

# OPASKA!

- ☞ Ovi materijali namijenjeni su isključivo studenticama/studentima koji su upisali predmet "Računala i procesi" na FER-u u šk. g. 2002/2003.
- ☞ Za svako drugo korištenje potrebna je pismena suglasnost autora!
- ☞ Materijali služe kao pomoć u praćenju predavanja, a ne kao njihova zamjena te se ne mogu tumačiti izvan konteksta predavanja!

M. Žagar, 2002-10-01




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Mario Žagar



Sveučilište u Zagrebu

Fakultet elektrotehnike i računarstva  
(FER)

14. RIP - Programabilni Logički  
Kontroleri (PLC)

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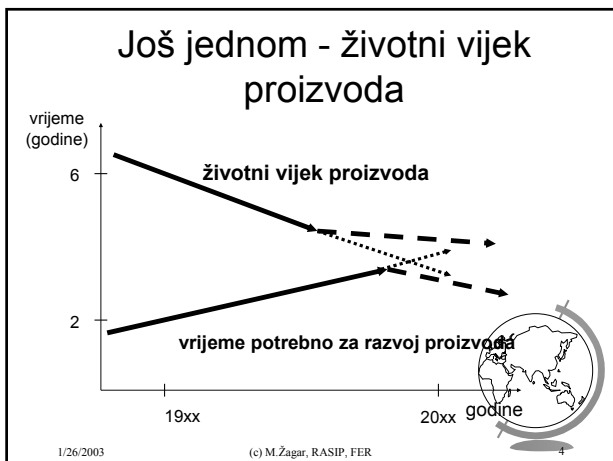
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- ### Pristup rješavanju
- ☞ klasično
  - ☞ "LabWindows"
    - ideja udaljenog instrumenta
    - "potrošen instrument i PC"
  - ☞ "LabView"
    - jezik G, GPIB-ENET, modularno prog.
    - zahtjevno okruženje (10K\$)
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- ### PLC
- ☞ šuma - drvo
  - ☞ brzina rješavanja problema
  - ☞ uređaj i funkcionalnost ne ovise o konkretnom mikroprocesoru - sakriven
  - ☞ vrijeme razvoja uređaja u pravilu što kraće
  - ☞ pouzdanost
  - ☞ industrijski uvjeti
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## PROGRAMIRANJE

- ☞ netko tko poznaje proces, ne mora biti računarac
- ☞ skup naredaba za logičko programiranje
- ☞ sve na razini logičkih simbola
- ☞ ljestvičasti (ladder) dijagrami
- ☞  $I3 = U1U2 + U3$



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## OMRON CPM1-10CDR-AC

Osnovne karakteristike

- ☞ Napajanje: **100-240[V], 50-60 [Hz]**
- ☞ Izolacijski otpor: **minimalno 20 [MΩ]**
- ☞ Otpornost na smetnje:
  - amplituda smetnji **1.5 [Vpp]**;
  - uz širinu pulsa smetnje **od 0.1 do 1 [us]**;
- ☞ Otpornost na ubrzanja: **do 15G**;
- ☞ Visoka otpornost na razne vrste vibracija;
- ☞ Težina uređaja do **0.6 [kg]** + modul za proširenje ulazno-izlaznih mogućnosti **0.6 [kg]**;



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## OMRON CPM1-10CDR-AC

Osnovne karakteristike (2)

- ☞ Pohrana programa: **u internoj memoriji**
- ☞ Način programiranja: **Ladder dijagrami**
- ☞ Dužina instrukcija:
  - **1 korak po instrukciji**;
  - **1 do 5 riječi po instrukciji**.
- ☞ Vrste instrukcija:
  - **14 osnovnih instrukcija (osnovne logičke instrukcije i sl.)**;
  - **134 posebne instrukcije (kontrola brojača, prekidi, vremenski skl.)**;
- ☞ Vrijeme izvršavanja instrukcija:
  - **0.72 us do 16.2 us za osnovne instrukcije**;



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## OMRON CPM1-10CDR-AC

Osnovne karakteristike (3)

- ☞ veličina memorije: **2048 riječi**
- ☞ radna memorija:
  - veličina **1024 riječi**
  - podijeljena u nekoliko blokova ovisno o:
    - ◆ namjeni - ulazno/izlazni bitovi, bitovi opće namjene, registri pridruženi vremenskim sklopovima i brojačima i sl.
    - ◆ načinu napajanja: obični RAM, RAM koji čuva sadržaj bez napajanja pomoću kondenzatora ili FLASH memorija;
- ☞ 128 vremenskih sklopova s rezolucijom od 10  $\mu$ s do 100 ms koji se mogu koristiti kao brojači ili timeri;



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## OMRON CPM1-10CDR-AC

Osnovne karakteristike (4)

- ☞ Ulazi i izlazi osnovne jedinice:
  - 6 digitalnih ulaza 24 VDC;
  - 4 izlazna releja 250 VAC, 2 A
- ☞ Vrlo velike mogućnosti proširivanje pomoću dodatnih modula
  - do tisuću ulaza i izlaza
  - ovisno o broju modula za proširivanje i mogućnosti adresiranja unutar PLC-a



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## KORACI RAZVOJA

- ☞ Projektiranje sustava;
- ☞ Pridruživanje U/I točaka;
- ☞ Pisanje programskog koda;
- ☞ Programiranje;
- ☞ Ispravljanje grješaka;
- ☞ Nadgledavanje izvršavanja programa;
- ☞ Pohranjivanje u memoriju PLC-a.



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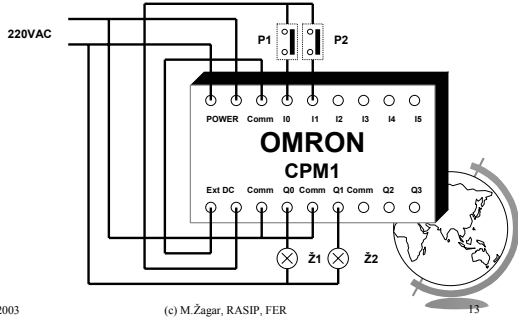
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PRIMJER SPAJANJA  
DEMONSTRACIJE S CMP1



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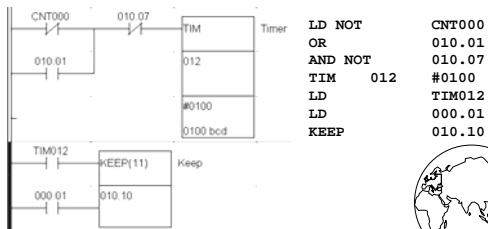
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LADDER (LJESTVIČASTI)  
DIJAGRAMI

Ladder dijagram

Ekvivalentni niz instrukcija



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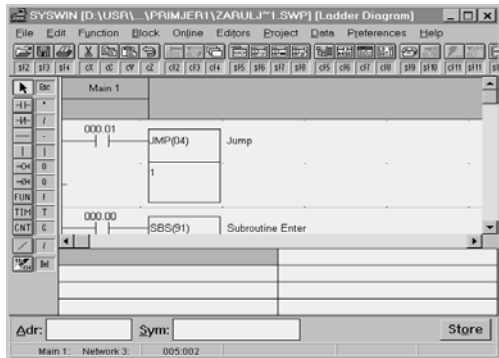
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SYSWIN



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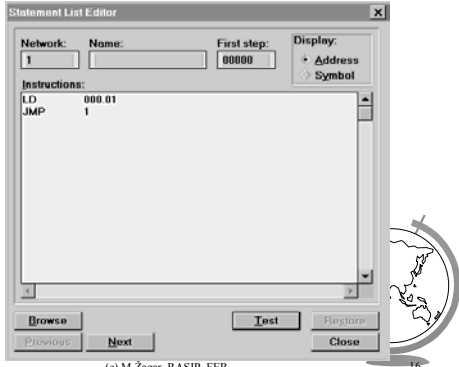
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# SYSWIN



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## Program: Main 1 -

```

00000 LD      000.01
00001 JMP      1

00002 LD      000.00
00003 SBS      1

00004 LD NOT  000.00
00005 SBS      2

00006 LD NOT  000.02
00007 JMP      1

00008 SBN      1

00009 LD      TIM002
00010 TIM      001 #0010

00011 LD NOT  TIM001
00012 TIM      002 #0010

00013 LD      TIM001
00014 OUT NOT 010.02
00015 OUT      010.00

00016 LD      TIM002
00017 OUT NOT 010.00
00018 OUT      010.02

00019 RET

00020 SBN      2

00021 LD      TIM006
00022 TIM      005 #0002

00023 LD NOT  TIM005
00024 TIM      006 #0002

00025 LD      TIM005
00026 OUT      010.00
00027 OUT      010.02

00028 LD      TIM006
00029 OUT NOT 010.00
00030 OUT NOT 010.02
00031 RET

00032 JME

00033 END

```

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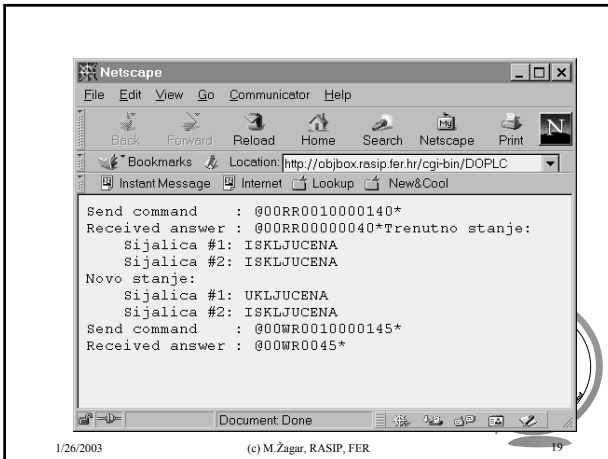
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## Upravljanje PLC-om

☛ mogući načini upravljanja:

- izgradnja ljestvičastog dijagrama
- pisanje programa u assembleru
- putem računala



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## Upravljanje putem računala

- ☛ PLC i računalo su povezani serijskim (RS233C) portom
- ☛ Parametri komunikacije preko RS232C:
  - brzina: 9600 Baud
  - 7 bitova podataka
  - 2 stop bita
  - parni paritet
- ☛ Parametri komunikacije su tvornički postavljeni
- ☛ Promjena parametara je moguća direktnim upisivanjem u DM memorijsko područje PLC-a



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## Komunikacijski protokol

☞ opis blokova koje razmjenjuju računalo i PLC

Računalo

Broj uređaja

Zaglavlje

Tekst

FCS

Terminator

→

PLC

Broj uređaja

Zaglavlje

Kod završetka

Tekst

FCS

Terminator

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## Komunikacijski protokol

- ☞ Broj uređaja  
služi za adresiranje PLC-a (konkretno samo 00)
- ☞ Zaglavlje  
sadrži kod naredbe (operacije)
- ☞ Tekst  
eventualni parametri naredbe
- ☞ FCS  
zaštita okvira (XOR svih znakova od početka okvira)
- ☞ Terminator  
sastoji se od znaka '\*' i CR
- ☞ Kod završetka  
informacija da li je operacija uspjela

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## Format naredbe i odgovora

- ☞ Format naredbe

@	d <sup>1</sup>	d <sup>0</sup>					*	\r
	Broj uređaja	Zaglavlje	Tekst	FCS	Terminator			

- ☞ Format odgovora

@	d <sup>1</sup>	d <sup>0</sup>	Kod završetka	Tekst	FCS	Terminator
	Broj uređaja	Zaglavlje	Kod završetka	Tekst	FCS	Terminator

d – brojevi zapisani dekadski, x – brojevi zapisani heksadecimalno

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## Naredbe

- ☞ Opis naredaba PLC korištenih u komunikaciji
- ☞ Inicijalizacija (INITIALIZE)

@	*	*	\r
---	---	---	----

- ☞ Obustava operacije (ABORT)

@	d <sup>1</sup>	d <sup>0</sup>	X	Z	*	\r
---	----------------	----------------	---	---	---	----

Broj uređaja    Zaglavlje    FCS



\* za INITIALIZE i ABORT PLC ne vraća odgovor

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## Naredbe (nastavak)

- ☞ Čitanje IR/SR područja (IR/SR AREA READ)
- Naredba:

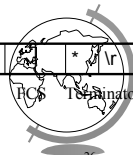
@	d <sup>1</sup>	d <sup>0</sup>	R	R	d <sup>3</sup>	d <sup>2</sup>	d <sup>1</sup>	d <sup>0</sup>	d d ...	*	\r
---	----------------	----------------	---	---	----------------	----------------	----------------	----------------	---------	---	----

Broj uređaja    Zaglavlje    Početna riječ    Broj riječi    FCS    Terminator

Odgovor:

@	d <sup>1</sup>	d <sup>0</sup>	R	R	x <sup>1</sup>	x <sup>0</sup>	x x x x ...	*	\r
---	----------------	----------------	---	---	----------------	----------------	-------------	---	----

Broj uređaja    Zaglavlje    Kod završetka    Pročitane riječi    FCS    Terminator



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## Naredbe (nastavak)

- ☞ Pisanje u IR/SR područje (IR/SR AREA WRITE)
- Naredba:

@	d <sup>1</sup>	d <sup>0</sup>	W	R	d <sup>3</sup>	d <sup>2</sup>	d <sup>1</sup>	d <sup>0</sup>	x x x ..	*	\r
---	----------------	----------------	---	---	----------------	----------------	----------------	----------------	----------	---	----

Broj uređaja    Zaglavlje    Početna riječ    Riječi koje treba upisati    FCS    Terminator

Odgovor:

@	d	d	W	R	x <sup>1</sup>	x <sup>0</sup>	*	\r
---	---	---	---	---	----------------	----------------	---	----

Broj uređaja    Zaglavlje    Kod završetka    FCS    Terminator



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## Naredbe - primjeri

☞ Čitanje IR/SR područja (IR/SR AREA READ)

Naredba za čitanje sa porta 10:

@	0	0	R	R	0	0	1	0	0	0	0	1	4	0	*	r
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Broj uređaja	Zaglavlje	Početna riječ	Broj riječi	FCS	Terminator
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Odgovor kada su obje ugašene (svi bitovi su 0)

@	0	0	R	R	0	0	0	0	0	0	1	4	0	*	r
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Broj uređaja	Zaglavlje	Kod završetka	Pročitane riječi	FCS	Terminator
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## Naredbe - primjeri

☞ Pisanje u IR/SR područje (IR/SR AREA WRITE)

Naredba za paljenje lijeve žarulje (1.bit porta 10) :

@	0	0	W	R	0	0	1	0	0	0	0	1	4	5	*	r
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Broj uređaja	Zaglavlje	Početna riječ	Riječi koje treba upisati	FCS	Terminator
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Odgovor:

@	0	0	W	R	0	0	4	5	*	r
---	---	---	---	---	---	---	---	---	---	---

Broj uređaja	Zaglavlje	Kod završetka	FCS	Terminator
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## Naredbe - primjeri

☞ Čitanje IR/SR područja (IR/SR AREA READ)

Naredba za čitanje sa porta 10:

@	0	0	R	R	0	0	1	0	0	0	0	1	4	0	*	r
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Broj uređaja	Zaglavlje	Početna riječ	Broj riječi	FCS	Terminator
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Odgovor kada je lijeva upaljena (1.bit je postavljen)

@	0	0	R	R	0	0	0	0	0	1	4	0	*	r
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Broj uređaja	Zaglavlje	Kod završetka	Pročitane riječi	FCS	Terminator
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## Naredbe - primjeri

☞ Čitanje IR/SR područja (IR/SR AREA READ)

Naredba za čitanje sa porta 10:

@	0	0	R	R	0	0	1	0	0	0	1	4	0	*	\r
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	----

Broj uređaja	Zaglavlje	Početna riječ	Broj riječi	FCS	Terminator
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Odgovor kada je desna upaljena (3.bit je postavljen)

@	0	0	R	R	0	0	0	0	0	4	4	*	\r
---	---	---	---	---	---	---	---	---	---	---	---	---	----

Broj uređaja	Zaglavlje	Kod završetka	Pročitane riječi	FCS	Terminator
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## Naredbe - primjeri

☞ Čitanje IR/SR područja (IR/SR AREA READ)

Naredba za čitanje sa porta 10:

@	0	0	R	R	0	0	1	0	0	0	1	4	0	*	\r
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	----

Broj uređaja	Zaglavlje	Početna riječ	Broj riječi	FCS	Terminator
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Odgovor kada su obje upaljene (1. i 3.bit postavljeni)

@	0	0	R	R	0	0	0	0	0	5	5	*	\r
---	---	---	---	---	---	---	---	---	---	---	---	---	----

Broj uređaja	Zaglavlje	Kod završetka	Pročitane riječi	FCS	Terminator
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