GENERATION & NETWORK

Multicurve Digital Under and Over Voltage Protection

TMS7000

PROCOM

The optimum operation of an electrical network depends particularly on the reliability and the availability of the protection, measuring and automation devices and the ability shown by these devices to communicate the information in their possession.

PROCOM, CEE's new modular system, satisfies these criteria by providing the possibility of using either separately or in an integrated system all of the intelligent functions of an electrical cubicle: Protection, Measurement, Automation, Communication.

CEE's exceptional experience in the field of network protection using static relays (more than 450,000 units in operation throughout the world) enabled our engineers to define, develop and manufacture PROCOM to the standards of quality and concepts of technical innovation which have been the foundation of CEE's reputation over the past 30 years.

PRINCIPLE AND APPLICATIONS

TMS7000 series relays are designed to monitor the voltage of three phase electrical networks either balanced or unbalanced. With a modular design, it fits perfectly into the PROCOM architecture or can be used separately in any traditional relay scheme.

Using microprocessor technology the TMS7000 samples the applied signals and uses (F.F.T.) Fast Fourier Transform to provide the value of the fundamental voltage as well as its symmetrical components.

The TMS7000 is remarkable firstly because of its wide range of operating frequency (15 Hz- 70 Hz) making it particularly suitable to supervise the voltage of networks whose frequency can vary widely (residual voltage during automatic transfer, overspeed of hydro generator), and secondly due to its insensitivity to 3rd harmonic voltages which allows it to use low earth fault settings (generator protection).

THE TMS ALLOWS

- The detection of **voltage drops (27) (V<, V<<)** single, two or three phase, dangerous to the operation of electrical equipment (in particular that of asynchronous motors as the torque is greatly affected that of synchronous motors as the possibility of a loss of synchronism) is predicted by an inverse time voltage characteristic. This detection is achieved by an element with 1 threshold whose operating characteristic can be selected as definite time, inverse or very inverse and 1 definite time low set threshold.
- The detection of **over voltages (59) (V>, V>>)** single, two or three phase result in the accelerated ageing or break downs of insulation of electrical equipment, more particularly in rotating machines. This detection is achieved by an element with 1 threshold whose operating characteristic can be selected as definite time, inverse or very inverse and 1 definite time high set threshold.
- The detection of **insulation faults (59N) (Vo>, Vo>>)** in electrical networks by monitoring the zero sequence voltage, and the emission of an alarm to alert the operator, when continued operation with a permanent fault is allowed.
- The detection of supply unbalances (47) (Vi>, Vi>>) (incorrect phase sequence, single phasing...) by monitoring of the negative phase sequence voltage, and the emission of an alarm to alert the operator of a permanent voltage unbalance.
- The detection **positive sequence voltage drops (27P) (Vd<)** as an overall three phase voltage supervision or rotating machine torque, in the case of temporary or permanent operation with an unbalanced supply (single phase reclose).
- Provision of **substation control schemes** by initiating load shedding or bus transfer, by monitoring the decay of the residual magnetic field at the terminals of motors before reclose, or inhibiting the closure of an element if the voltage of the unit to be supplied is not within defined limits

THE TMS7000 COMPRISES:

- The TMS7003, used when only the phase to phase voltages are available and are used as the measurement quantities in the relay (e.g. 2 VTs connected in V). The monitoring of the zero sequence voltage needs a dedicated winding, connected in open delta. This relay suits systems where the VT neutrals not distributed.
- The TMS7004, used when the phase voltages are available (neutral point distributed). The measurement quantity used in the relay can be selected by the user as either the phase or the phase to phase voltages. In the same manner, the monitoring method for the zero sequence voltage is user selectable, either by internal summation or by using a dedicated winding connected in open delta.

MAIN ADVANTAGES

The TMS7000 relays provide three main sets of advantages as follows:

Reliability and availability

The design and construction of this equipment meet the same standards of reliability and safety used by C.E.E.for the manufacture of conventional static protection devices:

- Compliance with I.E.C. 255 recommendations and standards,
- Mechanical, fool-proof fouling pins on cases and bases,
- Debugging and individual testing of certain critical components,
- Component selection based upon not only thermal withstand but also over voltages considerations,
- Withstand to severe environmental conditions: heat/humidity, 56 days, 40°C, 93% relative humidity.

In addition to these basic construction details, the TMS7000 devices incorporate an automatic self-supervision system which, together with the plug-in case facility, optimises their availability.

The automatic self-supervision system intervenes at three different levels:

- Detection of loss of auxiliary supply,
- Detection of a microprocessor failure using a «watchdog»,
- Detection of a breakdown in a microprocessor peripheral (such as RAM, EEPROM) by executing microdiagnostic programs.

The user is notified that the automatic self-supervision system has operated by the closure of a clean contact brought out to terminals and/or, if the case arises, by the interruption of the digital communication channel.

Power and flexibility of the communications

The TMS7000 series communicates with the external world in three major ways:

- **Local communication**

Dialogue between the user and the equipment is ensured by means of a keyboard on the device itself, which may be used to set up and read back all of the quantities, recorded, calculated or measured by the TMS7000.

An easy to read LED display unit enables the user to have direct readout of the electrical quantities in true primary values.

The phase or the symmetrical component (positive, negative, zero) having caused the alarm or trip condition is indicated on the flashing display.

- **Communication by digital channels**

The TMS7000 contains RS-232-C / DB9 and current loop (0 - 20 mA) digital serial communication channels selected by a switch by the user.

The RS-232-C / DB25 on the face plate enables the relay to be directly connected (copper wire or fibre optic) to a PC. The (0 - 20 mA) current loop plugs enable the relays to be connected into a network controlled by a PC or other equipment*. All data available locally, measurements, alarms or settings, may be transmitted to a remote location. When an event occurs such as the relay tripping or when requested via the communications or when the dedicated key is pressed, the RMS values of the phase and earth fault voltages, calculated during the approximate period 3.5 seconds prior to the event and 1 second after it, are made available to the centralised system.

*Consult us.

- **Communication by "all or nothing" channels**

The TMS7000 relays are fitted with electromagnetic output units to provide self-supervision, alarm, close or load shedding signals:

- self-supervision: by clean contact of the "watchdog" device (unit W).
- alarm: via the instantaneous operation of C indicating the passage of a setpoint.
- trip or load shed: two high closing current capacity relays

"A" and "B" for controlling power equipment, contactors or circuit breakers.

The configuration of each of these relays A, B or C is completely under the control of the user.

Adaptability and autonomy

As they are mounted in modular, plug-in, metallic type R cases, devices in the TMS7000 series may be used either:

- as independent modules.
- as modules integrated into a rack incorporating conventional static relays from the 7000 series.
- as modules integrated into a rack as an element of the PROCOM system.

The flexible presentation means that the TMS7000 devices may be easily adapted to the user's actual technical and economic requirements and can, for example, be inserted into existing schemes and installations.

The TMS7000's autonomous and flexible nature is further reinforced by the fact that it can, without the use of special devices, be connected to a source of ac or dc auxiliary supply having a very wide operating range (38 to 250 V, or 20 to 66 V).

GENERAL CHARACTERISTICS

1. Input and output quantities		
Voltage		
- voltage rated: TMS7003: Un (phase to phase voltage) TMS7004: Vn (phase voltage)		100 - 110 - 120 V 100/√3 - 110/√3 - 120/√3 - 400/√3 V
- residual voltage (3 Von)		100 - 110- 100√3 - 110√3 V
- operating range		0.04 to 2.4 Un or Vn
- continuous withstand		1.9 Un or Vn
- short time thermal withstand (10 seconds)		2 Un or Vn
Frequency		
- rated frequency		Fn = 50 Hz or 60 Hz
Auxiliary voltage		20 - 66 Vdc or Vac - 50 / 60Hz 38 - 250 Vdc or Vac - 50 / 60 Hz
Burden		< 10 W dc < 13 VA ac
Output contacts		
- A relay and B relay		1 NO and 1 changeover or 1 NF and 1 changeover
- C relay		1 changeover
- W relay («watchdog relay»)		1 NF
- maximum voltage	(C) (A, B and W)	250 V 600 V
- maximum continuous current	(C) (A, B and W)	2.5 A 5 A
- making capacity 0.2 s	(C) (A, B and W)	5 A 10 A
- breaking capacity		
· dc (L/R= 40 ms)	(C) (A, B and W)	25 W (0.5 A / 48 Vdc - 0.25 A / 110 Vdc) 50 W (1 A / 48 Vdc - 0.5 A / 110 Vdc)
· ac (COS(φ) = 0.4)	(C) (A, B and W)	625 VA ; I < 1.5A 1 250 VA ; I < 3 A
- «watchdog» operation		normally picked up drops off for abnormal conditions
Display and indications		8 digits / LED display, showing setting, configuration and fault details.
2. Nominal ranges of influencing factors		
· Temperature		-10°C +55°C
· Frequency		15 Hz - 70 Hz

3. Measurements	
Characteristic quantity	phase to phase voltage: TMS7003 phase voltage or phase to phase voltage: TMS004
Operating value	
· independent time	100 % of setting
· dependant time (maximum function >)	110 % of setting
· dependant time (minimum function <)	90 % of setting
Voltage settings	Un or Vn
· phase setting minimum: V<<	0.15 to 1.2
V<	0.2 to 1.2
· phase setting maximum: V>	0.7 to 1.5
V>>	0.7 to 1.5
· positive phase sequence setting minimum: Vd<	0.2 to 1.2
· negative phase sequence: alarm setting Vi>	0.03 to 0.3
alarm setting Vi>>	0.03 to 0.3
· zero phase sequence: alarm setting Vo>	0.03 to 0.15 * (3 Von)
alarm setting maximun: Vo>>	0.03 to 0.5 * (3 Von)
· setting step	0.01 Un. Vn or 3 Von
Time delay settings	
· independent time:	0.1 to 99 s
setting step	0.01 s
· dependant time: function minimum V<	0.1 to 3 s (time at V/V< = 0.2)
function maximum V>	0.1 to 3 s (time at V/V> = 2)
setting step	0.05 s
Drop-off:	Un or Vn
· setting maximum and minimum V and Vd	2%
· setting maximum and minimum Vi and Vo	1%
Accuracy class under reference conditions for the influencing factors	
· operating levels	1% Un or Vn*
· time delays	5 % of setting or ± 30 ms 7.5% of setting or ± 30 ms for extremely inverse time
*on the measured values	
Operating logic	
· minimum functions (V<, V<<)	«AND» or «OR» on the 3 phases (selectable)
· maximum functions (V>, V>>)	«OR» on the 3 phases
Voltage display	
· display	All measurement or settings
· default display	Average value of the phase to phase voltages
· rated phase to phase voltage adjustable	100 V to 240 kV
· display resolution	1 V from 100 V to 1 kV 10 V from 1 kV to 10 kV 100 V from 10 kV to 240 kV
· setting resolution	10 V
4. Operating curves	
V<	$\frac{Tx\ (V/V<)^{\alpha}}{1 - (V/V<)^{\alpha}}$ x réglage t (V<)
· independent or dependant time delay	
· inverse	T = 0.033 α= 0.02
· very inverse	T = 4 α=1
V<<, Vd<	temps minimum time defined at: 0.2 V<
· independent time delay	
V>	$\frac{T}{(V/V<)^{\alpha} - 1}$ x réglage t (V>)
· independent or dependant time delay	
· extremely inverse	T = 3 α =2
V_0>, V_i>, V>>, V_0>>, V_i>>	minimum time defined at: 2 V>
· independent time delay	

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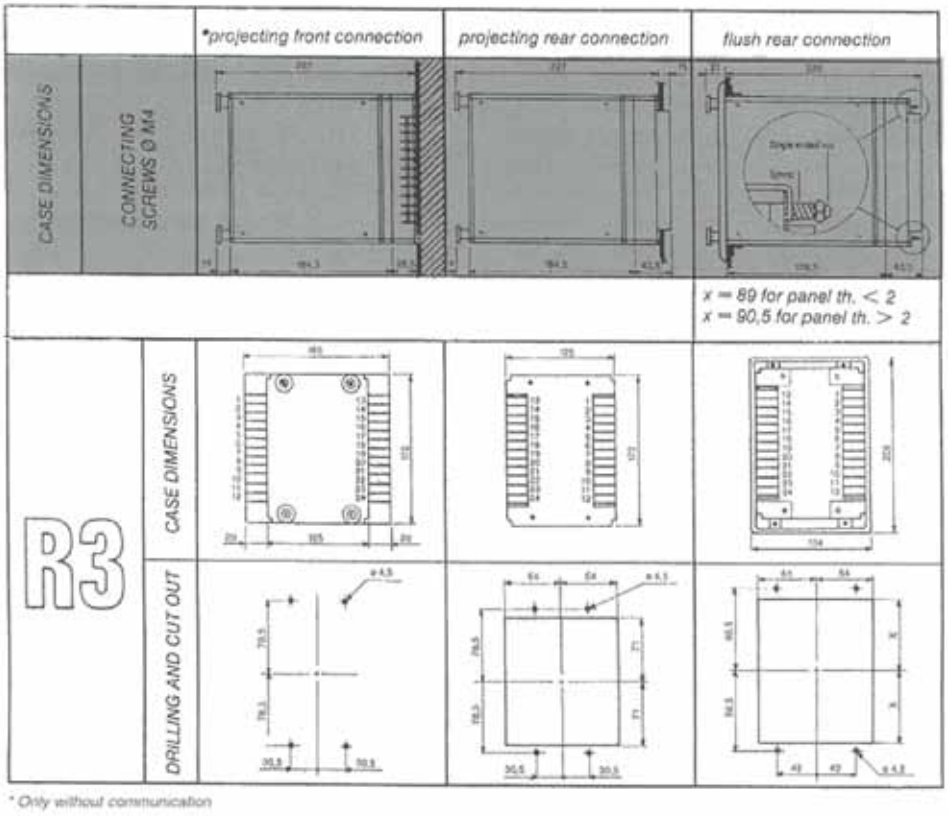
5. Digital communication	
Types	2 switchblade channels with dedicated sockets: · current loop / 0 - 20 mA · DB25 / RS232C
Protocol	Master / Slave to JBus or other standard* (*) Consult us
Transmission rate	1 200 - 2 400 - 4 800 bauds
6. Isulation to IEC 255-5	
· Dielectric withstand	
- all terminals together/ frame and between galvanically isolated groups	2 kV - 50 / 60 Hz 1 min (except current loop 1 kV / 1 min)
- DB25 socket	500 V - 50 / 60 Hz 1 min
- insulation resistance at 500 V	> 10 000 MΩ
- impulse voltage withstand (except DB25 socket)	5 kV - 1.2/50 µS
7. high frequencydisturbance withstand (to IEC 255-22-1) except DB25/RS232C socket	
- In common mode	2.5 kV - 1 MHz- Class III
- Differential mode	1 kV - 1 MHz - Class III
8. Case	R3
9. Weight	4 kg
10. Identifying drawings	TMS7003: 20 A1 TMS7004: 20 A2



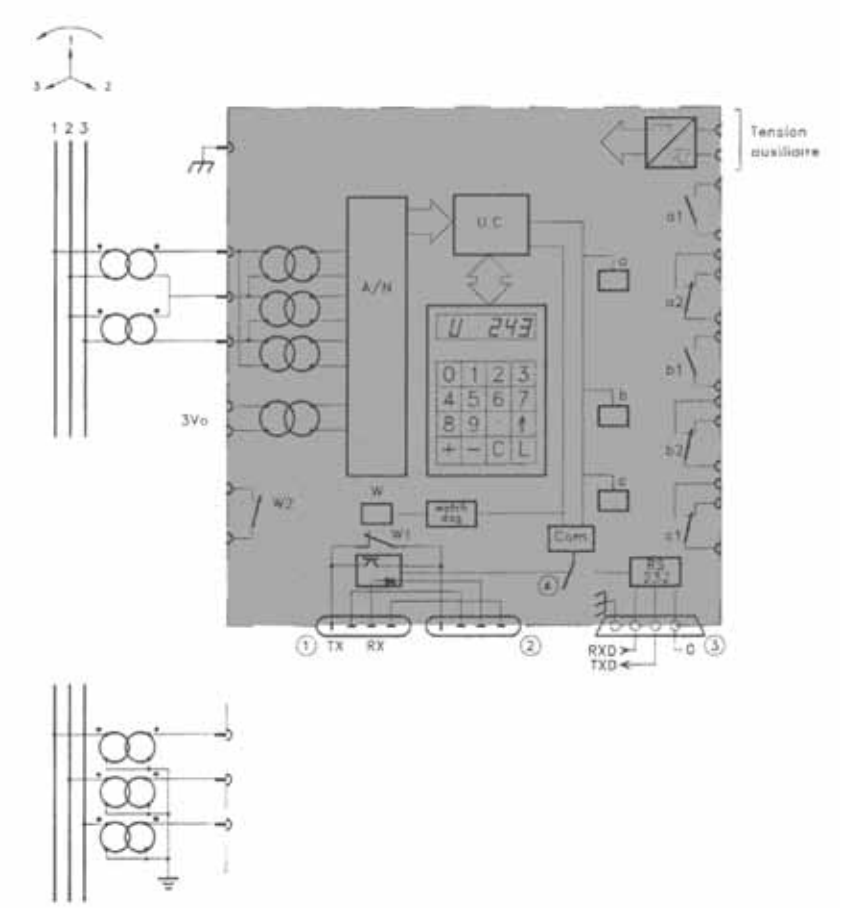


Fig. 4 - TMS7003 - Simplified operation and connection diagram

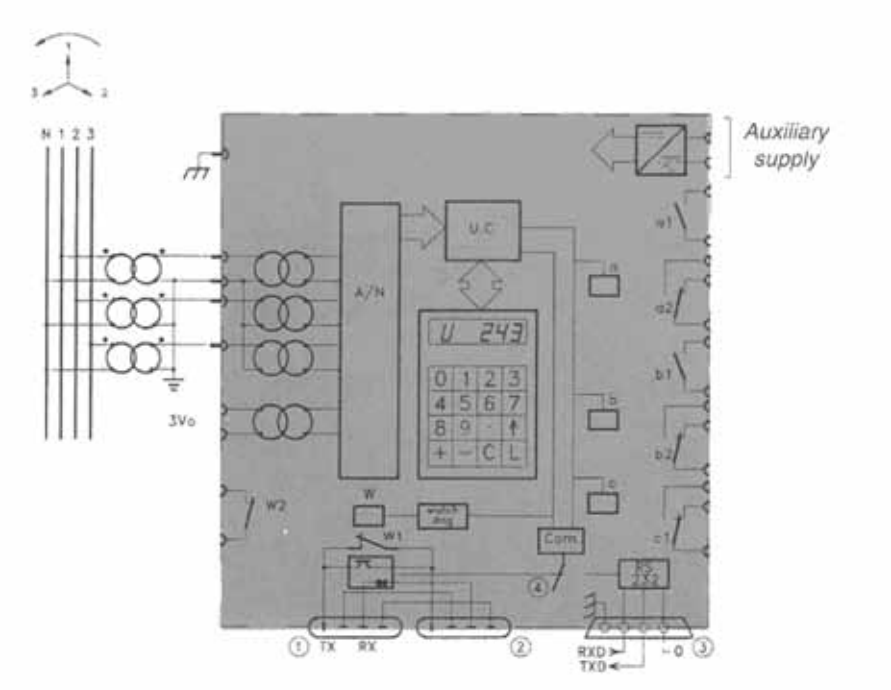
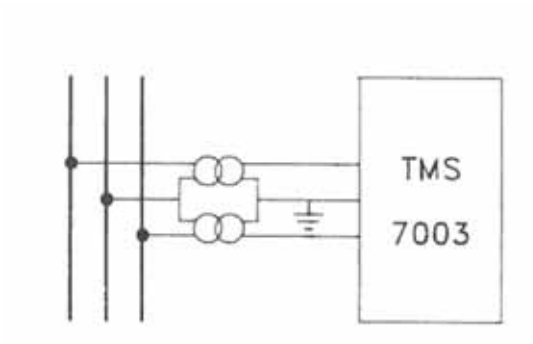
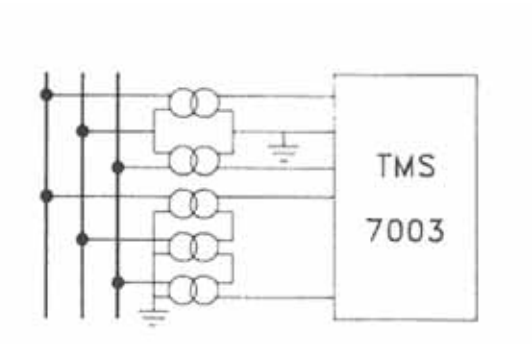


Fig. 5 - TMS7004 - Simplified operation and connection diagram

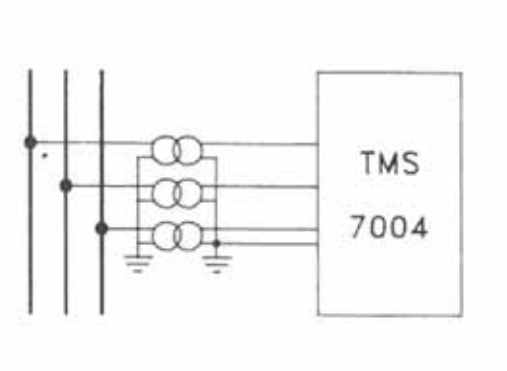
SOME APPLICATION DIAGRAMS



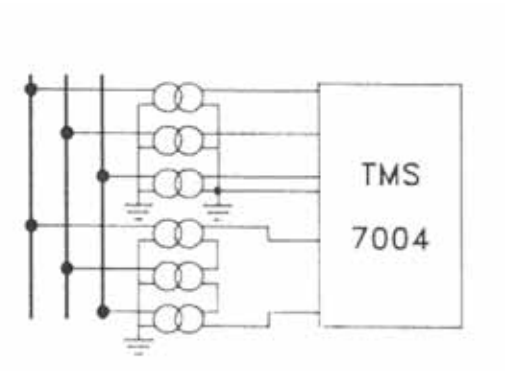
Measurement of 3 phase-to-phase voltages (U)



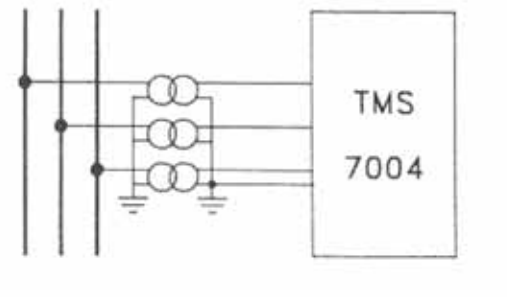
Measurement of 3 phase-to-phase voltages (U) + zero sequence voltage (Vo) supplied from par 3 VTs in a delta connection



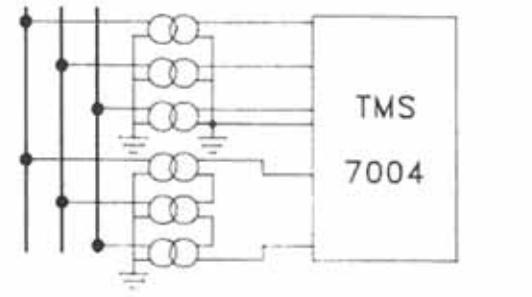
Measurement of 3 phase-to-neutral (V) + Zero sequence voltage (Vo) developed internally



Measurement of 3 phase-to-neutral voltages (V) + zero sequence voltage (Vo) supplied from 3 VTs in a delta connection



Measurement of 3 phase-to-phase voltages (U) + Zero sequence voltage (Vo) developed internally



Measurement of 3 phase-to-phase voltages (U) + Zero sequence voltage (Vo) supplied from 3 VTs in a delta connection

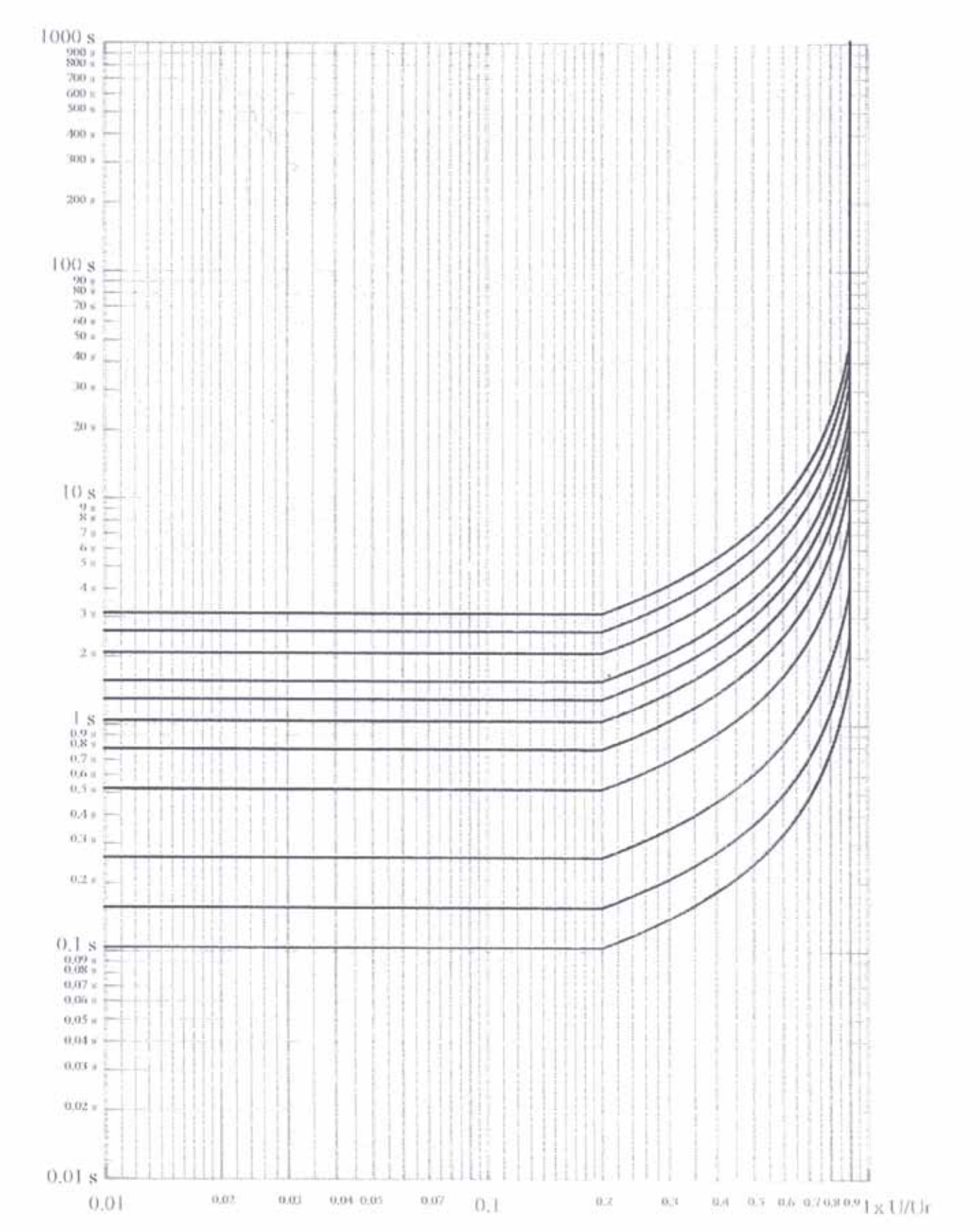


Fig.1 - Under voltage: Inverse curve

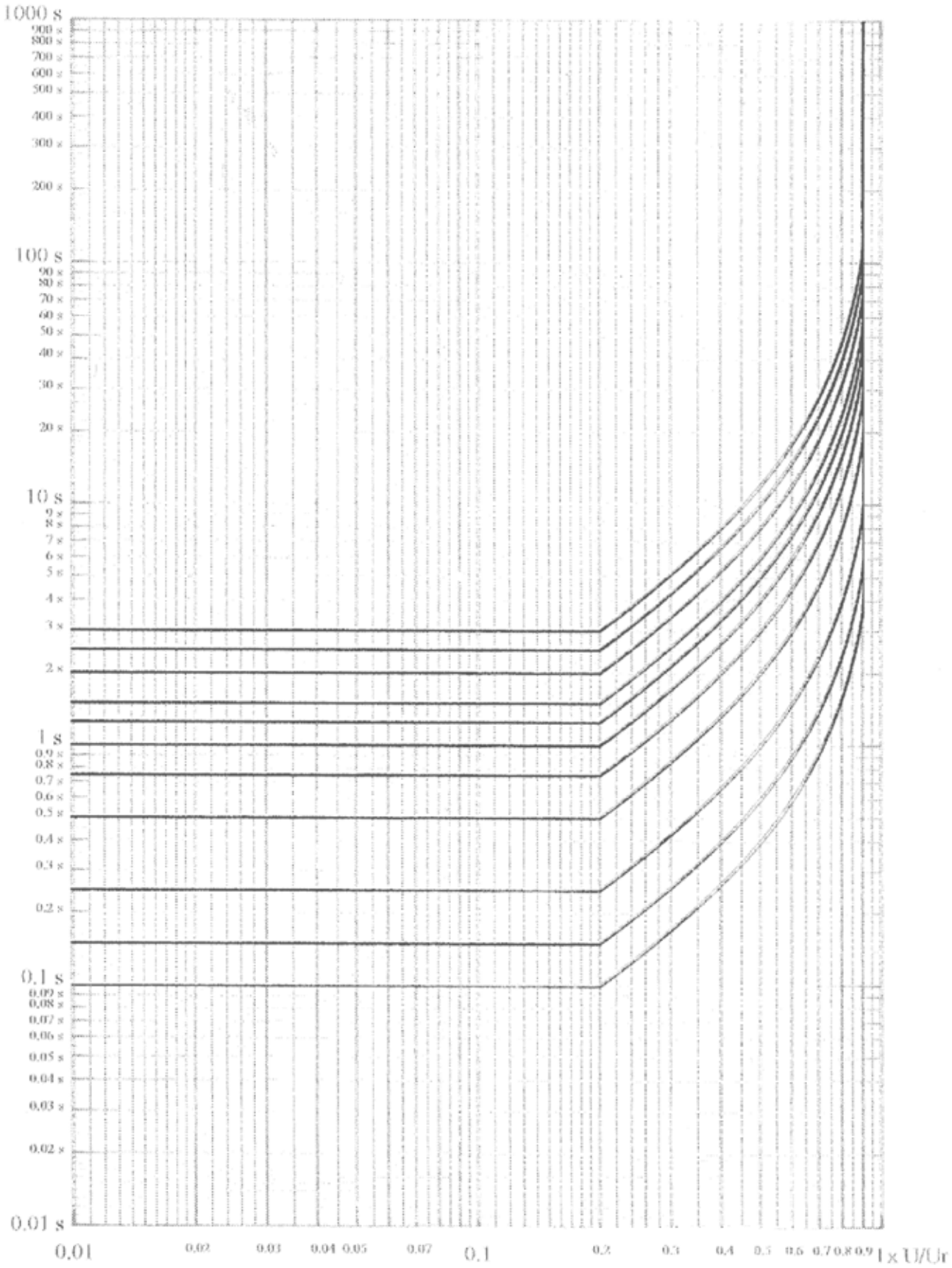


Fig. 2 -Under voltage: Very Inverse curve

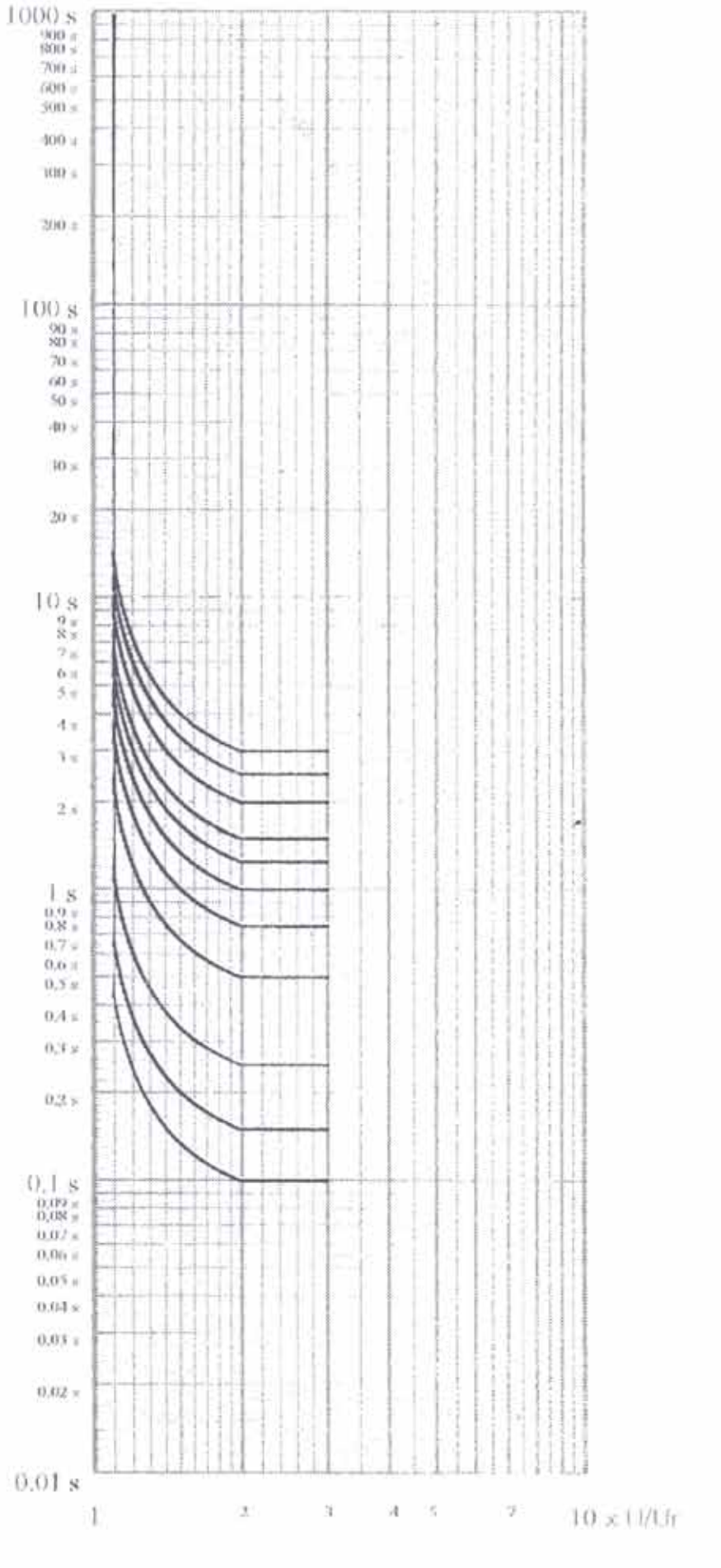


Fig. 3 - Over voltage: Extremely inverse curve

STYLE NUMBER IDENTIFICATION

TMS 7003 – A – B – C – D – E – F

Frequency	50 Hz 60 Hz	a b
Rated Voltage	100 V 110 V 120 V	a b c
Residual Voltage	100 V 110 V 100 $\sqrt{3}$ V 110 $\sqrt{3}$ V	a b c d
Auxiliary supply dc/ac	20.....66 V 38.....250 V	a b
Contacts	relay A : 1 NO - relay B : 1NO relay A : 1 NO - relay B : 1NC	a b
Case R3	projecting rear connection flush rear connection	a b

TMS 7004 – A – B – C – D – E – F

Frequency	50 Hz 60 Hz	a b
Rated Voltage	100 V/$\sqrt{3}$ 110 V/$\sqrt{3}$ 120 V/$\sqrt{3}$ 400 V/$\sqrt{3}$	a b c d
Residual Voltage	100 V 110 V 100 $\sqrt{3}$ V 110 $\sqrt{3}$ V	a b c d
Auxiliary supply dc/ac	20.....66 V 38.....250 V	a b
Contacts	relay A : 1 NO - relay B : 1NO relay A : 1 NO - relay B : 1NC	a b
Case R3	projecting rear connection flush rear connection	a b

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