

/ 20320—2013/

61400 21 2008
GB/T 20320—2006

风

(IEC 61400-21 2008 ,Wind turbines—
Part 21 :Measurement and assessment of power quality characteristics
of grid connected wind turbines ,IDT)

1	.....	1
2	.....	1
3	.....	2
4	.....	4
5	.....	6
6	.....	6
7	.....	10
8	.....	22
A ( )	.....	25
B ( )	.....	34
C ( )	.....	41
	.....	43
1	.....	9
2	.....	9
3	.....	11
4	.....	13
5	()	18
6	.....	19
B 1	.....	34
B 2	.....	35
B 3	.....	35
1	() ...	8
2	.....	12
3	(IEC 61000-3-6)	24
B 1	15 m/s N_{mi} f_{mi} f_{yi} ...	36
B 2	w_i	36
B 3		37
B 4	P_r ($c < x$)	37
B 5		38
B 6		38

2006

(3 8 3 21);

10 min

(6 4 7 4);

(6 5 7 5);

(6 .

1

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IEC 61000-4-15 (EMC) 4 : 15 :

(Electromagnetic compatibility (EMC)—Part 4 :Testing and measurement techniques—Section
15 : Flickermeter—Funct

3 5

() ()

,

3 6

:

$$\psi_k = \arctan(X_k/R_k) \dots\dots\dots (3)$$

:

$$\frac{X_k}{R_k} \dots\dots\dots ;$$

3 7

() ()

3 8

() ()

,

3 9

() ()

3 10

;

3 11

() ()

3 12

() ()

:

$$S_n = \sqrt{3}U_n I_n \dots\dots\dots (4)$$

:

$$\frac{U_n}{I_n} \dots\dots\dots ;$$

3 13

() ()

3 14

() ()

3 15

() ()

,

3.16

() ()

3.17

() ()

3.18

() ()

3.19

3.20

() ()

$$k_u(\psi_k) = \sqrt{3} \times \frac{U_{fic,max} - U_{fic,min}}{U_n} \times \frac{S_{k, fic}}{S_n} \dots\dots\dots (5)$$

：

$U_{fic,min}$ ———— ；

$U_{fic,max}$ ———— ；

U_n ———— ；

S_n ———— ；

$S_{k, fic}$ ———— ；

：

k_i k_u k_i , k_u k_u

3.21

；

3.22

，

4

：

$\frac{\Delta U_{dyn}}{U_n}$ (%)

ψ_k (°)

α_m (t) (°)

β

c (ψ_k)

$E_{\text{Pst}i}$			
f_{g}		(50 Hz 60 Hz)	
$f_{\text{m}i}$	i		
f_{over}			
f_{under}			
$f_{\text{y}i}$	i		
h			
I_{hi}	i		h
$i_{\text{m}}(t)$		(A)	
I_{n}		(A)	
$k_{\text{f}}(\psi_{\text{k}})$			
k_i			
$k_{\text{u}}(\psi_{\text{k}})$			
L_{fic}		(H)	
$N_{10\text{m}}$	10 min		
$N_{120\text{m}}$	120 min		
N_{bin}	$v_{\text{cut-in}}$	15 m/s	
n_i	i		
N_{m}			
$N_{\text{m}i}$	i		
$N_{\text{m}i \neq x}$	i		x
N_{wt}			
P		(W)	
$P_{0.2}$		(0.2 s)	(W)
P_{60}		(60 s)	(W)
P_{600}		(600 s)	(W)
P_{lt}			
P_{n}			
$P_{\text{r}}(c < x)$	c		
P_{st}			
$P_{\text{st},\text{fic}}$			
Q		(var)	
R_{fic}		(Ω)	
S_{k}		(VA)	
$S_{\text{k},\text{fic}}$		(VA)	
S_{n}			(VA)
THC		(% I_{n})	
T_{p}		(s)	
U		(V)	
$u_0(t)$			(V)
$u_{\text{fic}}(t)$			(V)
$U_{\text{fic,max}}$		(V)	
$U_{\text{fic,min}}$		(V)	

U_n (V)
 U_{under}
 U_{over}
 v_a (m/s)
 v_{cut-in} (m/s)
 v_i i
 w_i i
 X_{fic} (Ω)
 Z_1 (Ω)
 Z_2 (Ω)

5

:
A/D converter
DFT
HV
LV
MV
PCC
RMS
SCADA
THC
WT

6

6.1

6.4) (6.5) (6.6~6.7) (6.2) (6.3~
(6.8~6.9) A

6.2

() , P_n S_n U_n I_n
:

6.3

6.3.1

() 6.3.2 6.3.3

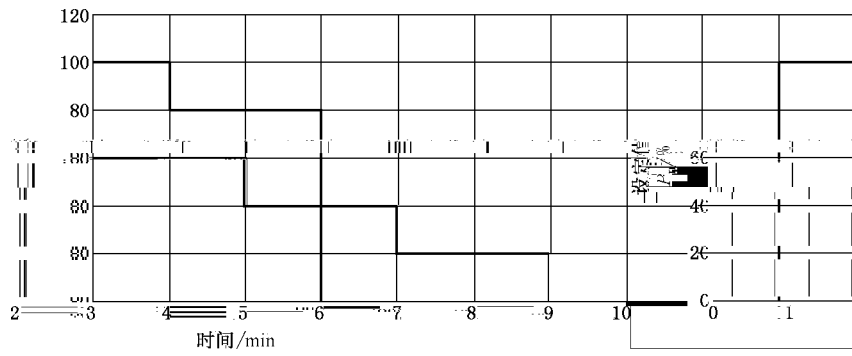
Q

， ， ，
 $Q = 0$ ，
：
6 5
a) $0.1 P_n \sim 0.3 P_n$ b) $0.9 P_n$ ，
1
(VD1 ~ VD6)
，
()
()
1 ()

100% , 20% 2min
20% , 1
0.2 s

：

SCADA



1

6.7

6.7.1

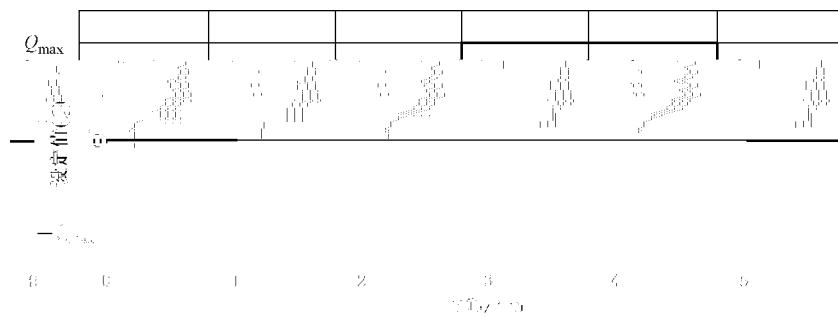
1 min 0% 10% ... 90% 100% ,
1min

6.7.2

：
0% 10% 20% ... 100%
1 min

2

50% , 1 min 0.2 s



2

：

SCADA

6.8

，

,

/ /

6 9

,

10 s 1 min 10 min

7

7 1

7 1

7 2 ~ 7 9

,

(7 2)

(7 3 ~ 7 4)

(7 5)

(7 6 ~ 7 7)

(7 8 ~ 7 9)

15 m/s

(1),

,

,

(2)

1 : 15 m/s

15 m/s ,

2 : 15 m/s

,

(0.2 s)

,

15 m/s

15 m/s ,

,

82

(7.33 5)

7 1 1

,

,

10 min 5% 0.2 s $\pm 1\%$ 0.2 s
0.2%
,
10 min $\pm 10\%$
10 min 2%
IEC 61800-3 2004 B 3
,
(2)
, (
) / -
1 :
2 :
7 6 1

- ģ

2

	1 0	IEC 60044-2
	1 0	IEC 60044-1
	± 0 5 m/s	IEC 61400-12-1 ()
+ A/D +	1%	IEC 62008

,

C

3

2 kHz

() ,

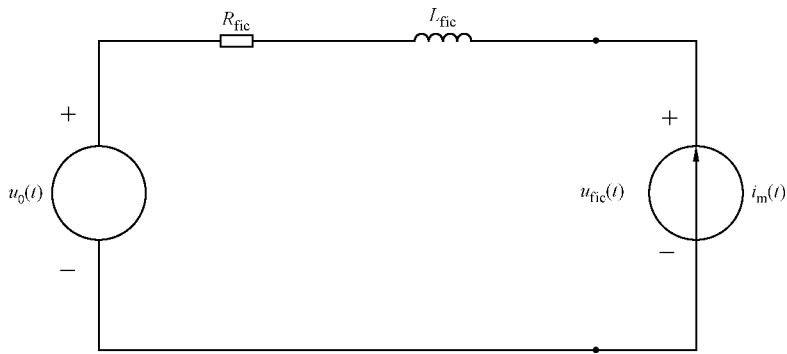
20 kHz

1 Hz

,

2 5

- Â - ģ



4

$$u_0(t) \quad R_{\text{fic}} \quad L_{\text{fic}} \quad i_m(t) \quad u_{\text{fic}}(t) \quad (7),$$

$$u_{\text{fic}}(t) = u_0(t) + R_{\text{fic}} \times i_m(t) + L_{\text{fic}} \times \frac{di_m(t)}{dt} \dots\dots\dots (7)$$

$$u_0(t) \quad :$$

a) , ;

b) $u_0(t) \quad \alpha_m(t) \quad |u_{\text{fic}}(t) - u_0(t)| \quad |u_0(t)|,$

$u_{\text{fic}}(t) \quad i_m(t) \quad u_0(t) :$

$$u_0(t) = \sqrt{\frac{2}{3}} \times U_n \times \sin(a_m(t)) \dots\dots\dots (8)$$

$$U_n \text{ ————}$$

$$a_m(t) = 2\pi \times \int_0^t f(t) dt + a_0 \dots\dots\dots (9)$$

$f(t) \text{ ———— } (\quad);$

$t \text{ ———— } ;$

$a_0 \text{ ———— } t = 0$

(10) $R_{\text{fic}} \quad L_{\text{fic}} \quad \phi_k :$

$$\tan(\phi_k) = \frac{2\pi \times f_g \times L_{\text{fic}}}{R_{\text{fic}}} = \frac{X_{\text{fic}}}{R_{\text{fic}}} \dots\dots\dots (10)$$

$f_g \text{ ———— } (50 \text{ Hz} \quad 60 \text{ Hz})$

(11) :

$$S_{k, \text{fic}} = \frac{U_n^2}{\sqrt{R_{\text{fic}}^2 + X_{\text{fic}}^2}} \dots\dots\dots (11)$$

$P_{\text{st}} \quad \text{IEC 61000-4-15} \quad ,$

$S_{k, \text{fic}}/S_n \quad \text{IEC 61000-4-15} \quad ,$

$u_{\text{fic}}(t)$

- Γ $u_0(t)$,

Γ 0 ,

- ：
- $$N_{m,i} = \frac{N_m}{f_{m,i}} \quad i$$
- 6) $v_{\text{cut-in}} = 15 \text{ m/s}$ 1 m/s , $f_{y,i} = f_{m,i}$ (15)：
- $$w_i = \frac{f_{y,i}}{f_{m,i}} \dots\dots\dots (15)$$
- ， $c(\psi_k, v_a)$ 99%
(4 5) ：

- 7) (16)：
- $$P_r(c < x) = \frac{\sum_{i=1}^{N_{\text{bin}}} w_i \times N_{m,i} \leq x}{\sum_{i=1}^{N_{\text{bin}}} w_i \times N_{m,i}} \dots\dots\dots (16)$$
- ：
- $$N_{m,i} \leq x = \frac{N_m}{f_{m,i}} \quad i$$
- $$N_{\text{bin}} = \dots\dots\dots$$

- 8) 99% $P_r(c < x)$,
- 4)~ 8) B 3
- IEC 61000-3-7 , 12
- ， 2 h 12
- ，
- 1： ， ，
- ：

$$u_1 = \frac{u_{12} - u_{31}}{3} \dots\dots\dots (17)$$

$$u_2 = \frac{u_{23} - u_{12}}{3} \dots\dots\dots (18)$$

$$u_3 = \frac{u_{31} - u_{23}}{3} \dots\dots\dots (19)$$

- ：
- $$u_1, u_2, u_3 \dots\dots\dots ;$$
- $$u_{12}, u_{31}, u_{23} \dots\dots\dots$$
- 2： IEC 61000-4-15 $u_{\text{fic}}(t)$, 35 Hz
- 400 Hz , 800 Hz
- $\alpha_m(t)$
- 3： B 4 1
- 4： 99%
- 5： 6 3 2 , $v_a = 6 \text{ m/s} \sim 10 \text{ m/s}$ $c(\psi_k, v_a)$
- 15 m/s , $v_a = 6 \text{ m/s}$
- 15 m/s 99% , $v_a = 7.5 \text{ m/s} \sim 8.5 \text{ m/s}$
- 10 m/s , 96% 91% 83% , $c(\psi_k, v_a)$
- 99% , $v_a = 7.5 \text{ m/s} \sim 10 \text{ m/s}$,
- B 3 , $v_a = 7.5 \text{ m/s} \sim 8.5 \text{ m/s}$

(4)

5) 15

1 : “ ” ,

1 500 Hz (7 3 3 2)

2 : IEC 61000-3-3 , B 4 2

3 : $P_{st, fic}$ T_p

4 : B 4 3

7 4

, 6 4

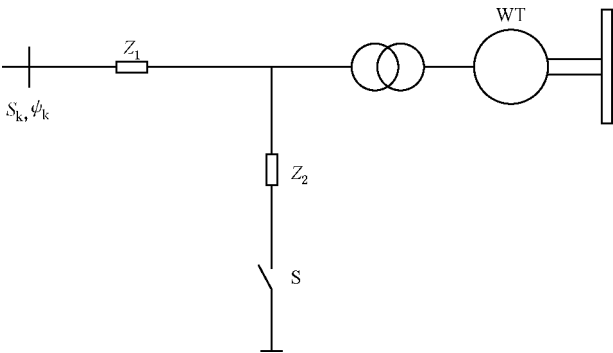
， 10 min
：GB/T 17626.7—2008 5.6

7.5

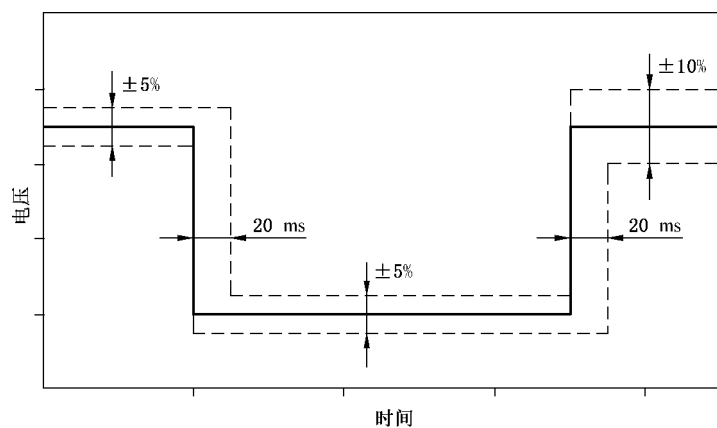
1， 6.5

10 min

(50 Hz 60 Hz)
(C)
a) $0.1P_n \sim 0.3P_n$ b) $0.9P_n$
5



5 ()
 Z_1 ，



6

： a) $1 P_n \sim 0.3 P_n$ ， ()
； b) $0.9 P_n$ ，

7.6

7.6.1

6.6.1 ， 10 min P_{600} 1 min P_{60} 0.2 s $P_{0.2}$ ，
：

—— ；
—— ；
—— 15 m/s ， 1 m/s 5 10 min ；
——

7 6 3

6 6 3 ,
:
—— 10 min ;
—— , ;
—— 1 , 100% 20% ,
2 min ;
—— , 90% ;
—— ;
—— 0.2 s
3 , 2
1 Hz
 ,

7 7

7 7 1

6 7 1
—— ,
—— ,
—— :
—— ;
—— ;
—— 10% , 30 1 min
;
—— 1 min , 1 min
—— 1 min , 0% 10% ...
90% 100% 0% 10% ... 90% 100%
3 , 2

7 7 2

6 7 2 ,
 , :
—— ;
—— ;
—— 10% , 30 1 min
;
—— 1 min , 1 min ;

———— 1 min , 0% 10% ...
90% 100% .0% 10% ... 90% 100%

—

()

,

± 1 s

$$P_{st}=P_{lt}=c\left(\psi_k,v_a\right)\times\frac{S_n}{S_k}.....(26)$$

$k_u(\psi_k)$ — ψ_k , 7 3 4

- 1 : B 4 2 , 10 min 2 h (28) (29)
- 2 : (30) (31) (28) (29) ,

8 3

IEC 61000-3-6
IEC 61000-3-6

(33) :

$$I_{h\Sigma} = \sqrt[\beta]{\sum_{i=1}^{N_{wt}} \left(\frac{I_{h,i}}{n_i}\right)^\beta} \dots\dots\dots (33)$$

- :
- N_{wt} — ;
- $I_{h\Sigma}$ — h ;
- n_i — i ;
- $I_{h,i}$ — i h ;
- β — , 3

3 (61000 3 6)

	β
$h < 5$	1 0
$5 \leq h \leq 10$	1 4
$h > 10$	2 0

$\beta = 1$
(33)

(33)

$\beta = 2$

()

,

,

,

GB/T 20320 :

(/)	
/m	
/m	
(/)	
(/ /)	
/kW	
/kVA	
/kvar	
/kVA	

,	
GB/T 20320	

GB/T 20320

N_{10m}				
N_{120m}				
$\psi_k / (^\circ)$	30	50	70	85
$k_f (\psi_k)$				
$k_u (\psi_k)$				

N_{10m}				
N_{120m}				
$\psi_k / (^\circ)$	30	50	70	85
$k_f (\psi_k)$				
$k_u (\psi_k)$				

3

10 20 ... 100% P_n ,

I_n

:

$Q = 0$
:

3.1

$P_{bin} / \%$	0	10	20	30	40	50	60	70	80	90	100
h	$I_h / \%$	$I_h / \%$	$I_h / \%$	$I_h / \%$	$I_h / \%$	$I_h / \%$	$I_h / \%$	$I_h / \%$	$I_h / \%$	$I_h / \%$	$I_h / \%$
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											

$P_{\text{bin}} / \%$	0	10	20	30	40	50	60	70	80	90	100
h	$I_h / \%$	$I_h / \%$	$I_h / \%$	$I_h / \%$	$I_h / \%$	$I_h / \%$	$I_h / \%$	$I_h / \%$	$I_h / \%$	$I_h / \%$	$I_h / \%$
13											
14											
15											
16											
17											
18											
19											
20											
21											
22											
23											
24											
25											
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33											
34											
35											
36											
37											
38											
39											
40											
41											
42											
43											
44											
45											
46											
47											
48											
49											
50											
THC / %											

3 2

$P_{\text{bin}} / \%$	0	10	20	30	40	50	60	70	80	90	100
f / Hz	$I_h / \%$	$I_h / \%$	$I_h / \%$	$I_h / \%$	$I_h / \%$	$I_h / \%$	$I_h / \%$	$I_h / \%$	$I_h / \%$	$I_h / \%$	$I_h / \%$
75/90											
125/150											
175/210											
225/270											
275/330											
325/390											
375/450											
425/510											
475/570											
525/630											
575/690											
625/750											
675/810											
725/870											
775/930											
825/990											
875/1 050											
925/1 110											
975/1 170											
1 025/1 230											
1 075/1 290											
1 125/1 350											
1 175/1 410											
1 225/1 470											
1 275/1 530											
1 325/1 590											
1 375/1 650											
1 425/1 710											
1 475/1 770											
1 525/1 830											
1 575/1 890											
1 625/1 950											
1 675											
1 725											
1 775											
1 825											
1 875											
1 925											
1 975											

33

[illegible]

:

:		
A 1		(VD1 ~ VD6)
	$0.1P_n \sim 0.3P_n$	:
A 2a)		(VD1 ~ VD6) ;
A 2b)		(VD1 ~ VD6)
A 3a)		(VD1 ~ VD6) ;
A 3b)		(VD1 ~ VD6)
A 4		(VD1 ~ VD6)
	$0.9P_n$	:
A 5a)		(VD1 ~ VD6) ;
A 5b)		(VD1 ~ VD6)
A 6a)		(VD1 ~ VD6) ;
A 6b)		(VD1 ~ VD6)
A 7		

5 3

A 9a)

A 9b)

6

6 1

(/ %)											
/ kvar											
/ kvar											

6 2

= 0 kvar :

(% P_n)											
/ kvar											

:

A 10

A 11 (50%)

7

			/s	

8

	10 s	1 min	10 min
/s			
/s			

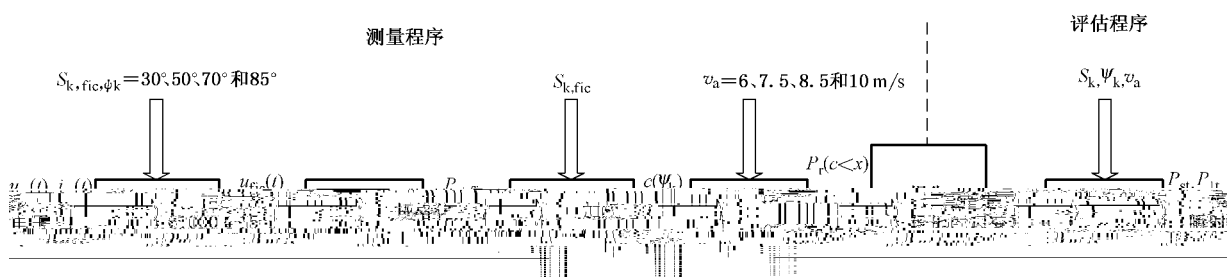
()

1

B 1

B 1

,



1

B 1

•

1) 15 m/s

$$u_m(t) \quad i_m(t);$$
$$2) \quad , \quad S_{k, \text{fic}}$$

4

$$\psi_k \quad u_{\text{fic}}(t);$$

3) $u_{\text{fic}}(t)$, IEC 61000-4-15

$$P_{st, fic} ;$$
$$4) \quad P_{\text{st, fic}} = c(\psi_k), \quad S_{k, \text{fic}};$$
$$5) \quad 4 \quad , \quad \psi_k \quad ,$$
$$P_r(c < x), P_r(c < x) \quad v_a$$

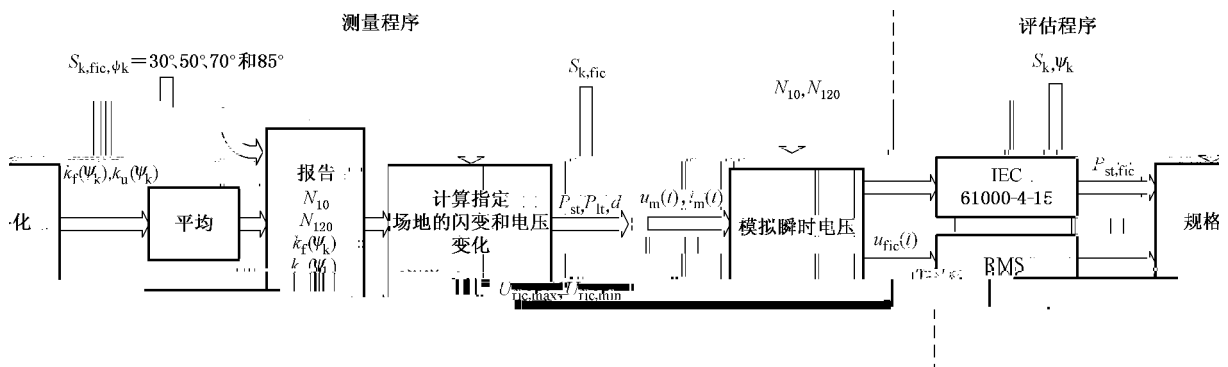
•
;

6) , $C(\psi_k, v_a)$ 99%

2

B 2

,



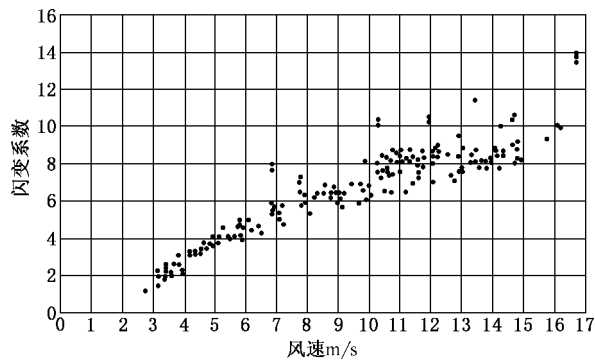
2

- 1) $u_m(t)$ $i_m(t)$;
- 2) $S_{k, \text{fic}}$ ψ_k $u_{\text{fic}}(t)$;
- 3) $u_{\text{fic}}(t)$ IEC 61000-4-15 $P_{\text{st, fic}}$ RMS $U_{\text{fic, max}}$ $U_{\text{fic, min}}$;
- 4) $P_{\text{st, fic}}$ $k_f(\psi_k)$ $U_{\text{fic, max}} - U_{\text{fic, min}}$ $k_u(\psi_k)$;
- 5) ψ_k $c(\psi_k, v_a)$;
- 6) $N_{10 \text{ m}}$ 120 min $N_{120 \text{ m}}$ 10 min

3

$$c(\psi_k, v_a) = \frac{U_{\text{fic, max}} - U_{\text{fic, min}}}{U_{\text{fic, max}}} \quad \psi_k = 50^\circ \quad 30^\circ \quad 70^\circ \quad 85^\circ$$

B 3 $\psi_k = 50^\circ$ $c(\psi_k)$



3

$c(\psi_k, v_a)$,
 1 m/s $c(\psi_k)$;
 w_i ;
 $P_r(c < x)$;
 99% , $c(\psi_k, v_a)$
 $v_{\text{cut-in}} = 3 \text{ m/s}$ 15 m/s
 15 m/s
 $c(\psi_k, v_a)$

B 1

$f_{m,i}$ $v_a = 6 \text{ m/s } 7.5 \text{ m/s } 8.5 \text{ m/s } 10 \text{ m/s}$ $f_{y,i}$

15 / N_i f_i f_i

I (m/s)	$N_{m,i}$	$f_{m,i}$ %	$f_{y,i} \%$ (6 m/s)/%	$f_{y,i}$ (7.5 m/s)/%	$f_{y,i}$ (8.5 m/s)/%	$f_{y,i}$ (10 m/s)/%
3 ~ < 4	30	5.38	11.64	8.21	6.64	4.98
4 ~ < 5	36	6.45	12.57	9.44	7.83	6.02
5 ~ < 6	45	8.06	12.37	10.04	8.59	6.80
6 ~ < 7	33	5.91	11.26	10.04	8.91	7.32
7 ~ < 8	42	7.53	9.58	9.53	8.83	7.56
8 ~ < 9	33	5.91	7.67	8.65	8.41	7.56
9 ~ < 10	33	5.91	5.80	7.52	7.74	7.34
10 ~ < 11	69	12.37	4.15	6.29	6.88	6.93
11 ~ < 12	87	15.59	2.82	5.07	5.94	6.39
12 ~ < 13	60	10.75	1.82	3.95	4.97	5.75
13 ~ < 14	45	8.06	1.11	2.97	4.05	5.07
14 ~ < 15	45	8.06	0.65	2.16	3.21	4.37
N_m	558					

w_i $f_{y,i}$ $f_{m,i}$ B 2
 w_i

2

w_i

I (m/s)	w_i 6 m/s	w_i 7.5 m/s	w_i 8.5 m/s	w_i 10 m/s
3 ~ < 4	2.165	1.527	1.236	0.927
4 ~ < 5	1.949	1.464	1.214	0.933
5 ~ < 6	1.533	1.245	1.065	0.843
6 ~ < 7	1.904	1.698	1.507	1.237
7 ~ < 8	1.273	1.267	1.173	1.005

2 ()

v (m/s)	w_i 6 m/s	w_i 7.5 m/s	w_i 8.5 m/s	w_i 10 m/s
8 ~ < 9	1 297	1 462	1 423	1 278
9 ~ < 10	0 980	1 272	1 308	1 241
10 ~ < 11	0 335	0 509	0 557	0 561
11 ~ < 12	0 181	0 325	0 381	0 410
12 ~ < 13	0 169	0 367	0 463	0 535
13 ~ < 14	0 138	0 368	0 502	0 628
14 ~ < 15	0 081	0 267	0 398	0 542

, B 3

3

v_a / (m/s)	6.0	7.5	8.5	10
$\sum_{i=1}^{N_{\text{bin}}} w_i \times N_{m,i}$	454 40	467 99	457 64	424 60

, $c(\psi_k)$ B 4, 3 m/s ~ 15 m/s
 $c(\psi_k)$ $c(\psi_k)$ 100,
 $P_r(c < 11.495) = 1.0$ B 4,
 (B 2) (B 3)

4

 $P(c < x)$

	m/s	$P_r(c < x)$ 6 m/s	$P_r(c < x)$ 7.5 m/s	$P_r(c < x)$ 8.5 m/s	$P_r(c < x)$ 10 m/s
11 495	13.4	1 000 0	1 000 0	1 000 0	1 000 0
11 379	13.4	0 999 7	0 999 2	0 998 9	0 998 5
11 298	13.4	0 999 4	0 998 4	0 997 8	0 997 0
10 584	14.6	0 999 1	0 997 6	0 996 7	0 995 6
10 472	11.9	0 998 9	0 997 1	0 995 8	0 994 3
10 444	14.6	0 998 5	0 996 4	0 995 0	0 993 3
10 418	11.9	0 998 3	0 995 8	0 994 1	0 992 0
10 418	10.3	0 997 9	0 995 1	0 993 3	0 991 1
10 364	14.6	0 997 2	0 994 0	0 992 1	0 989 8
10 308	14.6	0 997 0	0 993 5	0 991 2	0 988 5
10 286	10.3	0 996 8	0 992 9	0 990 3	0 987 2
10 280	11.9	0 996 1	0 991 8	0 989 1	0 985 9
10 104	10.3	0 995 7	0 991 1	0 988 3	0 984 9

4 ()

	m/s	$P_r (c < x)$ 6 m/s	$P_r (c < x)$ 7.5 m/s	$P_r (c < x)$ 8.5 m/s	$P_r (c < x)$ 10 m/s
10 059	14.2	0.995 0	0.990 0	0.987 1	0.983 6
9 931	14.2	0.994 8	0.989 4	0.986 2	0.982 3
8 882	12.9	0.990 6	0.978 8	0.971 3	0.962 0
8 858	12.9	0.990 2	0.978 0	0.970 3	0.960 8
8 846	12.1	0.989 8	0.977 2	0.969 3	0.959 5
8 836	11.3	0.989 5	0.976 5	0.968 3	0.958 2
8 831	12.1	0.989 1	0.975 8	0.967 4	0.957 3

B 4 99% B 5
50° , 99% $c (\psi_k, v_a)$

5

$\psi_k / (^\circ)$	30	50	70	85
$v_a / (m/s)$				
6.0		8.9		
7.5		10.1		
8.5		10.3		
10.0		10.4		

15 m/s , 99% ,
B 6
3 m/s~15 m/s
99% , B 6
15 m/s
99% , B 6
15 m/s ,

6

$v_a / (m/s)$	6.0	7.5	8.5	10.0
$P_r (v < 3 m/s) / \%$	17.8	11.8	9.3	6.8
$P_r (3 m/s < v < 15 m/s) / \%$	81.4	83.9	82.0	76.1
$P_r (v > 15 m/s) / \%$	0.7	4.3	8.7	17.1
/ %	99.2	99.2	99.2	99.2
/ %	98.4	94.8	90.5	82.2
: 3 m/s~15 m/s ,				

4

4.1

$$P_{\text{st.fic}} = c(\psi_k) \times \frac{S_n}{S_{k.\text{fic}}} \quad \text{..... (B 1)}$$

∴
 S_n ————
 , $c(\psi_k)$:

$$c(\psi_k) = P_{\text{st.fic}} \times \frac{S_{k.\text{fic}}}{S_n} \quad \text{..... (B 2)}$$

4.2

IEC 61000-3-3

 $F = 1$

$k_f(\psi_k)$
 , :

$$d_{\text{max}} = k_f(\psi_k) \times \frac{S_n}{S_{k.\text{fic}}} \times 100 \quad \text{..... (B 3)}$$

∴
 d_{max} ————

IEC 61000-3-3 ,

$$d_{\text{max}} = t_f \quad \text{..... (B 4)}$$

 $P_{\text{st.fic}}$:

$$P_{\text{st.fic}} = \left(\frac{\sum t_f}{T_p} \right)^{1/3.2} \quad \text{..... (B 5)}$$

 T_p , t_f , :

$$P_{\text{st.fic}} = 100 \times k_f(\psi_k) \times \frac{S_n}{S_{k.\text{fic}}} \times \left(\frac{2.3}{T_p} \right)^{1/3.2} \quad \text{..... (B 6)}$$

 $k_f(\psi_k)$:

$$k_f(\psi_k) = \frac{S_{k.\text{fic}}}{100 \times S_n} \times \left(\frac{T_p}{2.3} \right)^{1/3.2} \times P_{\text{st.fic}} \quad \text{..... (B 7)}$$

(B 7)

 T_p

4.3

Δu , $S_{k.\text{fic}}$, ψ_k , Δu
 $S_{k.\text{fic}}$, Δu , ψ_k , $k_u(\psi_k)$
 :

$$\Delta u = k_u(\psi_k) \times \frac{S_n}{S_{k.\text{fic}}} \quad \text{..... (B 8)}$$

$S_{k.\text{fic}}$, :

$$k_u(\psi_k) = \sqrt{3} \times \frac{U_{\text{fic,max}} - U_{\text{fic,min}}}{U_n} \times \frac{S_{k,\text{fic}}}{S_n} \dots\dots\dots (\text{B } 9)$$

:

$U_{\text{fic,max}}$ _____

$u_{\text{fic}}(t)$

;

$U_{\text{fic,min}}$ _____

$u_{\text{fic}}(t)$

()

,

:

1)

2) ,

,

3)

,

$$U_{1+} = \sqrt{\frac{3}{2}(u_{1+ \sin}^2 + u_{1+ \cos}^2)} \dots\dots\dots (C 10)$$

:

$$I_{P1+} = \frac{P_{1+}}{\sqrt{3}U_{1+}} \dots\dots\dots (C 11)$$

$$I_{Q1+} = \frac{Q_{1+}}{\sqrt{3}U_{1+}} \dots\dots\dots (C 12)$$

:

$$\cos\varphi_{1+} = \frac{P_{1+}}{\sqrt{P_{1+}^2 + Q_{1+}^2}} \dots\dots\dots (C 13)$$

,

[1] IEC 61000-3-3 Electromagnetic compatibility (EMC)—Part 3-3 : Limits—Limitation of voltage changes , voltage fluctuations and flicker in public low-voltage supply systems , for equipment with rated current ≤ 16 A per phase and not subject to conditional connection

[2] IEC/ TR 61000-3-6 Electromagnetic compatibility (EMC)—Part 3-6 : Limits—Assessment of emission limits for the connection of distorting installations to MV , HV and EHV power systems

[3] IEC/ TR 61000-3-7 Electromagnetic compatibility (EMC)—Part 3-7 : Limits—Assessment of emission limits for the connection of fluctuating installations to MV , HV and EHV power systems—Basic EMC publication

[4] IEC 61000-4-30 Electromagnetic compatibility (EMC)—Part 4-30 : Testing and measurement techniques—Power quality measurement methods

[5] IEC 61400-1 Wind turbines—Part 1 :Design requirements

[6] Thomas Ackerman (editor) Wind power in power systems John Wiley and Sons Ltd , January 2005 .

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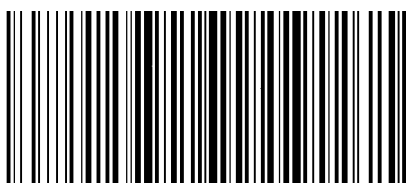
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