TECHNICAL DATA AND CHARACTERISTIC CURVES

CONTENT

1. RATINGS

1.1 Power Supply

Nominal auxiliary voltage Vx	24-60Vdc; 48-150Vdc; 130-250Vdc 100-250Vac 50/60Hz 125-250Vdc/100-250Vac (special application)
Operating range	DC ± 20% of Vx AC − 20%, +10% of Vx
Residual ripple	Up to 12%
Stored energy time	≥50 ms for interruption of Vx
Burden	Stand by: <3W DC or <8VA AC Max: <6W DC or <14VA AC

1.2 Frequency

Frequency protection functions	From 45 to 65Hz
Nominal frequency	50/60Hz

1.3 Current Inputs

Phase current inputs	1 and 5A by connection
Earth current inputs	1 and 5A by connection
Operating range	Selection by ordering code (Cortec)
Burden Phase Current	< 0.025 VA (1A) < 0.3 VA (5A)
Burden Earth Current	< 0.008 VA (1A) < 0.010 VA (5A)
Thermal withstand	1s @ 100 x rated current 2s @ 40 x rated current continuous @ 4 x rated current

1.4 Logic Inputs

Logic input type	Independent optically insulated
Logic input burden	< 10 mAmps per input
Logic input recognition time	< 5ms

1.4.1 Supply

The logic inputs shall be powered with a DC voltage, excepted the M auxiliary voltage range which acccepts both DC and AC voltage as logic input control voltage.

		Logic input electrical functionality		
Ordering Code (Cortec)	Relay ausiliary power supply range	Auxiliary voltage range for the logic inputs(*)	Minimum polarisation voltage level (Volt)	Minimum polarisation current level (mAmps)
A	24 - 60 Vdc	19 – 60 Vdc	15 Vdc	3.35 mAmps
F	48 – 150 Vdc	32 – 150 Vdc	25 Vdc	3.35 mAmps
M	130 – 250 Vdc 100 – 250 Vdc	48 – 250 Vdc 48 – 250 Vac	38 Vdc 38 Vdc	2.20 mAmps 1.90 mA rms
T	48 – 150 Vdc Special EA (**)	32 – 150 Vdc	25 Vdc	3.35 mAmps
U	130 – 250 Vdc Special EA (**)	48 – 250 Vdc	38 Vdc	2.20 mAmps
H	125 – 250 Vdc 100 – 250 Vdc	105 – 145 Vdc	96 Vdc	1.8 mA

(*) The tolerance on the auxiliary voltage variations for the logic inputs is ±20% in DC voltage and –20%, +10% in AC voltage.

(**) Logic input recognition time for EA approval. Dedicated filtering on 24 samples (15 ms at 50 Hz)

1.5 Output Relay Characteristic

Contact rating	
Contact relay	Dry contact Ag CdO
Make current	Max. 30A and carrry for 3s
Carry capacity	5A continuous
Rated Voltage	250Vac
Breaking characteristic	
Breaking capacity AC	1250 VA resistive 1250 VA inductive (P.F. = 0.5) 220 Vac, 5A (cos φ = 0.6)
Breaking capacity DC	135 Vdc, 0.3A (L/R = 30 ms) 250 Vdc, 50W resistive or 25W inductive (L/R=40ms)
Operation time	<7ms
Durability	
Loaded contact	10000 operation minimum
Unloaded contact	100000 operation minimum

2. INSULATION

Dielectric withstand	IEC 60-255-5	2 kV common mode 1 kV differential mode
Impulse voltage	IEC 60-255-5	5 kV common mode 1 kV differential mode
Insulation resistance	IEC 60-255-5	> 1000 MΩ

3. EMC TESTS

High frequency disturbance	IEC 61000-4-1	2.5 kV common mode, class 3 1 kV differential mode, class 3
Fast transient	IEC 61000-4-4 ANSI C37.90.1	4 kV common mode, class 4 2 kV others, class 4
Electrostatic discharge	IEC 61000-4-2	8 kV, class 4
RFI immunity radiated	ANSI C37.90.2 IEC 61000-4-3	35 v/M 10 V/m

4. ENVIRONMENT

Temperature	IEC 600-68-2-1 IEC 600-68-2-2	Storage –25 °C to +70 °C Operation -25 °C to + 55 °C
Humidity dam heat	IEC 600-68-2-3	56 days at 93% RH and 40 °C
Enclosure protection	IEC 60-529	IP 52, IK 07
Sinusoidal Vibrations	IEC 60-255-21-1	Response and endurance, class 2
Shocks	IEC 60-255-21-2	Response and withstand, class 1
Bump	IEC 60-255-21-2	Response and withstand, class 1
Seismic	IEC 60-255-21-3	Class 1

5. DEVIATION OF PROTECTION ELEMENTS

Glossary

I	:	Phase current
Is	:	I>, I>>, I>>> & I<
I2s	:	I2>, I2>> & I2>>>
Ies	:	Ie>, Ie>> & Ie>>>
DT	:	Definite time
IDMT	:	Inverse definite minimum time

Element	Range	Deviation	Trigger	Reset	Time deviation
Phase overcurrent elements I> & I>> & I>>>	0.1 to 40 In	± 2%	DT: Is ± 2% IDMT: 1.1Is ±2%	0.95 Is ±2% 1.05 Is ±2%	±2% +30…50ms ±5% +30…50ms
Earth fault overcurrent elements Ie> & Ie>> & Ie>>>	0.002 to 1Ien 0.01 to 8 Ien 0.1 to 40 Ien	± 2%	DT: Ies ± 2% IDMT: 1.1Ies ±2%	0.95 Ies ±2% 1.05 Ies ±2%	±2% +30…50ms ±5% +30…50ms
Negative sequence phase overcurrent elements I2>, I2>> & I2>>>	0.1 to 40 In	± 2%	DT: I2s ± 2% IDMT: 1.1I2s ±2%	0.95 I2s ±2% 1.05 I2s ±2%	±2% +30…50ms ±5% +30…50ms
Phase undercurrent element I<	0.02 to 1 In	± 2%	DT: I< ± 2%	0.95 I< ±2%	±2% +30…50ms
Broken conductor [I2/I1].	20 to 100%	± 3%	DT: I2/I1 ± 3%	0.95 I2/I1 ±3%	±2% +30…50ms
Thermal overload Iθ>, θ Alarm, θ Trip	0.10 to 3.2 In	± 3%	IDMT: Iθ> ± 3%	0.97 Iθ>±3%	−5% +30…50ms (ref. IEC 60255-8)

6. DEVIATION OF AUTOMATION FUNCTIONS TIMERS

Autoreclose timers tDs, tR, tI	±2% +10…30ms
CB fail & CB monitoring timers	±2% +10…30ms
Auxiliary timers tAUX1, tAUX2, tAUX3, tAUX4	±2% +10…30ms
Cold load pickup	±2% +20…40ms
SOTF/TOR	±2% +20…40ms

7. DEVIATION OF MEASUREMENTS

Measurement	Range	Deviation
Phase current	0.1 to 40 In	Typical ±0.5% at In
Earth current	0.002 to 1Ien	Typical ±0.5% at Ien
	0.01 to 8 Ien	Typical ±0.5% at Ien
	0.1 to 40 Ien	Typical ±0.5% at Ien

8. PROTECTION SETTING RANGES

8.1 [50/51] Phase Overcurrent (P120, P121, P122 & P123)

- Phase current — Fundamental only

NOTE : When I> or I>> is associated to an IDMT curve, the maximum setting recommended should be 2In.

8.1.1 Protection Setting Ranges

	Setting Range		
[51] Phase OC	Min	Max	Step
I> ?	No or Yes		
I>	0.1 In	25 In	0.01 In
Delay type	DT or IDMT (IEC_STI, IEC_SI, IEC_VI, IEC_EI, IEC_LTI, C02, C08, IEEE_MI, IIEEE_VI, IEEE_EI, RI, RECT curve)		
tI>	0 s	150 s	0.01 s
I> TMS	0.025	1.5	0.025
I> Reset Delay Type	DT or IDMT		
I> RTMS	0.025	3.2	0.025
I> tReset	0.00 s	100 s	0.01 s
I>> ?	No or Yes		
I>>	0.5 In	40 In	0.01 In
Delay type	DT or IDMT (IEC_STI, IEC_SI, IEC_VI, IEC_EI, IEC_LTI, C02, C08, IEEE_MI, IIEEE_VI, IEEE_EI, RI, RECT curve)		
tI>>	0 s	150 s	0.01 s
I>> TMS	0.025	1.5	0.025
I>> Reset Delay Type	DT or IDMT		
I>> RTMS	0.025	3.2	0.025
I>> tReset	0.00 s	100 s	0.01 s
I>>> ?	No or Yes or Peak		
I>>>	0.5 In	40 In	0.01 In
tI>>>	0 s	150 s	0.01 s

8.2 [50N/51N] Earth fault protection (P120, P121, P122 & P123)

- Earth fault current — Fundamental only
- Earth fault current ranges — See following table

NOTE : When Ie> or Ie>> are associated to an IDMT curve, the maximum setting recommended should be the maximum of the range divided by 20.

8.2.1 Protection Setting Ranges

	Setting Range		
[Earth] OC	Min	Max	Step
High sensitivity current set	Cortec code **P12-C-X---X**		
Ie>	0.002 Ien	1 Ien	0.001 Ien
Ie>>	0.002 Ien	1 Ien	0.001 Ien
Ie>>>	0.002 Ien	1 Ien	0.001 Ien
Med. sensitivity current set	Cortec code **P12-B-X---X**		
Ie>	0.01 Ien	1 Ien	0.005 Ien
Ie>>	0.01 Ien	8 Ien	0.005 Ien
Ie>>>	0.01 Ien	8 Ien	0.005 Ien
Low sensitivity current set	Cortec code **P12-A-X---X**		
Ie>	0.1 Ien	25 Ien	0.1 Ien
Ie>>	0.5 Ien	40 Ien	0.1 Ien
Ie>>>	0.5 Ien	40 Ien	0.1 Ien
Ie> ?	No or Yes		
Delay type	DT or IDMT (IEC_STI, IEC_SI, IEC_VI, IEC_EI, IEC_LTI, C02, C08, IEEE_MI, IIEEE_VI, IEEE_EI, RI, RECT curve)		
tIe>	0 s	150 s	0.01 s
Ie> TMS	0.025	1.5	0.025
Ie> Reset Delay Type	DT or IDMT		
Ie> RTMS	0.025	3.2	0.025
Ie> tReset	0.00 s	100 s	0.01 s
Ie>> ?	No or Yes		
Delay type	DT or IDMT (IEC_STI, IEC_SI, IEC_VI, IEC_EI, IEC_LTI, C02, C08, IEEE_MI, IIEEE_VI, IEEE_EI, RI, RECT curve)		
tIe>>	0 s	150 s	0.01 s
Ie>> TMS	0.025	1.5	0.025
Ie>> Reset Delay Type	DT or IDMT		
Ie>> RTMS	0.025	3.2	0.025
Ie>> tReset	0.04 s	100 s	0.01 s
tIe>>	0 s	150	0.01 s
Ie>>> ?	No or Yes		
tIe>>>	0 s	150 s	0.01 s
Ie>>> tReset	0.00 s	100 s	0.01 s

8.3 Undercurrent Protection (P122 & P123)

– Undercurrent: Fundamental only

– Phase current: Fundamental only

8.3.1 Protection Setting Ranges

	Setting ranges		
[37] Under Current	Min	Max	Step
I< ?	Yes or No		
I<	0.2 In	1 In	0.01 In
tI<	0 s	150 s	0.01 s

8.4 Negative Sequence Overcurrent Protection (P122 & P123)

– Phase current: Fundamental only

NOTE : When I2> is associated to an IDMT curve, the maximum setting recommended should be 2In.

8.4.1 Protection Setting Ranges

	Setting ranges		
[46] Neg.Seq. OC	Min	Max	Step
I2> ?	No or Yes		
I2>	0.1 In	40 In	0.01 In
Delay Type	DT or IDMT (IEC_STI, IEC_SI, IEC_VI, IEC_EI, IEC_LTI, C02, C08, IEEE_MI, IIEEE_VI, IEEE_EI, RI, RECT curve)		
tI2>	0 s	150s	0.01s
I2> TMS	0.025	1.5	0.025
I2> Reset Delay Type	DT or IDMT		
I2> RTMS	0.025	1.5	0.025
I2> tReset	0.04 s	100 s	0.01 s
I2>> ?	No or Yes		
I2>>	0.1 In	40 In	0.01 In
tI2>>	0 s	150s	0.01s

8.5 Thermal Overload Protection (P122 & P123)

– Phase Current: RMS

8.5.1 Protection Setting Ranges

[49] Therm. OL	Setting ranges		
Therm. OL ?	No or Yes		
Iθ	0.1 In	3.2 In	0.01
Te	1 mn	200 mn	1mn
k	1	1,5	0.01
θ Trip	50%	200%	1%
θ Alarm ?	No or Yes		
θ Alarm	50%	200%	1%

8.6 Multishot Autoreclose Function (P123)

Main shots: 4 independent shots.

External logic inputs: 4 inputs (external CB fail, phase start, earth start, blocking order).

Internal programmable trigger from phase and earth fault on all re-closing cycles.

External trigger from logic input.

Programmable dead times and reclaim time setting.

8.6.1 Multishot Autoreclose Settings

	Setting range		
[79] Autoreclose	Min	Max	Step
Autoreclose ?	Yes or No		
Ext. CB Fail ?	Yes or No		
Ext. CB Fail time	0.01 s	600 s	0.01 s
Aux1 ((I>) ?	Yes or No		
Aux2 (Ie>) ?	Yes or No		
Ext Block ?	Yes or No		
Dead time			
tD1	0.01 s	300 s	0.01 s
tD2	0.01 s	300 s	0.01 s
tD3	0.01 s	600 s	0.01 s
tD4	0.01 s	600 s	0.01 s
Reclaim time			
tR	0.02 s	600 s	0.01 s
Inhib time			
tI	0.02 s	600 s	0.01 s
Phase Cycles	0	4	1
E/Gnd Cycles	0	4	1
Cycles	4 3 2 1	Settings	
tI>	1 1 1 1	0 or 1 or 2	
tI>>	1 1 1 1	0 or 1 or 2	
tI>>>	1 1 1 1	0 or 1 or 2	
tIe>	1 1 1 1	0 or 1 or 2	
tIe>>	1 1 1 1	0 or 1 or 2	
tIe>>>	1 1 1 1	0 or 1 or 2	
tAux1	1 1 1 1	0 or 1 or 2	
tAux2	1 1 1 1	0 or 1 or 2	

0 = no action on autorecloser : definitive trip

1 = trip on pick up of the protection element, followed by reclosing cycle

2 = no trip on pick up of the protection element also if this has been set in the *CRTL/Trip commands/Trip* menu.

8.6.1.1 Further timing

Fixed time out for lacking of CB opening signal on trip protection : 2.00 s at 50 Hz
1.67 s at 60 Hz

Time out for lacking of CB closing signal on close control after dead time :

tClose Pulse(*): from 0.1 to 5.00 s in steps of 0.01 s
(*) Setting available in CB monitoring menu.

9. AUTOMATION CONTROL FUNCTIONS

9.1 Cold Load Pickup (P122 & P123)

	Setting range		
Cold Load PU	Min	Max	Step
Cold Load PU ?	Yes or No		
Level	20%	500%	1%
tCL	0.1 s	3600 s	0.1 s

9.2 Auxiliary Timers (P122 & P123)

Auxiliary timers: 4 assigned to the logic inputs Aux1, Aux2,Aux3, Aux4

	Setting range		
Auxiliary timers	Min	Max	Step
tAux1	0	200 s	0.01 s
tAux2	0	200 s	0.01 s
tAux3	0	200 s	0.01 s
tAux4	0	200 s	0.01 s

9.3 Broken Conductor Detection (P122 & P123)

Principle used: I2/I1

Functionality available for: (IA or IB or IC) > 10% In

9.3.1 Broken Conductor Detection Setting Ranges

	Setting range		
Broken Conductor	Min	Max	Step
Brkn.Cond ?	Yes or No		
Ratio I2/I1	20%	100%	1%
Brkn.Cond Time tBC	1 s	14400 s	1 s

9.4 Circuit Breaker Failure (P122 & P123)

9.4.1 CB Fail Setting Ranges

	Setting range		
CB Fail	Min	Max	Step
CB Fail ?	Yes or No		
I< BF	0.02 In	1In	0.01 In
CB Fail Time tBF	0.03 s	10 s	0.01 s
Block I>	No	Yes	Yes or No
Block Ie>	No	Yes	Yes or No

9.5 Trip Circuit Supervision (P122 & P123)

9.5.1 Trip Circuit Supervision Setting Ranges

	Setting range		
TC Supervision	Min	Max	Step
TC Supervision ?	Yes or No		
t trip circuit tSUP	0.1 s	10 s	0.05 s

9.6 Circuit Breaker Control and Monitoring (P122 & P123)

9.6.1 Setting Ranges

CB Supervision	Setting range		
	Min	Max	Step
CB Open S'vision?	Yes or No		
CB Open time	0.05 s	1 s	0.01 s
CB Close S'vision?	Yes or No		
CB Close time	0.05 s	1 s	0.01 s
CB Open Alarm ?	Yes or No		
CB Open NB	0	50000	1
ΣAmps(n) ?	Yes or No		
ΣAmps(n)	0 E6 A	4000 E6 A	1E6 A
n	1	2	1
tOpen Pulse(*)	0.10 s	5 s	0.01 s
tClose Pulse(*)	0.10 s	5 s	0.01 s

(*)Note: The tOpen/Close Pulse is available in the P123 for the Local /Remote functionality

9.7 SOTF/TOR Switch on to fault / Trip on reclose (P123)

9.7.1 Setting Ranges

SOTF	Setting range		
	Min	Max	Step
SOTF?	Yes or No		
t SOTF	0 ms	500 ms	10ms
I>>	Yes or No		
I>>>	Yes or No		

10. RECORDING FUNCTIONS (P122 & P123)

10.1 Event Records

Capacity	75 events
Time-tag	1 millisecond
Triggers	Any selected protection alarm and threshold Logic input change of state Setting changes Self test events

10.2 Fault Records

Capacity	5 faults
Time-tag	1 millisecond
Triggers	Any selected protection alarm and threshold
Data	Fault date Protection thresholds Setting Group AC inputs measurements (RMS) Fault measurements

10.3 Instantaneous recorder

Capacity	5 starting informations (instantaneous
Time-tag	1 millisecond
Triggers	Any selected protection alarm and threshold
Data	date, hour origin (any protection alarm) length (duration of the instantaneous trip yes or no

10.4 Disturbance Records

10.4.1 Triggers; Data; Setting Ranges

Disturbance Records	P122		P123		
Triggers	Any selected protection alarm and threshold, logic input, remote command				
Data	AC input channels digital input and output states frequency value				
	Default value		Setting range		
	P122	P123	Min	Max	Step
Pre-Time	2.5	2.5	0.1	3	0.1
Post-Time	0.5	0.5	0.1	3	0.1
Disturb rec Trig	ON TRIP	ON TRIP	ON TRIP or ON INST.		
Trigger	Any selected protection alarm and threshold Logic input Remote command				

11. COMMUNICATION

Type Port	Relay position	Physical Link	Connectors	Data Rate	Protocol
RS485	Rear port	Screened twister pair	Screws or snap-on	300 to 38400 baud (programmable)	ModBus RTU, Courier, IEC60870-5-103, DNP3.0
RS232	Front port (P122 & P123)	Screened twister pair	Sub–D 9 pin female connector	300 to 38400 baud (programmable)	ModBus RTU

12. CURVES

12.1 General

Although the curves tend towards infinite when the current approaches Is (general threshold), the minimum guaranteed value of the operating current for all the curves with the inverse time characteristic is 1.1Is (with a tolerance of ± 0.05Is).

12.1.1 Inverse Time Curves:

The first stage thresholds for phase (earth) overcurrent can be selected with an inverse definite minimum time (IDMT) characteristic. The time delay is calculated with a mathematical formula.

In all, there are eleven IDMT characteristics available.

The mathematical formula applicable to the first ten curves is:

$$t = T \times \left(\frac{K}{\left(I / I_S\right)^{\alpha} - 1} + L \right)$$

Where:

t	Operation time
K	Factor (see table)
I	Value of measured current
Is	Value of the programmed threshold (pick-up value)
α	Factor (see table)
L	ANSI/IEEE constant (zero for IEC and RECT curves)
T	Time multiplier setting from 0.025 to 1.5

Type of curve	Standard	K factor	α factor	L factor
Short time inverse	AREVA	0.05	0.04	0
Standard inverse	IEC	0.14	0.02	0
Very inverse	IEC	13.5	1	0
Extremely inverse	IEC	80	2	0
Long time inverse	AREVA	120	1	0
Short time inverse	C02	0.02394	0.02	0.01694
Moderately Inverse	ANSI/IEEE	0.0515	0.02	0.114
Long time inverse	C08	5.95	2	0.18
Very inverse	ANSI/IEEE	19.61	2	0.491
Extremely inverse	ANSI/IEEE	28.2	2	0.1217
Rectifier protection	RECT	45900	5.6	0

The RI curve has the following definition:

$$t = K \cdot \frac{1}{0.339 - \frac{0.236}{\left(I/Is\right)}}$$

K setting is from 0.10 to 10 in steps of 0.05.
The equation is valid for $1.1 \leq I/Is \leq 20$.

12.1.2 Reset Timer

The first stage thresholds for phase and earth overcurrent protection, negative sequence overcurrent and wattmetric/IeCos are provided with a timer hold facility "t Reset".

It may be set to a definite time value or to an inverse definite minimum time characteristic (IEEE/ANSI curves only). This may be useful in certain applications, for example when grading with upstream electromechanical overcurrent relays that have inherent reset time delays.

The second and third stage thresholds for the wattmetric/IeCos protection and earth fault overcurrent protection only have a definite time reset.

A possible situation where the reset timer may be used is to reduce fault clearance times where intermittent faults occur.

An example may occur in a cable with plastic insulation. In this application it is possible that the fault energy melts the cable insulation, which then reseals after clearance, thereby eliminating the cause for the fault. This process repeats itself to give a succession of fault current pulses, each of increasing duration with reducing intervals between the pulses, until the fault becomes permanent.

When the reset time of the overcurrent relay is set to minimum the P125, P126 and P127 relays will be repeatedly reset and will not be able to trip until the fault becomes permanent. By using the reset timer hold function the relay will integrate the fault current pulses, thereby reducing fault clearance time.

The mathematical formula applicable to the five curves is:

$$t = T \times \left(\frac{K}{1 - \left(I / I_S\right)^{\alpha}} \right)$$

Where:

t Reset time

K Factor (see table)

I Value of the measured current

Is Value of the programmed threshold (pick-up value)

α Factor (see table)

T Reset time multiplier (RTMS) setting between 0.025 and 1.5.

Type of curve	Standard	K factor	α factor
Short time inverse	C02	2.261	2
Moderately inverse	ANSI/IEEE	4.850	2
Long time inverse	C08	5.950	2
Very inverse	ANSI/IEEE	21.600	2
Extremely Inverse	ANSI/IEEE	29.100	2

12.2 Thermal Overload Curves

The thermal time characteristic is given by:

$$e^{\left(\frac{-t}{\tau}\right)} = \frac{(I^2 - (kxI_{FLC})^2)}{(I^2 - I_P{}^2)}$$

Where:

t	=	Time to trip, following application of the overload current, I
τ	=	Heating and cooling time constant of the protected plant equipment
I	=	Largest phase current
I_{FLC}	=	Full load current rating (relay setting 'Thermal Trip')
k	=	1.05 constant, allows continuous operation up to < 1.05 I_{FLC}
I_P	=	Steady state pre-loading current before application of the overload

The time to trip varies depending on the load current carried before application of the overload, i.e. whether the overload was applied from "hot" or "cold".

Curves of the thermal overload time characteristic are given in Technical Data.

The mathematical formula applicable to MiCOM Relays is the following

$$t\,\text{Trip} = \text{Te}\ln\left(\frac{|K^2 - \theta^2|}{|K^2 - \theta\text{trip}^2|}\right)$$

Where :

t Trip	=	Time to trip (in seconds)
Te	=	Thermal time constant of the equipment to be protected (in seconds)
K	=	Thermal overload equal to Ieq/k Iθ> with:
Ieq	=	Equivalent current corresponding to the RMS value of the largest phase current
Iθ>	=	Full load current rating given by the national standard or by the supplier
k	=	Factor associated to the thermal state formula
θ alarm	=	Initial thermal state.
θ trip	=	Trip thermal state

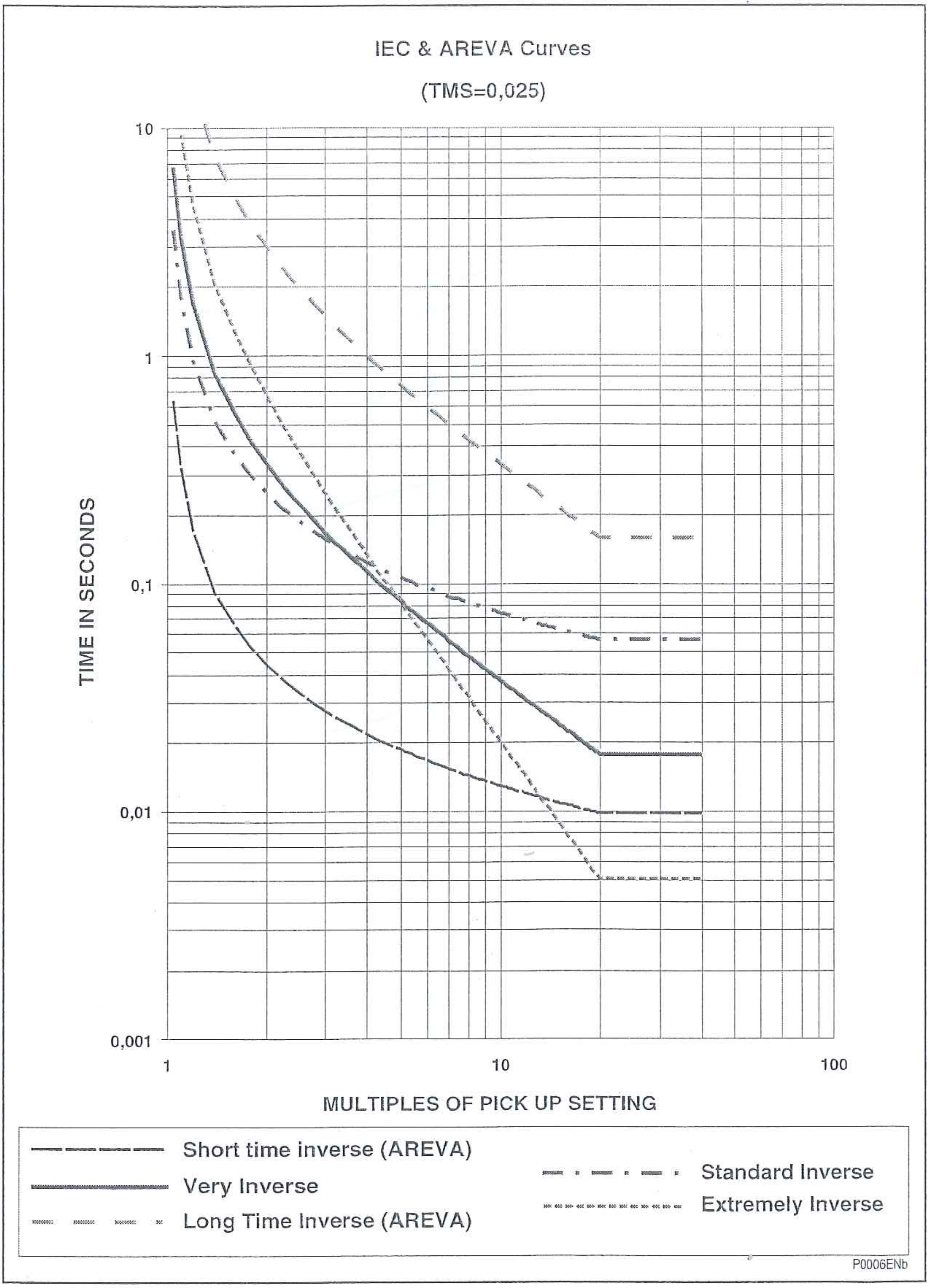
The settings of these parameters are available in the various menus. The calculation of the thermal state is given by the following formula:

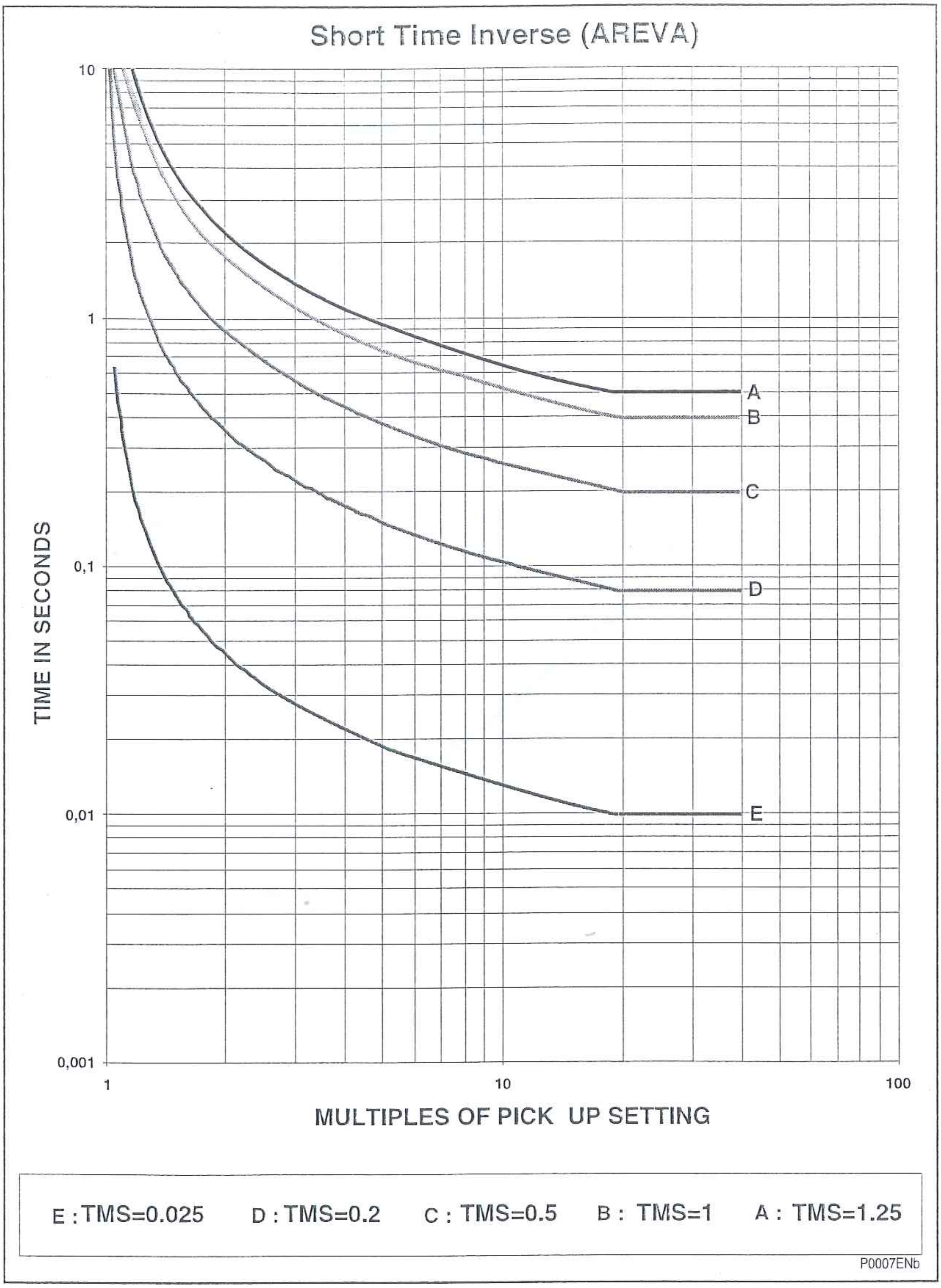
$$\Theta_{\tau+1} = \left(\frac{I_{eq}}{kxI\Theta >}\right)^2\left[1 - e^{\left(\frac{-t}{Te}\right)}\right] + \Theta_\tau e^{\left(\frac{-t}{Te}\right)}$$

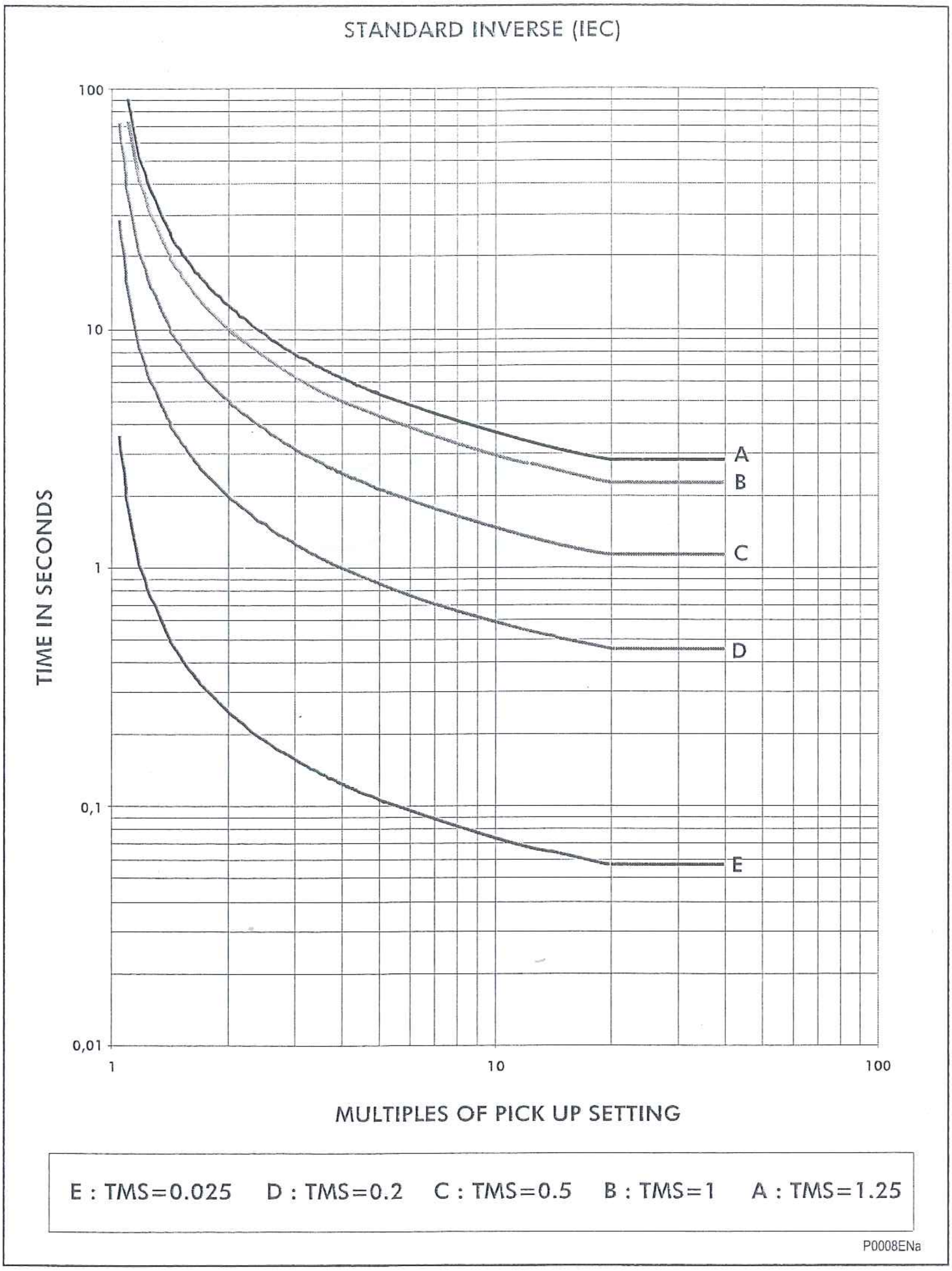
θ being calculated every 20ms.

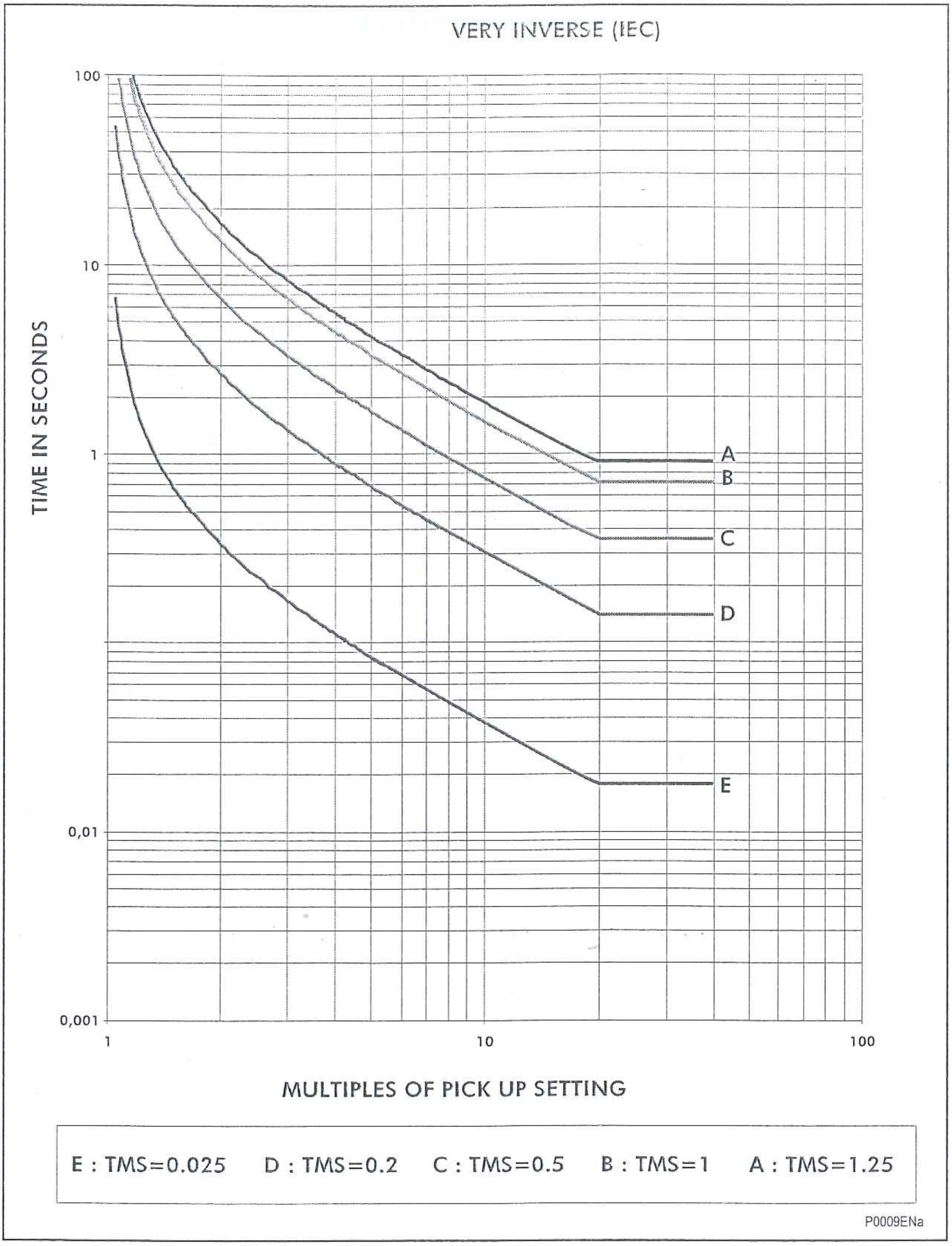
The following curves are given for indication only.

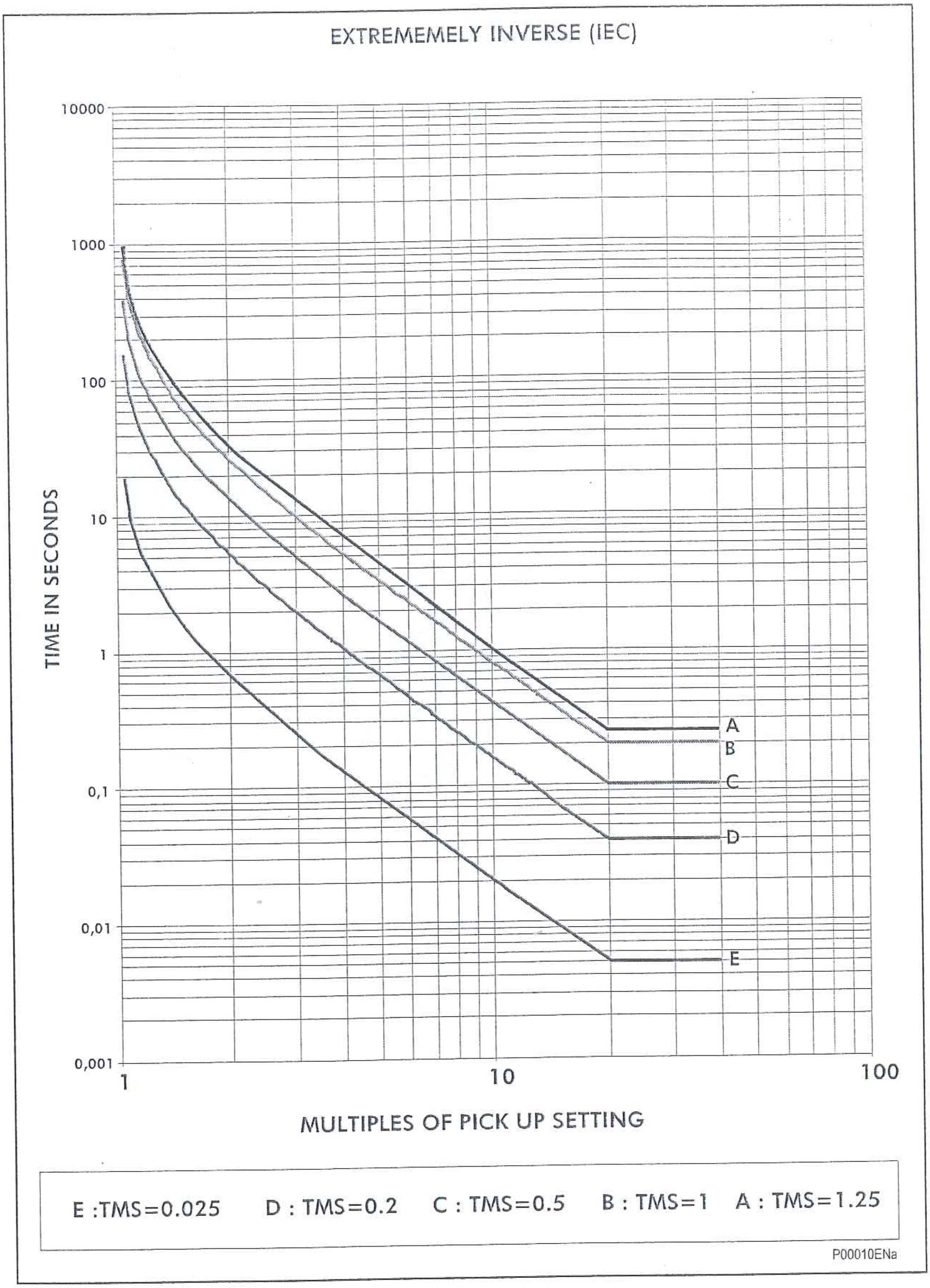
12.3 IEC Curves

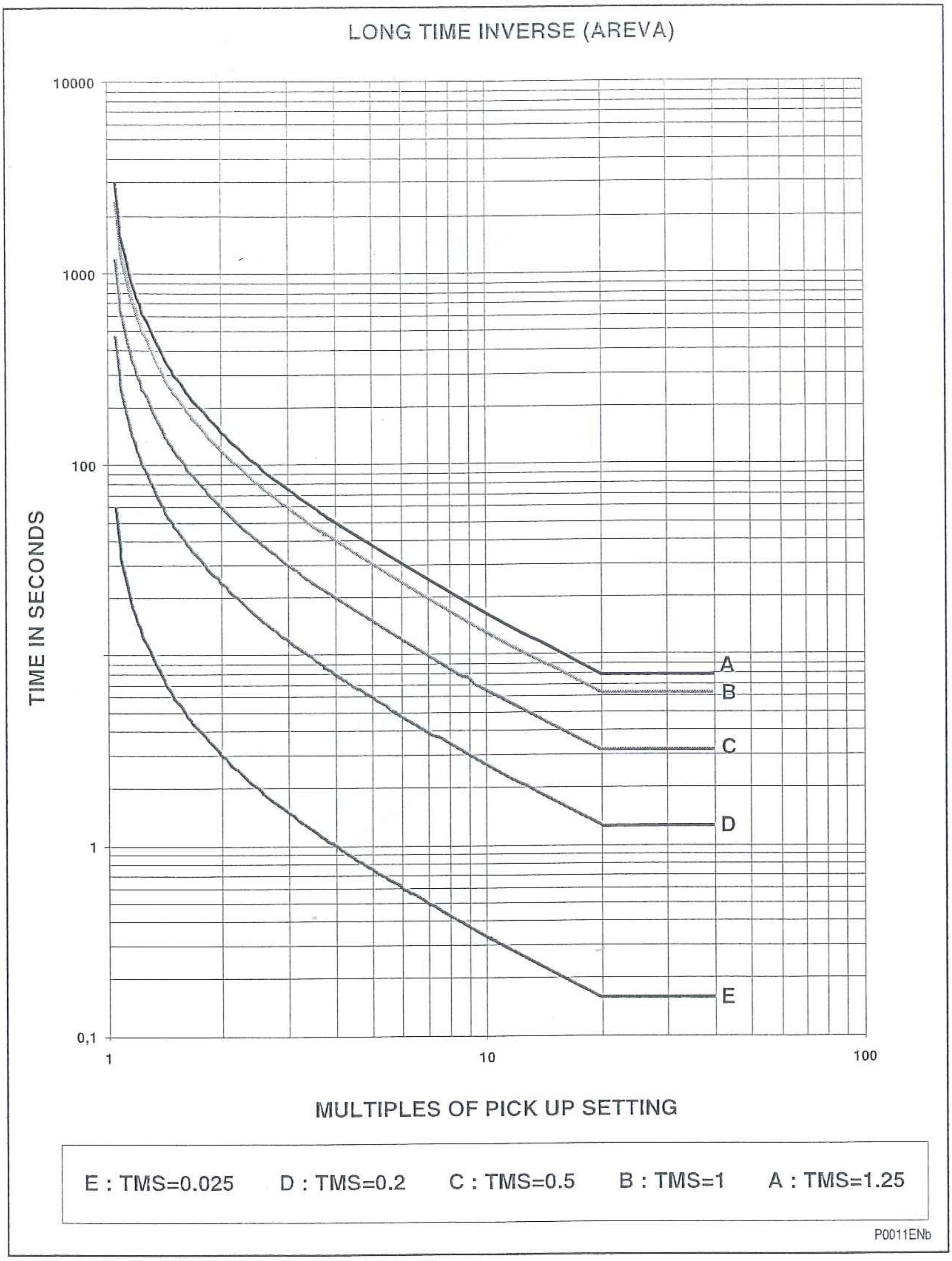



Short Time Inverse (AREVA)
10
1
0,1
0,01
0,001
TIME IN SECONDS
1
10
100
MULTIPLES OF PICK UP SETTING
A
B
C
D
E
E : TMS=0.025
D : TMS=0.2
C : TMS=0.5
B : TMS=1
A : TMS=1.25
P0007ENb

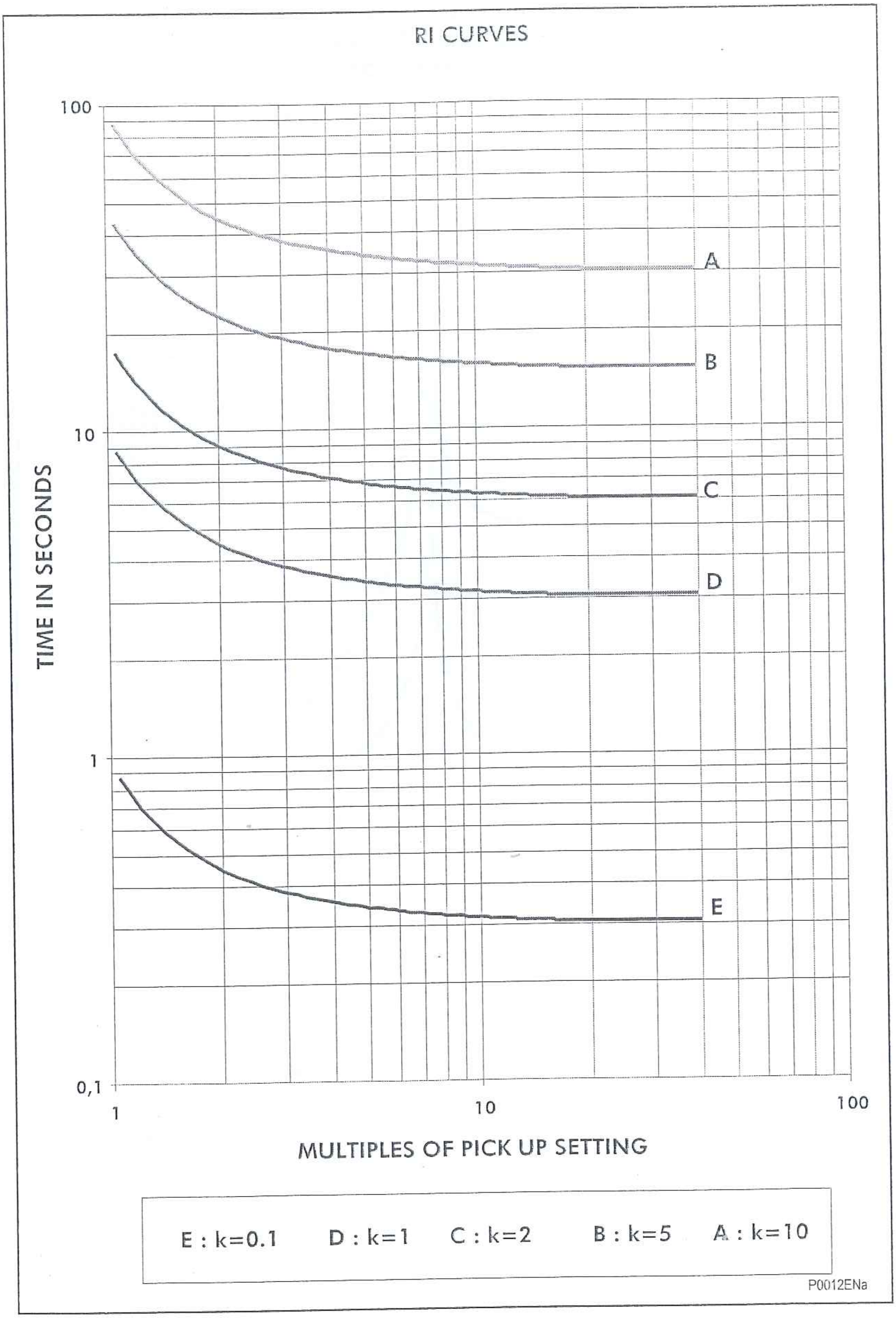

STANDARD INVERSE (IEC)
100
10
1
0,1
0,01
1
10
100
TIME IN SECONDS
MULTIPLES OF PICK UP SETTING
A
B
C
D
E
E : TMS=0.025
D : TMS=0.2
C : TMS=0.5
B : TMS=1
A : TMS=1.25
P0008ENa


VERY INVERSE (IEC)
100
10
1
0,01
0,001
TIME IN SECONDS
1
10
100
MULTIPLES OF PICK UP SETTING
A
B
C
D
E
E : TMS=0.025 D : TMS=0.2 C : TMS=0.5 B : TMS=1 A : TMS=1.25
P0009ENa

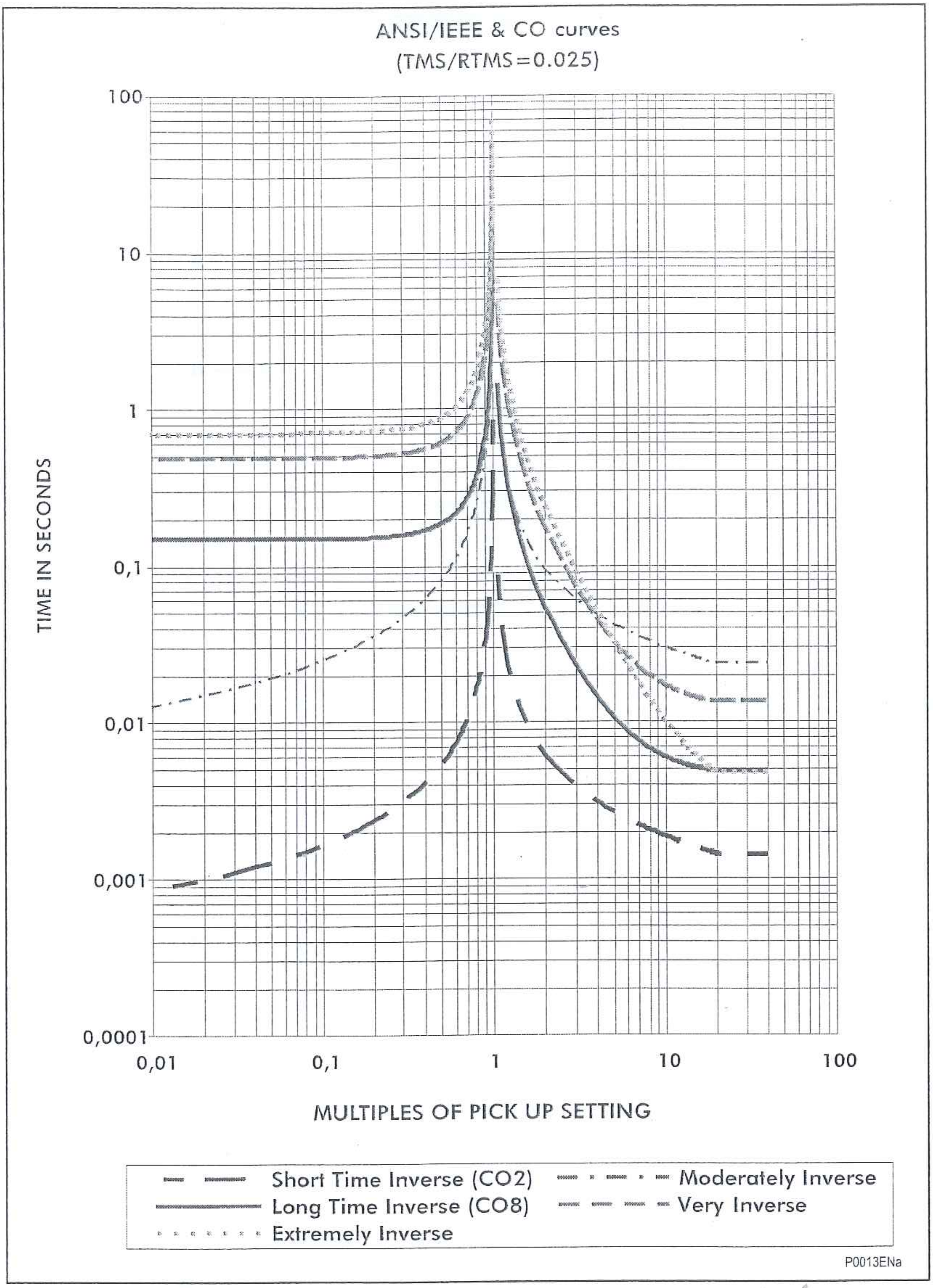

EXTREMEMELY INVERSE (IEC)
10000
1000
100
10
1
0,1
0,01
0,001
TIME IN SECONDS
1
10
100
MULTIPLES OF PICK UP SETTING
A
B
C
D
E
E :TMS=0.025
D : TMS=0.2
C : TMS=0.5
B : TMS=1
A : TMS=1.25
P00010ENa

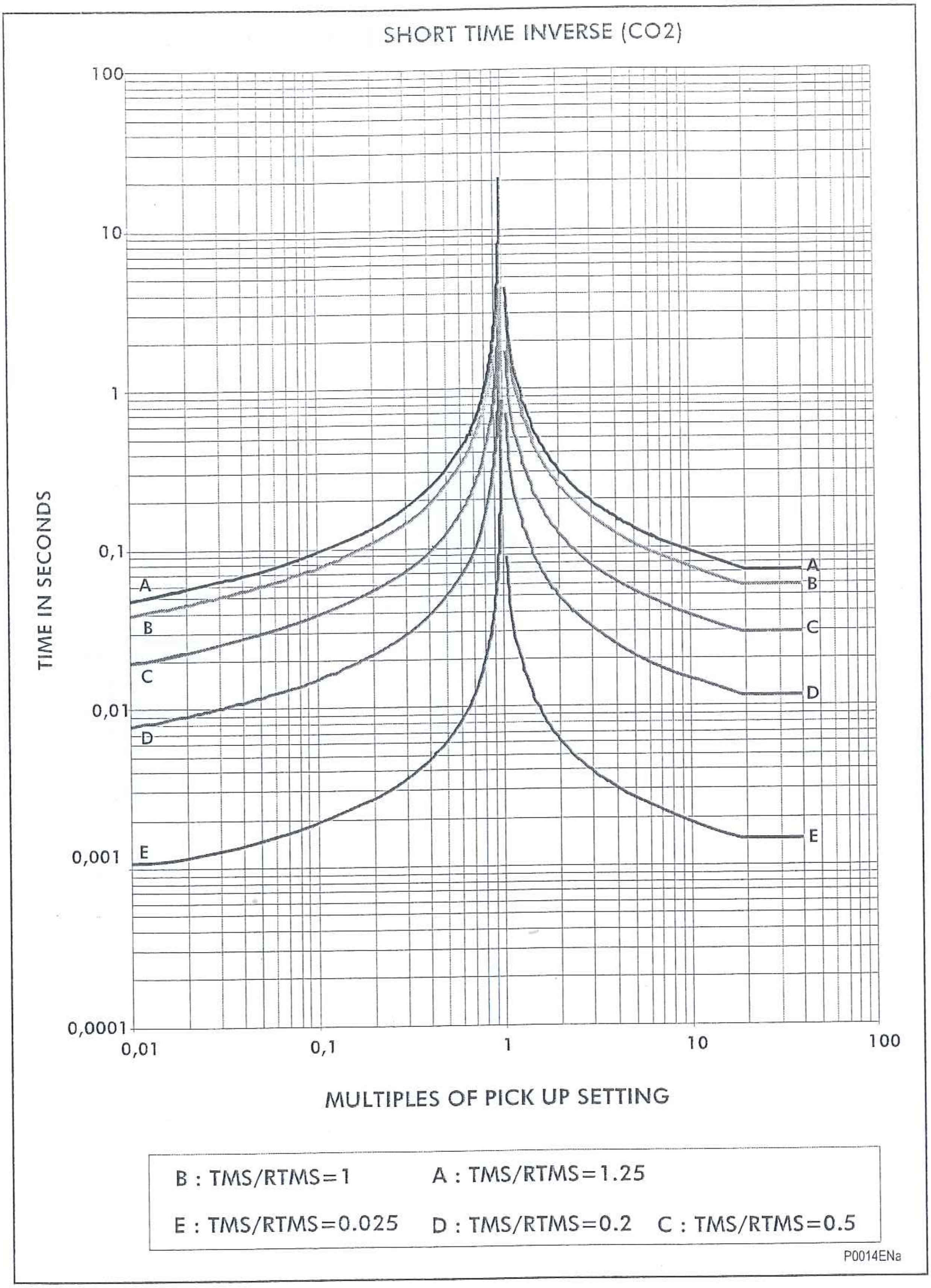

LONG TIME INVERSE (AREVA)
TIME IN SECONDS
10000
1000
100
1
0,1
1
10
100
MULTIPLES OF PICK UP SETTING
A
B
C
D
E
E : TMS=0.025
D : TMS=0.2
C : TMS=0.5
B : TMS=1
A : TMS=1.25
P0011ENb

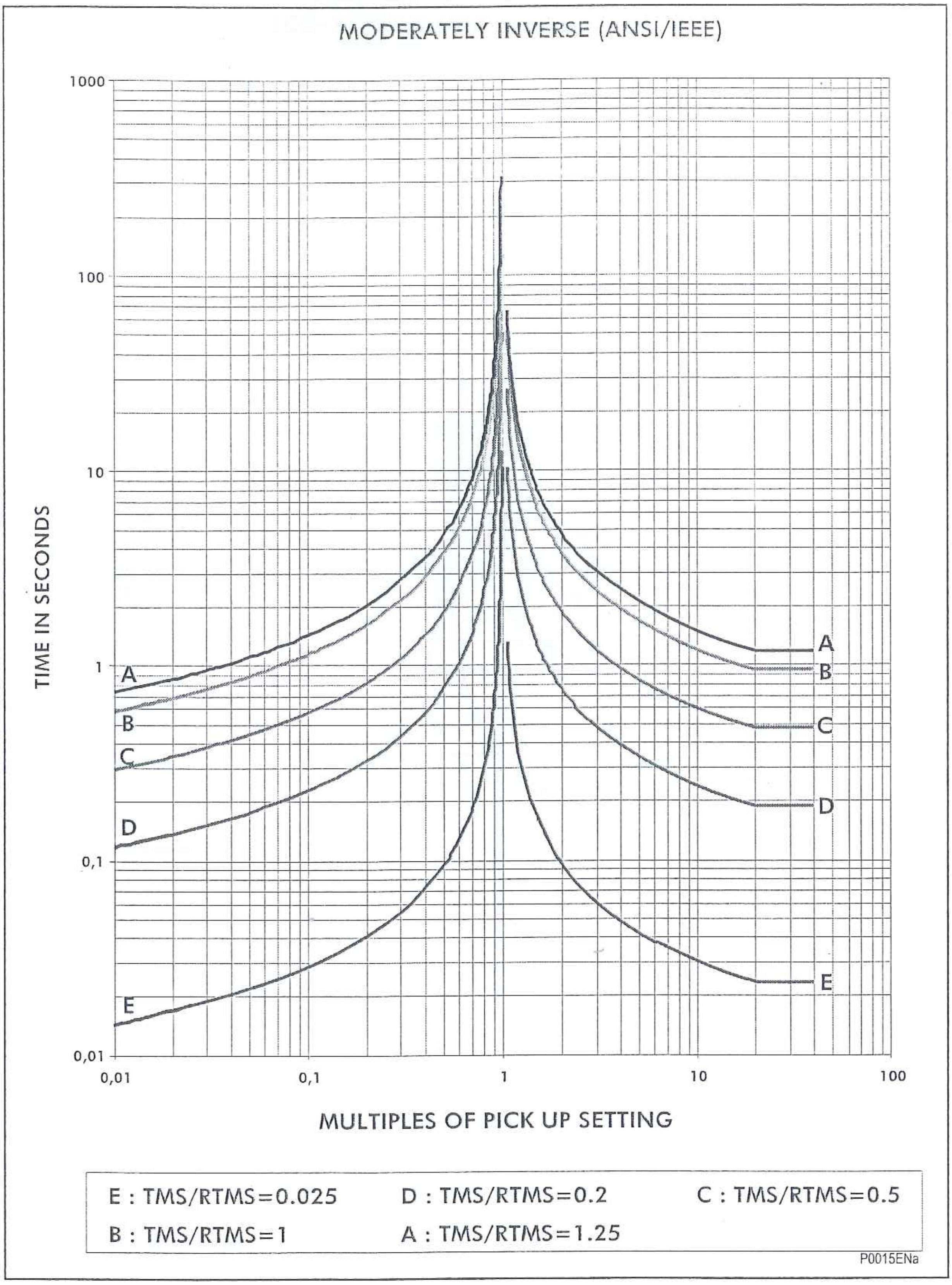
12.4 RI Curves

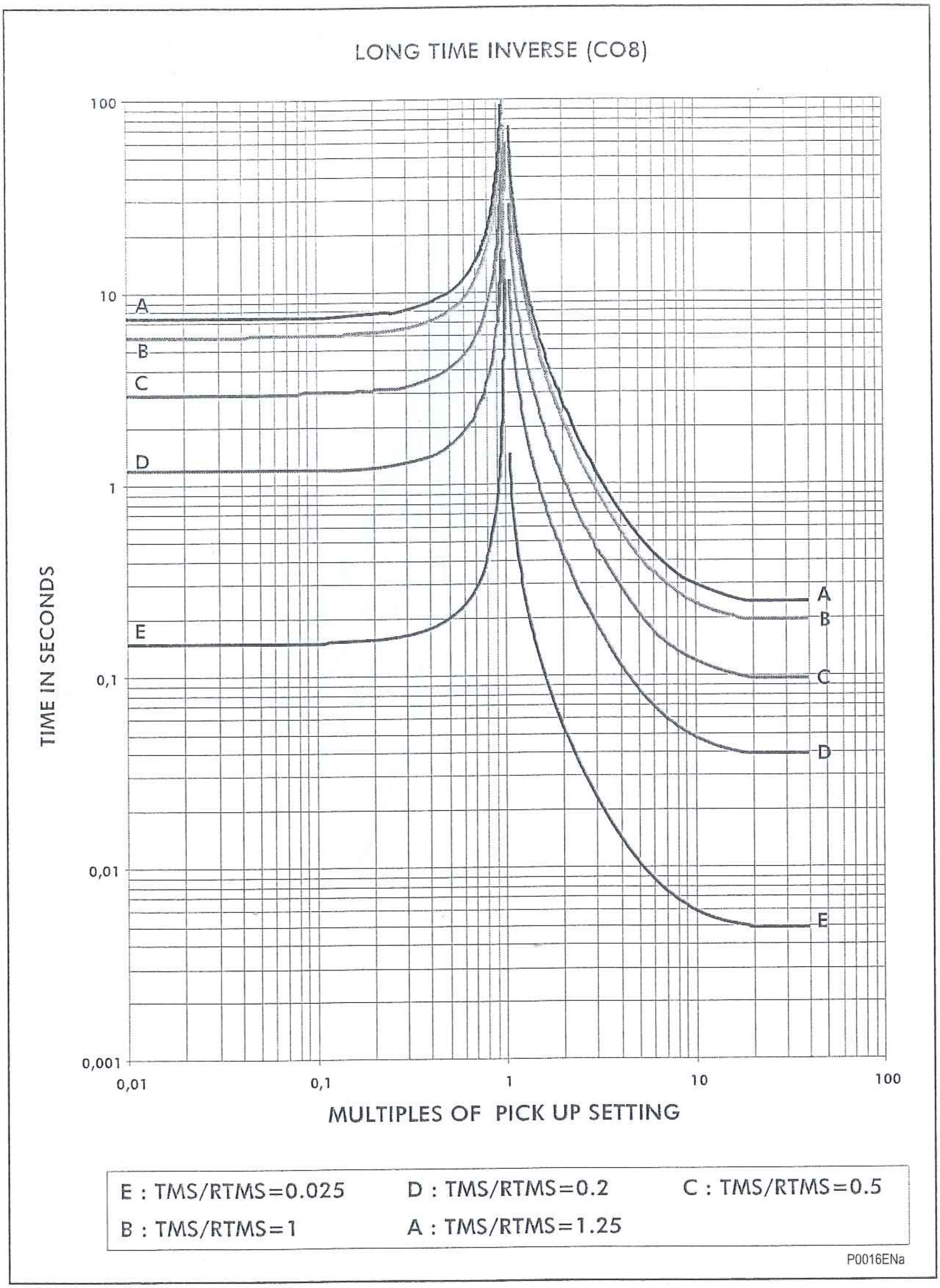


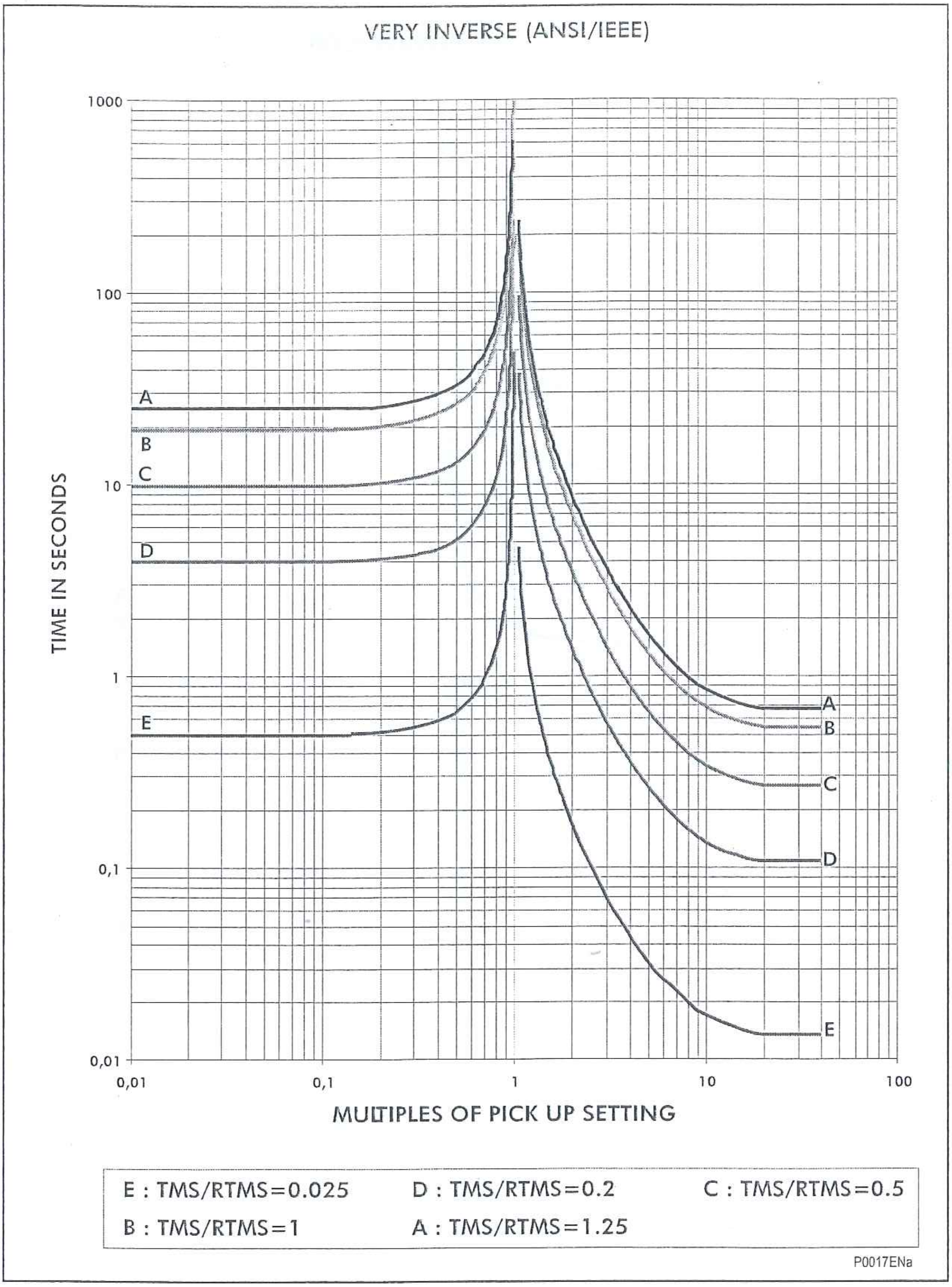
12.5 IEEE/ANSI & CO Curves

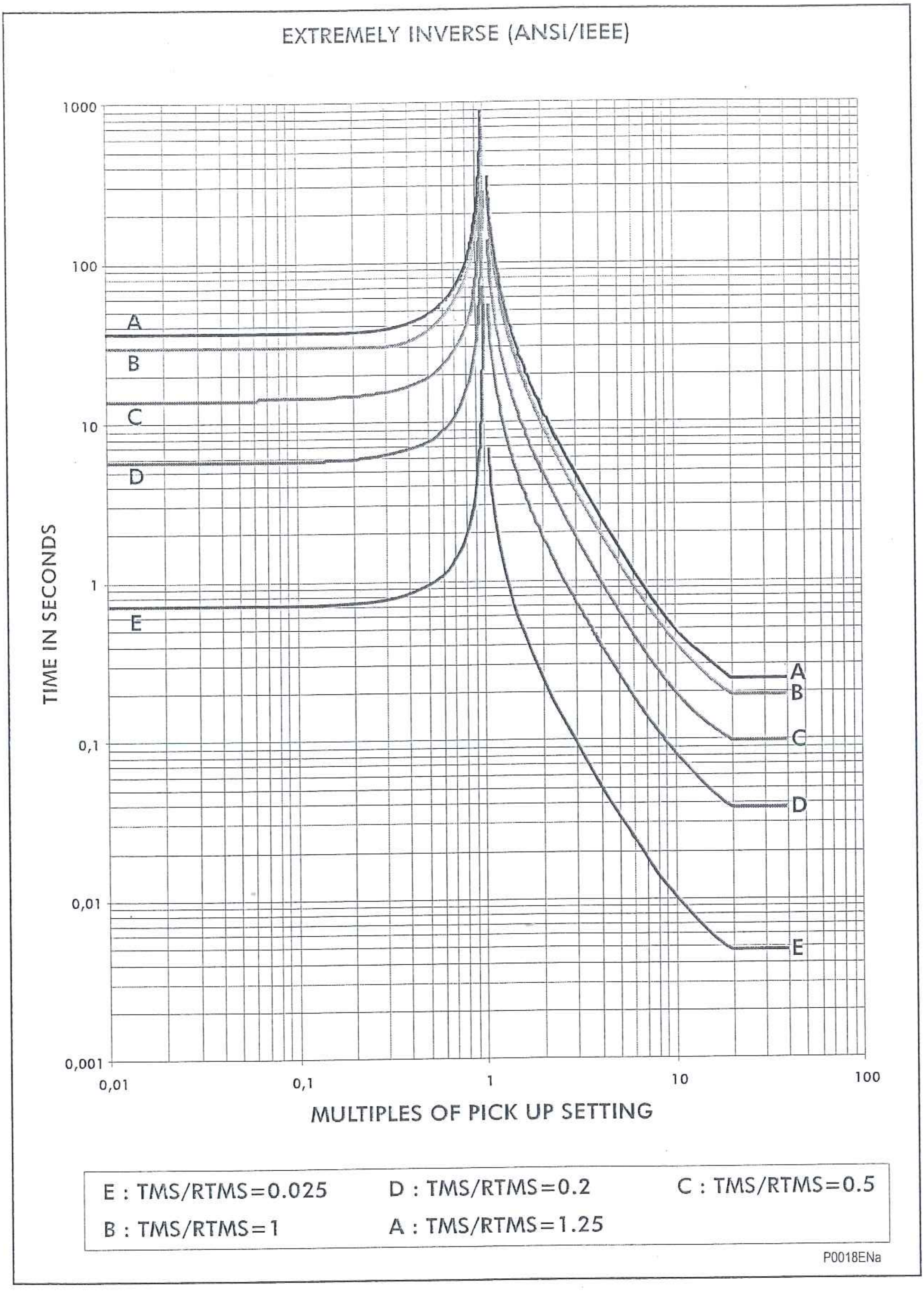



SHORT TIME INVERSE (CO2)
100
10
1
0,1
0,01
0,001
0,0001
TIME IN SECONDS
0,01
0,1
1
10
100
MULTIPLES OF PICK UP SETTING
A
B
C
D
E
B : TMS/RTMS=1
A : TMS/RTMS=1.25
E : TMS/RTMS=0.025
D : TMS/RTMS=0.2
C : TMS/RTMS=0.5
P0014ENa

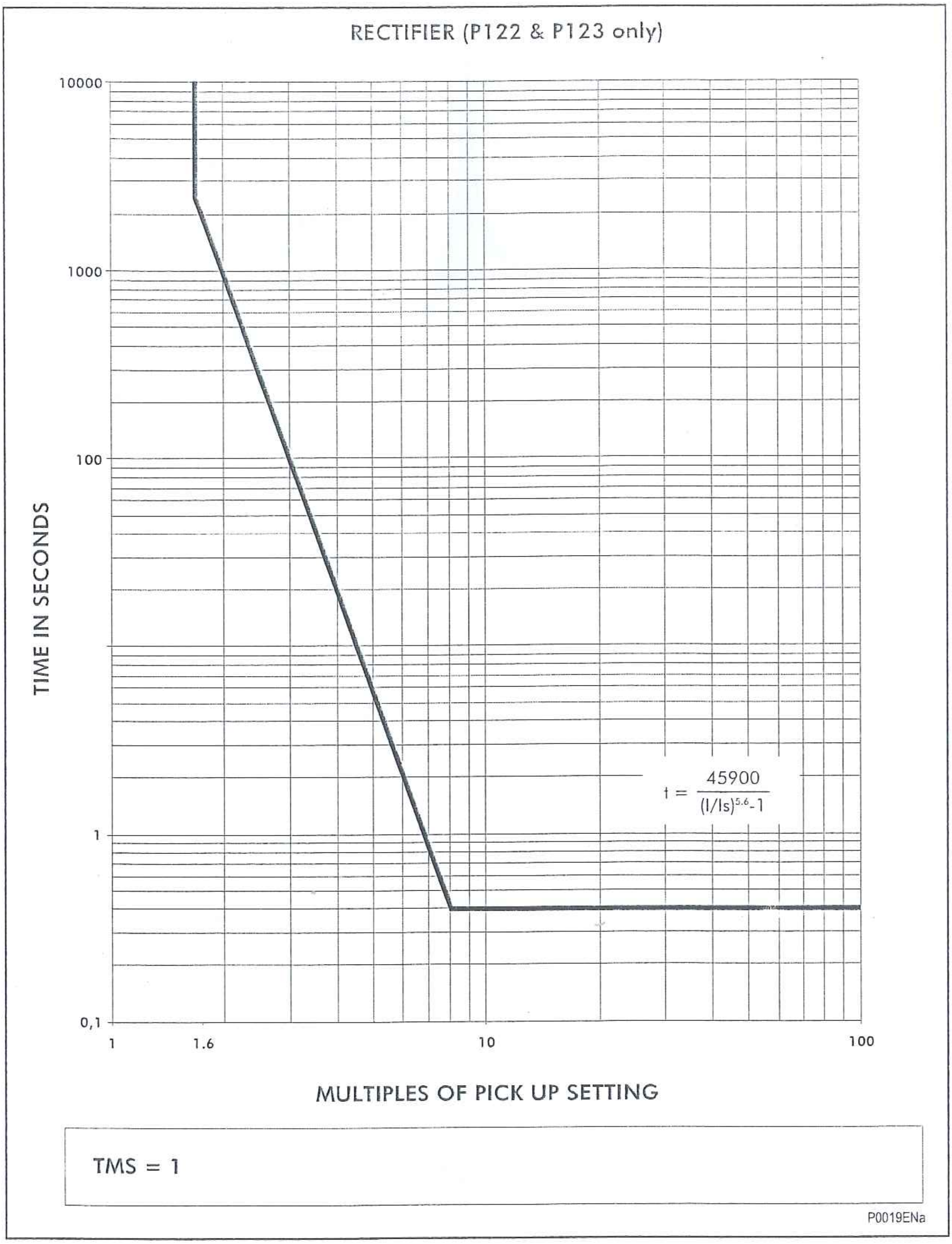

MODERATELY INVERSE (ANSI/IEEE)
1000
100
10
1
0,1
0,01
TIME IN SECONDS
0,01
0,1
1
10
100
MULTIPLES OF PICK UP SETTING
A
B
C
D
E
E : TMS/RTMS=0.025
D : TMS/RTMS=0.2
C : TMS/RTMS=0.5
B : TMS/RTMS=1
A : TMS/RTMS=1.25
P0015ENa


LONG TIME INVERSE (CO8)
100
10
1
0,1
0,01
0,001
TIME IN SECONDS
0,01
0,1
1
10
100
MULTIPLES OF PICK UP SETTING
A
B
C
D
E
E : TMS/RTMS=0.025
D : TMS/RTMS=0.2
C : TMS/RTMS=0.5
B : TMS/RTMS=1
A : TMS/RTMS=1.25
P0016ENa

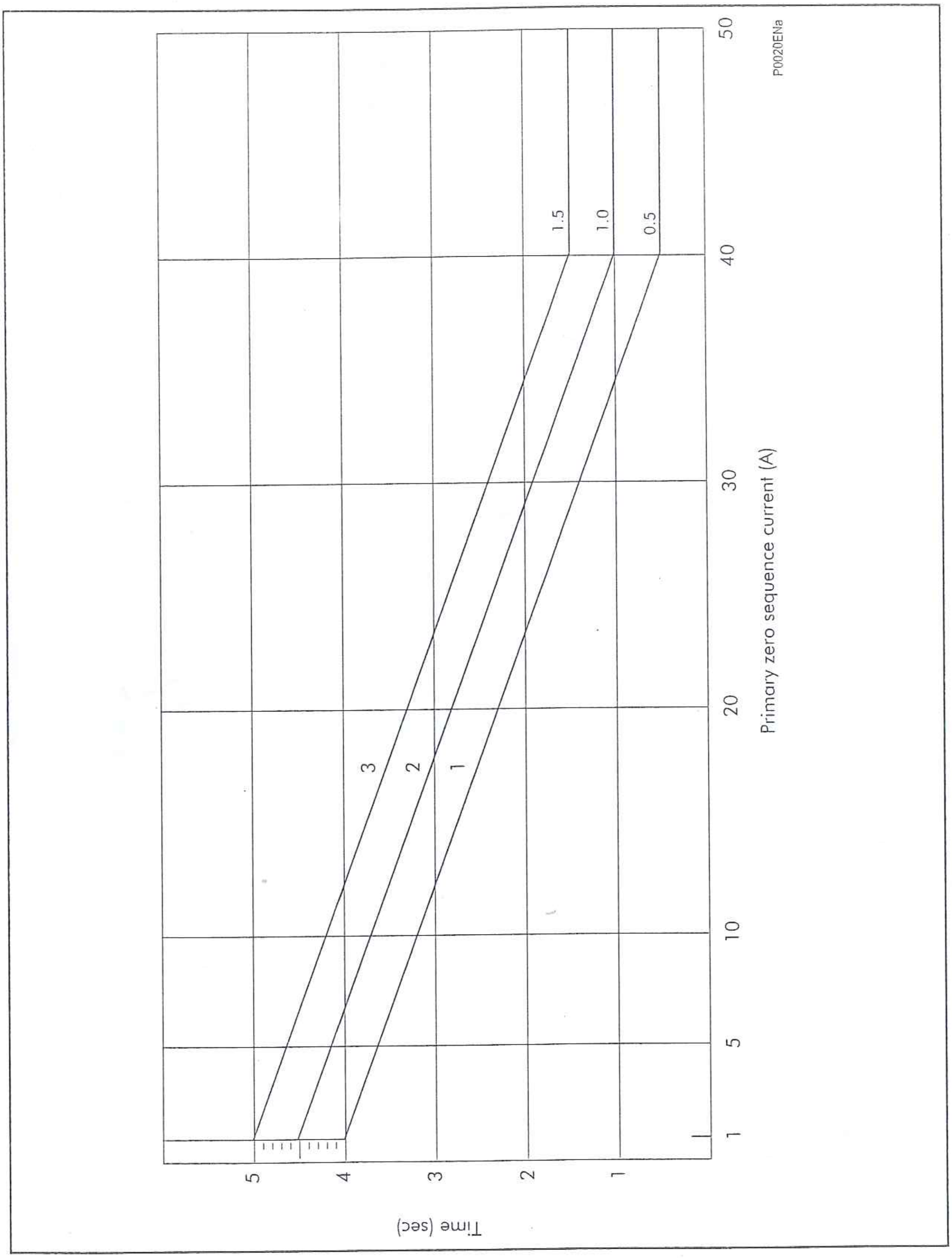

VERY INVERSE (ANSI/IEEE)
1000
100
10
1
0,1
0,01
TIME IN SECONDS
0,01
0,1
1
10
100
MULTIPLES OF PICK UP SETTING
A
B
C
D
E
E : TMS/RTMS=0.025
D : TMS/RTMS=0.2
C : TMS/RTMS=0.5
B : TMS/RTMS=1
A : TMS/RTMS=1.25
P0017ENa


EXTREMELY INVERSE (ANSI/IEEE)
1000
100
10
1
0,1
0,01
0,001
TIME IN SECONDS
0,01
0,1
1
10
100
MULTIPLES OF PICK UP SETTING
A
B
C
D
E
E : TMS/RTMS=0.025
D : TMS/RTMS=0.2
C : TMS/RTMS=0.5
B : TMS/RTMS=1
A : TMS/RTMS=1.25
P0018ENa

12.6 Rectifier protection curve



12.7 LABORELEC CURVE



12.8 Thermal overload curves