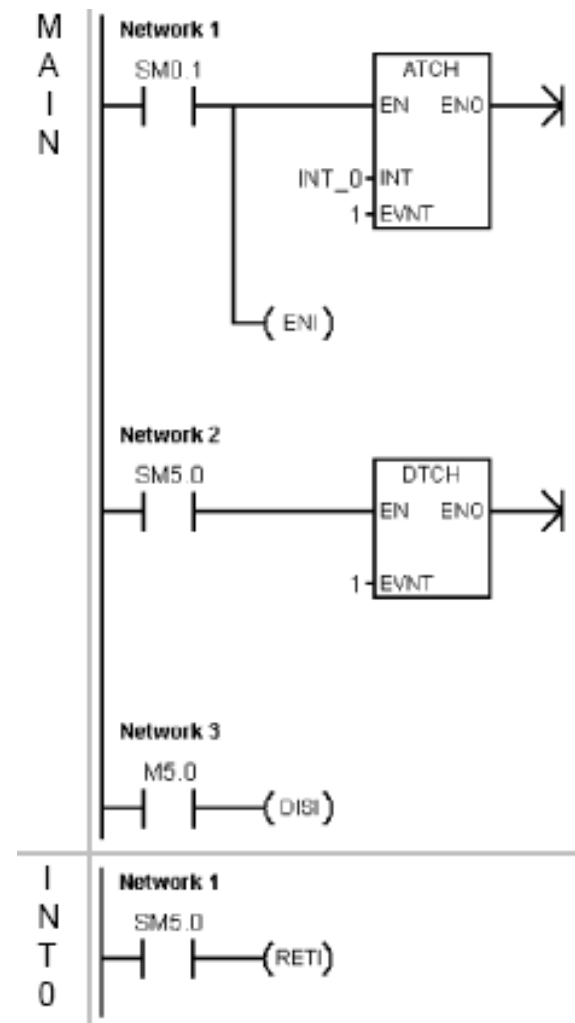
■ Prekid (*interrupt*)

- Prekid se dešava **trenutno**, tj. **ne čeka kraj scan-a!** (prekida se sama instrukcija, koja se sastoji od više manjih, koja se trenutno izvršava)
- Asinhronizam
- Princip je: **prvi** se pojavio - **prvi** će biti servisiran; ostali idu u **que** (red)
- Postoji prioritet:
 1. komunikacioni
 2. diskretni
 3. vremenski

■ Programiranje PLC-a

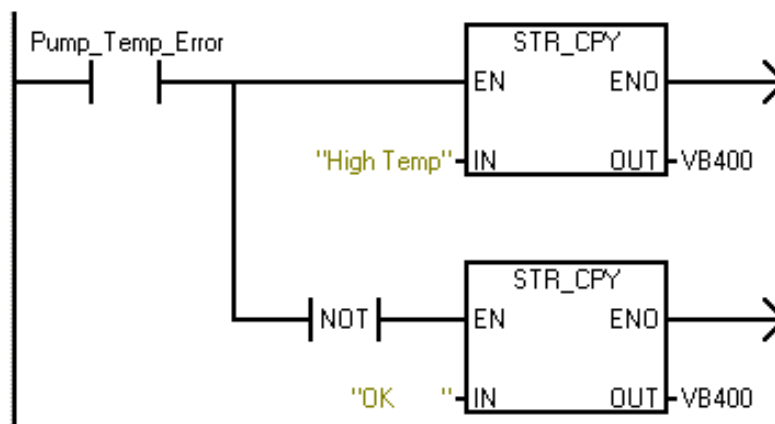
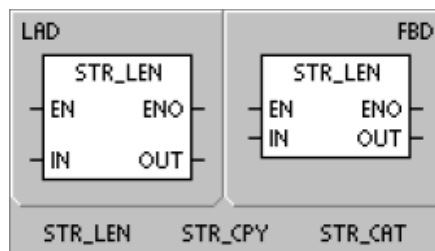
■ Prekid (*interrupt*)

- **Enable interrupts** (ENI) - dozvola prekida
- **Disable Interrupt** (DISI) - zabrana prekida
- **Attach Interrupt** (ATCH) - pridružuje prekidni događaj prekidnoj rutini i dozvoljava prekid
- **Detach Interrupt** (DTCH) – raskida prekidni događaj sa prekidnom rutinom i zabranjuje prekid
- **(C)RETI** –(conditional) povratak iz prekida



■ Programiranje PLC-a

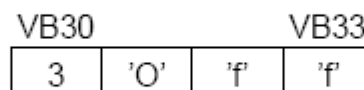
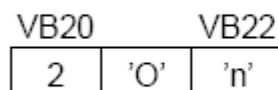
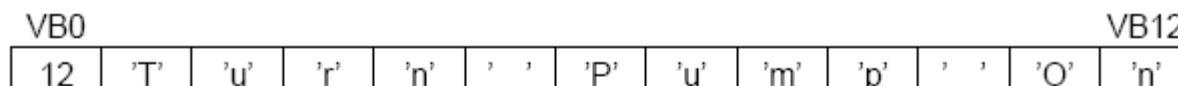
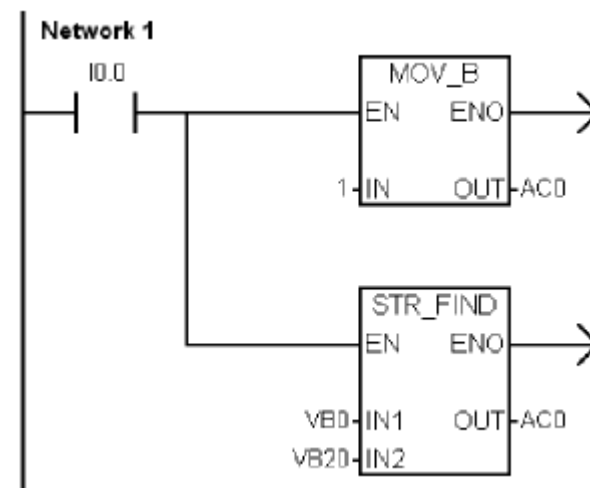
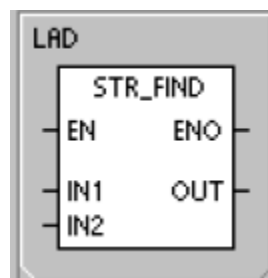
■ String – dodavanje, dužina, kopiranje



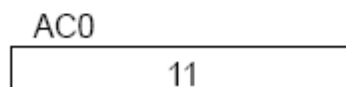
■ Programiranje PLC-a

■ String - find

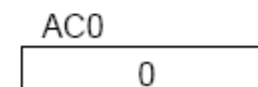
Traženje stringa u stringu (**STR_FIND**)
(**IN1** se traži u **IN2**, počev od **OUT** pozicije)



If the string in VB20
is found:



If the string in VB20
is not found:



■ Programiranje PLC-a

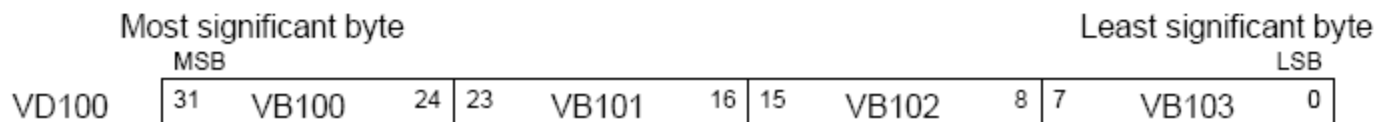
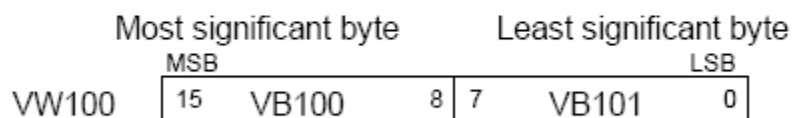
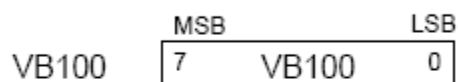
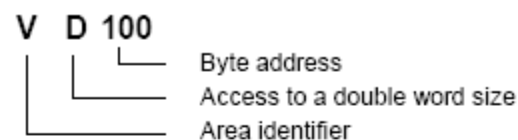
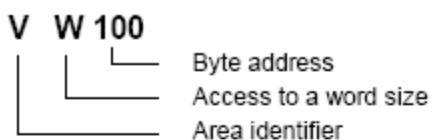
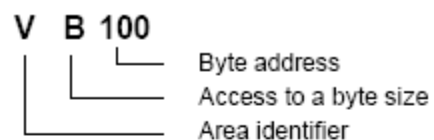
■ Podaci (tipovi)

	Description	S7 - 300/400	S7-1200	S7-1500
Bit data types	• BOOL • BYTE • WORD • DWORD	✓	✓	✓
	• LWORD	x	x	✓
Character type	• CHAR (8 bit)	✓	✓	✓
Numerical data types	• INT (16 bit) • DINT (32 bit) • REAL (32 bit)	✓	✓	✓
	• SINT (8 bit) • USINT (8 bit) • UINT (16 bit) • UDINT (32 bit) • LREAL (64 bit)	x	✓	✓
	• LINT (64 bit) • ULINT (64 bit)	x	x	✓
Time types	• TIME • DATE • TIME_OF_DAY	✓	✓	✓
	• S5TIME	✓	x	✓
	• LTIME • L_TIME_OF_DAY	x	x	✓

■ Programiranje PLC-a

■ Podaci (pristup)

Area identifier, data size, starting byte !



MSB = most significant bit
LSB = least significant bit

■ Programiranje PLC-a

■ Podaci

Process-Image **Input** Register: **I**

Bit: IO.1

Byte, Word, or Double Word: IB4

Process-Image **Output** Register: **Q**

Bit: Q1.1

Byte, Word, or Double Word: QB5

Variable Memory Area: **V**

Bit: V10.2

Byte, Word, or Double Word: VW100

Bit Memory Area: **M** (CPU 224XP: 32byte)

Bit: M M26.7

Byte, Word, or Double Word: MD20

■ Programiranje PLC-a

■ Podaci

Timer Memory Area: **T**

trenutna vrednost: 16 bita

timer bit

Current Value

T0
T1
T2
15 (MSB) T3 0 (LSB)

Timer Bits

T0
T1
T2
T3

Counter Memory Area: **C**

trenutna vrednost: 16 bita

counter bit

Current Value

C0
C1
C2
15 (MSB) C3 0 (LSB)

Counter Bits

C0
C1
C2
C3

High-Speed Counters: **HC**

brzi događaji, nezavisno od CPU scana.

Označen, 32-bit integer

Accumulators: **AC**

AC0, AC1, AC2, AC3

Special Memory: **SM**

Always On (SM0.0), First pass (SM0.1), 30 s off / 30 s on (SM0.4), analog

Local Memory Area: **L**

stek (razmena podataka za potprograme), inače slična Variable Memory Area

■ Programiranje PLC-a

■ Podaci

Analog Inputs: **AI**

16 bita -> AIW0 i AIW2

Analog Outputs: **AQ**

16 bita -> AQW0

Strings

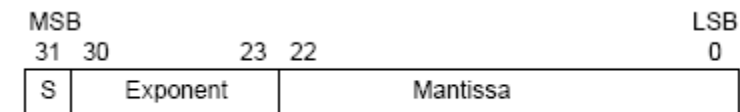
Length	Character 1	Character 2	Character 3	Character 4	...	Character 254
Byte 0	Byte 1	Byte 2	Byte 3	Byte 4		Byte 254

Constant value

Representation	Format	Sample
Decimal	[decimal value]	20047
Hexadecimal	16#[hexadecimal value]	16#4E4F
Binary	2#[binary number]	2#1010_0101_1010_0101
ASCII	'[ASCII text]'	'ABCD'
Real	ANSI/IEEE 754-1985	+1.175495E-38 (positive) -1.175495E-38 (negative)
String	"[stringtext]"	"ABCDE"

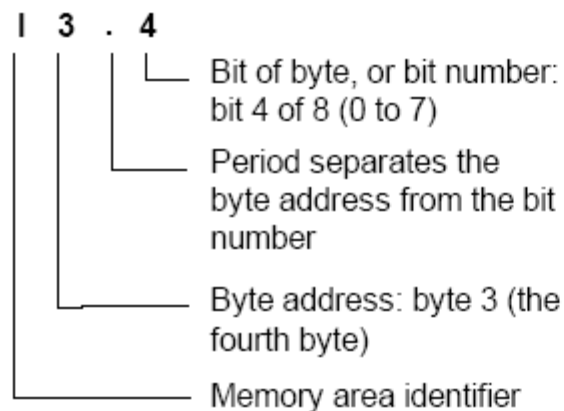
Opseg brojeva

Representation	Byte (B)	Word (W)	Double Word (D)
Unsigned Integer	0 to 255 0 to FF	0 to 65,535 0 to FFFF	0 to 4,294,967,295 0 to FFFF FFFF
Signed Integer	-128 to +127 80 to 7F	-32,768 to +32,767 8000 to 7FFF	-2,147,483,648 to +2,147,483,647 8000 0000 to 7FFF FFFF
Real IEEE 32-bit Floating Point	<i>Not applicable</i>	<i>Not applicable</i>	+1.175495E-38 to +3.402823E+38 (positive) -1.175495E-38 to -3.402823E+38 (negative)



Sign

Pristup memorijskom bitu



Process-image Input (I) Memory Area

	7	6	5	4	3	2	1	0
Byte 0								
Byte 1								
Byte 2								
Byte 3								
Byte 4								
Byte 5								

■ Programiranje PLC-a

■ Podaci (mapa, primer)

CPU 224XP	4 In / 4 Out	8 In	4 Analog In 1 Analog Out	8 Out	4 Analog In 1 Analog Out
I0.0 Q0.0 I0.1 Q0.1 I0.2 Q0.2 I0.3 Q0.3 I0.4 Q0.4 I0.5 Q0.5 I0.6 Q0.6 I0.7 Q0.7 I1.0 Q1.0 I1.1 Q1.1 I1.2 Q1.2 I1.3 Q1.3 I1.4 Q1.4 I1.5 Q1.5 I1.6 Q1.6 I1.7 Q1.7 AIW0 AQW0 AIW2 AQW2 Local I/O	Module 0 I2.0 Q2.0 I2.1 Q2.1 I2.2 Q2.2 I2.3 Q2.3 I2.4 Q2.4 I2.5 Q2.5 I2.6 Q2.6 I2.7 Q2.7	Module 1 I3.0 I3.1 I3.2 I3.3 I3.4 I3.5 I3.6 I3.7	Module 2 AIW4 AQW4 AIW6 AQW6 AIW8 AIW10	Module 3 Q3.0 Q3.1 Q3.2 Q3.3 Q3.4 Q3.5 Q3.6 Q3.7	Module 4 AIW12 AQW8 AIW14 AQW10 AIW16 AIW18
Expansion I/O					

■ Programiranje PLC-a

■ Podaci (mapa, primer)

Description	CPU 221	CPU 222	CPU 224	CPU 224XP	CPU 226
User program size with run mode edit without run mode edit	4096 bytes 4096 bytes	4096 bytes 4096 bytes	8192 bytes 12288 bytes	12288 bytes 16384 bytes	16384 bytes 24576 bytes
User data size	2048 bytes	2048 bytes	8192 bytes	10240 bytes	10240 bytes
Process-image input register	I0.0 to I15.7	I0.0 to I15.7	I0.0 to I15.7	I0.0 to I15.7	I0.0 to I15.7
Process-image output register	Q0.0 to Q15.7	Q0.0 to Q15.7	Q0.0 to Q15.7	Q0.0 to Q15.7	Q0.0 to Q15.7
Analog inputs (read only)	AIW0 to AIW30	AIW0 to AIW30	AIW0 to AIW62	AIW0 to AIW62	AIW0 to AIW62
Analog outputs (write only)	AQW0 to AQW30	AQW0 to AQW30	AQW0 to AQW62	AQW0 to AQW62	AQW0 to AQW62
Variable memory (V)	VB0 to VB2047	VB0 to VB2047	VB0 to VB8191	VB0 to VB10239	VB0 to VB10239
Local memory (L) ¹	LB0 to LB63	LB0 to LB63	LB0 to LB63	LB0 to LB63	LB0 to LB63
Bit memory (M)	M0.0 to M31.7	M0.0 to M31.7	M0.0 to M31.7	M0.0 to M31.7	M0.0 to M31.7
Special Memory (SM) Read only	SM0.0 to SM179.7 SM0.0 to SM29.7	SM0.0 to SM299.7 SM0.0 to SM29.7	SM0.0 to SM549.7 SM0.0 to SM29.7	SM0.0 to SM549.7 SM0.0 to SM29.7	SM0.0 to SM549.7 SM0.0 to SM29.7
Timers	256 (T0 to T255)	256 (T0 to T255)	256 (T0 to T255)	256 (T0 to T255)	256 (T0 to T255)
Retentive on-delay	1 ms 10 ms 100 ms	T0, T64 T1 to T4, and T65 to T68 T5 to T31, and T69 to T95	T0, T64 T1 to T4, and T65 to T68 T5 to T31, and T69 to T95	T0, T64 T1 to T4, and T65 to T68 T5 to T31, and T69 to T95	T0, T64 T1 to T4, and T65 to T68 T5 to T31, and T69 to T95
On/Off delay	1 ms 10 ms 100 ms	T32, T96 T33 to T36, and T97 to T100 T37 to T63, and T101 to T255	T32, T96 T33 to T36, and T97 to T100 T37 to T63, and T101 to T255	T32, T96 T33 to T36, and T97 to T100 T37 to T63, and T101 to T255	T32, T96 T33 to T36, and T97 to T100 T37 to T63, and T101 to T255
Counters	C0 to C255	C0 to C255	C0 to C255	C0 to C255	C0 to C255
High-speed counters	HC0 to HC5	HC0 to HC5	HC0 to HC5	HC0 to HC5	HC0 to HC5
Sequential control relays (S)	S0.0 to S31.7	S0.0 to S31.7	S0.0 to S31.7	S0.0 to S31.7	S0.0 to S31.7
Accumulator registers	AC0 to AC3	AC0 to AC3	AC0 to AC3	AC0 to AC3	AC0 to AC3
Jumps/Labels	0 to 255	0 to 255	0 to 255	0 to 255	0 to 255
Call/Subroutine	0 to 63	0 to 63	0 to 63	0 to 63	0 to 127
Interrupt routines	0 to 127	0 to 127	0 to 127	0 to 127	0 to 127
Positive/negative transitions	256	256	256	256	256
PID loops	0 to 7	0 to 7	0 to 7	0 to 7	0 to 7
Ports	Port 0	Port 0	Port 0	Port 0, Port 1	Port 0, Port 1

■ Programiranje PLC-a

■ Samodržanje (verzija 1)

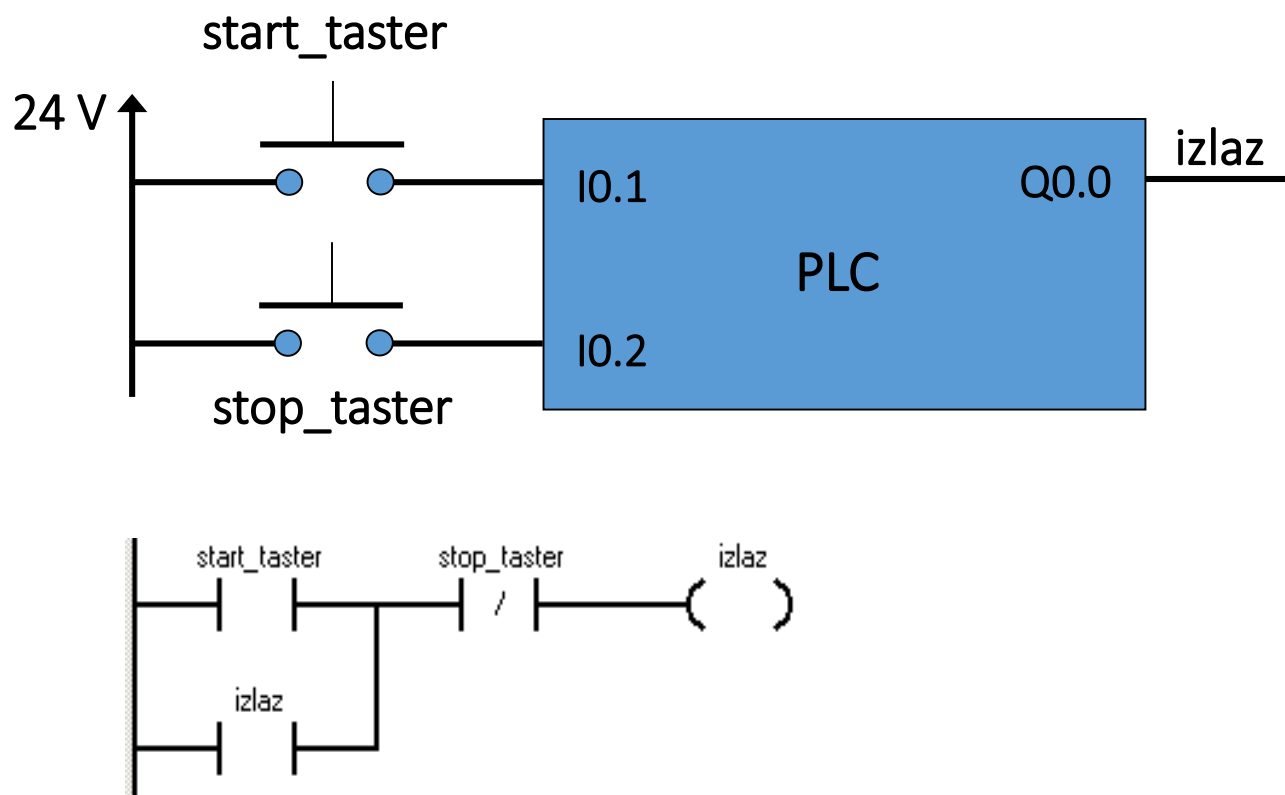
Pritisnut normalno *otvoren* **start_taster**
i nepritisnut normalno *otvoren* **stop_taster**
uključuju izlaz.

Izlaz **sam sebe** drži aktivnim (**setovanim**) sve dok neko ne pritisne **stop_taster**.

Ovo važi u slučaju da se koriste **dva radna tastera**.

■ Programiranje PLC-a

■ Samodržanje (verzija 1)



■ Programiranje PLC-a

■ Samodržanje (verzija 2)

Pritisnut normalno *otvoren* **start_taster** i nepritisnut normalno *zatvoren* **stop_taster** uključuju izlaz.

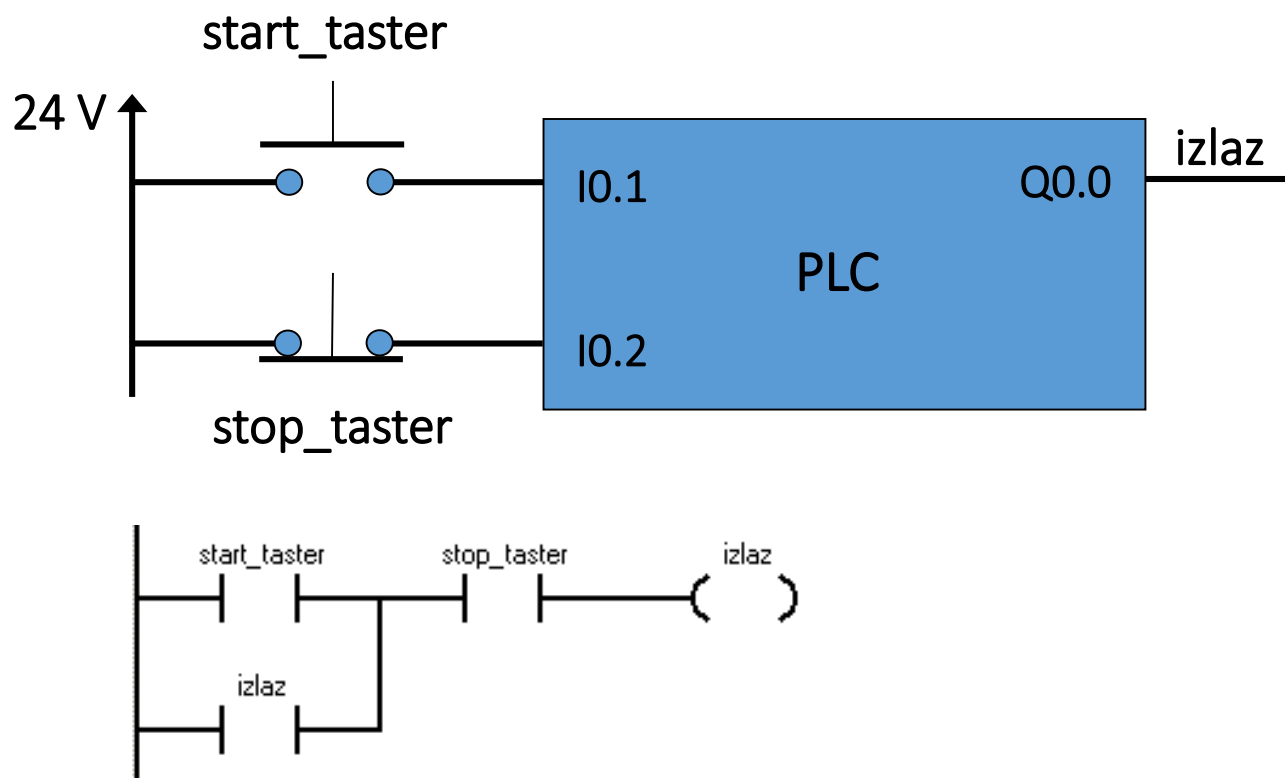
Izlaz **sam sebe drži aktivnim (setovanim)** sve dok neko ne pritisne stop_taster.

Ovo važi u slučaju da se za stop koriste mirni taster!

Na primer, podnaponska sklopka dok ima napona drži stop provodnim, ako napon nestane, stop izbacuje pogon.

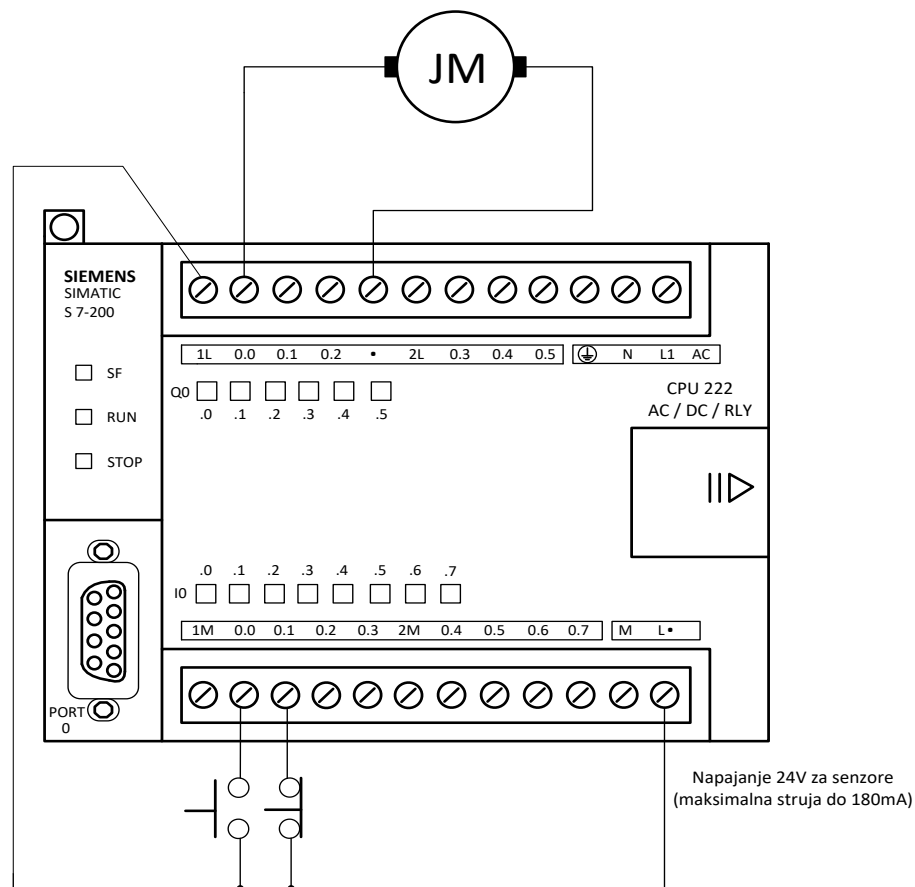
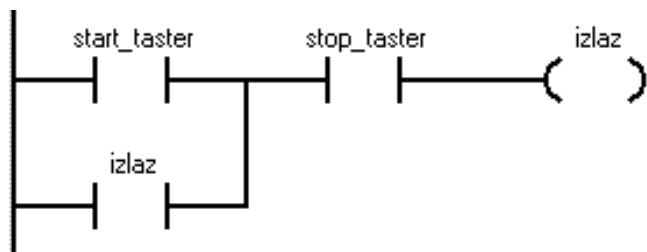
■ Programiranje PLC-a

■ Samodržanje (verzija 2)



■ Programiranje PLC-a

■ Samodržanje (verzija 2) - primer



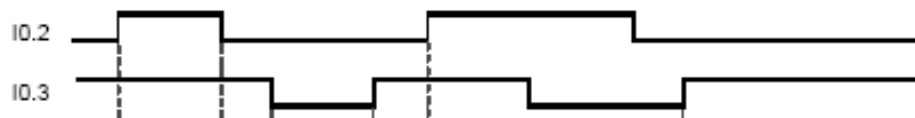
■ Programiranje PLC-a

■ Vremenski dijagrami

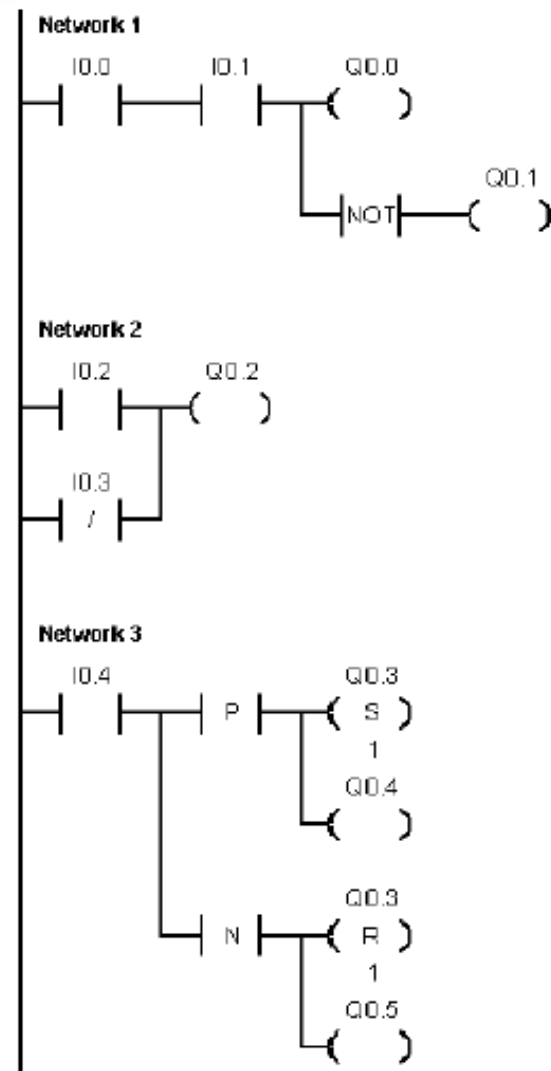
Network 1



Network 2



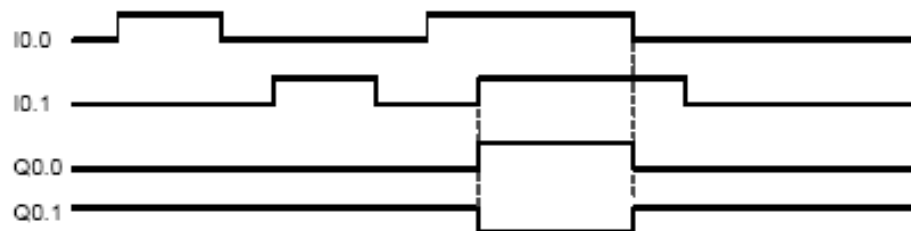
Network 3



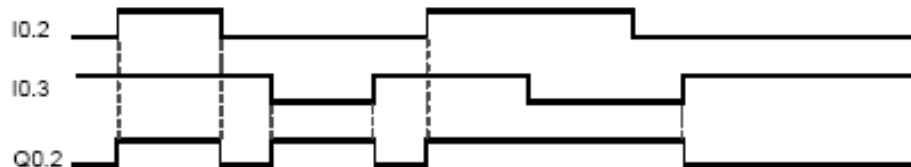
■ Programiranje PLC-a

■ Vremenski dijagrami

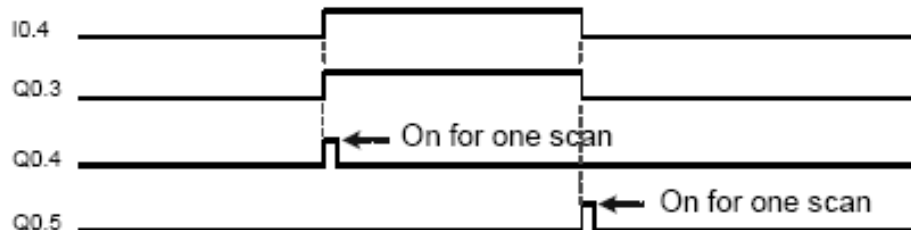
Network 1



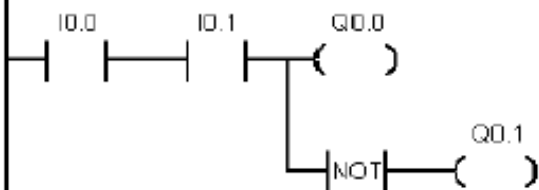
Network 2



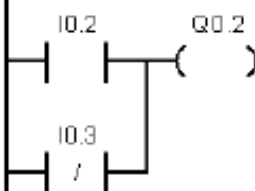
Network 3



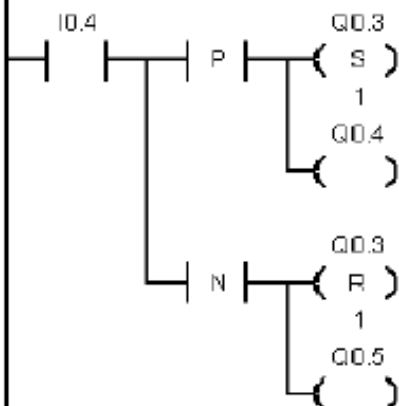
Network 1



Network 2

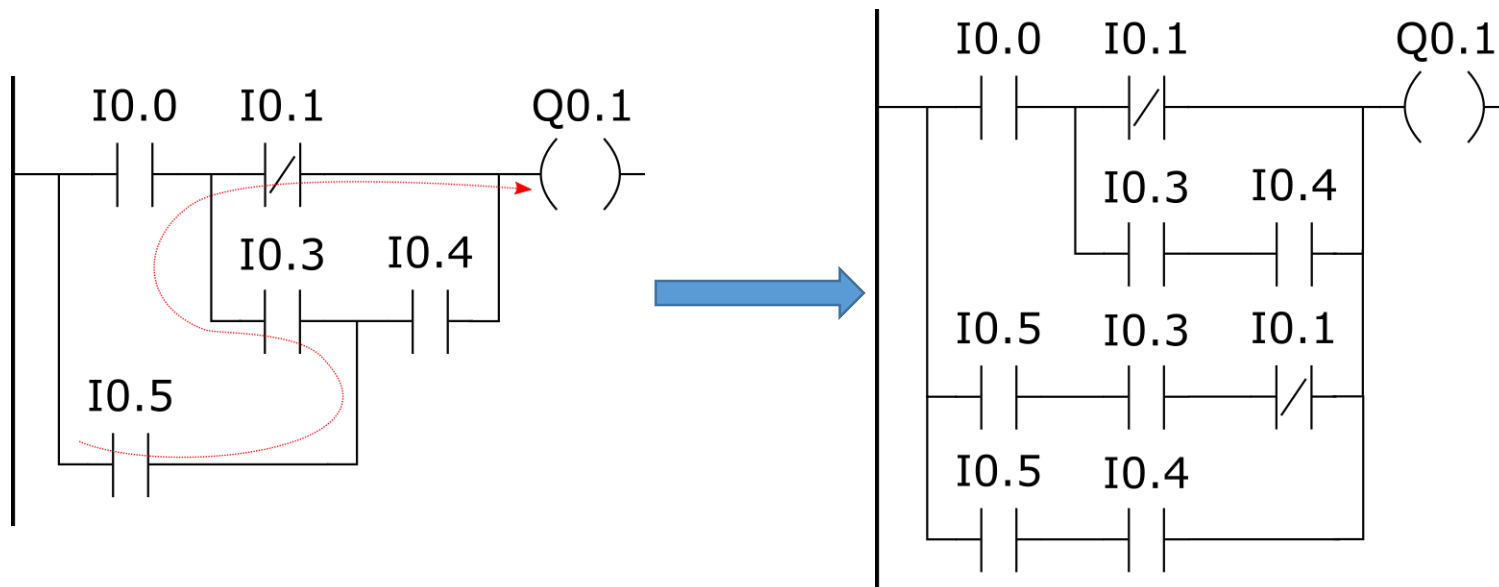


Network 3



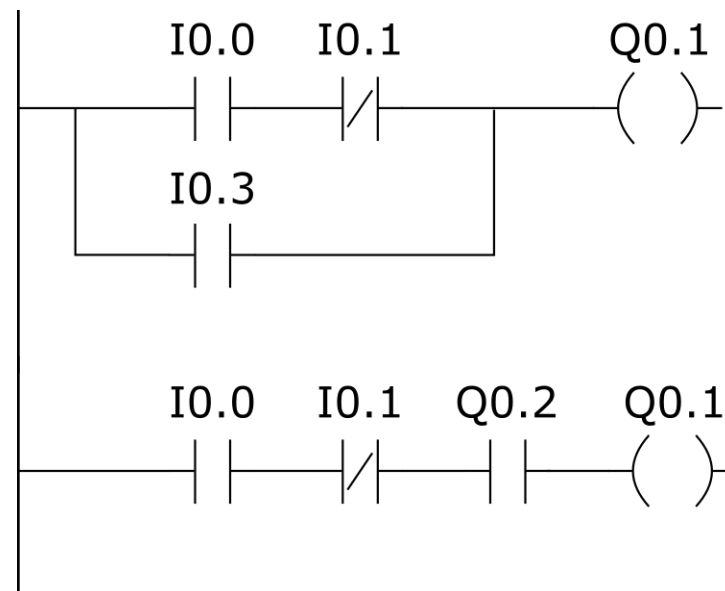
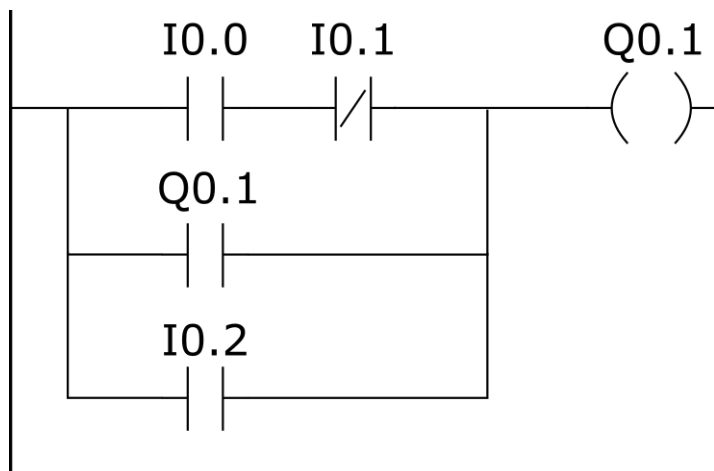
■ Programiranje PLC-a

■ Česte greške...



■ Programiranje PLC-a

■ Česte greške...



■ Kraj