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 \_\_\_\_\_ ( \_\_\_\_\_ , \_\_\_\_\_ )

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141 - \_\_\_\_\_ , \_\_\_\_\_  
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5. \_\_\_\_\_ ( \_\_\_\_\_ , \_\_\_\_\_ ) 1. \_\_\_\_\_ ;

2. \_\_\_\_\_ ; 3. \_\_\_\_\_

\_\_\_\_\_ ; 4. \_\_\_\_\_

\_\_\_\_\_ ; 5. \_\_\_\_\_ ; 6. \_\_\_\_\_

\_\_\_\_\_ ; 7. \_\_\_\_\_ ;

8. \_\_\_\_\_ - \_\_\_\_\_ .

**6.** \_\_\_\_\_ ( \_\_\_\_\_ )


**7.** \_\_\_\_\_ 06.09.20 \_\_\_\_\_

/	( _____ )	( _____ )	
1	1. _____ ; 2. _____ , _____ ; 1, 2, 3.	27.10.21	30%
2	3. _____ , _____ ; 4, 5.	24.11.21	60%
3	4. _____ ; 5. _____ ; 6, 7, 8.	15.12.21	100%

( \_\_\_\_\_ ) \_\_\_\_\_ ( \_\_\_\_\_ )

( \_\_\_\_\_ ) \_\_\_\_\_ ( \_\_\_\_\_ )

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1	2
1) ,	8000 2500 5 100 12 80
2) , / . 2000 1000	10:1 5:1, 10:1
3) ,	$\pm 0,5 \div 1,5$
4) , / ( / )	$0,8 \cdot 10^{-3}$ (50) $33,3 \cdot 10^{-3}$ (2000) $100 \cdot 10^{-3}$ (6000)

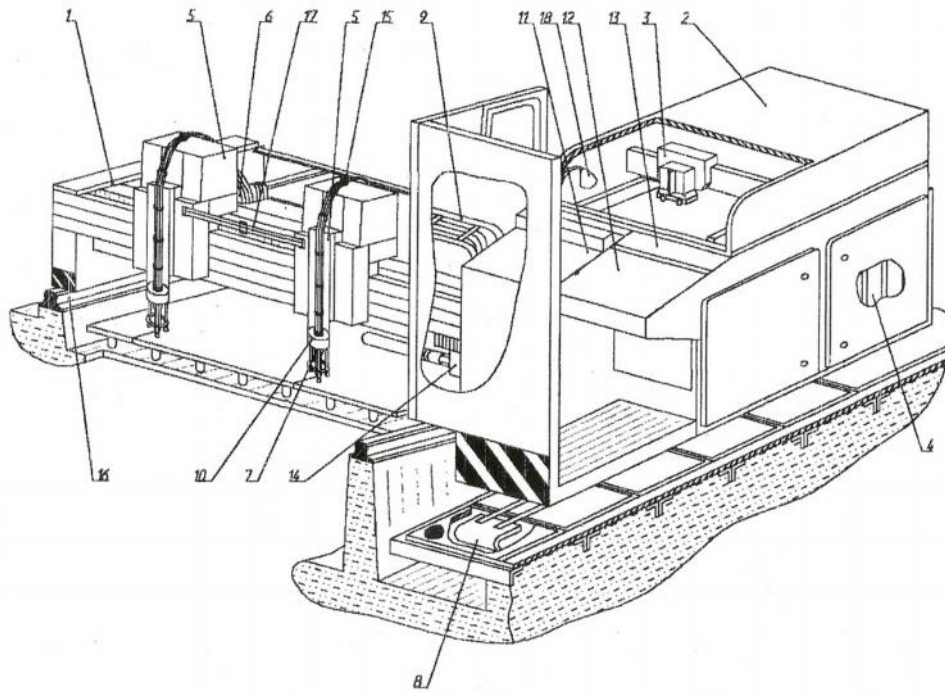
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5)		2
6)	,	2.5
7)	,	6.5
8)	,  ( )	11500 4400 1800 3300
9)	,	3500-3600
10)	, , <sup>2</sup>	50
11)	,	160
12)	,	16000
13)	,	4.2
14)	,	5.7
15)	,	12
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Технічні характеристики

- Примітки**
- 1 Штанга змінюється відповідно до вимог до кваліфікації оператора
  - 2 Залежить від конструкції машини
  - 3 Залежить від конструкції машини
  - 4 Залежить від конструкції машини
  - 5 Залежить від конструкції машини
- |   |                                      |            |
|---|--------------------------------------|------------|
| 1 | Довжина                              | 800        |
| 2 | Ширина                               | 250        |
| 3 | Висота при вертикальному положенні   | 60 і до 80 |
| 4 | Висота при горизонтальному положенні | 60 і до 80 |
- Технічні характеристики**
- |   |                                      |        |         |
|---|--------------------------------------|--------|---------|
| 1 | Висота при вертикальному положенні   | до 200 | 80      |
| 2 | Висота при горизонтальному положенні | до 200 | 5: 80   |
| 3 | Висота при горизонтальному положенні | до 200 | 3,5     |
| 4 | Висота при горизонтальному положенні | до 200 | 200-250 |

Лист	Назва	Кількість
1	Каркас	
2	Корпус машини	
3	Листовий метал	
4	Електропроводка	
5	Сиряна	
6	Корпус колеса	
7	Технічне керівництво	
8	Підшипник колісний	
9	Підшипник колісний	
10	Спеціалізована деталь	
11	Пруж. елемент	
12	Пруж. елемент	
13	Пруж. елемент	
14	Пруж. елемент	
15	Пруж. елемент	
16	Пруж. елемент	
17	Пруж. елемент	
18	Пруж. елемент	

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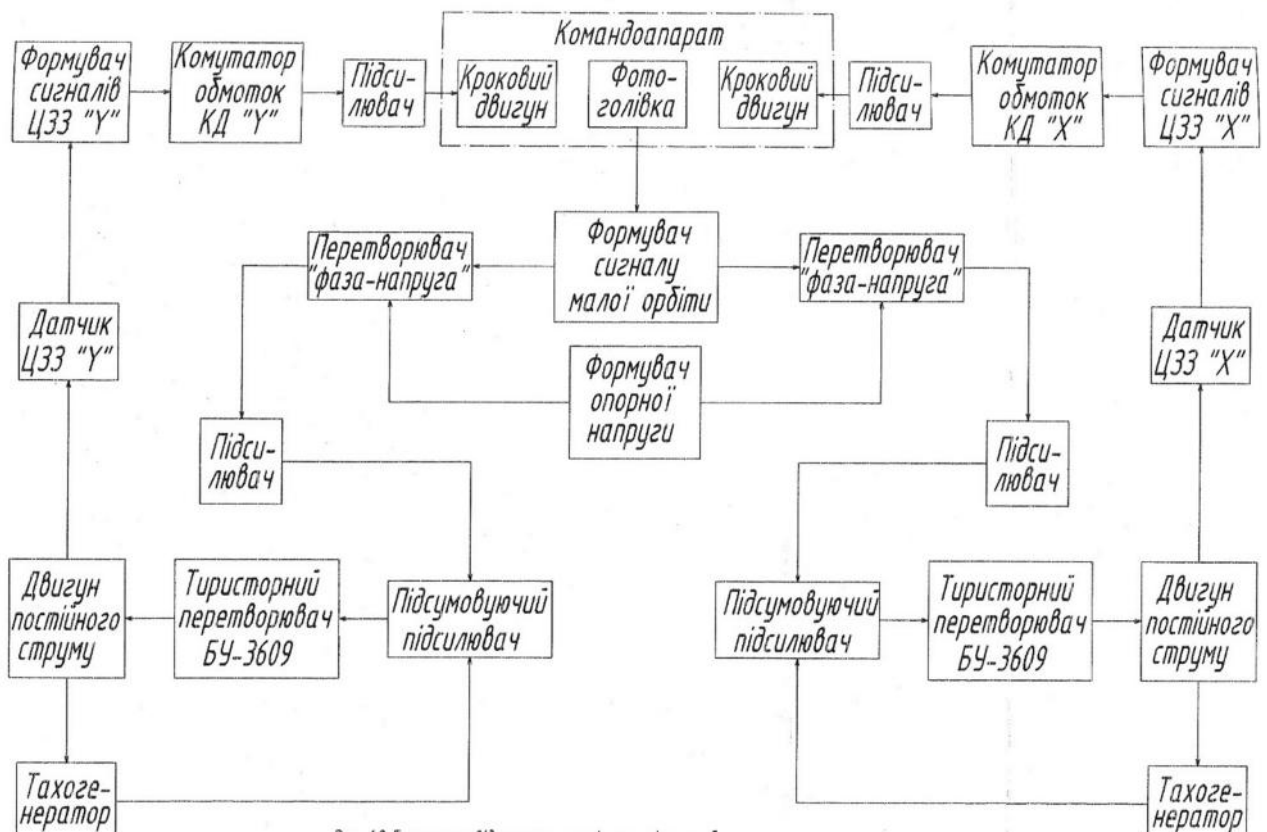
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$$100 \div 250$$

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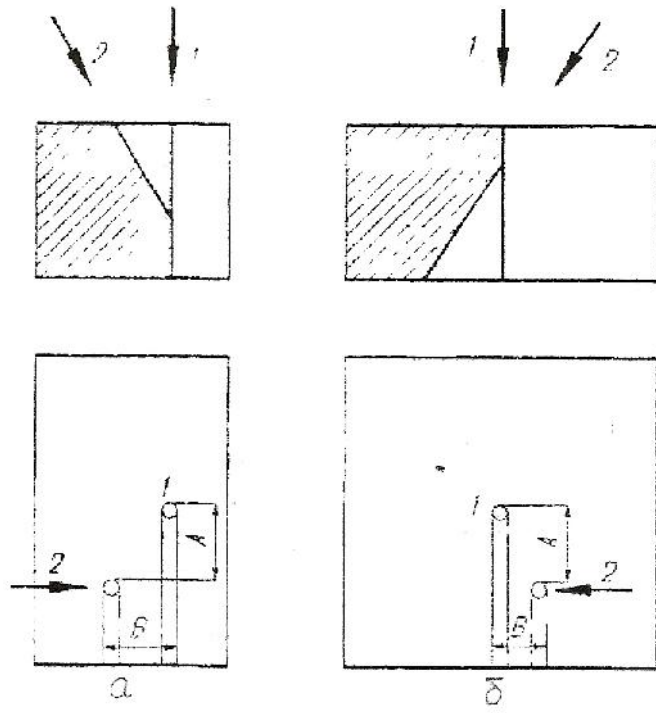
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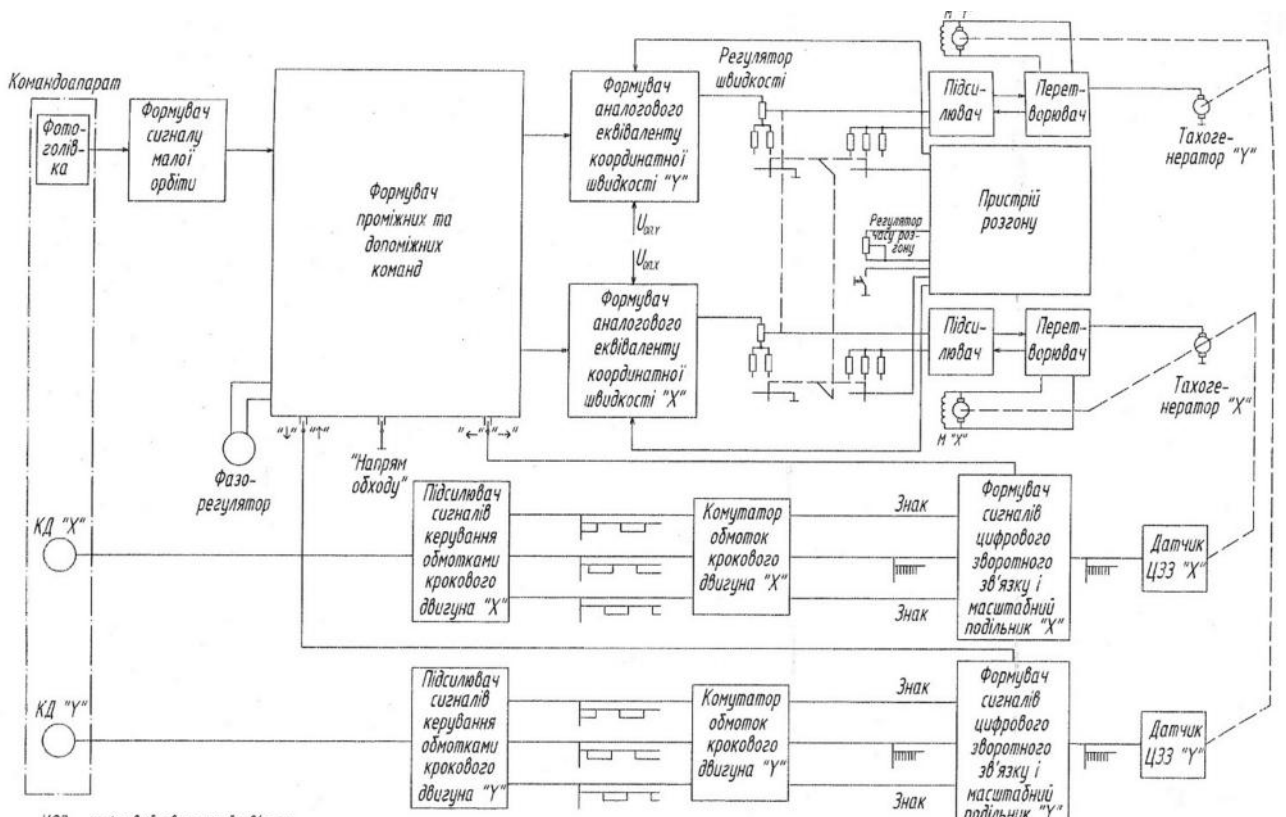
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ЦЗЗ - цифровий зворотний зв'язок  
 КД - кроковий двигун

Рис. 1.4 Система фотослідкуюча. Схема електрична функціональна

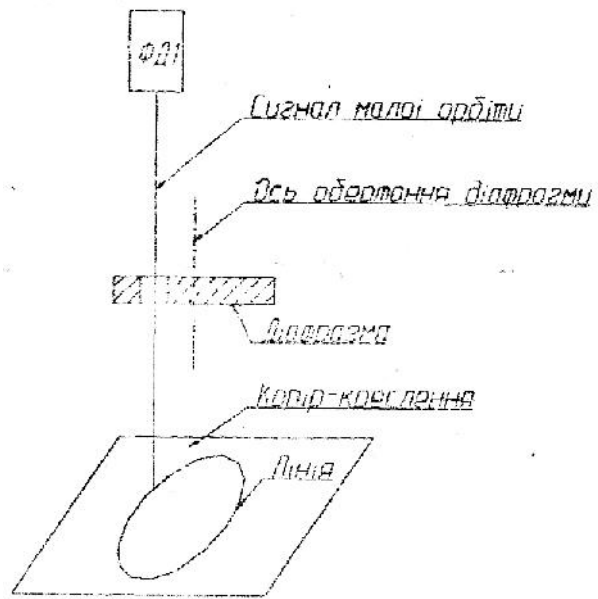
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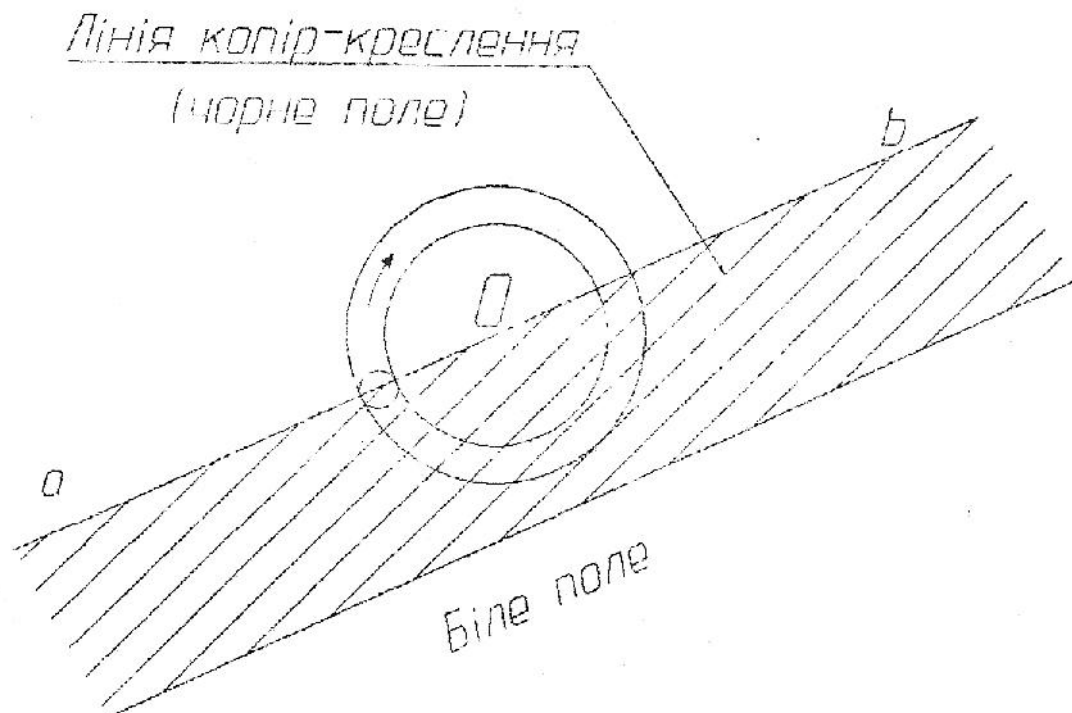


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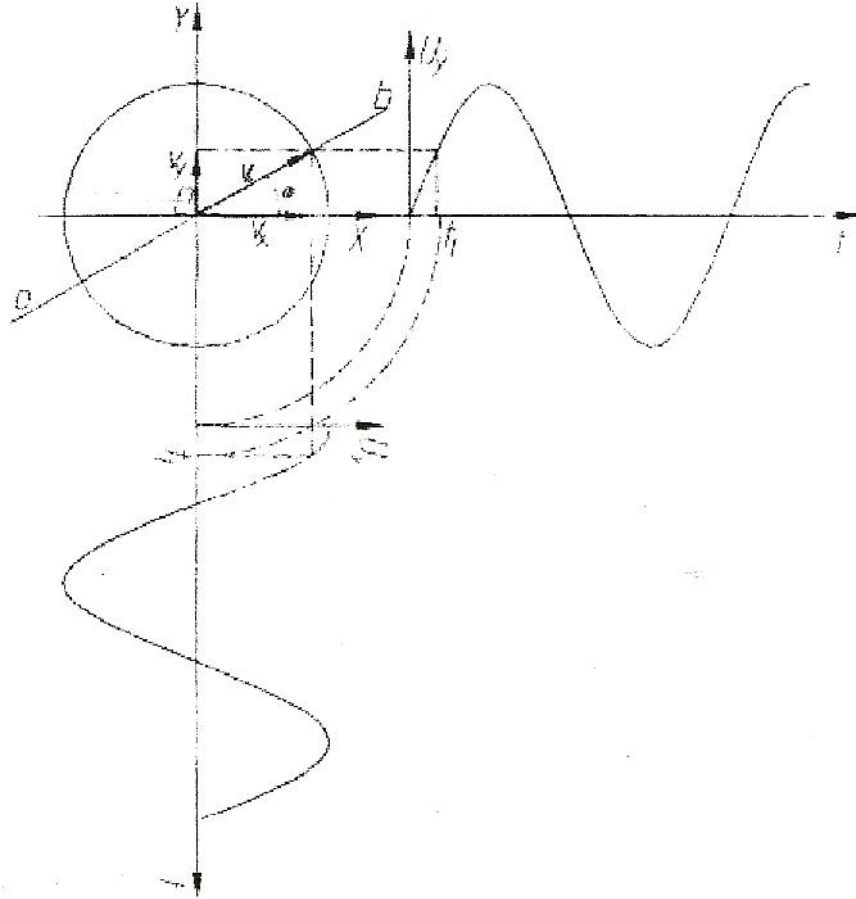
$$V_x = V_0 \tag{1.1}$$

$$V_y = V_0 \cdot \sin \tag{1.2}$$

$$U_x = U_0 \cdot \cos t_1 \quad (1.3)$$

$$U_y = U_0 \cdot \sin t_1 \quad (1.4)$$

$t_1 -$



. 1.7

$t_1 =$  .



« » . « » , , ( 5-2, 5-4 .1.8).

50-1000 / .

1000-2000 / .

6000 / . (« »).

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$S(x),$  :  
 $S(x) \sim (x + 0) = 1$  (2.1)

$S(x)$  , *sign x*:  
 $S(x) = 0,5 (1 + \text{sign } x) (x + 0)$  (2.2)

(  $x_1, x_2, \dots, x_n$  )  $n$ - ,

, - .  
 , ,  
 . ,  
 . . . ,  
 $n$ - ,  $n$   
 $n$ -  
 $2^n$  .

:  
 $X_i = S(x_i) (i=1,2,\dots,n)$  (2.3)

$2^n,$   
 $2^n$  .  
 .  
 ( ) ( );  
 - ( ) . .  
 :  $= f(x_1, x_2, \dots, x_n)$  ,  
 $R$ - (H<sub>j</sub>)  
 (j = 1, 2, ..., 2<sup>n</sup>) , :

$$S[f(x_1, \dots, x_n)] = F_i = \text{const} \quad (2.4)$$

$F_i$ -  
( $j = 1, 2, \dots, 2^n$ ).

(Hj)

$$X_i = S(x_i) \quad (i = 1, 2, \dots, n)$$

(H<sub>i</sub>),

$F_i$ ,

$F(X_1, X_2, \dots, X_n)$

$$S[f(x_1, \dots, x_n)] = F[S(X_1), S(X_2), \dots, S(X_n)] \quad (2.5)$$

$$(2.5) \quad R- \quad = f(x_1, \dots, x_n)$$

$$Y = F(X_1, \dots, X_n). \quad R-$$

$$q=2^{2^n}, \quad R-$$

$$2^L,$$

. R-

. [2]

### 2.1.2.

R-

«+» «-», 0 1, ,, " ,, " . .  
0 1 ,, " ,, " .

$$2^n-1,$$

$$q=2^n$$

, , - , . . .  
 -  $2^n - 1$ .  
 q-  
 $0 \leq x_i \leq 2^q - 1$ ,  $(n) = 2^q = 2^{2n}$   
 .  
 $n = 2$  :  $(n) = 16$ ,  
 .  
 .  
 $x_1 \vee x_2$  („ 1 2") ,  
 . 1, 1 2 ,  
 $0, x_1 = x_2 = 0$ .  
 $x_1 \sim x_2$  (« "2")  
 . , 1 2  
 .  
 $x_1 \wedge x_2$  („ 1, 2" „ 1 2")  
 . ,  $x_1 = 1$ ,  
 $x_2 = 0$   
 $x_1 / x_2$  .  
 , 1 2 1.  
 .  
 $0 \leq x_i \leq 1$  -  
 , .  
 , ;  
 $y = f(x_1, x_2, \dots, x_n) \geq 0$ ,  $f(x_1, x_2, \dots, x_n) \in \mathbb{R}$  , ;  
 $y = f(x_1, x_2, \dots, x_n) < 0$   $\mathbb{R}$  , .  
 , ,  
 $\mathbb{R}$  ,  
 .

$$y=f(x_1, x_2, \dots, x_n) \quad R- \quad , a Y=F(X_1, X_2, \dots, X_n)$$

$$Y=F(X_1, X_2, \dots, X_n),$$

$$y=f(x_1, x_2, \dots, x_n) \quad . [2]$$

### 2.1.3.

$$(D) \quad , \quad : \quad z = f(x,y) \geq 0 \quad (2.6)$$

$f(x,y) -$

$$D = S[f(x,y)] = [f(x,y) \geq 0] \quad (2.7)$$

,  $D$   
 $(, ) \quad (D), \quad - \quad (D).$

$(D_1) \quad (D_2),$

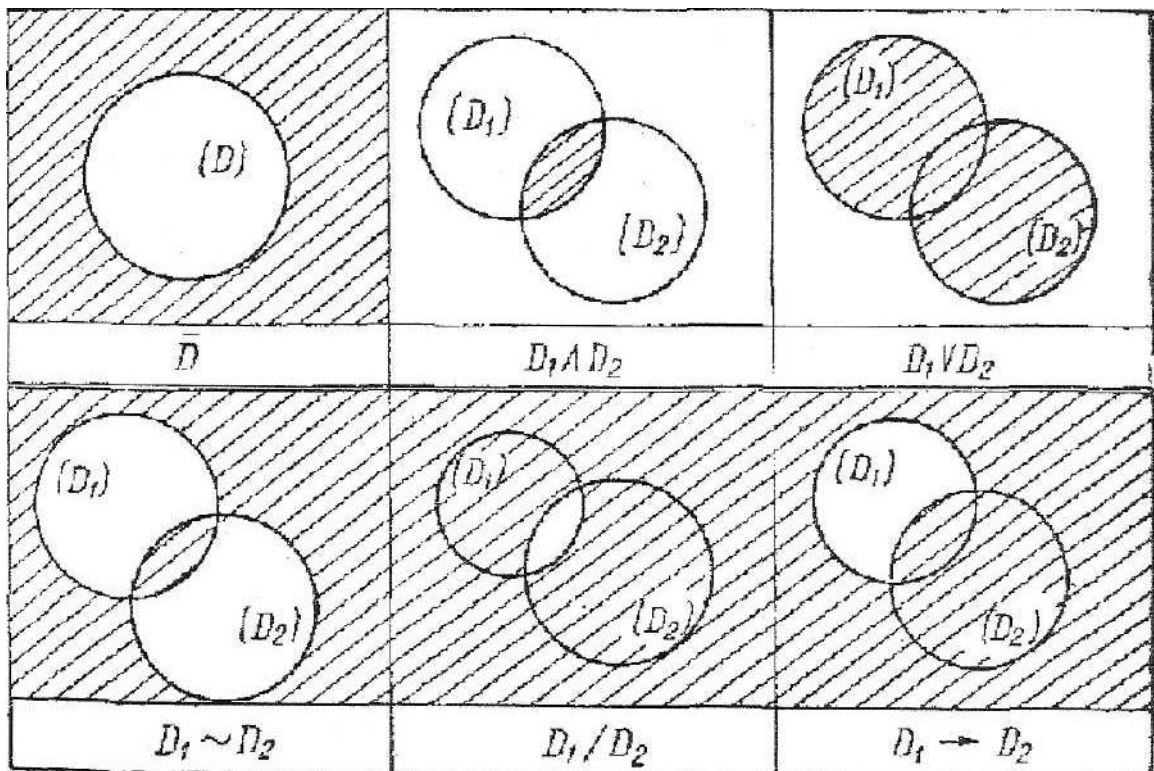
$f_1(, ) \geq 0 \quad f_2(x,y) \geq 0.$

$D_1 \quad D_2$

$F(D_1, D_2).$

$D_1 \cap D_2 \quad (2.1),$

$(D_1) \quad (D_2).$



.2.1

D<sub>1</sub> D<sub>2</sub>

, ,  
 , (D<sub>1</sub>,) (D<sub>2</sub>). ,  
 , . ,  
 D<sub>1</sub>, D<sub>2</sub>. , , ,  
 , , , . [2]

R-

2.1.4.

R-

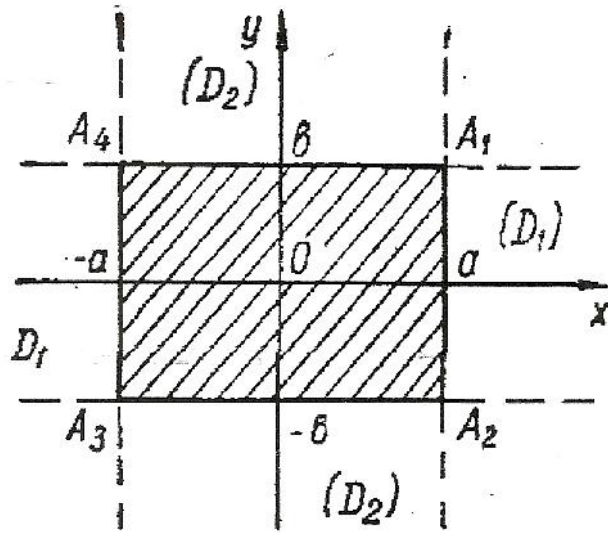
, ( ). ,  
 R- :  
 )  
 1 2 3 4 ( .2.2),  
 (D<sub>1</sub>) (D<sub>2</sub>),  
 2 - 2 0 b<sup>2</sup> - 2 0. R- , . :  
 ( 2 - 2) (b<sup>2</sup> - 2) 0 (2.8)

1 2 3 4. (2.8)

:

$$\frac{1}{2} [a^2 - x^2 + b^2 - y^2 - \sqrt{(a^2 - x^2)^2 + (b^2 - y^2)^2 - 2a(a^2 - x^2)(b^2 - y^2)}] \geq 0 \quad (2.9)$$

$$\frac{1}{2} [a^2 + b^2 - x^2 - y^2 - |a^2 - b^2 - x^2 + y^2|] \geq 0 \quad (2.10)$$



.2.2

$$a^2 + b^2 - x^2 - y^2 - |a^2 - b^2 - x^2 + y^2| \geq 0 \quad (2.11)$$

) , ( .2.3, ).

(D1) , (2.10),

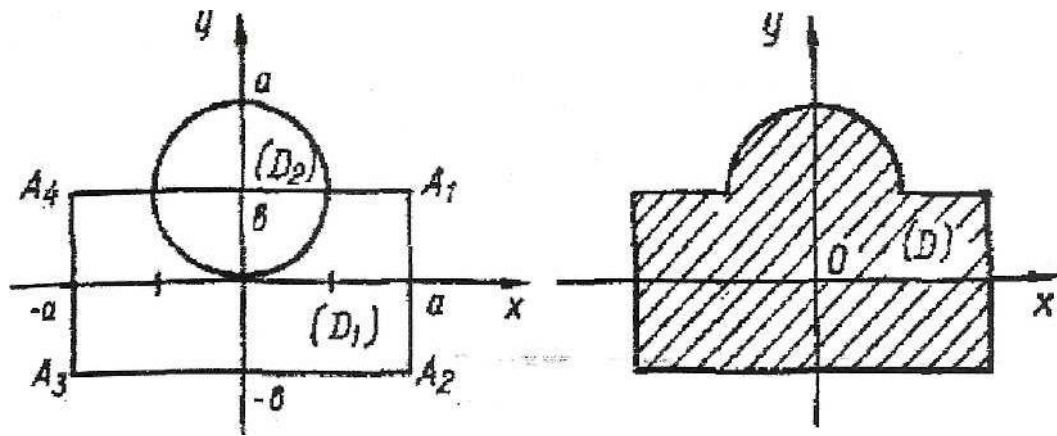
(D2) - . -  $x^2 - y^2 \geq 0$ . R- ,

(D) ( .2.3, ):

$$\begin{aligned} & \frac{1}{2}[a^2 + b^2 - x^2 - y^2 - |a^2 - b^2 - x^2 + y^2| + a \cdot y - x^2 - y^2 + \\ & + |a^2 + b^2 - x^2 - y^2 - |a^2 - b^2 - x^2 + y^2| - a \cdot y - x^2 - y^2] \geq 0 \end{aligned} \quad (2.12)$$

, :

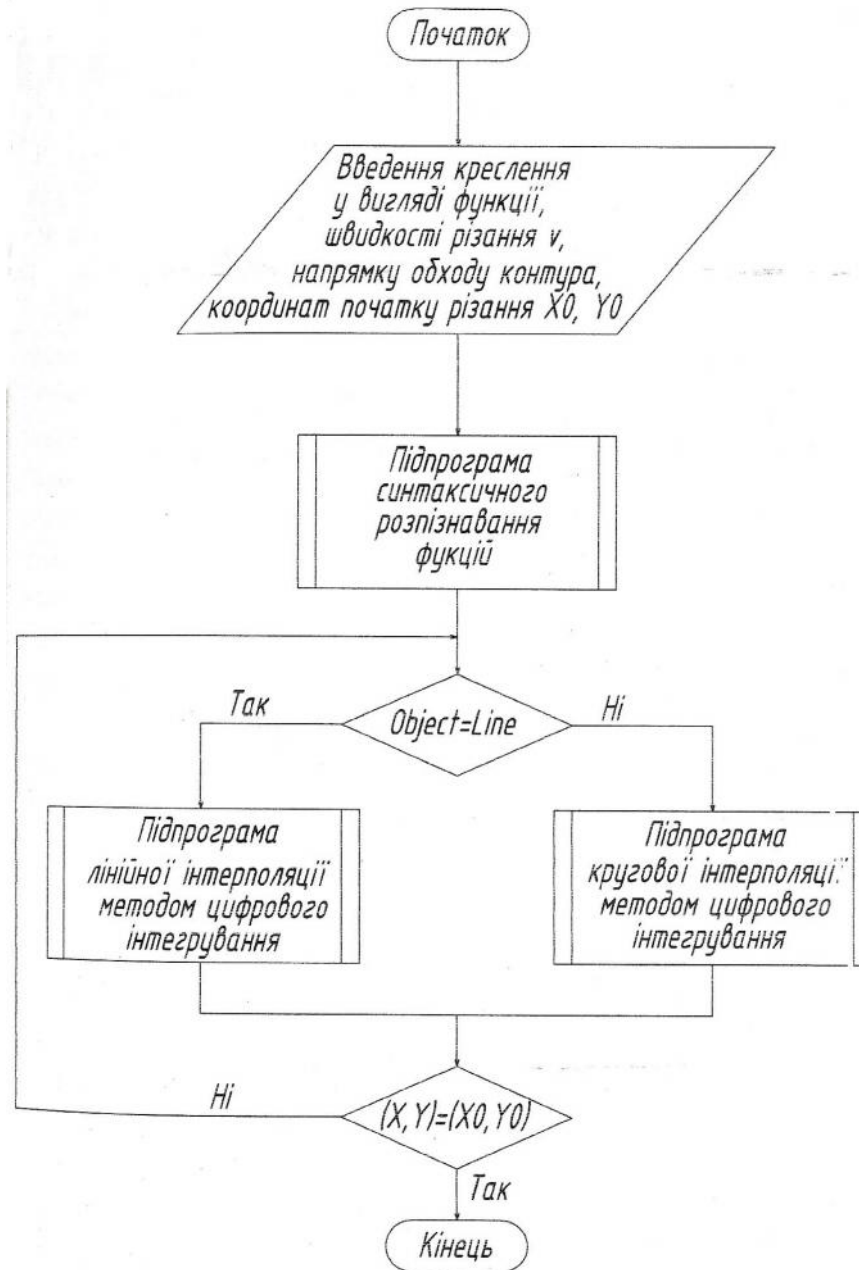
$$\begin{aligned} & a^2 + b^2 + a \cdot y - 2x^2 - 2y^2 - |a^2 - b^2 - x^2 + y^2| + \\ & + |a^2 + b^2 - a \cdot y - 2x^2 - 2y^2 - |a^2 - b^2 - x^2 + y^2|| = 0 \end{aligned} \quad (2.13)$$



. 2.3.

$D_1 \cup D_2$

( 2.4).



. 2.4



$$v_i = v_{i0} + \int_0^t a_i dt \quad (2.14)$$

$$s_i = s_{i0} + \int_0^t v_i dt \quad (2.15)$$

$s_{i0}, v_{i0}$  —  $t=0$  i-  
; i — t.

(2.14) (2.15),

(2.14) (2.15)

( ),

(j+1)-

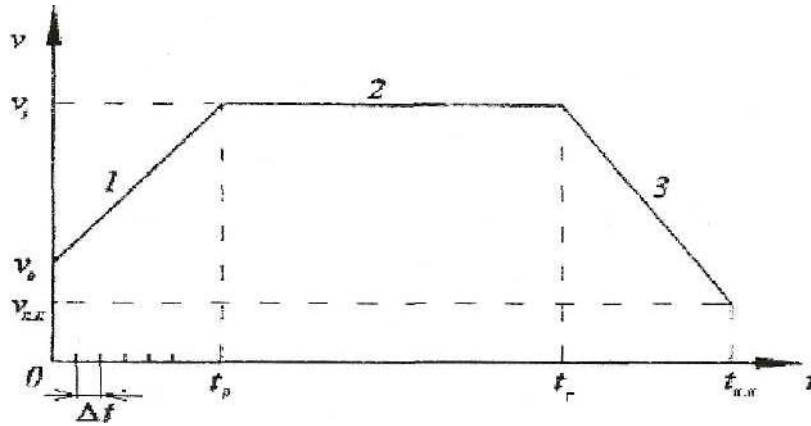
j-

:

$$v_{i,j+1} = v_{ij} + ai\Delta t \quad (2.16)$$

$$s_{i,j+1} = s_{ij} + (v_{i,j} + v_{i,j+1}) \frac{\Delta t}{2} \quad (2.17)$$

t—



. 2.5

$$(2.16) \quad (2.17)$$

t.

t.

: 1 — , 2 —

3 — ( 2.5).

$v_0$   $v_3$  2

. 3

-

$v_3$   $v_{kk}$ .

$t_p$   $t_r$

t

$t_p$   $t_{kk}$

s .

:

$$s = \sqrt{\sum_{i=1}^n \Delta s_i^2} \quad (2.14)$$

n -

(n=2).

$V_{i3}$

$S_{ik.k}$

$t$

$V_{ik,k} t$

$V_{kk} \cdot N$

$N$

$$\frac{V_{k.k}(N-1)}{N} < V_{k.k} > V_{k.k} \quad (2.19)$$

$V_{kk} -$

$; V_{k.k} -$

$; N -$

$N=2^k$

$(=5)$

;  $v_0$  — ;  $v_3$  — ;

[3]:

$$v_{i0} = \frac{v_0 \Delta s_1}{\sqrt{\sum_{l=0}^n \Delta s_l^2}} \quad (2.20)$$

$$v_{i3} = \frac{v_3 \Delta s_1}{\sqrt{\sum_{l=1}^n \Delta s_l^2}} \quad (2.21)$$

$$a_i = \frac{a \Delta s_1}{\max \Delta a_1} \quad (2.22)$$

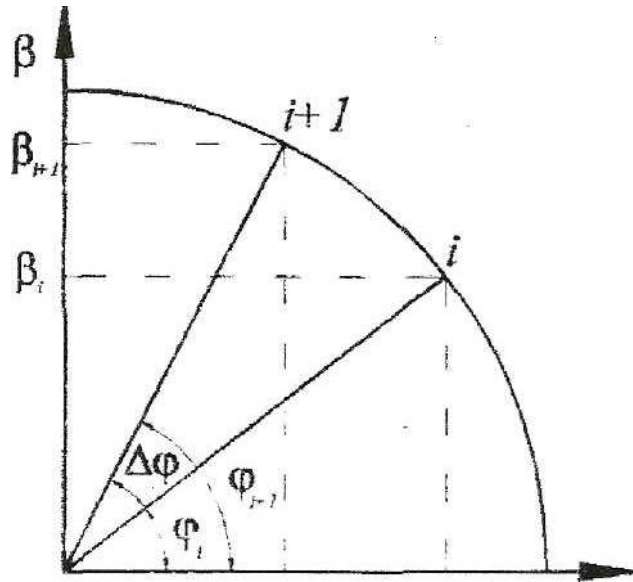
$v_{i0}, v_i$  — ;  $s_i$  — ;  $n$  — (n=2);  $a_i$  —

[3]:

$$\Delta s_i = \frac{(V_i + V_{i+1})(V_i - V_{i+1})}{2} \quad (2.23)$$

<b>1</b>				
2	-		-	
3	-	-	-	-
4		-		-

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+1

+1,

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$$+1 = + t \tag{2.24}$$

—

+1 +1 ( .2.6):

$$+1 = R \cos +1 \tag{2.26}$$

$$+1 = R \sin +1 \tag{2.27}$$

, +1 = + , = ( + +1) t/2, :

$$a_{i+1} = R \cos \{ \cos \Delta \{ - \sin \{ \sin \Delta \{ \tag{2.28}$$

$$S_{i+1} = R \sin \{ \cos \Delta \{ - \cos \{ \sin \Delta \{ \tag{2.29}$$

:

$$\cos i \ 1-0,5 \ i^2 \quad \sin i \ i$$

$$R \cos i = a_i; R \sin j = i, \quad :$$

$$a_{i+1} = a_i (1-0,5 \ i^2) - i \ i \tag{2.30}$$

$$i_{+1} = i (1-0,5 \ i^2) - i \ i \tag{2.31}$$

t:

$$v_{ai+1} = -\frac{S_i \Delta \{ \dot{\ }_i + 0,5 a_i \Delta \{ \dot{\ }_i^2}{\Delta t} \quad (2.32)$$

$$v_{Si+1} = -\frac{a_i \Delta \{ \dot{\ }_i + 0,5 S_i \Delta \{ \dot{\ }_i^2}{\Delta t} \quad (2.33)$$

,

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, a

$$a_{k,k} = R \cos \{ \dot{\ }_{k,k}$$

$$S_{k,k} = R \sin \{ \dot{\ }_{k,k}$$

0, , . ,

:

$$= \frac{v}{R} \quad (2.35)$$

$$0 = \frac{v_0}{R} \quad (2.36)$$

$$= \frac{v}{R} \quad (2.37)$$

$$.. = \frac{v}{R} \quad (2.38)$$

$$= \frac{r}{R} \quad (2.39)$$

## 2.2.

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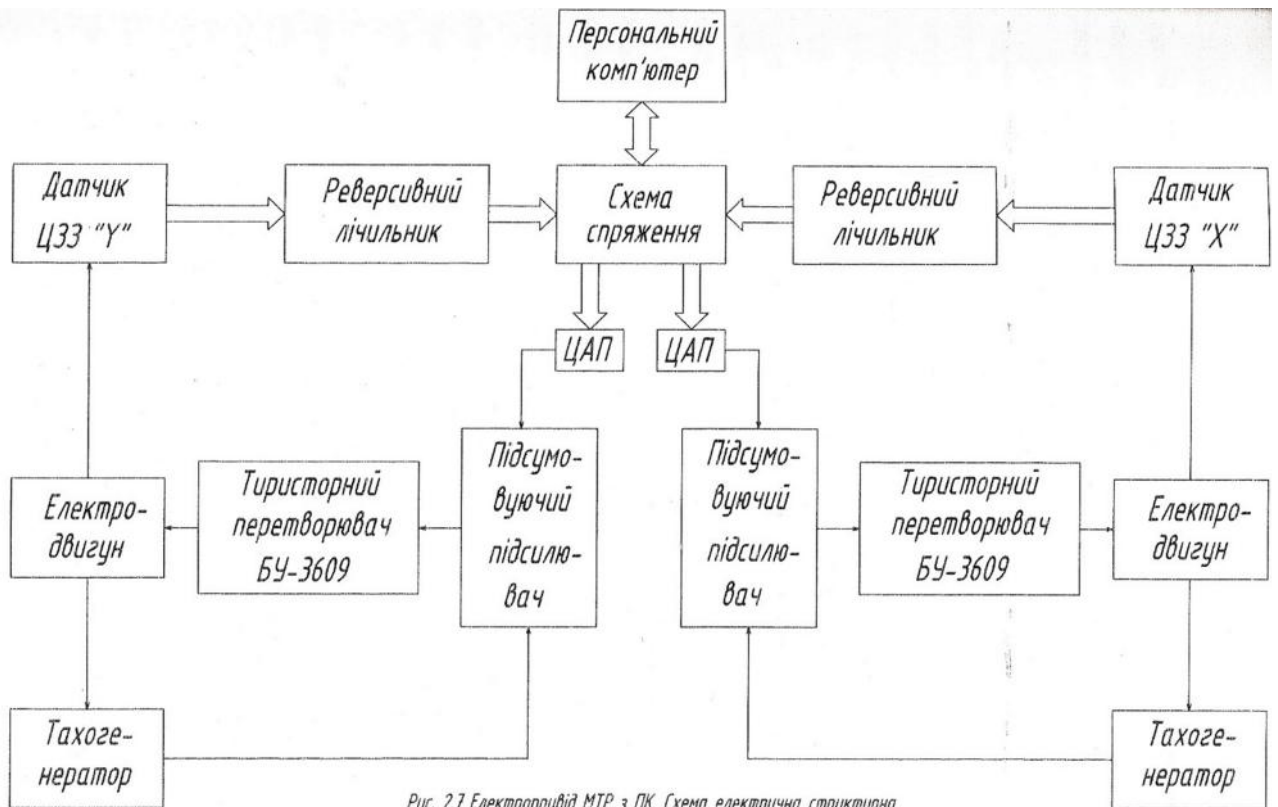


Рис. 2.7 Електропривід МТР з ПК. Схема електрична структурна

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**.1.**  
**3.1.1.**

- PCI - Peripheral Component Interconnect;
- LPT - Line PrinTer;
- RS-232C (COM - Communications Port).

: ISA (Idustrial Standard Architecture), EISA (Extended ISA), VESA (Video Electronics Standards Association), USB (Universal Serial Bus), FireWire, SCSI (Small Computer Interface)

. [ ,4] PCI

3.1.

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	PC	LPT	RS-232C
	( 132 / )	( 2 / )	

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**3.1.2.**

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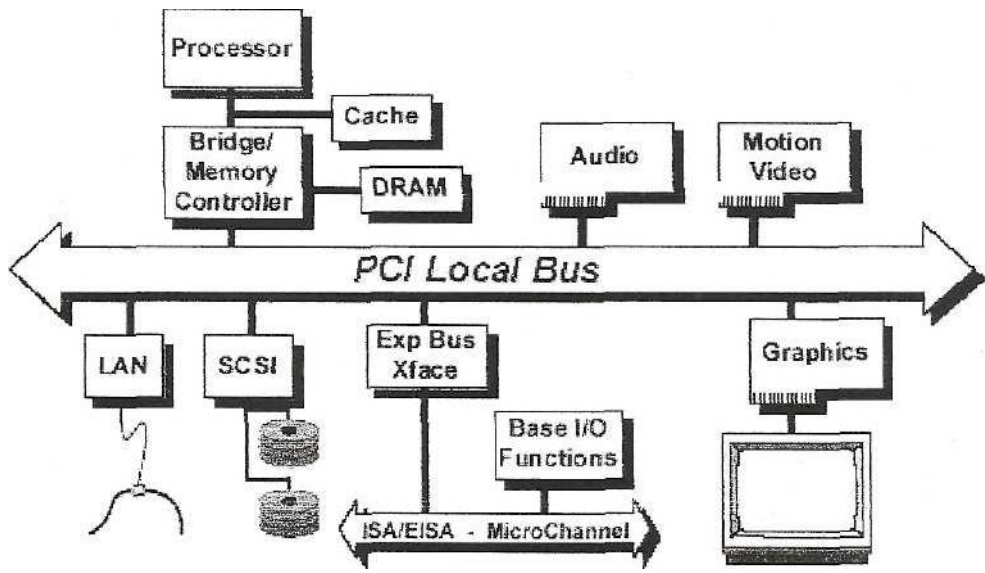
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PC

PC ( , ).



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Micro Channel (MC).

ISA-, EISA-

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3,3 -

ISA/EISA -

ISA/EISA

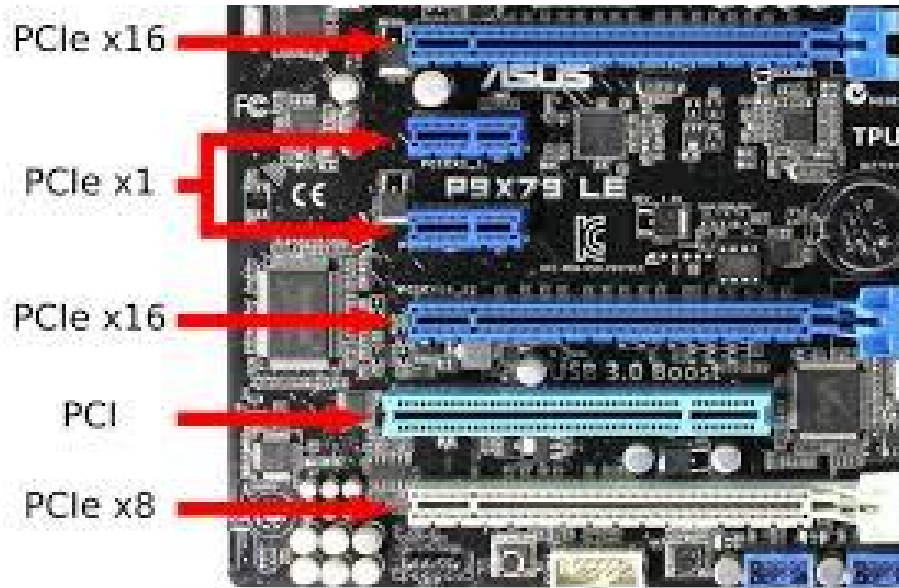
ISA/EISA -

5 3,3

« »

3

: «5 volt» (5 ),  
 5 ; « » , 5 -, 3,3 , - ' ;  
 «3,3 volt» (3,3 ), 3,3 ( .3.2).



, : ISA/EISA -  
 - ,  
 « »  
 - , ISA, EISA .  
 ( )  
 - , .  
 . [4]

### 3.1.3.

, .  
 , « »  
 « / » ,  
 :

:  
 - « » 32- (132 / ) 64-  
 (264 / );  
 - , ,  
 , ;  
 - ( 64  
 « » « » );  
 - / ' ;  
 - 33 ;  
 - ( ) . :  
 - « » ' ,  
 « , ».. ,  
 ( , )  
 ASIC - ;  
 - (47 -  
 ,49 - ) -  
 ;  
 - ISA-, EISA- - ( )  
 « » ),  
 .  
 :  
 - PCI. PC! - ,  
 , .  
 :  
 - . ,  
 ( - « » )  
 );  
 - 64- ;  
 - 5 , 3,3 ;

3,3

- .

- / :

- ;

- ,

- ,

- ;

- 2000 PSPICE

- ;

- 32 - 64 -

- ;

- , « , »;

- — , .

- - « » - ,

- « »/ ;

- ISA, EISA ,

- .

- :

- PC , ,

- .

- :

- -

- . [4]

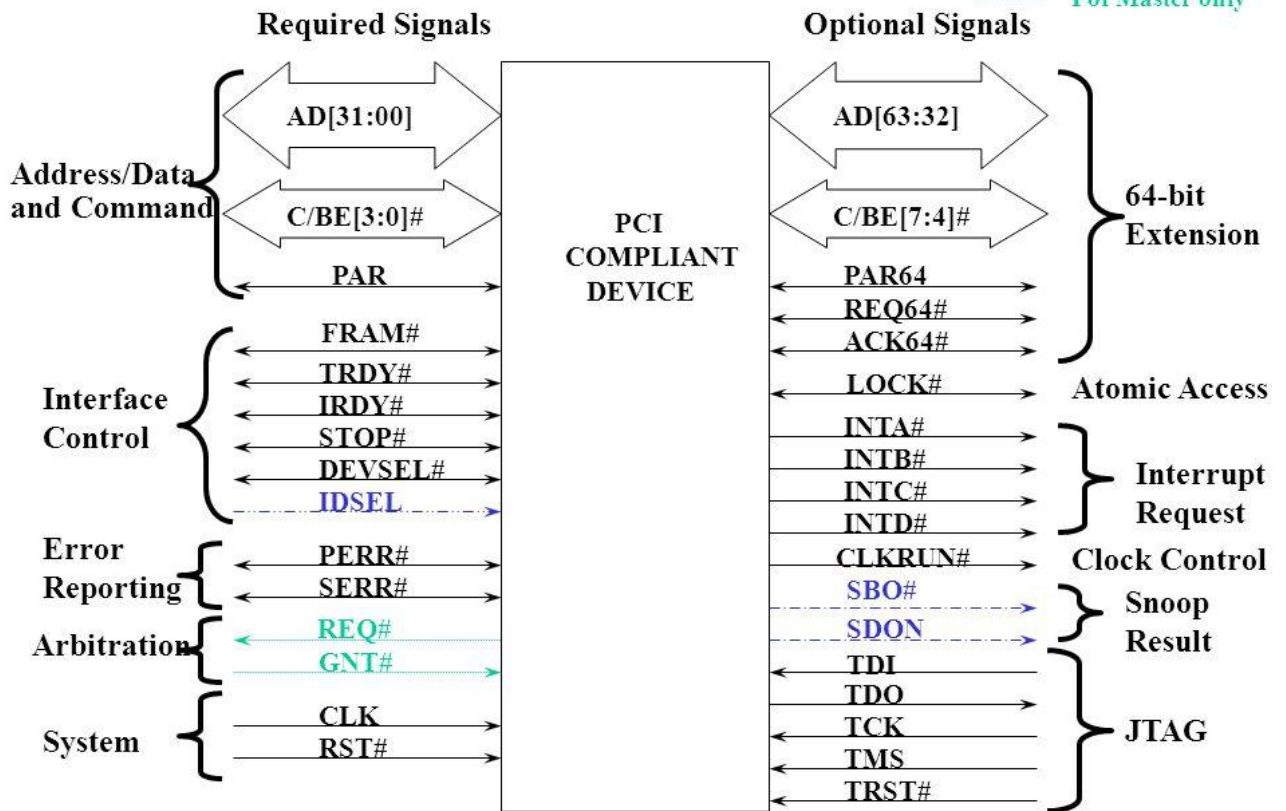
3.1.4.



" - 47.

### PCI-Compliant Device Signals

----- For Slave only  
----- For Master only



. 3.3

PCI

1) Input- Totem Pole  
 Output- Tri-State -  
 Sustained Tri-State -

s/t/s,

« »

s/t/s, « »

. *Open Drain* - -

2) « ».

# . 3.2

) CLK

Clock

1RQB#, iRQC# i 1RQD#, CLK, RST#, IRQ#,

33 MHz,

0 . RST#

Reset

RST# -

RST#,

SERR# ( ).

SBO# SDONE<sup>2</sup>

REQ# GNT#

(

). AD, / # PAR

, -  
 . REQ64# .  
 SDONE SBO# ,  
 FRAME# .  
 RST#  
 CLK. ,  
 « » ,  
 ( ) . , ,  
 « » ,  
 ) AD[31::00]t/s  
 3,  
 ,  
 - , FRAME#.  
 AD[31::00] (32 ) . -  
 - , -  
 (DWORD). , AD[07::00]  
 (isb), AD[31::24] (Isb).  
 « » , !RDY#, « »  
 , TRDY#.  
 IRDY# TRDY#. C/BE[3::0]t/s  
*Bus Command Byte Enables* (« »)  
 , / [3::0]# .  
 / [3::0]# *Byte Enable. Byte Enable*  
 , . / [0]#  
 0 (Isb), a C/BE [3]# 3 (msb)  
 64 - .  
 PAR t/s

Parity – 4 AD[31::00] / [3::0]#.

PAR

PAR

IRDY# -

, TRDY# -

PAR,

. (PAR

, AD[31::00],

). « »

PAR

;

PAR

)

FRAME# s/t/s

*Cycle Frame* (

)

« »

. FRAME#

,

.

FRAME#

,

.

FRAME#

,

RDY# s/t/s

*Initiator Ready* (

)

(« » )

. IRDY#

TRDY#.

-

,

IRDY# TRDY#.

RDY#

,

AD[31::00]

.

,

.

,

IRDY# TRDY#.

AD[31::00], C/BE[3::0]# PAR '

"1",

.

TRDY# s/t/s

*Target Ready* (

)

( )

.

TRDY#

IRDY#.

-

,

TRDY# IRDY# TRDY# ,  
 AD[31::00] .  
 : .  
 , IRDY# TRDY#.  
 STOP# s/t/s  
*Stop* , « »  
 .  
 LOCK# s/t/s  
*Lock* ,  
 . L #  
 , .  
 L #. LOCK#  
 GNT# ,  
 LOCK#,  
 . ' (Executable  
 Memory), LOCK#  
 , . ,  
 LOCK#, 16 ( )  
 ). ,  
 ' , L #.  
 IDSEL  
*Initialization Device Select*, ( )  
 .  
 DEVSEL# s/t/s  
*Device Select* ( ) ,  
 , , , .  
 DEVSEL# , .  
 ) .  
 5 :  
 PERR s/t/s

*Parity Error ( )*

(Special Cycle). PERR# -

PERR# -

(

PERR#

). PERR#

DEVSEL#

PERR#,

SERR# o/d

*System Error*

Special Cycle ( ), -

(NMI),

SERR#

SERR#

« »

SERR

(

),

SERR#.

SERR#,

SERR#.

3)

*{sideband}*.

4)

( ):

- ;

- ;

- , .

, , ,

;

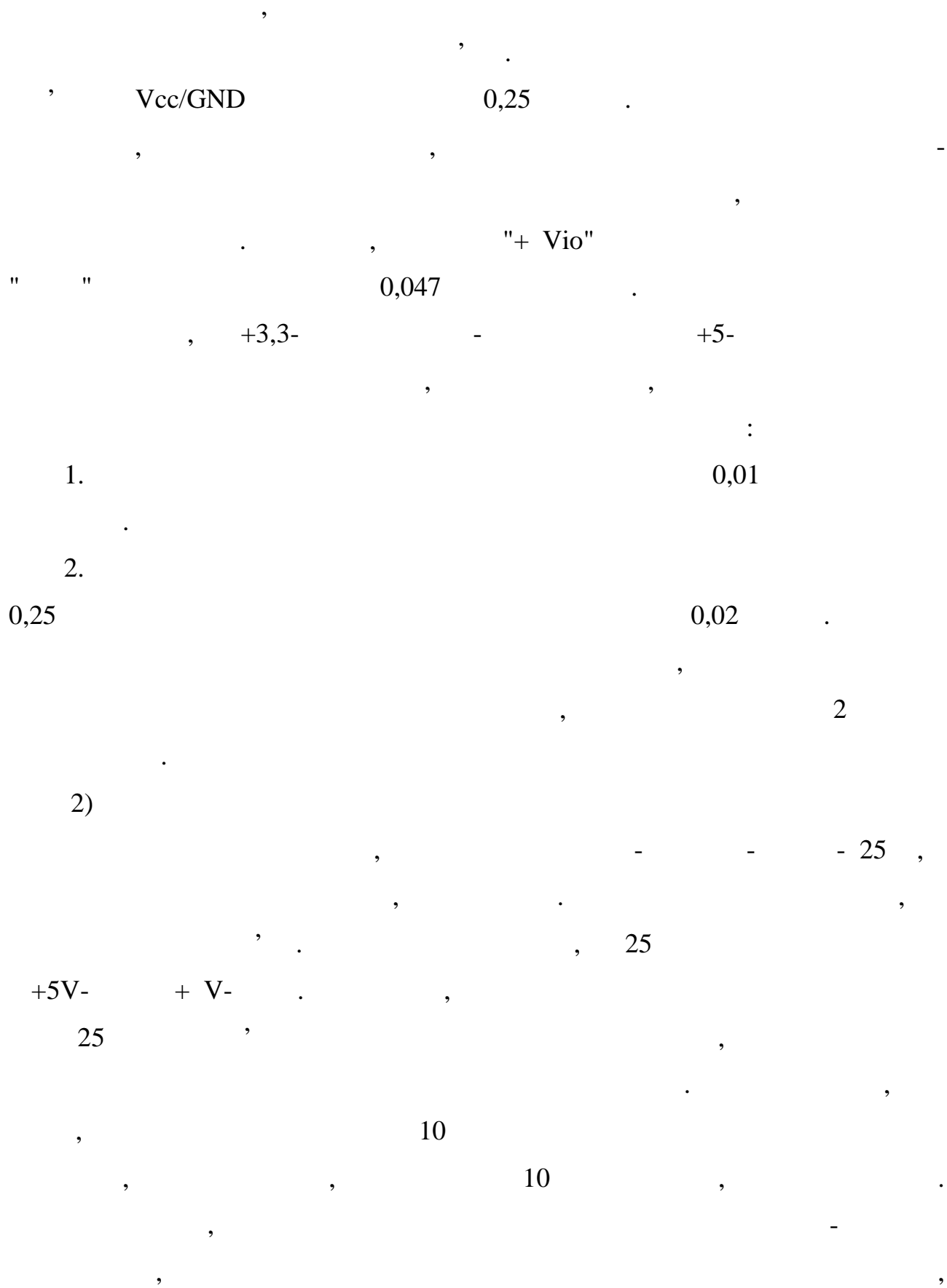
- IDSEL

;

- REQ64# . [4]

### 3.1.5.

1)





1.

2.

FET,

. [5]

### 3.1.6

C++.

. [6]

$$n_x = \log \frac{x_{\max}}{c} \quad (3.1)$$

$x_{\max} = 8000$  ;  
 $c = 0,025$  / ).

$$n_x = \log_2 \frac{8000}{0,025} = 18,288$$

19

4-

1533 7.

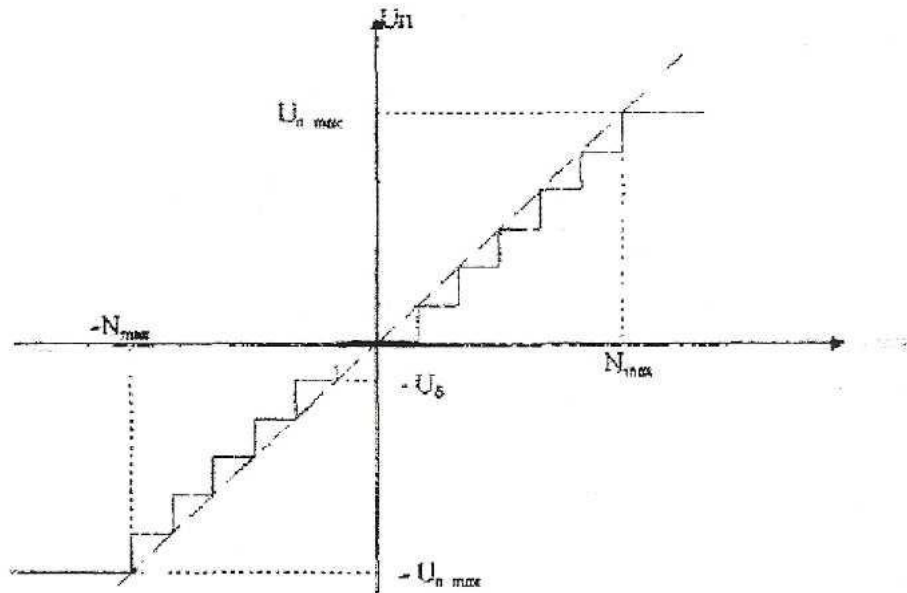
20-

162 1 [7].

**3.2.**

$U_n$

. 3.4.



. 3.4

( )  $U_s$

( $N_v=1$ )

$U_{3p}$

$U_{n.max}$

$$n_x = \log_2 \frac{U_{n.max}}{U_u} \quad (3.2)$$

$$n_x = \log_2 \frac{12}{0,003} = 11,966 \approx 12$$

12-

572 2.

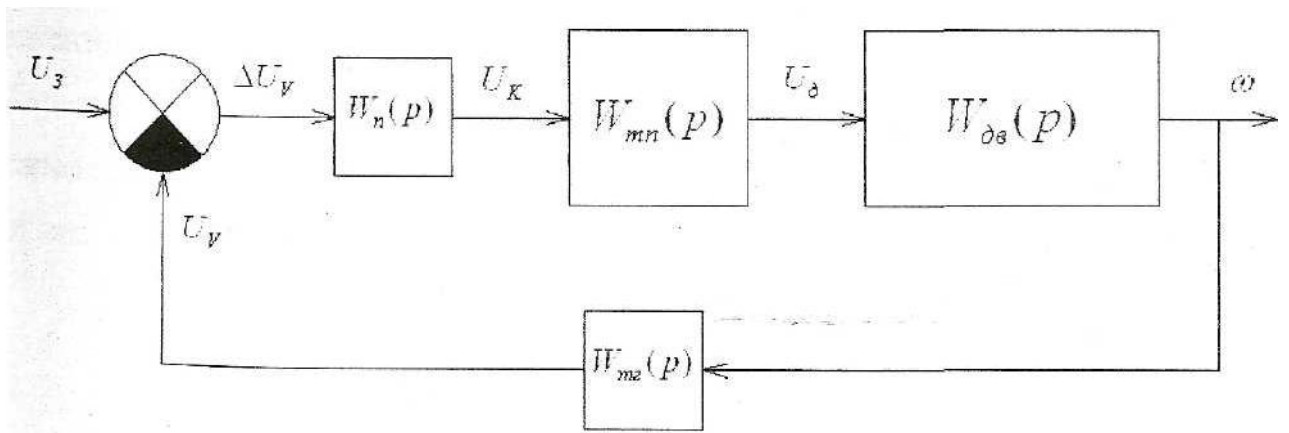
-

,

.

4.

4.1



. 4.1

. 4.1.

:  
 -  $W ( )$ ;  
 -  $W_{mn}(p)$ ;  
 - ,  
 -  $W_n (p)$ ;  
 - ( )  $W ( )$

## 4.2.

,  
,  
,  $J_{iH}$   
( ).  
, ( )  
-  
( , .)

### 4.2.1.

( .4.3)

$$i = \frac{Z_{31}}{Z_{32}} \cdot \frac{Z_{27}}{Z_{28}} \cdot \frac{Z_{24}}{Z_{26}} \quad (4.1)$$

Z, - ;

$$i = \frac{42}{16} \cdot \frac{56}{14} \cdot \frac{96}{24} = 42$$

### 4.2.2.

$$d_{22} = m_{s22} \cdot Z_{22}$$

$m_{s22} = 3,0012$  (ms22=3,0012);  
 $Z_{22} = 14$  (Z22=14);  
 $d_{22} = 3,0012 \cdot 14 = 42,0168$

### 4.2.3.

$$J = (69 \cdot 10^{-6} \cdot \dots^2)$$

$$J = J + mp^2 \quad (4.3)$$

$$p = \frac{d_{22}}{2 \cdot i} \quad (4.3)$$

$$d_{22} = \dots \quad ( \dots 22);$$

$$p = \frac{42,0168 \cdot 10^{-3}}{2 \cdot 42} = 5,002 \cdot 10^{-4}$$

$$J = 1,2 \cdot 5 \cdot 69 \cdot 10^{-6} + 1600 \cdot (5,002 \cdot 10^{-4})^2 = 8,143 \cdot 10^{-4} \cdot \dots^2$$

#### 4.2.4.

$$M_c = \frac{m_n \cdot g \cdot (\dots \cdot r + f)}{i \cdot y} \quad (4.5)$$

$$M_c = \frac{1600 \cdot 9,81 \cdot (0,07 \cdot 0,027 + 0,52 \cdot 10^{-3})}{42 \cdot 0,75} = 1,2 \text{ H} \cdot$$

#### 4.2.5.

$$0,2 \text{ / } ^2. \\ = +J. \quad (4.6)$$

j— — ;  
— — ;

$$v = \frac{a}{p} \quad (4.7)$$

( =0,2 / ^2);

$$v = \frac{0,2}{5,002 \cdot 10^{-4}} = 399,84 \text{ / } ^2$$

$$n = 1,2 + 8,143 - 399,84 = 1,526 \text{ .}$$

#### 4.2.6.

$$P = M_e \cdot \check{S} \quad (4.8)$$

(4.9);

(4.10).

$$M_e = \sqrt{\frac{M_c^2 + M_n^2}{2}} \quad (4.9)$$

$$\check{S} = \frac{v}{p} \quad (4.10)$$

v=0,1 /



=5,0

$$M_e = \sqrt{\frac{1,2^2 + 1,536^2}{2}} = 1,373 \cdot$$

$$\tilde{S} = \frac{0,1}{5,002 \cdot 10^{-4}} = 199,92 \quad /$$

=1,373 · 199,92 = 274,479

369,

4.1,

4.1

-369

,	55
,	110
,	0,8
, /	3600
,	25
,	0,13
, <sup>2</sup>	69 · 10 <sup>-6</sup>

:

$$M = \frac{55}{\tilde{S}} \tag{4.11}$$

— , ;

— , / ;

$$M = \frac{55 \cdot 5}{199,92} = 1,375 \cdot$$

1,8

:

$$M_{\max} = 1,8 \cdot M \tag{4.12}$$

$$M_{\max} = 1,8 \cdot 1,375 = 2,476 \cdot$$

( ,= 1,526 ).

### 4.3

#### 4.3.1.

$$W_m(p) = \frac{k_m}{T_m p+1} \tag{4.31}$$

$k_{mn}$  — (k<sub>mn</sub>=5);  
 $T_{mn}$  — , :

$$T_{mn} = \frac{1}{2mf} \tag{4.32}$$

$m$  — , (m=1);  
 $f$  — (f=50 )

$$T_{mn} = \frac{1}{2 \cdot 1 \cdot 50} = 0,01$$

$$W_{mn}(p) = \frac{5}{0,01p+1}$$

#### 4.3.2

- 1) , ;
- 2) ;
- 3) , ;
- 4) ;
- 5) U —
- 6) ( =const);
- 7) .

$$M = J \frac{d\Omega}{dt} + M_c \quad (4.15)$$

$$du - \quad ; \quad (4.5).$$

$$M = c_m I \quad (4.16)$$

$$= \frac{pN}{2fa} \quad (4.17)$$

$$= \frac{2 \cdot 1000}{2 \cdot f \cdot 2} = 159,155$$

$$= \frac{U - R_z \cdot I}{\cdot n} \quad (4.18)$$

$$= \frac{110 - 25 \cdot 068}{16,667 \cdot 3600} = 1,5 \cdot 10^{-3}$$

$$J \frac{d\Omega}{dt} = c_m I - \quad (4.19)$$

$$U = R + L \frac{dI}{dt} + c_e \Omega \quad (4.20)$$

R -  
L -

$$e = \frac{pN}{60a} \quad (4.21)$$

$$e = \frac{2 \cdot 1000}{60 \cdot 2} = 16,667$$

I (4.19) (4.20) :

$$J \frac{R}{2} \cdot \frac{L \cdot d^2\Omega}{R \cdot dt^2} + J \frac{R}{2} \cdot \frac{d\Omega}{dt} + \Omega = \frac{U}{2} - \frac{R}{2} \quad (4.22)$$

:

$$J \frac{R}{2} = \quad (4.23)$$

$$= 8,143 \cdot \frac{25}{16,667 \cdot 159,155 \cdot (1,5 \cdot 10^{-3})^2} = 3,411$$

$$\frac{L}{R_z} = T \quad (4.24)$$

$$= \frac{0,13}{25} = 5,2 \cdot 10^{-3}$$

$$= \frac{n}{U - R} \quad (4.25)$$

$$= \frac{3600}{110 - 0,8 \cdot 25} 40 \frac{1}{\dots}$$

$$\frac{R}{2} = \quad (4.26)$$

$$= \frac{25}{16,667 \cdot 159,155 \cdot (1,5 \cdot 10^{-3})^2} = 4,189 \cdot 10^3$$

(4.21), :

$$\frac{d^2\Omega}{dt^2} + \frac{d\Omega}{dt} + \Omega = U - \quad (4.27)$$

:

$$(s^2 + 3411s + 1)\Omega(s) = U(s) - W(s) \quad (4.28)$$

:

$$\frac{\Omega(s)}{U(s)} = \frac{-369}{s^2 + 3411s + 1} \quad (4.29)$$

:

$$W(s) = \frac{40}{3,411 \cdot 5,2 \cdot 10^{-3} s^2 + 3,411 s + 1} = \frac{40}{0,018 s^2 + 3,411 s + 1}$$

### 4.3.3

:

$$W_n(p) = k_n \quad (4.30)$$

n-

(n=8).

$$W_n(p) = 8 \quad (4.31)$$

### 4.3.4

.

( ) :

$$W(s) = \frac{U}{n} \quad (4.33)$$

U - (U = 110 );

n - (n = 3600 / ).

$$W(s) = \frac{110}{3600} = 0,031$$

### 4.3.5.

.

:

$$W_p(p) = W_n(p) \cdot W_m(p) \cdot W(s) \cdot W(s) \quad (4.34)$$

:

$$W_3(s) = \frac{W_p(p)}{1 + W_p(p)} \quad (4.35)$$

(4.34)

,

:

$$W_p(p) = \frac{k \cdot k_{mn} \cdot k \cdot k}{(T_{mn} + 1)(T_m^2 + T_m + 1)} =$$

$$= \frac{k_p}{T_{mn} T_m^3 + T_m^2 + T_{mn} T_m p^2 + T_m p + T_{mn} p + 1}$$

$$W_p(p) = \frac{k_p}{T_{mn} T_m^3 + (T_m + T_{mn}) p^2 + (T_m + T_{mn}) p + 1} \quad (4.36)$$

(4.35)

:

$$W_3(p) = \frac{k_p}{T_{mn} T_m^3 + T_m (T_m + T_{mn}) p^2 + (T_m + T_{mn}) p + 1} =$$

$$1 + \frac{k_p}{T_{mn} T_m^3 + T_m (T_m + T_{mn}) p^2 + (T_m + T_{mn}) p + 1}$$

$$= \frac{k_p}{T_{mn} T_m^3 + T_m (T_m + T_{mn}) p^2 + (T_m + T_{mn}) p + 1}$$

$$= \frac{T_{mn} T_m^3 + T_m (T_m + T_{mn}) p^2 + (T_m + T_{mn}) p + 1}{T_{mn} T_m^3 + T_m (T_m + T_{mn}) p^2 + (T_m + T_{mn}) p + 1 + k_p}$$

$$= \frac{k_p}{T_{mn} T_m^3 + T_m (T_m + T_{mn}) p^2 + (T_m + T_{mn}) p + 1} \quad (4.37)$$

:

$$W_p(p) = \frac{5 \cdot 8 \cdot 40 \cdot 0,031}{0,01 \cdot 5,2 \cdot 10^{-3} \cdot 3,411 \cdot p^3 + 3,411 \cdot (5,2 + 10^{-3} + 0,01) p^2 + (3,411 + 0,01) p + 1}$$

$$W_3(p) = \frac{48,889}{1,774 \cdot 10^{-4} p^3 + 0,052 \cdot p^2 + 3,421 p + 1} \quad (4.38)$$

[10].

:

$$a_0 p^3 + a_1 p^2 + a_2 p + a_3 = 0 \quad (4.39)$$

$$a_0 = T_{mn} \cdot T \cdot T ;$$

$$a_1 = (T_{mn} + T) ;$$

$$a^2 = T + m_n;$$

$$a^3 = k_p + 1$$

$$a_0 = 0,01 \cdot 5,2 \cdot 10^{-3} \cdot 3,411 = 1,774 \cdot 10^{-4} > 0;$$

$$a_1 = 3,411 \cdot (0,01 + 5,2 \cdot 10^{-3}) = 0,052 > 0;$$

$$a^2 = 0,01 + 3,411 = 3,421 > 0; a^3 = 48,889 + 1 = 49,889 > 0$$

$$= \begin{vmatrix} a_1 & a_3 & 0 \\ a_0 & a_2 & 0 \\ 0 & a_1 & a_3 \end{vmatrix}; \quad (4.41)$$

$$\Delta_3 = \begin{vmatrix} 1 & 3 & 0 \\ 0 & 2 & 0 \\ 0 & 1 & 3 \end{vmatrix}; \quad (4.42)$$

$$\begin{aligned} \Delta_3 &= 1 \cdot \begin{vmatrix} 2 & 0 \\ 1 & 3 \end{vmatrix} - 3 \cdot \begin{vmatrix} 0 & 0 \\ 0 & 3 \end{vmatrix} + 0 \cdot \begin{vmatrix} 0 & 2 \\ 0 & 1 \end{vmatrix} = \\ &= 1 \cdot (2 \cdot 3 - 1 \cdot 0) - 3 \cdot (0 \cdot 3 - 0 \cdot 0) + 0; \end{aligned}$$

$$\Delta_2 = \begin{vmatrix} 1 & 3 \\ 0 & 2 \end{vmatrix}; \quad (4.43)$$

$$\Delta_1 = 1 \quad \Delta_2 = 1 \cdot (2 \cdot 3 - 1 \cdot 0);$$

(4.44)

$$\Delta_3 = 0,052 \cdot (3,421 + 49,889 - 0) - 49,889 \cdot (1,774 \cdot 10^{-4} \cdot 49,889 - 0) + 0 = 8,407 > 0;$$

$$\Delta_2 = 0,052 \cdot (3,421 + 49,889 - 0) = 0,169 > 0;$$

$$\Delta_1 = 0,052 > 0.$$

$$L_{(s)} = 20 \cdot \log(|W_p(j \cdot \check{S})|) \quad (4.40)$$

$$\angle ( \check{S} ) = \arg(W_p(j \cdot \check{S})) \quad (4.41)$$

Mathcad.

3

100=80°,

L=-25 .

4.2

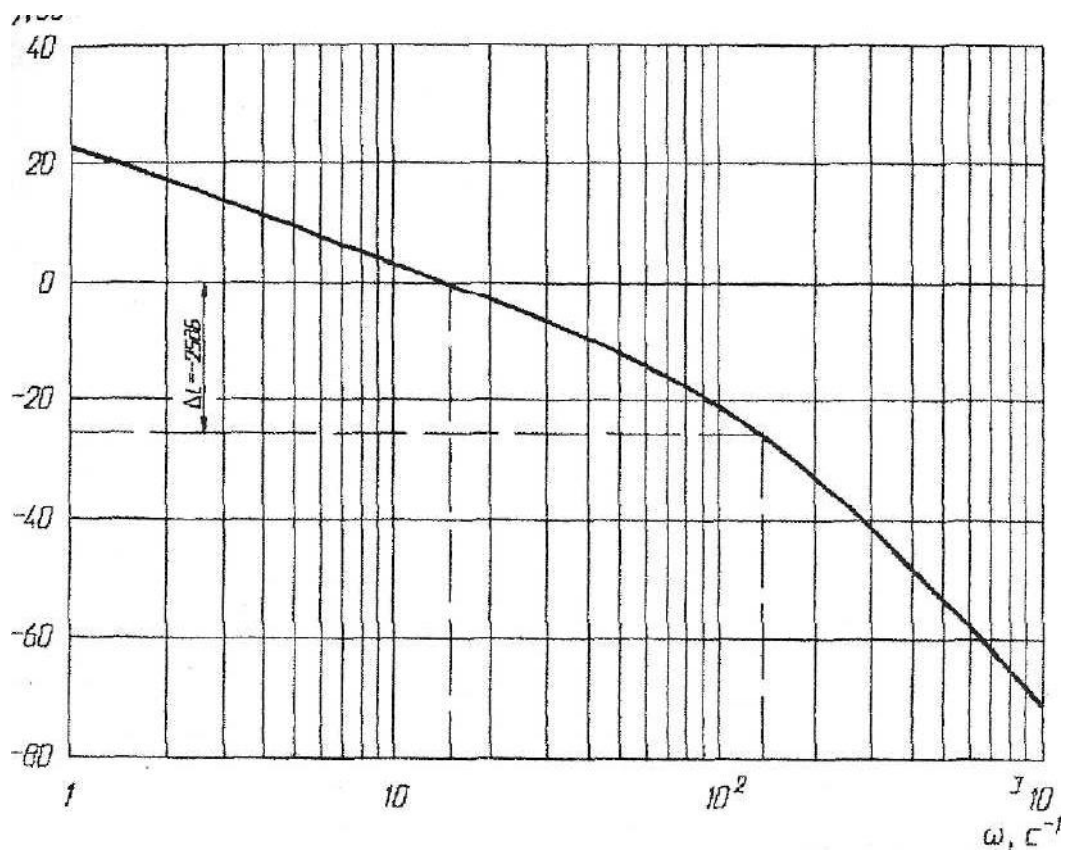
y=180°-

4.2

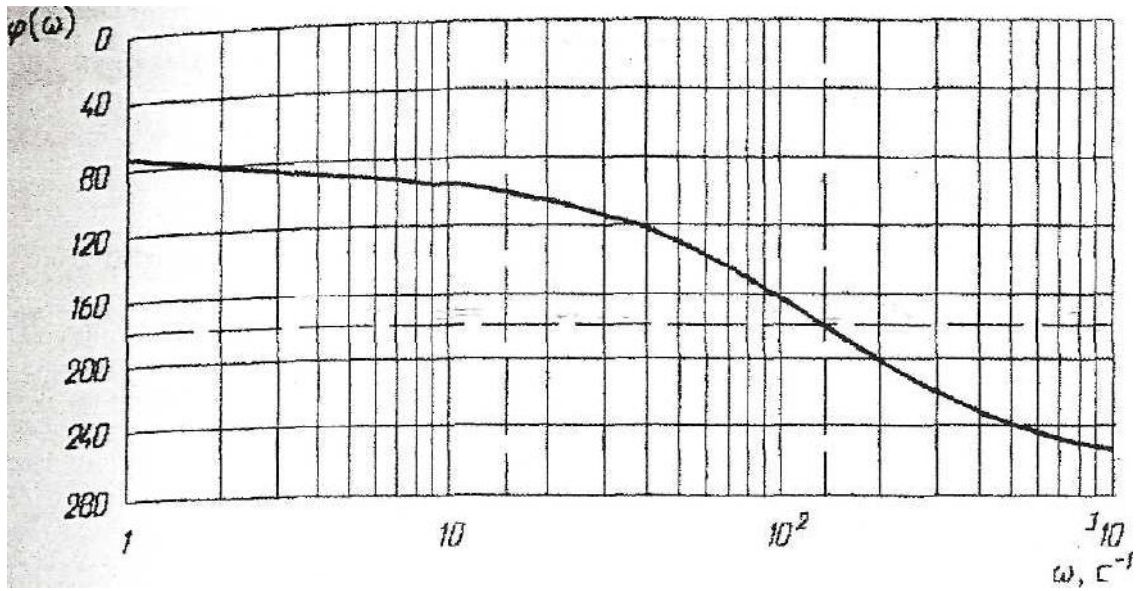
	L	( )
1	22,7803059	-74,5078601
2	17,0245948	-83,3905043
3	13,5512177	-87,0234778
4	11,0666485	-89,2856976
5	9,1318756	-90,9932207
6	7,54675629	-92,4217487
7	6,20342268	-93,6900723
8	5,0312989	-94,857712
9	4,00597741	-95,957742
10	3,08129487	-97,0099818
20	-3,098718	-106,415254
30	-6,8818317	-115,018502
40	-9,7304926	-123,148283
50	-12,093563	-130,824139
60	-14,1631105	-138,036199



70	-16,035807	-144,781349
80	-17,7654301	-151,067891
90	-19,3841778	-156,913508
100	-20,912556	-522,342049
200	-33,0611688	-199,517874
300	-41,7693226	-218,887824
400	-48,480798	-230,279054
500	-53,8993018	-237,648226
600	-58,4248439	-242,763749
700	-62,3020158	-246,506597
800	-65,6893071	-249,357268
900	-68,694478	-251,597684
1000	-71,3937791	-253,403281



.4.4



. 4.5

1(t)

[11]:

$$h(t) = \frac{F_1(0)}{F_2(0)} + \sum_{n=1}^k \frac{F_1(p_k)}{p_k \cdot F};$$

$$\frac{F_1(0)}{F_2(0)} = W_3(p);$$

$p_k$  -

$$F_2(p) = 0.$$

$$F_1(p) = 48,889;$$

$$F_1(p) = 1,774 \cdot 10^{-4} p^3 + 0,052 p^2 + 3,421 p + 49,889.$$

:

$$p_1 = -204,863;$$

$$p_2 = -66,931;$$

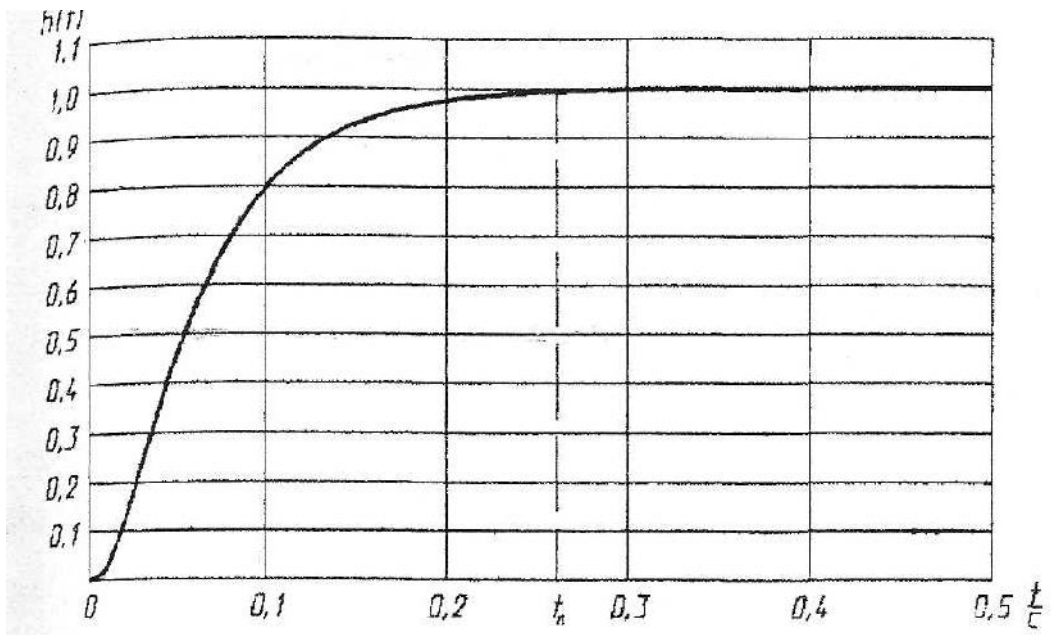
$$p_3 = -20,513.$$

Mathcad.

4.3.

4.3

t	h(t)	t	h(t)
0,1	0,023943	0,26	0,992220
0,02	0,108068	0,27	0,993654
0,03	0,222038	0,28	0,994823
0,04	0,339735	0,29	0,995774
0,05	0,448540	0,30	0,996550
0,06	0,543818	0,31	0,997181
0,07	0,624835	0,32	0,997695
0,08	0,692572	0,33	0,998114
0,09	0,748641	0,34	0,998456
0,10	0,794169	0,35	0,998154
0,11	0,832577	0,36	0,998247
0,12	0,863493	0,37	0,999145
0,13	0,888736	0,38	0,999295
0,14	0,909330	0,39	0,999417
0,15	0,926120	0,40	0,999517
0,16	0,939805	0,41	0,999598
0,17	0,950956	0,42	0,999664
0,18	0,960041	0,43	0,999718
0,19	0,967442	0,44	0,999762
0,20	0,973471	0,45	0,999798
0,21	0,978383	0,46	0,999827
0,22	0,982384	0,47	0,999850
0,23	0,985642	0,48	0,999870
0,24	0,988296	0,49	0,999885
0,25	0,990458	0,50	0,999898



. 4.6

0,26 .

5.

5.1

5.1.1.

5.1.

5.1

556	4	DD1	2	122,00
1533	7	DD2,DD3	4	50,00
1533	7	DD4-DD8	8	60,50
1533	5	DD9-DD11	6	45,50
1533	37	DD12-DD13	4	35,50
531	1	DD14	2	46,00
572	2	DA1	2	32,50
162	1	DA2	2	22,50
140	7	BA3	2	34,00
293	1	DA4-DA19	30	28,00
-0,125-1		R1-R3	6	2,00
- 0,5-1		R4-R33	60	2,00
2.087.096		UG1	1	140,50
15-15		X3	1	45,00
15-15		X3,,X4	2	45,00
		-	1	28720
				31580,5

### 5.1.2.

$$S = \sum_{i=1}^m C_{ti} \cdot (1+H) \quad (5.1)$$

1,3;

1,25;

...

...

...

0,22;

m-

$$S_{3i} = 1,3 \cdot 1,25 \cdot 40 \cdot 35,2 \cdot 2 \cdot (1 + 0,22) = 48\,526,72$$

### 5.1.3.

$$= + \quad (5.2)$$

$$= 31580,5 + 48\,526,72 = 80\,107,22$$

$$= \frac{1}{t \cdot (1+H)^t} \quad (5.3)$$

0,256 ;

0,8;

- , 2;  
 - ,  
 - .  
 -  
 ,  
 :  

$$= \frac{\sum_{i=1}^n d_{pi} \cdot a_i}{n} \quad (5.4)$$

n -  
 , 1;  
 d - , 1,5  
 .;  
 , - ,  
 12;  
 - .  
 12000 .,  
 20000 .  
 4,2 .  
 1 .  
 :  
 - :

$$= \frac{1 \cdot 4,2 \cdot 12}{1200} = 0,0042$$

$$= \frac{256}{\frac{1}{8 \cdot 2} + 0,0042} = 3838,08$$

- :

$$= \frac{1 \cdot 1 \cdot 12}{20000} = 0,0006 \quad -$$

$$= \frac{256}{\frac{1}{8 \cdot 2} + 0,0006} = 4057,05$$

:

$$= \dots \dots (5.5)$$

- , 4 ./ .;

- , ,

, 0,95.

,

:

-

:

$$= 4 \cdot 3838,08 \cdot 0,95 = 14584,71 \quad ./$$

-

:

$$= 4 \cdot 4057,05 \cdot 0,95 = 15416,8 \quad ./$$

#### 5.1.4.

.

,

(5.1).

, ,

4-

:

-

:

$$S = 1,3 \cdot 1,25 \cdot 3838,08 \cdot 35,2 \cdot 2 \cdot (1 + 0,22) = 535\,673,14 \quad .$$

-

:

$$S' = 1,3 \cdot 1,25 \cdot 4057,05 \cdot 35,2 \cdot 1 \cdot (1 + 0,22) = 283\,117,2 \quad .$$

#### 5.1.2.

.

:

$$S_{\dots} = S_{\dots} + S_{\dots} \quad (5.6)$$



$S_{1,0} = \dots$  ;  
 $S_{1,1} = \dots$  .

:

$$S_{1,0} = \dots \cdot \sum_{i=1}^n r_i \cdot (1+H) \quad (5.7)$$

- , / ;  
 - ;  
 $r_i = \dots$  , - .

:

$$S_{1,0} = \dots \cdot \frac{S \cdot (1-H)}{1,3} \quad (5.8)$$

- , ;  
 - ;  
 .  
 :  
 - :

$$S_{1,0} = \frac{3,0}{1} \cdot 1,3 \cdot 1,25 \cdot 35,2 \cdot (4 \cdot 12) \cdot (1 + 0,22) = 1\,071,34$$

$$S_{1,1} = 1,1 \cdot \frac{1,3 \cdot (1-0,2)}{1,3} \cdot 1,25 = 883,86$$

$$S_{T,0} = 1071,34 + 883,86 = 1\,955,2$$

$$S'_{1,0} = \frac{4,0}{2} \cdot 1,3 \cdot 1,25 \cdot 35,2 \cdot (1 \cdot 12) \cdot (1 + 0,22) = 169,7$$

$$S'_{1,1} = 1,1 \cdot \frac{1,7 \cdot (1-0,2)}{1,3} \cdot 1,25 = 140,0$$

$$S'_{T,0} = 140,0 + 169,7 = 309,7$$

**5.1.5.**

$$S = \cdot W \cdot \cdot \quad (5.9)$$

WE - 1 / . , . ;  
 , / .  
 6,5 / .,  
 — 5,5 / .

$$S = 1,1 \cdot 6,5 \cdot 5,5 \cdot 3838,08 = 150\,932,5$$

$$S' = 1,1 \cdot 5,5 \cdot 5,5 \cdot 4057,05 = 134\,998,3$$

**5.1.6.**

.5.2

5.2

	, .	, %	,	, %
	535 673,1	77,8	283 117,2	67,7
	1 955,2	0,2	309,7	0,1

	150 932,5	18,0	134 998,3	24,4
	688 560,8	100	418 424,0	100

-

:

$$S = \frac{S}{100} \quad (5.10)$$

-

:

$$S = \frac{688\,560,8}{100} = 6885,608$$

-

:

$$S' = \frac{418\,424,0}{100} = 4184,24$$

## 5.2.

:

$$S_I = \frac{S}{100} \quad (5.11)$$

:

$$S_I = \frac{6885,608}{100} = 68,85608$$

:

$$S' = \frac{4184,24}{100} = 41,8424$$

## 5.3.

;

$$= (S - S') \cdot \quad (5.12)$$

$$= (68,85608 - 41,8424) \cdot 15416,8 = 308\,336,0$$

:

$$= \text{---} \quad (5.13)$$

$$= \frac{8 \ 10 \ ,2}{30 \ 33 \ ,0} = 0,26 \quad = 3 \ .$$

- 80 107,22 ;
- ,
- 47,1 %;
- 84,1%;
- 10,5%;
- 45,8%;
- 48,7%;
- 42,4%;
- 308 336,0 .;
- 3 .



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: , PCI

-	5-	3,3 -	
1.	-12V TRST#	-12V TRST#	32-
2.	TCK +12V	TCK +12V	
3.	GROUND TMS	GROUND TMS	
4.	TDO TDI	TDO TDI	
5.	+5V +5V	+5V +5V	
6.	+5V INTA#	+5V INTA#	
7.	INTB#          INTC#	INTB#          INTC#	
8.	INTD#          +5V	INTD#          +5V	
9.	PRSNT1#	PRSNT1#	
10.	+5V(I:O)	+3,3V(I:O)	
11.	PRSNT2#	PRSNT2#	
12.	GROUND GROUND	,	3,3 –
13.	GROUND GROUND	,	3,3 –
14.			
15.	GROUND RST#	GROUND RST#	
16.	CLK          +5V(I/O)	CLK          +3,3V(I/O)	
17.	GROUND GNT#	GROUND GNT#	
18.	REQ#          GROUND	REQ#          GROUND	
19.	+5V(I/O)	+3,3V(I/O)	
20.	AD[31] AD[30]	AD[31] AD[30]	
21.	AD[29] +3,3V	AD[29] +3,3V	
22.	GROUND AD[28]	GROUND AD[28]	
23.	AD[27] AD[26]	AD[27] AD[26]	
24.	AD[25] GROUND	AD[25] GROUND	

25.	+3,3V AD[24]	+3,3V AD[24]	
26.	C:BE[3]# IDSEL	C:BE[3]# IDSEL	
27.	AD[23] +3,3V	AD[23] +3,3V	
28.	GROUND AD[22]	GROUND AD[22]	
29.	AD[21] AD[20]	AD[21] AD[20]	
30.	AD[19] GROUND	AD[19] GROUND	
31.	+3,3V AD[18]	+3,3V AD[18]	
32.	AD[17] AD[16]	AD[17] AD[16]	
33.	C:BE[2]# +3,3V	C:BE[2]# +3,3V	
34.	GROUND FRAME#	GROUND FRAME#	
35.	IRDY# GROUND	IRDY# GROUND	
36.	+3,3V TRDY#	+3,3V TRDY#	
37.	DEVSEL# GROUND	DEVSEL# GROUND	
38.	GROUND STOP#	GROUND STOP#	
39.	LOSK# +3,3V	LOSK# +3,3V	
40.	PERR# SDONE	PERR# SDONE	
41.	+3,3V SBO#	+3,3V SBO#	
42.	SERR# GROUND	SERR# GROUND	
43.	+3,3V PAR	+3,3V PAR	
44.	C/BE[1]# AD[15]	C/BE[1]# AD[15]	
45.	AD[14] +3,3V	AD[14] +3,3V	
46.	GROUND AD[13]	GROUND AD[13]	
47.	AD[12] AD[11]	AD[12] AD[11]	
48.	AD[10] GROUND	AD[10] GROUND	
49.	AD[10] AD[09]	AD[10] AD[09]	
50.	,	GROUND GROUND	
51.	,	GROUND GROUND	
52.	AD[08] C/BE[0]#	AD[08] C/BE[0]#	
53.	AD[07] +3,3V	AD[07] +3,3V	

54.	+3,3V AD[06]	+3,3V AD[06]	
55.	AD[05] AD[04]	AD[05] AD[04]	
56.	AD[03] GROUND	AD[03] GROUND	
57.	GROUND AD[02]	GROUND AD[02]	
58.	AD[01] AD[00]	AD[01] AD[00]	
59.	+5V(I/O) +5V(I/O)	+3,3V(I/O) +3,3V(I/O)	
60.	ACK64# REQ64#	ACK64# REQ64#	
61.	+5V +5V	+5V +5V	
62.	+5V +5V	+5V +5V	64-
	,	,	64-
	,	,	64-
65.	C/BE[6]# C/BE[5]#	C/BE[6]# C/BE[5]#	
66.	C/BE[4] +5V(I/O)	C/BE[4] +3,3V(I/O)	
67.	GROUND PAR64	GROUND PAR64	
68.	AD[63] AD[62]	AD[63] AD[62]	
69.	AD[61] GROUND	AD[61] GROUND	
70.	+5V(I/O) AD[60]	+5V(I/O) AD[60]	
63.	GROUND	GROUND	
64.	GROUND C/BE[7]#	GROUND C/BE[7]#	
71.	AD[59] AD[58]	AD[59] AD[58]	
72.	AD[57] GROUND	AD[57] GROUND	
73.	GROUND AD[56]	GROUND AD[56]	
74.	AD[55] AD[54]	AD[55] AD[54]	
75.	AD[53] +5V(I/O)	AD[53] +5V(I/O)	
76.	GROUND AD[52]	GROUND AD[52]	
77.	AD[51] AD[50]	AD[51] AD[50]	
78.	AD[49] GROUND	AD[49] GROUND	
79.	+5V(I/O) AD[48]	+5V(I:O) AD[48]	

80.	AD[47] AD[46]	AD[47] AD[46]	
81.	AD[45] GROUND	AD[45] GROUND	
82.	GROUND AD[44]	GROUND AD[44]	
83.	AD[43] AD[42]	AD[43] AD[42]	
84.	AD[41] +5V(I:O)	AD[41] +3,3V(I:O)	
85.	GROUND AD[40]	GROUND AD[40]	
86.	AD[39] AD[38]	AD[39] AD[38]	
87.	AD[37] GROUND	AD[37] GROUND	
88.	+5V(I/O) AD[36]	+3,3V(I/O) AD[36]	
89.	AD[35] AD[34]	AD[35] AD[34]	
90.	AD[33] GROUND	AD[33] GROUND	
91.	GROUND AD[32]	GROUND AD[32]	
92.			
93.	GROUND	GROUND	
94.	GROUND	GROUND	64-